

Coastal Recreation Resources in an Urbanizing Environment

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COASTAL ZONE
INFORMATION CENTER

A Symposium on

COASTAL RECREATION RESOURCES IN AN URBANIZING ENVIRONMENT

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Foreword

A broad array of coastal resources and their attendant values are the focus of a growing local, state, and national interest in preserving the nation's coasts. Many of these resources and values are unique and fragile. But they are subject to ever increasing pressures for use and modification. However, once coastal resources are altered or destroyed, the loss is generally irreparable for coastal communities and the people who benefit from the resources.

This monograph emphasizes coastal resource values and examines the public and private roles, including special interest groups, in coastal recreation management; utilization of living resources—finfish, shellfish and wildlife; and utilization of physical resources—tidal water, wetlands and shorelines.

The papers included in this monograph examine these resource descriptions, with regard to defining uses and values, problems of descriptions, and identifying conflicts, management and research needs.

These papers were originally presented and discussed at a Symposium on Coastal Recreation Resources in an Urbanizing Environment held in Hyannis, Massachusetts in April, 1976. The authors are nationally recognized authorities who discuss information of value to resource professionals, business interests, planners, conservationists and others concerned with a wide range of coastal recreation resources as they relate to people.

John H. Noyes
Ervin H. Zube

Public and Private Roles in Coastal Recreation Management



Cape Cod National Seashore

The Federal Role in Coastal Recreation Management

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Introduction

This morning I would like to discuss three aspects of the coastal recreational problem:

- 1) The nature of the problem as I see it;
- 2) The role of government, with emphasis on the Federal role; and
- 3) Several emerging new factors that will bear watching.

The Problem

In my view, the problem can be stated quite simply—"we have an ever increasing number of people wanting to use and enjoy a fragile and often dwindling natural resource—our coastlines. Let's look at the problem in more detail.

The population of U.S. coastal counties is, in general, increasing much more rapidly than inland counties. Already two-thirds of our population live within a day's drive of shorelines and this proportion is increasing. People prefer to live on or near the coast for a number of reasons, but probably most importantly because of the area's recreation potential. It is hard to believe, but one set of statistics indicates that the time spent in recreation along our Great Lakes and ocean shorelines has risen to 10-days per capita per year. With a trend towards more leisure time, we can expect even greater pressures on our coastal recreational resources.

Unfortunately, when we go to the beach nowadays we do not go unfettered. And the simple act of getting to the beach is often now a problem. Automobile congestion on highways leading to Cape Cod or mid-Atlantic beaches on mid-summer weekends is unbelievable. At the end of this frequently tortuous drive, there must be parking lots, filling stations and other accessories to accommodate the needs of the automobile. But cars are not the only problem. Dune buggies, off-road vehicles, motorcycles, boat trailers, and campers now compete for space and attention on and off the beach. A host of new support facilities, such as equipment to pump campers, are now needed. And who knows, next

year it could be necessary to have service facilities for recreational submarines!

Although about 130,000,000 Americans live within 100 miles of the shoreline, only about two percent of our coasts are in publicly owned recreational areas. Most of the shoreline of the United States is not available for public recreational purposes either because it is privately held, or is unsuitable or inaccessible. In fact, the amount of shoreline potentially available for public recreational purposes is being steadily reduced. Considerable portions of shoreline are being walled off by private development. Insensitive industrial and commercial development often creates an environment making beaches unsuitable for recreational pursuits, and, finally, the high price of coastal real estate often puts the acquisition of otherwise suitable area beyond the reach of the public and their governments.

The Nature of Coastal Recreation

One of the key elements in the coastal experience is, of course, the water itself. In addition to the ordinary ways water is used for recreation (swimming, boating, scuba diving, etc.) man has always had a fascination for the water's edge and the sea itself. It arouses curiosity and images of distant lands. The unbroken horizon with its infinite sweep, provides rest and relaxation. It is both alluring and enduring and many find the water's edge a spiritually moving place.

Given the attractiveness and desirability of our shorelines, how can we make beaches available to more people and maintain the positive attributes of the shoreline?

There really are two ways to approach this problem, but we usually consider only one. We can either bring people to the shore or attempt to bring the shore to the people. While many of our most urgent problems involve the first situation, that is, bringing more people to the shore, in my mind, the possibility of bringing the shore to more people holds considerable promise.

First, a quick review of some of the problems caused in attempting to bring more people to the shore. First, as I mentioned earlier, are all the problems associated with increasing automobile congestion. These include satisfying the growing needs for additional parking facilities, gas stations; minimizing pollution and noise; and generally catering to the scale of the automobile rather than the human. The environmental degradation caused by highway construction and expansion, of course, is also a factor. Clearly, improved public transportation to beaches is an answer in certain areas. Additional coastal recreational areas must be opened up and improved public access obtained.

But what are the possibilities of bringing the shore to more people? The New England Aquarium in Boston is a good example of what can be done, as are the "marinelands" in various parts of the country. But it seems to me that much more could be done, especially in our large inner cities. Re-opening urban waterfronts to public use and enjoyment must be given much higher priority. Steps in this direction are being taken along the Boston and San Francisco waterfronts. The Gateway National Park projects in the New York and San Francisco metropolitan areas also represent an innovative new approach. As you consider coastal recreation needs, I would encourage you to explore this "reverse" dimension.

Role of Government

It is generally acknowledged that the government plays a major role in providing outdoor recreation. While some private sector activities exist, given the large amounts of money needed and the scale of the activity involved, there appears to be a general acceptance of the government's role in supporting public beaches.

There are three aspects of the federal government's involvement:

- 1) to fund and operate large, nationally important sites;
- 2) to operate programs that encourage and assist states and local governments in their recreational programs; and
- 3) to encourage and assist states and local governments in the planning and management of their coastal areas, including providing assurance that other federal programs will not frustrate state and local government plans for public beaches.

Perhaps a few examples of government involvement are necessary, but please don't hold me to these statistics.

The Department of the Interior's National Park Service operates about 10 national seashores and four national lake shores. The first national seashore was Cape Hatteras, established in 1937. Now about 450 miles of the United States shoreline are included in this system, the newest of which are the Gateway and Golden Gate Parks.

As you know, the Bureau of Outdoor Recreation of the Department of the Interior operates the Land and Water Conservation Fund through which several hundred million dollars a year are made available to state and local governments

to assist in acquiring additional park land and open space. The outdoor recreation plans which are developed as a part of this program are also important in the overall coastal recreational context.

The U.S. Fish and Wildlife Service operates its refuge system which contains more than 32 million acres and receives 20 million recreational visits annually. Recreational sites administered by the Corps of Engineers, surprisingly, see over 300 million recreation-days of use per year. Of course, there is a myriad of other federal programs that contribute, in one way or another, to the coastal recreational picture, but there isn't time to go into detail here.

Role of Coastal Zone Management

The concept of coastal zone management came into being in the late 60's as the result of a nationally important report authored by a federal commission (the Straten Commission). This Commission recommended to Congress that legislation be enacted to encourage and provide support for increased planning and management of the nation's coastal areas. The report emphasized the value of the nation's shorelines and the growing loss of beaches because of poorly planned development.

The federal legislation, the Coastal Zone Management Act, was passed in October of 1972 after several years of study in the Congress. It authorized the creation of a federal program which would provide financial grants to coastal states for the planning and the administration of coastal management programs for their shorelines. My office, the Office of Coastal Zone Management, was created in the National Oceanic and Atmospheric Administration of the Department of Commerce to direct the program.

Coastal zone management can be thought of as having three parts. The first part is to obtain an understanding of the functioning of the coastal ecosystem. Obtaining inventories of the resources present along the shoreline and in the coastal waters is an important part of this effort.

Second, based on this understanding, state policies are adopted with regard to both the conservation of valuable natural coastal areas and the encouragement of necessary water-dependent coastal development. The third element involves adoption of implementing devices to insure that the coastal policies are carried out. This could include state laws, permit systems, and the like.

All 30 coastal states are currently receiving grants from my office to develop coastal management programs. Most are completing the second year of what will likely be a three or four year process. Several states, notably Washington, Oregon, and California, expect to be completing their programs within a few months and submitting them for federal approval. After the Secretary of Commerce certifies that the plans meet the federal requirements contained in the Act, my office is in a position to help fund the administration of these programs.

All of the coastal states are including marine recreation as an important element of their coastal planning efforts.

As a case in point, the California coastal plan has a number of important coastal recreational policies contained within it. I urge you to examine this plan in more detail if you are interested in the way the recreational dimension will be included in state coastal programs.

Some Emerging New Factors

Before closing, I would like to mention two emerging factors that could affect the long-term coastal recreational picture. The first involves new legislation, about to be passed by Congress, which will considerably modify the Coastal Zone Management Act. The second factor pertains to the existing marine sanctuary program also administered by my office.

The legislation currently pending in Congress (which subsequently was signed into law by President Ford on July 27, 1976), will greatly strengthen the basic Coastal Zone Management Act as well as provide for a new program of federal assistance to states and communities about to be impacted by coastal energy activities. The legislation will be important to coastal recreation because it requires states to specifically include a planning process for improved public access to public coastlines and, in addition, authorizes the creation of a new financial assistance program to assist in land acquisition which will improve public access.

The new Coastal Energy Impact Program will include funds to prevent, reduce, or ameliorate recreational and environmental losses suffered in connection with coastal energy activity.

The marine sanctuaries program came into being under Title 3 of the Marine Protection, Research and Sanctuaries Act of 1972, commonly known as the Ocean Dumping Act. This provision allows the federal government to designate areas of the ocean from the high tide mark out to the edge

of the continental shelf for research, protection, and recreational purposes. The first national marine sanctuary, designated last year, is at the site of the sinking of the U.S.S. *Monitor* off Cape Hatteras, North Carolina. A second marine sanctuary was designated in federal waters adjacent to John Pennecamp Coral Reef State Park in the Florida Keys. This device can be thought of as the water counterpart of the National Park System and could be very important in protecting unique marine recreational resources. We intend to give this program substantially more visibility and attention in the future.

Summary

In conclusion, I hope my remarks have given you some additional perspectives on the coastal recreation problem. Certainly, the federal government has an important role to play but so do state and local governments, especially in the area of coastal zone planning and management. What is really called for, therefore, is a "partnership at the shoreline."

I close with a quote from a book entitled "*The Challenge of Leisure*" by Arthur N. Pack.

"Deprive man of intimate relationship with the soil or some equivalent, and his bodily powers, as well as his spiritual and mental fiber, weaken and decay. Surrounded by steel, concrete, asphalt and glass, and doing the same meaningless, repetitive job day after day, with no feeling of creating something in its entirety, the worker becomes ill-adjusted, unhappy, and unstable.

A relationship with nature because it envisages the changing seasons and nature's moods of friendliness, of beauty and creation, it feeds the very soul of Man and raises up his eyes to the infinite possibilities of wider horizons until he is no longer a cog of man-created machines but a living power at one with creation."

Coastal Recreation in Massachusetts

Matthew B. Connolly, Jr., Director
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Introduction

Americans are participating in outdoor recreation more than ever before. The United States Bureau of Outdoor Recreation found that increases in leisure activities, particularly water-related recreation, far outstrips population increases. For example, from 1960-65, demand for fishing increased by 12 percent, swimming by 18 percent, and boating by 15 percent, while population grew by only 8 percent. Projections for the 1960-1980 period indicate that swimming will increase by 72 percent while the population is likely to increase by only 29 percent.¹

In Massachusetts, the State Comprehensive Outdoor Recreation Plan estimates that the demand for swimming is highest of all recreation demands and is likely to exceed by four times all other needs for recreation in the next 25 years.² Because of a simultaneous dwindling of undeveloped coastal resources, meeting recreation demands is more difficult in coastal areas than in any other Massachusetts region. The New England River Basins' *SENE Study* estimates that approximately 130,000 additional acres are needed in coastal counties to meet all future recreation demands.³ But the amount of coastal town acreage developed for non-recreation uses has increased by up to 500 percent over the last twenty-five years.⁴ Some coastal towns, previously considered rural, currently have little undeveloped coastal land remaining.⁵ Urban areas, chronically deficient in coastal recreational facilities, have few small and inexpensive coastal sites left. Thus, options for redistributing recreation opportunities are limited.

The high cost of land is another facet of the recreation dilemma. Traditionally, beaches have been purchased by the public sector since private enterprise cannot make a reasonable profit on beach recreation given the limited season, the high acquisition and operating costs necessary, and low revenues. Recently, as the price of coastal land has continued to escalate, other recreation ventures have begun to founder.

Although marinas, boatyards, boat and motor sales have enjoyed high profits compared to other marine industries during the past few years,⁶ marina owners say that they are having greater difficulties establishing and expanding their businesses. They cite lack of, or cost of, waterfront land as a primary cause.⁷

The immediacy of the recreation dilemma is critical. Solutions must be found within the next decade or most remaining opportunities will be lost. Coastal recreation benefits cannot be narrowly construed: public land acquisition in the coastal zone can complement and help implement other Coastal Zone Management policies. Acquisition can, under proper management, conserve marine ecosystems and prevent property losses in flood damage areas as well as provide coastal recreational opportunities. Recreation sites and activities are good "gateway enterprises," attracting visitors who spend money on food, lodging, and tourist facilities.⁸ Recreation can also spur development, and impart high values to existing housing stock as well as remaining open lands.⁹

However, the detrimental impacts of recreation should not be overlooked. Recreation activities place high demands on transportation networks and other municipal services. Over-utilization and conflicting uses degrade the quality of the recreation experience as well as the surrounding natural and man-made environs, and the cost of maintenance and operation of the recreation facilities quickly approaches the cost of acquisition.

The Massachusetts shoreline as a whole is deficient in recreation facilities, particularly in eastern Massachusetts (Boston Harbor and the North and South Shores) and on Martha's Vineyard and Nantucket. Eastern Massachusetts needs more opportunities for all recreation activities; southeastern Massachusetts needs more public beaches for swimming; Cape Cod needs more facilities for boating and camping, but provides ample swimming opportunities, particularly on

the National Seashore; and the Islands are deficient in all recreation activities.

Unfortunately, suitable new sites for recreation are not available in all of the regions. Opportunities in eastern Massachusetts are the most limited, particularly for large sites such as state beaches and campgrounds. Acquisition of a few large military sites, however, could alleviate some of the shortages in this region. Buzzards Bay, Cape Cod and the Islands offer a greater number of opportunities for developing large recreation sites. However, these sites are distant from major population centers, and serious transportation problems are caused by excessive numbers of people driving to recreation sites. Additional investment in sites far from population centers can further aggravate congestion and other transportation impacts. Therefore, it is essential that improvements in public transportation be considered the critical first steps in providing or expanding recreation opportunities.

Transportation improvements should foster greater use of underutilized or new recreational sites, should reduce the volume of the current transportation impacts of congestion and noise, and should be compatible with the capacity of recreational sites to accommodate visitors. Appropriate to the scale of these sites, jitneys, boat service, and bicycle and hiking trails should be developed and expanded. Such low intensity transportation can provide access without causing traffic impacts.

Acquisitions must also be sensitive to the scale of potential recreation appropriate on the site, as well as the scale of the surrounding community. For this reason, Coastal Zone Management finds that, generally, acquisition of small dispersed sites is preferable to acquisition of very large sites.

Similarly, small scale improvements at existing sites can mitigate existing impacts, and add to recreational opportunities. Such improvements include expansion, provisions for multiple use, and improved maintenance. This strategy is particularly appropriate to eastern Massachusetts and other urbanized areas where there is little undeveloped land and use of existing facilities is intense.

Coastal Zone Management's primary concern is to increase and enhance public use of the Massachusetts shoreline while improving existing facilities and minimizing future conflicts, over-utilization and environmental impacts. Our plan is to improve transportation and access; to acquire new sites in recreation poor areas; to expand suitable existing sites through small acquisitions or encouraging multiple uses; and to improve maintenance.

Access: Distribution and Transportation

Access to recreation is a function of the distribution of and transportation to recreation sites. When recreation opportunities are available near concentrations of people, the necessity for long trips becomes less acute: e.g., Boston Harbor beaches are within a 15-30 minute transit ride of most metropolitan area residents. However, where the distribution of recreation opportunities is not proportional to the concen-

tration of residents, the need for transportation links is more critical.

In Massachusetts, coastal recreation sites, as well as coastal resources, water quality, and other requisites are not evenly distributed; transportation links, understandably, were not planned to ameliorate the recreation imbalance. The uneven distribution of existing recreation sites and needs is portrayed in Table 1.¹⁰ The table indicates that the eastern Massachusetts region, including the North and South Shore areas and greater Boston Harbor, is most deficient in recreation areas. The State Comprehensive Outdoor Recreation Plan, the Massachusetts Growth Policy and the Coastal Zone Management Public Opinion Survey corroborate this finding.¹¹ Conversely, Cape Cod and southeastern Massachusetts collectively provide the greatest supply of major water related activities. Sixty-five percent of Massachusetts's population is located in eastern Massachusetts, but only 25 percent of the public water-related facilities are located there.

Furthermore, the situation is even more acute than the figures indicate, as eastern Massachusetts residents participate more in outdoor recreation than do citizens of the rest of the state. In order to reach areas where recreation supply is more plentiful, week-end recreationalists have established a "commuting" pattern, based on the auto, which causes severe traffic jams and local congestion. This coastal recreation commuting is serviced primarily by the following routes: I-95 and Route 128 to the North Shore; Route 1 to the near North Shore; Routes 3 and 3A to the South Shore and beyond to Cape Cod and Buzzards Bay; 228 to the near South Shore; Routes 6, 6A and 28 through Cape Cod; and I-95, 6 and 25 through Buzzards Bay and Mount Hope Bay.

Some recent improvements in these major transportation links have been recreation oriented. For example, a proposed extension around Buttermilk Bay to connect with the Bourne Bridge may ease congestion; possible double barrelling of Route 6 from Dennis to Orleans could ease traffic problems on the lower Cape; and widening of I-95 will increase use of North Shore recreation. Improvements like these, while increasing access to a broad area, will intensify impacts at the end of the recreational journey, since coastal towns are by nature geographic dead-ends and bottlenecks.¹²

Some non-auto alternatives complement or partly substitute for private vehicle transportation. The Boston Metropolitan Region is serviced by public transportation. City dwellers can take buses or subways to nearby beaches in Revere, Lynn, South Boston, Dorchester, and Quincy. Recently, the southeast Region of the state has formed a transit authority which provides bus service for New Bedford, Fall River, Dartmouth, North Fairhaven, Mattapoisett and Somerset. Cape Cod has frequent bus service among towns on the Cape and from the Cape to Boston and the South Shore. Also, boat service from Boston to Provincetown offers transportation to recreation, as well as being a unique recreational experience itself.

Improvements like these are a necessary part of improving recreation access, and the state must take the lead in

encouraging their implementation. Transportation must be planned for recreation. Creative alternatives to the automobile can be made more attractive. Prepackaged bus trips, well publicized weekend recreational transportation, increased use of boats to Boston Harbor Islands, to other parts of the Harbor, South and North Shores, and to Cape Cod National Seashore are alternatives which can be instituted now and as recreation sites are acquired or expanded.

Meeting Coastal Recreation Needs: Space and Services

The primary alternative to improving transportation to recreation is to acquire, develop or facilitate recreation development in the most deficient regions. Given unlimited funding, it might be an ideal solution. However, since coastal recreation is dependent upon amenities like clean water, undeveloped sandy beaches, etc., finding the best sites in the needy regions is not always possible. This section identifies the requisites of major water-related activities and interprets from unmet "activity days" (Table 1) the land and water acreage necessary to satisfy needs.

Boating

Recreational boating requires marine facilities and services, ships or moorings in a harbor or similarly protected embayment, or launching ramp access. Ancillary services include Coast Guard and Harbor Master protection and, often, security police protection. Clean water is desirable but by no means necessary. Requirements for minimum water depths and bottom types become more critical as boat sizes increase.

In Massachusetts, approximately 100 recreational harbors hold over 300 marinas whose slips and ramps provide about 20 percent of the total supply of coastal boating activity days; 30 coastal public access ramps provide another 20 percent; while private, town and marina moorings provide 40 percent. Satisfying just the presently unmet coastal boating demand will require doubling these "access" facilities.

This demand could be met by the construction of 1000-1500 additional marinas, similar in size to existing marinas, at a probable private/public investment of \$500 million to 1 billion; or the construction of 150 additional public access ramps, at a probable public investment of \$15 to 25 million;¹⁴ or dredging for mooring space of 2500-5000 acres of harbor bottom, at a probable public cost of \$2 billion;¹⁵ or combinations of the above.

Clearly, the least costly and most timely public means of providing boating opportunities is through the public launching ramp. Also, the ramp provides better access to the water for middle income, trailer boat owners whose numbers are increasing relative to other boat owners.¹⁶ Marinas, which require as much area as ramps both on land and water, are becoming increasingly expensive to develop and operate, and thus, the private sector is unlikely to meet demand.¹⁷ Also, dredging simply to provide mooring space has become prohibitively expensive.

Certainly, the state could encourage combinations of the three alternatives which would serve the different regions in varying degrees of efficiency. For example, many harbor

masters feel that their harbors are under-utilized, particularly in greater Boston and Mount Hope Bay.¹⁸ In these areas, marinas may be needed as facilities which attract people and provide services. Conversely, launching ramps and/or dredging may be the only feasible alternative in critically crowded harbors. Nonetheless, construction of public access ramps is the least expensive and most efficient way of meeting boating demand in deficient areas.

Swimming and Beach Use

Preferred characteristics for swimming include undeveloped sandy shoreline, safe surf and currents, and parking and service facilities. Clean water, as defined by public health standards, is mandatory.

By far, swimming has higher participation rates than all other recreation, although its recent growth in participation is not as high as boating and fishing.¹⁹ Since beach use and swimming provide so many people of all different income levels with inexpensive recreation, advocacy for open beaches or public ownership of beaches has been strong. The Colonial Ordinance granted shoreline owners the land between the mean high and low water lines, but reserved for the public the rights to navigate, fish and fowl below the high water mark. In 1973, the Massachusetts Legislature asked the State Supreme Court for an opinion on whether these retained rights include walking as a lawful public use of the foreshore. The Court felt that such an interpretation was a taking without compensation and was thus unconstitutional. Responding to this decision, the Special Commission Relative to the Management, Operation and Accessibility of Public Beaches stated in its final report: "Acquisition of rights by express dedication, acquisition or other such means, is, in effect, the only way in which significant expansion of public beach resources will occur."²⁰

Table 1 shows that 80 percent of the total demand for shoreline swimming is met but badly distributed, and limited to 250 miles of free or fee charged beaches.²¹ Furthermore, the absolute numbers still seeking opportunities for coastal swimming is still higher than for any other activity.

In order to meet unfulfilled demand, roughly 50 miles or from 100-10,000 acres of additional beach is needed²² (depending on whether "lineal" beach or major park beaches are developed). Some demand can also be met by substituting similar facilities, i.e., inland ponds and public pools instead of urban coastal beaches; although one survey indicates that ponds and pools cannot substitute for coastal beaches because of the special qualities of wind, waves and visual character of the shoreline.²³

Along the Massachusetts shoreline, about 100 miles of undeveloped (without abutting residences) non-public sandy beach remain for possible addition to public supply.²⁴ Most of this beach is in small sections with about 5-10 sites suitable for large scale recreation facilities. Usually located away from population areas, these few large sites are on Martha's Vineyard and Nantucket, in the Buzzards Bay region, and Cape Cod. The North and South Shore, and certainly Boston, have very few undeveloped sandy beaches left.

Table 1—Recreation supply/demand

	1975 Supply * (Activity Days)	1975 Demand (Activity Days)	Demand Currently Satisfied (Percent)	Needs (Demand not satisfied) (Activity Days)
<i>Boating</i>				
**Eastern Mass.	2,800,000	9,100,000	30	6,300,000
SoEa. Mass.	1,100,000	850,000	130	none
Cape Cod	1,800,000	2,800,000	64	1,000,000
Islands	90,000	1,400,000	6	1,310,000
TOTAL	5,790,000	14,150,000	41	8,360,000
<i>Swimming</i>				
Eastern Mass.	4,000,000	30,000,000	13	26,100,000
SoEa. Mass.	1,700,000	3,900,000	44	2,200,000
Cape Cod	29,700,000	9,200,000	323	none
Islands	3,500,000	5,500,000	64	2,000,000
TOTAL	38,900,000	48,700,000	80	9,800,000
<i>Camping</i>				
Eastern Mass.	300,000	900,000	33	600,000
SoEa. Mass.	400,000	100,000	400	none
Cape Cod	500,000	1,400,000	36	900,000
Islands	31,000	900,000	3	869,000
TOTAL	1,231,000	3,300,000	37	2,069,000
<i>Salt Water Fishing</i>				
Eastern Mass.	Impossible to es-	7,600,000		
SoEa. Mass.	timate, but pre-	900,000		
Cape Cod	sumed at least as	1,800,000		
Islands	high as boating	806,000		
TOTAL		11,106,000		

* Activity days are defined as the use of a facility for any period of time during a single day. Also known as user days.

**Statewide Comprehensive Outdoor Recreation Plan (SCORP) regions were used for demand figures and represent broad areas; e.g., Eastern Mass. covers metropolitan Boston, the South Shore and the North Shore and west to about Route 495. However, for supply, Coastal Zone Management figures, calculated for coastal towns only, were substituted. Thus, the table shows inland and coastal demand for the supply of coastal recreation resources.

Another alternative to meeting needs is to open "resident only" beaches to everyone; however, this change would probably lead to crowded conditions. The Special Commission concurs, stating that "although the Commission believes that such restrictions (residents only) are generally not lawful or appropriate, it recognizes that such remedial action (lifting of all restrictions) would prevent or discourage resident recreation, pose difficult municipal finance problems and, more generally, only spread traffic, parking and other such problems from (other beaches)." ²⁵

In short, beyond what can be gained through transportation improvements, there is not much flexibility in meeting existing beach needs. Small, well distributed sites are not only desirable because they pose fewer traffic, social and other environmental impacts, but they also offer the only possible long-term option for meeting beach demand in a shoreline as developed as Massachusetts', particularly in Boston Harbor, and the North and South Shores. Similarly, expansions of existing facilities can alleviate deficiencies in some regions, particularly if transportation to them can be improved. Finally, large sites can be purchased on an as-available basis, e.g., surplus federal properties.

Salt Water Fishing

Salt water fishing has relatively few requirements that differ from boating and swimming. However, fishing needs can also be met in more flexible ways than by boat or beach use. People can fish from most piers, bridges or jetties—places that might not be suitable for other forms of coastal recreation. Similarly, as mentioned before, Massachusetts law allows beach passage between mean low and high tide for "navigation, fishing and fowling"; thus opportunities are limited mostly by lack of shore access points. ²⁶

Since the supply of fishing opportunities is difficult to estimate it is specious to argue that there are unmet needs. However, studies indicate that salt water fishing participation has increased nationally by 45 percent since 1960. The value of fish caught by salt water sportfishermen in Massachusetts is estimated at nearly \$20 million. ²⁷ Additionally, Massachusetts has higher amounts of fishing participation than the combined neighboring states of Maine, New Hampshire, and Rhode Island. Fishermen in those states fish almost as frequently in Massachusetts as they do in their home states. ²⁸

Massachusetts' salt water fishing is an increasing coastal activity which generates substantial income, and which makes further demands on coastal access. Alternatives for satisfying fishing demand include beach acquisition and construction or rehabilitation of usable piers for use by fishermen. Even the smallest access points along the coast are useful for fishermen. Thus highway and bridge projects, utilities, etc., can provide fishing opportunities at minimal expense.

Other Opportunities and Constraints

This section explores combinations of coastal uses which together can enhance or degrade basic recreational experi-

ences. For example, the tourist who is able to camp, swim and tour historic houses in the same area experiences more enjoyment than supply/demand statistics for individual activities illustrate. On the other hand, inappropriate combinations of activities, such as swimming and surf fishing occurring on the same beach can detract from the value of each individual activity. Although each conflict must be decided on a site-by-site basis, location, proximity of activities to one another, and timing and seasonalness of activities are important factors in planning for multiple uses. The following examples illustrate desirable multiple uses along the Massachusetts coast.

Camping, Hiking and the Coastline

Campers and hikers require large areas for their trailers and tents, water supplies and sanitary facilities; and trails to lead them from camping areas to interesting destinations.

A system of coastal trails and campgrounds for hikers, bicyclists and equestrians would make more coast accessible to more people; could link population centers with recreational facilities; and would allow people to enjoy the scenic qualities of the coastline. Near-shore coastal campgrounds could function as origins for recreationalists, and trails would provide links to the swimming, boating and fishing on the shore.

The demand for camping is rapidly increasing: 55,000 more people camped in state campgrounds in July 1975 than in July 1974. ²⁹ The unmet demand for camping (Table 1) and the expense of near-shore land make unlikely the expansion of shoreside camping areas. However, opportunities for trail development are limitless, ranging from bike routes currently being developed by the Massachusetts Department of Public Works to scenic rivers to utility easements.

Tourism and the Coastline

The coastal zone attracts a large number of visitors who come to enjoy the swimming beaches, sailing and boating opportunities, and fishing experiences the coast offers. Rolling dunes, a craggy rock ledge, expanses of blue water, and the sights and sounds of a busy fishing harbor are probably some of the first things that come to people's minds when they think of the coast. The coast's ability to soothe, to humble, to excite, or just to pre-occupy makes it a primary tourist attraction.

The state's tourist industry sustains an estimated 74,400 full-time, year-round jobs. Income attributed to tourism is estimated at \$1.2 billion annually. ³⁰ The coast accounts for most of the jobs and much of the state's tourist income. For example, 56 percent of the state's hotels, motels, trailer parks, and campgrounds are located along the coast (excluding those in Boston). ³¹ Additionally, two of the most obviously coastal regions, Cape Cod and Martha's Vineyard, attribute 75 percent and 95 percent of their respective Gross National Products (GNP's) to the tourist industry.

Maintaining a healthy tourist industry, which for some regions is the primary source of income for residents, requires a continuing effort to provide the recreational facilities tourists demand—swimming beaches, fishing and

boating opportunities—and to preserve those aspects of the coast's visual environment which serve to attract tourists.

Other Multiple Uses

Many other coastal uses can also coexist with recreation. For example, public utility rights-of-way can be used to provide access for shore fishing; institutions can provide access for general recreation and tourism; and port operations can serve as exciting focal points for sightseeing. The seasonal differences in Massachusetts also offer creative possibilities for multiple uses: parking lots at marinas can provide winter storage for boats; beaches used by swimmers in the summer can be used as campgrounds in the fall; tourist hotels can change to winter convention centers.

Conflicting Uses and Environmental Impacts

Conflicting uses and environmental impacts stem from inappropriate intensity and mixing of incompatible uses. Conflicts result from physical competition for space, psychological incompatibility and destruction of resource-related values. Conflicts, if allowed to continue unmanaged, may result in reduced health and safety and deterioration of environmental and recreational qualities. Examples of such coastal conflicts include: boating impact (bacterial waste, danger) on swimming; boating impact (speed, wake, noise) on fishing; beach use with car impact (noise, visual) on adjacent private properties. Although there may be many possible conflicts under certain conditions, solutions can also be varied. Examples of types of solutions include:

- Conflicts are between the operational aspects of each activity, i.e., where equipment and space needs conflict or the speed or intensity of the activities conflict. Such conflicts may be resolved through mechanical manipulation, e.g., reduction of speed, separation of spaces, etc.
- Conflicts are in timing, seasonality and sequencing, i.e., where uses are incompatible at different times of the day or season. Solutions may involve separating uses in time rather than space.
- Conflicts may be resolved through minor management rules, e.g., leashing of dogs or other administrative and policing solutions.

Although resolution of some conflicts are only possible through prohibition of a use, many can be resolved by improved management.

Maintenance and Pricing

Throughout regional Coastal Zone Management public meetings, citizens cited maintenance of recreation areas and lack of facilities as major concerns.

While federal or state funds frequently support local acquisitions, once the community acquires an area, its maintenance is borne by or charged to the town. This practice partly accounts for why fees are charged to out-of-town residents.

Maintenance expenditures are not small. Last year the Department of Environmental Management spent \$775,000 for the operation of its beaches (vs. \$435,000 in revenue) and \$3.8 million for parks (vs. \$992,000 in revenue).³² Maintenance

cost problems are serious enough that the Special Legislative Commission, in recommending legislation to prohibit non-resident discrimination at beaches, consciously exempted pricing differentials "at municipal beaches where the municipality uses tax revenues to maintain and operate the beach facilities, and the fee differential reflects an adjustment in charges that effectively equalized resident and non-resident daily use payments."³³

If communities are not allowed to recover tax funded maintenance expenses through differential pricing, town residents would either be subsidizing out-of-town users, or might not be able to maintain beaches adequately. Adequate maintenance is important because it increases the capability of resources to support greater use. Thus, where a differential in access fee is necessary to cover maintenance, the well-maintained facility warrants the higher fee.

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7. John L. Compton and Robert B. Ditton, *A Feasibility, Management and Economic Study of Marinas on the Texas Gulf Coast*. (Sea Grant, Texas: Department of Recreation and Parks, Texas A & M University, 1975.) p. 8.
8. Patterson, *Op. Cit.*, pp. 3-7, 3-8. Indicates multiplier factors of charter fishing and marinas as 3.08 and 2.76 respectively, ranging slightly under fish processing and higher than other marine manufacturing.
9. Compton and Ditton, *Op. Cit.*
10. Table 1 presents information from two sources. Demand for recreation activities has been extrapolated from the State Comprehensive Outdoor Recreation Plan. Calculated as "activity days," (defined as use of a facility period of time during a single day), this estimate for demand has been determined using economic information developed in ORRCC, modified by survey

information developed in SCORP. Supply figures, also translated into activity days, have been developed from a specific CZM recreation inventory, i.e., for sites only in/near the shoreline. Space requirements for activity days are subsequently developed in the rest of the text.

11. Massachusetts Office of State Planning, *Towards a State Growth Policy*. (Boston, Mass., 1975.); and Massachusetts CZM, "Citizen Survey" (Boston, Mass., 1976.)
12. Special Legislative Commission, "Report Relative to the Management, Operation and Accessibility of Public Beaches Along the Seacoast." (Boston, Mass., 1975.) p. 31; cites traffic and parking problems stated at public hearings.
13. Calculations were developed from a Massachusetts CZM inventory of all coastal harbors and access ramps. Besides the major public access ramps, there are over 100 additional small ramps which have been included under "marina slips and ramps;" over 60 of these small ramps are located in marinas on Cape Cod.
14. Calculations were based on the need for a five-fold increase in the number of existing marinas or ramps in order to double total supply, as each currently provides 20 percent of the total boating supply. Assumptions for cost estimates include: \$0.5 million for construction, dredging and land acquisition of one marina; \$100,000 for major ramp construction and land acquisition for 10 parking spaces.
15. Calculations were based on assumptions that one acre of water at a depth of five feet was necessary to safely moor 15-20 small boats and dredging costs at approximately \$8 per cubic yard. Therefore, dredging one acre to minimum depth would cost \$40,000; 5,000 acres would cost \$2 billion.
16. David A. Storey, *The Massachusetts Marina Boatyard Industry*. (Amherst, Mass.: Massachusetts Agricultural Experiment Station, University of Massachusetts, 1972-73.)
17. According to the National Association of Engine and Boat Manufacturers in an article called "Shoreline Recreation Resources of the U.S.," boats purchased nationwide increased from 2,440,000 in 1947 to 8,025,000 in 1960, or an increase by 220 percent. Marina development in Massachusetts has not similarly increased. Twenty years (MacConnell, *Op. Cit.*) of land use change corroborates this finding.
18. This information is based on an informal Massachusetts CZM telephone survey of harbor masters. Opinions were solicited regarding maintenance problems, harbor capacity and conflicting uses. Almost 50 percent of the harbor masters felt that their harbors could sustain more use.
19. SCORP, *Loc. Cit.*, p. V-61.
20. The Special Legislative Commission Relative to the Management, Operation and Accessibility of Public Beaches, "Third Interim Report," Chapter 40 of the Resolves of 1972, prepared by David Rice. (Boston, Mass., August, 1975.) p. 11.
21. The amount, ownership, and access information of Massachusetts beaches was developed based on previous inventories including New England River Basins Commission's *SENE*, the Special Legislative Commission report, as well as field checking and Citizen Advisory Commissions' information and mapping.
22. Recreation beaches can be developed, at a minimum, as simple linear access on sandy beaches, or at a maximum as major park beaches including parking, associated facilities, upland park, picnic tables, etc. Fifty miles of the latter type of recreation beach would require 10,000 acres, assuming 200 acres per mile of beach.
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29. Commonwealth of Massachusetts, Department of Environmental Management, Division of Forests and Parks. Based on inventory of tourism statistics.
30. Department of Hotel, Restaurant and Travel Administration, University of Massachusetts at Amherst, Research Report, *The Economic Impact of Tourism on the Commonwealth of Massachusetts*, prepared for the Massachusetts Department of Commerce and Development, December, 1974. Part-time or seasonal jobs are adjusted to full-time, year-round equivalents, e.g., two full-time six month jobs equal one full-time year round job. Income attributed to tourism includes both direct, indirect and induced expenditures.
31. Of the state's 1308 hotels, motels, trailer parks, and camps, 736 (or 56 percent) are located in the Counties of Barnstable, Bristol, Dukes, Essex, Plymouth, and Nantucket. U.S. Bureau of the Census, *1972 Census of Selected Service Industries, Massachusetts*.
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Coastal Use Planning

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Land Use Planning Evolution

Recreation, coastal zone, and land use planning have had a long evolutionary process in Delaware that is still continuing. The State Planning Office was created by an act of the General Assembly in 1961. The office has four broad statutory responsibilities: 1) the provision of planning assistance to the governor, the general assembly, and state agencies; 2) planning assistance to local governments; 3) the preparation of the capital improvements program and budget for the state government; and 4) the preparation of the Delaware development plan. By executive order we are responsible for a variety of other tasks, the most significant of which is review and coordination of federal funds working under the general authority of the federal 1968 Intergovernmental Cooperation Act.

In 1964 the planning office initiated work on the first statewide development plan. This plan was a traditional regional plan. It was completed and accepted by the governor after public hearings in 1968. One of the special studies conducted as part of the development of that plan was a shoreline study and plan, which recommended that certain portions of the shoreline be held for conservation uses, others be put into recreation, and still others go into urban development.

The concepts of the shoreline plan were picked up in the overall development plan and were also incorporated in the first comprehensive outdoor recreation plan that we did in compliance with the planning requirements of the National Land and Water Conservation Fund Act.

The state plan was reaffirmed when a new state administration took office in 1969.

The state planning act, while mandating an overall state development plan, clearly indicates that the state plan is a policy plan and has no regulatory significance. During the late sixties it became apparent that certain industrial developments were in the planning stages that could potentially

modify, in a rather significant fashion, the lifestyle of southern Delaware. Chief among these was the acquisition of land in southern New Castle county, along Delaware Bay, by Shell Oil Company and the rezoning of that land to heavy manufacturing by the county in which it was located; the acquisition of approximately 1,100 acres of land in southern Kent county, on Delaware Bay, by the Delaware Bay Transportation Company, a consortium of oil companies with an announced interest in developing a lower bay deepwater port; and several other proposals for deepwater port facilities in the lower Delaware Bay adjacent to a natural deep channel of some 65 feet.

In order to establish a state government response to these initiatives, the governor appointed a task force of marine and coastal affairs. The task force worked for approximately a year before it filed its preliminary report. Based on the preliminary report, the governor proposed the legislation that ultimately resulted in the Coastal Zone Act, which was signed into law on June 28, 1971. The law categorically prohibited heavy industry uses in a statutorily defined coastal zone. It also prohibited "offshore bulk product transfer facilities." Finally, it established a permit system for new manufacturing uses and the expansion of nonconforming manufacturing uses in the coastal zone. The state planning office was given responsibility for the administration of the statute.

It should be noted that the Coastal Zone Act controlled only industrial and manufacturing activities. All other uses continued to be controlled through the normal zoning processes of municipalities and counties. I would also point out that county planning and zoning, in the two southernmost counties, is a relatively new phenomenon, with enabling legislation being passed by the General Assembly only in 1968.

During this time, the state also established the Beach Protection Act, which set up a revolving fund for erosion control measures, but perhaps more importantly, established a state regulatory process for construction in the beach areas,

the objective of which was to keep new construction behind the dune lines.

Growing Urban Pressures

When the current administration took office in 1973, the pressures of urbanization in the coastal areas was increasing, particularly in the area of condominium development along the Atlantic coastline. This was generally a result of spillover from Ocean City, Maryland. The governor proposed a comprehensive legislative program that included a Coastal Zone Management Act, which would have brought all urban uses under a state permit process in the statutory coastal zone.

With the passage of the National Coastal Zone Management Act, the state planning office was given lead responsibility for the implementation of that act in Delaware. At about the same time, it became quite obvious that the overall state plan needed to be reviewed and updated. The controversy over the state Coastal Zone Act was growing rapidly with the introduction of bills into the General Assembly that would remove the heavy industry prohibition from the statute.

In order to bring all of this into focus in as objective a fashion as possible, the governor created, by executive order, the Delaware Tomorrow Commission. The charge to the commission was as follows:

"Whereas, it is essential that the state of Delaware devise a statewide development policy on growth in the areas of industrial, commercial, and residential development including open space, recreation, and transportation; and

"Whereas, the General Assembly has recognized these problems by enacting specific legislation or resolutions, such as Senate Bill 257, House Bill 882 and House Concurrent Resolution 49, dealing with specific areas of this overall general problem.

"Whereas, in 1971 the state of Delaware enacted into law the Coastal Zone Industrial Control Act which regulates industries in the coastal areas of the state, and in the two years since the passage of this act there has been considerable controversy over it and the state's policy on economic growth; and

"Whereas, a comprehensive state development policy must be developed for all, but only after considering the interests of not just government but business, industry, labor, environmentalists, and most importantly, the people of Delaware.

"Now, therefore, I, Sherman W. Tribbitt, by the authority vested in me as governor of the state of Delaware, do hereby declare and order as follows:

1. The "Delaware Tomorrow Commission" is hereby established.
2. The commission is charged with the responsibility to develop a statewide plan for growth.
3. The commission shall investigate development policy of other states as well as hold meetings and seminars throughout the state to receive contributions from our citizens."

Tomorrow Commission

The commission was composed of 31 members, including the state agencies most associated with physical development, the county and municipal governments and numerous citizen groups including both traditional conservation groups, such as the Sierra Club, and groups oriented toward development, including the state agencies most associated with physical development, the county and municipal governments and numerous citizen groups including both traditional conservation groups, such as the Sierra Club, and groups oriented toward development, including the state Chamber of Commerce and the Building Trades Council. We recognized that 31 members was about as large as any commission could get and still serve as a reasonable forum for debate. We also wanted to get as many people involved in the process as we could. The result of that apparent conflict was a division of the commission into three committees: land use and community development, economic development, and cost of public services. We then divided the commission membership up equally among the three subcommittees and augmented the commission members on the committees with, generally, an equal number of committee members who were not commission members. We also had a technical advisory committee made up of working planners and other professionals from state and local governments. Finally, professional services were rendered to the commission both by my staff and by representatives of various schools at the University of Delaware, who were working as consultants to my office for this project. We involved the School of Agriculture, the College of Business Economics, and the Division of Urban Affairs. The end result was that we had something like 120 people working with the program on a continuing basis.

The commission worked for about a year before it issued its first draft report last fall. That report was reviewed and changed by the commission and published for public distribution, as a second draft, in the early winter. Public hearings were held in January, 1976, throughout the state, following which the commission revised the second draft and published a final report. The final report has been accepted, by the governor, as an amendment to the state development plan. The commission report is essentially a series of fifty recommendations dealing with broad policy issues affecting state growth. One of the recommendations is that a statewide land use plan and regulatory system be developed and that once such a plan and regulations are in operation, the categorical heavy industry prohibitions in the existing coastal zone act be repealed.

Other Coastal Preservation Actions

While the Delaware Tomorrow project was going forward, my office, working with a coastal zone management committee that we had established involving state agencies, local governments, and some private groups, was initiating the technical work on the National Coastal Zone Management Act. Concurrently, the Department of Natural Resources was

beginning development of another outdoor recreation plan.

Additionally, New Castle county, our northernmost and most urban county, along with the cities of Wilmington and Newark, which are located in that county, began work on a 208 water quality management program, and a second 208 program was initiated by the Sussex County government for the eastern portion of that county, which is the area adjacent to the Atlantic ocean.

The result of all of the above is that my office has been given the responsibility, by the governor, to begin drafting the statewide land use plan enabling legislation. When that legislation is drafted, it will be given by the governor to the Delaware Tomorrow Commission, who will consider it further and hold hearings on it for revision prior to its introduction into the General Assembly.

We have been working diligently to orchestrate the work of the two 208 programs, our coastal zone management program, and other related planning activities, including the outdoor recreation plan and the highway and transportation plans. We achieved one major breakthrough last fall when all of the jurisdictions involved agreed to participate in the development of a standard set of population estimates and projections for the state. This work has been accomplished. Those projections have also been adopted, by the governor, as an amendment to the state plan.

We have seen very positive benefits from coordinating the production schedules on the 208 projects and the coastal zone management program, since there are significant similarities between these programs, to the extent that data needs are virtually identical. We are even into one joint venture contract with one of the 208 projects. In other areas, we have geographically segmented research so that the 208 projects pick up part of the work and we pick up the cost for the work outside of the 208 areas.

Recreation Planning

In the area of pure recreational planning, specifically in needs assessment, the quality of our planning has been weaker than in any other area. Other than user data generated primarily from car counts and daily permits sold at state parks, we have no primary recreation user data. Until recently this has been largely an academic problem because Delaware's experience in state parks is relatively new. Until about ten years ago we had only two state parks, and one of those only amounted to 37 acres. In the past ten years we have gone from those two state parks to ten major parks, the end result of which is that our park program has been primarily a real estate operation.

We are now shifting over into development and doing so at a time when our bonding situation is critical. We are, therefore, going through a difficult period of trying to ascertain what kinds of development should be put into place in order to permit people to get onto the parks as soon as possible at a minimal cost to the state government.

In other areas of coastal planning, I believe that we have been fairly successful, and perhaps even innovative, in our research efforts. We have established a standard land use

coding system statewide. Several years ago we succeeded in getting a supplemental appropriation from the general assembly, which we used to contract with the Soil Conservation Service to accelerate the completion of the soil survey statewide. We are working at a standard scale of 2000 feet equals one inch. We recently obtained statewide soil survey maps from SCS at that scale, as well as air photo reproductions at the same scale from USGS.

We have used a significant portion of our coastal zone planning money to finance a variety of contracts from the University of Delaware to convert a large amount of basic scientific research into reports that are usable by planners, engineers, and other government officials. These range from studies of the relative value of wetlands; a paper on the causes of beach erosion; ground water resources, storm tides and flooding (which we are using to cross check the HUD flood insurance maps. We are also responsible for the HUD flood insurance program in Delaware, and are working that as an adjunct to the coastal zone management program). We are planning to conduct the first summer census of the Atlantic coast beach communities this summer.

Oil and Gas Exploration Problems

We are confronted with the plans of the U.S. Department of the Interior to lease OCS lands off Delaware for oil and gas exploration and development. Without getting into the multitude of problems associated with that type of endeavor, we have run into significant data problems in getting stratigraphic data from DOI. We were successful in negotiating a contract involving Delaware, some of our adjacent states and the organization that carried out a deep stratigraphic test off Atlantic City, so that we will get the actual data on a proprietary basis. Working through our geological survey, we found out that some seismic data is available commercially to augment the limited data available from USGS.

In addition to acquiring that data, using money made available to us from OCZM through the OCS impact fund, we are using additional OCS impact money in cooperation with the Maryland Geological Survey and USGS to have some of our own seismic runs made parallel to the Atlantic coast and up Delaware bay. This run is being made so it can be tied back to holes on land as well as tied to existing seismic runs that have been made offshore so that we can, in turn, tie it back to the strat test. As a result, we believe we will wind up with the first hard data on the basement geology of Delaware.

Summary

We have been attempting to work the Coastal Zone Management Program, the 208 planning, outdoor recreation planning and regulation on a statewide basis. We have been attempting to foster the conversion of huge amounts of essentially academic data into information usable for decision making by state and local governments. While it is too early to say that all of this has been successful, the process has been underway for about two years at this time, and my optimism for successful achievement is increasing rather than decreasing.

Community Coastal Recreation Management

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Local Roles in Coastal Recreation

Typically, after you have been informed of the federal government's role—and then the state's role—in coastal recreation management, you come to the local community's role with some very clear-cut prejudices.

One prejudice may be that the locals are too dumb or too oblivious to see the big picture, that is, their inter-relationship with man and resource.

Another may be that the community is concerned too much with jealously guarding its autonomy at the expense of the public good.

Certainly there are other biases we all could add, including the fact that if wise management of our coastal recreation resources in an urbanizing environment had been undertaken long ago at the local level of government, there would be much less reason for many of us to have to address the roles of our state and federal agencies.

Back in 1971, in the publication *The Quiet Revolution in Land Use Control*, it was said, and I quote:

"This country is in the midst of a revolution in the way we regulate the use of our land. It is a peaceful revolution, and its supporters include both conservatives and liberals. It is a disorganized revolution, with no central cadre of leaders, but it is a revolution nonetheless.

"The ancient regime being overthrown is the feudal system under which the entire pattern of land development has been controlled by thousands of individual governments, each seeking to maximize its tax base and minimize its social problems, and caring less what happens to all the others.

"The tools of the revolution are new laws taking a variety of forms but each sharing a common theme—the need to provide some degree of state or regional participation in the major decisions that affect the use of our increasingly limited supply of land."

I am speaking here with the perspective of four years as a member of the town council of South Kingstown, R.I., a summer vacation area and the home town of the University of Rhode Island. The town's 63 sq. mile area makes it the largest community in the state geographically, and it issued the largest number of new building permits in the state during 1975.

A 1973 projection indicated South Kingstown could expect a 1990 population of 21,000. More recent estimates suggest we will reach that total this year. I might point out that, just a few years ago, the town was blessed with people occupying summer homes between June and September and then packing up their kids and returning to their year-round homes in Rhode Island, Massachusetts and Connecticut. They paid their taxes on their summer homes but required little or nothing by way of services such as schools, sewers, roads and other amenities.

Fertile Territory

Today, our coastal area is fertile territory for year-round homes. Subdivisions of a hundred or 200 houses are now being constructed or planned. The town's tax revenues from undemanding summer guests is a thing of the past.

South Kingstown has some 5.5 miles of ocean coastline and an additional 41.5 miles of waterfront along tidal rivers and ponds. Our outdoor recreation inventory lists nearly 6,000 acres of recreation, conservation and open space, about 10 percent of which is coastal. Of our 606 acres of coastal lands, more than 400 are owned by the federal and state governments. The town owns two of the 600 acres and the balance, about 200 acres, is in private ownership.

Coastal Management Conflicts

Two recent issues illustrate the conflicts we face in coastal management. Both involve recreation and an increasingly urbanized environment.

The first involves residential development on a barrier beach at Green Hill, along the south shore of the town. Undeveloped in the past because it was often buffeted by hurricanes and storms, the barrier beach started sprouting houses in 1971. In 1972 and 1973, after 15 to 20 houses were up, the newly-formed state Coastal Resources Management Council issued cease and desist orders barring any further development. A split town council, after many acrimonious meetings and one explosive public hearing, declined to institute a zoning change prohibiting further residential construction. Luckily, the state Coastal Resources Management Council persisted in its cease and desist approach for as long as it could. Last May, just four days before the last town elections, the local council adopted a flood danger zone ordinance which forced the matter to its penultimate conclusion which is to say it is now headed for the courts.

The high flood danger ordinance prohibits construction of any overnight living accommodations on our barrier beaches but does allow a limited number of commercial and public uses such as bathing beaches, beach clubs and cabanas, marinas, boat liveries, yacht clubs and so on. The hitch is that each use requires a special exception from the Zoning Board of Review and an environmental impact statement.

A second current issue involves an application by the State Department of Natural Resources, to "upgrade" a rather quiescent state beach at East Matunuck. When this proposal started off, it called for the re-location of a road, which runs parallel to the dunes, to an area which is contiguous to a salt marsh. It also suggested an increase in the number of parking spots from 350 to about 1800.

One of the issues that keeps cropping up in connection with both the Green Hill and the East Matunuck State Beach cases (but especially Green Hill) is that a lot of the demand for coastal recreation facilities comes largely from residents of Connecticut, a state in which there is little or no coastal management. Could you, as a local elected official, respond to complaints from your fellow citizens by pointing to our obligation to accommodate our out-of-state neighbors? Especially when the local and state governments to the west have been so derelict?

Listen to these words from the former mayor of Stamford, Connecticut:

"I submit that a consideration of public-versus-private interests in controlling our shoreline bears great similarity to locking the barn door after the horse has been stolen. Private interests have already won out for most areas of Long Island Sound.

"For example, during the past 18 years, New York's Nassau and Suffolk counties on Long Island have lost more than one-quarter of their available marsh and wetland area. Connecticut has fared worse. Intensive residential, industrial and commercial development required to support a large growth in population has appropriated our shorelines. Less than two percent of Connecticut's shore is available to the public for recreation. This hasn't happened yet all over Southern New England, but it's

guaranteed if laissez-faire advocates prevail in land development."

Again, what is the local community's role in coastal recreation management? Zoning land on barrier beaches out of the use for which it was purchased isn't easy on a local legislative body. Then there is the confiscation issue. And then, when a municipality is already pushing its debt limit for schools, water and sewers, you have to expect a great deal of resistance to financial proposals which ask for community acquisition or development of coastal recreational facilities.

Naturally, the perspective of a person speaking in behalf of a coastal community differs quite markedly from one who speaks for an inland community which wants access to coastal resources. There are many in South Kingstown, as there are here on Cape Cod, who move in and then want to keep everyone else out. In good faith or bad, there are those who would build the barricades in the name of conservation, preservation of nature, traffic congestion or whatever.

Environmental Master Plan

Most local communities, unfortunately, end up ad hocing their way to coastal recreation management.

