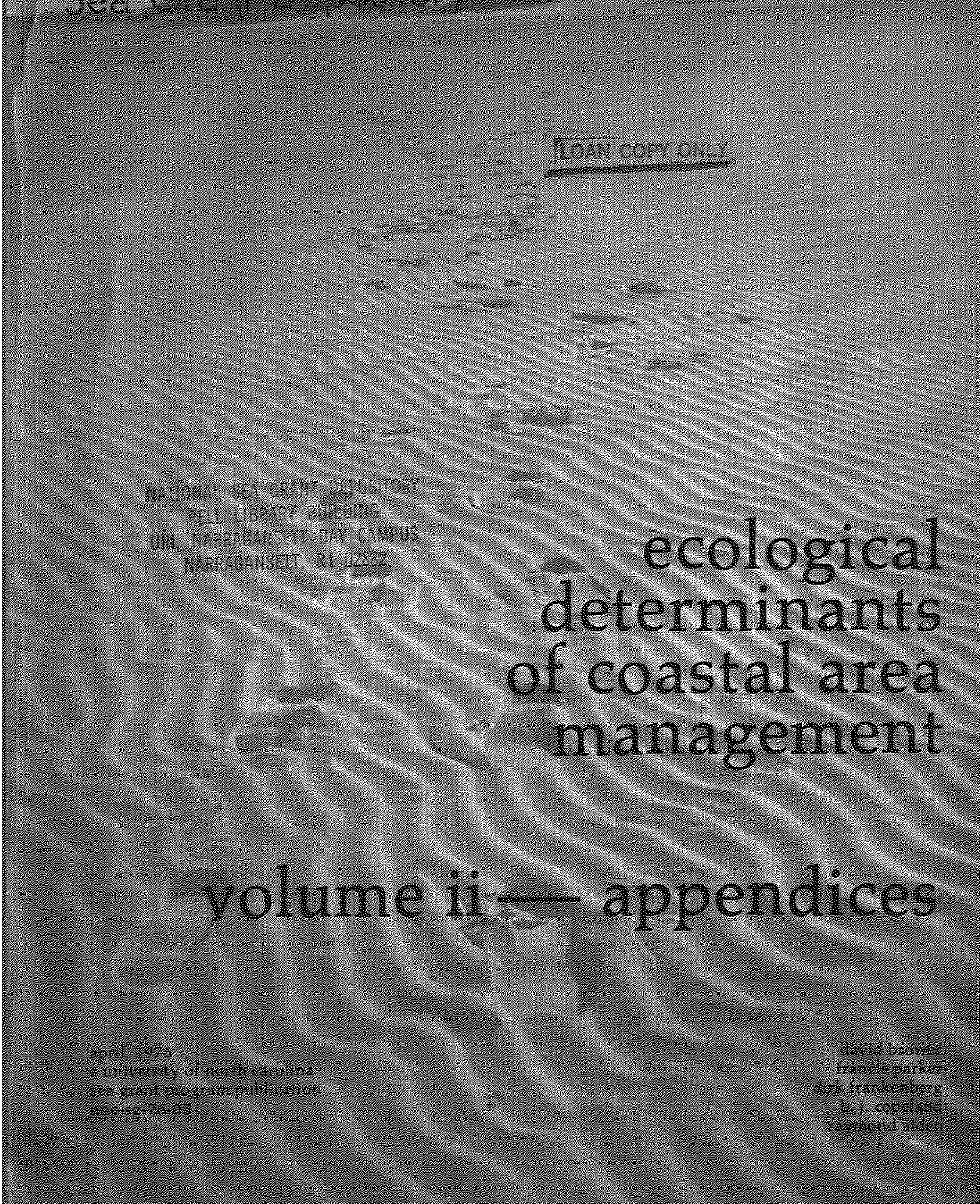

ecological determinants of coastal area management

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david brower
francis parker
dirk frankenberg
b. j. copeland
raymond stein

ECOLOGICAL DETERMINANTS OF COASTAL AREA MANAGEMENT

VOLUME II--APPENDICES

Edited by: Raymond Alden
David Brower
B. J. Copeland
Dirk Frankenberg
Francis Parker

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Sea Grant Program, 1235 Burlington Laboratories
North Carolina State University
Raleigh, North Carolina 27607

Project Directors

David Brower, Principal Investigator
Center for Urban and Regional Studies

Dirk Frankenberg, Co-Principal Investigator
Director, Marine Sciences Program

Francis Parker, Co-Principal Investigator
Department of City and Regional Planning

THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL
CHAPEL HILL, NORTH CAROLINA