In my own town, we chose to develop an Environmental Master Plan which is an official statement of town policy on four specific areas: (1) conservation, (2) recreation, (3) open space, and (4) design.

Of our ocean shoreline, the Environmental Plan has this to say:

The Plan endorses strong zoning measures to restrict development along the coastline where a significant degree of storm damage is likely, or where building would increase the storm damage potential of other nearby lands. Specifically, the following policies are recommended:

1. Adoption of a flood danger zoning district to prevent undesirable development as noted above;
2. Prevention of construction of residences on a barrier beach;
3. Restriction of uses on barrier beaches which would contribute to erosion of dunes;
4. Prevention of development along the immediate ocean-front in non-barrier areas, and the enforcement of a building setback line.

It is further the policy of the Town to avoid continuous or uninterrupted development along the coast, or of such development that would contribute to a garish, over-commercialized or shoddy appearance. The present commercial areas should be limited to their present extent, and are encouraged to improve properties to the maximum extent possible. The Town should promote and support the preservation of remaining open lands and encourage the continuation of agricultural uses in flood danger areas. State holdings at East Matunuck Beach may be improved for public recreation, but the salt marshes in the area should be preserved to the maximum extent possible.

To me, the Environmental Master Plan is our community's statement of its role in coastal recreation management. It declares that we recognize coastal utilization that is not harmful or destructive of the resource.

Summary

In short, the Environmental Master Plan says that we looked at ad hocism in coastal recreation management and decided we didn't like what we saw. It expresses further that we have examined our environmental conscience in advance of further demands on our coastal resources and have, accordingly, adopted goals and legislation which will allow people to

enjoy our coastal environment with restrictions that we think are in the public interest.

The plan is not parochial nor is it exclusionary. Simply stated, it provides for uses and restrictions—right now—which will enable many people to enjoy our coastal area without destroying its character or vitality.

We felt, when the Environmental Master Plan was adopted, that it was the fulfillment of a local government's responsibility which was better accomplished without big brother's intervention.

Any town can follow the same route if it has the will and the concern. The problem seems to be that not enough have.

The Marina Operator Today

Richard Palmer, Member, Board of Directors
Connecticut Marine Trades
Stratford Marina, Stratford, Connecticut

The dream of having your avocation become your vocation is one that many of us have. My dream came true, happily. I bought my first boat, a 24-foot power boat and then with my accounting background and some resources available to me, I invested in a going marina as a partner and then eventually became the sole owner. I've now been in the marina business more than 10 years and have faced most of the problems of any small business over this period of time, such as increased taxes, insurance, utility costs, rising labor rates, and increased material costs.

In addition to this, the marina operator has faced and is faced with other, somewhat unique, considerations as follows:

- I - Competition with publicly financed marinas.
- II - Ecological restraints and other regulations.
- III - Competing uses of waterfront land and the "best use of land theory".

I will now try to go into a little more detail on these three points.

Competition with Publicly Financed Marinas

The demand for dockage and mooring space has been growing by leaps and bounds over the last 10 to twenty years to the point where municipalities have been installing boating facilities to accommodate their residents. This is fine. These facilities are badly needed and as long as the demand exceeds the supply the threat to the private marina operator is not too great. However, as soon as the scale starts to balance between supply and demand, the marina operator finds himself in a position where he is in unfair competition with a municipal marina that has a good deal more resources, no real estate taxes, no requirement to make a profit and a great deal more influence with the governing bodies that issue approval and permits. Under these conditions, how long can a private operator stay in business without some kind of protection or relief? How long will it be before the marina

operator looks to some other kind of use for his property investment?

Ecological Restraints and Other Regulations

Waterfront property has become a "sacred cow." Of course the extent of this varies in each municipality. However, many of the restrictions are the same from town to town. The marina operator must, before he can expand or even maintain his facility, go through a series of approval steps. In the town of Stratford, Connecticut, all waterfront property is what they call "non-conforming," which means that even if a person wants to change a door or window in a building he must go through the procedure of a duly called public hearing before he can obtain a building permit.

That's not so bad when you compare it to the procedure required to expand and/or maintain your water facilities. You first must obtain local approval as outlined above, then apply to the state. This at one time required a scale drawing of the marina facilities showing the changes to be made. Now a registered surveyor must make the drawing which could result in an expenditure of thousands of dollars just to get a seal on a drawing that probably could have been done by the individual owner. After this is completed, a public notice is issued. Following a waiting period another public hearing is held and then the various state departments must give their blessing to the project.

When and if approval comes from the state, then all of the same information must again be submitted to the Army Corps of Engineers, but on a different set of forms. Then there is another public notice and possibly another public hearing. Now, *maybe*, a year or so later permission to proceed is granted. How can a marina operator whose operation is exposed to numerous storms and constant silting problems be expected to maintain the marina?

I at one time worked for a large corporation as a systems designer and was frustrated by having to sell various levels of

management on a new idea that would save considerable operating costs. Then I thought to myself, "let me go into my own business where I can make decisions right away." If only I had had a crystal ball!

Competing Uses of Waterfront Land and "The Best Use Theory"

Over the past few years I have been approached many times with proposals to turn my property into condominiums, hotels, yacht clubs, recreational complexes, and many other exciting facilities. Some of these proposals were not economically sound. However, others were very economically sound and very tempting from a "best use" and a profit standpoint. To date I have resisted these opportunities mainly because I believe that the need for a good marina still exists. However, one of these days, I'm going to stop letting my heart run my business and make my land available for its "best use." Believe me though, except for a love of the business, this would have happened already.

Discussion

There should not be a serious conflict between public and private marinas. At the present time, as I mentioned, the demand for marina facilities exceeds the supply. Further, as public marinas are developed, they should be designed to cater to the more "transient" boat owner. They should operate much as camp grounds operate.

Secondly, development of public marinas should be planned and conducted with the constant consideration that there may come a time when supply meets demand. Overdevelopment would have one of two effects. Either private marinas would be forced out of business or the public sector would find itself burdened with facilities that are not used to full potential.

I personally feel, and I think most would agree, that the public sector should not force private businesses out of the market place. Thus, the first effect should be avoided. But the second effect is no better. Government has too many responsibilities and demands to meet for it to become burdened with unneeded facilities. Thus, when developing public marinas and other boating facilities, government should seek to construct the facilities in such a way that they can be easily converted to other uses.

Government Regulations

Today, we would all agree that environmental considerations are important. Certainly that is true for those of us involved with recreational boating. After all, boating is no fun at all on a river that is nothing more than an open sewer, or a lake or other body of water that is merely a cesspool.

However, as more and more people are recognizing, concern for the environment must be kept in a proper perspective. The same can be said for government regulation generally. There is far too much red-tape facing those of us in the boating business today, or who want to make any use of the waterfront.

For example, there is a man who wants to permanently moor a ferry in Haddam, Connecticut on the Connecticut River. The ferry would house a restaurant. However, before he can do this, he must go to 11 different agencies at three levels of government—federal, state and local—for a total of 13 different permits. Obviously, this takes time and money. And now he faces an additional problem. He has made it through eight of the agencies, but if the other permits are not received by May 1, he will have to begin the process all over again because some of the permits he has obtained will expire.

This is clearly absurd. Marina operators face the same type of situation. At the very least, there must be greater coordination and cooperation among regulatory bodies. The Connecticut Department of Environmental Protection (DEP) has taken a significant first step by creating a permit information office. Anyone having to deal with DEP can now work with one person regardless of the number of different DEP permits he may need.

But, more of this needs to be done. As I indicated, many times a person must go through essentially the same permit application processes with DEP and the Army Corps of Engineers. To the extent that the same information is involved, agencies such as these should work together. Why couldn't DEP and the Army Corps hold a *joint* hearing on pending applications for the same project?

Government regulation has its place, but it must not be allowed to reach the point of placing insurmountable roadblocks in the way of the private sector.

Land Use

Some states, including Connecticut, have recognized recently a problem with farm land similar to that marina operators are beginning to face. The state is now seeking ways to protect this farm land. It seems to me that the time is fast approaching for similar efforts to be undertaken with regard to waterfront property.

As I indicated, those of us in the marine industry have all received tempting offers for our property recently. As we face growing pressures on our businesses in terms of property taxes, and regulations, all of which serve to drive up the cost to the consumer and/or drive down our already low profit margins, we will be more and more tempted to accept these offers.

When and if this happens, there will be two results. First and most obviously, there will be a decrease in boating services provided by the private sector. This, in turn, will lead to an increase in the demand for the public sector to provide such services. There are three things to keep in mind at this point. 1) The popularity of boating and related recreational activities is increasing. 2) The public sector, at least in Connecticut, has been somewhat reluctant to provide these services. 3) There are already severe pressures on both municipal and state budgets to fund already existing programs.

Thus, it appears unlikely at this point that the public sector could fill this gap. Thus, there would be an additional

imbalance between supply and demand for waterfront recreational facilities.

The second result, of more importance to this discussion, will be the removal of still more waterfront property from the pool available for public recreation. Further, to some extent, the property presently under private ownership tends to be that best suited for marina and boat yard use. It is costly enough to develop a new facility now. That cost will increase even more as such facilities are forced to locate in less desirable areas. It will be more costly to build a facility and provide the necessary access to Long Island Sound, the Connecticut River, Narragansett Bay and other similar bodies of water that are well-suited for recreational activity. Further, the environmental problems to be overcome may increase. For example, it may become necessary to do more dredging and remove more material.

Therefore, the need for coordination and planning of waterfront usage is increasing. Efforts will have to be made to balance the needs and desires of many interests, among them: local communities, recreational activities, private development, present owners of waterfront property, ecology, commercial interests requiring waterfront locations, and many more.

The Long Island Sound Study was a significant regional effort to look at this problem and seek some solutions. In Connecticut, as in many other states, we now have a coastal area management office that is working in this area.

This coordination and planning will not be easy to achieve. There are many factors which can impede the effort. For

example, the Connecticut Coastal Area Management officials decided to add 10 "public" members to their board. Immediately, they ran into the problem of there being many more than ten interests wanting to participate. In Connecticut, we have a further confusing factor. People consider local autonomy and local control over zoning as "sacred" as motherhood and apple pie. Any program or any effort that appears to lead to a diminution of municipal control will face a hard fight.

Summary

We at CMTA are hopeful that Connecticut's Coastal Area Management program will be able to overcome many of these problems. We also hope that the program will recognize the needs for recreation and the basic fact that certain businesses, whether related to recreation or not, must locate on the water. A marina can't be located in Pittsfield, Massachusetts.

Properly developed and implemented, a coastal area management program could solve many of the conflicts between the public and private sectors in a way that best serves the interests of all.

Waterfront land is a relatively scarce resource. If water related recreation is to have any future, we must begin to act to save waterfront land. Hopefully, this conference will be a meaningful step towards this particular problem and the general problems of recreational activities in an urbanizing environment.

Striped Bass Research

Robert B. Pond

Treasurer and Founder, Stripers Unlimited
South Attleboro, Massachusetts

History of Club

Stripers Unlimited was founded in 1965 as a service organization for striped bass fishermen. Its five main goals were:

- 1—To develop a fraternity of fishermen willing to help one another.
- 2—To stop indiscriminate netting of striped bass.
- 3—To develop legislation of benefit to sportfishermen.
- 4—To curb pollution of striped bass waters.
- 5—To develop more areas of public access.

We hoped these goals reflected the needs of the fishing fraternity.

We organized fishing tournaments in a three state area. The purpose was to introduce fishermen to new areas of fishing.

We published an annual guidebook listing our members and their fishing preferences. The guidebook also contained articles on fishing areas and techniques.

Our first goal was quite easily accomplished since it dealt with our own membership. The others were much more difficult since they dealt with legislation. Most legislation is decided in favor of economic impact so we felt any program which aided sportsfishing would have priority. A sportsfishing survey conducted in 1955 reported a total of 4,557,000 saltwater anglers who spent \$488,939,000. In setting our goals we failed to realize that the commercial fishery which was worth in excess of \$5,855,000,000, provided an income for over 125,000 fishermen plus many other people in related industries.

In fighting pollution we found that the commercial fishermen were as aware of the problems of pollution as we were.

Sportsfishermen found the lobster fishermen on their side during legislative hearings on wetlands preservation. Sports and commercial fishermen fought side by side for the 200 mile limit. From the *Maine Times* comes this observation about the 200 mile limit bill and pollution. "In its present

form all the 200 mile limit bill does is to give the U.S. the chance to extinguish its own flickering fisheries. If, for example, the fishermen continue to permit the massive pollution of the seas, sludge dumping off New York and other cities, the constant oil spills and tanker rinsings, the constant heave-ho of nuclear wastes, and the endless procession of toxic chemicals, metals, and non-biodegradables, then no amount of fish husbandry can replenish the stocks."¹

Both groups wished to protect the environment they loved. As Rene Dubos stated in *So Human An Animal*, "Deep in our hearts we still personalize natural forces and for this reason feel guilty at their desecration. The manifestations of nature are identified with unchangeable needs of human life, and are charged with primeval emotions because man is of the earth, earthy."²

Yet there were areas of conflict due to a lack of understanding of the striped bass themselves.

Daniel Merriman authored an excellent research project on *The Striped Bass Of The Atlantic Coast* for his doctorate in 1936 and 1937. He did a complete profile on the striper. He observed that "over a long period of time the abundance of striped bass on the Atlantic coast has shown a sharp decline." He established from catch records that striped bass were subject to a dominant year class phenomenon³ which had periodically increased the abundance of stripers only to see that year class decimated within a three year period by over-fishing.⁴ From past records he also reported that "there can be little doubt that striped bass in early times entered and spawned in every river of any size where proper conditions existed along the entire Atlantic coast. As cities were built, dams constructed, and pollution mounted in one area after another, the number of rivers that were suitable for spawning became fewer and fewer."⁵ He was more concerned with the health of the rivers that were still suitable for spawning than the number of spawning females. He noted "there is no necessary connection between the number

of eggs produced in a particular spawning season and the number of fry that survive. It is apparent that environmental factors are most effective in determining the percentage of survival. Since the striped bass is an anadromous fish (moves from salt water to fresh to spawn) anything that affects the rivers in which the eggs hatch and larvae develop is worthy of consideration."⁶

Striped Bass Cycles

In 1965 we were experiencing the last of one dominant year cycle which had started in 1958 and had now run its course. The scarcity of stripers led us to the University of Rhode Island where we discussed Dr. Merriman's work and its implications with Dr. Saul Salla, head of the Fisheries Department. His solution to the problem was a suggestion to break the cycle by starting new areas of reproduction in rivers that once held spawning populations. This project seemed to be within our scope and limited budget.

Several important breakthroughs had been accomplished in hatching and rearing techniques. Funded by a special striped bass stamp in the Santee-Cooper landlocked striper fishery, Dr. Robert Stevens had developed the hormone treatment of female stripers to ripen the eggs in captivity. He encouraged us in our work. At Edenton National Fish Hatchery, Nathan Powell had developed rearing techniques for fry and fingerling striped bass.

In the spring of 1970 Richard Salzburg, a graduate student from the University of Rhode Island, and I took a U.R.I. hatchery truck and one car and headed for Maryland. With the help of Joseph Boone, a Maryland fisheries biologist, and the commercial fishermen we were able to get several ripe males and one ripening female striped bass. We made the long trip to the Edenton National Fish Hatchery where Nathan Powell, hatchery superintendent, was waiting to inject the fish with hormones. We were very hopeful of success but the eggs failed to survive.

We managed to acquire some striped bass fry from North Carolina and learned how to rear stripers from larvae to fingerlings during that year.

Hatchery Operation

In 1971 we set up our first hatchery operation in Vienna, Maryland on the banks of the Nanticoke River. However these fish behaved differently from the South Carolina fish and failed to ripen properly in captivity. We finally had to rely upon the commercial netters to obtain ripe running females for the eggs we needed. The survival rate was very poor but we obtained enough surviving fry to take back to our newly acquired headquarters in South Attleboro, Massachusetts. We were able to raise a few and watch them develop. Certain odd behavior patterns became evident. The fry became lethargic, started to spiral in the tanks and failed to develop a visible swim bladder. We took samples to the University of Rhode Island to Dr. Richard Wolke, who sent them on to Cornell University for further study. No results were obtained.

Later in the spring of 1971 Richard Salzburg and I took the U.R.I. hatchery truck to the Hudson River and with the help of the Hudson River Fishermen's Association, obtained male and female striped bass which we took back to U.R.I. where Bruce Rogers, a graduate student at the University's Experimental Station, had set up a pool for the fish. At this time Bruce Rogers suggested we have the eggs analyzed for chlorinated hydrocarbons since the fry behavior indicated symptoms of DDT poisoning. DDT was known to damage nerves and to inhibit the reproduction of fish.

Discovery of DDT and PCB Contamination

Dr. Charles Olney of the Agricultural Department at U.R.I. made the analysis. He found high levels of DDT in the eggs of the Hudson River fish.

Our guidebook for 1971-1972 reported our findings and our fears that these chemicals were in sufficient quantity to eventually destroy the striper population.

In 1972 we managed to raise a small supply of Maryland fry to fingerling size. We stocked these in the Parker River at Plum Island in Massachusetts. We had more analyses of striped bass eggs done and found that an industrial chemical, polychlorinated biphenyls was present. It had probably been present from the beginning but a new type of analysis had just been perfected in Sweden which was able to detect PCB. PCB is similar to DDT, is much more persistent and is much more prevalent in the environment.

In 1973 we continued to observe damage to Maryland striped bass eggs and fry and we recorded our observations with photography. We recorded on film the weakening of the egg membrane to a degree where rapid movement of the eggs caused the weight of the developing larvae to tear the tissues. Photographs also showed the eggs stretching into an hour glass shape and finally rupturing? in other eggs small holes appeared in the membranes allowing the yolk material to escape. We lost about 85 percent of our eggs during the first twenty-four hours due to these two causes.

At about thirty hours, while the larvae was still in the early stages of development, the outer corion which protects the small developing cells, ruptured and exposed the immobile, helpless larvae to the outside elements. The few which survived these insults and lived for seven days died when their swim bladders failed to inflate. This occurred in 99 out of 100. Needless to say we were extremely concerned for the survival of the striper population.

Federal Research Projects

As a result of our concern, two federal projects were initiated. The first was a monitoring program conducted by the Fish and Wildlife Service of the Department of the Interior. They analyzed the eggs of spawning stripers from Florida to Maryland for chemical contamination. They found extremely high levels of contamination in all of the Maryland eggs tested. The second project was conducted at the Gulf Breeze Laboratory in Florida. Its purpose was to establish levels of PCBs toxic to fish larvae. They established a level of 7ppm

as toxic to the flathead minnow. Since the levels in striped bass eggs were as high as thirty parts per million this increased our concern for the striper. We expected others to share this concern. However the state of Maryland considered everything to be normal. Perhaps their seeming lack of concern stemmed from the fact that mortality in the hatchery could have been caused by human error, such as poor oxygen supply or poor handling techniques.

It wasn't until 1975 that the trouble we had observed in our hatchery began to appear in the commercial striper fishery. The 1970 dominant year hatch which had influenced the fishery since 1973 had outgrown pan rock size. The lack of these three and four year old fish was a most telling blow to the commercial fishery. Later, during the summer, the sports catch indicated an absence of two year old fish and the danger to striped bass became obvious. This indicated that since 1971 very few stripers had survived to reach the yearling stage. The most frustrating thing was that our group seemed to be the only ones concerned enough to take action.

In our 1975 guidebook we wrote a fictional story about the plight of the striper and the possible effects of chemical contamination on humans who ate the fish. We had reviewed the very limited information available on the effects of chlorinated hydrocarbons on humans as documented in *Silent Spring* and reports on Yusho disease in Japan.

Threatened Species

On October 8, 1975 we applied for a threatened species classification for striped bass under the Endangered Species Act. Frankly, at this point, we felt we should apply for a threatened species classification for man as well, but lacked direct evidence that he was in as dire straits as the striped bass.

Our application was rejected with no mention made of the points we had documented such as the high levels of chlorinated hydrocarbons in the eggs, the damaged eggs and fry and the lack of recruitment into the fishery. The National Marine Fisheries Service concluded their statement of rejection "the striped bass population of Chesapeake Bay and the Hudson River are not now threatened with extinction and are unlikely to become so in the foreseeable future."

During the time our application was being considered however, the state of New York determined that the flesh of the Hudson River striped bass had levels of PCBs high enough to render them unfit for human consumption. About the same time Kepone, another chlorinated hydrocarbon, was discovered to be in high levels in the James River in Virginia. Because of these findings both the Hudson and the James Rivers had been closed to commercial harvest of striped bass.

In November of 1975 the Congressional Research Service of the Library of Congress published for the Committee on Science and Technology a report on "The Effects of Chronic Exposure to Low Level Pollutants in the Environment". Among the observations of this report were the following statements. "The advent of radiation from a number of sources as well as chemicals in large quantities with the po-

tential for producing mutagenic changes, have produced an increased concern for the impact on the genetic makeup of a highly industrialized society."⁷ They quoted the March of Dimes as follows. "Birth defects are the foremost child health problem in the United States."⁸ Their thoughts on mental retardation, "if the malformation induced by thalidomide were a mental retardation of 10 percent of the I.Q., instead of a highly characteristic and unusual deformation of the limbs in an equal number of subjects, we would be unaware of it to this day."⁹ Quoting Dr. Epstein they remarked, "there is a growing realization that much human disease is environmentally caused. We are talking about real major health problems, such as preventable cancer and birth defects and not esoteric problems of interest to the extremist few."¹⁰

When applying for the threatened species classification for striped bass we were also concerned with possible effects on humans by low level chemical contamination. The Congressional Research Service in their report enlarged their concept of the Endangered Species Act to include the following. "In regards to endangered species in fish and wildlife and the ecosystem, one has several concerns; 1) whether the effects on individual organisms are symptoms of possible human hazards; 2) whether economically valuable species are being adversely affected and; 3) whether a species is threatened with extinction. Thus the problem in viewing ecological impact of low level environmental insults is in determining when the adverse effects either threaten the species or indicates a threat to human health and welfare."¹¹

DDT and PCBs Subtle Effects

Dr. George Harvey published a paper on *Observations on the Distribution of Chlorinated Hydrocarbons in the Atlantic Ocean Organisms* in which he made the following observations. "Since both DDT and PCBs are known to operate in subtle ways, producing susceptibility to disease, impairment of instincts, reduction of reproduction potential, such effects might easily require several generations to become evident in population reduction. However the concentrations of PCBs that we found to prevail in the Atlantic Ocean organisms during 1970-1972 are within the range that could produce effects."¹²

We have observed such effects in our work with Maryland striped bass eggs and fry. Our observations of fingerling behavior have convinced us that extreme nerve damage exists in Maryland fish when compared to the North Carolina striped bass. Their feeding instincts appear to be impaired. They have become bottom feeders refusing to take food as it drifts down through the water. In nature we are now observing fewer striped bass feeding on the surface. Almost all striped bass caught by sports anglers are now caught on bottom rigs, on live bait or on deep trolled lures. Compared to ten years ago this feeding behavior in the wild indicates a dramatic change from their former habits when surface lures accounted for much of the striped bass harvest.

Recently, while fishing in the ocean off Martha's Vineyard,

we encountered stripers with eggs only hours away from ripeness. They were far from their spawning rivers. A biologist from Montauk, New York found similar ripe fish in the ocean and was able to strip the eggs from the fish, hatch the eggs and raise the fry in his laboratory.

Any one of these instinct changes alone should be enough to warrant high level concern for the striped bass but we have been unable to get any responsible government scientist to take an interest in studying these rather obvious changes. Possibly they feel that there is little hope in trying to do anything about the problem.

Possible Human Hazard

However, if what we are observing indicates a "symptom of possible human hazard" then something must be done about it. From our observations so far it would seem that these poisons cannot be handled by the reproductive system. Rene Dubos in *So Human An Animal* states this about genetic disturbances. "As a general rule the processes essential for survival and reproduction are buffered against environmental and genetic disturbances; in other words, they are not readily affected by the environment. Two eyes, a four chambered heart, the ability to maintain an approximately stable body temperature, the suckling instinct in an infant, the sex drive in an adult, the capacity to think symbolically, and to learn a symbolic language are characteristics that develop in almost every human being irrespective of the environment in which he lives."¹³ The buffer in striped bass does not seem to be working, and observing the increased number of hyperactive and learning disabled children that teachers report coming into the school systems, I wonder if it is working in humans.

Stripers Unlimited sees the plight of fish and wildlife as symbolic of the plight of mankind.

In our 1972-1973 guidebook we reported the story of PCBs and the threat they pose. We are well aware that the manufacturers of these chemicals had no desire to poison the environment. The problem was not even recognized by the chemists who developed them. It was only later after the damage had already become apparent in wildlife that the offending chemicals were identified and their pathways traced.

There has been a toxic substances bill before Congress for the last five years that would force pretesting of toxic materials, and it still has not been passed. The bill is already fifty years too late. In our insane desire for growth we are using this planet as if we were the last generation to inhabit it. The bureaucratic tarbaby called government seems to be unable to deal with the problems created by our technological society.

One of the big frustrations in trying to focus attention on the problem of the striper is that there is no expertise in any established agency to deal with the contaminants already loose in the environment. In *The Effects of Chronic Exposure to Low Level Pollutants in the Environment* A. B. Bridges is quoted as stating: "A final recommendation is that, at this point in knowledge, it is dangerous to consider mutagenic

effects on the population of radiation and chemicals in isolation from each other." He suggests that an Environmental Genetics Hazards Commission might eventually be necessary in order to consider environmental genetics damage in a comprehensive fashion.¹⁴

The frustration of Stripers Unlimited in seeking to find someone qualified to tackle the problem we saw developing in the striper fishery before it reached its present crisis stage, makes us feel that the time for such a move is right now.

Stripers Unlimited has broadened its outlook over the past ten years. From a narrow-thinking, self-interested organization of fishermen it has grown into an association of people concerned with all aspects of the environment, especially the mindless destruction of our finite resources.

Dr. Merriman's work in 1936 indicated a need to protect small striped bass. Minimum lengths were established which increased the weight of the fish landings by two or three times. This increase was reflected in the commercial landings statistics as he predicted, reaching a peak in Maryland in 1961.

In Chesapeake Bay, since 1969, commercial landings indicate a marked decrease in several species of fish. Striped bass are down 45 percent. The white perch and yellow perch have decreased 75 percent. Two anadromous fish, the alewife and shad, are down 82 percent and 84 percent respectively.¹⁶

Between 80 percent and 90 percent of the aquatic vegetation is gone from the bay. Swans, geese, and ducks that depend on this vegetation are now forced to feed in farm fields surrounding the bay.

Beautiful, unique Chesapeake Bay, once touted as being the most studied and carefully guarded estuarine zone in the world by the scientific community, is being allowed to die in the name of progress.

Dredge spoil from the C and D Canal has loosed great quantities of silt to float in the bay. Dumps containing such chemicals as PCBs still leach into the marshes. Waste treatment plants using chlorine continue to do their damage to the rivers feeding the bay. Power plants are now operating or are planned for siting on prime striped bass spawning grounds.

Summary

The urbanized society inhabiting our coast exists much like its tree-top neighbor, the squirrel, storing food in cans and packages on supermarket shelves, as a squirrel stores nuts. We have become far removed from nature. We have become as unconcerned as the animals with our future source of food, from the sea. We have allowed the sea to become polluted to such an extent that it can no longer be considered the safe, clean, inexhaustible source of food man needs so desperately.

Man must now, for his own survival, begin to consider himself to be more than an animal. We were given dominion over the land and sea. Dominion is defined to be "a wise ruler" not a destroyer. As Rene Dubos so aptly put it, "all successful individual lives and all successful civilizations have

been supported by an orderly system of relationships linking man to nature and society."

"The rape of nature, therefore, is not the only thing at stake, but the very survival of mankind."¹⁵

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Using Coastal Resources; or, Can You Get There from Here?

D. W. Bennett, Conservation Director
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The American Littoral Society is a public interest, non-profit organization of some 5000 members interested in the study and conservation of marine life in the coastal zone. Half our membership lives in the urban swath from Boston to Washington, D.C., nearly all of them within an hour's drive of the shore, many within walking distance. While many of our members use the coastal area for recreation, others are commercial fishermen and to them the ocean is their livelihood.

The two major problems I see about Coastal Recreation Resources in the Coastal Zone, the title of this conference, are (1) the resource—the environment—is in trouble, and (2) there are too many people too close to it. Of course, the two problems are related in that the environmental stresses are brought about by people. In fact, the most direct solution to this stress or overuse of the resource would be to have fewer people. It is probably best to dismiss that solution immediately, for while the population of the northeast is growing less rapidly than in the so-called sunbelt of the country, there are no indications that we can turn the clock back a century or so and free the coast from massive human pressures. People and their pollutants will remain with us; we must try to cope with them.

But things can be done—some that the Littoral Society has been doing—to improve the coastal environment and thus its usefulness as a recreational resource. Everything I suggest relates to one issue, protecting coastal resources and getting people to use them carefully and well.

What we as a "special interest," or what I prefer to call a "public interest," group have been doing is trying to protect and upgrade the marine environment on the one hand and helping provide better—cheaper, freer—access to the shoreline for recreation.

The Marine Environment

The Society's first major environmental action involved, and

still does, the protection of coastal zone marine habitat, especially the estuaries and salt marshes which are so valuable as spawning and nursery grounds for many game fish and as year-round habitat for shellfish, waterfowl, and shore-birds. This means that the Society came out against and has campaigned to stop dredge-and-fill operations in salt marsh and radical modification of estuaries which destroy habitat and disrupt normal water circulation patterns. We estimated that our most important single function was to prevent damaging permanent land modification—once you fill marsh it's gone, along with its natural productivity.

Our secondary concern along the coast has been water pollution, secondary only because we believe that water pollution in many cases is temporary, that its processes can be reversed. We have been active in support of the Federal Water Quality Act and state regional sewage plans. We support passage of a federal law dealing with the discharge of toxic substances into waterways. One of our special publications deals specifically with power plant siting in the coastal zone, documenting the case against once-through cooling in coastal waters. We are a member of a coalition arguing for much tighter controls on outer continental shelf oil drilling. But there is nothing novel in our stand on water pollution. We are against it. Who isn't?

So, one side of our effort is to protect the natural resources of the coast, to protect wildlife and its habitat in the coastal zone. Let us agree for this discussion that there is wildlife there and some habitat. There are birds to see, beaches to walk, and fish to catch.

The other side of our effort is to make sure that people can get to the resource, that there is public access. We assume that the marine waters of this country below mean high tide are public waters, held in trust by the States for all people to share equally. While this right comes from common law and has been applied to fisheries and navigation, recent court decisions have held that these rights extend to

other users of the sea—of tidal waters—including recreation. This right of access can be broken down into several categories, which I would like to list and talk about.

Beach Access

The public, especially in the Northeast, is having trouble getting to beaches easily and inexpensively. This is most true for typical beach users, those who come for the day to swim and lie in the sun, but it is also true for other beach users: surfers, fishermen, divers, beachcombers, and even joggers. (A Society member was escorted from a beach for jogging off-season last winter. Another was asked to leave a beach on Christmas Day—the beach was “closed for the season.”) Parts of the shoreline are closed to the public because the adjacent uplands are privately owned. Some beaches themselves are privately owned. Sometimes passage parallel to the waterline, even below mean high tide, is blocked by fences.

It is our belief that a major effort must be launched, probably in the federal government, to open more beaches to the public, either through the provision of access across uplands to the beach or by the outright purchase of sections of shoreline that have passed into private hands.

Boat Launching Facilities

The same holds true for launching ramps, too little access to tidal waters. In many cases, local towns will bar out-of-towners from municipal ramps or will charge higher fees for non-residents. Because ramps lead to public trust (riparian) tidal bay and river bottoms, states and the federal government have a handle on licensing ramps and should assure that reasonable non-discriminatory fees are charged.

Bridge Fishing

We need to redefine what bridges are, especially in coastal waters. Rather than considering them structures to carry cars across water, they should be considered structures which can both carry cars and cater to fishermen. This can be done by building hanging platforms from bridges for fishermen. A bill in the New Jersey legislature would force the Department of Transportation to design fishing platforms into all new bridges crossing suitable waters. Florida has had such a program for years. This is an especially valuable arrangement in urban areas. Many city and town bridges can serve fishermen.

Fishing Piers and Jetties

All such structures out into coastal waters should be thought of as possible fishing platforms. Jetties can be capped to provide safe fishing accesses. Piers might be built where suitable. Abandoned bridges and city docks can be used for fishing.

Marinas

Marinas are, at once, a natural, normal use of coastal land and, in all too many cases, polluters of the coastal marine environment. Our stand is that until a solution to the sewage problem caused by large boats in large marinas is solved, no new marina construction or expansion of existing marinas should be permitted. I bear little sympathy for a system that encourages the dockage of thirty-to-fifty-foot boats whose owners are permitted to spill and dump at will. Both EPA and boating associations have gone back and forth on the issue of overboard discharge versus holding tanks. While there is no easy solution to the problem, neither side has been particularly impressive in its attack on the issue.

Stocking

In general, we take a dim view of programs to stock fish to increase angling success in marine waters. A better approach is to protect habitat and adopt regulations regarding existing stocks, and let nature do the bulk of the work. However, salmon in New England waters might add impetus to the drive to clean up the rivers and remove migration-blocking dams.

These are some of the issues that the Society acts on as a certain kind of “community.” We have published our positions on other issues: the 200-mile limit, deepwater ports, LNG plants, oil refinery location, and commercial versus sport fishing squabbles. Our conservation committee helps decide what we do and our members return questionnaires which seek their environmental concerns.

We see our role as one of calling agencies’ attention to things we believe should be changed. We have a point of view and like any “special interest” group we use any means available to get that view out and about. But the phrase “special interest” group is a questionable label. I prefer to think of environmental groups like the American Littoral Society as representing the public’s interest, in issues that affect the public’s environment. Our interest is not “special;” it is universal.

Utilization of Living Resources



A Description of Recreational Finfishing Along the Atlantic Coast in Relation to the Utilization of Living Marine Resources

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Recreational vs. Commercial Fishes

It is popular today to speak of recreational fishes or commercial fishes. But there is really no such division of species—there are only fishes. It is true that recreational fishermen may spend a considerable amount of time and money and travel a long distance to catch a special kind of fish which has little or no value to the commercial fishermen. Nevertheless, very few species of fish are caught wholly by one group or the other.

We persist, however, in thinking of some species as being purely of recreational or of commercial value. Tarpon, a large, bony, herring-like species, besides being highly sought by anglers as an excellent game fish, is sometimes canned and marketed. Also, its large scales are sold as curios. Menhaden, while one of our most important commercial species, is sought by anglers who frequently set out to foulhook these plankton feeders to use as bait for larger carnivorous fishes, such as striped bass. And east coast anglers would be in dire straits if they did not have menhaden chum for bluefishing. Still, we have been so accustomed to thinking of either our commercial fisheries or our recreational fisheries that we usually see them as separate entities and often even antagonists. But our fisheries should not and cannot be thought of as being separate if we are ever fully to utilize fishes as an important living resource of the sea.

Unhealthy Sign?

For years now in speeches, reports and articles we hear again and again that the annual United States commercial catch of food fishes has remained at about 2 billion pounds for over two decades.¹ Economists view this sustained level as an unhealthy sign, considering the extent of our coastline, the size

¹Within the last ten years or so foreign nationals have been catching nearly a billion pounds of food finfishes annually off United States shores.

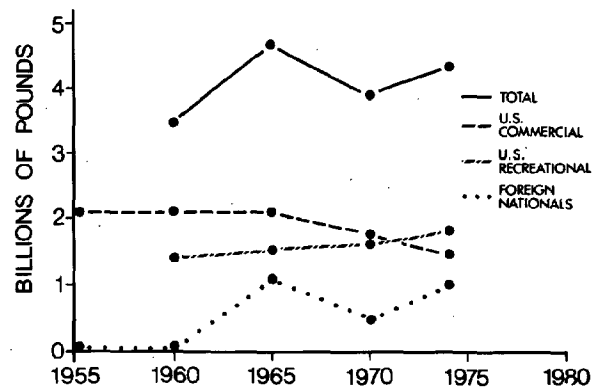


Figure 1. Graph showing the catch of marine food finfishes from off the United States by various fishing groups.

of our estuarine area, and the breadth of our continental shelves. If, however, we add to the commercial catch the amount caught by anglers, we see that the effective catch nearly doubles (Figure 1) and that the average yearly increase is at about two percent, a rate very close to that for the rest of the world.

It is not to say, however, that there are no differences between these two groups of fishermen. Anglers catch and keep many more kinds of fishes than do commercial fishermen. Of the more than 1,000 species of fishes off our Atlantic coast, nearly half are caught at some place and at some time by anglers. In addition, nearly 100 of the remaining species, especially the forage fishes, are used by anglers for bait, either whole or ground into chum. Compared to what anglers catch, less than 100 species of fishes are commercially important. And of these, the most important, as judged by numbers, are forage fishes. For example, along the Atlantic coast during 1970 there were 28 categories of fishes which yielded to anglers more than ten million pounds (Figure 2).

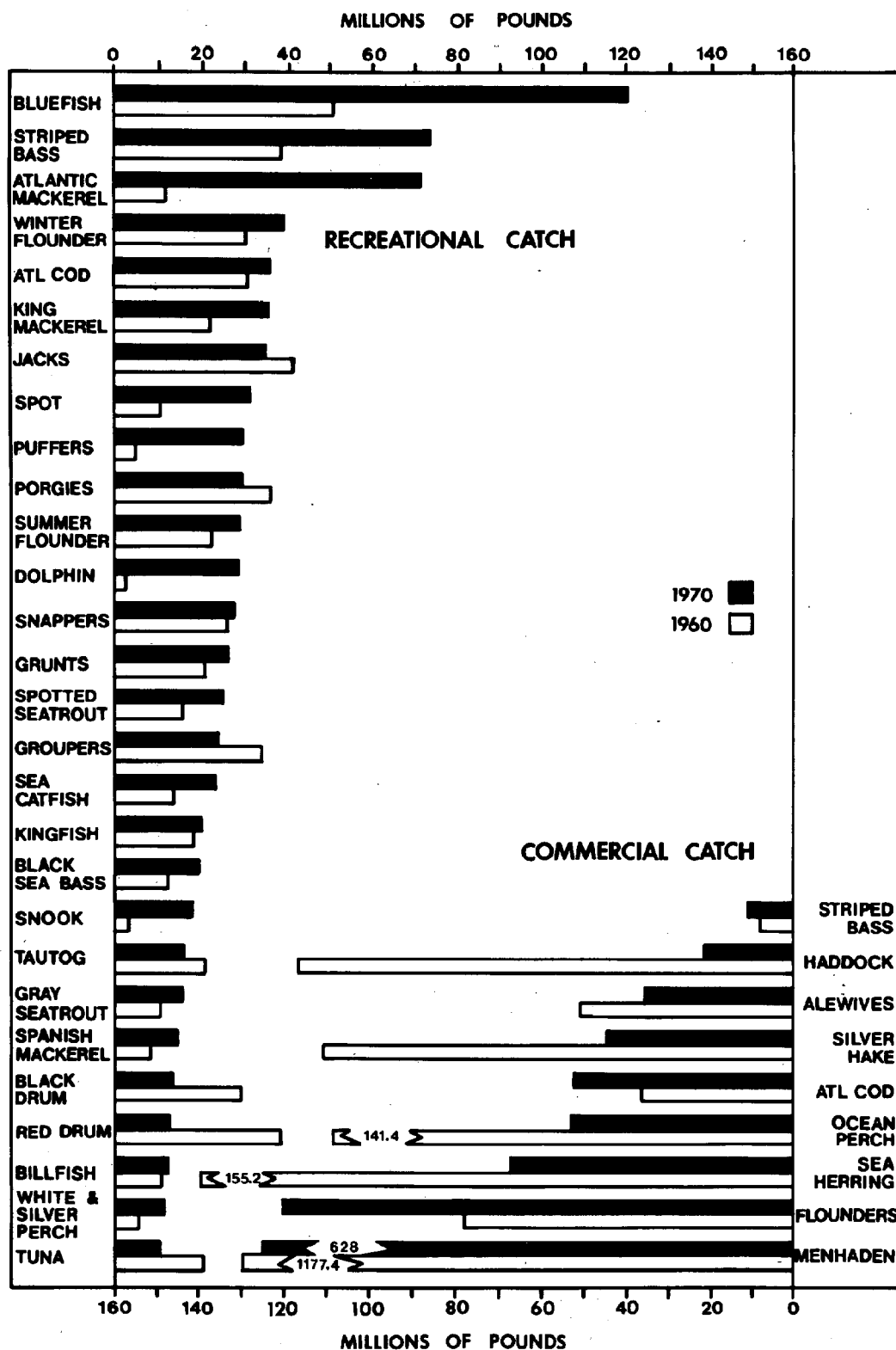


Figure 2. Graph showing finfishes of the Atlantic coast yielding 10 million pounds or more to recreational and commercial fishermen in 1960 and 1970.

There were only nine categories that yielded that amount to commercial fishermen.

While both commercial fishermen and anglers strive to catch fish, commercial men must catch substantial quantities in order to stay in business. As a result, they have concentrated on two major groups of fishes. One group consists of pelagic fishes which live mainly in the upper levels of the sea and which form dense schools, such as the menhaden, herrings, tunas and mackerels. The other group consists of demersal fishes which congregate on or close to the bottom, including species such as the flounders, cod, haddock, halibut and hakes. Anglers, on the other hand, are fishing for recreation as well as for food, thus they can justify spending long hours and considerable amounts of money to catch fish, even if they often come home empty-handed or with only a single specimen. As usually happens, the catch of an individual angler is rather small for each trip he makes.

Nevertheless, these individual catches add up to a substantial amount because there are so many anglers—there were over nine million of them in 1970 and their numbers have been increasing at a rate of 300,000 a year. They fish the year-round at all hours of the day and night along the coast and offshore wherever people have access to the water and whenever the weather permits. They fish at the water's edge; from the beach or shore, docks, bridges, piers, wharves, bulkheads and jetties; and on vessels of all sizes ranging from small dories to ocean-going boats measuring more than 120 feet in length and sailing more than 100 miles offshore.

Fish Migrations

The availability of particular species determines to a great extent what fishes an angler will catch. And the availability is determined in large part by the changing patterns of fish migrations. Along our Atlantic coast all but a very few of the species are migratory and those that don't migrate are usually small and of little direct use to anglers. Some species, such as the tunas and swordfish travel thousands of miles during a single season, crossing into waters claimed by several countries. Others, the tautog for example, which usually occur within several miles of the coast, carry on limited migrations, moving into somewhat deeper offshore water during the cold of winter and into shallower inshore water during the warmth of summer.

Most species of fishes in this hemisphere tend to move northward and shoreward during spring and southward and offshore during fall and winter, their movements being correlated to a considerable degree, though imperfectly, with water temperature. This is true of bottom-dwellers, such as cod and flounders, as well as those which are characteristically active swimmers and more or less independent of the bottom, such as Atlantic mackerel and bluefish. The fishes move along the coast as temperatures change progressively from less favorable to more favorable levels. In doing so they have the annoying habit, at least to fishery managers, of not paying any attention to political boundaries and continually cross one after the other with little difficulty. Each species concentrates within areas where the prevailing temperature

best fits its particular requirements. Once a species finds an area where the temperature is suitable, its movements become dominated by other factors, such as the location and availability of food or suitable spawning grounds.

Temperature Structures

Along the Atlantic coast there are complicated temperature structures of the water which permit a remarkable diversity of fishes to gather during the course of a year, or even during a single season. This phenomena is perhaps best seen in the Middle Atlantic Bight, that is, the area extending from Cape Cod, Massachusetts, to Cape Hatteras, North Carolina, and including the entire continental shelf between these two capes. During spring as the nearshore and surface water begins to warm, schools of Atlantic mackerel migrate from offshore and southerly areas. At the same time, and even throughout the summer, a large cell of cold winter water persists along the bottom.

Cold-water species, such as Atlantic cod and pollock that had migrated down from the north during the winter return in the spring, though some remain in this cold cell. With heating of the surface water during the summer, warm-water migrants move in, for example bluefish, seabass and summer flounder. As the water warms even more during the summer, many oceanic and pelagic fishes arrive—skipjack tuna, Atlantic bonito, little tunny. From mid-summer to early fall when the temperatures of nearshore and surface water are warmest, there are tropical fishes, such as snappers, groupers, and triggerfishes. As the water cools in the fall, the warm-water migrants return southward or offshore to spend the winter. About the same time the cold-water migrants move in from the north to spend the winter. Thus, from spring to fall, anglers have a wide range of species at their disposal—cold-water, temperate-water, tropical and oceanic groups. In winter, though the last three groups have left, anglers still have many cold-water species.

Fishing "Whims"

In addition to the patterns of fish migration, the species of fishes caught are determined in part by the whims of the angler as to the choice of species he will seek, where he will fish, and what bait he will use. These choices change continually over the years, sometimes very quickly. For example, just this last year we have seen a tremendous interest in angling for sharks. People who a short time ago would never dream of wasting their time fishing for them, are now sailing offshore almost daily and spending large sums of money to catch one. Tilefish is another example. In 1970, within a few months after the accidental rod and reel catch of tilefish off New Jersey, some twenty large party, charter and private boats began making the necessary 200 mile round-trip to catch this splendid fish. It lives only along the bottom in the deep water at the edge of the continental shelf off our east and gulf coasts.

Some fifty years ago giant bluefin tuna, weighing from 300 to over 1,000 pounds, were looked upon as being a nuisance, not only to be avoided but to be killed by any means.

These large fish are now the basis of an important fishery and are so eagerly sought by both anglers and commercial fishermen that allocation regulations have recently been placed on fishing for them. Early in the 1900's a small angling fraternity started for summer flounder fishing. People became interested in this species partly because of its fine flavor and partly because of the scarcity of other popular species at that time. Today summer flounder rank among the most important of our fishes.

Interdependency of Marine Species

If we looked closely at a particular species that is sought almost exclusively by anglers, say tarpon, and examined some of the various factors that contribute to its survival and well-being—its rate of reproduction, growth, longevity, food, predators, diseases and so forth—we would very soon see its interdependency on many other fishes as well as other marine organisms. For example, to speculate a little, suppose the growth during the first six months of a tarpon's life depends on the abundance of a larval stage of ballyhoo, a small baitfish. The number of surviving larvae may depend on the amount of spawn produced by mature ballyhoo, which young tarpon eat. Ballyhoo, being in demand by anglers for bait which they rig for billfishes and other large oceanic fishes, could be extensively fished to supply anglers, so much so as to be overfished. Conceivably the total spawn might be reduced enough to affect the tarpon.

Suppose that the number of tarpon reaching maturity depends on the rate of predation by the bull shark. Bull sharks being in demand for their skin which is used to make fine leather, may be so heavily fished by commercial men as to reduce their numbers, thus acting to increase the likelihood of tarpon reaching maturity.

Or suppose late in the tarpon's life, shrimp and small crabs form a very important food item. A pesticide sprayed over a nearby marsh to kill mosquitos may quickly wash in-

to the estuary and kill the shrimp and crabs as well. This loss of food could greatly reduce the growth rate of tarpon as well as other species of fishes that the tarpon would also eat.

Suppose an angler poling a boat along the shallow expanse of a pristine estuary finds in fishing tarpon great excitement and pleasure. He enjoys the fishing and tranquillity of the estuary so much he decides to buy some of the marshland to build a vacation home. Thus, he will be close to his favorite fishing area and be able to fish it more often. He dredges the shallow water to provide a suitable harbor for his boat and fills the marsh where his house will be. Other anglers fishing in this estuary do the same. The filling of land with material dredged from the bottom eliminates the plants along the shore as well as the bottom vegetation which provides nursery areas and shelter for the considerable assemblage of young fishes and invertebrate animals including shrimps, crabs, pompano and other commercially valuable species as well as young tarpon. Gradually, but inevitably, the once excellent fishing falls off and may in time cease altogether.

Summary

What we must learn is that we cannot deal effectively with any single species of fish without considering all of the species as well as the other marine organisms, for they are all interdependent to a greater or lesser degree and they affect each other in various ways. Nor can we disturb the habitat of one species without affecting the lives of many others. Recreational fishing involves many people of diverse interests; indeed, many times more than the nine million that fish each year. We must learn that we cannot treat recreational fishing intelligently without considering all of the biological, economic and social demands placed on it by all of the various groups that use the marine environment. Only when this is done can we ever have wise management of our fishery resources.

Marine Recreational Fisheries— Uses and Values

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In 1970, the responsibility for federal activities related to marine game fish was transferred from the Bureau of Sport Fisheries and Wildlife in the Department of the Interior to the newly created National Marine Fisheries Service in the Department of Commerce. Included in this responsibility is the collection and dissemination of statistics on commercial and sport fishing, as cited in the Fish and Wildlife Act of 1956 (public law 84-1024), and on migratory marine fish species and the effect of fishing on them, as cited in the Migratory Marine Game Fish Act of 1959 (public law 86-359). These activities also include economic and biological studies, and management programs for recreational fishery resources. A combination of all these activities are necessary for sound management and conservation of the resources to achieve maximum benefits to the public. Economic and social statistics are necessary to determine the extent of the benefits to society from our activities on marine recreational fisheries, and how best to achieve maximum benefits. Catch and effort statistics, coupled with biological studies, are needed to develop plans to effectively manage the fishery resources. I would like to first discuss the growth of the marine recreational fisheries in the United States. The term recreational fisheries should be taken to include essentially all non-commercial fishing.

Marine Recreational Fisheries

National surveys of fishing and hunting have been conducted for the Department of Interior by the Bureau of Census at 5-year intervals since 1955 to estimate, for broad geographical areas, participation and expenditure data on all fishing and hunting activities in the United States. In 1955, according to this survey, 4.6 million saltwater anglers fished in the United States, and the number more than doubled in 15 years, with 9.5 million anglers in 1970. This increase in participation, at an annual rate of 5 percent per year, may be

attributed to various factors including an increase in the population, in real income per capita, in improved travel facilities and total travel per capita.

However, the major contributor is very likely the increased amount of leisure time since 1955, with increased participation in various outdoor activities, including saltwater fishing. Recreation days spent saltwater fishing in 1955 totaled 58 million and in 1970 increased to 114 million, an average of 12 days annually per angler. Anglers made 95 million trips during 1970 traveling 2.6 billion miles. Marine recreational fishermen spent \$489 million in 1955. Expenditures in 1970 totaled \$1.2 billion, an average annual expenditure of \$129 per angler or \$11 a day per angler while on a trip. Five categories accounted for over 80 percent of total expenditures in 1970; equipment 38 percent, food and lodging 14 percent, bait 12 percent, transportation 10 percent, and party and charter boat fees 7 percent. Nearly 60 percent of equipment expenditures were boat related and 20 percent was for fishing equipment.

Catch Statistics

Systematic collection of statistics on the catch of marine recreational fish over large geographical areas has been attempted only in recent years, largely because collecting such statistics is difficult and expensive. Anglers are dispersed along the coast fishing from boats, piers, jetties, docks, and from shore. They may fish day or night, several days a week throughout the year. Both field sampling and indirect sampling methods, such as mail questionnaires and household interviews, have been used to collect catch statistics. Both approaches are expensive and have serious limitations, particularly on a national basis. Most states do not have a saltwater fishing license, which would provide a partial sampling frame. Several states have occasionally and irregularly collected catch statistics, although only the Pacific

states collect catch data continuously, but they do so for only part of their recreational fishery.

Until 1960, no catch statistics were available on marine recreational fisheries for the nation as a whole. Each 5 years since 1960, the Bureau of Census has conducted salt-water angling surveys as a supplement to the national surveys of fishing and hunting. Those persons identified as saltwater anglers in the national survey were asked to report the number and average weight of fish caught, by species, during the year for seven geographical regions of the United States, excluding Hawaii. Only anglers 12 years of age and older, classified as substantial participants by having fished during parts of at least 3 days or spent at least \$7.50 on the sport during the year, were included.

Results of the 1960 survey showed the 6.2 million anglers in the United States caught an estimated 633 million fish weighing 1.4 billion pounds. The catch increased in 1965 and again in 1970, when 9.4 million anglers caught 817 million fish weighing 1.6 billion pounds.

The spotted seatrout was the most abundant single species in the U.S. recreational catch in 1970, with anglers taking 67 million fish, or 8.2 percent of the total number of fish caught. Atlantic mackerel, spot and bluefish accounted for 6.4, 5.5, and 4.5 percent of the total number caught respectively. By species groups, the seatrouts were 13.1 percent of the catch followed by mackerels, croakers, and flatfishes. These four species accounted for over one-third of the total number of fish caught.

Bluefish ranked first in the recreational catch in total pounds landed for a single species, 120 million pounds or 7.7 percent of the total catch. Spotted seatrout, striped bass and Atlantic mackerel accounted for 6.7, 5.3, and 4.5 percent of the total weight caught respectively. By species groups, the mackerels ranked first in pounds landed, 157 million pounds, or 9.9 percent of the catch, followed by seatrouts, bluefish, and drums. These four species groups made up one-third of the total weight of the catch.

Sixty percent of the weight caught by recreational anglers in the United States was made up by 10 species or species groups; mackerels, drums, seatrouts, bluefish, flatfishes, striped bass, croakers, catfishes, porgies, and snappers.

In 1970, Atlantic coast anglers totaled 5.0 million, while 2.3 million anglers fished on the Gulf Coast, and 2.2 million on the Pacific Coast. Based on both the number of fish and the weight of fish caught, the most important species on the Atlantic coast were mackerels, bluefish, flatfishes, and striped bass. Gulf coast anglers found seatrouts, drums, catfishes, and croakers most important, while the salmon, Pacific basses, rockfishes, and bonito were predominant on the Pacific coast.

Anglers fishing in the ocean caught 43 percent by number and 53 percent by weight of the total catch with the remainder from sounds, rivers and bays. Boat anglers took 67 percent by number and 75 percent by weight of the total. All shore fishing accounted for 33 percent of the total by number and 25 percent of the total by weight.

Commercial Fishing Statistics

Most species of marine fish are now harvested by both sport and commercial fishermen. In 1970, United States commercial fishermen landed 4.0 billion pounds of menhaden, a species not taken by anglers. Now if you exclude the catch of menhaden as well as the catch in Hawaii, the Great Lakes and the Mississippi River, the commercial finfish catch in 1970 was 2.01 billion pounds. The catch by sportsmen in 1970 was 1.58 billion pounds, or 44 percent of the total U.S. finfish landings of 3.59 billion pounds.

Combining the recreational and commercial catches in the United States by species, it is evident that with some exceptions, there is little direct competition for the same species in some fisheries. For example, 95 percent of the tuna, 93 percent of the salmon and 91 percent of the haddock were taken by commercial fishermen. Sportsmen caught 95 percent of the bluefish, 90 percent of the croakers, and 88 percent of the striped bass. However, in local areas, there is certainly some direct competition, both seasonally and geographically, for these or other species.

I would like to now discuss the Marine Recreational Fisheries Statistics Program of the National Marine Fisheries Service. The data available to date have been collected at 5-year intervals using household surveys to interview anglers throughout the country. These surveys covered broad geographical areas, require a 1-year recall by respondents, and are based on a small sample size of anglers. The National Marine Fisheries Service recognizes the need for the collection of catch and effort statistics and has been devising improved survey techniques for an operational approach to the continuous collection of data on recreational fisheries.

Pilot Survey

In 1974, the National Marine Fisheries Service funded a combination mail-telephone household pilot survey to collect recreational catch and effort information in the District of Columbia and the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia.

This regional survey was in two phases. During Phase I, the population was screened by telephone to obtain information on participation in saltwater recreational activities during the previous 12 months and to provide a sampling frame for the second part of the survey. During Phase II, households indicating participation in saltwater recreational finfishing and shellfishing were sent mail questionnaires to obtain data on participation, catch of species, fishing effort, and expenditures for the first 6 months of 1974. A telephone followup questionnaire was administered to a sample of the nonrespondents to the mail questionnaire. Similar information was collected for the rest of 1974 in three bi-monthly periods.

Results of Phase I estimated 10.8 million marine recreational anglers in 4.9 million households in the aforementioned states fished in 1973-74. These participants included

recreational shellfishermen as well as finfishermen of all ages, without regard to frequency of participation or level of expenditure. By comparison, the 1970 salt-water angling survey estimated 3.4 million anglers, classified as substantial participants 12 years of age and older, finfished from Maine to Cape Hatteras, North Carolina.

The data from Phase II are now being prepared for publication and will include catch, effort, and expenditure estimates. A similar pilot regional survey was just completed for 1975 in the eight southeastern and Gulf states, from North Carolina to Texas.

Value of Marine Recreational Fisheries

I would like to now discuss the value of the marine recreational fisheries. The resource manager is frequently called upon to determine the value of a fishery for various reasons, including conflicting uses of the coastal zone, allocation of a fishery resource between user groups or for allocation of public funds. Various techniques have been proposed to assess the value of recreational fishing as well as other recreational activities. Evaluation of a recreational activity is difficult, since the intangible values do not fit well into conventional market mechanisms. We might ask what is the output of the marine recreational fishery? The fish caught are certainly important, although the value of the entire recreational experience must be considered. Thus, the output is really fishing.

When we think of fishing, it is usually the on-site activity that comes to mind, although this is only a part of the entire experience. First, there is the planning of the trip, then the travel to the site, the on-site activity, and the return trip home. The last and important part of the experience is the recollection; the memory value, if you will. If all the satisfactions outweigh all the costs of the trip, we then plan another trip. The total satisfaction, total benefits, are, therefore, a function of the entire experience. Thus, although the actual catching of fish is part of the value of the trip, the chance to get away from the work-a-day world, to have peace and quiet, or the companionship of others may be much more important as measures of the value of the fishing experience. In a sense, we are asking, how much would an angler be willing to pay to use the resource above what it costs to participate in fishing?

A part of the National Marine Fisheries Service effort in the sport fisheries program is to develop data in order to evaluate the benefits society gets from recreational fisheries resources. Another effort is to develop standardized procedures which will help assess these values. Given the limitations of data and methods available, and the apparent lack of agreement on how to determine the value of recreational fishing, some value estimates have been prepared by National Marine Fisheries Service economists. These estimates result from adding estimates of the primary and secondary benefits of the marine recreational fisheries. The primary or net economic value that should be assigned to a recreational day has been estimated between 75 cents and \$25, by the

United States Water Resources Council and others. The value within this range would depend on the type of recreational activity. Our economists have estimated that a day of marine recreational fishing has a net economic value of about \$13. Thus, multiplying \$13 by the 114 million days fished during 1970, the primary economic benefit of the marine recreational fishery would be about \$1.5 billion.

The secondary economic benefits of the fishery, in the form of income and employment, result from the total expenditures of anglers, or the cost of participation in the fishery. These secondary benefits might, in a sense, be a measure of the maximum loss that a local economy might suffer if the fishery were to disappear from the area. The actual loss to the local area would then depend on what alternative attractions it has or could develop, and the proportion of expenditures going to the local area. Total expenditures in 1970 by saltwater anglers were \$1.2 billion, which represents the secondary economic value of the fishery. Thus, adding the primary and secondary benefits, the gross value of the marine recreational fishery in the United States is estimated to be \$2.7 billion. This estimate does not include recreational shellfishing, which, for some areas, would add a substantial amount to the gross value of the fishery.

Domestic Commercial Fisheries

Estimates of value are available for U.S. domestic commercial fisheries at exvessel or dockside, wholesale and retail levels. However, the retail value of the commercial fisheries does not represent the total economic value of the fisheries to the economy. One method of estimating the gross value, based on a report by Gruen, Gruen and Associates, adds the primary economic value, estimated as one-half of the dockside value, to the secondary economic value, estimated as 3.2 times the dockside value. For 1970, estimated values of all U.S. domestic commercial fisheries, including shellfish, were \$613 million dockside, \$1.33 billion wholesale, and \$1.85 billion retail. The computed estimate of gross value is \$2.27 billion.

Excluding the catch of freshwater fish, shellfish, and menhaden, the previously mentioned 2.01 billion pounds of commercially caught marine finfish had an estimated dockside value of \$272 million representing a gross estimated value of \$1.01 billion. The estimated gross value of the marine recreational finfisheries in 1970 was \$2.7 billion, or about 2.7 times that for the commercial finfisheries.

Summary

As I indicated earlier, the collection of statistics is a costly and difficult task for both individual states and the federal government. However, data on marine recreational fisheries are needed. Projections indicate that by the year 2000 there will be 29 million substantial participants in marine recreational fisheries in this country, or three anglers for each one today. The future demands that will be placed on the fishery resources by these recreational anglers and commercial fish-

ermen require the development of rational fishery management plans.

A basic data element necessary for formulating these plans is adequate catch and effort statistics on the recreational fisheries. However, we must consider the goal of recreational resource management as providing maximum benefits to the user. Thus, determining the factors that provide anglers with a quality fishing experience is certainly important. Included in these factors are social, economic, and environ-

mental considerations such as species preferences, size preferences, the relationship between success and participation, availability of facilities, access, and detailed studies of the economics of the fisheries. A knowledge of these factors coupled with catch and effort statistics and the goals of the commercial fisheries are vital for the optimum utilization and allocation of fishery resources between and among user groups.

Conflicts and Management in Marine Recreational Fisheries

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Introduction

Over the years many words have been spoken and a good number of papers have been written about management in Marine Recreational Fisheries. Unfortunately, that's about all that's happened, lots of talk and paper wasted, but little effort expended to solve the problems or implement management programs directed at marine recreational fishermen.

When I was first asked to participate in this conference, I thought, "here we go again." However, recent events have caused me to be more optimistic. Congress has passed the "Studds-Magnuson," Fishery Conservation and Management Bill, and President Ford is expected to sign the bill into law at the very time we are assembled here. This so-called "200 mile limit" will greatly affect future fisheries management and its impact on marine recreational fisheries could be substantial.

But before examining some of the provisions of the new law, I would like to review some of the conflicts or problems that presently confront marine recreational fisheries.

Conflicts

In my opinion, the conflicts or problems can be grouped into a few basic categories.

Common Property. Undoubtedly, the most pervasive problem affecting marine recreational fisheries is the common property value of the target resource, the fish we seek to catch. Common property simply means the resource does not belong to anyone until it has been taken into possession. With very few exceptions, there are no special entitlements that set aside a resource for the exclusive use of recreational fishermen.

The common property concept causes most of the conflicts and controversies in marine fisheries. As long as two individuals have the right to seek the same resource, human interaction cannot be avoided.

Institutional. The lack of an adequate regulatory mechanism

has made it all but impossible to effectively manage our important marine fisheries. Of course, this is of consequence to all users of the resource; not just marine recreational fishermen. However, the problem for recreational fishermen is aggravated by parochial interests of many state resource management agencies and a traditional bias at all levels of government favoring commercial fisheries.

Knowledge. Another critical problem confronting marine recreational fishermen is our lack of knowledge about the resources and the socioeconomic structure of the recreational fisheries.

Earlier, we heard two excellent presentations about the who, what, where, when, why and how much of marine angling. However, I think both Mr. Freeman and Mr. Deuel would agree that while the information we have is significant, it is not of sufficient detail to make sound, objective management decisions.

I suspect our next speaker will give us a further insight about the need for more information on the resources.

Representation. In order for the interests and needs of marine recreational fishermen to receive proper consideration in the management process, they must have input, or representation in that management process. I can assure you this is easier said than done.

Marine recreational fishermen are relatively unorganized and have not achieved an effective common voice, or if you will, lobbying power for their special interests. There are several reasons for this, but none are so substantial that they cannot be overcome. In fact, there are several activities underway at the present time to correct this situation. I suspect the "200 mile bill" will be the catalyst for their success.

The other part of the representation problem lies in the failure of the resource management agencies (institutional problems aside) to develop mechanisms for user representation. Here again, the situation is changing and I think the problem will be corrected in the near future.

I would like to point out that Massachusetts, and my

agency in particular, has led the way in this area. Back in the early 1960's, the Marine Fisheries Advisory Commission was formed to guide the Division of Marine Fisheries in carrying out its management responsibilities. Since its inception, that Commission has always had equitable representation of marine resource users. As a consequence, user conflicts and confrontation have not been numerous or severe and when they have occurred, we have generally had a high degree of success in resolving them.

Access. The ever increasing demand on our coastal zone by different interests, both public and private, coupled with an increase in the number and mobility of marine recreational fishermen, is making it increasingly difficult for the fishermen to reach and utilize the resource.

Although the access problem is common to all users of the coastal zone, the problem is more acute for fishermen because of their numbers and the specialized nature of the activity. While several thousand bathers may easily be accommodated on a mile of beach, a hundred or more anglers would be cause for concern.

Money. Being an official of the Commonwealth of Massachusetts, I could not close my discussion about problems without raising the issue of money—or more precisely, the lack of it.

Good intentions, be they on the part of the public or government, cannot resolve the problems confronting marine recreational fishermen without money. It is not my intention to get into a debate about where the money should come from or how much. That argument has been going on for more years than I've been in the business, and I don't think we could end it here today, so I'll close the subject for now with one thought, the basic principle of consumerism—"you get what you pay for." I submit that marine recreational fishermen have paid little and have received about the same in return.

Resolving the Conflicts

In my opening remarks, I stated that I thought the new Fishery Conservation and Management law would provide ways to address the problems confronting marine recreational fisheries. Let's examine some of the provisions of the law and see how they might work.

I think it's safe to say most people envision the "200 mile limit" as a tool to "kick the foreigners out" and a way to help our commercial fishermen. However, the law does neither of these things directly. What it does do is set up a process for rational management of our marine fisheries resources. What happens to foreigners, our commercial fishermen, and marine recreational anglers, is going to depend on the output of the Regional Fishery Management Councils.

Council Powers. The strength of the management process lies in the Regional Fishery Management Councils. These councils will have the power to devise management plans that will be implemented at the federal level by the Secretary of Commerce. The councils are empowered to act on fisheries occurring outside the territorial waters of the states. Fur-

ther, the Secretary has the authority to pre-empt state authority in territorial waters if the state does not act in concert with the management plan. The significance of this provision cannot be over-emphasized. For the first time, jurisdictional problems affecting most marine fisheries can be overcome and it should be possible to manage a fisheries on a resource basis rather than the parochial desires of the states or their constituents.

Optimum Sustained Yield. Of further significance to marine recreational fishermen are provisions in the law that spell out an optimum sustained yield (OSY) concept as the basis of management. In the past most marine fisheries management attempts have been directed toward maximum sustained yield (MSY), a concept that considers little, other than the effects of harvesting on the population. In contrast, OSY addresses the socioeconomic impact of management as well as biological considerations. This approach will strengthen the position of recreational interests in management decisions.

Representation on Councils. The law sets the size of the council and mandates a procedure for selecting council members. Basically, it provides that the heads of the state and federal resource agencies shall be members and approximately twice as many members will be selected by the Secretary from lists of nominees, having interests in marine fisheries, submitted by the governors of each state in the region. There are no set criteria for membership relating to commercial representation, recreational representation, etc. In view of the fact that the commercial fishing industry and other special interest groups are organized and politically active, it is incumbent upon recreational fishermen to work in concert to insure they are adequately represented on the councils. The mechanism has been established. It's up to the fishermen now.

Other Changes. I am convinced that the successful application of the Fishery Conservation and Management law will bring about many other changes in marine fisheries management that will benefit marine recreational fishermen.

In order to carry out their duties, the Regional Fishery Management Councils will need up to date, factual information. This data in turn could be made available to the states for the management of their territorial fisheries or such activities as coastal zone planning, wetlands preservation, access development, etc. Also, successful management applications will tend to highlight poor management practices and place these programs under public scrutiny, hopefully causing them to be changed.

Management

Having looked at some of the problems affecting marine recreational fisheries and having reviewed a process for overcoming these problems, I would like to close my discussion with a quick summary of what I perceive to be broad objectives of a marine recreational fisheries management program.

Rational Management. First and foremost, we must have rational management on a resource basis, utilizing the

Optimum Sustained Yield concept, and including recognition of recreational angling as a legitimate use of the resource and an important source of protein in the national diet.

The management process should consider all possible options that will tend to reduce conflict and provide a measure of quality to the fishing experience.

Licensing of Participants. Again, I do not want to precipitate a major discussion on the pros and cons of a saltwater angling license. However, I believe most reasonable people, interested and concerned about the future of saltwater angling (I count myself among them), are convinced that some form of licensing of saltwater fishermen is needed. It is interesting to note that the saltwater fishermen's inland counterpart has recognized and supported a similar need for many decades. The last "free resource" gives way very slowly.

Obviously, licenses would be an important source of revenue to support management, research and enforcement programs. But in its own right, the license is also the best source of information and statistics to be used in management.

I also have a personal view about the value of a saltwater angling license. It relates to the "you get what you pay for" principle cited earlier. Once a person has to pay for a license to fish in the saltwater, his right becomes a privilege. As such, he may become much more concerned about what's affecting his privilege and may become an important force in the management process.

Provide Access. One of the best ways to provide direct tangible benefits to marine fishermen and resolve one of the major conflicts, is through the development of access facilities. Purchase of coastal property and the constructing of parking lots, boat ramps, fishing piers and jetty improvements are expensive, but with proper planning, development of these facilities could relieve pressure on other sites, reduce conflicts over the use of limited facilities, and provide for a better distribution of fishing pressure.

Habitat Protection. Maintenance of habitat is of utmost importance to the maintenance of adequate fishery resources. Continued encroachment by development of coastal areas

steadily reduces the value of these areas as spawning and nursery habitats and alters the basic nutrient flow that is needed to support marine life. Our environmental protection standards must be enforced and we must make even greater attempts to ensure protection of these valuable areas either through legislation or direct purchase. Speaking in support of these concepts to this audience is like talking about the virtues of motherhood, but I think we need reminding, particularly at times when the economy causes short term actions to take precedent over hard-fought-for long term principles.

Resource Enhancement. Fishery managers have the ability to materially improve some of our fishery resources. Hatcheries, various forms of artificial propagation, and sea farming, can substantially increase the number of fish available for harvest by the angler. Other enhancement activities, like habitat improvement and the construction of fish passage facilities for anadromous fish, also should be undertaken by the resource management agencies.

Service Programs. Another management activity that directly benefits the marine recreational fisherman is "Information/Education" (I&E). I&E work should include the publication of species informational leaflets, fishing guides and maps and could provide up to date fishing information through a hot-line setup or the news media. Other service provided through an I&E program could aid the management process. Technical publications and management information could be prepared in lay terms and distributed to the users.

Conclusion

Although the problems confronting marine recreation fishermen are many, at no time has the opportunity to overcome these problems been so great. The Fishery Conservation and Management Act of 1976 provides a vehicle to solve many of these problems. But the law alone is not the answer. The fishermen must get involved in the process. Whether we succeed or fail in resolving these issues is now up to us.

The Importance of Fisheries Research in Understanding Marine Ecosystems

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Oceanography

During the three decades following World War II the various academic fields comprising oceanography in the broadest sense have caught the public's interest as have no other technical and scientific endeavors save the aerospace program. Television regularly brought to every household the exploits of "Flipper" and the drama of underwater activities. In more recent years the general public has been enthralled by Jacques Cousteau and his exploration of the ocean depths.

During the same period it became quite fashionable for authoritative marine scientists to talk of feeding the world's ever growing human population on the basis of the harvest from the sea. Indeed, with the development of new fishing gear and larger vessels it seemed almost possible to produce continually increasing amounts of protein and other nutrients from the marine and certain freshwater fisheries. Foreign fishing vessels roamed the world's oceans harvesting fish of all types for human consumption. Many species of fish were taken, not for direct human consumption, but for conversion into nutritious feeds which could be fed to chickens and other domesticated animals. These animals were in turn secondarily ingested by humans as a source of protein. Unfortunately, in the process of converting fish into chicken tissue a substantial portion of the nutrients originating in the sea is lost.

Biological Productivity

In the mid 1960's numerous scientists began to turn their attention to the problems inherent in attempts to feed growing populations by utilizing the sea's biological productivity. Dr. John Ryther of the Woods Hole Oceanographic Institution, in an article in a 1969 issue of *Science* entitled, "Photosynthesis and Fish Production in the Sea," pointed out that 90 percent of the world's oceans are essentially biological deserts. He further noted that the upwelling regions of the oceans (a total area about half the size of California)

produce about half the world's supply of fish. The remaining half of the harvestable fish come from coastal waters and very few areas of offshore waters.

In recent decades much of the fishing effort has been concentrated in the limited coastal areas known to produce significant yields of commercially important finfish and shellfish. Fisheries and biologists have attempted to quantify the productivity of certain species on the Atlantic and Pacific continental shelves of North America. Their calculations lead some scientists to conclude that more fish are being landed than are produced on a continuing basis in certain areas of the Atlantic continental shelf, and in fact there has been a substantial decline in landings of especially valuable species such as the cod and haddock. In other instances research data has enabled a more efficient management of species such as tuna and salmon on the Pacific coast of North America.

Unfortunately, this decline in landings of finfish has occurred at a time in history when the world citizenry has had to look to other than the traditional sources of nutrients, especially proteins. Economists and fishery biologists are now aware that unless the marine fisheries are better managed, and environmental deterioration halted, many of the most valuable commercial and recreational species will become generally unavailable.

Fisheries Research

Thus the average citizen, albeit he is a recreational or non-fisherman, now has a real stake in fisheries research. The well-known fishery biologist, Dr. J. L. McHugh, has noted that mismanagement, overfishing (both domestic and foreign) and environmental deterioration are the root causes for the failure of several of the most important contemporary fisheries. If the collective living resources of the sea are to be wisely managed, a far greater understanding of their individual life histories, migratory pathways and functions

within the food chain will be necessary. Granted that overfishing is a problem, research will be required to produce data upon which resource managers can base catch limitations and quotas. Finally, growing volumes of pollutants and new categories of chemical contaminants that enter aquatic ecosystems require additional research oriented towards understanding the potential and actual impacts of these materials on living marine resources and fishery products.

Recognizing that recently identified problems require innovative research for their solution, many fisheries agencies have initiated entirely new programs or have assigned new priorities to existing projects and investigations. Whereas less than a decade ago a particular fisheries or ichthyological laboratory might be staffed solely by scientists trained in fisheries biology, today almost all such laboratories have staffs consisting of ecologists, plankton biologists, chemists, microbiologists and the other disciplines required in today's fishery research programs. While a scientist may be designated as a fishery biologist, he may well be solely concerned with the ecosystem in which the fish exists. It is also only recently that marine gamefish have been intensively studied. The Sandy Hook Laboratory was dedicated to the investigation of marine sportfish in 1961.

Pollution Effects

It is most interesting that some of the first observations concerned with the effects of petroleum products and other pollutants on estuarine and oceanic organisms were made by fishery biologists. Well before the turn of the century the early fishery biologist G. B. Goode noted that the original oil refineries located on Newark Bay, New Jersey, had produced effluents which demonstrably affected the quality of finfish and shellfish indigenous to the bay. Later, about the time of World War I, the noted shellfish biologist, Julius Nelson, observed that certain industrial effluents entering the waterways of the lower Hudson River estuary had begun to impinge adversely upon the commercially important oyster populations of Raritan Bay. As the nation was then entering a period of great industrial expansion and technological revolution, little heed was given to the warnings sounded by Goode, Nelson and other farsighted individuals who warned of the impact of urbanization and industrialization on the living resources of the coastal zone.

Today, marine and fishery biologists are in the forefront of the environmental movement concerned with the impact of man on his environment. It is well-known that aquatic organisms, and in particular certain marine species, are especially sensitive to environmental perturbations. Scientists working at the Woods Hole Oceanographic Institution have recently found that small, shrimp-like organisms called amphipods are particularly sensitive to petroleum and petroleum-derived chemicals. The numerous species of amphipods are not only good indicators of certain forms of pollution they are also one of the principal sources of food for many sport and commercial fish, particularly juveniles.

Other marine scientists have discovered that phytoplank-

ton species—the single-celled plants of the sea—are affected by petroleum-derived chemicals. In some instances it has been demonstrated that contaminants such as DDT and PCB, and other insecticides and chlorinated hydrocarbons, are taken up by the phytoplankton and later concentrated in the tissues of finfish and other animals which feed upon the planktonic forms. This phenomenon is called "biological magnification" and has been shown to culminate in increased amounts of contaminants in the marine life which graze on plankton—the so-called herbivores. Examples of particular importance to fisheries biologists include forms such as the recreationally important tuna, swordfish and other bill fish as well as menhaden or mossbunker and the carnivorous finfish which in turn feed upon them.

Mercury Contamination

In recent years fishery biologists have become particularly concerned about the problem of mercury in fish tissues; this problem is probably the epitome of biological magnification. In some manner, not yet completely understood, compounds of mercury enter aquatic food chains which terminate in large predacious fish such as tuna, swordfish and certain sharks. Considerable alarm was generated when it was reported that toxic mercuric substances were present in processed fish products available for human consumption. The natural concern of the consumer market resulted in temporarily decreased seafood consumption and a serious adverse effect on certain segments of the fishing industry.

Considerable research is underway, both in this country and abroad, to determine the degree of contamination of fishery products by mercury and other heavy metals as well as a wide variety of organic compounds. Results to date indicate that the vast majority of seafood products and recreational or gamefish are wholesome and free of harmful contaminants, probably more so than most foodstuffs available to man. Many fishery biologists are, however, continuing to monitor the living aquatic resources from the field, as well as processed seafoods, to determine how the products of man's industrial society impact upon his harvest from the sea.

Natural Toxic Substances

Marine scientists have long been interested in certain natural phenomena which result in production of toxic substances known to cause adverse effects in marine life which, in turn, may affect mankind. For instance, tropical fisheries have throughout history been limited because of a phenomenon called ciguatera poisoning. This is considered to be a result of fish grazing upon microscopic life which inhabit coral reefs. Current thinking is that the microorganisms contain a toxic substance which is concentrated in the tissues of the fish. If these herbivorous fish are in turn fed upon by larger predators, the toxic substances, having their origins in the microorganisms, are further concentrated in the bodies of the predator fish thus jeopardizing their use by human beings.

Some fishery biologists and marine scientists believe that the possibility of ciguatera poisoning has increased in recent years, in part, at least, because of man's activities. During World War II the construction of defense installations on tropical atolls resulted in the filling of natural channels connecting the atoll lagoons with the open sea. The consequent reduction in circulation within the lagoons may have resulted in conditions which foster the growth of microorganisms known to be involved in the ciguatera phenomenon. More research on this problem is needed to increase substantially the yield of tropical fisheries, particularly those small scale native activities peculiar to certain islands or archipelagos as well as the recreational gamefish sought by tourists in tropical and semitropical waters.

Paralytic Shellfish

Another problem known to man long before the advent of industrial pollution is paralytic shellfish or mussel poisoning. Again, this is a problem seemingly restricted to certain portions of the world's seas, especially cool temperate waters. In North America it is a phenomenon of the Pacific coastline; on the Atlantic seaboard it has generally been noted to the north of Cape Cod. Again, this problem arises from the ingestion of a microorganism—in this case a planktonic dinoflagellate—by certain marine animals capable of concentrating the toxin present in the microorganism. The common blue or edible mussel, found on both coasts as well as in northern European waters, is particularly efficient in concentrating this microorganism and hence the name "mussel poisoning."

There are, however, a variety of bivalve mollusks which do ingest plankton, including the toxic dinoflagellates, and thus may also be rendered toxic. Many of these bivalves provide recreation for clam diggers. Fortunately, the rapid increases in numbers of dinoflagellates which may result in contaminated shellfish are usually seasonal. The admonishment, "eat mussels taken only during months having an R in their spelling" is well-heeded both by recreational and commercial shellfishermen as well as the consuming public.

During 1972 and 1974 occurrences of toxic shellfish were reported further south in New England coastal waters than is regarded normal. One or two occurrences of human poisoning occurred following consumption of bivalve shellfish. Again, considerable public consternation resulted in a rapid drop in consumption of shellfish, particularly in New England. Fishery biologists now monitor plankton blooms likely to consist of species which could cause harm. Some biologists attributed the toxic plankton blooms in New England to the effects of dredging. This has not, however, been verified and a more likely explanation is that abnormal currents and/or weather conditions resulted in the troublesome blooms. Both state and federal fishery agencies now understand that such blooms must be predicted and understood if the public confidence in shellfish products is to be maintained.

The so-called "red tides" are actually plankton blooms

(rapid increases) in which the dominant organisms are pigmented so that when they reproduce themselves in unusually large numbers the waters are discolored. The causative organisms may be in some cases the same or similar to those which result in paralytic shellfish poisoning, i.e. species of dinoflagellates. Plankton blooms which cause "red tides" are common along portions of the Florida coastline. In these southern waters "red tides" have often resulted in massive fish kills in which dead fish literally cover the beaches for several miles in a stretch. The consequences of such kills are of obvious concern to the citizenry, the sport and commercial fisherman, as well as the fishery biologist. Sprays resulting from heavy surfs during "red tide" blooms have been reported to be particularly irritating to persons sensitive to the toxins produced by certain of the dinoflagellates. The "red tide" episodes in Florida apparently are the result of certain natural phenomena in which the various factors influencing blooms occur simultaneously and lead to unusually large populations of the causative organisms.

In recent years "red tides" have become more numerous and extensive in the marine waters of the New York metropolitan area. Although these blooms were noted in the early history of this region, in recent years they have caused far more concern. Research has been underway at the Middle Atlantic Coastal Fisheries Center of the National Marine Fisheries Service which seems to indicate that extensive pollution of the waterways furnished essential nutrients which produce and sustain these blooms. Numerous swimmers, fishermen and other persons using the waters for recreational purposes claim to have been made ill by contact with "red tide" infested waters and surf spray. No massive fish kills have been observed inshore although numerous scuba divers have observed inexplicable kills on natural and artificial reefs. These events were noted during the same months when plankton blooms involving "red tide" organisms were seen to occur. When these blooms occur, the State of New Jersey and public health officials have usually closed the affected beaches to swimming, surfing and other contact sports or activities. Again, this results in substantial losses in the recreational and tourist oriented businesses. Recently "red tides" have resulted in extensive closures of shellfish beds in New England and the loss of large numbers of valuable gamefish in Gulf states.

While fisheries research may not directly ameliorate the problems involved with "red tides" and "mussel poisoning" it will provide data useful in understanding the precursor conditions which lead to unusual plankton blooms and should enable eventual prediction of blooms.

Other Experimental Studies

While many fishery biologists are concerned with field programs involving population dynamics, resource assessment and deterioration of the environment, other investigators working in fishery laboratories are concerned with experimental studies which have far reaching implications of importance to the general citizenry and industry. In recent

years the behavioral sciences have become extremely important to the understanding of how marine organisms at various levels of organization respond to each other and to the environment. For instance, the results of behavioral studies of the schooling, migration and feeding of bluefish in relation to temperature and light have been cited in popular books written for the recreational fisherman. These investigations have, however, also resulted in data of considerable value in the siting of nuclear electric power plants and industrial facilities which discharge heated effluents. Other investigations of fish behavior have produced information on generalized patterns of behavior in the lower vertebrates and invertebrates. These results are of great importance to scientists and sociologists interested in the evolution of behavior patterns and their modification in the so-called higher vertebrates, including man.

For centuries certain tribes and societies have reared and farmed the edges of the sea for aquatic organisms to provide nutritious food for human consumption. In recent decades the culturing of pearl oysters and other economically important organisms has developed into a substantial industry. These activities often involve husbandry of aquatic organisms suggestive of agricultural practices in which animals and plants are bred and reared under semicontrolled conditions rather than hunted or gathered from their natural environment. Much of the successful efforts in such aquaculture endeavors have centered in the Far East.

Aquaculture

In recent years it has become more widely recognized that the creatures of the sea which can be hunted are becoming limited and if man is to increase the yield of the seas it will be done through such activities as aquaculture and utilization of unexploited resources. In addition, certain freshwater species are hatchery reared for release to the natural environment to provide increased recreational stocks.

Starting in prehistory, man first domesticated wild animals. Later he selectively bred these forms to provide strains that were more useful to him; docility and increased yield of food and labor were the usual traits emphasized. Today fishery biologists are attempting to increase the size of fish and shellfish, the rate at which they grow to a harvestable maturity and even improve their appearance or aesthetic qualities. Using modern genetic research, but still including empirically evaluated results of test breeding, fishery biologists are trying to develop new strains of trout and salmon, oysters, lobsters and other shellfish.

Throughout the world scientists are now investigating the genetics of species traditionally used in aquaculture endeavors as well as new species which might later lend themselves to commercially viable projects. Because so little is known about the specific mechanisms involved in the genetics of marine organisms, such investigations are opening up entirely new opportunities for study. Fishery biologists working with the chromosome structure of marine species of finfish have made preliminary findings indicating that the

chromosomes are often highly aberrant in the eggs of coastal finfish species. Some biologists are concerned that anomalies in genetic mechanisms and subsequent growth and development may be the result of pollution and toxic contaminants.

Heavy Metals Research

In a similar vein, fishery biologists are engaged in research to determine how heavy metals affect the all-important enzyme systems of various marine species. Preliminary data suggest that certain metals have far more deleterious effects than do others. Perhaps more important, some species of animals are much more sensitive to these metals than are other, closely related forms. This suggests that it is unwise to generalize or make conclusions based on research conducted with a single species of organism or type of contaminant. Since a variety of enzyme systems are involved in transmitting the "information" contained in the chromosomes into the effective mechanisms involved in the growth and development of the individual—be it a lobster or flounder—the importance of the various interrelationships between genetics and enzymology are obvious. Such research, while directly applicable to fisheries problems; is also basic and adds to our understanding of the biochemical mechanisms underlying all life.

Finally, much fisheries research is directly useful to the aquarium hobbyist. As the problems inherent in dog and cat ownership in cities have increased, large numbers of people have turned to rearing saltwater fish for "pets." The development of new aquarium systems designed originally for fisheries research has resulted in methodologies which can be used to breed, rear and hold delicate tropical fish. At the same time many dedicated hobbyists will make observations important to certain elements of fisheries biology and management.

It should be noted that in recent years increased emphasis has been placed on cooperation between fishery biologists and the physically oriented marine scientists. For instance, in order to understand the effects of ocean disposal of solid wastes on living resources the fishery biologist must know the directions and rates of movements of contaminants entrained in the water column. The biologist also requires knowledge of how the physical and chemical nature of sediments is altered by various wastes. Some of these changes can be measured by the biologist but in many instances the biologist must have the cooperation of the physical oceanographer, geochemist and sedimentologist to make the fullest use of his data.

Conversely, the present day geologist interested in understanding past geological events must have the cooperation of the fishery and marine biologists. Sediment reworking, i.e. burrowing by worms and other bottom dwelling animals, can markedly alter geological events or records. Thus the findings of biologists interested in benthic organisms have considerable relevance to the geological oceanographer and the historical geologist.

Similarly, the studies of the fishery plankton biologists are of interest to the chemical oceanographer; the plankton is known to alter markedly the chemical constituency of seawater both by the uptake of chemicals in the water as well as by the production of metabolites which significantly change the milieu in which they dwell. Without the assistance of the plankton physiologist-biochemist the seawater chemist may have difficulty in analyzing or even accurately measuring certain seawater constituents.

Bringing the results of fishery research and oceanography to the attention of the various user and interest groups has become a major activity of the fishery oriented agencies. Numerous states working within the NOAA Sea Grant program distribute periodic newsletters, brochures and papers which serve to inform the public and industry of the latest developments and findings provided by fisheries research. In other instances new programs have been initiated which foster cooperative studies involving fishery biologists and physical scientists. The new NOAA Marine Ecosystems Analysis (MESA) Program is one such endeavor; this program

presently focuses on the various problems in the New York Bight, that part of the Atlantic off New Jersey and Long Island and one of the most intensively used bodies of marine water in the world.

Summary

It should now be obvious that the field of fishery biology serves a greatly expanded audience. No longer is the information acquired by fishery research agencies solely oriented towards the commercial and recreational fishermen and industries. Fishery data is increasingly being utilized by a spectrum of user groups including industries of a wide range, environmental agencies and conservation groups, local governments and the general citizen, interested only in the aesthetics or recreational attributes of the coastal and marine environments. This new role of fishery research has been accepted by most agencies and future research should enable marine fishery scientists to add to the future well-being of the world's citizenry.

Shellfish—Description, Uses, Values

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Introduction

Shellfish consist of benthic invertebrates in two major groups, the molluscs and decapod crustaceans. In particular the bivalve molluscs, consisting of such families as the oysters, scallops, clams, and mussels; and the decapod crustaceans, represented by such groups as the crabs, lobsters, shrimps and crayfish are important both commercially and recreationally. Most shellfish are used as food items, and their popularity as recreational resources is largely due to their exposure as commercial products. For this reason, the following discussion will be limited to shellfish which are important in both commercial and recreational fisheries.

The biology of molluscan bivalves is remarkably similar. The distribution and abundance of these shellfish are limited by certain positive and negative environmental factors (Galtsoff, 1964). Among the positive factors are bottom sediment, movement of water masses, salinity ranges, appropriate food, and water temperature. Negative factors include sedimentation, disease, competition, predation, and pollution.

The reproductive cycle of bivalves is primarily temperature controlled. Gametogenesis occurs in the spring with spawning being stimulated by rapid temperature increases which occur during the summer. Fertilization occurs externally and the presence of male sperm in the water chemically triggers further mass spawning. The resultant veliger larvae spend a two week developmental period as zooplankton, before undergoing metamorphosis and settling to the bottom. Settling areas are usually well defined, because larvae are dependent on tides and entrainment in water masses for retention in the estuary. Pritchard (1951) described estuarine circulation and how residual landward drift of bottom masses distributes larvae in the estuary. Tidal stream morphology is an important factor in limiting abundance of oysters (Keck et al. 1973). Oysters are found in greatest numbers

on the outside edges of the meanders commonly found on tidal rivers.

In addition the gregarious setting behavior displayed by various bivalves results in the formation of well defined communities called beds, bars, or reefs. The gregarious setting phenomena is controlled by pheromone release and has been documented for oysters (Hidu et al. 1969) and clams (Keck et al. 1974).

The shellfish communities support a wide variety of species (Wells 1961) and (Maurer and Watling, 1973), such as xanthid crabs, grass shrimp, gastropods, and fowling organisms. Because of their high biological productivity, these shellfish grounds are often areas which attract gamefish.

Negative Influences on Shellfish

Two negative factors affecting distribution are predation and pollution. Juvenile bivalve molluscs are especially susceptible to predation by xanthid and portunid crabs (Ropes 1968 and Walne & Dean 1972) and carnivorous gastropods such as the oyster drill (Carriker, 1961). Pollution in the form of domestic sewage, heavy metals and pesticides have rendered many valuable shellfish resources useless. Clem (1971) reports that approximately 1/5 of our 10 million shellfish supporting acres have been closed due to pollution. All of Delaware's oyster producing rivers have been closed due to pollution since the early 1950's. These rivers represent a potential loss of approximately 55,000 bushels of seed oysters/year to an industry that is struggling to survive the MSX epidemic of 1957 (Maurer et al. 1970). Andrews (1974) reports that there is considerable circumstantial evidence that the Delaware Bay epizootic, MSX, was a result of general environmental degradation, and salinity changes caused by unusually dry weather.

Bivalve shellfish may feed by filtering surrounding water

through their gills. Because shellfish are highly efficient biological filters, they are indicators of water quality. This ecological relationship has been well documented for bacterial and viral types (Geldrich et al. 1962, Cook, 1969, and Liu et al. 1967). Many shellfish recipes require only superficial cooking and oysters and clams are often eaten raw. For these reasons it is even more important that shellfish growing areas be free of contamination. Unfortunately, in many cases areas most readily accessible to the recreational shellfisherman are the areas most likely to be effected by pollution. In addition, there have been occasional outbreaks of paralytic shellfish poisoning, which occurs when the bivalves feed on a small marine organism, *Gonyaulax*, that produces a toxin. As a precaution all persons interested in recreational shellfishing should obtain information on regulations and approved shellfish areas from local enforcement agencies.

The decapod crustaceans are highly mobile when compared to the sedentary bivalves. Estuarine areas are commonly used as nursery grounds with adults migrating between more offshore waters and the estuary. The crabs and lobsters are largely carnivorous scavengers, while the smaller shrimp feed heavily on detrital material. Reproduction is temperature related; however, it is also closely tied to the molting cycle. Mating occurs while the female is in a soft condition. The eggs are retained and brooded on the abdominal region until they hatch. The larvae go through a complex metamorphosis that lasts as long as a month. Crab larvae are commonly referred to as zoeal and megalops stages.

Oysters

The American oyster, *Crassostrea virginica* is the principal edible oyster of the Atlantic and Gulf Coasts. The oyster typically inhabits the littoral and intertidal zones of the estuarine habitat. Oysters survive in salinities between 5‰ and 30‰; however, they are most commonly found in areas where salinities range between 15‰ and 25‰. The oyster can be caught by several methods. When found intertidally the oyster can simply be picked off the bottom during periods of low tide. Unfortunately, due to severe winter temperatures in the north, most intertidal oyster beds are found south of North Carolina.

The most productive method for the recreational oysterman is to obtain a small handscape or dredge of about 1/2 to 1 bushel in capacity. This size dredge can be easily handled by one person.

A second and more difficult method is tonging which utilizes a large scissors-like tool with long wooden handles and attached baskets at the bottom. The tonger works from a small boat, opening and closing the handles to gather oysters between the two baskets.

Hard Clams

The hard clam or quahog, *Mercenaria mercenaria*, is common to shallow intertidal areas from the Gulf of Maine to Florida. Depending on size the hard clam has several colloquial names; large clams are called chowders; medium to

small clams are called steamers or cherrystones; and the smallest legal size clams are known as littlenecks.

Field surveys have shown that clams prefer to set in coarser sediments (Wells 1957) especially with large shell fragments (Pratt & Campbell 1956). The fact that juvenile clams are often found in old shell deposits has been exploited by several scientists (Castagna 1970, Keck et al. 1975).

Clams can be caught in a variety of ways. Wading or treading clams is an old technique. Bathers simply probe the bottom for clams with their feet. When the bather feels a clam he submerges and picks it up.

Hand rakes or scratch rakes are used while wading in shallow water. The rake has long teeth to dig up the clam and a basket to lift the clam to the surface.

The Bull rake is a large boat operated rake, that is highly efficient. The rake may be 2 to 4 ft. in width and is capable of catching 20 to 30 clams per drift. Clammers will let the tide or wind push the boat while working the rake into the bottom.

Cultivating Clams

The University of Delaware is currently involved in a clam planting project that has both commercial and recreational value. Clam transplants and planting of juvenile stocks have been successful in many areas. A common factor in the success of the plantings was the protection of the clams from a variety of crabs, the principal predators of small bivalves. Walne & Dean (1972) and Ropes (1968) report that the green crab, *Carcinus maenas* is a particularly vicious predator. Keck and Maurer (unpublished data) showed that the blue crab, *Callinectes sapidus* may consume as many as 40 small clams a day. The crabs are particularly adept at finding their prey in fine silt sediments.

Godwin (1964) and Menzel and Sims (1964) used fences to successfully protect clams from crab predation. However, Haven and Loesch (1972) had little success with netting as it is susceptible to storm damage. The prohibitive cost of fencing large areas and its limitation to use in shallow water requires that other means of protection be developed.

Castagna (1970) has protected juvenile clams with a crushed aggregate. The aggregate method is useful in that it allows clams to be planted at extremely small sizes. By planting at small sizes hatchery feeding and holding costs are substantially reduced.

At the University of Delaware clams were grown in a closed system mariculture facility as described by Loosanoff and Davis (1963) and Pruder et al. (1973). The larvae and recently set juveniles were batch fed algae (Hartman et al. 1973) and grown in recirculating tanks. In this manner 2.6 million clams were reared to planting size of about 3 mm.

A one acre plot was planted with a crushed shell aggregate. Baffles made of vexar screening sewn on iron frames were set around the plot to reduce current flow, allowing the clams to burrow under the shell without being washed from the plot.

Several small experimental plots have produced 50%

survival rates after one year. Assuming 50% survival each year for the 3 years necessary for the clams to reach legal size the plot should produce 250,000 littleneck clams worth approximately \$17,500. With the recent advances in mariculture technology, put and take management programs could become a reality for recreational and commercial shellfisheries.

Soft Clams

Mya arenaria, the soft clam is widely distributed from Labrador to Cape Hatteras, North Carolina. The Chesapeake Bay and New England coastal areas appear to be centers of abundance. Locally the soft clam is often called "manninose." The soft clam was originally used as bait by cod fisherman. However, today the soft clam has become a popular food item, particularly in its fried form.

The soft clam is found in bays, coves and other protected areas. It is usually found in a muddy sand bottom (Hanks 1966). The clam lives deeply buried with its distinctive long siphon extending to the surface. In the New England area the majority of the clam beds are found intertidally. For this reason the soft clam is quite important as a recreational resource in New England. In the Chesapeake region the clams are found subtidally and require special hydraulic dredges for harvesting.

In intertidal areas, the soft clam is hand harvested using a clam hoe, which is a short-handled, fork-like tool with four to six flattened tines. Harvesting is accomplished during periods of low tide. The presence of the rounded siphon hole on the surface indicates clams are below. Care must be taken when digging the clams to prevent crushing the fragile shell.

Blue Mussels

The blue mussel, *Mytilus edulis*, is an under-utilized shellfish resource. The common mussel is one of the more abundant shellfish found from Maine to North Carolina. Mussels are most abundant in colder waters that remain below 25°C during the summer (Wells & Gray 1960). Mussels commonly grow in large clumps held together by well developed byssal threads. Mussels are found intertidally and are readily available to the recreational shellfisherman. Although mussels are considered gourmet items in Europe, their use in the United States has been limited. Public education as to the uses of mussels should improve its popularity and use as a recreational resource.

Blue Crabs

The blue crab, *Callinectes sapidus* is a swimming crab in the family Portunidae (Jaworski, 1972). The last pair of walking legs have developed into well formed paddles. The Blue crab is a common inhabitant of the East and Gulf coast ranging from Nova Scotia to Uruguay (Williams 1965). The male or "Jimmy" crab is distinguished by the inverted T shaped abdominal apron. The immature female's apron is triangular, while on the mature female or "sook" the apron is broad

and rounded. Mature males attain a carapace width of 6 to 7 inches. The adult females are generally smaller. The carapace is a bluish-green and the chelipeds (claws) of the mature male are usually blue, hence the name "blue claw" or blue crab.

Blue crabs have a life span of two to four years. Commercial size is reached in 12 months in Florida (Tagatz 1968). At least 18 months is required to attain commercial size north of the Chesapeake (Van Engle, 1958).

The female crabs mate in the soft stage of their final molt. Males mate several times and protect the females while they are in the soft condition. The terminology "doubler" or "buck and rider" are used to describe mating pairs. The spermatzoa is carried in the female's seminal receptacle and is viable for at least a year.

The female moves to more saline waters to spawn. The eggs are fertilized as they are extruded through the seminal receptacle. As many as 2 million eggs may be produced (Jaworski 1972) which are attached to the female's abdomen. Crabs carrying eggs are called "sponge" crabs.

After the eggs hatch the larvae go through several zoal and megalops states. The larval period may last as long as 40 days. During the larval period the young crabs move up estuary where tidal marshes are used extensively as nurseries.

The blue crab is an omnivorous scavenger and predator of small molluscs. Darnell, (1958) reports that bivalve molluscs constitute as much as 63% of the adult crab's diet.

The Blue crab can be caught in many ways; however, the simplest method employs the use of bait, hand lines and dip nets. Crabbing can be done from shore or a boat, which make the resource readily available. It is often better to crab the headwaters of tidal creeks, as the catch will be primarily the large "Jimmy" crabs. Small hand traps which close on the crab as it is pulled to the surface are also highly efficient. Many states allow recreational fishermen to use a limited number of commercial crab pots. The commercial pot is quite productive, but the costs of over \$10.00 are prohibitive for the recreational fisherman.

Lobsters

The range of the American or Maine lobster *Homarus americanus* extends from Labrador to North Carolina. The greatest number of lobsters are taken in the northern portion of its range, and abundance decreases in the South. Lobsters were thought to be generally nearshore organisms; however, populations of lobsters have been found offshore on Georges Bank and near the Canyon areas off the New Jersey and Delaware coasts. Cooper and Uzmann (1970) conducted a tagging study with lobsters on the Georges Bank. The recoveries demonstrated a shoreward migration in spring and summer and a return to deeper water in fall and winter. The authors also concluded that the growth rates of offshore lobsters are more rapid than that of inshore stocks.

Reproduction of the lobster is very similar to that of the Blue crab. Mating takes place when the female is soft. Sperm is held in the seminal receptacle and eggs are fertilized as

they are laid. The eggs are a greenish-black color when first laid. The eggs are brooded for about ten to eleven months. Prior to hatching the eggs become a translucent orange color. The eye of the larval lobster is clearly visible in ripe eggs. Spawning usually begins in May and reaches a peak in June or July when water temperatures are above 20°C (Hughes and Mattheissen 1962). Depending on size a female lobster may lay between 6,000 and 90,000 eggs (Goggins & Fortier 1964). The newly hatched larvae are about 1/3 inch long and resemble small mysid shrimp. After five molts the larvae resemble adults and settle to the bottom. It is estimated that a one pound 3-3/16 inch lobster is between 4 & 10 years old. Lobsters can reach weights in excess of 40 lbs. and may be fifty to one hundred years old (Goggins & Fortier 1964). The lobster like the blue crab is basically a carnivorous scavenger. The lobster is nocturnal and spends the majority of its time hiding in burrows and crevices of its rocky bottom habitat.

Scuba techniques can be used to catch lobsters. Most successful dives are during the night due to the lobsters' nocturnal behavior. During the day, rag mops can be used to extricate the lobster from his burrow. When threatened with the mop the lobster attacks and will hang on while being pulled from the burrow. More efficient means employ the use of the standard wood slat lobster pot.

Recreational to Commercial

As one progressively improves the technique used for harvesting shellfish and subsequently spends more money and time engaged in shellfishing, there is a tendency to leave the realm of pure recreational fishing and become semi-professional. A good example was the growth of a small lobster fishery in Lewes, Delaware. The Harbor of Refuge Breakwater located at the mouth of Delaware Bay is an ideal habitat for the American lobster. The University of Delaware proceeded to survey the population (Winget et al. 1970). As a result a May through September season was established. The first open year was a success with some people landing as high as 1,000 lbs. during the summer. Since that time the fishery evolved from a recreational situation, where many people fished a few pots to a commercial fishery where a few people fished a large number of pots.

Uses

As mentioned earlier those species which are important commercially are the species most prized by the recreational shellfisherman. The primary use of shellfish are as food items. In fact, most shellfish are considered gourmet items and demand high market values. The U.S. Fish and Wildlife Service has published a Kitchen Test Series covering a wide variety of species and recipes. Instructions are detailed and provide information on buying, storing, shucking, cleaning, and preparation of fish and shellfish dishes. The series can be purchased for \$2.55 from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

A wide variety of shellfish are used as bait. Shucked

clams are widely used as bait for bottom foraging fish such as Drum, Seabass, and Cod. Peeler crab segments are highly touted baits for weakfish and tautog. The smaller grass and sand shrimps such as *Crangon* are often used as bait for spot and croakers.

Finally, beachcombing and shell collecting has become a popular pastime for tourists visiting the shore. The calcareous shells of bivalve and gastropod molluscs are often highly colored and structurally ornate. Tropical and subtropical species tend to produce shells, which are most valued by shell collectors (Abbott 1968). The genera most highly prized by shell collectors include *Conus*, *Spondylus*, *Oliva*, *Murex*, *Busyon*, *Scaphella* and *Strombus*.

Table 1 lists a group of over 100 shellfish that are used recreationally on the Atlantic and Pacific Coasts. This Table was compiled through the efforts of Dr. J. L. McHugh, State University of New York, Stony Brook, New York.

Economic Impact

The following assessment of the economic impact of recreational shellfishing was made in the Lewes, Rehoboth area of Delaware. Although the information concerns a limited area, the data will probably reflect the recreational impact in other areas.

The Lewes-Rehoboth resort area is located adjacent to the Delaware Bay and Atlantic Ocean. The coastal zone is characterized by sandy beaches, tidal wetland, and two small bays, Indian River Bay (9,064 acres) and Rehoboth Bay (9,312 acres). The towns are popular as a resort for people from Washington, Baltimore, Wilmington and Philadelphia metropolitan areas. Although the year-round population is less than 6,000 people, weekend influx results in a population that ranges between 50 and 100 thousand people.

Aerial surveys conducted by the Delaware Department of Natural Resources and Environmental Control indicated that approximately 52,000 man-hours were spent on recreational clamming during the 3 month summer season. Extrapolation of the effort figures with catch data results in an estimate of 700,000 to 1,300,000 clams harvested recreationally each summer. The market value is dependent on size and ranges between \$25,000 and \$45,000. Although the market value of this fishery is considerable, in comparison with the money spent by tourists for lodging, food, and purchase of recreational equipment the value is insignificant.

A survey of local bait and tackle dealers was conducted to ascertain the impact of shellfishing on business. Two types of businessmen were interviewed: 1) those who deal strictly in bait and tackle and, 2) those who have general purpose stores and deal in bait and tackle as a seasonal extra. Bait and tackle store owners estimated that between 25 percent and 35 percent of their total business was dependent on shellfishing gear. The general store owners' estimates were considerably lower, ranging from 1 percent to 15 percent of their total sales. Table 2 lists the ranges in actual equipment sold, with average figures based on the reports of 10 local bait and tackle dealers. Assigning current market values to

**Table 1—Molluscan and crustacean shellfish
in recreational or subsistence catches in the United States**

Common names	Scientific names	Source and use
Crustaceans: shrimps		
Ghost shrimp	<i>Callinassa californiensis</i>	P - bait
	<i>C. gigas</i> , <i>C. affinis</i>	- bait
Mudshrimp	<i>Upogebia pugettensis</i>	P - bait
Spot shrimp	<i>Pandalus platyceros</i>	P
Coonstripe shrimp	<i>P. hypsinotus</i>	P
Northern pink shrimp	<i>P. borealis</i>	P
Ocean pink shrimp	<i>P. jordani</i>	P
Dock shrimp	<i>P. danae</i>	P
Northern shrimp	<i>P. borealis</i>	A
Humpy shrimp	<i>P. goniurus</i>	P
Side stripe shrimp	<i>Pandalopsis dispar</i>	P
Grass shrimp	<i>Palaemonetes vulgaris</i>	A - bait
Sand shrimp	<i>Crangon septemspinosus</i>	A - bait
Little gray or bay shrimp	<i>Crago</i> spp.	P
Little green shrimp	<i>Hippolyte clarki</i>	P
Brown shrimp	<i>Penaeus aztecus</i>	A, G
Pink shrimp	<i>P. duorarum</i>	A, G
White shrimp	<i>P. setiferus</i>	A, G
Red-banded transparent	<i>Spirontocaris picta</i>	P
Transparent shrimp	<i>S. paludicola</i>	P
Rock shrimp	<i>Sicyonia</i> spp.	
Seabob	<i>Xiphopenaeus kroyeri</i>	G
Ridgeback prawn	<i>Eusicyonia ingentus</i>	P
River shrimp	<i>Macrobrachium</i> spp.	A, G
Crustacea: lobsters and crabs		
American lobster	<i>Homarus americanus</i>	A, P
Spiny lobster	<i>Panulirus argus</i>	A, G
	<i>P. interruptus</i>	P
Slipper lobster	<i>Paribaccus antarcticus</i>	
Mud crabs	Family Xanthidae	A, G, P - bait
Blue crab	<i>Callinectes sapidus</i>	A, G
Stone crab	<i>Menippe mercenaria</i>	A, G
Rock crab	<i>Cancer irroratus</i>	A
Red rock crab	<i>C. productus</i>	P
Jonah crab	<i>C. borealis</i>	A
Dungeness crab	<i>C. magister</i>	P
Red crab	<i>C. antennarius</i>	P
Green crab	<i>Carcinus maenas</i>	A - bait
King crab	<i>Paralithodes camtschatica</i>	P
	<i>P. platypus</i>	
	<i>Lithodes acquispina</i>	
Tanner crab, snow crab	<i>Chionoecetes tanneri</i>	P
Common names	Scientific names	Source and use
Hermit crabs	<i>Pagurus pollicaris</i>	A - bait
	<i>Pagurus</i> spp.	A, P - bait
Pelagic red crab	<i>Pleuroncodes planipes</i>	P - bait
Sand crab	<i>Emerita analoga</i>	P - bait
Sand crab	<i>Ovalipes ocellatus</i>	A - bait
Horseshoe crab	<i>Limulus polyphemus</i>	A - bait
Fiddler crabs	<i>Uca</i> spp.	A, G, P - bait
Shore crab	<i>Hemigrapsus oregonensis</i>	P - bait
Mollusks: gastropods		
Northern or pinto balone	<i>Haliotis kamtschatkana</i>	P
Black abalone	<i>H. cracherodii</i>	P
Green abalone	<i>H. fulgens</i>	P
Pink abalone	<i>H. corrugata</i>	P
Red abalone	<i>H. rufescens</i>	P
White abalone	<i>H. sorenseni</i>	P
Channeled conch or whelk	<i>Busycon canaliculatum</i>	A
Knobbed conch or whelk	<i>B. carica</i>	A
Conch	<i>Strombus</i> spp.	
Slipper limpet	<i>Crepidula fornicata</i>	A
Periwinkle	<i>Littorina littorea</i>	
Moon snail	<i>Polinices lewisii</i>	P
	<i>P. duplicatus</i>	A
	<i>Lunatia heros</i>	A
Limpet	<i>Acmaea digitalis</i>	
Clams:		
Cockle	<i>Cardium corbis</i>	P
Heart cockle	<i>Clinocardium nuttalli</i>	P
Geoduck	<i>Panope generosa</i>	P
Horse clams	<i>Tresus capax</i>	P
	<i>T. nuttalli</i>	P
Butter clam	<i>Saxidomus giganteus</i>	P
Hard clam	<i>Mercenaria mercenaria</i>	A, P
	<i>M. campechiensis</i>	G
Native littleneck clam	<i>Venerupis staminea</i>	P
Manila littleneck	<i>V. semidecussata</i>	P
	<i>V. japonica</i>	P
Razor clam	<i>Ensis directus</i>	A
	<i>Siliqua patula</i>	P
Soft clam	<i>Mya arenaria</i>	A, P
Sunray venus	<i>Macrocallista nimbosa</i>	A, G
Surf clam	<i>Spisula solidissima</i>	A
Piddock	<i>Zirfaea pilsbryi</i>	P
	<i>Penitella penita</i>	P
Bentnose clam	<i>Macoma nasuta</i>	P
	<i>Macoma</i> spp. (2)	P
Sand clam	<i>M. secta</i>	P
Bodega clam	<i>Tellina bodegensis</i>	P
Pismo clam	<i>Tivela stultorum</i>	P

Common names	Scientific names	Source and use
California jackknife clam	<i>Tagelus californianus</i>	P
Purple clam	<i>Sanguinolaria nuttalli</i>	P
Abalone jingle	<i>Pododesmus cepio</i>	P
Rangia	<i>Rangia cuneata</i>	A
California mussel	<i>Mytilus californianus</i>	P
Blue or bay mussel	<i>M. edulis</i>	A, P
Ribbed mussel	<i>Modiolus demissus</i>	A
American oyster	<i>Crassostrea virginica</i>	A, G, P
Pacific oyster	<i>C. gigas</i>	P
Western oyster	<i>Ostrea lurida</i>	P
Bay scallop	<i>Aequipecten irradians</i>	A, G
Rock scallop	<i>Hinnites multirugosus</i>	P
Pink scallop	<i>Chlamys</i> spp.	P

Common names	Scientific names	Source and use
Octopus	<i>Octopus vulgaris</i>	A
	<i>O. dofleini</i>	P
	<i>Polypus</i> spp.	P
Squid	<i>Loligo opalescens</i>	P
Long finned squid	<i>L. pealei</i>	A
Genera most highly prized by shell collectors:		
	<i>Conus</i> spp.	
	<i>Spondylus</i> spp.	
	<i>Oliva</i> spp.	
	<i>Murex</i> spp.	
	<i>Busycon</i> spp.	
	<i>Scaphella</i> spp.	
	<i>Strombus</i> spp.	

the average sale figures, approximately \$5,000 annual profit is realized on the sale of shellfishing equipment.

Table 2—Annual shellfishing equipment sales reported by ten local bait and tackle dealers

	Min.	Max.	Ave.
Hand crab traps	288	3,000	330
Commercial crab pots	50	600	288
Dip nets	100	1,000	315
Bait (chicken backs)	500 lb.	4,000 lb.	1,500 lb.
Hand clam rakes	30	360	150

Thus, the sale of these items has a highly significant impact on the local tourist industry.

Human Values

Most people visit the coastal zone because they enjoy the sun, beaches, and water. The scenic beauty is aesthetically pleasing to the tourist. Man has been and still is a "hunter". There is a certain pride associated with providing one's own dinner. Recreational shellfishing provides the opportunity for mixing physical exercise, aesthetic awareness, and self-reliant, psychological values into a unique experience.

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Shellfish: Research and Management

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Overview

In the last thirty years, the population mobility and leisure time of the American people have increased greatly resulting in a growing influx of people to our coastal areas. Along with other activities, many of these people are attracted by the recreational shellfishery.¹ It is very difficult to put a dollar value on this fishery either directly, with regard to the value of the shellfish landed because of inadequate catch reports, or indirectly, taking into consideration spin off such as, money spent in travelling to and from the shore.

However, coastal communities have been forced to strike a balance between the local commercial shellfisherman and recreational interests, both resident and non-resident, in allowing the usage of the already depleted available shellfish stock. This has resulted in greatly reduced recreational harvesting in some areas as compared to almost no commercial harvesting in other areas, depending on the best interests of the cities and towns involved.

In Massachusetts, the shellfish resource in non-contaminated areas is under local control as set out in the broad limits of the state law which regulates legal size, seasons and maximum commercial limits. And, although most fisheries laws and regulations traditionally favor or deal with commercial enterprises, Massachusetts has protected the right of the individual to take shellfish since 1647.² According to law (Chapter 130, Section 20A and 52; Mass. G.L.) any resident of the Commonwealth is entitled to take, in accordance with local regulations, shellfish from the waters of the Commonwealth, and each coastal community is obligated to set aside areas for this purpose, i.e. areas where commercial shellfishing is prohibited. This law may be, and in the past has been abused in several ways in some communities:

1. Areas set aside contain virtually no shellfish.
2. Different areas are set aside for state residents living

in the local area and other state residents or non-residents.

3. No areas are set aside at all and non-resident shellfishing is prohibited.
4. Non-resident shellfishing is encouraged as a tourist attraction but at the possible expense of commercial fishermen.

Massachusetts has approximately 1,200 miles of coastline interspersed with estuarine systems, salt ponds and protected bays, many of which produce a variety of shellfish. However, 935 miles are privately owned, 90 miles federally owned and only 175 miles are publicly owned. (Reynolds, et al 1976). It is quickly apparent that access to the shellfish resources in some areas is severely limited. Also, not all of the publicly owned shoreline is adjacent to shellfish producing areas, since much of it is bathing beaches on open coast. Better than one-half of Cape Cod shores are inaccessible to the general public.

Besides access, other factors tend to limit the availability of shellfish to the recreational digger. Of the 800,425 acres of coastal water area within the Commonwealth only 43 percent contain harvestable shellfish and much of this area is of marginal value. Pollution (mostly domestic sewerage) has resulted in the closure of 29,000 acres of these productive shellfish beds thereby rendering these inaccessible to the recreational digger and leaving only 310,881 acres (EPA, 1975) of so-called clean productive shellfish area for all purposes. The bulk of the closed productive area which is classified as grossly contaminated is found in and around Boston Harbor and along the North Shore. In terms of an untapped resource, it is estimated that there are approximately 150,000 bushels of legal sized soft-shelled clams (Chesmore, et al, 1970) within this area which cannot now be harvested. It should be emphasized that not all of this resource would be available for recreational purposes even if the area were open.

In 1971 an opinion poll was conducted by the Division of

Marine Fisheries, Shellfish Technical Assistance Project, to gain knowledge about attitudes and trends relating to the demand and management of the shellfish resources in Massachusetts from the shellfish constables, who are directly involved in management of the resource on the local level. In the questionnaire, the shellfish constables were asked to list the relative importance of each type of shellfishing (family-recreational, wild-commercial, private grants). Interestingly, the order of importance most accepted throughout the Commonwealth was that recreational fishing is considered most important, wild-commercial fishing next, and private grants last. This opinion was especially prevalent north of Cape Cod and in the Buzzards Bay area. These two areas are the most highly urbanized in Massachusetts. Cape Cod and the Islands also favored this order with wild commercial fishing placing a close second in those two regions.

Species most sought after by recreational shellfishermen in order of importance on a state-wide basis were *Mya arenaria*, soft-shelled clams; *Mercenaria mercenaria*, quahogs; and *Argopecten irradians*, bay scallop. Of least importance in order were *Ostrea virginica*, oysters; and *Mytilus edulis*, blue mussels. Some regional differences in preference did occur mainly due to species availability.

The number of people engaged in recreational fishery varies widely from year to year without apparent reason. However, a sharp downward trend has been noted in the

past four years with regard to the number of non-resident permits being issued. Although all residents of the Commonwealth have the right to shellfish, the coastal communities may charge more to non-residents of the town for a license. Many of the towns have used this method to limit or reduce fishing pressure in their waters by charging excessively high prices for non-resident licenses and some allow no out-of-state licenses. Of the fifteen towns on Cape Cod, the fees for non-residents in 1975 were as follows: 4 towns charged \$25.00; 5 towns charged \$15.00; 4 towns charged \$10.00; 1 town charged \$5.00; 1 town issued no non-resident licenses; 1 town issued no out-of-state licenses.

At the same time, the fees for residents in these towns ranged from \$1.00 to \$5.00. In 1969, 34,588 resident permits were issued compared to 10,084 non-resident permits. In 1972, 22,651 non-resident permits were issued while in 1973, 21,789 resident permits were issued and only 3,662 non-resident permits were issued. This is a difference or reduction of 18,989 non-resident permits in a five-year period between 1969-1973. This reduction is due in part to the cost of the permits and a general decline in the abundance of shellfish.

Recreational fishery produced one-fourth to one-third of the annual harvest in the years 1971-1974 as reported by the local shellfish wardens:

	1970	1971	1972	1973	1974
Family	91,919*	88,322	61,664	46,323	59,866
Commercial	<u>308,151</u>	<u>341,149</u>	<u>172,969</u>	<u>102,457</u>	<u>158,311</u>
Total	400,070	429,471	234,633	148,780	218,711

*reported in bushels

Species reported: Quahog; Soft shell clam; Oyster; Bay scallop; Ocean quahog; Razor clam; Mussell; Sea clam

Management

It is apparent that the major factors contributing to the decline of the shellfisheries in general have been: increased demand, overfishing, pollution, habitat destruction, and public access. Responsibility for managing the Commonwealth's shellfish resources is essentially in the hands of the coastal communities who by law have control and jurisdiction over them. The management effort *should* and *must* consider both the recreational and commercial fisheries. The towns will have to evolve a management plan based on long and short range goals for each species and area in order to be effective.

Basically it is the town shellfish officers who are the managers of the shellfish resources. Their program should include periodic inventories of local shellfish areas on a rotational basis to insure continual availability of shellfish and adequate parent stock; control of shellfish predators; experi-

mental shellfish growth and survival studies as a guide to transplant projects; local information and education programs and enforcement of local and state shellfish regulations.

These duties would require someone to work full time who is knowledgeable in shellfisheries management and the local waters, and is provided with the necessary equipment to undertake surveys, experiments and law enforcement.

Local control, however, does not absolve the Commonwealth from its responsibility to the shellfisheries. Town management efforts will need guidance and coordination, particularly on a regional level where two or more towns share a common body of water. The local shellfish managers will need more advisory and technical guidance from professional fisheries biologists. This service is now being provided through the Shellfish Technical Assistance Program, however, vast improvements are necessary.

Recommendations and Research Needs

Recognizing the need for pollution abatement, wise management of the remaining resources, reclamation of lost resources, and an overall desire to increase shellfish production and harvest, the following recommendations are made regarding management and research needs:

1. *Shellfish management programs.* Under Chapter 130, section 20A of the General Law, the coastal cities and towns will receive up to 50 percent reimbursement for any monies spent in the shellfish programs. It is agreed that this will be beneficial but, two changes are needed. One is an amendment requiring some form of prior State (Division of Marine Fisheries) approved management program to assure that the funds will be used in the best interest of shellfish management. Not all cities and towns have the expertise necessary for wise management of shellfish programs and they should avail themselves of the advice of shellfish experts within the Division of Marine Fisheries. The other is that funds should be provided to the Division for appropriate management and administration of this program.
2. *Development of underutilized species.* The harvesting of shellfish such as blue mussels, surf clams and ocean quahogs should be considered in an effort to alleviate pressure on other species. Concurrently, regulation and management plans for these less popular species should be formulated.
3. *Harvest data.* Develop a standard system of obtaining accurate catch data, particularly with regard to the recreational shellfishery and with additional consideration to reporting catch by area.
4. *License fees.* Evolve an equitable system of recreational license fees predicated upon increasing resident fees which are unrealistically low and reducing non-resident fees; particularly in view of the state shellfisheries financial reimbursement program.
5. *Research.* Research on shellfish aquaculture techniques and their possible application in local management programs should be continued and expanded on the state and local level in order to enhance both the commercial and recreational fisheries. Research and evaluation should include hatchery techniques, raft culture, grow out techniques, predator control and economic feasibility studies. Multi-disciplined studies, in conjunction with suitable research institutions, regarding all aspects of shellfish ecology should be pur-

sued in order to better understand shellfish populations and eventually manipulate the organisms and their environment.

6. *Increased utilization of contaminated shellfish stocks.* The "relaying" of contaminated shellfish to clean areas for natural depuration and use as parent and seed stock for reseeding should be explored thoroughly as a means of increasing shellfish harvest in the state. The present minimum program should be expanded and legal obstacles corrected by legislation. Cost analysis, transplant survival and estimates of benefit should be made for each specie. A comprehensive survey of the contaminated growing areas should be made to determine available stocks, best harvest methods and best use.
7. *Private aquaculture.* Private shellfish grants should be encouraged especially in "marginal" shellfish producing areas both on a large and small scale. Increased production on "private grants" can only serve to enhance surrounding public grounds through increased spawning and setting of larval shellfish.
8. *Reclamation of contaminated areas.* In order to reclaim productive areas lost to utilization by contamination, it is urged that sewerage treatment programs with at least secondary treatment be encouraged and implemented as soon as possible.

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Footnotes

1. Shellfish—in this paper refers only to mollusks, not to crustaceans such as crabs, lobsters or shrimp.
2. Colony Ordinance of 1641-47, made an historic change in the common law in respect to the seashore. Chapter LXIII, Sec. 2. "Every inhabitant who is an householder shall have free fishing or fowling in any great ponds, bays, coves and rivers, so far as the sea ebbs and flows..."

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Recreational Use of Shellfishes: Issues and Conflicts

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Introduction

Less than a year ago, in this same town, a National Conference on Effective Management of Marine Fisheries convened. The purpose was to discuss model state marine fishery legislation drawn up by a committee of the Council of State Governments. References to special problems of the marine recreational fisheries and the conflicts between recreational and commercial users of the living resources appear throughout the published proceedings (1975). One speaker (Carlton, 1975) addressed his remarks specifically to conflicts and cooperation between the two major user groups and to ways in which such difficulties might be resolved. Nothing I can say here would add much to that excellent summary of the subject.

Fortunately, this session today deals with shellfishes, a much neglected recreational resource, which was not included in the paper by Carlton (1975). This is not to say that mollusks and crustaceans have been neglected by recreational fishermen. Anyone familiar with our coastal fisheries knows intuitively that large quantities are taken by recreational and subsistence fishermen for food and bait.

The neglect has been by those who have been trying to assess the marine sport fisheries. Most studies have estimated catches of finfishes only, and very few have attempted to include invertebrates. The three published surveys of saltwater angling (Clark, 1962; Deuel and Clark, 1968; Deuel, 1973) did not include invertebrates, but that deficiency has been remedied in the current survey (Ridgely and Deuel, 1975). When estimates of invertebrate sport catches have been made the results have suggested that these are indeed major recreational resources. In one small area of New York, for example, Levenson (1971) found that blue crab (*Callinectes sapidus*) ranked fifth in numbers caught by recreational fishermen in Hempstead Bay, Long Island. Only winter and summer flounders (*Pseudopleuronectes americanus* and *Paralichthys dentatus*), bluefish (*Pomatomus saltatrix*), and northern puffer (*Sphoeroides maculatus*) were taken in greater numbers, and this was at a time (1966-68) when blue

crab was at a low point in abundance in the New York Bight area, if commercial landings are a valid index (McHugh, 1976).

I see this subject of issues and conflicts as a broad one, touching on all aspects of shellfish research and management. Therefore, I cannot avoid venturing into the topics assigned to the other two speakers in this session, and must say something about the resources, research, and management.

Some Dimensions

Most people agree that recreational catches of invertebrates in coastal waters of the United States are large. Nobody knows exactly how large, because no state conducts a complete and continuing survey of all aspects of marine recreational fishing, and the recent federal survey has been published only in brief as yet (Ridgely and Deuel, 1975). However, the importance of invertebrates might be inferred from the published national surveys (loc. cit.). For example, in 1970 it was estimated that recreational fishermen in the United States took nearly 1.6 billion pounds of marine finfishes (Deuel, 1973). In the same year the reported commercial marine food finfish catch, excluding Hawaii, was nearly 1.7 billion (Wheeland, 1973),* almost identical with the sport catch. Allowing for the fact that recreational catches probably are exaggerated (Deuel, 1973) and commercial catches underreported (Keck et al., 1973; Adkins, 1972; A.F. Chestnut, personal communication) this is still an impressive comparison.

Assuming that commercial and recreational shellfish catches also were about equal gives an estimated recreational catch in 1970 of about 862 million pounds. This does not include shells of mollusks, which, if included, would raise the total weight to about 2 billion pounds. Whether this estimate is correct is impossible to determine at this stage.

*Total 1970 commercial landings, less invertebrates, industrial fishes, and landings from fresh waters. Hawaii was omitted because it was not included in the survey of saltwater sport fisheries.

However, the preliminary report on the most recent survey (Ridgely and Deuel, 1975) suggests that only about a third as many people participate in recreational shellfishing as in recreational finfishing. On that basis a closer estimate of the national catch of shellfishes by recreational fishermen might be about 670 million pounds live weight, still an impressive figure. The detailed results of the 1973-1974 survey will be awaited with interest.

To discover whether some of the individual states had attempted estimates of recreational shellfish catches I wrote to appropriate agencies in nine coastal states, mostly on the west coast and the Gulf of Mexico. All have replied. Three had no information, the others reported partial information, i.e. for one or a few species, or for only a small area, or for only part of a year. The replies are summarized in Table 1.

Table 1—Estimates of recreational catches of shellfish per year for selected states

Catch per year				
State	Species or species group	Numbers	Weight in pounds	Remarks
AK	Razor clam	1,000,000		Cook inlet only.
AL	Shrimp (3 species)		257,400	Average for 1972-74 inclusive.
CA	Market crab			Catch important.
	Rock crab			Catch important.
	Spiny lobster		250,000	Extremely important, equals commercial catch.
	Abalone (4 species)		2,500,000	Somewhat less than commercial catch.
	Gaper clam			Important, probably greater than commercial catch.
	Littleneck clam (2 species)		10,000	
	Pismo clam			Maximum sustainable yield about four million clams per year.
	Razor clam Washington clam	171,000		One beach only Greater than commercial catch.

State	Species or species group	Numbers	Weight in pounds	Remarks
FL	12 species or groups			No information. Also large catch of many species by shell collectors.
LA	Oyster			No information. Limit two sacks per boat-day on public reef.
	Crustaceans			No information. Shrimp sport fishermen number 40,000.
NC	5 species or groups			No information.
OR	20 species or groups	3,430,000		In 8 months in 1971.
TX	Mollusks			No information. Almost entirely oyster. In 1972.
	Shrimp (3 species)		900,823	
	Blue crab	99,375	33,125	In 9 months in 1968.
WA	Razor clam	9,700,000		
	Clams		2,100,000	Puget Sound only.
	Oysters	1,600,000		Puget Sound only.
	Shrimp		18,000	Puget Sound only.
	Intertidal crabs	42,000		Puget Sound only.
	Crabs	200,000		In pots. Puget Sound only.

Some of the numbers are surprisingly large. For example, in one relatively small part of the Alaskan coast, Cook Inlet, a million razor clams were taken by recreational diggers, about three clams for every resident of the state. Assuming that 400 of this medium sized species make up a bushel this would be an annual catch of 2,500 bushels. This is much larger than the reported annual commercial catch of razor clams in Alaska.

In California it is estimated that about 2.5 million pounds of abalone are taken per year. In Oregon, of some 20 species or species groups of shellfish, nearly 3.5 million individual animals were taken for recreation in less than a year. In Washington nearly 10 million razor clams per year were reported, and in Puget Sound more than two million pounds

of clams of all species were taken.

A surprisingly large number of crustacean and molluscan species is taken by recreational fishermen. Lists of species or species groups received from correspondents on the Pacific and Gulf of Mexico coasts, and personal knowledge of other species taken along the Atlantic coast of the United States gave a total of more than 100 recreational species or species groups (Table 2).

This is probably a conservative figure. It also was pointed out (Charles R. Futch, personal communication) that live mollusks of many genera are taken by shell collectors. The most highly prized, and therefore particularly sought after, include the genera *Conus*, *Spondylus*, *Oliva*, *Murex*, *Busycan*, *Scaphella* and *Strombus*.

Bait Fisheries

The importance of bait fisheries to the recreational fisheries should not be ignored. Bait fishing may be a commercial operation, or it may be conducted by individual recreational fishermen to provide their own bait. A single example will serve to illustrate the magnitude of the commercial bait industry. On the west coast of Florida in 1956 (Woodburn et al., 1957), the retail value of shrimp (*Penaeus duorarum*) caught for bait was about \$2,000,000. Shellfish taken for bait do not necessarily appear in statistics of commercial fish landings from all regions of the United States coast.

Issues

The principal issue, from a management point of view, raised by recreational harvesting of mollusks and crustaceans is that unless the harvest is known with reasonable accuracy and unless it can be controlled as necessary to maintain the resource in healthy condition, attempts to manage the commercial fishery will be pointless. The importance of this problem is not generally appreciated either by commercial or by recreational fishermen. A large and uncontrolled recreational fishery can nullify a management program and contribute to overfishing of the resource.

Recognition is growing that to be of maximum economic benefit to commercial fishermen a management program should include some form of control over entry of capital and labor. Recreational fishermen, unless they happen to sell some or all of their catch, have no economic incentive. Rather, they probably are interested in getting the maximum catch, or some finite anticipated catch, in the shortest possible time. Even if it were desirable and possible to limit the numbers of commercial fishermen, it might be neither desirable nor possible to control recreational fishing in the same way. Nevertheless, both groups must be equally subject to control if management is to succeed.

The only feasible way to control the recreational segment of a fishery by conventional methods probably would be to take the following steps: 1) determine the total allowable catch; 2) subdivide the total allowable catch into a commercial and a recreational segment; and 3) allocate the recre-

ational quota to individual fishermen as a bag limit. The social-political feasibility of arriving at this series of decisions will depend heavily upon the size of that bag limit and hence its acceptability. Another problem will arise if the numbers of sport fishermen continue to increase, as they probably will. The only possible solutions then would be either to increase the recreational share of the total allowable catch or to reduce individual bag limits, both very difficult things to accomplish.

Particularly in molluscan shellfishing areas water quality is an important issue. Many grounds around the coasts of the United States are closed to shellfishing because water quality does not meet established standards. In New York, for example, about 139,000 acres are closed (MacMillan, 1975). Many of these areas have substantially larger shellfish populations, especially hard clam, than do the harvested grounds, thus the temptation is great to take clams illegally. Areas in which water pollution is heaviest often are the most heavily populated, another factor that favors poaching.

Other species, like oysters, less resistant to pollution, may be wiped out. Collapse of the oyster industry in Raritan Bay and adjacent waters in New Jersey and New York has been attributed to water pollution (Wallace, 1971; Dewling et al., 1972).

Where hardy species, like hard clam, are abundant in polluted areas, it is possible that these areas serve as sanctuaries to replenish the supply on harvested grounds. In New York and other states it is the custom to transplant shellfish from closed areas to waters certified for harvesting, allowing a reasonable time after transplanting for the mollusks to cleanse themselves. Such projects have two principal purposes, to reduce abundance in closed areas, thus reducing the temptation to poach, and to make shellfish available to the industry. Usually it is not known what role the stocks in polluted waters play in the dynamics of the resource as a whole. It would be especially important to understand the contribution made by these restricted stocks, so as to take full advantage of such serendipitous sanctuaries.

Conflicts

With some outstanding exceptions, conflicts between recreational and commercial users of invertebrate resources have been fewer and less violent than conflicts over some finfish resources. The most emotional conflicts over finfishes on the Atlantic coast concern striped bass, bluefish, and menhaden. American and spiny lobster users in various places along the coast have entered into equally emotional and violent controversies, but as far as I am aware this has happened with few other crustacean and mollusk resources. In California several mollusks have been reserved as recreational resources. Pismo clam and razor clam have been declared recreational resources in that state. The so-called littleneck clams also are important recreational resources in California, but limited commercial fisheries are permitted to harvest them, with a bag limit of 50 clams per day (E.C. Greenhood,

**Table 2—Crustacean and molluscan shellfish
in recreational or subsistence catches in the United States
(A = Atlantic, P = Pacific, G = Gulf of Mexico)**

Common names	Scientific names	Source and use
Brown shrimp	<i>Penaeus aztecus</i>	A G
Pink shrimp	<i>P. duorarum</i>	A G
White shrimp	<i>P. setiferus</i>	A G
Seabob	<i>Xiphopenaeus kroyeri</i>	G
Grass shrimp	<i>Palaemonetes vulgaris</i>	A—bait
Little green shrimp	<i>Hippolyte clarki</i>	P
Red-banded trans- parent shrimp	<i>Spirontocaris picta</i>	P
Transparent shrimp	<i>S. paludicola</i>	P
Spot shrimp	<i>Pandalus platyceros</i>	P
Coonstripe shrimp	<i>P. hypsinotus</i>	P
Northern pink shrimp	<i>P. borealis</i>	P
Ocean pink shrimp	<i>P. jordani</i>	P
Dock shrimp	<i>P. danae</i>	P
Northern shrimp	<i>P. borealis</i>	A
Humpy shrimp	<i>P. goniurus</i>	P
Side stripe shrimp	<i>Pandalopsis dispar</i>	P
Sand shrimp	<i>Crangon septemspinosus</i>	A—bait
Little gray or bay shrimp	<i>Crago</i> spp.	P
Rock shrimp	<i>Sicyonia</i> spp.	
Ridgeback prawn	<i>Eusicyonia ingentus</i>	P
River shrimp	<i>Macrobrachium</i> spp.	A G
American lobster	<i>Homarus americanus</i>	A P
Spiny lobster	<i>Panulirus argus</i>	A G
	<i>P. interruptus</i>	P
Ghost shrimp	<i>Callinassa californiensis</i>	P—bait
	<i>C. gigas, C. affinis</i>	P—bait
Mudshrimp	<i>Upogebia pugettensis</i>	P—bait
Sand crab	<i>Emerita analoga</i>	P—bait
Hermit crabs	<i>Pagurus pollicaris</i>	A—bait
	<i>Pagurus</i> spp.	A P—bait
Pelagic red crab	<i>Pleuroncodes planipes</i>	P—bait
King crab	<i>Paralithodes</i> <i>camtschatica</i>	P
	<i>P. platypus</i>	P
	<i>Lithodes aquispina</i>	P
Tanner crab, snow crab	<i>Chionoecetes tanneri</i>	P
Green crab	<i>Carcinus maenas</i>	A—bait
Blue crab	<i>Callinectes sapidus</i>	A G
Sand crab	<i>Ovalipes ocellatus</i>	A—bait
Rock crab	<i>Cancer irroratus</i>	A
Red rock crab	<i>C. productus</i>	P
Jonah crab	<i>C. borealis</i>	A
Dungeness crab	<i>C. magister</i>	P

*When not taken directly for recreation.

Common names	Scientific names	Source and use
Red crab	<i>C. antennarius</i>	P
Mud crabs	Family Xanthidae	A G P—bait
Stone crab	<i>Menippe mercenaria</i>	A G
Shore crab	<i>Hemigrapsus oregonensis</i>	P—bait
Fiddler crabs	<i>Uca</i> spp.	A G P—bait
Horseshoe crab	<i>Limulus polyphemus</i>	A—bait
Limpet	<i>Acmaea digitalis</i>	P
Northern or pinto abalone	<i>Haliotis kamtschatkana</i>	P
Black abalone	<i>H. cracherodii</i>	P
Green abalone	<i>H. fulgens</i>	P
Pink abalone	<i>H. corrugata</i>	P
Red abalone	<i>H. rufescens</i>	P
White abalone	<i>H. sorenseni</i>	P
Slipper limpet	<i>Crepidula fornicata</i>	A
Moon snail	<i>Polinices lewisii</i>	P
	<i>P. duplicatus</i>	A
	<i>P. heros</i>	A
Periwinkle	<i>Littorina littorea</i>	A
Channeled conch or whelk	<i>Busycon canaliculatum</i>	A
Knobbed conch or whelk	<i>B. carica</i>	A
Conch	<i>Strombus</i> spp.	P
Abalone jingle	<i>Pododesmus cepio</i>	P
California mussel	<i>Mytilus californianus</i>	P
Blue or bay mussel	<i>M. edulis</i>	A P
Ribbed mussel	<i>Modiolus demissus</i>	A
Western oyster	<i>Ostrea lurida</i>	P
American oyster	<i>Crassostrea virginica</i>	A G P
Pacific oyster	<i>C. gigas</i>	P
Bay scallop	<i>Argopecten irradians</i>	A G
Rock scallop	<i>Hinnites multirugosus</i>	P
Pink scallop	<i>Chlamys</i> spp.	P
Bodega clam	<i>Tellina bodegensis</i>	P
Bentnose clam	<i>Macoma nasuta</i>	P
	<i>Macoma</i> spp.	P
Sand clam	<i>M. secta</i>	P
Surf clam	<i>Spisula solidissima</i>	A
Pismo clam	<i>Tivela stultorum</i>	P
Hard clam	<i>Mercenaria mercenaria</i>	A P
	<i>M. campechiensis</i>	G
Native little- neck clam	<i>Venerupis staminea</i>	P
Manila littleneck	<i>V. semidecussata</i>	P
	<i>V. japonica</i>	P
Butter clam	<i>Saxidomus giganteus</i>	P
Washington clam	<i>Saxidomus nuttalli</i>	P
Sunray venus	<i>Macrocallista nimbosa</i>	A G
Purple clam	<i>Sanguinolaria nuttalli</i>	P
Cockle	<i>Cardium corbis</i>	P
Heart cockle	<i>Clinocardium nuttalli</i>	P

Table 2 (Continued)

Common names	Scientific names	Source and use
Soft clam	<i>Mya arenaria</i>	A P
Razor clam	<i>Ensis directus</i>	A
	<i>Siliqua patula</i>	P
California jack-knife clam	<i>Tagelus californianus</i>	P
Piddock	<i>Zirfaea pilsbryi</i>	P
	<i>Penitella penita</i>	P
Geoduck	<i>Panope generosa</i>	P
Horse clams,	<i>Tresus capax</i>	P
Gaper clam	<i>T. nuttalli</i>	P
Rangia	<i>Rangia cuneata</i>	A
Octopus	<i>Octopus vulgaris</i>	A
	<i>O. dofleini</i>	P
	<i>Polypus</i> spp.	P
Squid	<i>Loligo opalescens</i>	P
Long finned squid	<i>L. pealei</i>	A

personal communication). In Massachusetts conflicts have been resolved by setting aside certain beaches for recreational shellfishing (John M. Hickey, personal communication).

It is surprising that there have not been more conflicts. One of the principal reasons for the strong feelings about fisheries for striped bass, bluefish, and menhaden in New York is the high visibility of commercial fishing for these species, which leads to accusations of destruction. Yet in the New York hard clam fishery, conducted in shallow waters near shore, no major conflicts have arisen, although fishing effort is obviously intense by both groups and there is some concern about the capacity of the resource to withstand this continuing pressure. One possible reason may be that people do not become emotionally attached to clams in the same way that a dedicated striped bass angler identifies himself with his quarry, or as most of the population of the United States has become attached to marine mammals. Baymen who make a living harvesting hard clam in Great South Bay, Long Island, for example, show no resentment of recreational and subsistence clambers, provided that they observe the laws and do not sell their catches. Recreational users of the resource do not claim priority. The principal issue, the difficulty of establishing a complete management program in the absence of knowledge of the size of the recreational catch and its effect on the capacity of the resource to renew itself, is scarcely recognized. Conflicts that do exist, and they are bitter at times, are between commercial clambers who obey regulations and those who do not, and between individuals who work the public grounds and firms which have private control over bottom. Public ground shellfish harvesters generally are opposed to private leasing of bottom.

Conflicts between recreational invertebrate fishermen and

commercial fishermen are likely to be about how to share the total allowable catch. As in the finfisheries, the extreme situation is one in which it is argued that the resource should be reserved entirely for recreational use. As already mentioned, the powerful sport fishing lobby in California has succeeded in applying this extreme concept to several species of bivalve mollusk. Justification for such regulations is almost always that commercial fishing is destructive, and that therefore to ban commercial fishing is good conservation.

Actually, division of the catch, by itself, has nothing to do with conservation. Behind the argument lies the belief that commercial fishermen take large quantities of the resource while recreational fishermen take insignificant amounts. This usually is a paradox, based upon only a part of the issue, the individual catch. All comprehensive studies have shown that for many species it must be recognized that the numbers of fishermen in the two groups are unequal. It is clear that the sum of small catches by large numbers of recreational fishermen may exceed the sum of large catches by relatively few commercial operators.

A striking example can be developed from figures presently available. According to Ridgely and Deuel (1975) 388,000 households in New York participated in recreational shellfishing in 1973-74. The number of participants per household in New York was about 2.2. Thus, about 853,600 people in New York State took shellfish for recreation. The number of commercial shellfishing licenses issued in 1973 and 1974 were 6,462 and 8,027 respectively (MacMillan, 1975). If all recreational shellfishermen took some hard clams, there would be about 100 times as many recreational as commercial clam fishermen in New York State in the early 1970s.

Non-commercial clambers are allowed to have in their possession at any one time not more than half a bushel of legal-size clams. Using a conservative estimate, that each recreational clam digger took an average of only half a bushel per year, the total annual catch would be about 426,800 bushels. Some recreational clambers may take less than the limit and may go clamming only once in a year, but that probably is the exception. Reported commercial landings in 1973 and 1974 were about 7.2 million and 8.0 million pounds of hard clam meats respectively, an annual average of about 633,000 bushels. Thus, although the estimated commercial catch is probably too low, the estimated recreational catch may be conservative also. As a first approximation it is possible to say that the recreational take of hard clam in New York waters may equal the commercial catch, or possibly exceed it.

An experienced full-time commercial clammer takes an average of about three bushels a day and works about 200 days a year. Thus, the average total annual catch may be about 600 bushels. Relatively few commercial shellfish license holders, perhaps not more than 10 percent, are full-time professionals. If 10 percent is correct, in 1974 in New York about 800 clambers worked a full year. If the working

assumptions are correct, their total catch would be about 480,000 bushels. It is probably conservative to estimate that the remaining 90 percent took an additional 480,000 bushels.

Therefore, if these assumptions are at all close to reality, the total commercial hard clam catch in New York is about one million bushels. Many residents of Long Island frequently take clams for recreation or subsistence. If 10 percent of the recreational shellfishermen take half a bushel twice a month, their annual catch would be about one million bushels. This suggests that the recreational catch may be considerably larger than the commercial. However, these estimates are based on so many untested assumptions that they should be used with great caution. The important point is that careful estimates of the recreational and the commercial catch should be made as soon as possible.

Management

At the minimum, five pieces of information are necessary as a basis for managing a fishery (McHugh, 1975). These are: 1) standing crop; 2) growth; 3) recruitment; 4) natural mortality; and 5) fishing mortality. All five must be measured frequently, because all vary with time. Most molluscan shellfish stocks should yield such information fairly readily because they are non-migratory at the harvestable stage. But mollusks in shallow waters are so readily accessible to commercial and recreational fishermen, and the harvesting segment of the industry is usually so loosely organized, that it is difficult, if not impossible, to get the necessary information by the usual method, e.g. in the form of accurate catch and effort data provided by fishermen's logbooks. The relatively costly alternative is to make planned scientific surveys.

If total allowable catch can be determined, the next step is to decide how to allocate the total catch among users, and to determine how quotas can be monitored and enforced. This is perhaps the most difficult set of decisions, and it is made more difficult if the resource fluctuates widely in abundance, as most shellfish populations do.

Limited or controlled entry is presently an appealing solution to the problem of managing commercial fisheries, because it has attractive economic as well as conservation features. Controlled entry does not appear to be a solution to management of a recreational fishery, however, for among other things, it probably would be considered unconstitutional. Thus, under a limited entry system the recreational catch probably would have to be controlled by an overall quota and individual bag limits. The system presently in use in many states, placing limits on amounts of shellfish in possession at any one time, would not be adequate. It is likely that resistance would be strong to more stringent regulation.

To return to the hard clam example, in New York, the annual individual bag limit might be between half a bushel and one bushel per year, or perhaps might have to be less. This would be greater than some recreational clammers presently take, but much less than others. The various alternatives to this approach appear to be very complicated. Perhaps the only practical solution would be to adopt the zon-

ing method used in Massachusetts.

Summary

Prospects for managing shellfish fisheries of shallow waters, when recreational catches are large, do not look promising. In addition to all the complicated aspects of decision making and control, only a few of which have been touched on here, are many difficult social-political considerations. In most places where important inshore shellfisheries exist public attitudes are not conducive to effective management, partly because public understanding is deficient. An important element for successful management will be public education, for a clearer understanding of the issues and wide acceptance of the need for controls.

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Wildlife: Description, Use and Values

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Introduction

Four or five years ago, I was invited by the World Forestry Congress to present a paper on the Economics of Forest Wildlife in North America—not Massachusetts or Montana, or even the United States, but all of North America. After involving a few unsuspecting colleagues in the assignment, I worked long and hard to produce little of real consequence.

True, a few local surveys were found which gave dollar values to the harvest records of big game and fur bearers. Some went further and assigned dollar amounts to the collateral costs of harvest which further impacted on the local economy, such things as travel and equipment costs, food and lodging, etc. However, the sum total of these spot surveys scarcely gave an insight into the true value of forest wildlife on this continent.

More to the point, it became evident in the course of this exercise that to relegate wildlife to the same economic status as wheat, corn and beef-on-the-hoof was to miss the point completely. First off, it plays into the hands of the developers—the drainers, fillers, cutters and polluters—who rejoice in comparing their inflated claims of the social value of development and change with the inherent value of natural systems. It is, in fact, the trap which we fell into with our River Basins programs several years ago when we sold wildlife for the mitigation dollars of the Corps, Reclamation and other champions of a new social order.

Secondly, and related to the first, any assignment of value to use-days or units of living beings fails to credit and account for the elusive values that any one life form contributes to a functioning life system. Modern-day economists, I understand, have a word to express this in some measure—*externalities*, the values beyond obvious values, values outside of use periods.

A reckoning of wildlife values in coastal and adjacent waters presents the same difficulties I've just described for forest wildlife. And, having built a case of sorts denying the

logic of attempting to do this solely on a basis of human-use, consumptive or otherwise, I'll now reverse my field and attempt to do the best I can with it.

Waterfowl

A major consumptive use of the wildlife of our coasts and estuaries concerns waterfowl, and the total national involvement in this sport is substantial. The last National Survey of Hunting and Fishing in 1970¹ showed that 2.9 million participants spent in excess of \$244 million during 25 million recreation days in hunting these birds. There is no good way, of course, of sorting out the part of this total which centers on the areas under discussion. We can, however, look to the distribution of birds and gain a clue from a few examples.

In the Atlantic Flyway, more than 75 percent of the Canadian geese winter on and near tidewater from Kent County in Delaware to Hyde County in North Carolina.² While much of the actual harvest occurs over cropland, it's a fair assumption that the open bays and network of tidal streams contribute substantially to their presence in the area.

Maryland, without question, is the mother lode for Atlantic flyway geese. Waterfowl hunters in the state number 50,000 and expenditures, depending on the survey and what all it included, range from \$17 million to \$23.5 million annually. Included in this figure is \$8 million for lease or rental of hunting sites in high-use areas and, of that total, \$2.5 million was expended on rental of 1600 offshore blinds. In moderate-use areas land rentals were negotiated on 3650 farms and 475 offshore sites, and in fair-use areas rentals were arranged for 5600 farms and 1150 offshore blinds. The harvest last year included 273,000 geese, 101,000 ducks and lesser numbers of coots, sea ducks and other species. Resident game, including quail and white-tailed deer are also taken regularly in coastal marshes, particularly toward the end of the season when hunting pressure drives them from upland habitats.³

The Texas Gulf Coast winters in excess of 3.5 million ducks and geese or about 15 percent of the total United States population. This figure, incidentally, includes nearly four-fifths of all red head ducks, a species on the wane and in need of shepherding. A 1968 survey revealed that 309,000 man-days of hunting occurred in this area with a hunter expenditure which added to \$3 million. Since the total figure was computed on the basis of a \$9.75 expenditure per hunter the amount seems quite low. Surely today's cost would be double that figure.⁴

The fact that two of our four flyways hug our oceanic coastlines testifies to the importance of these waters in sustaining waterfowl. And, above all other areas, we can look to Alaska to see the intimate association of waterfowl with estuaries.

Alaska has a diverse tidal shoreline measuring 34,000 miles or roughly one-third of the coastal shores of all the United States including the Great Lakes. A large part of the waterfowl entering the Central and Pacific flyways are produced here in such lush estuarine sites as Yukon River Delta, Yakutat Bay, Copper River Flats, and Bristol and Kuskokwim Bays, to name just a few. And as great as the numbers of nesting birds are, these flocks swell dramatically during spring and fall when nearly the entire population of birds from Alaska, Siberia and Northeast Canada rest and feed in its estuaries. The coastal waters of this state produce and nurture a substantial segment of North America's waterfowl.⁵ As for a dollar value, who can assign it? But, at the same time who would question that without these lush coastal pastures the \$244 million spent on waterfowling would be diminished appreciably.

Horvath Report

You are all familiar, I'm sure, with the so-called Horvath report⁶ covering an economic survey of wildlife recreation in the Southeast. While this study provided detailed information on wildlife-oriented activities for that geographic region, it did not attempt to segregate the portion of those activities which relate specifically to our area of interest—the coastal and estuarine zone. However, seven of the 11 states covered by the study have contact with oceanic waters and, in describing major habitat types covered, the report did state that, "estuaries and coastal marshes, along with interior wetland, comprise extremely important habitat components." We can, therefore, assume with some confidence that a substantial portion of the waterfowling depended on those habitats of concern to us here.

The 11-state survey estimated that the total hunting effort for all game added to 101 million days or 123 million occasions. The Southeast is quail and squirrel country and, as would be expected, small game accounted for substantially more recreation time than was recorded for big game and waterfowl. Yet, waterfowl hunting alone was measured at nearly 6 million days on 6.8 million occasions.

Although there are fewer waterfowl hunters than small game hunters in the Southeast, they prize their sport more

highly. The study revealed that waterfowlers placed an average daily value on their sport of \$49 compared with \$39 for small game. And, by another measurement, "dollars demanded to give up a day of hunting," waterfowl again rated ahead of small game with a value of \$67 compared to \$55. Using the latter value on waterfowling the total value in the Southeast figures to be over \$357 million. The growing observation that duck and goose shooting is becoming a rich man's sport also is borne out in part by the study. Individuals in an annual salary range of \$25,000 and up gave it a daily value of \$98 compared with only \$31 by those whose annual income was under \$3,000.

Furbearing Animals

Our coastal marshes are also highly productive of furbearers, and, while that value lends itself to dollar accounting, the record keeping is such that good figures on the total worth of this resource are hard to establish. A decade ago it was estimated that the sale of fur and meat returned about \$6 million to trappers in the Gulf and Atlantic states. Roughly \$5 million was represented by fur and the remainder, \$1 million in carcasses, mainly nutria. This figure was further broken down to allot \$4.6 million of the total to Louisiana alone, and \$4 million of that was accounted for as having been taken in 3.5 million acres of coastal marsh. The trapper take that year (1966) in Louisiana included 1.25 million nutria, 320,000 muskrats, 78,000 raccoons, 28,000 mink and 3,600 otters.⁷

Of course, what has happened to the fur market since those lean years is difficult to imagine. A tripling of the total revenues would appear to be a fair reflection of the enormous increase in fur values. In Louisiana, where comparable figures are available, that seems to have been the case, since the fur take in that state was put at \$11 million for the 1973-74 season and at \$12 million for 1974-75.

In Maryland a similar trend is evident. Duane Pursley, program director for the Maryland Game Administration, provided me with trapping figures for the 14 Bay counties of the State. In 1974-75 the value of fur taken from those coastal marshes was recorded at nearly \$1.5 million, most of which accrued from a muskrat harvest of 232,000.

Alongside other values of coastal wetlands, the fur yield has never bulked large. But today's historically high prices could change that. Muskrats are bringing \$4-\$6 dollars, raccoons \$12 to \$25, red fox \$40-\$50 and otters about the same.

Good documentation of the values deriving from a consumptive use of wildlife is difficult to establish and the problem is aggravated when one turns to nonconsumptive uses. There is evidence in recent years that the latter use is substantial and growing, and probably related in part to an increased public antipathy towards hunting and trapping.

Other Recreational Language

Bird watching is one of the fast-growing diversions. The 1970 National Survey of Hunting and Fishing¹ gave a figure of

6.8 million people engaging in this recreational activity. While this figure is less than half the number of hunters, the days of recreation enjoyed (411 million) is more than twice that for hunters (203 million), due obviously to the year round season on bird watching. The same survey tallied 4.5 million bird and wildlife photographers who snapped shutters for 38 million days, and 27 million nature walkers who were out on 337 million days.

On lands administered by the Bureau of Land Management and the Forest Service, hunter visitations have remained relatively stable in recent years, whereas viewing and photographing wildlife has grown dramatically, as much as 25 percent per year in some areas.⁸ The spectacular growth of my own organization, the National Audubon Society, is a further indication of the growing interest in birdlife and environmental issues. From an organization of only 41,000 in 1963, we grew to 142,000 in 1970 and 331,000 in 1975—an 8-fold increase in 12 years.

Attaching a dollar value to such enthusiastic participation in wildlife-oriented events involves a considerable judgment factor. The Horvath study⁶, previously mentioned, gave a user value of \$65 to \$80 per day, considerably higher than for hunters. On this basis, the value of wildlife and habitat resources in the Southeast was assessed at \$12.3 billion for nonconsumptive users as compared with \$11.8 billion for consumptive users.

As to what allocation can be made of these high values to coastal resources, I can only quote from McConnell's overview on estuaries.⁴ He said: "Nongame enthusiasts, particularly birders, are especially interested in estuaries. Millions of individual birds are attracted to the rich estuaries. Approximately 80 percent of the 500 plus species of birds known to occur in Texas have been seen along the coast. Bird watchers spend money here just to look." This same study gives figures from the General Land Office in Texas which assigns to Texas coastal counties a recreation value of \$441 million during 1968-70. Activities such as hunting and trapping were not included. And by way of adding another local example, more than one-half million persons are known to pay boat fares annually to view ocean birds, whales, sea otters, sea lions, etc. in the Pacific Ocean off California.¹¹

Record-Keeping Systems

As some of you may know, the Division of Wildlife Refuges in the Department of the Interior entered into a system of record-keeping a few years back which would permit a better understanding of the use to which these areas are put by the public. The information, tallied on a monthly basis, is computerized so read-outs for a variety of activities is readily available. In order to gain a focus on what was happening on those habitats pertinent to our discussion here, I requested, and promptly got, tabulations for those refuges over all of the United States which are of a coastal nature. The total of such refuges numbered 131 and reports were available

from 67. The difference between the two figures represents unmanned refuges which do not report and others whose reporting is done through another station.

The attendance figures for this select group of refuges are of interest. Wildlife oriented recreation was by far the most popular reason for visitation with just under 10 million participants in fiscal year 1975. What remains, of course, is to assign a \$50 value to each visitation. The resultant product of \$500 million, as an annual value to the public of coastal refuges alone, should put a gleam in the jaundiced eye of the office of Management and Budget, the executive department which consistently has refused to acknowledge the public worth of these areas.

Visitations to these coastal refuges for purposes other than wildlife were well below that total. Fish-related visits numbered less than 1.5 million and non-wildlife oriented recreation drew 2.5 million participants.

Marked by a few years delay, the concern of professional wildlife managers closed on the public's interest in non-game birds with a symposium last May (1975) in Tucson, Arizona. The resulting proceedings of 343 pages includes a great wealth of information pertaining to this long-neglected resource.⁹ Once more, however, I must lean on your collective imagination to relate what is happening to non-game birds in general to what is happening in the salt marshes, tidal gluts and river deltas.

In their paper on economic values and recreational trends, Payne and De Graff put a 1974 value of \$500 million on activities associated with the enjoyment of non-game birds. This total was judged to be conservative since it covered only direct costs and excluded such peripheral expenditures as travel, food, lodging and alcoholic beverages. By comparison, waterfowl hunters in 1970 spent a total of \$180 million and, with an allowance for increased hunting and inflated costs, the 1974 figure was placed at \$300 million. The duck-hunter figure also excluded accessory costs, including the alcoholic beverages. Exclusion of the latter would seem to make for a more favorable comparison on the part of bird watchers. However, as a relatively new recruit to the world of bird watching, I'm not entirely sure about that.

Bird Watching

The manner by which this considerable interest in birds was made manifest is of interest. A survey of Amherst, Massachusetts residents showed that 40 percent fed birds and, state-wide, one-third of all households put out an average of 60 pounds of feed. In Maine about the same number fed but more generously—125 pounds per year, a reflection, no doubt, of the harsher winters or the growing popularity of that state as a haven for retirees. In any event, 20 percent of all United States households purchase an average of 60 pounds of birdseed a year at a total cost of \$170 million.

An annual expenditure of \$15 million was estimated for feeders and birdhouses, \$3 million for bird guides, and another \$4 million for gift books about birds.

Bird watching, according to this report, accounts for

one-half to two-thirds of all binocular sales, with those in the higher price range of \$250 and up accounting for three-fourths of all sales. A total investment in binoculars for this purpose was judged to be \$115 million in 1974.

Bird photography is a big thing but, as pointed out by the authors, cameras serve a manifold purpose, subject-wise, and pinpointing costs attributable to birds is difficult at best. They looked at the \$3.7 billion outlay in 1972 for items such as cameras, lenses, film, processing, and attributed 4 percent of the total, \$190 million for 1974, to bird photography. It seems reasonable. In turn, I leave to you the interesting prospect of relating all these figures to the wealth of non-game birds in our coastal zone.

Wildlife and Coastal Waters

My remarks thus far, have centered on the dollar value, direct and indirect, of wildlife of our coastal waters. And such an accounting is some measure of the contribution these situations make to the public interest. As I mentioned at the outset, however, it is but one of the arguments for preservation of such areas and maybe even the weakest of the lot.

As our basic living needs have been met, even surpassed in a lavish measure, our people have come to put far greater values on things once taken for granted. Today, the hue and cry is for preservation of diversity in our natural world, and the avoidance and remedy of environmental abuses, not only as they relate to our own well-being but for the benefit of all living things. Our new-found concern for endangered wildlife, extending to the little-known pupfish, even molluscs and plants, is an indication, I believe, of the new values we are assigning the world around us.

Few, if any, of our natural habitats afford us the diversity of wildlife found in coastal waters and the lands and tributaries over which they wash. And the part played by this rich lode of wildlife in the maintenance of a healthful, functioning system is yet to be determined. Consider, for example, that of all the bird species in eastern North America, nine-tenths have been recorded from the Gulf coast marshes alone.¹⁰ It is facts such as these that make it futile to attempt a fair appraisal of the value of such areas in sustaining many species of wildlife on this continent. However, some of our most abundant species seem intimately tied to coastal situations.

Almost the entire population of snow and blue geese, which number in the millions, are dependent on the marshes of the Texas and Louisiana coasts. These are their sole wintering grounds. Other major groups intimately tied to coastal marshes and estuaries include pelicans and cormorants, the long-legged waders, eagles and ospreys, cranes and rails, shorebirds, gulls and terns and a few passerines.¹⁴

On the west coast, the black brant is still another species closely tied to a coastal life, both on its breeding and wintering grounds. The principal breeding area is just above high tide level along the delta of the Yukon and Kuskokwim rivers in Alaska. Their migrations follow the Alaskan

and Canadian coastlines to wintering grounds in the bays of Washington, Oregon and California and into the larger bays and lagoons of Baja California and Mexico. Some follow along the Asiatic coast to winter in Japan. Wherever they come from and wherever they go their total existence is in coastal waters.

In California, black brant are a thing of the past. Since the late 1940's the species has declined from well over 60,000 birds to near zero today.

While much speculation attended its steady decline, the best guess is that human activity, harassment and disturbance was the cause of it.¹³ Of course management shortcomings are capable of remedy and black brant could probably be reinstated as residents of California if, in fact, the causes mentioned are the real ones leading to abandonment of the area.

Coastal Waters Destruction

But destruction of such areas is forever and what's happening in this respect is a national disgrace. The National Estuary Study of 1970¹⁵ shows that of 16.7 million acres of the Nation's estuaries, 665,000 acres or 4 percent, considered important to wildlife, were lost to dredging and filling in one 20-year period (1950-69). This same study revealed that virtually all of such areas have been impaired in some measure. The degree of modification is given as: severe—23 percent, moderate—50 percent and slight—27 percent.⁵

Actual documentation of wildlife losses due to destruction of coastal waters has not been done in a very convincing way. However, one study has come to my attention concerning a large bayfill operation in Hillsborough County, Florida in 1968. The following effects were recorded for Alafia Sanctuary on Green Key: nesting by American egrets dropped from 18-28 pairs to zero. Brown pelicans, which normally nested until fall, hatched one batch of young then deserted the Island, nesting cormorants declined by 50 percent and the numbers of wood ibis that nested there dropped from 25-30 to 2 or 3. Although a dozen yellow-crowned night herons normally nested in the area, none did so following the nearby filling operation.¹⁶

I would suggest one more imperative for the preservation of our coastal waters. Yesterday's concern for endangered wildlife has become today's preoccupation. We seem prepared to go to any length, spend any amount, to rescue these animals from the finality of total elimination. Yet other species which have not gained this doubtful distinction are taken for granted. Must we wait until a species achieves this select but growing list before steps are taken for its preservation?

By one person's count, our bays, estuaries and open waters satisfy, in full or in part, the needs of 24 endangered species, not including the whales. In itself that should be reason enough for treating these areas gently. But, as I stated earlier, our coastlines produce and sustain wildlife in prodigious variety and many are highly sensitive

in their demands for this unique habitat. If the public concern for endangered wildlife is as genuine as it appears, then a concerted effort to preserve these wetlands today could spare us much hand-ringing tomorrow.

Audubon Society

National Audubon Society has had a traditional concern for endangered species and colonial birds, with studies on the latter extending back for 50 years. While the initial interest was in the inherent value of the birds, we now view these colonial species as being sensitive indicators of the well-being of the environment in which they are confined.

In the past few years, we have enlarged considerably our ground and aerial surveys over the Gulf coast, Mexico and parts of the Eastern seaboard. And that enlargement of our data gathering ability has been accompanied by an improvement in our data processing potential. This past year we established a computerized data bank under a cooperative arrangement with Cornell Laboratory of Ornithology. The Fish and Wildlife Service and others in the Department of the Interior, likewise, have given a new urgency to wetlands studies. They have many new projects in development, some of which cover the economic aspects. I'm sure Mr. Palmisano will be reporting on these. All told, the treasure which is our coastal waters seems to be gaining a recognition long overdue. Hopefully, a decade from now (if we're not too late) a symposium such as this one will deal more with solutions and less with problems.

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Human Encroachment on Barrier Beaches of the Northeastern U.S. and Its Impact on Coastal Birds

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Introduction

The northeastern U.S. coast includes some of the greatest population densities in the country. Here lies "Megalopolis," that diffuse, linear city-and-suburb amalgam stretching from Boston to Richmond, and it is here also that some of the greatest pressures for recreational pursuits are felt by coastal resources. Despite these increasing pressures, there are still some essentially undeveloped barrier beaches and marshes to be found there, which are now facing or will in the near future face a continuous spectrum of human encroachment pressures ranging from few changes to virtual elimination of the natural scene.

It is our intent here to outline briefly some of the more serious kinds of encroachment that have occurred in the northeast, using Long Island, New York as an example, and to indicate in general terms the impacts that they have produced on the birds which formerly occurred in great numbers there, are still trying to remain, or are newly arrived or recolonizing species attempting to live in disturbed beach areas. A complete catalogue of impacts such as we outline remains to be prepared, and while trends are clear, many details still need to be worked out. We should point out that some of these changes could be construed as "beneficial" in the sense that while some species were eliminated, others increased in both range and numbers. We prefer to take an objective view that these human activities formed an undesirable disturbance of a natural system, which led to severe changes in the relative abundance, and ecology, of many species. Most ecologists would consider this a detrimental effect.

Given the human population pressures in the northeast, we feel a sensible approach is assessment of the impact of human encroachment, and then amelioration of it whenever and wherever possible. People cannot be removed entirely from the coastal area, but with careful thought, men and beasts—in this case coastal birds—can reach a more compat-

ible *modus vivendi* than at present, if we are willing to devote the effort and money necessary to achieve it.

Beach Development

Encroachment in its extreme form is probably typified by the Rockaways on western L.I., where all natural features of the beach have been removed by building and development (Fig. 1). The beach is no longer able to respond as a natural system to the inexorable forces of the ocean, so man-made defenses that rarely work are thrust against it: groins, jetties, seawalls. Beaches are heavily used by swimmer and sunbather, stroller and fisherman, and on the bay-side, salt marshes have been filled in. Adjacent inlets are stabilized by jetties, stopped in their natural coastwise migration parallel to littoral drift; they are dredged on a regular basis to maintain navigation channels; new inlets are precluded from opening in the barrier beaches; and the natural landward rollback of the island by periodic overwash, inlet formation, dune breaching, destruction and subsequent formation, is eliminated; new salt marshes cannot form on shallow, sloping sediments. The island is immobilized in granite, brick and macadam and erodes accordingly (Figs. 2, 3).

The scenario seems horrific, and in many senses is. To be sure, very many coastal birds disappear from this situation, and virtually all breeding species do. But in migration and during the winter, mollusc- and fish-eating species restricted to the water (such as scoters, grebes, and loons) are still present; scavenging gulls have actually increased with man's development, and congregate near his sewage outfalls and garbage dumps. Brant, almost wiped out with the eelgrass blight of the 1920's, have adapted to eating sewage-nurtured *Ulva*, one of the few algae thriving near habitation. The erection of hundreds and thousands of groins and jetties down the Atlantic Coast (Fig. 1) has probably been the prime factor in the southward range extension of several rock-loving birds formerly not occurring with any regularity south of northern

New England, among them Purple Sandpiper, Harlequin Duck, Common and King Eiders. These structures have likewise allowed northward wintering of some species that stay quite close to them for shelter and food, such as Ruddy Turnstones and Double-crested Cormorants.

It is when we examine the effect of beach development on breeding birds that man's impact here is seen to its fullest. In areas of total development such as the Rockaways and Coney Island, all naturally breeding beach species have been eliminated, as their habitat has been totally destroyed or is so heavily used as to preclude their nesting. Terns, skimmers, and Piping Plovers are gone, and cannot return. Ironically, exceptions have occurred, generally only at the tips or ends of prograding barrier islands or spits, such as Breezy Point (Rockaway Inlet), Short Beach and Democrat Point (Fire Island Inlet), where, as a result of jetty construction, sand is accreting on that side of the inlet first reached by the still-continuing longshore or littoral drift. The purpose of the jetties is to entrap sand before it reaches—spilling into and occluding—the inlets. As jetty sand compartments fill up, the low, flat frequently-overwashing profile of a natural barrier beach (Fig. 4) recurs, even to the formation of new marshes on the backside of the beach. Being at the ends of spits or islands, these locations are relatively isolated, so it is here that the last remaining colonies of birds formerly breeding on the undisturbed beaches of Long Island—especially terns—can now be found. Unfortunately, the fishing is so good at these inlets that human disturbance, especially by off-road vehicles (ORVs), has all but elimi-

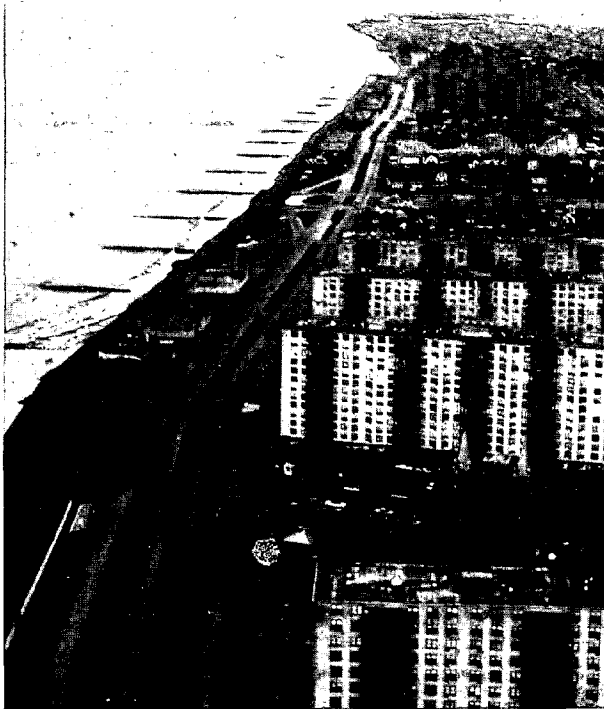


Figure 1. Rockaway Beach, Queens Co., looking WSW towards Coney Island in October 1974. Note beach loss and one groin every block.



Figure 2. Outer Banks of N.C. (Cape Hatteras National Seashore) on the north side of Buxton village following severe storm in February 1973. Note extensive overwash fans. View to the NW.



Figure 3. Parking Field 9, Jones Beach State Park; now permanently closed to public. Note proximity of Ocean Highway to moving high water line. View to the NNE, June 1975.



Figure 4. Portsmouth Island, Cape Lookout National Seashore, N.C. in February 1973. Note profile of a naturally overwashing beach with inlets free to open, close and migrate; cf. Figures 1 and 14. View to the NW.

nated successful nesting to the point of young actually fledged.

Where do breeding birds go when beach development eliminates them? The vast majority simply cease to nest in the area; the species become locally extirpated. In the last few years, though, we have noticed Common and Roseate Terns, and to a lesser extent, Black Skimmers, attempting to adapt by using a new habitat: whole colonies sometimes numbering only a few pairs, sometimes thousands, are nesting directly on open marshy islands. While historically there have apparently always been a few pairs attempting marsh nesting, we have never heard of any numbers in the northeast. In three locations on L.I. where human pressures and disruption are increasing (Shinnecock Bay, South Oyster Bay and Jamaica Bay), normal beachfront habitat is now unavailable for nesting, so the species are resorting to spring-tide deposited wrack clusters on marsh islands behind the beaches and in a few cases are actually nesting on the ground in short *Spartina alterniflora* marshes. We do not know their nesting success generally, except that in the 2000+ pair colony in Shinnecock Bay, essentially zero productivity in both 1975 and 1976 was attributed to a combination of high tides and extensive Norway rat predation. Rat burrows were much in evidence there in 1976, and numerous dead and partially eaten adult terns were strewn about. If this colony continues to be unsuccessful, its loss to the area breeding population would be significant, as in 1976 it accounted for about 10 percent of the Common Terns on L.I., and was only one of four colonies containing in excess of 1000 pairs. On the other hand, if Common and Roseate Terns are able to adapt to breeding in marshes successfully, as do the marsh-adapted Forster's and Black Terns, especially where there is little tide swing, the species' continued presence as breeders near highly developed beaches would be possible, barring further encroachment on the marshes.

American Oystercatcher, a southern species now colonizing N.Y. and New England, faces identical pressures on its preferred oceanfront beach. It has solved the problem in the same manner as the terns, moving onto marsh islands for nesting and feeding when confronted with heavy human use of beaches.

Dredge Spoil Islands

In addition to terns and oystercatchers, other beachfront or true colonial nesters such as Piping Plover, Black Skimmer, Herring and Great Black-backed Gulls, and herons, egrets, and ibises are now resorting to dredge spoil islands—man-made structures created when bottom-dredged material is deposited on land, and now in many locations the only relatively undisturbed habitat for these birds left on our coast. Located as they invariably are along major “inside” waterways and at inlets (Fig. 5), these islands now provide the largest single source of available habitat for colonially nesting waterbirds along the entire coast of Long Island; are excep-

tionally important in coastal New Jersey; and in a survey of the Outer Banks of North Carolina in 1973 we found that between Oregon and Ocracoke Inlets—a distance of 75 miles—95 percent of the total of 6300 pairs of colonially nesting waterbirds were using spoil islands (Buckley and Buckley, 1975). The main Outer Banks beaches were so eroded due to man's intervention and so hard-pressed by ORVs and other recreational demands that they were unavailable for bird use.

On Long Island proximity of people to the beaches from Shinnecock Bay east to Montauk Point—which are part of the mainland and thus inlet-free and not in a barrier configuration—had eliminated most beachfront nesting. The very few remaining colonies in eastern L.I. are almost without exception on private or otherwise generally inaccessible islands. From Shinnecock Bay westward, where barrier beaches and inlets occur, there are occasional attempts at beachfront nesting, usually by Least Terns, but virtually all other colonies are now on dredge spoil islands adjacent to the permanent (jettied) inlets: Shinnecock, Moriches,

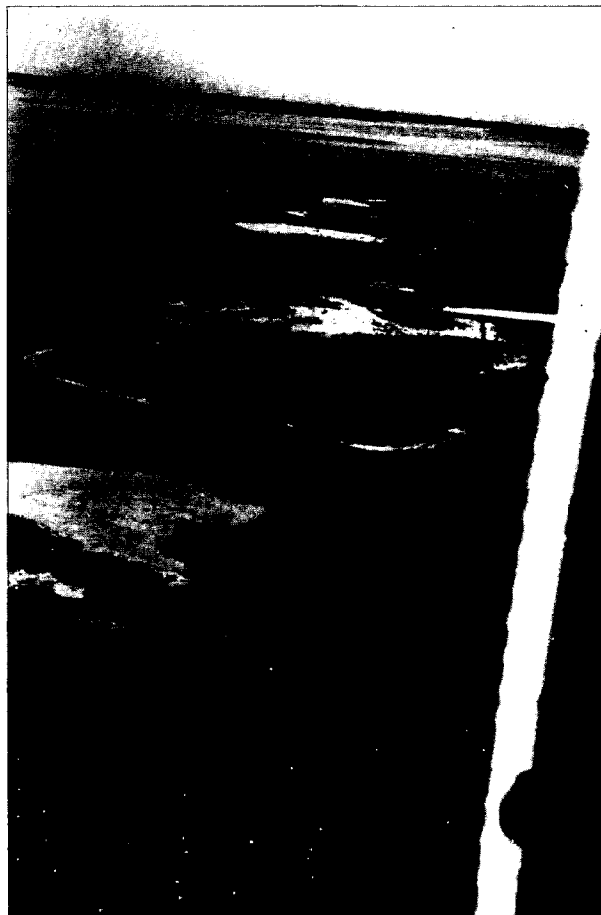


Figure 5. Dredge spoil islands, Oregon Inlet, Cape Hatteras National Seashore, N.C., looking NW, February 1973. Note different plant successional stages related to dates of last spoil deposition.



Figure 6. Gull colony present between lanes of roadway at Captree State Park since 1940s. View taken June 1974 looking ESE across Fire Island Inlet towards F.I. Lighthouse.



Figure 7. Cormorants wintering on dredge spoil islands in Oregon Inlet, Cape Hatteras National Seashore, N.C. Taken in February 1973.

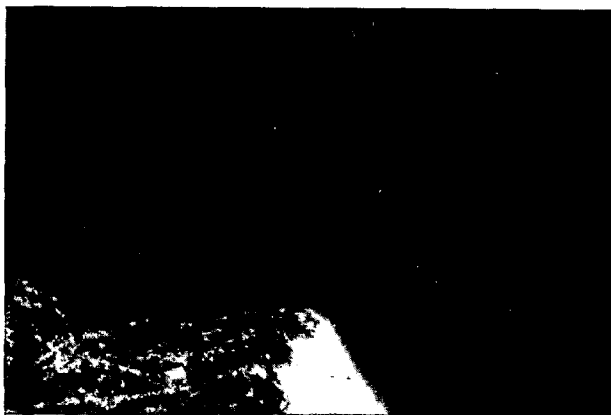


Figure 8. Scars from off-road vehicle use in *Spartina alterniflora* marsh, Short Beach (Jones Beach State Park), in September 1974.

Fire Island, Jones, East Rockaway, and Rockaway. In recent years colonies at the last two inlets (Atlantic Beach and Breezy Points, respectively) have failed to materialize or to produce young, owing to human interference. These areas also happen to have no adjacent spoil islands, so at breeding time have become essentially waterbird-free. Along the Jones Beach strip herons, ibises, gulls (Fig. 6), terns and skimmers have achieved a remarkable "peaceful coexistence" with man, and colonies are scattered along, and between, lanes of roadway the entire 18-mile distance from Fire Island to Jones Inlets; admonitory signs and draconian enforcement against parking outside of parking fields and against crossing the roads except at designated locations have helped immensely, but were an unintended benefit. Even with Jones Beach lowering percentages, spoil islands on L.I. in 1975 still accounted for breeding sites for 36 percent of all herons and ibises, 33 percent of all gulls and 21 percent of all terns and skimmers, totalling an estimated 42,000 pairs (Buckley *et al.* 1975; Buckley and Buckley *in prep.*). We can confidently expect that as recreational pressures increase on L.I. beaches and waterways, these percentages will go up, not down, so the resource value of spoil islands is, if anything, underestimated and well below its likely maximum.

At other times of the year, spoil islands are also vital to birds. Migrating shorebirds feed by the thousands in the shallow flats created—and soon colonized by invading plants and animals—when a spoil island is made by allowing the slurry to flow undiked into the surrounding shallow waters. They become feeding and resting grounds for innumerable gulls, shorebirds. Brant and cormorants (Fig. 7), especially if the islands are not frequented by boating parties. During the summertime when recreational boating traffic is heaviest, remote or overgrown spoil islands are frequently the only refuge for shorebirds at high tide, or for non-breeding gulls, terns and waterfowl.

Spoil islands are created by dredging of navigable waterways, and when fresh unpolluted spoil is left to dry, it will by the next season probably be populated by Least Terns and Black Skimmers. But the very dredging that creates the new habitat for breeding destroys old feeding areas: the highly productive shallows and flats in inlets and tidal bays sustaining large populations of small fishes and the birds feeding on them. Inasmuch as weather is a limiting factor in dredging, it is usually done—at our latitudes—only from about April through October. At these times obtaining food for nestlings is critical, and even more devastating can be the dumping of spoil directly atop an existing colony full of incubating adults, which we have seen done several times.

In addition, once the islands are created, their very positions—adjacent to inlets and alongside small boat channels—makes them attractive goals for boaters, fishermen and other water-oriented recreationists. On Long Island, several islands have already become scarred by tracks from trail bikes and dune buggies (Fig. 8), transported by boat at great in-



Figure 9. Trespassers on island in Jamaica Bay Wildlife Refuge, summer 1975. Note motorcycle. Photo courtesy T.H. Davis, Jr.

convenience. Unsanctioned and often illicit camping (Fig. 9), replete with all its 20th century detritus—strands of discarded monofilament line, Polaroid film backing, beer can pop-tops and six-pack holders—is increasing annually and threatens to become a major problem. Thus there are strong pros and cons to the dredge spoil situation. What seems to have the potential for unmitigated disaster, can, with foresight, planning and management become at least a mixed blessing, if not an environmental asset.

Salt Marsh Alteration

Salt marshes are one of the most important parts of our coastal wildlife habitat, and they too are subject to heavy population pressures; their extensive despoilation from dredging, filling and pollution are well known. However, even with unavoidable dredging and filling there are wildlife management opportunities which can turn a potential long-term disaster into a short-term perturbation from which the marshes can recover.

Permits for cutting trenches, ditches and boat channels across coastal marshes are no longer as easy to obtain as they once were. It still goes on, and seems inevitable that it will increase if oil in marketable quantities is discovered off the New England and Middle Atlantic states. But if carefully done, it too can produce striking effects on birds by introducing a diversity of habitat and thereby of birdlife. As an example, Nassau Co.'s recently constructed Wantagh ocean outfall sewer line cut a 250' swath across Great South Bay salt marshes and bottoms (Fig. 10). (The buried pipe now leaks sewage but that's another problem.) After burial, the right-of-way was covered with fresh, clean fill originally removed during construction. This expanse of sand and mud with intermittent pools of shallow water and recolonizing *Spartina* forms ideal habitat for a rich diversity of marsh birds, and last summer, following the discovery there of the first Long-billed Curlew on L.I. since 1938, intensive field work revealed some of the greatest concentrations and mix-

tures of shorebirds seen on western L.I. in recent years. It was also in an unsuspected tern and skimmer colony on a high patch of sparsely vegetated sand over the pipeline that we found the first known nest in New York of Gull-billed Tern (Fig. 10), thereby extending the species' breeding range some 150 miles north of its previous limit.

Not to extoll the benefits of such drastic marsh surgery, we must point out the vast quantities of shellfish and benthic plants and animals that were destroyed in the process of cutting the outfall line, as well as the inevitable effect on mainland L.I.'s watertable which will result from dumping hundreds of millions of gallons of fresh water into the ocean, instead of recharging the fast-disappearing aquifers. And point pollution at the outfall is yet another matter. As if that were not enough, 10 miles to the east Suffolk Co. is proposing an identical ocean outfall, certain to produce the same mixed bag of effects. But here the preferred route will take them directly through the middle of the largest known tern and skimmer colony (2800 pairs) on mainland L.I. (i.e., not on spoil, or other isolated islands), and the only one harboring the rare and local Roseate Tern (Cedar Beach, Fig. 11). So far authorities have turned a deaf ear to the protestations of biologists and conservationists, and the issue will likely wind up in court.

Another kind of ditching is that done to salt marshes to attempt control of mosquitoes, especially *Aedes sollicitans*. Aside from the aesthetic impact of unrelievedly parallel ditches extending row upon row (off to the horizon in some plac-



Figure 10. Ocean outfall line for Nassau Co.'s Wantagh sewage treatment plant, cut across South Oyster Bay marshes. Sandy, vegetated area atop cut, at bottom of picture, harbored tern colony. View NNW, June 1975.



Figure 11. Cedar Beach ternery, Jones Beach strip, looking W, June 1975. Note proximity to four-lane Ocean Highway; plantings of pines along roadway; and narrowing of barrier island W of ternery as beach enters full erosional shadow of jetty on the end of Fire Island (out of view to SE). Suffolk Co. SW sewer district ocean outfall line is to cut across colony right to left, near bottom of picture; cf. Fig. 10.

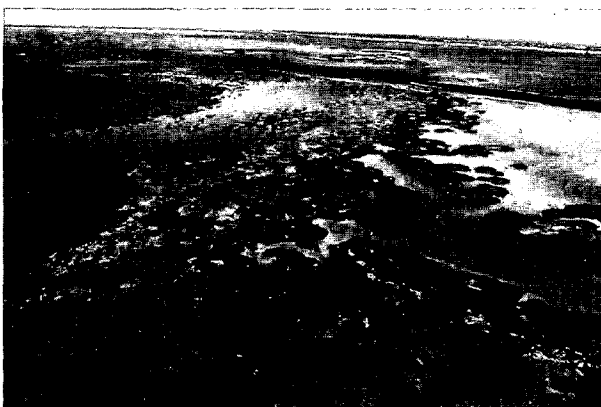


Figure 12. Unditched Oak Beach Marsh, N of Ocean Highway (Jones Beach strip), looking W in September 1974.

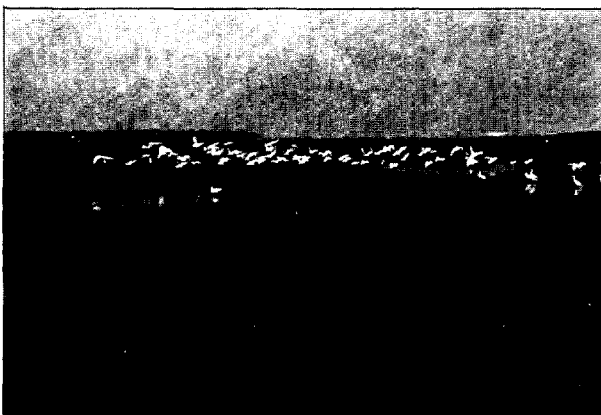


Figure 13. Concentration of egrets in Oak Beach Marsh, September 1961, looking NNE.

es), many doubts have been raised about the deleterious ecological effects ditching has on salt marshes. Studies are few and far between, and we are aware of almost no work done on the effects of marsh ditching on birdlife. There are three exceptions, all concerning the only unditched salt marsh of any consequence remaining on the south shore (or perhaps the entirety) of Long Island, N.Y. Located near Oak Beach, on the Jones Beach Strip, this 300-acre marsh supports the only known L.I. breeding population of the rare and local Black Rail, and at present the only salt marsh population of Virginia Rails on L.I. Post and Enders (1969; 1970) attribute both these occurrences to the unditched nature of the marsh and attendant vegetational zoning. Post (1974) likewise studied the breeding ecology of Seaside Sparrows at Oak Beach with control populations nearby in ditched salt marshes. While he found no difference in breeding success, breeding pairs behaved differently in the two habitats; in unditched Oak Beach marsh, they formed group territories for nesting from which they made distant foraging flights; in ditched marshes they maintained all-purpose activity spaces from which other conspecifics were excluded. We suggest that the remarkable aspect of this study is not that there were differences in breeding behavior (which we would have predicted based on the habitat differences), but rather there were none in overall nesting success. We would be surprised if other species were as plastic in their ability to tolerate as radical an environmental manipulation as ditching, and would go so far as to predict that for most species reduced success would occur in ditched marshes. Such studies remain to be done, however, and the existence of Oak Beach unditched marsh is also being threatened by the proposed Suffolk Co. sewer pipe.

What we do know from many years' observation, although a quantitative study remains to be done, is that the shallow pool and panne topography of Oak Beach Marsh (Fig. 12) produces the greatest shorebird species diversity of any natural (i.e. non-impounded) location on L.I., that the concentrations of herons (especially Little Blue and Louisiana) in those pools (Fig. 13) are probably reached or exceeded at only one of two other L.I. locations, if at all, and that, in season, no other salt marsh habitat on L.I. supports the diversity of freshwater (dabbling) ducks that Oak Beach Marsh does. Clearly, the area is uniquely valuable to birds, and the most frequently offered explanation is its unditched nature. Adjacent, ditched marshes offer but a pale ghost of this marsh's diversity and numbers.

Barrier Beach Uplands

The upland areas of barrier beaches normally support a circumscribed vegetation reasonably clearly zoned, which has been described by many ecologists. Where man has arrived with his vehicles and habitation on barrier islands, he has usually created and/or strengthened a Maginot Line-like, so-called primary dune, intended to be a barrier against the ravages of the onrushing (and inexorably rising) sea. Thus fas-

tened in place (only cosmetically, as each severe coastal storm demonstrates; see Figs. 2,3). The beach loses its ability to advance landward as it rolls over on itself, its characteristically flat profile, its clear but ever-shifting ocean-to-bay vegetational zones, and their attendant birds. Back-beach bare sand flats and grass fields become first shrublands, and then small maritime forests. In many parks, extensive plantings of native and exotic conifers are made. With all these vegetational changes come significant changes in birdlife. Unquestionably, landbird diversity increases, and spectacularly so. Vast amounts of new habitat are suddenly made available. Songbirds in migration stop and linger where previously there was no habitat; ornamental plantings provide nesting habitat for Mourning Doves, Purple Grackles and House Finches; shrublands support great numbers of wintering Myrtle Warblers; woodland owls arrive to winter in sheltered coastal Black Pine groves adjacent to salt marshes overrun with voles, mice and rats. The southern relative of the Whip-poor-will, Chuck-will's-widow, is slowly expanding its range northward from its previous limit in extreme southern New Jersey. In 1975 the first nest in New York State was found in just such a planted pine grove near Oak Beach Marsh, and within sight of the Gull-billed Terns nesting on the sewage pipe outfall cut. And as man's boating and other recreational activities have interfered more and more with the sites where heronries have been traditionally located in shrubbery and low trees, the birds have taken to the tops of tall trees. In 1975 a 220-pair Great Egret colony was situated on the tops of four adjacent groves of planted pines in between traffic lanes at Jones Beach State Park, high and safe from all comers, but surely a far cry from their preferred habitat on low islands out in the marshes.

Recreational Pressures

Recreational pressures, rather than industrial, commercial or housing pressures, have probably made the greatest impact on birds in most coastal areas. Whether by creation of vast recreational complexes such as Jones Beach State Park on L.I., or by establishment of marinas and summer beach cottage colonies as on the Outer Banks, or by running various ORVs along the beaches to fishing spots as at Fire Island (Fig. 14), or for sightseeing or for picnicking as on Cape Cod, or by covering inland bays and sounds in summer with myriads of small boat enthusiasts who land on every available island or barrier beach such as in New Jersey, human pressure has reduced almost to the vanishing point the habitat needed by these birds for breeding. And people themselves do far less harm than uncontrolled—or worse, abandoned—pets, especially dogs. One dog in a few hours can obliterate an entire tern colony. The pressures interact in bizarre ways: with the great increase in small boat activity has naturally come marina growth, resulting in turn in much fish cleaning and many entrails being dumped overboard. This, in turn, has allowed a population explosion of Herring and Great Black-backed Gulls, which, for their part, have dis-

placed terns and skimmers from the few remaining suitable nesting colony sites in so many areas of the northeast. It is not that terns are "better" than gulls but rather that man has, once again, upset a natural ratio.

Wildlife Refuge Problems

Sometimes in our attempts to aid wildlife we unwittingly create problems. An excellent case in point is Jamaica Bay Wildlife Refuge. The City of New York created the heart of Jamaica Bay Wildlife Refuge by diking two large freshwater impoundments in 1953 to provide a shallow, freshwater habitat lacking in the Bay area. It was immensely successful, as was the then burgeoning and immediately adjacent Idlewild Airport. Then in 1956 the city opened two immense garbage dumps within a mile of the Refuge ponds. Up went the gull population, as they found idyllic conditions: the dumps for food, two large islands in mid-Bay for nesting, the Refuge ponds for drinking and bathing, and the airport runways for loafing and preening, most especially on rainy days when the shallow pools on the runway are irresistible. Conditions are so rosy for the gulls that upwards of 100,000 have been in the Bay during recent Novembers. The problem that gulls have created for planes taking off at now immense JFK International Airport are too well known to be repeated here, but are not likely to be solved, despite frantic efforts by airport officials to chase the birds away, until the two major dumps are closed.

Habituation

Lest we paint too gloomy a picture we must point out that despite the negative impacts man has had on birds in coastal areas—numbers of breeders drastically reduced, some species extirpated, and certain areas relatively birdless—there still are large numbers of coastal birds around. This has been due to their remarkable abilities to habituate to man's presence, and to adapt to a constantly changing environment. We have already mentioned Seaside Sparrows' reactions to ditched salt marshes, to Common Terns' attempted movement to spoil islands and salt marshes when the beaches were no longer available, to Great Egrets' use of the tops of planted pine groves for their heronries.

In the context of the gulls' problem just mentioned we should point out that only because the gulls have habituated to the presence of the planes, is there not an even greater problem at JFK airport, at least one of whose glide paths passes directly over the two garbage dumps. When a plane comes in low, the birds scatter fast (Fig. 15); in general they seem to avoid the glide path entirely. When the NYC subways roar past the shorebird flats on the East Pond at Jamaica Bay Wildlife Refuge (Fig. 16), it's still astonishing to see hundreds of birds not even flinch or pause in their feeding to look up; the same non-reaction is given to passing jets; weekend boaters know how they barely rate a passing glance from gulls or terns resting on a jetty so long as the boat does not disgorge passengers; likewise, ORV users know they will not

unduly disturb resting flocks of sandpipers on the beach—so long as cars, not pedestrians, move past the birds and keep going.

Even the marvelous Ghost Crabs of the Outer Banks (Fig. 17) have reached, in some places, an accommodation with the hordes of ORVs: where traffic has not simply eliminated the animals, they have become crepuscular and nocturnal. This contrasts markedly with their behavior on vehicle-free islands where they are aggressively diurnal.

Conclusions and recommendations

Having enumerated some of the conflicts and the effects—most largely negative, although some might be considered positive under certain conditions—man has had on birds in the coastal environment, we wish to conclude with some recommendations for the future. We would hope that, if implemented, they would result in mitigated impacts of the kinds we have described, inasmuch as man will be an intrusive part of the coastal ecosystem for the foreseeable future.

1) We need increased research on the ability of species to adapt to changed environmental conditions—and before the changes, not after.

2) We need increased recognition that man impinges on birds along coasts at all times of the year, not just when they are breeding, and that very often long term but indirect results of his action can be more profoundly disruptive to birds than short term but direct results.

3) We must recognize both that man cannot be removed from the coast so that birds must to some extent accommodate him, as well as that under some conditions, man must be totally excluded from some areas if we are not to eliminate some of the birds.

4) We must pay more attention to multiple use of areas by season, so that all-or-none inclusions or restrictions are replaced by carefully tailored regulations.

5) We need a tremendous increase in education of the public to the possible ways by which they thoughtlessly damage our avian coastal resources.

6) We need increased inventories of our coastal bird resources before we attempt environmental manipulation even if the actions are only *likely* to affect birds significantly.

7) On a more specific basis, we need to time unavoidable human activities such as construction, dredging, spoil deposition, etc., to avoid disturbing significant aggregations of breeding birds.

8) We need to recognize those areas that have especial ecological value to breeding birds, such as Long Island's Oak Beach Marsh, various dredge spoil islands, etc., and take extraordinary measures to protect them from encroachment.

9) We need to assess how we have already altered the coastal environment of birds, and take steps to restore favorable conditions by habitat creation, manipulation or management.

10) We have to realize that in some instances we will be forced to choose between human use and wildlife preservation because sometimes they are mutually exclusive.

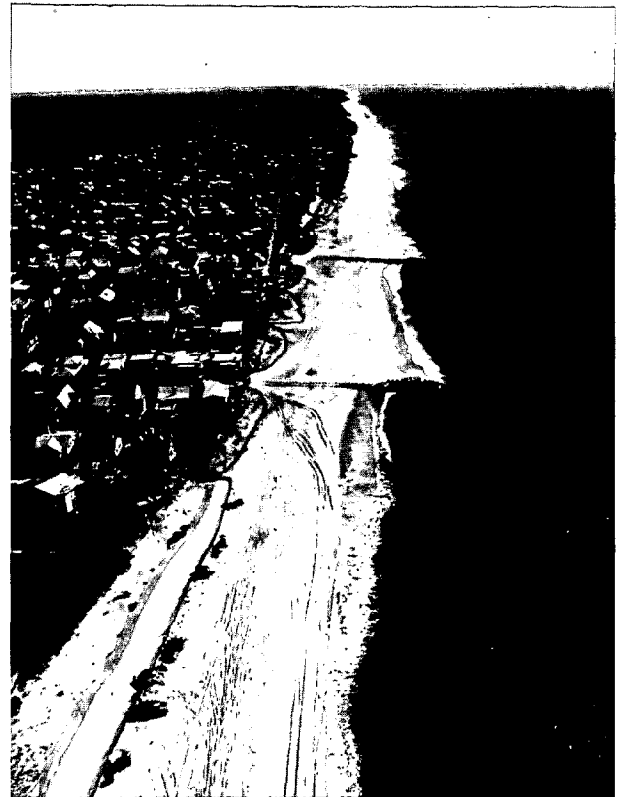


Figure 14. Ever-narrowing ocean beachfront on Fire Island National Seashore. Note vehicle tracks, density of houses, and down-drift (= towards the viewer) erosional scouring past the only groins on Fire Island. View over Village of Ocean Beach looking ENE, September 1974. Cf. Figs. 2 & 4.



Figure 15. Gulls scattering in front of helicopter, Canarsie Pol, Jamaica Bay Wildlife Refuge. View looking E, February 1975.

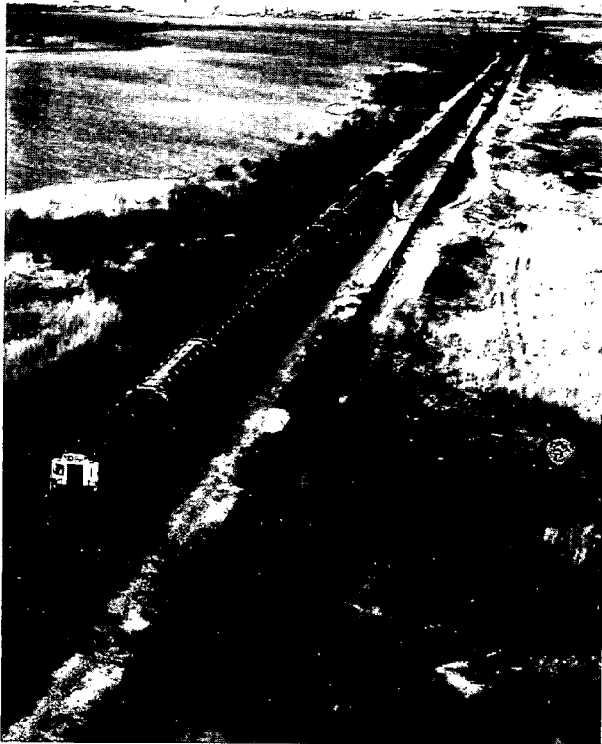


Figure 16. Rockaway Line of N.Y.C. subway system traversing dike containing East Pond, Jamaica Bay Wildlife Refuge. Thousands of ducks and shorebirds populate waters and shores of ponds in season; runways of J.F.K. International Airport just out of picture to right, top. View to N, October 1974.



Figure 17. Aggressive male ghost crab in authors' vehicle track at midday. Taken on Fisherman's Island National Wildlife Refuge, Cape Charles, Va., June 1969.

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The Role of Ecological Information in Planning for the Future of Wildlife Resources

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Introduction

The narrow coastal zone fringing the continents and the surface layer of the sea, to only a few meters in depth, comprises less than one percent of the volume of the oceans, yet represents more than 90 percent of the seas' primary productivity and living biomass. These land-water-air interfaces are also sites of disproportionately high human development activities. Though coastal areas have been used for centuries by man for transportation, food production and habitation, only since the turn of the century has our technology developed to the point where major ecosystems and possibly the natural functions of the oceans themselves might be jeopardized.

This poses a significant problem to those of us trying to plan for a future with both a high standard of living and a high quality of life. Our ability to alter the environment continues to increase at a rate that far exceeds our ability to predict the environmental consequences of our actions. The present energy dilemma which we face will almost certainly broaden this range of relative ignorance. Impact assessment state-of-the-art relative to coastal and marine systems has not developed much beyond an approach which involves avoiding the actual or potential "big bads."

Fish and Wildlife Service Responsibilities and Activities

Historically the FWS has performed a number of functions for the administration. The first half of this century saw the Biological Survey undertake basic life history studies of many forms of wildlife both game and non-game. The emphasis gradually changed to land management for wildlife which involved acquisition of refuges and activities to enhance the production of wildlife on both public and private lands. By mid-century the Service had become primarily a management agency, managing its own refuge lands, and through hunting regulations, the nation's vast waterfowl population. A considerable ecological capability was housed in the Service and

in the sixties, when the public acquired an environmental consciousness, the Service could provide assistance to decision-makers in developments requiring environmental impact analyses. The role of the Service as an ecological advisor has steadily increased since that time.

Presently the FWS has management responsibilities for migratory birds, endangered species, selected marine mammals, anadromous fishes and national wildlife refuges. In its advisory role, the Service reviews and comments on environmental impact statements and many permits requiring appropriate federal participation. The agency also provides technical assistance in activities involving comprehensive natural resource planning at national, regional, state and local levels.

The Office of Biological Services has recently been established to improve FWS advisory capabilities by: 1) development of appropriate ecological information; 2) improved impact assessment; 3) development of information transfer mechanisms to bring information effectively to bear on decision-making processes.

Development of Ecological Information

The varied nature of the disturbances and the diversity of resources subject to impact require a broad base of information to adequately assess development impacts in the coastal zone. The approach being developed by the Service to develop this base involves a comprehensive characterization of coastal ecosystems. Environmental Characterization may be briefly defined as a structured approach to ecological information development, synthesis and analysis designed to provide an understanding of the functional processes and natural resource elements comprising complex coastal ecosystems. The procedure is designated to make maximum use of existing information essential to the resource assessment and in providing guidance to the development of future studies. A description of significant natural

resources and functional processes of the ecosystem are highlighted in the characterization.

Impact Assessment

The Service provides technical assistance to other federal agencies in the preparation and review of EIS and the issuance of permits for development activities in the coastal zone. Improved impact assessment capabilities is a primary objective of the Office of Biological Services.

Analysis of industry activities related to OCS Oil and Gas Development is presently being undertaken to determine the environmental disturbances to be anticipated and an evaluation of optional approaches. All phases of development must be considered and a comprehensive environmental studies program designed to provide timely planning information for each step of development. Environmental studies should be scheduled to provide essential resource information early in the leasing program to determine tracts which should be excluded from the sale and to establish appropriate lease stipulations. Exploratory drilling requires permits and often detailed ecological information near the platform site. Production and transportation of petroleum initiates a series of development activities often removed from the lease area. Pipelines, navigation dredging, chronic and acute spills, near and onshore development of storage and service facilities are only a part of the total environmental impact of production and the coastal zone will undoubtedly feel the brunt of these impacts.

Information provided by the environmental characterization will identify the distribution of the significant living resources as well as essential and unique habitats. Extensive permanent alteration of these resources should be considered a "big bad" to be avoided in the course of normal development. Other living resources are addressed in the impact analysis but are considered more "expedient" than the sig-

nificant resources and do not necessarily dominate the decision process.

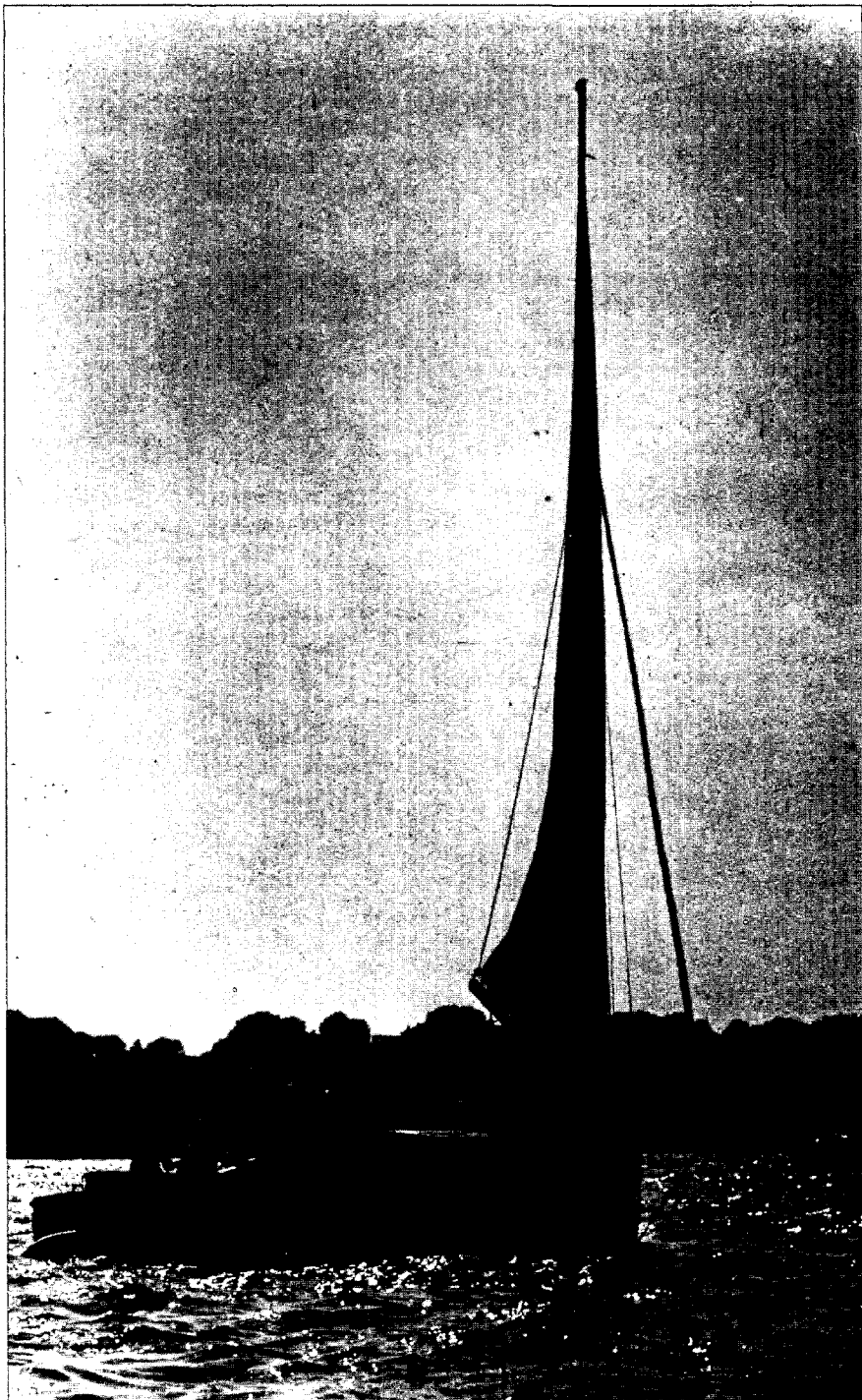
In addition to living resources, processes which drive the coastal ecosystems are also subject to alteration by development. Living resources are part of the web of life and significant disruption of processes such as nutrient cycling, hydrologic patterns, successional trends and trophic relationships can have a severe detrimental impact. The state-of-the-art is generally inadequate for predicting such changes but the potential threat is no less real. Studies designed to improve predictive modeling of major coastal ecosystems will probably occupy the time of investigators for many years to come before adequate models can be developed which quantitatively predict impacts.

The Service's approach makes maximum use of the state-of-the-art relative to impact analysis. To make full use of presently available technology, four separate lines of investigation are being pursued: 1) literature review; 2) case history studies; 3) consultation with acknowledged experts in the respective fields; 4) an analysis of the permit process within the FWS.

Summary

The volume of environmental information presently being developed staggers the imagination. Sophisticated information transfer mechanisms are required to make full use of even a fraction of the data available. The Service is developing an information transfer network designed to provide maximum use of systems currently available and to store and retrieve information being developed by ongoing studies. Development decisions and comprehensive planning efforts are underway and decisions are being made now. The best decisions will be made in light of the best information available.

Utilization of Physical Resources



Ipswich Chronicle

Preserving and Protecting Natural Resources

John T. Scanlon, Executive Director of Save the Bay, Inc.
East Greenwich, Rhode Island

I am here to tell you that the work of preserving and protecting our valuable natural resources has begun and is proceeding nicely but not without problems.

The topics being discussed here today contain valuable information. Information which needs to be expertly communicated to a receptive citizenry. It is my belief, and one which we at Save The Bay incorporate into our daily operations and philosophy, that our people are sensitive to the demands on the fragile environment but need to be taught the reasons why some of the onslaughts are putting these natural resources in jeopardy.

The message I bring you this morning is succinctly contained in the paragraph of Save The Bay's charter, which says, "People well-informed and well-organized can do something positive about determining the kind of environment in which they choose to live."

All those recreational interests represented here today need to understand that caring is not enough. We must organize our forces, our information, our messages into a meaningful objective and then embark on a program of "deliberated telling" so that those audiences we want to get our message can be cultivated.

I learned a lot here this weekend. But I got the overwhelming feeling that the sinners were not in church, that we were talking to ourselves and that perhaps what we need is a different perspective on what it is we are attempting to achieve.

My other message carries the plea that those of us who work at developing marine recreational usage of our waterways remain alert to the dangers faced by these waterways. In brief, the overdevelopment of sensitive shorefront areas as we saw elaborately illustrated by the husband and wife research team dealing with Long Island and in the discussion on the Gulf Coast, signals the problem we must solve.

Recreational Use Protection

It is easy to allow the erosion of recreational values in the face of escalating economic demands. But I know in the

Rhode Island area, which I represent, we have banded together in developing a 21,000 member organization to find ways of saving our important resources for people.

It has been our hope and our plan to get as deep a commitment from official sources as we can to plan for recreational use of Narragansett Bay as a primary use, (not exclusive) but certainly primary, and to have all other planning decisions follow from that. I am happy to report to you today that a short time ago we were able to get the Statewide Planning Council to accept such a provision and to incorporate it as an integral part of the recreational part of the Statewide Guide Plan.

The battle to preserve the bay from the intrusion of additional oil and gas development is a constant one. It is an area which brings the environmental community into face to face confrontation with political and developmental forces on a regular basis. However, our purpose in being is to ask the hard questions and to muster the necessary public support in getting answers to those questions. The road an environmentally sensitive person or group travels is not an easy one and the choices they must make do not lead to a primrose path. But my experience tells me that the easy path leads backwards or nowhere. The road that lies ahead is a hard road because there is no way to do less and accomplish more, no way to produce less and have more and no way to give less and get more.

We cannot sit waiting for great things to happen. Somebody (including you and me) has got to do the thinking, the conserving, the protecting, the changing, the rebuilding, the reordering, the caring. It appears to me, at least, that the only way to do a better job is to work at the job. Work harder and be smarter or both, or more importantly, work together.

The job is too big and important for any of us to work at alone. It is certainly too big for all of us to be working at cross-purposes. I ask you to join together in deciding which path to take and then to work hard at getting that message aggressively communicated to a public who needs to know.

Conflicts in Uses and Misuses of the Tidal Water Zone

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Nassau-Suffolk Regional Planning Board
Hauppauge, Long Island, New York

Introduction

The human impact on basin, shore, and water profoundly affects the complex whole. To the natural or scientific descriptors of the system, e.g., sediments, water and salt budgets, and beach profiles, should be added man's uses and abuses of the marine environment. The real drama is in understanding the day-to-day interactions that take place on, in, and around this marine environment as the result of burgeoning urbanization.

Ever-increasing numbers of people and ever-expanding uses of the water affect, and are affected by, the presence and condition of the tidal zone. It is reasonable to assume, for example, that future use of the shoreline for fishing, swimming, and tourism is in jeopardy. The greater the population, the greater its recreation demand, and the greater the impact on the natural resource and its capacity to fulfill the demand. Present trends that spoil the natural environment can be offset, however, by adopting sound conservation practices. Conservation is the key to maintaining and enhancing the marine environment. The introduction to a report to the Regional Plan Association of New York points this out:

An ... instance of dangerous tampering with nature concerns the wetlands. These are the key to an adequate water supply, the basic component in a natural system of flood control, and a vital biological element in marine productivity ... Without its tidal marshes, Long Island's fishing industry would be practically non-existent. Yet we permit our swamps, marshes, and bogs to be dredged, drained, filled and polluted with the mistaken notion that man-made works are somehow superior to these biological natural features which subtly perform a great, continuous task free of any capital or maintenance charge.¹

When one begins to look at how the coast is used, and tries to do it without bias—that is, without starting off as a

"conservationist" or any other "ist" except perhaps "pragmatist"—two things quickly become evident. First, that certain conflicts are built in between one use of water or shore and another use; competition is inescapable. There's just so much shore and so much water, and no more. Second, that pollution has a directly damaging impact on shellfish and recreation industries, and an indirectly damaging impact on most marine activities. A sound marine economy rests on a properly conserved marine environment. The loss of wetlands, for whatever reasons, results in attrition for the entire ecosystem.

If conservation of the natural environment is so important, one might reasonably ask, "What is the problem? Why aren't good practices put into force?" A fast inventory of uses of the marine environment brings into focus the fundamental fact that each use by itself can individually be validated; conflict arises when one use impinges on another. For example, the desire to maintain wetlands conflicts with other uses, such as sand and gravel mining, solid waste disposal, or residential development. From an economic point of view these are legitimate competing uses. Yet one must assess full economic costs, including social costs like public taxes for pollution control, in order to choose intelligently among competing uses.

To make use of the marine environment one must have access to the sea. The access required depends on use, and ranges from deep-draft harbors to the natural shoreline. Use of the sea can be passive, as in *transportation* or *recreation*. Or it can consist of *extraction* from the sea or *insertion* into the sea. An extracted product may be a food for man or animal derived from the biosphere, or it may be a mineral derived from sea water, from the sea floor, or from beneath the sea floor. Much of the waste from our economy ends up being "inserted" into the sea, either directly or by secondary transport through rivers and groundwater. Liquid effluents dumped in the sea include industrial wastes, sewage outflows,

and oil spills. Solid wastes are, for example, sewage sludge, chunks of cement, and dredge spoils. In addition, coastal waters receive waste heat from industry, primarily from electric generating plants. The flow pattern of each of these four major use categories—recreation, transportation, extraction, and insertion—is summarized in Figure 1.

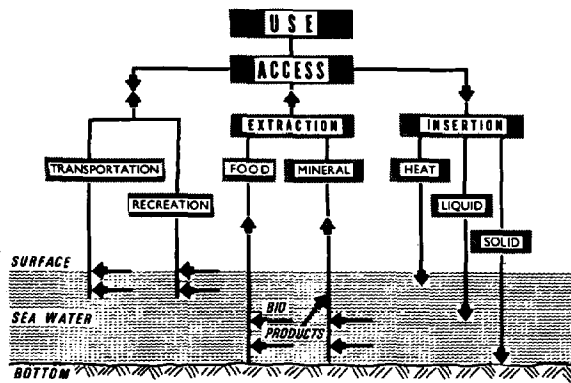


Figure 1.

Recreation

Fewer working hours and increasing prosperity have led to increased demands for outdoor recreation. Recreation stands fourth on the list of expenditures, after food, housing, and transportation.² At the same time urban problems, particularly the "hot summer" phenomenon, draw attention to the need for increased recreational facilities for the urban poor. Both salt water and fresh water are, of course, natural playgrounds. In 1968, 112 million Americans participated in marine-oriented recreation activities, and spent \$14 billion.³ The numbers are climbing much more rapidly than the population as a whole.* The demand for water recreation is soaring.

Water recreation ranges from a casual stroll on the beach to a vacation at an ocean resort or a world cruise. Swimming is the number one outdoor recreational activity around Long Island Sound,⁴ and of all Americans over twelve, 28 percent participate in fishing, 23 percent participate in boating, and 7 percent water ski. It is no surprise that an important part of Long Island Sound's economy is providing recreational goods and services, especially marine-oriented. Such activities as boat building, sales and services of fishing gear and boat rentals, party boat operations, swimming and diving equipment sales, and the rental of housing to vacationers are all strongly growing business areas.

This marine-oriented business depends directly upon the survival of a healthy marine environment for its prosperity.

*It is projected that swimmers alone will increase by 72 percent between 1965 and 1980, while population as a whole will increase by 29 percent.

The growing number of people participating in coastal and offshore recreational activities places increasing pressure on our limited coastal resources. Already deteriorating due to industrial development and pollution, the coast is now sustaining further impact from the recreational activities themselves and from the commercial developments to service them.

Here we face the crux of the problem, as we saw before: conflict among competing uses. Recreational use of the shoreline conflicts with other uses and can actually change the marine environment. Parking lots, boat ramps, and docking facilities alter the shoreline. Beachfront owners and commercial resorts wish to limit access to their shoreline, whereas the public desires free access. People walking around or camping may destroy the delicate plant life in dune areas, salt marshes, and tidal pools. Commercial collecting of live organisms for sale to tourists may devastate natural populations of organisms. Power boats release oil and gas. Raw sewage from boats, beach facilities, and coastal resorts is often discharged straight into the water with no treatment. Sport fishing may deplete some species past the point of maximum sustainable yield and so lead to decreasing resources. Recreational boating does not mix well with commercial shipping. On top of all that is the heavy demand for safe and clean swimming areas, because swimming is the region's most popular outdoor sport.

Swimming—It is important to note that there is a certain amount of conflict or competition even within one use category. Swimmers, for example, must stay in a separate area from power boating for their own safety; fishing is incompatible with water skiing. Different uses have different maximum densities for safe enjoyment. The order of decreasing permissible density runs from sunbathers to swimmers to fishermen in slowly-moving boats to water skiers. As the density of users increases, the problem of safety becomes more acute.

Boating—The space required for boating is much greater than that needed for swimming. Docking or launching facilities must be provided on the shoreline, as well as parking spaces for cars and boat trailers. The number of boats that can safely use nearshore water is limited; as more people become affluent enough to buy boats, the demand for boating space will rapidly exceed the available areas. For dock space, a waiting list of four and five years is common in most marinas in the region, and the high density of boats on weekends already limits enjoyment of many parts of the Sound. There is great danger that the proliferation of boats will choke the urban marine areas as the automobile has the cities. The problem is how to allocate limited boating resources equitably among an exponentially-growing population of boat owners. Shore facilities should be limited to the capacity of the offshore area.

Sport Fishing—Sport fishing is closely tied to the boating industry and shares its dependence on water clean enough to support marine life. Continuance of this sport depends largely upon water quality in the bays and harbors where

most sport fishing is done, and upon navigable channels. For many occasional and serious anglers who do not have the means or desire to fish from boats, facilities such as fishing piers can provide access to water.

Housing—The marine environment has an important though indirect bearing on the real estate industry. People build and rent houses in the tidal region partly because the water is there, near enough for recreation and enjoyment. Access to harbors and bays usually increases property values substantially. The tremendous and increasing demand on available waterfront land complicates the choice between development of new home sites and protection of natural resources. It often means filling in irreplaceable wetlands. Any kind of waterfront land is a valuable asset for the developer and for the people who live nearby.⁵ Water frontage creates low-maintenance open space, provides many kinds of recreation facilities, and is so popular that it increases surrounding land values up to five or ten times normal value.* On Long Island, waterfront plots can command a premium of \$5,000 to \$15,000 over non-waterfront plots, according to Richard D. Schoenfeld of the Long Island Builders Institute.⁶ As a result, many areas have been under heavy pressure for development. Most of the loss of wetlands over the past 20 years has occurred from bulkheading and filling marshes to make construction sites for residential or commercial property.

The 1972 NYS Tidal Wetlands Act, if implemented, should protect the remaining wetlands from irresponsible filling and home building. Fortunately, builders on Long Island have generally been a progressive group. They have supported planning innovations like clustering, buffer strips, and planned unit development, in which environmental conservation is integrated by planning a whole community at once. Most Long Island builders are aware of and act to preserve aesthetic and productive aspects of the marine environment, setting aside waterways and natural features. Sound land planning practices can provide waterfront access while preserving large marsh areas as open space. Mr. Schoenfeld writes:

It is essential that while compatibility between marine environment interests and builder interests could be achieved, it must be remembered that builders are people-oriented as opposed to any other orientation. Popular demand and availability of suitable land to accommodate increased population is the builder's first concern. In no event does the average builder wish to see the marine environment unnecessarily deteriorate or destroyed in any fashion and will work toward the accomplishment of these objectives. Swimming, boating, visual beauty, and to some extent fishing are perhaps the major aspects which are quickly brought to mind by the average builder's reflection upon the worth of marine environment to his own property.⁷

*Waterfront building lots in Suffolk County had an average price of \$300 per front foot in 1972, or \$35,000 per acre. Inland acre building lots start at \$3,000.

Water Transportation

Until the development of railroads, water transportation was the only economical method for moving heavy goods over great distances. To move goods over land required the tremendous effort of roadbuilding to smooth out the irregularities of the land and to provide a bearing surface for wheels. The sea has the advantage of being flat, and displaced water supports the load of the vessel. The only construction involved is the building of ports at either end of the route to permit the transfer of goods from the land to the ship.

Most large cities in the United States were originally ports. The harbor was the action center of the city, for employment, recreation, marketplaces, and parks. There is no more dramatic example of the impact of technological change than the transformation of the waterfront from what it was a hundred years ago to what it is now. Then it was the focus of the excitement of ships; now it often is rotting wharves, pockets of filth, and a dangerous place to be, day or night. It is not nostalgia but such unacceptable conditions that motivate the rehabilitation of urban waterfronts.

They will not be rehabilitated to do their old job, however. Transoceanic passengers going by airplane, increases in vessel size, and cargo containerization have drastically altered requirements for port facilities. Fewer, larger, and more automated port facilities are replacing the numerous wharves that once were required to handle the multitude of small vessels, which were unloaded by methods not significantly different from those used in Phoenician times. Thus, most U.S. ports are a mixture of efficient modern facilities and semi-abandoned older piers. New York Harbor is a striking example. Despite substantial increases in cargo tonnage we actually need less urban waterfront. The President's Council on Recreation and Natural Beauty recommended in 1968 "that Federal agencies be authorized to conduct, in cooperation with State and local governments, a coordinated program of urban waterfront restoration that would emphasize recreational, scenic, and aesthetic values, including physical and visual access."⁸ This is a major challenge for both urban and marine environmental planners.

Each of the two main developments in water transportation—larger vessels and containerization—has meant certain changes in the marine environment. The larger the ship, the deeper it rides in the water, and the deeper the harbor has to be to accommodate it. The advantages of an increased capacity are lower costs for fuel, capital, and labor per unit weight. The tendency towards larger ships has been particularly marked for tankers. In 1945, the standard tanker was the T-2 tanker with a dead weight (total carrying capacity) of 16,460 tons. The upper practical limit for supertankers of 1 million dead weight tons will probably be reached by 1990. Freighters and bulk carriers are also increasing in size, though less dramatically. In 1970, the maximum size for freighters and bulk carriers was 25,500 and 105,000 tons respectively. As the capacity of the vessel increases, its draft increases roughly as the cube root of the tonnage. In 1972 the maximum draft for New York Harbor was 45 feet, which

limited ships entering the harbor to a tonnage of about 70,000 dead weight tons. New Haven Harbor had only 35 feet of water in its entrance channel. To maintain the harbors even at their present depth requires dredging to remove sediment and waste deposits. For supertankers and big bulk carriers, existing harbors will have to be deepened or new harbor facilities provided.⁹ Harbor maintenance and deepening affects the ocean in four ways: dredging (1) modifies water movements in the harbor which in turn causes (2) changes of salinity and (3) altered sediment transport; and (4) the dredge spoils, often polluted, are usually disposed of at sea.

Containerization for handling miscellaneous cargos has meant a move to different facilities—sometimes refurbishing old ones, sometimes abandoning them and building a brand new port. Miscellaneous products are packed into a standardized container by the originator, sent by truck or rail to the port, and then lifted into a container ship. At the destination of the cargo, the process is reversed. In this manner, the dockside handling of the cargo can be automated because the containers are standard sizes, regardless of their contents. Handling of bulk cargo, liquid or solid like oil or sand, is also automated, using pumping, suction, or other bulk handling methods. Dockside storage tanks must be provided to hold the cargo until it can be sent to the consumer. These streamlined, large-scale methods are having a major impact on the nature of the urban waterfront.

Extraction

The use of the sea for extracting resources—from water, from underlying sediments, and from subsurface deposits—is both profitable and necessary, but can, like other uses, be distorted to misuse. The products of extraction are conveniently grouped into living and non-living resources. First let us examine the non-living resources.

From the Water: Desalinated Water—The water demand of coastal areas is rising much more rapidly than over the country as a whole, a reflection of intensive urbanization taking place along the seabords. At present, these demands are being met from surface or subsurface sources. Connecticut, for example, obtains its supply entirely from stream-fed reservoirs (75 percent) and groundwater sources (25 percent). But New York City and the Long Island communities must pay special heed to alternative sources. New York City now obtains its water supply from upstate New York, including some from Delaware River Basin sources. The U.S. Army Corps of Engineers has studied the feasibility of tapping the Hudson River.

On Long Island the water supply problem is especially acute. Nassau County is approaching the balance between demand and safe yield of its underground reserves. In fact, the demand may already be excessive, as evidenced by lowered water levels in surface water such as Hempstead Lake. If rainwater doesn't replenish the groundwater supply, the delicate balance between sea water and fresh water at the shore's edge may be disturbed. It is this dynamic boundary, formed by pressure of fresh groundwater against seawater,

that prevents the landward intrusion of salt water.¹⁰ When groundwater pressure is reduced past the balance point, by pumping too much water out of the ground into the town water supply, or by discharging too much sewage (which is, after all, fresh rather than salt water) into the ocean, seawater begins to seep in under the land and infiltrate the groundwater. Brooklyn and Queens lost their groundwater supply this way a number of years ago. This delicate balance Nassau County is now approaching or may even have reached. Suffolk County, although it has an ample groundwater supply now, should prudently consider supplemental sources.¹¹ One potential supplemental source is known to be inapplicable for Long Island: fresh water from sources beneath the continental shelf or from submarine fresh water springs.

There is a potentially infinite source of fresh water: seawater converted by desalinization. At the end of 1967 there were, worldwide, 625 desalting plants in operation or under construction, with a total capacity of over 200 million gallons per day. They use any of three methods: distillation, membrane processes, or freezing. The cost of desalting water is dropping. In 1952, desalted seawater cost more than \$4.00 per thousand gallons. By 1967, this cost was reduced to about \$1.00 per thousand for a plant with a capacity of a million gallons a day. This cost doesn't compare favorably with groundwater costs yet; however, in plants larger than a million gallons, or in plants using brackish water of 6 parts per thousand salinity—far less salty than seawater—the costs can be reduced to 65¢ and 35¢ per thousand gallons respectively.¹²

Desalinization is no panacea. Seawater desalination plants take in seawater and discharge hot brine at about twice the salinity of seawater. The disposal of hot brine can have deleterious effects on the nearshore environment: since it is denser than seawater, the brine could fill topographic depressions near the shore and form a stable layer of saline water near the bottom, impeding water circulation. Eventually, this would result in depletion of dissolved oxygen in bottom waters and destruction of all life except sulphate-reducing bacteria.

From the Sea Bottom: Sand and Gravel—Sand and gravel are among the most important mineral resources taken from the ocean. In 1967 sand and gravel was valued at \$1 billion for the United States.¹³ Sand and gravel in Long Island—its only mining—in that same year had an annual value of about \$8 million.¹⁴ During 1967 Suffolk County produced 4.6 million tons of sand and gravel and was the largest producer in New York State. Nassau County was second with 4 million tons. About 90 percent of the sand and gravel produced comes from upland mining operations, often located adjacent to harbors, since for this large-volume, low-cost industry, transportation costs are what's critical. One-third of the sand and gravel sold to New York City construction-industry customers is barged by water, the rest goes by truck. In urban coastal areas, marine deposits will be sought after for an increasing fraction of the sand and gravel requirements,

for two good reasons. As land deposits are exhausted, operators will first exploit nearshore deposits in protected waters before mining deeper deposits in exposed waters. Second, many zoning controls now prevent opening up new sand and gravel pits, due to the unsightly land scars they leave behind. Consequently, harbor improvement and channel deepening, yielding sand and gravel as a by-product profitable for construction, are favorite operations for the industry. Since bottom lands are in the public domain, dredging operations for sand are usually part of town or county public improvement, where the prime purpose is to dig a channel, improve a beach, or modify the circulation of a bay or harbor.

Sometimes, regard for the public benefit is negligible or even non-existent; then the dredging usually becomes a major controversy. Potential ill effects of sand and gravel production near shore include bluff erosion and loss of beach. Neither is likely to be acceptable to shoreline property owners and local residents. However, the public interest may be well served by combining a dredging project with a mining operation. For example, instead of requiring governmental expenditures for harbor improvements, the usual Long Island township practice is to allow commercial dredging. The town gets the work done and also receives a royalty for each ton of sand and gravel taken. The improvement of Huntington Harbor would have cost \$2 million; because the bottom consisted of usable sand and gravel, the town was able to sell the privilege of mining this resource and realize half a million dollars profit.¹⁵

Profit is not the last word on the subject. Controversy over the Huntington Harbor dredging focuses for us once again the crux of the problem of uses and misuses: competition among different kinds of uses of the marine environment. On the one hand, dredgers claim that through their operation in 1965 the harbor bottom was rehabilitated and should become a more productive area for shellfish than it was before.¹⁶ On the other hand, shellfish companies claim that 90 percent of the area dredged had been shellfish-producing area of the best quality and that at least a portion of this area will not be conducive to shellfish growth for a long time.¹⁷ These areas were capable of producing an estimated one-half million dollars worth of shellfish annually.

What *does* dredging do to marine life and the shape of the shore? We don't really know some of the essential information. Much of the heat in present debate comes from lack of light on such issues as: bottom rehabilitation through dredging on salt water intrusion, pollution control versus salinity control, how dredging inlets affects their stabilization, the use of groins for erosion control and beach stabilization, and where to dump dredging spoils.

Meanwhile, it is argued, on the one hand, that wetlands are more important to marine life-cycles than sand and gravel deposits. Since offshore dredging does not affect wetlands directly, the ecological loss is less than, say, filling in wetlands. Furthermore, mining operations clean up an ecologically useless "mucky" bottom and leave behind fine-grained materials after removing the sand and gravel. This silt blanket

resettles and new bottom growth eventually covers it again. Finally, it is said that if dredging improves water circulation in polluted harbors, ecological conditions in these bays and harbors may be enhanced rather than damaged.¹⁸

The answering arguments, on the other hand, focus on two adverse consequences of dredging. First, sand and gravel operations disturb the living balance in the dredged area; the silt blanket covers the bottom, making it unfit for many desirable organisms like oysters, which grow better on a sandy bottom. The turbid water caused by the silt blocks out sunlight, killing off plants by ending photosynthesis. This stops not only the food supply of finfish and shellfish but also one of their major sources of oxygen—photosynthetic oxygen. Furthermore, the decay of any aquatic animals killed off in the process produces noxious gases detrimental to other life forms and consumes oxygen present in the water.¹⁹ Dredging operations have had devastating effects on the shellfish in Northport Harbor, Oyster Bay, Mount Sinai, and Wading River. Conservationists and baymen agree that most bottom lands dredged to date were not "mucky" bottoms originally. They were hard or sand bottoms that were detrimentally affected by dredging. In addition, the so-called "mucky" bottoms are not ecologically useless.²⁰ They provide a decomposition zone under a photosynthetic one. In other words, digging up the decomposition zone buries the nutrients necessary for the growth of all the marshland vegetation instead of allowing the nutrients to recycle back into the system.

The other objection is that controls on dredging operations have often been sloppy or non-existent. Contractors have dug deeper channels than called for, or dredged areas not within their contract, or left large, deep holes in the bottom. These deep holes accumulate waste deposits which gradually degrade water quality or cause odor problems in hot weather. Some of the dredges used in the sand and gravel operations are equipped to dig deeper than 16 feet, often with an endless chain of dippers. The dredged material is sorted into gravel, sand and silt, and the marketable aggregates are shipped to local or New York construction markets. Between 1955 and 1968 Mount Sinai Harbor was dredged by a private contractor.²¹ More than 3 million cubic yards of sand and gravel were taken from the harbor's bottom.²² When the operation began, the top of the wetlands north of the beach was removed to a depth of 40 feet, for the sand underneath. The dredges were to backfill to a finished grade of 12 feet below water level. Not only was the backfill ineffective to restore any wetland growth, but there still are deep holes in the harbor. The dredges exceeded boundaries set for the east and also went into the south where no boundaries or check points had been established. Approximately 60 percent (140 acres) of the former wetlands was destroyed.*

*This estimate is based on various testimony presented to the Oceanographic Committee of the Nassau-Suffolk Regional Planning Board.

The dredge problem is further illustrated where dredges contracted to remove the sand bar off Center Island Beach in Oyster Bay were supposed to dig to a depth of about 18 feet below mean low water (mlw). They in fact went as deep as 33 feet below mlw. Conflicts arise due to the lack of controls in existing legislation, in which adverse consequences of dredging are not articulated. Use of dredging for speculative real estate development or make-work projects involving political patronage rarely is in accord with desirable conservation or public-interest objectives.*

The point is that dredging can be beneficial, but must be planned for compatible use, and must be supervised. Harbors do silt in and do require circulation channels. Navigation and mooring channels are also necessary. We do need dredging to build up ground for shoreline roads, waterfront power plants, and fuel storage tank sites. Moreover, there is no question that sand and gravel mining is a necessary industry: construction requires the aggregate for the manufacture of concrete. At the present time, offshore mining appears to be the most economical method. However, certain compromises will have to be reached if ecology and beauty are to be served as well. Up to now, Nassau and Suffolk Counties' public works departments and the U.S. Corps of Engineers have used navigation as the sole criterion for dredging. Recently, the President's Science Advisory Committee made a heartening suggestion:

We recommend that issuance by the United States Army Corps of Engineers of permits for dredging, and decisions concerning the Corps' own operations, be continued on the anticipated effect on all resources, not on effects on navigation alone.²³

It is possible, with good planning and proper control, to use dredging intelligently and at the same time preserve the marine environment.

From Beneath the Sea Floor: Oil and Gas—By far the most important economic resource from the continental shelf is petroleum and natural gas. Between 1850 and 1950, U.S. fuel consumption increased by a factor of 14.7; per-capita consumption increased by a factor of 2.3. Not only is the total energy demand going up, but the type of fuel has shifted markedly. Around 1850 wood was the dominant fuel. By 1885 coal was dominant, losing its place to oil and gas by 1947. Because of limited supplies, however, oil will probably be replaced before the year 2000. Coal is one possible replacement, but even this resource can last only a few hundred years; ultimately the world's energy demands will be met by nuclear fuels or other energy sources. For the present, the profits of oil production offset the short life expectancy of oil as a dominant fuel, and oil companies continue to invest in new exploration, especially offshore.

*Article 1 of the Suffolk County Charter, adopted by referendum, November 1970, requires county agencies to submit statements of environmental impact of certain projects to the Suffolk County Council on Environmental Quality for review.

In 1971 about 16 percent of the United States oil and gas production was from beneath the sea; 25 percent of world production, including the United States, was from the sea.²⁴ As continental resources are depleted, the fraction of offshore production is likely to increase.

The production of petroleum from under water presents a number of environmental problems. Withdrawal of oil and gas in a nearshore area can lead to subsidence of the land. The extensive extraction of oil from Lake Maracaibo in Venezuela has dropped the shorelines so much that dykes have had to be constructed to prevent inundation.

Some spillage of oil is common during offshore drilling, but extensive pollution can result when blowouts occur. During drilling, the weight of the mud in the hole being drilled (drilling mud) must be carefully adjusted to equal the pressure of the oil reservoir. Oil formations are usually sealed by impervious clay layers and may be at abnormally high pressures; when such reservoirs are encountered unexpectedly, the reservoir pressure may exceed the weight of the drilling mud. Blowout preventers on the drill tubing, if properly installed, should forestall accidents, but blowouts from human error do occur. When a well blows out, the drilling mud is expelled and oil and gas pour out of the hole. Often a well catches fire, and the fire has to be extinguished by explosives before attempts can be made to bring the well back under control. To control a blowout, another hole is drilled at a slant to intersect the "wild" well. When contact is made, cement is injected to form a seal in the "wild" well. It takes weeks, usually, to control the well; during this time an enormous amount of oil may be discharged. On February 10, 1970, a Chevron production platform 10 miles off the Louisiana coast caught fire. It took two months and 300 pounds of TNT to extinguish the fire, but then the well began discharging water with a 5 percent oil content—2000 gallons per minute. Eighty-four ships were employed in an attempt to contain the oil slick that formed.

Even without such catastrophes, offshore oil production poses problems. The offshore production platforms are potential hazards to navigation. Drilling and production operations may reduce the aesthetic values of the seashore,²⁵ aesthetic values which, as the recreation discussion made clear, are worth hard, cold cash. The noise of oil drilling may adversely affect wildlife; seismic exploration for subsurface structures has been blamed for fish kills.

The facts remain that the nation uses more energy than ever, and that oil and gas are at present the best available energy sources. This puts considerable impetus behind solving underwater production problems like subsidence, blowouts, navigation, aesthetics, and damage to wildlife. It is no longer at a distance, "over there in California" or off Louisiana shores; it is a major challenge for the whole Atlantic seaboard for the 1970s.

Food From the Sea: Fish and Shellfish—The living resource of food extracted from the sea has a long history around the Sound, and is the subject of much folklore and nostalgia. Lately, though, the decline in both fishing and

shellfishing industries has caused some concern.

The United States per-capita consumption of fish for food has been remarkably constant at about 11 pounds per year. As is well known, fish is high in protein. Given the consumption of fish and its nutritive value both for people and for animals, it is clearly not slackening demand that is bringing down the fishing industry. One of the main reasons is fewer fish. Fishing is a form of hunting and gathering; it is quite unlike meat production. Cattle growers control the feeding, breeding and killing of livestock in order to maximize the meat yield: nearly all the meat produced can be consumed by man. The only reduction in yield results from loss of livestock by disease and occasional predators. In contrast to the farmer, the fisherman has very little control over his stock, and, rather than increasing it, he preys upon it—along with other fish predators. Fish species have a natural distribution with climatic and self-induced variations. The population dynamics produce a certain age distribution for each species so that, on the average, the population is in a steady state. If fish are removed at a constant rate below the maximum sustainable yield, a new steady state is established: a smaller population with fewer old fish. This is perfectly tolerable. But if the rate of fishing is high, beyond the maximum sustainable yield, the standing stock will drop drastically and may become unprofitable for fishing. For many species the maximum sustainable yield is between one-third and one-half the natural standing stock.

This is a significant part of the conflict between commercial and sports fisheries. Each claims the other is overfishing; each alone is a legitimate use; but between them both, some species have been fished beyond the maximum sustainable yield.

In addition, various types of pollution and the destruction of wetlands reduce the available stocks. The vitality of the fish industry is intimately tied to the health of the wetlands. Wetlands produce food and serve as a spawning and nursery area for the growing fish.²⁶ Menhaden, for example, spawn in the ocean or Long Island Sound. When the young fish are about one inch long they swim to the wetlands, where they find food and protection from larger fish. After spending about eight months in the nursery areas, the young menhaden return to the ocean during the winter and may migrate to the south. By this time they have been transformed from slender, transparent larvae into deep-bodied juveniles resembling adult menhaden.²⁷ Many of the fish caught by local fishermen mature in the wetlands of Long Island and Connecticut. Preservation of these wetlands is essential for the preservation of the industry. Without these tidal wetlands, the life cycle of the menhaden, as well as flounders, fluke and other fishes, would be broken.

A wetland partly or completely filled in for housing sites is a wetland partly or completely useless to fish. But even without fill, much wetland productiveness has been poisoned by waste discharge from homes, boats, industries, farms, and municipal sewers. Furthermore, dredging operations and ditching to eliminate mosquitoes have damaged or destroyed

wetland production of basic food chain organisms. Hence, wetlands that do still exist often show very marked reductions in productivity.

One improvement in fish products—potentially a great boon to the fishing industry, and offering year-round employment as well—is presently hampered by rules of the Food and Drug Administration against using whole fish for human consumption. An improved type of fishmeal called fish protein concentrate (FPC) can be produced from industrial fish. This product is odorless and tasteless and can be stored indefinitely without spoilage, since all of the fish oil has been removed. A plant processing FPC was recently established in Greenport, entailing an investment of over \$1 million.²⁸ Unfortunately, odors from the plant, together with a shortage of fish, have forced it to close. An FPC industry on Long Island has good potential, if adequate standards are instituted to prevent nuisance factors and if the menhaden stocks revive. An FPC industry could also lead to the development of ancillary food packaging and processing on Long Island. The Food and Drug Administration recently changed its position on FPC and now allows sale of one-pound packages of FPC made only from hake species. FDA does not allow the sale of products containing FPC as an ingredient.²⁹

Insertion

Wastes have to be disposed of somewhere, and in some form. Both sewage wastes and solid wastes like rubbish, garbage, and dredge spoils have been undergoing some transformations before they are dumped—inserted—into the water. They are compressed or separated mechanically or treated biologically or chemically, for instance. But we still are finding exactly how much impact these metamorphoses really make on the water chemistry, how much of the ocean floor is covered by which wastes, and what that means for bottom plant and animal growth, to list a few areas of research. Other substances we insert into the ocean are beginning to be dealt with as having priority for research and management. The quantity and effects of pesticides on ocean life are virtually unknown. The effects of heated water pouring out of such industrial plants as electric power generating facilities are presently under research.

Human Sewage—Most of Long Island Sound's waters are clean, attractive, and relatively unpolluted.³⁰ Thousands of residents and visitors still swim and fish without fear for their health in most places. But evident signs of sewage pollution have begun to appear in Long Island Sound coincident with the increasing population. The problem was first obvious and is now most critical in western Long Island Sound, near New York City.³¹ It is by no means confined to that area. For example, the Suffolk County Health Department has observed through its beach inspection program a slow but steady deterioration in water quality in the less populated areas of the eastern Sound.

Overflow from cesspools, seepage of polluted ground water, and illegal direct discharge of sewage are finding their way into the surrounding water. Boats polluting directly into

the water need to be stopped by enforcement of regulations, a good education program, and convenient dockside evacuation facilities. Between 1960 and 1970 the Suffolk County Department of Health found it necessary to refuse swimming permits for a small number of beaches on both the north and south shores and on some inland lakes.³² Suffolk County Water Authority indicated the presence of ABS (synthetic detergents) in the ground water and in most of the streams tested.³³ This is a positive sign that sewage is finding its way not only into the marine waters but also into the drinking water supply on Long Island.

Solid Wastes—The municipal refuse pile of the United States grows by about 200 million tons each year. Collection and disposal of refuse costs \$4.5 billion or an average of \$28 per ton. The yearly trash pile includes 46 billion cans, 26 billion bottles, 30 million tons of paper and 4 million tons of plastic. With rising populations in coastal areas, management of this waste has become increasingly difficult and expensive. Every present disposal method creates new problems. Large metropolitan areas, many of them coastal, are caught in a dilemma of unacceptable alternatives and face the immediate crisis of being buried in their own rubbish.

The major method of rubbish disposal is sanitary landfill operation. The rubbish is piled on the ground or in an excavation and is covered daily with a few inches of fresh soil. Coastal communities have long used wetlands for landfill. Consequently, valuable wetlands are destroyed and the filled area is later developed as real estate or parkland. About 10 percent of New York City is built on former disposal sites; San Francisco Bay is still being filled in. Landfills also adversely affect nearby marine waters by leaching. Rainwater seeps into the ground, dissolves materials from the wastes in the fill, and loses its oxygen through oxidation of the organic matter. This new ground water may contaminate other ground waters or be discharged to nearby marine waters. In short, the material in a landfill may be out of sight, but should not be out of mind, since it is not removed completely from the system.

Two other answers to waste disposal—burning or dumping at sea—also have spin-off problems. Approximately 70 percent of rubbish is burnable; but reducing the trash pile by incineration causes air pollution. That can be more expensive than landfill, what with all the regulations and regulators that are needed to keep air pollution down.

Dumping wastes at sea has a frustrating aftermath: the floatable components are carried ashore by surface currents. New York City used to barge refuse to sea for dumping, but a significant part was redeposited on the New Jersey and Long Island shores. A U.S. Supreme Court decision in 1933 stopped the practice. Other cities have had similar experience. Various schemes to compress rubbish and garbage to increase its density and so avoid the flotation problem have been developed, but not enough to be put into practice.

Solid wastes other than rubbish are regularly dumped at sea in disposal areas designated by the Corps of Engineers. Obsolete military hardware and ammunition debris, old ce-

ment and slabs of macadam from excavation, dredge wastes, sewage sludges, and chemical wastes, all are going down to the sea bed daily. For example, each year between 1964 and 1968, about 0.8 million tons of waste solids were dumped in western Long Island Sound and 4.6 million tons in New York Bight.

The problems posed by the solid wastes depend on their composition and quantity. At the very least, they cover bottom-dwelling organisms; after dumping ceases, organisms adapted to the new substrate can become established. At worst, the waste deposits may have a large oxygen demand, or toxic components may leach into overlying waters. Wastes may remain within disposal sites or may be spread by bottom currents. Wastes from dredging are extremely variable in composition. In industrialized harbors, the dredged materials consist of municipal and industrial wastes and usually resemble sewage sludges. Petroleum is common in these wastes. In other areas the dredged material may be clean sand, useful for construction or landfill. At present, oil-soaked muds and clean sands are often dumped together with no organized effort to use the sand (because dumping it may be less expensive than shipping it, and sand is less desirable than gravel for construction). A major advance toward acceptable sea-dumping practice would be classification of wastes and intelligent disposal based on their probable environmental effects.

Pesticides—Pesticides are causing serious and widespread problems among marine organisms and among animals that feed on them, especially birds. Large amounts of chlorinated hydrocarbons (DDT) and similar pesticides are used for crop control on the uplands, and for mosquito control in the salt marshes, tributary streams, and catch basins. Through seepage, groundwater flow, and direct contact, these persistent pesticides find their way into bays or the ocean. Since they are relatively insoluble, they are taken in undiluted by the microorganisms in the water and enter the food chain. As they move up the food chain, they become concentrated; appreciable amounts are being found in fish, fish-eating birds, and other carnivores.³⁴

Unfortunately, little detail is known about pesticide effects on marine life. It is clear that some species die, become sterile, or don't survive the embryonic stage, resulting in reduced populations of higher forms like fish.³⁵ This in turn allows excessive growth of algae and further pollution from the unconsumed algae dying and decomposing on the bottom. From the fact that broad correlations do exist between DDT concentrations and mortality, it seems patently obvious that pesticides serve no beneficial purpose in the marine environment. In fact, the damage may be more insidious and complete than from any other source now threatening the marine ecological system. DDT affects entire species on a world-wide basis rather than a single population, and may well wipe out those varieties by eliminating reproduction.³⁶

Alternatives are needed, like the development of new pesticides which rapidly decompose into relatively harmless components. Some areas around Long Island Sound are

experimenting with biological control schemes. Most of Nassau County's mosquito control work is being done by irrigation and water control with ditches or small channels to improve water flow and eliminate breeding areas, and by encouraging organisms that feed on mosquitoes or mosquito larvae. Along the New Jersey coast, upland marshes have been flooded to flush out larvae, and biological controls have been introduced: natural balance is eliminating the mosquitoes. Using chemical pesticides other than DDT can bring great improvement. Spraying in Nassau County is done with malathion. Where biological management is not effective or possible, fuel oil emulsions are used as a larvicide. A very thin layer of oil, one molecule thick, is enough to kill larvae. Most salt marsh mosquitoes have thus been eliminated in Nassau; the remaining pests come from stagnant fresh waters. Since the long-range effects of the various alternatives are unknown, research in this field is obviously indicated. We need not wait for research results, however, to act against DDT. The Suffolk County Mosquito Control Commission stopped using DDT in 1970 after recognizing its operations were causing widespread pesticide contamination. DDT was used in Nassau over a four-year period but was discontinued because it brought poor results relative to cost. New York State banned the use of DDT on January 1, 1971.³⁷

Thermal Discharges—Many industrial processes—involving chemicals or metals, for example—require dissipation to the environment large amounts of heat. Long Island Sound people are quite familiar with one particular such process: electricity generation. There are 17 electric generating plants using oil or coal (fossil fuels) around the Sound, and 7 more have been proposed.

In an electric generating plant using steam to turn the turbine, steam is heated to a high temperature and pressure by burning a fossil fuel or by heat exchange with a nuclear reactor. The steam then drives a turbine connected to the generator which produces the electricity. The low-temperature, low-pressure steam leaving the steam turbine must be condensed to water; condensation reduces its pressure and maintains flow. This water is then returned to the boiler to be reheated to steam.

The condensing stage requires great amounts of water to cool the steam. Cooling water flows through miles of tubing surrounded by steam, absorbs the heat, and then is discharged back into the river or ocean whence it was pumped ("once-through" cooling). Alternatively, the water may be cooled by evaporation in cooling towers and recirculated through the plant. To illustrate the great amounts of water involved and the proportion used by the electric industry: in 1964, United States industry used about 50 trillion gallons of water for cooling; 81 percent of that was used in the generation of electricity.

There has been considerable improvement through the years in using steam efficiently, and thus the cooling water "goes farther" these days. Fossil-fuel plants use less cooling water per kwh than nuclear facilities, however; "going nuclear" is no improvement from the water's point of view. In a

fossil-fuel plant, about 40 percent of the heat is converted to electricity; of the 60 percent waste heat, about 15 percent goes into the atmosphere by stack gases and by losses from the plant, and the remaining 45 percent goes into the cooling waters. In a nuclear plant there are no stack losses of heat and about 5 percent of the heat is dissipated from the plant to the atmosphere; since in nuclear plants 32 percent of the heat converts to electric energy, that leaves 63 percent going as waste heat into water. Because of lower operating temperatures, heat rates of nuclear plants are somewhat lower than those of the most efficient fossil-fuel plants.

Efficiency overall is better, yes. But much more electricity is being generated now, and individual plants are larger than before, hence the total amount of water running through is much greater. Finding good, available water in massive quantities is already problematical. Areas of high electric load density are usually areas of water shortage or poor water quality. Heating water further reduces water quality by lowering dissolved oxygen and raising oxygen uptake. The maximum demand for electricity also comes when flows are usually low, either in late summer or in mid-winter.

It becomes clear, then why the Long Island Sound area has 17 generating facilities operating and 7 more are proposed. The vast quantities of water required make shore locations convenient. Because fresh water is preferred to salt water (which corrodes the pipes), power plants have built on estuaries, with their intakes close to the surface. But the heated water exacerbates adverse effects of other pollutants, and the quantities of water demanded by expanded electricity needs are causing industry planners to look offshore. The generating plants presently located around the Sound use more than 2.1 billion gallons of cooling water daily; this demand can be expected to increase more than eight-fold over the next two decades.

Since siting power plants right on the seashore will compete with recreational and other uses of the beach, we can expect in the future to see large power plants, nuclear-fueled, located near shore or on platforms offshore. The effect of heated water discharges depends on numerous variables, so it will be essential to develop adequate safeguards against potential damage to the marine environment of the Sound.

Summary

Conflicts among uses, competing demands made on the waters and shores of urbanizing America are the crux of the present situation. What the tidal zones will be like in the future—economically and aesthetically—hangs precariously on how well the environment itself is served now, when competition created by rapid urbanization is balancing this way and that. Protection and conservation of these zones are essential if swimming and boating, fishing and clamming are to continue. But competing with those uses are dredging to get sand and gravel for construction or to clear navigable

channels, and extracting and shipping oil. An intractable and direct conflict exists over wetlands: the need for preservation *as is* for fish and shellfish life cycles, versus the need to fill them in and build them over with the rubbish and residences of an expanding population.

There's more involved than just competition for space or use, however. Actual misuse is evident, that is, a use whose methods are unacceptable and undesirable. On-shore practices like agricultural fertilization, pesticide use, and the disposal of human and animal sewage have been and are depreciating the value of Long Island waters by pollution. Thermal pollution from generating plants in the western Sound aggravates already-severe oxygen depletion and overfertilization stemming from sewage treatment plants and the character of tidal flow there. Dredging that exceeds its boundaries and depths wreaks irreparable havoc.

Some of the conflicts may be resolved by public awareness and financial support for conservation programs. Some of the conflicts can be ameliorated by stringent enforcement of existing rules and regulations. Some of the conflicts will yield only to energetic coastal planning and management. We already know a great deal about the marine environment, and have some good laws; putting knowledge and laws to work effectively depends now on active and concerned citizens.

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Research on Coastal Zone Management

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Introduction

Massachusetts, like the other coastal states, is currently faced with what would appear to be an exceedingly complex task, which is to develop a realistic and effective coastal zone management program. Incorporated in this program must be such seemingly straight-forward objectives as identification of coastal zone boundaries; definition of permissible land and water uses within these boundaries; identification of means for controlling land and water uses; and guidelines in establishing priority of uses.

During the past six years, my company has been involved in various types of environmental surveys along the New England coastline. The major purpose has been to provide the environmental information necessary to determine, for example, whether certain coastal activities are or are not permissible, whether certain areas are or are not critical, whether certain areas are of higher priority than others. We have found such criteria, seemingly simple in the abstract, to be in fact extremely elusive in the real world. Their complexity, unfortunately, seems at times to increase in proportion to the amount of information gathered. I would say that those directly responsible for development of Massachusetts' coastal zone management program not only deserve, but require, a huge amount of patience and cooperation from the public.

Coastal Zone Decisionmaking

For purposes of illustrating the complexities of coastal zone decision-making, I would like to use as an example an estuarine area of Massachusetts where we have been conducting research for nearly six years. While six years may appear to be a long time to devote to a single area, I can assure you that significant trends or unnatural events in the marine environment may become discernible at a much slower pace.

The area to be discussed in relation to the coastal zone management criteria cited above is the Taunton River estuary, which includes upper Mount Hope Bay, located in the

northeast corner of Narragansett Bay. On the basis of a report prepared by the Environmental Protection Agency in 1971, one would imagine this area as an ecological disaster if not a national disgrace. The receptacle of a broad variety of pollutants in large amounts—raw sewage, toxic industrial compounds and heavy metals, agricultural pesticides, and the waste heat of four electric generating plants—the Taunton River and upper Mount Hope Bay would, superficially at least, appear to be on the verge of ecological collapse.

How does an area such as this fit into a coastal zone management program? Should it be written off as an embarrassing eyesore no longer useful for anything but unlimited industrialization and abuse and hardly worth managing? If it is to be managed, what priority—in terms of other coastal areas of Massachusetts—should be assigned to it? Finally—and perhaps most important—what is meant by the word, “manage,” and how does one manage an area such as this in terms of preserving what is left of its environmental integrity?

Taking these questions in order, an unqualified answer to the first question is *yes*, the Taunton River and upper Mount Hope Bay are most definitely worth saving. In fact, and despite the abuse it has received and continues to receive, it turns out that this estuary may be as biologically productive and valuable as any in the Commonwealth. A few examples are given here to illustrate this point.

During 1972 and 1973, over 3,700 bushels of hard clams, or quahogs, were harvested from the Lee River, which is considered part of the Taunton River estuary-Mount Hope Bay complex. Because the Lee River is polluted, these shellfish had to be transplanted to a clean area and allowed a period of self-cleansing before they could be harvested directly for consumption. However, the interesting feature here is that this volume of shellfish was harvested from an area approximating only six acres. The estimated population density exceeded that of productive fishing areas in other parts of Narragansett Bay by more than a factor of ten.

Species diversity is frequently used as an index of the environmental health of an area, with a low diversity index suggestive of environmental stress. Our analyses of the finfish populations in upper Mount Hope Bay, most specifically the Lee River, over a three-year period indicate a relatively high species diversity, considerably higher, in fact, than that of the majority of estuaries in Massachusetts—polluted or unpolluted—that have been investigated by similar methods.

As a third example, our company undertook an intensive study of the entire Narragansett Bay area during 1972 and 1973 to determine, among other things, which areas of the Bay were the major spawning centers for different species. It was found that three of the most important species of finfish that reproduce in the Bay—menhaden, winter flounder, and silversides—spawned more intensively in the area of upper Mount Hope Bay than in any other part of Narragansett Bay.

As the fourth, and final example, over a six-year period we have identified over 80 different species of finfish near the mouth of the Taunton River. Included in this group are large numbers of anadromous fish, such as alewives, blueback herring and smelt, that migrate up the Taunton River to spawn in fresh water; catadromous species, as the eel, that migrates down the river to the sea en route to its oceanic spawning grounds; important recreational species such as bluefish and striped bass, which presumably are attracted to the area by the presence of large numbers of forage species such as menhaden and silversides; occasional species that normally frequent fresh water, such as yellow perch, bullheads and crappies; species that are predominantly oceanic in habitat, such as silver hake; and exotic species such as four-eyed butterflyfish and permit that have wandered into Mount Hope Bay from regions far to the south.

This is not intended to imply that, on the strength of these findings, pollution must be beneficial and therefore should be encouraged. The fact that thousands of bushels of edible shellfish in this area cannot be harvested directly is clear evidence of how a once-valuable resource can be wasted by pollution, and there may be more subtle or long-term effects resulting from pollution that we have failed to detect.

However, the important point, I think, is that areas as grossly polluted as this should not necessarily be dismissed as being no longer of ecological significance. Similarly, it is important for management purposes to realize that certain forms of pollution, although probably not desirable, do not invariably have catastrophic consequences.

Certainly the evidence would indicate that the Taunton River estuary and upper Mount Hope Bay, despite their high levels of pollution, are presently characterized by high biological productivity and undoubtedly contribute significantly to the commercial and recreational fisheries of southern Massachusetts. On this basis alone, the area deserves a relatively high priority in management considerations.

How to Manage

The question then is, how is an area such as this to be managed in a way that will preserve its productivity?

The problems involved seem formidable. There is, first of all, a problem of magnitude. The Mount Hope Bay Watershed is 547 square miles, over 340,000 acres of land, of which 92 percent drains into the Taunton River. The Taunton River itself is 38 miles long. Water, and many of the potentially toxic substances it may contain, draining into the river at any point upstream, must eventually reach the highly productive waters of upper Mount Hope Bay to exert additional stress upon its biota. It is clear that a management program with jurisdiction limited to the coast can offer only limited protection. Yet the management of the entire watershed area would seem to be an unrealistic, if praiseworthy, objective.

Secondly, there exists a political problem. Twenty-five separate communities lie within the Mount Hope Bay watershed. It seems unlikely that the needs and interests of twenty-five distinct communities could be coordinated in such a way that a uniform management policy would be acceptable to the entire watershed area, yet this degree of cooperation would be required to insure protection of the estuary downstream.

Thirdly, there is a problem of economics. The decline of the textile industry, particularly that of Fall River, has resulted in significant unemployment in this area. Development of other regional industries—tanneries, dye manufacturers, chemical and electroplating industries, plastic manufacturers, electric generating plants, etc.—have absorbed an important segment of the labor force, yet it is these industries that contribute to the pollution of Mount Hope Bay. Restrictions upon their operations for conservation purposes invite the possibility of termination of their operations for economic reasons, with subsequent increases in unemployment.

Finally, there is the scientific problem of determining whether or not a proposed activity involving some environmental impact upon this estuary will in fact cause appreciable harm. As indicated above, this area presently is of high biological productivity even though severely polluted. Is the Taunton River-Mount Hope Bay ecosystem teetering on the verge of disaster, requiring only a slight increase in environmental stress before it collapses? Or do the populations of this ecosystem reflect a long-term adjustment to the various stresses imposed and hence a form of resilience and stability not generally found in less industrialized, more pristine areas? And if the latter represents the truer picture of the upper Mount Hope Bay ecosystem today, then what forms of activities might be regarded as posing no real threat to this ecosystem and might therefore be designated as permissible?

An excellent and very timely example of the difficulty in answering a question such as this involves the dredging operations in Mount Hope Bay recently proposed by the U.S. Army Corps of Engineers. This project would involve the removal of approximately 3.2 million cubic yards of

bottom material from various areas of Mount Hope Bay and the Taunton River in order to improve navigation; the spoil would be disposed of offshore at a site seven miles southwest of Cuttyhunk Island, known as Browns Ledge. The project, which would require 14 months to complete, has met with vigorous opposition, primarily from fishing interests who question the potential impact of dumping upon the fishery resources of Browns Ledge. It would also seem that the potential impact upon the ecosystem of Mount Hope Bay might be questioned as well.

For example, two important species of finfish referred to earlier, the winter flounder and the silverside, both deposit demersal rather than floating, or pelagic, eggs, that normally rest upon the bottom. Dredging operations result in increased levels of turbidity in the area of dredging, and dredging over a sustained period of time could result in appreciable siltation of the bottom. Excessive siltation at the time of spawning, therefore, could result in the smothering and loss of these eggs.

As a second example of potential concern, dissolved oxygen concentrations near the bottom in upper Mount Hope Bay fall to seemingly precariously low levels during summer. Dredging, in the process of releasing large amounts of organic material and hydrogen sulfide from the sediments into the water column, could increase the biological oxygen demand still further, possibly to the lethal point for some species.

As a third example, appreciable concentrations of mercury and other metals, the result of industrial discharge into the Taunton River, presently rest in the sediment of upper Mount Hope Bay. With dredging, these metals may be released from these sediments and, through various pathways, recycled through the food chain of upper Mount Hope Bay. It is conceivable that these could reach dangerously high levels in various species, seriously upsetting their physiological functions and reactions, or perhaps making them unfit for consumption.

It is worthwhile to focus briefly upon the question of mercury, since its release, in the process of dredging, could be the most serious consideration of all. The danger lies in the possible conversion of inorganic mercury to methylmercury by micro-organisms. If mercury entering the Taunton River and upper Mount Hope Bay has in fact combined with hydrogen sulfide in the bottom sediment, the result is the relatively insoluble—and presumably less dangerous—mercuric sulfide. If, however, the mercury brought into suspension by dredging is converted to the highly toxic methylmercury, this compound may be concentrated by various

aquatic organisms, particularly by finfish that can absorb it through their gills. Other members of the food chain, including the plankton and bottom-dwelling shellfish may concentrate it as well. Unfortunately, the rate of methylmercury uptake by these organisms is not adequately understood, appearing to vary under different environmental conditions.

These are examples of some of the questions that must be considered by those responsible for the management of coastal zone areas such as Mount Hope Bay. They are not easy questions, and it is difficult to make predictions with any degree of certainty. On the one hand it is a project that promises substantial rewards in the form of high benefit-to-cost ratios. At stake, on the other hand, may be the productivity and environmental integrity of an estuarine area of major significance to Massachusetts. And too often the technical information upon which to base a judgment is embarrassingly inadequate.

Summary

In summary, our investigations of the Taunton River and Mount Hope Bay have suggested the following points that I think are pertinent to coastal zone management:

First, simply because a river, bay or estuary is polluted—even if grossly so as in the case of Mount Hope Bay—does not mean it is no longer biologically productive and should be dismissed as expendable. Rather, polluted estuaries may nevertheless be valuable spawning and nursery areas and may conceivably be as important to the coastal fisheries as those that are devoid of pollution.

Second, many years may be required to understand the aquatic populations in a given area in terms of overall productivity, trends in population abundance, and how these trends may be influenced by specific forms of environmental stress. Obtaining a sufficient amount of data to detect these trends is often a horrendous and time-consuming task. For this reason, it is unrealistic to expect on-the-spot yes or no answers to environmental issues from regulatory agencies, which rarely have had the opportunity to acquire the specific data necessary for making these decisions.

Third, and finally, the coastal zone cannot—for management purposes—be conceived of simply as a narrow band that parallels and more or less overlaps the high tide mark. Possibly the most serious form of pollution in Mount Hope Bay—mercury—originates from a source seven miles up the Taunton River, where the water is nearly fresh. I think this serves as a reminder that the coastal zone, however it may be defined, is as vulnerable to events outside its boundaries as it is to those within.

Coastal Recreation Aesthetics: Meaning and Measurement

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Introduction

The major problem of outdoor recreation in the last three decades, at least the one that has received the most attention, has been to provide areas and services sufficient to meet an accelerating recreation demand. By now everyone is familiar with the dilemma of supply and demand, but it was not until about 1962 when the Outdoor Recreation Resources Review Commission published the report of its landmark study that the dimensions of the problem became commonly recognized. The pattern is familiar and one that has developed in many areas of resource use and allocation. We are faced with resources that are mostly stable and limited and use figures that continue to climb. In outdoor recreation, the problem is nowhere more pressing than in the coastal zone, especially in and near urban areas. Not only is the shoreline a highly prized resource for recreation, it is for all practical purposes finite.

Given the circumstances, it is necessary and unavoidable that we have gone through a period that might be described as more places for more people, whether the places were beaches, campsites, trails, or rooftop playgrounds. Underlying this frenzy of activity and concentration on quantity there has also been a concern for quality. Unfortunately we have never really known what to do about it and, mostly out of frustration, have tossed everything into a single heap called aesthetics. It appears now that "quality" is becoming an even more active and integral part of our planning and management deliberations. It is significant that two recent planning studies, one by the Great Lakes Basin Commission and one by the New England River Basins Commission for Long Island Sound, have come out with separate volumes devoted entirely to shoreline appearance and aesthetics. However, the insecurity that we feel in dealing with these matters is clearly expressed in this statement from the Long Island Sound study:

The need for scenic quality has only recently become a

subject of formal study. Demand projections for scenic quality are new, and the subject is enormously complex. While scientific analysis and experimental studies have been conducted, and more are in progress, no objective method for determining need or demand for scenic quality has yet evolved. Yet, there is general agreement that visual quality is needed. (Roy Mann Associates, 1975, pp. 1-2)

The increase in concern for quality considerations, and it seems to be a trend, can be attributed to several origins but owes no small part to an overall increase in environmental awareness among North Americans. We are finally beginning to question the wisdom of our accumulated industrial wealth if it means living in places like Gary or Pittsburgh. We might also point to a parallel phenomenon that is occurring in demand for the fine, performing and folk arts— theater, opera, symphonies, architecture, sculpture, painting and pottery. These are, one would hope, signs of an increasingly affluent society on its way to being leisured and cultured. Finally, the concern for quality of recreation places and experience is derived from a sense of desperation that comes from a knowledge that we are running out of places to go. Especially in places where it matters most, like the shoreline and cities, it is now largely a matter of getting along with what we already have. In many cases, the problem can no longer be alleviated by adding more parks for the simple reason that there is no more room for parks.

The message for quality is not a new one. You may have heard it in the writings of men like George Catlin, Frederick Law Olmstead, John Muir, John Burroughs, Aldo Leopold, or Bob Marshall. The message is loud and clear, but unfortunately it is in code. The code is composed of abstractions and intangibles, and the task is to decipher these into terms that are concrete and subject to empirical investigation.

At a national conference on marine recreation, the mod-

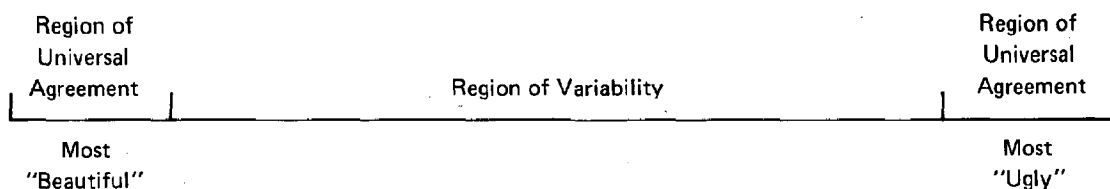


Figure 1. "Beauty and the Beast" Paradigm of Aesthetic Perception

erator for the final, summary session concluded that efforts directed toward understanding environmental and experiential quality were mostly hopeless, since "beauty is in the eye of the beholder." In the sense that human experience is variable and to the extent that we cannot dictate absolute standards of quality, that conclusion is correct. However, it is also the mentality of ambivalence that causes us to ignore our better human sensibilities and the more sensitive users of outdoor recreation resources.

The subject of aesthetics and recreation quality is large and confused. Nonetheless, as quality considerations grow more important, some very good and important research is beginning to emerge. Most of you are familiar with the work that is being conducted in the area of user attitudes (wilderness users, beach users, etc.), environmental perception, landscape design, and the like. This paper has to do with such studies, but it is meant to focus on what we might call the "hitting the fan" phenomenon in recreation research. That is, recreation research is characterized by spurts of interest and activity with little concern for *a priori* development of theory. The effect can be illustrated with the metaphor of a man who builds a sailboat in his basement and then has to blast out a wall to remove the completed vessel. Besides having a certain intellectual elegance, the building of theoretical models promotes a more parsimonious and efficacious research effort. In addition, such models allow an ordering of information and the development of an efficient technology for planning and management.

Meaning and Measurement

When it comes to understanding the magnetism possessed by the sea and shorelines, I am always impressed by a quotation attributed to John F. Kennedy. He said:

I don't know why it is that all of us are so committed to the sea, except I think it's because in addition to the fact that the sea changes, and the light changes, and ships change, it's because we all came from the sea. And it is an interesting biological fact that all of us have in our veins the exact same percentage of salt in our blood that exists in the ocean, in our sweat, in our tears. We are tied to the oceans. And when we go back to the sea—whether it is to sail or to watch it—we are going back from whence we came.

Without pressing the point, it is interesting to note that the human eye is a marine eye. The anatomy of human vision is more closely related to that of marine vertebrates than to the eye, such as is found in insects, that evolved on land. I am a chauvinist of heredity to the extent that I believe that there is probably some universal perception of beauty deeply rooted in the genetic code. This is almost certainly true in the case of certain homeostatic controls (e.g., response to heat and cold). I will also postulate that on an aesthetic continuum (Figure 1) ranging from "most ugly" to "most beautiful" not only could we distinguish between the two extremes but we would all agree in our assessments. It is in the middle region where environmental and social conditioning has the greatest effect on individual preferences. The research task is made more difficult by the fact that the middle, variable region is by far the larger portion of the continuum.

In order to perceive aesthetic qualities and conditions or recreation quality, we must *sense* the environment. In man, the assimilation of sensory information is made possible by a complete set of mechanisms—visual, auditory, gustatory, olfactory, haptic, and proprioceptive. In describing human interaction with the built environment, one investigator (Fitch, 1970) points out that: "In architecture, there are no spectators: there are only participants." This is a maxim that can be applied directly to recreation. Even the passive visitor to the shore is stimulated by the variable qualities of the environment.

Sight is the master sense in man and most studies of landscape preference have centered on *visual* preference. Recognition of the *total* sensory experience, however, promises to be a most productive line of research. Think back to your experiences with the coastal zone and consider the many sensory impressions that are triggered, perhaps unconsciously—the sound of surf and of bell buoys, the taste of salt, the warmth of sun heated sand, the unmistakable smell of the sea. These are the aesthetics of the marine environment transformed from intangibles to concrete variables available for investigation.

Where do we stand now in terms of completed research? It would be fair to say that it is accumulating and useful but still sparse in comparison to what still remains unknown. Coomber and Biswas (1973) have formulated a model of sce-

nic evaluation (Figure 2) that describes the nature of research in this area and provides at least one look at a process carried through to implementation of findings. Those of you who are familiar with Anderson's User-Resource Planning Method will recognize the similarities between the two models.

At mid-level in the diagram are grouped four research approaches that describe a major portion of current investigations. Briefly, these are:

1. **Measurement** whereby elements of the landscape scene are quantified and measured. Shafer's work (1969) in using landscape photographs to measure environmental variables is an example.
2. **Ranking** systems attempt to identify preferred landscape types. Again, studies by Shafer are an example.
3. **Rating** systems employ some objective measure of environmental variables. Craighead and Craighead (1962), for example, developed a five point scale to measure 14 environmental criteria in a study of recreation areas and activities.

4. **Uniqueness** scales tend to inventory environmental characteristics and differentiate areas. Leopold's study of river valleys (1969) is probably the most familiar example.

Total Sensory Experience

It is significant that this model is restricted to the scenic environment, since much of the completed research deals with visual impact. As noted previously, however, the total sensory experience should develop as an object of research. Another avenue of investigation would examine psychological associations whereby perception is transformed into behavior by attitudes, values, and social motivation. We know from studies of sensory deprivation, for example, that the mind seems to demand variety in sensory input, otherwise it may create its own hallucinatory experience. It might be suggested that the constant variety and change of the coastal zone may be a major factor in its almost universal appeal.

Related work is being done in the area of wilderness attitudes, solitude as a component of the recreation experience, and other studies of a similar kind. Specific to the marine environment are studies like those of Spaulding's and his investigation of Rhode Island fishermen. These are important contributions to the literature, but again we lack an organizing model that gives form to a more or less amorphous collection of studies. One approach might be to follow something like Neulinger's (1976) "Paradigm of Leisure." (Fig. 3)

The psycho-social dimensions of landscape preference and recreation quality are probably the most neglected segments of our research activity. This will also be the most difficult to get at, because underlying overt behavior are the effects of social and environmental conditioning and the individual psychological traits that each of us are born with. Neulinger's approach to theoretical modeling is by no means the only one and maybe it isn't even the best one. But it is the kind of organizing effort that will initiate the best research and allow the most practical applications.

We are reminded of one respondent in a survey we recently completed of Long Island surf fishermen. His questionnaire indicates that he is a writer, that he made less than \$1,000 last year, that he fishes every day, and that he eats his catch. How do we identify this fisherman, and how do we classify him? At our present level of knowledge, we would probably have to list him as a vagrant. Despite his work ethic compulsion to cite an occupation, we are led to wonder what it is about men and the sea that makes such a lifestyle so unreasonably inviting to us all. Answering that question is the objective of our study of coastal aesthetics and recreation quality.

Application and Implications

Like agriculture, recreation is a production based discipline. Whereas the goal of agriculture is the production of food and fiber, the objective of organized recreation is to provide areas and services for leisure activity. In both cases, research

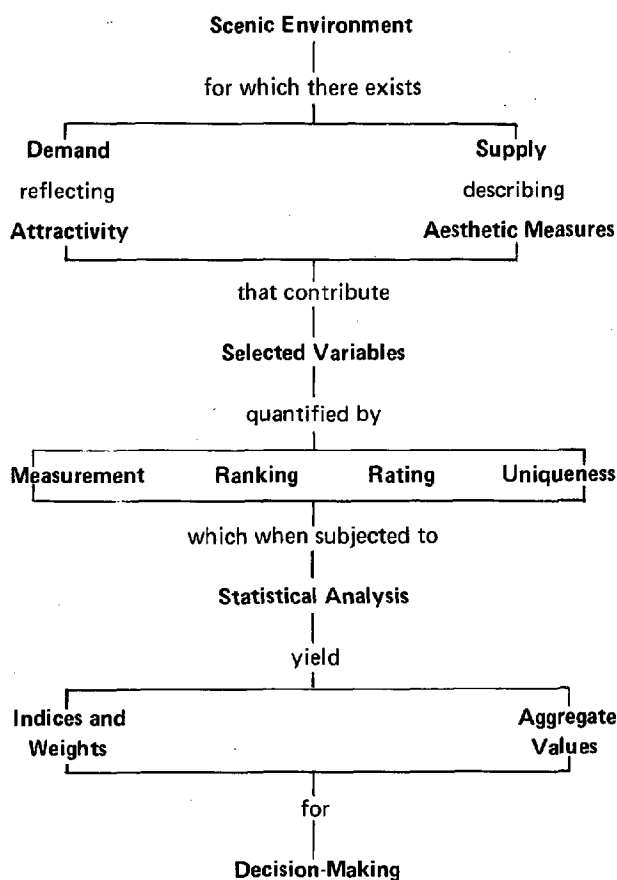


Figure 2. Process of Quantitative Analysis of Physical Environment (after Coomber and Biswas)

Perceived Freedom			Freedom Constraint		
Motivation			Motivation		
Intrinsic	Intrinsic and Extrinsic	Extrinsic	Intrinsic	Intrinsic and Extrinsic	Extrinsic
(1) Pure Leisure	(2) Leisure Work	(3) Leisure Job	(4) Pure Work	(5) Work-Job	(6) Pure Job

State of Mind

Figure 3. A Psychological Paradigm of Leisure (after Neulinger)

findings, even those that are most basic, should sift through the scientific mill and manifest themselves finally in a better product. What is the role of intangibles in the management of coastal recreation resources and what are the applications of research findings.

Future prospects for the coastal zone call for increased use of areas and facilities with relatively little overall expansion of the basic resource. The marine environment is vast, but most recreation activity is restricted to water only a few feet in depth and a shoreline that is one dimensional in character. As use pressures become more intense, and they have already reached a point of saturation in some places, management systems will have to rely on more sophisticated forms of technology to maintain desirable levels of resource quality.

Using the example of wilderness recreational management, we make one basic assumption, an assumption that several completed studies seem to support. We assume that solitude, isolation, and remoteness from human activity are necessary criteria for a wilderness recreation experience. In management terms, this means making decisions on maximum use levels that do not exceed social or recreational carrying capacities. For the coastal zone, the most sensitive users are probably those like surf fishermen, though a sense of solitude may be important to any individual or activity group.

While working with Resources for the Future, Kerry Smith and John Krutilla (1974) developed a computer system, based on IBM's GPSS system, that simulates the use of wilderness trails under varying conditions. The resource manager describes his trail system and experiments with several alternative factors such as the total number of users in the area, size of parties, location of campsites, trailhead loca-

tions, entry time and dates, and the like. It is possible for the resource manager to experiment with potential use conditions and management techniques (e.g., reservation systems, limitation of access, etc.), using the simulation model, before committing himself to a decision.

It is this kind of technology that will become increasingly useful and necessary for the management of recreational resources. Generally, the resource manager will have to make decisions on the lesser of two thresholds: (1) the natural carrying capacity of the resource or (2) the "aesthetic" carrying capacity of the user. This second category is composed of a broad range of conditions, and it is used to describe those elements that contribute to or constrain the recreation experience. Whichever of the two carrying capacity evaluations reaches a limiting threshold first will determine the basic management plan. Of the two, more is now known about natural carrying capacity and the ecological processes involved. Information related to "aesthetic" carrying capacity is beginning to accumulate, and we should begin to formulate procedures, such as simulation modeling, that will make this concept operational in the field.

Summary

1. The marine environment is highly desirable for recreation. In a metaphysical way, we will never know why it is so appealing. The mystery that has always been associated with the sea is certainly one of its attractions. Taken in that light, however, it becomes a measurable variable that can be incorporated into scientific investigation and resource management.
2. The human leisure experience and what has been termed "aesthetic" carrying capacity are composed largely of intangible qualities. They are difficult to handle, and the research in this area has lagged. They are essential elements of the planning/management processes, however, and will become increasingly important as the supply-demand ratio approaches unity. In some coastal regions, the saturation point has already been exceeded.
3. The research effort is beginning to pay off, but it still lacks the overall structure that will make it most productive. Let me mention one precaution and one suggestion. First, we must avoid making conclusions about demand that are based on studies of consumption. The environmentalist Garrett Hardin and others have cited the case where more sensitive wilderness users continue to seek more and more remote areas as those closer by become more highly used. The point is that studies conducted at the site may be completely erroneous when it comes to making overall conclusions about aesthetic taste. The suggestion is that we begin thinking more about experimental forms of research as an alternative to descriptive surveys. The experimental approach tends to do two things: (1) it produces discrete bits of information, and (2) it promotes useful theoretical modeling.

4. Finally, there is the need to transform research findings into a technology that can be applied in the field, alleviating problems and optimizing recreation opportunities. In the era of 747s the time of flying by the seat of our pants should be only a fond memory.

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Salt Marsh Studies in Rhode Island

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Introduction

In 1971 the Rhode Island General Assembly passed an act creating the Coastal Resources Management Council (CRMC) and granted it broad powers. The broad basis upon which the CRMC is charged to make management decisions is set forth in the 1971 Act (46-23-1, G.L.R.I.) as follows:

... to preserve, protect, develop and where possible restore the coastal resources of the state for this and succeeding generations through comprehensive and coordinated long range planning and management designed to produce the maximum benefit for society ...

The CRMC has jurisdiction over all resources and activities below mean high water and over all shoreline features including salt marshes. The CRMC operates through the granting of permits for activities within its area of jurisdiction.

The great majority of the research and data analysis necessary for development of CRMC policies and regulations for specific resources and activities is undertaken by the Coastal Resources Center at the URI Graduate School of Oceanography. Early in the planning process it became apparent that it would be useful to undertake a special project on salt marsh management. A detailed inventory of the state's salt marshes was needed and, since comprehensive resource management requires trade-off decisions, we felt we should investigate the feasibility of developing a relatively simple and pragmatic method for rating the relative values of individual salt marshes.

Rhode Island law predating the state's Coastal Management Act states that no salt marsh shall be altered without a permit and in the past requests for filling have not been granted. In some cases, however, the benefits of altering or even destroying some salt marsh might outweigh the losses. If funds were available to the state to purchase tracts of marsh, which should be selected and on what basis? Should

all salt marshes receive equal protection or do factors such as size, location or vegetation productivity make some more valuable than others? This question is frequently asked by marina owners who wish to expand their facilities and often could only do so at the cost of filling areas of salt marsh. It was felt that a rating method would be useful only if it could be used by state biologists utilizing unsophisticated methods and not involving undue amounts of time. The Center's salt marsh project was therefore designed to include three principal parts:

- 1) An inventory of all the state's salt marshes including those of less than 5 acres and all fringe marshes.
- 2) An investigation into the feasibility of rating the relative values of individual marshes.
- 3) A legal study designed to emphasize the taking issues and the problem of equal protection.

The project got underway in 1974 through funds provided in part by a planning grant from NOAA under the provisions of the federal Coastal Zone Management Act of 1972. The final results of this work are approaching completion and should be available within the next several months.

The Inventory

Relatively sophisticated techniques including the use of aerial infrared photography have been used successfully to map vegetation. Funding constraints, the small size of Rhode Island and the availability of recent black and white aerial photographs persuaded us, however, to rely on existing data sources and extensive field checking. The inventory was undertaken by Dr. William Halvorsen (URI Dept. of Botany) and William Gardiner. They prepared base maps utilizing 1:24,000 maps of land use and vegetation cover (MacConnell, 1974) drawn from 1970 black and white aerial photographs of the entire state taken at a uniform scale of 1:12,000. Also noted were salt marshes identified in a number of other studies undertaken in recent years. The entire shoreline of

the state was then covered on foot or observed from a small boat.

According to Rhode Island law, salt marshes are defined as any land bordering or beneath tidal waters upon which grow one or more of the following plant species: salt marsh grass (*Spartina alterniflora*); salt marsh meadow grass (*Spartina patens*); spike grass (*Distichlis spicata*); black rush (*Juncus gerardi*); saltworts (*Salicornia spp.*); seaside lavender (*Limonium carolinanum*). Salt marshes identified in this inventory were mapped on the basis of this definition. Numerous areas of salt marsh that had not appeared in previous surveys were found, as were mistakes in the presence or size of identified marshes.

When, upon visual inspection, previously unidentified salt marsh was found, or the base map deviated from what was observed, direct measurements were taken. Black and white aerials taken in 1974 were then examined stereoscopically in the lab to determine the precise outline of the marsh. If the boundaries of the marsh were not traceable from the photographs additional field measurements were sometimes undertaken. Only "fringe marsh", defined as a band of marsh vegetation 5 meters or less in width, was noted merely as present or absent. The acreage of fringe marsh was calculated using a mean width of 2.5 meters.

The results of this survey were transferred onto shoreline maps drawn to a scale of 1:12,000. A total of 76 miles of fringe marsh was identified (18.2 percent of the entire R.I. shoreline) and a grand total of 3,658 acres of salt marsh were mapped. A comparison with other surveys shows the following:

1955	2,315 acres	includes only marshes greater than 40 acres
1959	2,244 acres	
1964	2,192 acres	
1962	4,238 acres	includes marshes greater than approximately 5 acres
1974	3,243 acres	
1976	3,658 acres	all marsh including fringe marsh

Early surveys of large salt marshes showed a reduction in acreage over time. The trend in later studies is less clear. The work accomplished by Halvorsen and Gardiner, however, will provide a clear baseline from which further changes may be monitored.

Marsh Rating

This phase of the project was undertaken by Dr. Candace Oviatt and Dr. Scott Nixon of the URI Graduate School of Oceanography. It was decided that the following four criterion would be evaluated in ten salt marshes: storm buffer, net harvest production, nursery for larval fish and wildlife habitat. A criteria that could be termed "aesthetic value" which is known to be important, but for which no useful and straightforward technique of measurement could be devised, was not included. The ten marshes selected for two years of intensive study range in size from 1.2 to 130 acres, include marshes in all parts of the state, and marshes which intuitively cover the broadest range in "apparent value." Five are washed by eutrophic waters, some have been part-

ly filled, some have had their natural water circulation patterns artificially altered. A total of 24 parameters were measured in each marsh including net harvest productivity (height, density, gdw/m², seed production), and the abundance, diversity and distribution of crabs, shrimp, fish, birds and insects.

Preliminary analysis of the results of this work indicates that the marshes studied cannot be assembled into groups of more or less value if all the parameters are rated and no parameter is judged to be more important than others. If each parameter is rated 1-10 and composite ranks are calculated for each marsh, the result is six marshes with a composite rank of five and four with a composite rank of six. A multivariate statistical rating designed to graphically display similar and non-similar marshes gives similar results. Measurements designed to evaluate the value of individual marshes as a storm buffer show that their ability to absorb storm waters is determined by their size and the average tidal range. All marshes in Rhode Island are covered at high tide by the equivalent of 1/5 the water volume of Narragansett Bay. Marshes do not, however, act as giant sponges to absorb flood waters. Furthermore, salt marshes are usually found in quiet protected areas and they appear to have little ability to act as storm wave buffers. In high energy areas salt marshes are prone to rapid erosion.

Preliminary examination of the results of these studies, however, do appear to show that urban marshes in the upper Narragansett Bay have more productive vegetation (see also Nixon and Oviatt, 1973). This is probably due to the higher tidal ranges and enriched (polluted) waters. Fish larvae appear to be as abundant in urban as non-urban marshes and species diversity is also similar.

This work indicates, therefore, that no simple method for rating the value of individual salt marshes can be devised if all the parameters studied are given equal weights in the rating process. We do not feel that our understanding of the values of salt marshes is at this time sufficiently complete to confidently apply different weighting factors to the parameters measured.

Legal Studies

Only a preliminary review has been completed to date. It is apparent, however, that if any system is devised to place salt marshes into one or more categories of "value" and manage them according to their standing in this system, severe legal problems will arise unless the reasonableness of the classification system can be clearly demonstrated. Such a system, unless fully substantiated in fact and clearly relating to the providing for the protection of salt marshes, could open a Pandora's box of problems for those charged to manage this resource.

Summary

As previously stated the final results of this work will be available within the next several months. This project will provide Rhode Island with baseline data on its salt marsh

resources and will probably lead the CRMC to continue to provide all salt marshes, large or small, attractive and unattractive, equal protection against the inroads of filling and other human activities that may damage this valuable resource.

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Conflicts Between Research and Recreation Wetlands

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Introduction

Most of the conflicts between the desires of research scientists and the general public in search of recreation in wetland areas are probably of minor importance compared with conflicts that may arise from applications of wetlands for public purposes that may be suggested by research results. It is also likely that the greatest conflicts between scientists and the public will not arise in urban areas but in less changed wetlands away from population centers. I believe research is badly needed in coastal ecology. This can be seen as a self-serving statement from a scientist, but I believe our major handicap in managing recreational resources along the coast is our abysmal lack of understanding of how nature works. Consider some controversies on land: the wisdom of clear-cutting as a way of managing our national forests, predator control on federally owned rangelands, the value of biological versus chemical pest control in agriculture. We lack enough knowledge to settle these issues with what seems reasonable certainty to all those involved in the conflicts. But here we are talking about the land, where we live, where we have been able to see how nature works most easily and where we have thousands of years of recorded observations to work with.

Although the edge of the sea is the most accessible part of the ocean, we lack all but a rudimentary knowledge of its ecological relationships. We don't have a long background of observations on how the animals and plants live. It is simply hard to see what is going on. R. T. Keck pointed out how difficult it is to see in muddy waters even with SCUBA. My favorite coastal environment, salt marsh, is out of water over half the time, but even there you must not mind getting your trousers wet if you are to watch the animals' behavior.

But in order to understand how to manage coastal ecosystems in urban areas we must know how human activities affect these systems. I write mainly from the viewpoint of basic science—understanding how nature works rather than how to manage a resource, although the two merge into

each other and share most interests and concerns to at least some degree. I believe there are two kinds of area treatments required for research: 'pristine' areas and areas that can be modified in controlled ways.

Pristine Areas

Pristine areas are wetlands which have not been greatly altered from the form they reached through natural evolution (outside of the influences of men). I presume in saying this that human influences, disturbances and pollution, will generally work to degrade the wetland systems. The idea of preserving wetlands in as natural a state as possible is to preserve all of the species and interactions between species that have evolved together in the wetlands. These areas can then serve as controls from which to measure the degree of change caused by human activity. If we lack these undisturbed systems we can never hope to understand completely the way systems react to disturbance.

Another purpose of the pristine areas is to preserve natural genetic variation. Modified environments often select a restricted set of genotypes and allow others to become extinct locally. McHugh said polluted areas may serve as a valuable reserve for spawning shellfish. I don't quarrel with this but do point out that it is possible that these shellfish are selected for pollution resistance which may not be the same thing as, for example, best growth rate or taste. If there are no undisturbed environments of a particular type, the genotypes selected against in the modified systems may become extinct absolutely.

Although these arguments for preservation of pristine systems are logically convincing there are no examples known to me of a case in which such preservation did serve as we might expect it to. There are abundant examples of pest control in which an insect predator was imported from the natural range of an accidentally introduced plant pest. If the predator had been exterminated from its original range

before importation, then the biological control would have been impossible. But as far as I know there are no cases in which the introduction *required* a pristine natural area in which to locate the predatory insect.

P. A. Buckley argues that areas undisturbed during the nesting season are essential for preservation of shorebirds, gulls, terns, etc., but also showed that the birds have certain flexibility and often find very local areas sufficiently undisturbed for their purposes. Perhaps all this means is that there are still sufficient numbers of reasonably well preserved systems so that we have not yet encountered any trouble from the lack of preservation of them, or it may mean we have been unable to recognize our loss when it has occurred.

I would argue that, in spite of lack of solid examples of its usefulness, preservation of complete and unmodified natural areas is highly desirable. Furthermore, when considering wetlands, I would suggest that it is necessary to preserve the associated ecosystems in as pristine a state as possible because of the high degree of interaction between coastal ecosystems. This means preserving the protecting dunes and barrier islands, the associated estuaries, and the upland drainage area for these systems. Obviously complete preservation of such associated ecosystems is not possible in our part of the world. There is fallout of pollutant lead, hydrocarbons, etc., from the atmosphere all over the earth. But, if absolutely unmodified systems are not available for preservation, relatively unchanged ones are. Their preservation will inevitably lead to conflict with recreational uses.

Controlled Modification

The other general class of wetland use desired by scientists is controlled modification for experimental purposes. The desirability of experimenting with entire ecosystems is great. There are many results of changes in ecosystems that can simply not be predicted from present knowledge of how the parts of even the simplest systems are put together. Experimental approach is also an efficient way to examine the results of complex interactions. Experiments with ecosystems are difficult because of the complexity of the system, but in the case of coastal wetlands the systems are sufficiently bounded that we can hope to study them. Perhaps the results can then be extended to other ecosystems where experiments would be even more difficult. Therefore, it is especially important that there be good control of the experiment. Disturbance by fishermen, bird watchers or sunbathers and swimmers will make the interpretation of the experimental results more difficult.

Some types of experiments are designed to stress the ecosystem with high temperatures or pollutants. The purpose of the test is to change the system in order to study its response. Or an experiment might be designed to study the role of a wetland in the existence of viruses, for example, to see how a wetland might influence the survival of disease-causing viruses from sewage contamination. The wetland itself would not necessarily be damaged but its use by humans as a food source definitely would be temporarily restricted.

As another example, I would suggest that controlled oil spills on marshes would be useful. We know oil kills organisms but have little understanding of the effects of low levels of oil or how recovery occurs, especially at the level of the ecosystem.

I would attempt to summarize the desires of research scientists as 1) the preservation of some wetlands with their supporting ecosystems in as natural a state as can be achieved for comparative purposes and as sources of wetland organisms and genetic variation, and 2) the ability to use other wetlands for experiments, i.e., to modify them including modifications that degrade wetlands temporarily.

Wetlands Recreation and Conflicts

The desires of people who want to use wetlands for recreational purposes vary according to the type of recreation envisioned. Recreation is constrained by weather, accessibility, etc., but for my purpose I will assume the desire is for the maximum possible use consistent with the preservation of those aspects of the wetland which attract people in the first place. In the case of fishing that would mean the preservation of the high levels of wetland and estuarine production as well as the open water and channels where the actual fishing is done. For water skiing only the preservation of the open water would be necessary, although a careful analysis would probably indicate that preservation of marshes as sediment traps would be an essential aspect of maintaining open water suitable for skiing in many areas. For aesthetic appreciation of salt marshes, bird watching and educational uses, boardwalks properly designed can provide recreational use with very little impact of any sort.

The conflicts between desires of research scientists and users or managers of recreation areas are obvious. Perhaps the maximum conflict would arise in the "pristine areas." If there is really to be a complete protection for all of the co-evolved interactions within the natural ecosystem, then very little human use of the system can be permitted. An extreme case would be the preservation of the wetland system for the use of only those scientists using it as a control for their study of other wetlands. A less extreme position might still ask for a minimum of harvesting of natural resources, a minimum of disturbance by visitors, and would certainly want to achieve as close to total lack of pollution as possible. The ultimate position would exclude even the scientist and preserve the system for its role as a natural reservoir of organisms. It is not hard to see that the preservation of any very large special areas for a privileged group of researchers (and visiting controllers of funds or colleagues) would not go over very well with anyone else.

Conflicts in other wetland study areas should be fewer, ordinarily, but would involve some restriction on the ability of the public to do just what they want. In almost any sort of study involving manipulation of a wetland ecosystem the researcher would want, if not to restrict the actions of the public, at least to know what those actions were and to quantify them. For example, for a study we are considering

to try to increase production within a marsh system we would need to know how many and what kinds of fish people were catching and removing from the system.

A more severe conflict would be involved with the more drastic sorts of manipulative experiments. A study of the ability of wetlands to serve as a sewage treatment system would certainly necessitate controlled access by the public. If, in an effort to study their fate in such an ecosystem, the sewage contained human pathogens, then access would have to be even more carefully controlled. The latter situation certainly would bring on objections from the people who felt threatened directly by the experiment as far as their personal health was concerned. If the experiment was run in a manner, e.g., with artificial or with sterilized sewage, so that no disease problem existed, people probably would object on aesthetic grounds, for fear that changes would be objectionable in some way, or just because the management involved would restrict their freedom.

Summary

I strongly feel it is desirable to experiment with natural eco-

systems to find out how these complicated collections of organisms and environments function. For such experiments to be adequately interpreted we must have good control systems. There are also good arguments for conserving what I have called pristine systems to preserve all aspects of the wetland system, including those of whose existence we may not even be aware at the present. Conflicts between research and recreation-bent people will occur. But they will be temporary in most cases with the public ultimately benefitting from knowledge that leads to better wetlands management. For "completely preserved" areas the conflicts will be permanent, but these areas will, by their nature, not be found in urban areas.

Carls, in this symposium, said, "The mystery associated with the sea will always be one of its attractions." Scientists are attracted by the opportunity to try and explain those mysteries and through explanations, eventually they will enable people to increase both their wonder about and access to the coastal wetlands in our increasingly urbanized environment.

Law and Coastal Recreation: Land Use Management and Conflict Resolution

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Introduction

Among the species of the coastal environment, it is *homo sapien* alone that develops and muses over formal rules defining rights and interests in that environment and its uses. Not surprisingly, our use of law serves disparate interests and needs and both manages and mismanages our use of lands, waters and resources. These brief remarks address both dimensions of the legal experience for it is useful to consider present efforts to utilize law to assure sound management only in light of how law has served in the past as a means of management and mismanagement of coastal land use.

The nominal topic of my conference contribution is the legal dimension of conflict in coastal wetlands management and use. Close examination of the conference program revealed to me, however, that my presentation is distinctive in being the only one clearly identified as "legal." That fact encourages me to range more broadly, to be somewhat unlawyerly by venturing beyond both topical and physical boundaries of coastal wetlands. Nevertheless, neither my range nor my ranging is boundless; the content of my remarks remains legal and their context is coastal and recreational.

The Traditional Role of Law

Historically, the law's most significant role has been to facilitate coastal land, water and resource allocation in accordance with market-determined use priorities. The concepts of private ownership and free alienation of interests in property impose threshold demands of certainty in the definition of both the physical boundaries and the rights of ownership.

With respect to boundaries, naturally-defined limits such as low and high water marks have been conveniently, but arbitrarily, employed together with inland line-drawing tied to natural and artificial markers to produce the necessary certainty. As to ownership rights, early nineteenth century indications from the courts show substantial public interest

in and power to control private land use gave way in late nineteenth and early twentieth century judicial decisions which bridled at the restrictive effects of such principles in an era of both *laissez-faire* and urbanization.

The fact remains, however, that legal limitation of purely market forces has at no time been totally absent. Public regulation or prohibition of uses with injurious effects to public health or safety have always been legally permissible under nuisance-oriented conceptions of the general police power. And more comprehensive and systematic public regulation through exercise of the police power to protect the general public welfare was approved by the Supreme Court when it sustained zoning regulation as a legitimate means for coping with the pervasive and sharp conflicts attendant to land use in an urbanizing society.¹ Neither form of public regulation, however, purports to establish significant legal impediments to the otherwise legally-reinforced market allocation system; nuisance-oriented regulation establishes only minimal outer limits on the private use and marketability of land; zoning serves primarily to minimize use conflicts that would otherwise need to be dealt with in nuisance-oriented regulation and thereby legally assures a greater degree of certainty as to use rights and rationality in actual use. Both assume the fact that development will occur and that such development will be defined, subject to relatively marginal legal limitations, by market forces and economic self-interest.

This background on the historical functions of law is, of course, particularly relevant with respect to coastal wetlands and other coastal lands. Hand-in-hand, the law and market forces have functioned with respect to the physically scarce—and increasingly market scarce—supply of coastal land to promote development of developable lands and conversion of nondevelopable into developable lands. Recreation as a use has been valued in this process in primarily consumptive, private, short-range and site-specific terms with little

or no regard for either external and long-range environmental or social effects, the latter generally being undervalued or undervalued by the private market mechanism.²

The Capacity and Emerging Role of Law

In recent years, and particularly in the last decade and a half, expressed public concerns of both an environmental and a social-economic character have stimulated interest in legal action counter-balancing the legally-facilitated private market allocation of coastal lands, waters and resources. Stagnant common law principles and public constitutional and statutory law have all been employed, together with new legislative measures, to assert and implement previously disregarded public interests in the management and utilization of coastal wetland and shoreland areas. As might be expected, such efforts following upon longstanding quiescence have often generated strong and highly emotional resistance as well as pitched legal battles.

Against the background of prior legal history, the courts have addressed the legal issues posed by the active assertion of public rights and interests in coastal lands and, quite predictably—at least to a lawyer, uncertainly reasoned to what often seem to be confusingly different results. In my remaining remarks, my focus will be upon the active use of law in coastal lands management and directions taken by the courts in response to the new activism.

Public and Private Property Rights and Interests: It has been long recognized in the law that coastal waters, together with the lands beneath and the resources within them, are in the public domain and held in trust by the states for the benefit of the public.³ Such ownership vests the respective states with management powers and, according to some court decisions, imposes both limitations on the sale or other disposition of these resources⁴ and affirmative responsibilities to preserve and conserve them.⁵ The latter, in particular, may be of major significance with respect to wetlands and other resource protection laws and their validity, a matter explored, *infra*.

The near-shore transition from public to private domain varies from one state to another. Massachusetts is among the few states in which private ownership extends seaward of high water, the boundary being the closer of the line of low water or one hundred rods from high water. Such private ownership is subject to reserved public navigation, fishing and fowling rights and the use of both the waters and the shoreland in connection therewith, and private wharf construction or other occupying uses are not permissible without obtaining a license.⁶ On the other hand, public uses other than the enumerated trio are not permissible in the private shore unless secured by consent or longstanding prescriptive use by the public.⁷

In most other states, the public domain and use rights extend for all purposes to the mean high water line and are excludable only by permitted wharf construction or other occupancy of the area by the littoral owner. Recent court

decisions in Oregon and Texas establish or confirm, however, public rights to beach and shore areas extending landward to the natural line of vegetation.⁸ Public recreation and shore access rights and opportunities in these states are thus generally guaranteed rather than subject to public agency supply of areas maintained and acquired for that purpose.

The public interest in, and authority to regulate the use of, privately-owned shorelands is, however, substantial. Early Massachusetts court decisions indicate that both near-shore and on-shore private lands may be subject to a greater degree of regulation in their use because of their physical proximity and relationship to the public domain.⁹ The statute sustained in one of the cases prohibited littoral owners from removing sand and gravel, trees, shrubs or vegetation and was upheld with acknowledgement that “protection and preservation of beaches, in situations where they form the natural embankment to public ports and harbors, and navigable streams, is obviously of great public importance.”¹⁰ In reaching its decision, the court noted that the owner’s violation of the statute had resulted in severe wind and water erosion.

That statute is presently codified as Chapter 91, Sections 30 and 30A which specify as their purpose the protection of harbors and navigation. The statute has little reported history of being enforced, however, and destruction and construction in dune and other areas to which the statute specifically speaks seems to attest to the law’s nonuse. Its usability may, of course, be limited in light of its focus on harbors and navigation, but here it becomes important to note that the coastal wetlands statute administered by local conservation commissions, or other appropriate local agencies, extends its special permit requirements beyond wetlands to beaches, banks and dunes and is founded on the protection of, among other things, marine and shellfisheries¹¹ which are, together with navigation, among the ancient protected rights of the public in coastal waters.¹²

Public Use Rights in Public Shore Lands: It is axiomatic that publicly-owned beach and other shorelands are subject to public control or regulation of their use. Reasonable restrictions are essential to manage conflicts among competing interests in the use of these lands and their resources, including restrictions that prevent environmentally unsound or destructive misuse or overuse. Typical measures pertain to public health and safety, pollution, off-road vehicles, fisheries and shell fisheries management, and intensity or manner of use.

Some such regulations, however, have recently come under intensive attack. These control measures are those which restrict or prohibit nonresident access to, or use of, municipally-owned and managed public beaches. Here again, conflict between the interests of the general and the local public is strong, a mirror image of the public—often local public—and the private interests in the use of beach and shore front of privately-owned upland. Several courts, on various grounds, have struck down such restrictions in recent

years¹³ and the conflict promises to ripen into legal disputes with greater frequency and closer to home in the coming years.

It is, of course, a short-sighted solution to merely force open local public beaches to all members of the public without instituting and enforcing environmentally sound intensity and manner of use measures such as those which have been established for Massachusetts state-owned beaches and the beaches of the several national seashore areas.¹⁴ Similarly, transportation and traffic problems, perhaps using perimeter parking and shuttle service, must be central factors in considering issues of access unless we are to totally sacrifice local safety and convenience and the historical and cultural character and amenities of coastal communities to a singular view of the general public right and interest.¹⁵ Recreational as well as residential or other traditional development uses may, of course, be environmentally unsound, if not properly controlled.

Public Regulation of Private Development: Returning to the matter of the public interest in and regulation of private wetlands and other coastal lands management and use, one commonly finds the focus there is on wetlands development control. More particularly, the issue is no longer whether sufficient statutory authorities exist for the protection and conservation of these and other coastal lands, but is whether or not the imposition of such regulatory controls is so restrictive of identifiable private rights attendant to ownership that the effect of the regulation is to deprive the owner of all practical use of the land. If so, of course, the regulation constitutes an indirect and constitutionally impermissible taking or condemnation of the land if the owner is not paid compensation for the deprivation of use.

The significance of the "taking" issue cannot be overemphasized in light of the realities of wetlands, shorelands, dunes and other fragile and critical natural areas needing protection regulation. Simply stated, the competing interests are such that realization of the private economic value necessitates alteration of the land which destroys the values the public wants protected by regulation while on the other hand, realization of the latter values severely limits or destroys the private economic value of the land.

While the significance of the "taking" issue cannot be overemphasized, the issue undoubtedly has been overanalyzed. Thus, the comments that follow are impressions or reflections on, rather than a close analysis of, the topic. The effort is to suggest where the courts have been in both the distant and more recent past and, more adventurously, to speculate about where they are going and what the significance is of the trend that I perceive for recreation in the coastal region.

The mid- and late-nineteenth century court decisions found little difficulty in sustaining severe regulation of private lands and their uses, particularly where the uses threatened injury to public property rights or interests.¹⁶ Then came *Pennsylvania Coal Co. v. Mahon*¹⁷ and Mr. Justice

Holmes's announcement of a new test for whether a regulation is so severe as to constitute a "taking." The standard announced was, in effect, a benefit-cost or balancing test limited by the requirement that the regulation in no case may deprive the owner of all reasonable use of the land. In the zoning-oriented years that followed, application of that standard in the development-oriented, conflict-resolving context of zoning restrictions took on the meaning that no regulation that substantially deprived an owner of the reasonable use of land could be sustained. Yet, where necessary in the early 1960s, the Supreme Court itself merely paid lip service to *Pennsylvania Coal* and relied upon its earlier case law to sustain a prohibition against use of an owner's land for the only purpose to which it was reasonably suited.¹⁸

Also in the early 1960s, the state courts first faced the "taking" issue in the context of severely restrictive flood plain and wetlands regulations statutes. These early cases adopted the analog of zoning regulation and, despite recognizing the legitimate purposes of such regulations, struck down or tended to view such regulations as takings of private property without compensation.¹⁹

More recently, a strong trend toward sustaining strict wetlands and similar regulatory restrictions has begun to develop. In both Wisconsin and New Hampshire, it has been declared that ownership rights do not include an inherent right to alter and convert property from its natural state and use capacity into land usable for residential, commercial or industrial site development.²⁰ These cases rest on the conclusion that such uses may be permitted, but may also be prohibited if they would cause injury to public rights to the regulated land.

In another significant recent case, the Connecticut Supreme Court side-stepped its own early 1960s decision limiting regulation and revived a prior decision more favorable to wetlands and flood plain regulation.²¹ Somewhat more cautiously than either the Wisconsin or New Hampshire court, the Connecticut court made protection of resources in which public rights and interests existed a central consideration in sustaining the regulation. Similarly, the Massachusetts Supreme Judicial Court in *Turnpike Realty Co. v. Dedham* sustained a severe flood plain zoning restriction, emphasizing the protection afforded the property of others—which could presumably include public property—and the public interest in avoiding public works and disaster relief expenditures connected with flooding. The Massachusetts court, as did the Connecticut court, distinguished the earlier Connecticut and similar cases which it, too had previously viewed with favor.

Each of the cases in the recent line of judicial decisions expressly recognizes, in *Pennsylvania Coal Co. v. Mahon* terms, that recreational, educational and scientific uses of privately-owned lands subject to development restrictions are residual reasonable uses that save the regulatory restriction from attack even under the *Pennsylvania Coal* test. This,

itself, may encourage an affirmative search for opportunities to realize economic benefit from such uses although even such uses are, under the applicable statutes, subject to regulation consistent with the protective purposes of the statutes. More significant, of course, is that the cases afford the means for protection and conservation of wetlands and their dependent sport and commercial fisheries and shellfisheries and for preservation of beaches, banks and dunes against destruction caused directly or indirectly by their alteration. The importance of this cannot be missed by the participants at this conference who well appreciate the positive results of these developments for coastal recreation as well as the natural environment.

This, I reemphasize, is what I perceive as an emerging trend. It is by no means a certain, definitive or unchallenged view. In the final analysis, it is an optimistic view that is at once better grounded than to be mere wishful speculation and guardedly hedged by the realization that a judicial change in direction would not be unprecedented.

Conclusions

Broad ruminations are not really grist for analytical conclusions. Perhaps what remains and ought to be said is that the magisterial powers of the law can undo and restore the status quo ante in some of man's transactions, but it is largely powerless to undo the damage and destruction that has been already visited upon coastal lands. Likewise, it is primarily money rather than the authority of the law which can accomplish the expansion of the supply of coastal areas open to public recreational and other uses; even restrictive regulations of the use of private lands cannot impose the obligation of opening such lands to public use. Thus, there is much to which the law and lawyers do not and cannot speak even through formal legislation. The law can help, but it does protect the rights of individuals even against a majority of the people and demands at some point that the people as a whole rather than individuals bear the costs of the benefits the people seek to secure.

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Impact of Boating on Shoreline

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Abstract

The increase in recreational boating activity and facility construction in recent years has raised questions concerning observed and potential congestion in coastal zone waters; possible impact on estuarine resources; and the needs of the growing boating public for improved access and activity opportunities.

A methodology for the identification of recreational boating carrying capacities in the tributaries and sub-tributaries of Chesapeake and Chincoteague Bays has been developed under Maryland's coastal zone management program. Since boating satisfactions and safety depend to a large extent on boating behavior, experience, and recreational activity preferences, boating capacities cannot be related rigidly to water body physical parameters alone. On the other hand, in the absence of better tools, computed capacities can help states determine the desirability of issuing or, denying additional permits for new marina construction within or adjacent to congested waters.

The careful exercise of state powers relating to boating activity, as distinct from the processing of marina construction permits, can also improve net boating satisfactions to the boating public, through educational, regulatory, and enforcement measures. Such measures must work to distribute trailer boat access demand and general boating demand evenly among water bodies with reserve capacity and discourage over-use where capacities are apparently exceeded.

Among the findings of the study prepared by Roy Mann Associates for the Maryland Department of Natural Resources in 1975-1976 were the following:

Localized overcrowding or congestion is a serious concern in a number of sub-bay units of the tidal waters of Maryland. Congestion appears to be primarily a function of accessibility to the water and the physical characteristics of tributary water bodies. Most instances of congestion occur in proximity to large concentrations of boating facilities in nar-

row waterways or inlets, at tributary mouths, or in small embayments, where activity on the water surface is constricted by shoreline configuration and water depth.

The rate of accident occurrence does not appear to have risen over the years, although the number of boats using the tidal waters has increased steadily from 77,368 registered boats in 1965 to 113,748 in 1974.

The demand for boating facilities appears to be outstripping supply by a significant degree. Principal shortages, primarily of launching ramps, appear to exist in proximity to the major metropolitan regions, i.e., Baltimore and Washington. In order to satisfy unmet demand, increased facility programming will be needed in both the public and private sectors.

Boating facilities often impinge on sensitive shoreline resources. Boating activity itself may in certain cases exacerbate shoreline erosion, increase turbidity levels in shallow areas with soft bottoms, and degrade water quality through the discharge of wastes in poorly flushed water bodies where high levels of activity occur. Further field research appears needed to ascertain the existence and extent of these and other effects in Chesapeake and Chincoteague Bays.

A strengthening of Maryland Department of Natural Resources capabilities for dealing with boating activity and facility development will be essential if the growing demand for boating and its consequences for user satisfaction and environmental and social impact are to be adequately faced. Strengthening of capabilities would incorporate increasing staff and operational budget in the several divisions of the Department that deal with boating facilities and management; the augmentation of the present capital improvement program budget for launching ramps; and increased coordinative functions between the Energy and Coastal Zone Administration, other Departmental divisions, and county and local construction programs.

Shoreline Conflicts in Coastal Recreation

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Introduction

Initially I would like to address two questions, what are our Coastal Resources and why is there conflict over the uses of these resources?

Our "Coastal Resources" whether they're recreational or industrial resources are essentially cultural constructs emerging from the interaction of human wants and capabilities with the natural environment. Obviously, changing economic, social and technological circumstances force us to redefine our "Coastal Resources." For example, not too long ago wetlands were considered useful only as a dumping site for trash, old cars, tires, etc. Now they are considered a valuable coastal resource due to scientific studies and increasing environmental interest.

In today's rapidly advancing world it is often difficult for managers and planners to keep pace with changing circumstances. As a result extreme conflicts have arisen and often gotten out of hand before equitable solutions could be found. Unfortunately projects in the best long-term interest of the public have often been lost in the confrontation—such has been the fate of many recreation areas.

Our coastal shoreline totals some 100,000 miles and seventy-five percent of our population is concentrated along it. As the coastal population of the U.S. continues to swell, the pressures for access to and use of the shoreline increase proportionally. Obviously the amount of available shoreline decreases constantly and competition for shoreline space becomes intense. The participants in this competition are many and varied: heavy industry, commerce, transportation, public and private recreation, waste disposal, mining, conservation. All vie for a place on the waterfront.

Their needs are many and often contradictory. An industry may seek a coastal location to conveniently dispose of its wastes, a home owner to provide an attractive private vista, an individual to find clean water for bathing or boating. The competition can be healthy if it forces planners to recog-

nize and carefully evaluate the alternatives for a given site. It is undesirable, however, if it unnecessarily reduces the number of activities which a coastal area can support.

Impending Conflict

In Rhode Island, we are faced with an impending conflict over the use of the abandoned naval lands along our coast. A rather comprehensive study of the feasibility of using some of these lands for a Bay Island Park System was conducted by the Coastal Resources Center. In this study the South end of Prudence Island, one of the larger islands in Narragansett Bay, was designated as the major recreational area and central receiving area for the water accessible portions of the park. Picnic and camp sites, hiking trails, walking and bicycle paths, scenic overlooks and fishing access points were to be provided. The total cost would be \$125,000. However, other studies have recommended that an oil storage facility and terminal be constructed on the south end of Prudence Island.

At first glance, it would appear that the two uses of the area (recreation, oil storage) would be incompatible. Perhaps they are not. But, to make matters more difficult, members of the Governor's OCS Task Force decided that the south end of Prudence Island may be the only site in the state which would be suitable for a concrete platform fabrication yard due to the deep water immediately off its shore and the fact that it is sheltered. If Georges Bank offshore oil becomes a reality, and gravity platforms are the wave of the future, the state certainly doesn't want to close the option of attracting the Concrete Platform fabrication industry. Obviously it is difficult to predict technology trends but they happen so quickly that the planner is often caught unaware. However, he or she would rather be one *step ahead* than behind.

The decision-makers are faced with a difficult task. How to compare recreational uses to industrial uses of the area.

They must also consider setting aside the area for some future use not yet clearly defined. Obviously the state needs economic growth. According to the Council on Environmental Quality if development were concentrated on Georges Bank there would be up to 80,000 new jobs in Rhode Island and Massachusetts in 10 years. It should be noted that this influx will cause a burden on recreational areas. The Industrial Development alternative would mean increased revenue. A park system would not bring in high revenues. How can a Bay Island Park System compete on the free market?

Ownership and hence distribution of land is determined by who can and will pay the most for it. The market distribution system prejudices itself in favor of high return uses and it does not necessarily encourage the successful competitor to modify his activities to accommodate other uses. For example, there is no economic incentive for an industry to bury its storage tanks in order to provide a recreation area. How do you place a value on public recreation? The return is so diffuse and largely non-monetary. It is also very difficult to even measure the spinoff monetary returns to the economy from a given recreational facility (i.e., restaurants, souvenir shops). Many people have tried to place a monetary value on natural areas based on a correlation of natural energy flow with the dollar value of producing energy. But how do you measure the value of preserving a way of life? We must recognize that like a famous painting, the uniqueness and quality of a given recreational area may be worth more than simply its physical components.

Bay Islands Park

The advisory Committee on the Bay Islands Park stated that: "The Bay Islands Park proposal provides a rare, one-

time opportunity to help guarantee for future generations of Rhode Islanders the excellent quality of life still available in our state and if for any reason the state earmarks the bay islands primarily for industrial use, it will be casting aside forever the only major opportunity of this magnitude to demonstrate in a tangible way that the quality of life in this state is its greatest natural resource."

The question we should ask is: how important are new recreation areas to the state or for that matter New England? On any given warm sunny day in July you will find the public beaches near metropolitan centers jam-packed, but beaches in rural areas will be almost vacant. There is obviously a spatial imbalance in the availability of opportunities and facilities for recreation in New England. Inevitably this leads to pressures on the carrying capacity of the site where the demand is excessive. Competition and conflict over the recreation space follows, along with the probability of deterioration in the character and quality of the resource base. A fine example of this is the degradation of many of our sandy barrier beaches because too many people have trampled the dune grasses which maintained the barrier beaches.

The need is not for additional recreational areas per se but rather for a redistribution of recreational areas. Let us hold on to some of those natural recreational areas which are located near urban centers and not let them fall prey to a cruel market system. Yet let us be sure that we carefully evaluate the possibility for multiple land use. A well hidden oil storage facility on the south end of Prudence Island may be quite compatible with a park. With planning, recreational and industrial uses can often be compatible. Isn't it about time that industrial parks truly became parks?

Recreational Impact on Shorelines

Research and Management

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Introduction

Recreational use of shorelines affects much more than just the beach. The shoreline zone includes beaches, dunes, interdune depressions, tidal flats, glacial marine scarps, salt marshes, and all other environments found along the coast. The approaches taken to research and manage the shoreline zone must deal with the entire system, not just the parts which make up the whole. The various subunits of a shoreline system are interrelated and what affects one part can ultimately affect all others. Recreational use of the shorelines results in impacts on all the basic parts, in one way or another. While most people heading for the beach spend most of their time near the water, the fact that they have access to the beach implies an impact has been made on some part of the coastal system.

Modern use of shorelines falls into three basic categories: people on foot; people in or on some mode of terrestrial transport vehicle, such as motor bikes, pedal bikes, or horses; and people swimming. The recreational impact on shoreline resources varies with both the type of recreation and the system being affected. Each natural system has its own level of tolerance to the types of impacts being applied, and researchers must determine the level of sensitivity of each area, how the systems recover, and how management might alleviate the impact.

Much has been said and written about "fragile dune and marsh systems." But an important question revolves around what "fragile" means. Coastal ecosystems are in fact well adapted to the severe environmental forces which eliminate many species of plants and animals that are found inland. These organisms are hardy, able to withstand great extremes of temperature, salinity, drought, burial by moving sand, waves, and flooding. The ecosystems made up of these organisms have developed adaptations which allow them to survive continual change. They are fragile, but only in the sense that the new stresses being applied by modern, mobile

man, are too severe. These systems have not adapted to human stresses, and thus are subject to breakdown when such stress becomes too great.

The greatest difficulties with recreation use come in those lands, such as the National Parks, where two goals are sought: the use of the resources for recreational, aesthetic and educational purposes; and at the same time, preservation of the very resources that people want to use. This basic conflict becomes increasingly difficult to resolve as more and more people flock to the coasts.

Main Thesis

The major point of this presentation is that the increasing use of coastal shoreline resources requires implementation of management procedures which prevent deterioration of the resources. We cannot allow heavy use of the shores and still retain natural conditions. Some effort must be made to channel and control the impacts. Shoreline resources can be easily damaged by moderate to heavy use, and therefore must be protected from such use.

The role of research groups, such as the National Park Service Cooperative Research Unit, is to study the problems of use, and the relative sensitivity of each ecosystem to impacts of various kinds, both natural and man-made, and from this information provide managers with options for actions that are in keeping with the protection of the resource, as well as the facilities that might be planned. The high cost of facilities requires that they be used where most needed, and research needs to be aimed at determining which parts of the system are in greatest need of management.

Examples of Research

Many groups are conducting research on shorelines, but this paper will describe briefly the approach being used by the University of Massachusetts National Park Service Cooperative Research Unit, and how it relates to management

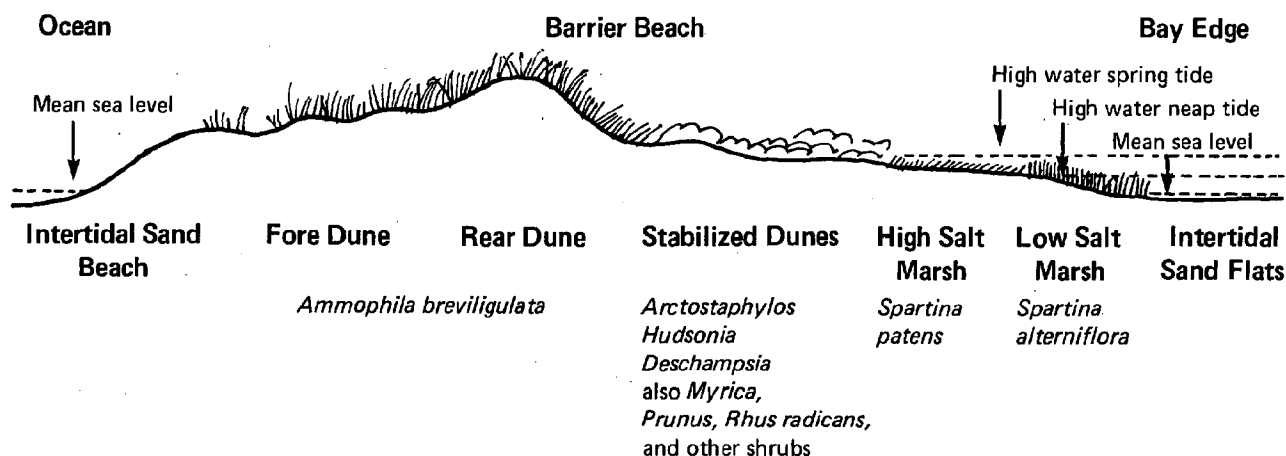


Figure 1. Diagram showing the major ecological zones of a typical New England barrier beach and areas impacted in ORV studies done on Race Point, Cape Cod National Seashore. Plants listed in each zone are the dominants. Sensitivity to ORV stress increases from ocean to bay.

decisions for recreational use of shorelines.

Off-Road Vehicles: Our major effort has been to study the environmental effects of off-road vehicles (four-wheel drive) in the Cape Cod National Seashore. The research approach is experimental. As far as we know it is the first of its kind in this country. Various ecosystems within the reach of off-road traffic have been impacted in a controlled fashion so that rates of deterioration and recovery might be measured. This work is still preliminary, but some trends are becoming evident. The ecosystems being tested are as follows and are more fully illustrated in Figure 1:

1. Sand Beach—The beach is an important site for nutrient recycling processes, drift line deposition, development of new sand dunes and a habitat for many animals, both interstitial microscopic species and macroscopic wildlife such as terns and other shorebirds. It is formed and shaped by waves and is thus the first defense against storm damage.
2. Dunes: Fore Dunes and Rear Dunes—The dune zone consists of two basic parts: the newly formed fore dunes, and the older rear dunes. Dunes catch and store sand blown up from the beach and are dependent on grass vegetation for stability and development. They are the natural barriers against severe storm flooding for the habitats behind the dunes, and are responsible for slowing down the effects of storm surges inland. In those environments where such flooding is harmful, the dunes are a major defense. Dune vegetation can be broken down into either grassland, or woody communities, characteristic of more stabilized dunes. In our research, we impacted the beach grass dunes (*Ammophila breviligulata*) which represent the first stages in dune succession, and the more stabilized Bearberry (*Arctostaphylos uva-ursi*) heath and beach heather (*Hudsonia tomentosa*) heathlands, as well as stabilized Hairgrass (*Deschampsia flexuosa*) grassland.

3. Salt Marshes—Marshes are a major source of primary productivity for estuarine waters, and form a barrier against erosion in the intertidal zones of bays and sounds. They are also significant wildlife habitats, as many people now know. In our research, the two main parts of the intertidal salt marshes were impacted—the high marsh, flooded only by spring tides; and the low marsh, flooded by every tide and marked by the upper levels of the high neap tides. Salt meadow cordgrass (*Spartina patens*) dominates the high marsh and salt marsh cordgrass (*Spartina alterniflora*) the low.
4. Intertidal Sand Flats—The sand flats that are exposed at low tide are very important habitats for shellfish, a number of which are significant commercially (such as the soft shell clam—*Mya arenaria*); marine worms, some of which are also commercially important species (like the clam worm—*Nereis virens* and bloodworms—*Glycera*); and as feeding grounds for migrating shorebirds. Sand flats are also the environment on which new salt marshes form once enough sediment has accumulated.

Preliminary Findings

Of all the ecosystems studied so far, the intertidal salt marshes and sand flats are the most severely affected by vehicle impacts from an ecological point of view, since they are examples of very complex ecosystems with many interdependent parts. Vehicle impacts in these environments can lead to a chain of significant environmental changes which threaten the survival of the systems in those areas being impacted. Dune environments are also seriously affected, but the complexity of those habitats does not compare with the intertidal zone of marshes and flats, and is thus more easily managed and repaired. The many and complex food webs leading to the great diversity of marine life, including commercial species, are dependent on the proper functioning of the intertidal ecosystem, and we have shown that vehicles



Figure 2. Impact of ninety ORV passes on a low salt marsh in the Race Point study area. Destruction of the salt marsh peat is clearly evident, and tidal water remains in tire ruts creating a panne with high salinity. (Photo by the author)

can significantly affect this functioning on a local level.

The low salt marsh community (dominated by *Spartina alterniflora*) is the least capable of tolerating vehicle impact, and the slowest to recover, of the intertidal habits studied. The pressure of a vehicle on the soft peat crushes the substrate, as well as tearing it apart. After only 90 passes of a jeep, sufficient damage was done to a low marsh study site to preclude any further driving (Figure 2). Depressions developed which retained salt water, creating what might be called "pannes." These depressions are excellent mosquito habitat, having limited drainage. After two years, very little recovery is evident, although there is slow invasion of the ruts by *Spartina*. Nevertheless, the scar and resulting depression is still very plain. Even the passage of 10 vehicles can create a long-lasting depression. It is clear that vehicle traffic through salt marshes should not be permitted.

Experimental evidence indicates that the open sand channels and extensive sand flats in Hatches Harbor (Cape Cod National Seashore), a major study area, are at least maintained by vehicles, if not created by them. The passage of vehicles over sand flats compacts the sand and prevents the normal colonization by shellfish spat, or seedlings of marsh plants. Where vehicles traverse the flats, sand is compacted into a pavement-like consistency; in protected areas, the sand is very porous. Compaction prevents shellfish below the surface from extending their siphons through the sand to obtain water and food at high tide. In addition, shear stresses in the sand can crack the shells of bivalves such as the soft shell clam. From this evidence, we have concluded that driving impacts are the most severe in salt marshes and sand flats, and must be highly controlled, if not eliminated entirely.

Patterns of Recovery

In the stabilized sand dunes, we observed two patterns of recovery. Bearberry heath (*Arctostaphylos uva-ursi*) is easily

damaged by vehicle impact (as little as fifty passes), but the plants recover relatively well as long as their resilient creeping stems are not broken or damaged. Beach heather (*Hudsonia*) is as rapidly destroyed; however, unlike *Arctostaphylos*, it has not re-established itself during the period that we observed the impact site (Figure 3). After two years, no substantial *Hudsonia* plants were present in the vehicle tracks, although seedlings were just beginning to appear. This response can be related to this species' manner of growth; it does not reproduce readily by means of rhizomes or runners, but by seed, while bearberry expands via creeping runners as well as seed. Hairgrass (*Deschampsia*) communities are easily damaged as well, especially the lichens (*Cladonia*) associated with this grassland; they show an intermediate recovery rate, between the bearberries' moderate regrowth and the beach heather's very slow recovery. From these tests, it is clear that beach heather communities are the most sensitive dune communities and must be protected from vehicle impact. Depressions created by vehicles passing over a bearberry community will be visible for a long time, even if the plants are not killed. Therefore, all traffic on stabilized dune vegetation should be prevented.



Figure 3a. Controlled ORV impact on a *Hudsonia* (beach heather) community after 300 passes on Race Point, 8/27/74. (Photo by J.M.B. Brodhead, NPSCRU)



Figure 3b. *Hudsonia* impact site after one year showing lack of recolonization; 8/13/75. (Photo by the author)

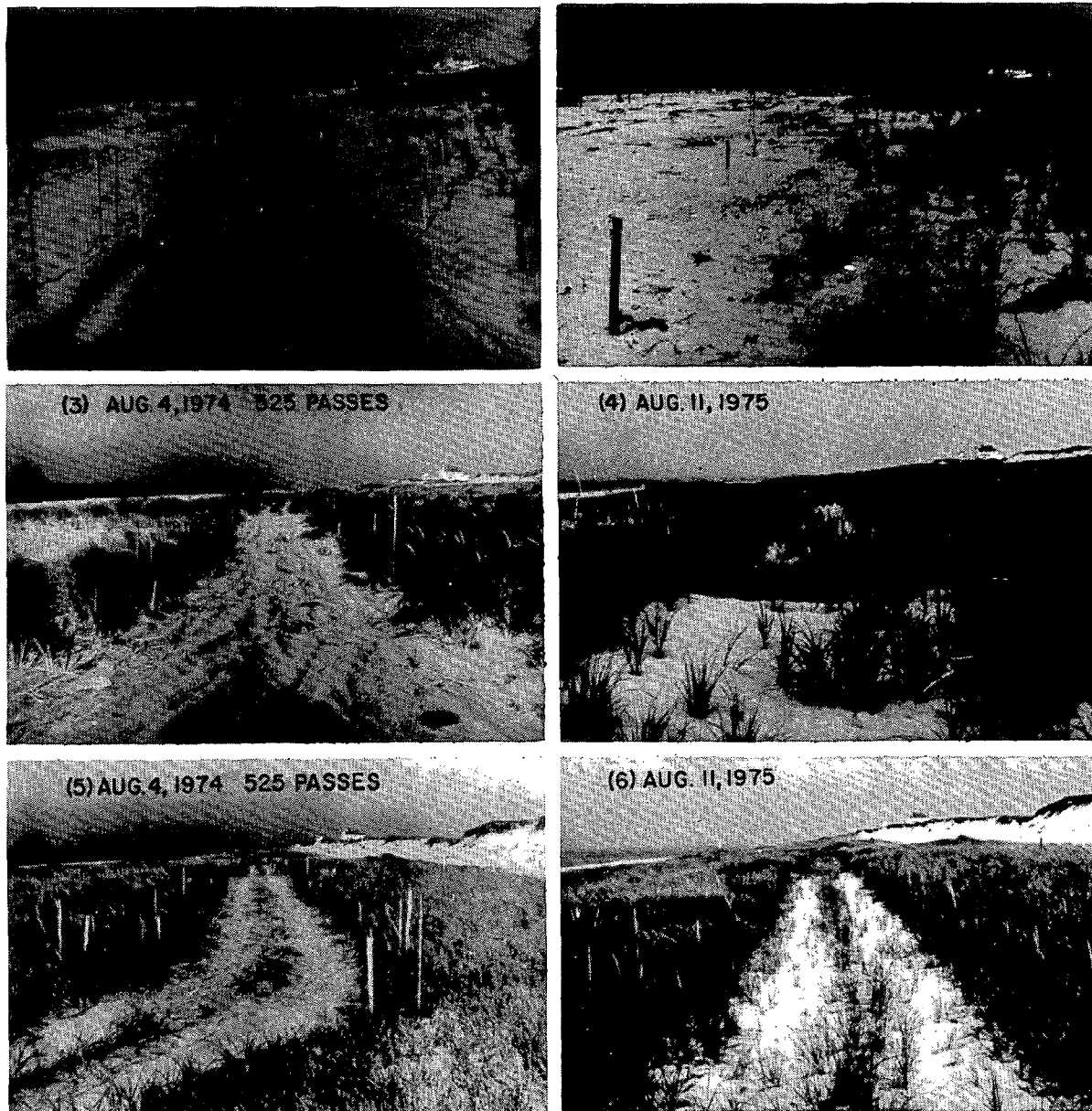


Figure 4. Controlled ORV impacts and recovery at Race Point on the fore dune edge (1 and 2), fore dunes (3 and 4) and rear dune (5 and 6). Recovery was most rapid in the fore dunes, and least on the rear dune. (Photos by J.M.B. Brodhead and the author)

Of the various zones in the beach grass (*Ammophila*) dunes, the least sensitive are the foredunes. While initial impact of vehicles was quite severe on the beachgrass vegetation (broken rhizomes were churned up from below, and all above ground vegetation killed), the recovery rate was very rapid. After only one growing season, the grass had shown signs of recovery, and after the 1975 season, the above ground biomass had nearly returned to the initial values (Figure 4). The foredune is a region of significant sand accumulation with resultant growth stimuli and rapid elongation of rhizomes. Rates of rhizome growth here measured up to

2 cm/day. Further up on the dune, recovery was slower. The region of least regrowth and least salt accumulation is at the top of the dune ridge. While this area still supports a typical beachgrass community, the vigor of the plants is not as great as in the foredune. Only time will tell how long it takes the upper dune system to recover completely. Further experiments will be made of procedures that might be used to accelerate the recovery rates.

On the beach, the most sensitive zone is the drift line on the winter berm; vehicle traffic can pulverize and kill seedlings of annuals and the young plants of perennials, such as

Ammophila, which are associated with the drift. It was found that all young beach grass plants in the drift lines had grown from fragments of rhizomes or culms which had washed up in the drift. The presence of the organic detritus around the beach grass fragments acts as a sand trap and an excellent mulch that promotes the rapid growth of the young plants, the possible forerunners of a new dune strand community. Heavy beach traffic on drift lines in the summer thus might prevent the development of new dunes. The environmental changes caused by vehicle traffic in the sand can also affect the rates of nutrient cycling by beach microorganisms.

The most unstable parts of the beach are the summer berm and intertidal zone. Here the dominant organisms are microflora and fauna which live between the grains of sand. Tests made on the populations of microorganisms and their natural changes suggest that natural variations may be much greater than any caused by vehicles; that sand moves around so rapidly in this zone suggests that it is a region where vehicle traffic would have the least overall impact.

It should be noted that these studies were done on an accreting beach system, with systems that exist under optimal conditions. The results might be different on an eroding shore. In 1976, we will conduct tests on the retreating beaches along the eastern shore of Cape Cod—Coast Guard Beach and Nauset Beach.

The observations and tests concerning wildlife showed nesting terns will tolerate a passing vehicle much more readily than they will tolerate pedestrians. People on foot, and their dogs, are much more disturbing to the birds and represent much more of a threat to them than people in vehicles. Visitors who get out of vehicles and walk up to the edge of a nesting colony (perhaps to read the sign) are creating more of an impact on the birds than if they remained in their vehicles and approached the colony on wheels. The greatest problem presented by vehicles comes when drivers pass directly through a colony (either accidentally or intentionally), possibly running over eggs and chicks. Such problems can be minimized by continued posting of nesting colonies and law enforcement.

Dune Studies

Geological studies showed that sand transport by a vehicle can create problems on dune slopes, but has little consequence on the level terrain, except for ruts and hollows made by the vehicles. The angle of wheels, rate of travel, and sand moisture conditions all affect sand movement. As vehicles move up a slope, a small quantity of sand is pushed back in the track. Over a period of time, the dune profile may be significantly lowered in those areas where numerous vehicles traverse the dune. Such sand movement precludes invasion by plants, beyond the destruction of plants caused as a vehicle goes over them; this produces a greater tendency for blow-outs to develop. Vehicle traffic tends to maintain dune instability and leads to the migration of dunes, unless controlled. Tests on tire size and truck weight gave preliminary

results which show that wide, soft tires, regardless of truck size, move the least amount of sand. More studies are planned to test these observations in greater detail under varying conditions in 1976.

Sand transport studies in Hatches Harbor showed a net movement of sand into the harbor and up the channels which surround the marshes and sand flats. This implies that sand will continually enter the region and slowly bury marshes that fringe the channels as long as vehicles keep the channels open. During 1976, a much more detailed study will be conducted on the sedimentary processes of the Hatches Harbor region.

All the information which we now have, though it is still preliminary, indicates that vehicle traffic has the least environmental impact when it is restricted to the summer berm and intertidal zone of the ocean beach. Vehicles should be excluded from nesting grounds. Vehicles have major impacts when driven over stabilized dunes of beach heather and hairgrass; this impact causes lesser damage in bearberry. The greatest environmental impact seems to occur in the intertidal sand flats and salt marshes, particularly the low salt marshes.

Microbiology and limnology of fresh water ponds in Cape Cod National Seashore—Dr. Jesse Ortiz of the University of Massachusetts Public Health Department began a study during the summer of 1975 on the public health problems related to recreational use of fresh water ponds in the Cape Cod National Seashore. His work is designed to study the epidemiological problems related to heavy use of these resources during summer months and attempt to determine what health problems might be related to swimming in these ponds.

At the same time, Dr. Michael Soukup and Dr. Stuart Ludlum in the Department of Zoology, were conducting a limnological survey of the same ponds to determine what factors might be involved in the natural changes of pond ecology and how human use might be altering the natural patterns. In addition, Dr. Soukup's studies on the currents in the ponds can give some idea of the routes pathogens might follow when introduced to the water by human recreational use.

These studies are designed to provide basic data on the conditions in the ponds and to determine how increasing recreational use might be altering the natural resource and perhaps endangering the visitors themselves.

Other Visitor Use Studies in Cape Cod National Seashore

Experimental studies are being done by Dr. Norton Nickerson and his students at Tufts University on the impact of foot traffic on dune vegetation. His work has shown that damage to *Ammophila* plants varies depending on whether visitors wear shoes, or go barefoot. People with shoes have a much greater impact than those without. Their data can be used to get some idea of how many passes it takes to damage the grasslands and create long lasting trails, which, if not corrected, can lead to blow-outs and dune breakdown in places.

Successful Management Approaches

As a result of the research as described above, we hope that management guidelines can be prepared to insure the optimal use of the coastal resources. As scientists, we are also faced with the problem of obtaining basic, publishable data which will be reviewed and entered into the scientific literature. Therefore, we have two basic goals in this work: management guidelines and published papers.

There is already growing evidence that large numbers of people can see and enjoy coastal resources if certain facilities are constructed so that they fit into the environment. Carefully planned wooden walkways can channel any number of people to desired locations over the sand, or over the marsh. Such walkways have been built in several coastal parks and are very successful. They also provide a means by which visitors can see ecosystems that they might otherwise have no knowledge of. Such facilities exist at Fire Island National Seashore, Cape Cod National Seashore and the Parker River Wildlife Refuge on Plum Island. While these are man-made structures, they prevent deterioration of a major resource—dune vegetation.

In the same light, we are accumulating evidence to show which ecosystems are the most sensitive to vehicle traffic and which are less so. From this information we can recommend which areas should be closed to vehicle traffic and which areas can be driven on without too much environmental damage. Nevertheless, any planned vehicle track through a coastal area should be maintained in some minimal way. There is really no such thing as a "carrying capacity" of dune or marsh vegetation for vehicles. Even one vehicle exceeds the carrying capacity. It only takes a few vehicle passes to significantly damage the vegetation; therefore, any track used by the normal number of vehicles that appear on Cape Cod beaches in the summer will be essentially a permanent feature of the dune zone as long as it is used, and when no longer used, will be visible for a long time. It thus becomes essential to manage the vehicle traffic and the dune tracks, especially where the potential for severe deterioration of the track is likely, or underway. Otherwise, tracks that are difficult to follow, or uncomfortable, will encourage drivers to seek other, unplanned routes which may be even more damaging, and therefore widen the impact area. Wooden ramps over dunes can minimize dune breaks and erosion by vehicle traffic.

Research Needs

Further research is needed to determine the relative sensitivity of ecosystems to various kinds of use. We are planning to look at the variations of impact that occur with different vehicle types, sizes, tire type, inflation, and so forth. Our initial studies were done on an accreting beach system, Race Point, and these will be followed by new tests on an eroding and retreating beach region, Nauset. Dr. Steve Leatherman of Boston University will be conducting geological tests on Coast Guard Beach and Nauset Beach to determine if vehicle

traffic may result in a more rapidly migrating barrier beach, and compare this migration with the model that we have developed for the Outer Banks of North Carolina.

More studies are needed on the ways to lessen visitor impact through structural controls or restrictive approaches. The placement of facilities for visitor use must be chosen in light of the natural processes which mold and shape the coastline. Research is needed to pinpoint those areas that are least suitable for facilities (for instance, eroding shorelines, low elevations subject to flooding, and so forth) and those which are better in terms of longer, natural stability. If such research had been done before the bathhouses and parking lot were built at Coast Guard Beach in Cape Cod National Seashore, they would not be in danger of washing away now, a little more than a decade after they were built.

Conclusion

Based on the results that are beginning to come in, and having seen those areas where successful management approaches have allowed larger numbers of people to use a coastal resource such as a swimming beach, while at the same time protecting the major portion of the environment from damage, it is clear that management actions must be taken when large numbers of people and their vehicles are using the shoreline. "Benign neglect" cannot be tolerated. Any human use of the coastal environment is going to result in changes of some kind, in some cases severe, in others, less so. To protect the major portion of our coastal resources so that they will be an inspiration to others requires that the use be carefully defined and in keeping with the environment and its tolerances.

Acknowledgements

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Research and Management: The Case of Fire Island National Seashore

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Introduction

My firm was contracted during 1973 by the National Park Service to prepare an inventory of environmental conditions and to review management options with reference to conditions at the Fire Island National Seashore. The Seashore occupies sections of a barrier island, estuaries, the Atlantic Ocean, and the "mainland" on the South Shore of east-central Long Island in Suffolk County, New York. This presentation will highlight some of the experience gained during that contract from the point of view of a consultant to a Federal agency. The presentation first sketches the history of the National Seashore and the context of the current planning effort, then touches selectively on some major substantive findings and recommendations, and concludes with several remarks on the present state of the unfinished and controversial planning for Fire Island.

The Fire Island National Seashore Controversy

Fire Island National Seashore owes its origin to the northeaster¹ of March 1962, which caused extensive damage along the barrier islands of South Shore Long Island. In the aftermath of this storm, Robert Moses, a powerful and controversial figure in the affairs of New York State, urged the eastward extension of a highway which previously had been built along the barrier islands west of Fire Island Inlet. Local property owners strenuously opposed the highway as a major threat to the environmental setting of their summer homes. Consequently they raised funds to buy up for public donation the "Sunken Forest," a fine example of a maritime Atlantic oak-holly forest that is sheared by salt-laden winds at the height of the protecting dunes.

The early 1960's was the period for Federal acquisition

of National Seashores and National Lakeshores, and Fire Islanders successfully presented their case in Washington. Congress accepted the gift of the Sunken Forest, authorized the Federal purchase of about 2,700 more acres (but by no means all) of the island, and exempted the most developed western section of the Seashore from Federal taking without the owners' consent (P.L. 88-587, 11 September 1964). The Act vested substantial authority in the Secretary of the Interior to require approved, local zoning ordinances which were expected to govern future development while conserving environmental resources in the villages not subject to condemnation. Robert Moses' road was stopped.

A Master Plan to guide the development of Federal lands was prepared promptly (NPS 1965), but never released publicly. It envisioned construction of numerous visitor centers, and stressed recreation rather than preservation in consonance with then-current NPS administrative policy (NPS 1968). Most of the funds appropriated for the Seashore were spent for land acquisition. The Seashore received relatively little attention from senior, Washington-level bureaucrats, and NPS field personnel changed.

Private development continued with relatively little interference, either by the Seashore administration or by the zoning authorities of the local municipalities, to the dissatisfaction of the official Seashore advisory commission and many of the Seashore's original proponents. Some of the socioeconomically dissimilar villages showed great concern for environmental preservation; others, relatively little. New summer houses were built in the "development district," commercial establishments multiplied, and residential structures were converted to guest-house enterprises.

The major Federal construction was a new half-million dollar marina and visitor center at Watch Hill, at the western end of the series of developed villages. The marina destroyed tidal marsh vegetation. Most Seashore visitors arrived by private boat; villagers came by ferry, and increas-

¹Storms which develop outside the tropics, in contrast to hurricanes, are known as northeasters in the mid-Atlantic coastal States.

ingly by four-wheel drive vehicle via the beach and through the dunes. The roughly eight-mile long stretch of barrier island (from Watch Hill east to a county park linked to the South Shore by bridge) was cleared of scattered structures (except for a few leaseholders) and allowed to revegetate. Meanwhile, the western five miles of Fire Island, also linked by bridge to the South Shore, were being developed into one of the major bathing beaches of the New York metropolitan region by the Long Island State Parks Commission. The historic, mid-nineteenth century Fire Island Lighthouse, situated a short distance west of the National Seashore boundary, became obsolete for navigation and was abandoned by the Coast Guard in favor of a new beacon atop the State Park water tower.

The Seashore was expanded through the donation of the historic William Floyd Estate (P.L. 89-244, 9 October 1965). Floyd was one of the signers of the Declaration of American Independence, and his descendants continue to occupy the Estate on a leasehold basis that will terminate by 1990. The Estate forms a detached unit of the Seashore on the South Shore mainland at Mastic Beach.

Friends of the Seashore, both local residents and the New York Congressional delegation, pressed the NPS for action on the Master Plan, and offered to seek additional Federal funds. The NPS was both reluctant to request more funds prior to completion of an approved Master Plan, and slow to produce a Plan in their absence.

During the early 1970's a new planning effort, envisioning somewhat reduced ultimate Federal development, was mounted by the NPS, and my firm as a subcontractor prepared parts of the environmental inventory of the Federal Lands (JMA 1972). NPS policy then was to develop a schematic, conceptual Master Plan, the details of which could be specified later, as funds became available for implementation. Such plans can be prepared with relatively little information on existing conditions, but their environmental effects are difficult to assess or predict. And such assessment was to be demanded of NPS in accordance with the National Environmental Policy Act that became effective on January 1, 1970 (P.L. 91-190).

On August 9, 1972 a group of property owners filed suit before Judge Dooling in the Federal Court for the Eastern District of New York charging the NPS with failure to produce a Master Plan after almost 10 years of Federal involvement with the Seashore, with failure to prepare an EIS on the Master Plan, and with failure generally to carry out the congressional mandate to preserve the Seashore environment (George Biderman et al. vs. Rogers C. B. Morton et al., Civil Action 72 C 1060, Eastern District of New York).

Plaintiffs specifically requested the Court to restrain the local municipalities from issuing building permits and zoning variances for proposed commercial development on a previously undeveloped bay-to-ocean tract in the western section of the Seashore and to curtail vehicular use of the beach. Plaintiffs emphasized the lack of factual information which hampered environmentally-based planning and ren-

dered difficult the preparation of the EIS. One result was the scope of services of a contract, eventually awarded to my firm, for a comprehensive environmental inventory of Seashore resources. Both the District Court and the US Court of Appeals for the Second Circuit denied plaintiffs' request for injunctive relief, noting that the relief sought would have to come from Congress, rather than from the courts. Nevertheless, the courts were impressed with the need to expedite planning aimed at environmental protection. In the words of Chief Judge Kaufman:

We cannot help but urge those with the power and authority to preserve this gem of an island to halt their procrastination and get on with the urgent business of saving this charming and fragile outpost of nature before the encroachments of haphazard development irrevocably despoil it.

To this end NPS issued a Draft Master Plan and a Draft Environmental Statement during March 1975, subsequently held public hearings and issued a draft general management plan during June 1976. The 1975 and 1976 documents incorporated findings from the environmental inventory of the Seashore.

The Environmental Inventory Process and Findings

My firm was involved initially during 1971 as a subcontractor during an inventory of the federally owned lands on Fire Island. We prepared a report that addressed vegetation and geomorphology. The geomorphological effort was primarily a review of the available literature, but it included a map (scale, 1:4,800) of landforms based on the interpretation of aerial photographs. The vegetation report contained detailed descriptions of the plant communities on the barrier island, an extensive flora, and a detailed vegetation map (scale, 1:4800) based on field investigation supplemented by aerial reconnaissance. The familiarity with the Seashore gained during this work was the deciding factor during the 1973 competitive selection of a firm to perform another inventory contract.

The second contract resulted in the preparation of a 461-page report with 63 tables, 118 figures, and a large map folio (JMA 1975). Our charge was broader than before, and our geographical study area was considerably larger. The contents of the report are outlined in Table 1. The ensuing paragraphs highlight the scope and findings of each section.

Summary Recommendations

The brief general introduction and summary recommendations deal primarily with land acquisition alternatives, which are not addressed directly elsewhere in the inventory. The formulation of management, development, and construction alternatives was not a specific task under our contract. The alternatives we considered in the introduction and in the inventory chapters, therefore, were derived primarily from discussions with NPS planning personnel. We sought to address the major problems seen by the NPS planning team during 1973 and 1974.

Table 1—Contents of the Environmental Inventory of Fire Island National Seashore (JMA 1975)

Chapter	Pages	Tables	Text Figures	Folio Maps ¹
General Introduction and Summary Recommendations	3	0	0	0
Geomorphology and Geomorphic History	75	2	22	2
Groundwater Resources	22	1	11	0
Surface Water Quality and Aquatic Biota	78	19	14	1
Soils	4	2	0	2
Vegetation and Flora	54	3	16	2
Wildlife	36	8	1	0
Archaeology	13	0	2	0
Historic and Cultural Resources	11	0	3	0
Storm Damage	18	4	7	0
Existing Land Use	61	14	24	2
Optimal Capacities for Development	15	4	5	0
The Need for a Federal Presence	16	5	4	0
Acknowledgments and Authorship	2	1	0	0
Bibliography	53	0	0	0
Total	461	63	109	9

¹The large-scale folio maps (most at 1:4,800; estuarine resources at 1:24,000) were displayed at the Conference on Cape Cod. The land-use map forms the base maps for NPS documents published during 1975 and 1976.

We concluded that three first-priority land-acquisition actions and two second-priority actions should be addressed by NPS. In the short run we saw acquisition of the surplus Coast Guard Lighthouse for use as a major visitor interpretation center and the establishment of a mechanism (in concert with the Federal Flood Insurance Administration [FFIA]) to acquire federally insured properties damaged by major storms as the foremost priorities. In the long run the NPS should encourage owners to donate, and be prepared to accept and manage, properties in the communities of the development district. Given the income level of Fire Island property owners, donations could be encouraged; the NPS would have to maintain a long-term presence in the communities and not request a redrawing of Seashore boundaries so as to exclude them. We assigned second priority to developing a mechanism to ensure the use of private land in conformance with local (or, if necessary, federal), environmentally protective, zoning standards. As a longer-term measure, we urged that the NPS request extension of the authorized boundary of the Seashore westward to Fire Island Inlet. The NPS would be able then, not only to accept a donation of land from the State of New York if the State should ever want to dispose of it, but more importantly, the whole of Fire Island could be treated as a geomorphic unit when the NPS supports future research at the National Seashore.

We regard the NPS acquisition of beach and dune proper-

ties in the developed communities (except after storm damage, in concert with FFIA) as providing relatively little benefit. We also recommended that the NPS establish and publicize criteria for acceptable and unacceptable commercialization in the developed communities, and then take vigorous enforcement action against unacceptable development.

Geomorphology

The geomorphology section offered a discussion of theories of barrier-island development, a comprehensive discussion of coastal processes based on ongoing research at Fire Island, and a discussion of the vulnerability of geomorphic subdivisions keyed to a folio map. We concluded that there is no economic way to protect development on the barrier island from major hurricanes, which can be expected, on the average, three times per century. The barrier-island system itself, however, is in no danger of disappearance. Indeed, the inlets can be kept in place and navigable only through costly jetties and dredging as the sand deposited by alongshore currents is trapped by them.

Coastal processes during major hurricanes (the last one at Fire Island was the storm of September 1938) are understood poorly. A number of potential alternative measures, however, can be used to protect beaches and dunes during the brief erosive episodes of ordinary-storm and fair-weather periods. The concepts we presented, unfortunately, subse-

quently were ignored by the Corps of Engineers in what could have been a major contribution to the understanding of beach erosion in the Fire Island region (US-ACE 1976). We opposed groins and endorsed both beach nourishment and inlet sand-bypassing as technical stopgap measures to protect structures on Fire Island. We also pointed out the need to provide structural crossings of the shorefront dunes for pedestrians and vehicles, if significant gaps are not to be worn through the protective dune line. There still are important unresolved questions regarding Fire Island geomorphology, which the NPS should undertake research to resolve, because the NPS shares responsibility for beach protection with the Army Corps of Engineers for the National Seashore (P.L. 88-587).

Groundwater

The groundwater section, like that on surface-water quality and aquatic biota, was developed from the extensive existing literature without benefit of original field research. The existing village and public developments on Fire Island are sufficiently dense that already they are supplied with potable water from artesian wells several hundred feet deep. Exceptions during 1974 were Atlantique, Lonelyville, and Water Island, which still relied on bottled water and the shallow fresh-water aquifer. An undetermined, but presumably large, number of householders used shallow wells for non-potable supplies (lawn sprinkling, water closets). Ocean Beach is the only settlement with a sewage system, which discharges to Great South Bay. Elsewhere wastes were disposed through cesspools and septic tanks. A County requirement that new tanks be located at least 100 feet from water-table wells became effective during 1960, but has not been enforced rigorously. No water-supply related health problems have been significant to date. The quantity of groundwater available to Fire Island is unlikely to be limited by any conceivable future development on Fire Island itself.

Should the recharge area for major regional aquifers be covered by development in central Suffolk County, and should treated wastewater effluent be disposed through ocean outfalls rather than recharged to groundwater, Fire Island's supplies of potable water could be impaired by salt-water intrusion in as few as 50 years. But the current position of the offshore saltwater-freshwater interfaces in the major aquifers is not known, and rates of potential saltwater intrusion are difficult to quantify. We saw little necessity for NPS action regarding groundwater, other than a general opposition to ocean outfalls in the region.

Surface-water Resources

Because the Great South Bay and adjoining estuaries are resources of major significance that have been subject to pollution, they have received a substantial amount of scholarly attention. The ocean water off Fire Island generally is of high quality. The exchange of ocean water with the back-barrier lagoon system is limited to the inlets, and the flushing time for the Great South Bay is long, about 48 days. Bacterial

populations associated with surface runoff and wastewater effluent that enter the Bay generally are sufficiently great that sizeable areas, measured in hundreds or thousands of acres, are closed to commercial shellfishing harvesting each year. The associated economic loss is substantial.

The concentrations of various pollutants in the vicinity of Fire Island increase measurably during the summer months, when the barrier-island population and recreational boating peak. Only seven percent of Suffolk County was sewered during 1970, and duck farms also have contributed to the pollution of the estuaries. Duck farms have decreased in number during the past decade and have acted to decrease pollution; construction is under way for a major sewage treatment facility in western Suffolk County (which is to have an ocean outfall, despite controversy and litigation); so water quality in the bays should increase during future years.

The NPS has limited ability to influence surface-water quality in the Fire Island National Seashore. It should seek to preserve marshes, minimize mosquito ditches, investigate the creation of new marshes, require boat pumpout and separate sewage-holding facilities at marinas so that boat wastes can be transported to the mainland for treatment, and monitor bacteria and other pollutants in recreational shellfishing areas.

Soils

The major restrictions on land use offered by soils at the Seashore are associated with their susceptibility to occasional flooding. Fire Island contains no fully developed soils, according to Soil Conservation Service investigations. The island is composed of sand on which organic material has accumulated in areas which support dense vegetation. Tidal marshes have accumulated deep muck.

The William Floyd Estate has coarse textured soils typical of South Shore Long Island. Their depth to water table is governed by distance from the bay, because slopes are gentle (to thirty-two percent).

Vegetation and Flora

The vegetation of Fire Island is diverse and reflects great variation in environmental factors, particularly wind, salinity, the availability of soil moisture, and the extent of human intervention. The gradient in the intensities of environmental factors across Fire Island is neither gradual nor uniform, and the floristic composition of the vegetation changes abruptly over short distances in many places. On-shore winds, which often are strong, desiccate vegetation on the oceanfront dunes and periodically mist the vegetation with salt spray. Many habitats are so severe that plants of only a few species can survive; in contrast, scattered, protected habitats harbor many species. Irrigation and artificial fertilization, which supplement the relatively mild, ocean-dominated climate, have permitted a host of introduced ornamental species to survive, both with and without cultivation.

Twelve vegetation types were mapped on Fire Island

primarily from field observation during 1971, and primarily from aerial photo-interpretation during 1974. The interim flora contained about 475 species.

Above the high water line of the ocean beaches, beachgrass is the most abundant plant on the foredunes. On back dunes dense thickets of beach plum, bayberry, and poison ivy cover many acres. Generally, the density of plant cover increases with distance from the ocean front. In a few protected areas there is dense, broadleaf forest with a wind-pruned canopy less than 25 feet tall. Shrubs and herbs are more diverse in the oak-holly forests than in the dune and swale communities. The availability of soil moisture, salinity of the water, and depth to water table are major determinants of the natural spatial distribution and floristic composition of vegetation types. Small depressions support cranberry bogs; forest bogs and transitional zones support azaleas and ferns. On the bayshore, extensive salt marshes vary in species composition according to the depth and duration of flooding. Pedestrians and vehicles quickly create pathways through the plant communities. Native plants become re-established only slowly after the traffic ceases (see the page by Godfrey in this volume).

In the villages of Fire Island an array of vegetation types exists. Some villages contain a matrix of relatively undisturbed native vegetation types into which houses and walkways were set. Next to the houses there are open landscapes formed by planted lawns, beachgrass, or low thickets, as well as occasional closed landscapes. The closed landscapes rarely are formed by fences or planted shrubs. They more commonly derive from remnants of high shrub thickets or forests which were preserved to screen individual houses from their neighbors. Some residents have modified the natural vegetation by pruning native thickets so that they now survive as sparse, low hedges around irrigated lawns. Other residents have substituted elaborate cultivated landscapes, similar to those on the mainland, for the more easily maintained vegetation native to Fire Island.

The two areas of greatest floristic distinctiveness on the barrier island are the expanse of forest and high thicket from Point O'Woods through the Sunken Forest eastward to Water Island. Much of this area is under Federal protection; some has been developed, as at Cherry Grove and Fire Island Pines. The other area is near Democrat Point in Robert Moses State Park, where several plant species have been collected that are rare in the Long Island region. This area is threatened by the possible expansion of parking lots, a golf course, or other intensive recreational development. At present the NPS can do little to protect these resources, other than indicate their value to the Long Island State Parks Commission. The NPS has opposed the introduction of exotic plants into Federal land, but exotics have been introduced extensively by State and County park managers, as well as by private owners.

The William Floyd estate is a mostly forested tract fringed by extensive bayside tidal marshes. Oak forest occupies about half of the land area; young locust-cherry forest is another

widespread upland type. Lowland forest and dense thickets border the tidal marshes. The estate has been farmed to an undetermined extent in the past, and long has been managed to increase its attractiveness to wildlife. A preliminary flora lists 100 species typical of South Shore Long Island. Extensive field work should reveal several times that many species.

Wildlife

The wildlife inventory was based on a literature review supplemented by field investigations during the spring of 1974. The goal of this section was to ascertain the relative wildlife value of the several habitats as a basis for land-use planning. Voluminous data exist on the birds of the vicinity of Fire Island (see the paper by Buckley in this volume); our field investigations were directed primarily toward mammals, reptiles, and amphibians.

All the major vertebrate groups are represented in the fauna of the Seashore. Fowler's toad is the only amphibian known from Fire Island; it and 11 other species of amphibians are known to inhabit the Floyd estate. Eight species of reptiles are known from the barrier island; 13 from the estate. (For Long Island as a whole about 41 reptiles and amphibians have been reported.) The vicinity of the National Seashore has been the scene for observation of birds representing 347 species, of which 52 species are known to breed on the barrier island. The marshes and food resources of the shallow estuaries are major feeding grounds for migratory birds. On the barrier island 18 species of mammals have been reported; on the Floyd estate, 30. (The land fauna of Long Island includes 35 mammals.) Marine mammals have not been reported from the estuaries near Fire Island in modern times, although the distributional ranges of 26 species broadly encompass this section of the Atlantic coastline.

Alternative rankings of habitats according to the numbers of species they harbored consistently distinguished marshes, native forests, and high thickets as most important; bare sand, planted black pine forests, and the open ocean as least important. The Seashore still supports a diverse and abundant fauna. At present, dogs and cats are allowed to roam at will in the villages. We recommended the elimination of domesticated animals from the Seashore as a long-term goal. Hunting of rabbits, deer, and migratory waterfowl probably can be permitted indefinitely with little conflict, because the intensive-recreation season does not overlap with the hunting season. To maximize wildlife use of the eight-mile wild zone, we recommended that future camping facilities be installed in Federal lands between the western villages, rather than in the eastern section of the barrier island.

Archaeology

An archaeological reconnaissance survey of the barrier island confirmed expectations that no record of prehistoric habitation has been preserved on the dynamic land surface. One broken tip from a broad-edged quartz knife was collected on the surface of a dredged-spoil landfill near the parking lot at Smith Point County Park. No artifacts were encountered

during shallow testing in the tidal marshes. We recommended that further study on the barrier island include the historic remains around the Fire Island Lighthouse and the sites of shipwrecks. Should bayside dredging be conducted, the operations should be monitored by a professional archaeologist. No study of the William Floyd estate was authorized by our contracts.

Cultural Resources

The history of Fire Island was summarized from existing information. European contact with the barrier islands was initiated by Giovanni de Verrazano, who sailed northeast from modern New York Harbor during 1525. The saga of the island is intertwined with storms and shipwrecks. Recreational development began during the mid-nineteenth century, and the oldest community is Point O'Woods.

Because the communities differ in age, development density, income levels, and life styles, they display a range of house types, landscapes, and vegetation patterns. There is a range of friendliness or aversion to visitors. Some villages are occupied chiefly by families; some, by "groupers;" some, by "gays." Inter-village travel is relatively limited, and occurs mainly on foot along the beach. Village residents have little contact with the town, county, or federal park facilities on Fire Island.

The remoteness of Fire Island (apart from Robert Moses Park and Smith Point Park) is one of its distinctive features, and results from the virtual absence of motor vehicles. It also helps to make possible the coexistence of such diverse communities in close geographical proximity to one another. The cultural diversity on Fire Island is a great asset to the National Seashore, and should be maintained. East-west travel on Fire Island should remain primarily by foot. More than 90 percent of village respondents indicated that they would not use their cars to reach Fire Island, even if they were permitted to do so.

Because there is no road to permit a visitor to travel the length of Fire Island within a few minutes with virtually no personal exertion, the Island can be learned and appreciated only slowly. Numerous ferry or private-boat trips and prolonged, fatiguing hikes over sand pathways are necessary for accumulation of an experience of Fire Island as a whole. To preserve the effective size of Fire Island, the National Park Service must continue to work toward the minimal use of vehicles within the Fire Island National Seashore. More than ample opportunities exist for motorists to obtain high-speed glimpses of moderately to intensively-managed barrier-island environments both east and west of Fire Island. The National Seashore should be preserved as an alternative for those willing to invest the time and effort required to appreciate its subtle natural beauty. At the same time, however, the National Park Service should make a concerted effort to teach those not now aware of the natural and human history, ecological complexity, and subtle beauty of Fire Island what the island can offer. To this end, development of a major, year-round interpretive center at the Lighthouse would be a

vital first step.

Storm Damage

Data on storm frequencies and damage were summarized, chiefly from previous compilations by the Army Corps of Engineers. Fire Island is inherently a storm-buffeted zone, on which structures are damaged by disturbances which may originate either in the tropics or outside the tropics. Storms that cause "moderate" damage along the coast of Long Island are recorded almost every year; storms with "severe" damage, about once every ten years. Great tropical hurricanes affect the region about three times per century, as a long-term average. Descriptions of damage in the National Seashore were provided for recent major storms, as well as documentation of local responses to storm damage and recent flood-hazard maps promulgated by the Federal Flood Insurance Administration.

Federal flood insurance is being purchased by most Seashore property owners. We expressed serious reservation about the appropriateness of current FFIA regulations for barrier-island environments, however reasonable they might be for inland floodplains. The regulations specify minimum floor elevations, but do not require deep pile foundations and do not exclude construction on marshes, dunes, or the open beach itself. As presently constituted, the regulations appear destined to continue, even for new construction, the long tradition of public subsidy following storms to property owners in predictably hazardous environments.

Existing Land Use

Existing land use data for the non-federally owned lands of the barrier island were compiled from aerial photographs, field reconnaissance, and a questionnaire survey (30 percent return of 3,600 questionnaires). Records in county and municipal assessment offices were examined closely for information on tax value and ownerships. Numerous local residents, together with utility and agency personnel, assisted our efforts.

There were approximately 3,593 structures in the exempted communities during 1974. About 3,436 were utilized as residences, 96 were designated for commercial uses, and 60 were institutional structures. The gross density of development ranged from 6.7 structures per acre in Ocean Beach to 1.0 structure per acre in Point O'Woods. One third of the commercial structures and one fifth of the institutional structures of the villages were in Ocean Beach. There were 278 structures within 80 feet of a generalized line which indicated the seaward limit of vegetation along the ocean front. During the decade of NPS involvement on Fire Island, the number of structures increased by 864 (31 percent). During 1928 there had been 950 structures; after the 1938 hurricane, 707. Of 330 zoning variances requested between 1965 and 1972 from the towns of Brookhaven and Islip, only 31 were denied.

The mid-summer population ranged from 16,000 to 20,000 people; the year-round population was 215. The

year-round population has declined 26 percent since 1960 (when there were 290); the number of structures increased 50 percent during the same period.

Optimal Development Capacity

As of summer 1974 there were about 1,575 vacant homesites in the exempted communities (assuming development of open land at a density equal to past development), of which 248 were in dunes or marshes. Development therefore could continue for another 15 years at the 1964-1974 average rate of increase (87 structures per year). Most existing development does not comply with current local minimum zoning standards. There is more buildable land in the western villages (Town of Islip) than in the eastern villages (Town of Brookhaven). Utility services are available. The summer population could increase by about 7,000 if allowable single-family residences are developed fully. A third of homeowners expect to winterize their structures to prolong the useful season into the autumn and spring months.

The threats to Seashore resources posed by exempted community development and the consequent population increase concern about the dunes, the native vegetation, and the quality of water in Great South Bay. Most existing residents recognize the fragility of dunes. Some, however, probably will continue to circumvent structured dune crossings en route to the beach. Although poison ivy discourages indiscriminate hiking through vegetation by scantily clad bathers, aerial photographs nevertheless show numerous bare sand trails throughout the barrier island. It seems unlikely that trampling will decline as population increases. Perception of vegetation damage is much less acute than perception of damage to dunes, according to questionnaire results. Water quality prospects are difficult to assess. Minor contamination of shallow freshwater could increase and provide a local source of contaminants to the Bay, but no quantitative data are available. Few community residents (three percent) embrace the prospect of continued development enthusiastically.

The prime recreational resource of the Seashore is the ocean beaches, whose capacity for bathers is almost unlimited, given the prospective minor increases in public access that can be provided by enhanced ferry service. Even on peak-use days during 1974, there were substantial areas of virtually empty beach on Fire Island. Recreational vehicles, however, cannot increase indefinitely on the beaches of the state and county parks, especially near the inlets. Already, several hundred vehicles may be found on the state and county beaches on peak-use days.

The federal marina at Sailors Haven is filled in excess of capacity, when 200 to 300 boats anchor on the shoal on peak days. Sanitary facilities require upgrading to handle the 25,000 to 30,000 visitors monthly at Sailors Haven. The Watch Hill center as of yet is less popular. It, too, has capacity limited by staff and facilities, rather than by natural resources. Few residents of the exempted communities visit the federal centers. Visitors to both the federal centers and

the communities tend to return year after year.

The Need for a Federal Presence on Fire Island

Regional population trends suggest a substantial prospective increase in Suffolk County during the next several decades. Nassau County, situated between Suffolk County and New York City, has been developed almost completely, and little open land remains. The Suffolk County visitors will come to Fire Island by private boat or ferry. Residents of the towns of Islip and Brookhaven may use town beaches on the barrier island, but those from other towns must use county, state, or federal facilities. During the 1969 season, 58 percent of visitors to federal centers resided in Nassau and Suffolk Counties; only 9 percent came from New York City; and 7 percent were from other states. Most seasonal residents in the villages during 1974 came from New York City (67 percent); only a few (12 percent), from the two suburban counties. We expect that relatively few of the new residents in the region will occupy waterfront sites or have access to private boats. The need for public transport facilities to federal land, therefore, should increase.

Pressures to complete and to intensify development in the exempted communities also may be expected to increase. Local zoning ordinances state, on paper, that single-family dwellings are the most intensive use for virtually the whole of Fire Island from inlet to inlet. But already there is one 100-unit condominium (at Fire Island Pines), which may be indicative of a future trend. Given past experience, decisive federal action with respect to new development is essential to preserve the Seashore in the fashion directed by Congress.

Certain communities, notably Seaview, during recent years have attempted to exclude non-residents from the ocean beach. The NPS should continue generally to oppose the restriction of the beach to exclusive community use, but federal acquisition of community beaches should not receive high priority. There is ample beach to accommodate visitors to federal centers without use of any community-owned section. No village could exclude hikers effectively without incurring substantial expense. If long-term policy aims at federal acquisition of all land now in the exempted communities, the short-term question of beach control need not be of great concern.

Federal enforcement of zoning, aimed explicitly at minimizing long-term private investment in structures and public investment in infrastructures in the communities on Fire Island, would have general public benefits. It will help to assure the preservation of the barrier-island ecosystem from massive human intervention, and it will minimize long-term losses of public and private investment to damage by major storms. It also will benefit community residents by preserving the existing, relatively low-density character of the villages on Fire Island.

The long-term policy of the National Park Service also should be directed toward the ultimate expansion of public ownership on Fire Island into the exempted communities. This policy first should be implemented by prevention of

the rebuilding of those existing structures located precariously on beach, dune, or marsh sites. Such structures are the most vulnerable to destruction by the action of moderate storms which occur every few years.

An untried mechanism exists already for federal acquisition of damaged properties in the form of federally subsidized flood insurance. Under the National Flood Insurance Program (42 USC 4001-4128), any homeowner on Fire Island can purchase up to \$70,000 of flood insurance on a single-family house and its contents. Although the flood insurance legislation authorized the federal government to enter into negotiations to purchase any insured property which was damaged substantially beyond repair, this authorization had not been exercised anywhere in the United States as of late 1974.

An owner of property which has federal flood insurance also could be eligible for low-interest federal loans administered by the Small Business Administration under the Flood Disaster Protection Act of 1973 (P.L. 93-234 as amended). Thus, the owner of a property valued at \$90,000, which was destroyed totally, conceivably could receive nearly \$70,000 in insurance benefits (after depreciation was deducted). He also could receive a federal loan for \$20,000 to enable him to rebuild his home, if Fire Island were declared a federal disaster area after a major storm. If rebuilding were to occur on Fire Island as a result of such federal benefits, the inevitable consequence would be an ever-increasing series of publicly subsidized storm losses. Because the Federal Flood Insurance program was intended ultimately to reduce, rather than to augment, storm losses nationwide, there is a critical need for the formulation and coordination of federal policy with respect to Fire Island and other similar barrier-island and coastal localities.

Finally, we considered it highly desirable that the NPS take control of the Fire Island Lighthouse and develop it into a major federal visitor center. This would provide a federal center accessible to large parking lots for automobiles and buses and adjacent to a large existing population of potential visitors. The site offers an opportunity for the NPS to provide historic and natural history interpretation to a segment of the regional population that is not now served by NPS. These are people who cannot afford private boats or ferry charges to reach existing federal centers.

Conclusions

Our data and professional judgments concerning the present and future conditions of environmental resources at Fire Island National Seashore have been useful to NPS planners in their continuing work on management plans. This can be demonstrated by comparison of the NPS documents (NPS 1965, 1975a, 1976) and our report (JMA 1975). Our views increasingly have been adopted in the recent NPS planning efforts.

The 1975 draft master plan gave precedence to management considerations for the Seashore, particularly with reference to the highly visible action of recommending a revision

of the boundary to exclude the western communities from the Seashore. There was predictable public outcry against this measure at public meetings held in Patchogue and in New York City during 1975. There also was public opposition to the construction of a sizeable "bicycle path" along the center of the island. Otherwise, the recommendations of the planning team were accepted almost completely (cf. NPS 1975b: Alternative A; NPS 1976).

The NPS has contracted a consultant's report on zoning, and has worked on a model ordinance which local municipalities are going to be required to adopt. The results of these efforts have not yet been released, at least not to us. Consideration has been given to a federal plan for further acquisition of land in the communities in the wake of major hurricanes. The Lighthouse is to become a part of the National Seashore. Additional public meetings are scheduled for the summer of 1976.

It is to be hoped that the Congress will fund adequately the prompt implementation of plans which have been developed through a long process incorporating environmental inventory and public interaction.

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Summary and Conclusions on Coastal Recreation

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We seek the wise use of precious natural resources in an environment which is increasingly urban. The pressure of our numbers and of our material cultures must be controlled and brought more nearly into equilibrium with the life of the marine environment. Every conference speaker grappled with one or another aspect of this challenge, still it is useful to explore some implications of the conference theme which may not have received enough attention.

Marine Ecosystems vs. Human Communities

It is impossible to study marine ecosystems without considering the relationships of those systems to the ecology of human communities as well. This observation was implicit in Dr. Buckley's description of wildlife adaptations in Jamaica Bay and in Dr. Teal's pleas that through political action some designated marshlands be excluded from further human impact and preserved in as pristine a state as possible. Indeed participants like Mr. Bennett of the American Littoral Society, Mr. Scanlon of Save the Bay, and planners like Mr. Davis of Long Island have stressed the importance of political actions and administrative policies in controlling the most severe human impacts on the marine environment. But what about the viability of the human environment? Is not the "health" of our own communities also essential to the survival of the natural ecosystems we prize and which we here defend?

It would be a tragic error to view the politics of natural ecosystem preservation as somehow independent of the pressing social problems of unemployment and demoralization in urban America. Need we be reminded that the phenylchlorides, the heavy metals, and the petroleum by-products which have wiped out so many of our best fisheries have in so doing also destroyed human communities where men and women raised their families and built their homes at the water's edge? How many oystermen and baymen and their families flocked to nearby towns and cities when their means

of making a livelihood from the marine environment was destroyed? And how many ever again found work at the water's edge?

Of course there is no problem in proving that the United States ranks among the most urbanized nations in the world; the difficulty comes in knowing what to do about it. As the geographer Brian Berry has shown, more than 90 percent of our population lives within a twenty five mile radius of a major urban center, but our largest metropolitan regions are located on the ocean coasts or on the Great Lakes. The implications of these facts for the future of marine resources cannot be exaggerated. Almost no large marine estuary in coastal United States is far enough removed from a major city to be immune from severe impact by human uses. But at the same time those impacts would be far greater even than they are were it not for important aspects of the ecology of human communities. As an example consider the case of Jamaica Bay, which has recently been incorporated in, Gateway National Recreation Area, the National Park Service's new urban park.

Jamaica Bay

Jamaica Bay is a typical East Coast tidal lagoon, but within a twenty minute transit radius of its marshy shores there resides some two million residents of the boroughs of Queens and Brooklyn. About 8,000 of these city folk now maintain small pleasure craft and recreational fishing boats on the Bay, a large number relative to other similar estuaries, but certainly not large in comparison with the numbers who could boat and fish on the bay if they so chose. Suppose additional thousands of the millions living close to the water's edge were to become wild about recreational fishing? Some consequences of this trend would soon become apparent. Bait which is dug and netted in the bay would decrease in quantity, as would the bird and fish populations that feed on killies and larvae. Eventually the crush of

pleasure boats on the bay might become enough to discourage further numbers, but most certainly not before severe damage was done to the fishery.

Obviously this grim scenario is prevented, in part, by the incredible diversity of human life styles which co-exist in a major city like New York. For every boating and fishing family there are tens and even hundreds of others who prefer to spend Sunday with their relatives in the backyard, or who are attracted to the beaches, to the picnic areas, and to the pleasure grounds of the central city itself. Thus we arrive at a very simple observation: if people like these who are adapted in so many ways to an urban habitat, if hundreds of thousands of such people must uproot themselves because their cities can no longer offer them the necessities of life, then the pressures of increased population on less populated shorelines could become catastrophic.

In the same vein, if the beaches closer to the cities, like those at Lynn and Revere and at Coney Island and the Rockaways, are not cared for and made more attractive and accessible, it will become increasingly difficult to preserve the more sensitive environments of the barrier beaches and the natural seashores like those of the outer reaches of Cape Cod.

Fisheries Research

Presentations by the fisheries researchers from Rhode Island, from New Jersey, and from Delaware prove that great strides have been made in recent years in quantifying national finfish and shellfish catches. Perhaps of most interest for the purposes of this admittedly biased summary was the comparison between commercial and recreational finfish catches. For striped bass and other estuarine fish the recreational catch is more important than the commercial catch, a fact which again emphasizes the relationship between the marine environment and the social environment of the cities. Here again I speak from experience with Jamaica Bay and with similar estuaries in the North Atlantic states.

Recreational fishing tends to be a blue collar sport, especially the type of serious fishing which tends toward marginal employment. Now in New York and similar North Atlantic cities depression in the construction industry, in which large numbers of recreational fishermen are employed, has led to increases in subsistence or semi-professional fishing, and perhaps in some cases to overfishing of estuarine species. A further implication of these relationships, which I realize remain extremely impressionistic, is that increased levels of employment in construction and other blue collar work will tend to somewhat relieve the pressure on estuarine fishing grounds in urban areas.

Fortunately there is no lack of crucial rebuilding projects required in the cities, projects whose benefits for the marine environment would be immense. The construction of sewer treatment plants and the renewal of decaying urban waterfronts alone could provide enough work to reverse the trend in construction industry employment in our coastal cities. Marsh planting and dune rebuilding, mariculture and beach nourishment are all relatively labor intensive investments. Those of us with PhD's have so far been the beneficiaries of labor intensive environmental projects like the writing of ecological inventories. Should we not also be working to spread the benefits of environmental husbandry to blue collar America?

Important ecological projects require huge investments of "social capital." They cannot be effected through market mechanisms alone any more than the Interstate highway system could have been financed through private capital. In consequence these marine husbandry projects will require a good deal of political backing and this can only come through the effective combining of the voices of union leaders, industrialists, and environmentalists. This is a coalition which has generally not existed in the past but which must occur now. Certainly the building of that coalition, is a worthy goal for the members of this professional field in the coming years.

COASTAL ZONE
MANAGEMENT CENTER