Contributing Authors

Raymond Alden . . .	Marine Sciences Program, UNC
Vincent Bellis . .	Department of Biology, ECU
Candace Carraway .	Joint Degree in Law & Planning Program, UNC
Edwin Chester . . .	Joint Degree in Law & Planning Program, UNC
B. J. Copeland . .	Director, UNC Sea Grant Program
Glenn Dunn	Joint Degree in Law & Planning Program, UNC
Ron Fiore	Department of Zoology, NCSU
Val Klump	Marine Sciences Program, UNC
Wilson Laney . . .	Department of Zoology, NCSU
Ed Pendelton . . .	Department of Zoology, NCSU
Roger Pratt	Department of City & Regional Planning, UNC
Ed Proffitt	Department of Biology, ECU
Mary Joan Pugh . .	Department of City & Regional Planning, UNC
Johanna Smith . . .	Marine Sciences Program, UNC
Nancy Tomkovick . .	Marine Sciences Program, UNC
John Williams . . .	Department of Zoology, NCSU

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APPENDIX ONE

ECOLOGICAL DETERMINANTS

Contributing Authors

Vincent Bellis . . Department of Biology, ECU
Ron Fiore . . . . . Department of Zoology, NCSU
Val Klump . . . . . Marine Sciences Program, UNC
Wilson Laney . . . Department of Zoology, NCSU
Ed Pendelton . . . Department of Zoology, NCSU
Ed Proffitt . . . . Department of Biology, ECU
Johanna Smith . . . Marine Sciences Program, UNC
Nancy Tomkovick . . Marine Sciences Program, UNC
John Williams . . . Department of Zoology, NCSU

Supervised by

Raymond Alden
Marine Sciences Program
University of North Carolina at Chapel Hill

B. J. Copeland, Director
UNC Sea Grant Program
North Carolina State University at Raleigh

Dirk Frankenberg, Director
Marine Sciences Program
University of North Carolina at Chapel Hill

I. BARRIER ISLANDS

The genesis of the barrier islands has been debated by geologists for well over 100 years. No single theory, however, explains the complete evolution of the North Carolina Outer Banks and a multiple causality for barrier island formation seems likely from the evidence that currently exists (Pierce and Colquhoun 1970; Schwartz 1971). Even though the exact nature of the evolution of the Outer Banks is subject to considerable speculation, the following simplified sequence for their formation can be proposed. The initial barrier islands of North Carolina were probably formed in place on the continental shelf at a time of a low sea level stand several thousand years ago (Pilkey _et al_. 1975; Pierce and Colquhoun 1970). Sediments brought down rivers were built up by wind and wave action to form a typical mainland beach. With the onset of a worldwide warming trend, sea level began to rise as melting glaciers released hugh quantities of water into the ocean. As sea level rose, the lower-lying areas behind the beach were flooded, detaching the shore ridge from the mainland and forming an ancestral barrier. The present Outer Banks of North Carolina are most likely the result of 1) the extensive modification and migration of a set of "primary barriers" formed around 4000 years ago when sea level rise decelerated, and 2) the addition and extension of "secondary barriers" through spit elongation and offshore bar emergence. Such a sequence has been suggested (Pierce and Colquhoun 1970) and approximately 60% of the outer banks from Virginia to Cape Lookout are thought to be "secondary barriers." The extent, direction and rate of barrier island modification and migration depend upon the response of the island to varying hydraulic climates and sediment inputs and are critical processes in the barrier island system as a whole.

I.A. The Beach and Shoreface Dynamics

Val Klump and Johanna Smith

As suggested by Swift (1975), it is helpful to consider a barrier island system as a large-scale littoral sand body consisting of a shoreface maintained by the prevailing hydraulic regime (wave, current and sea level climate) and attached washover fans whose surfaces are modified by storm, eolian (wind) and biological (including human) activities.

The largest portion of the outer banks consists of straight or gently curving coastline dominated by nearshore and beach zone processes. These dynamic processes integrate the coastline and the other major barrier island environments into a single complex system.

I.A.1. The Beach in Profile

The profile of any given beach (Figure 1) represents an equilibrium between the amount of work required to remove beach sand and the ability of the waves to do removal work (Johnson 1919). The shape of this profile is controlled primarily by grain size, wave climate and sediment input (Bascom 1964; Ingle 1966).

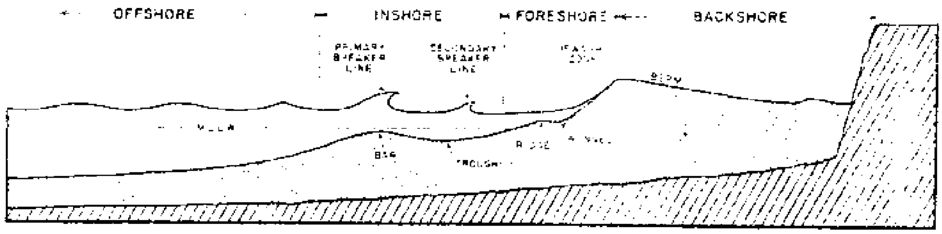


Figure 1. Terminology associated with the beach environment (from Ingle 1966). M.L.L.W. = mean lower low water.

The effect of <u>grain size</u> is relatively simple: the coarser the sediment, the steeper the beach. Shingle beaches often attain slopes of nearly 40°, while shores on muddy coasts are essentially flat. Beaches of sand (as found in N. C.) are rarely steeper than about 10° (Swift 1975). The process by which grains of different diameter adjust to a given slope under the influence of the prevailing wave climate is termed sorting.

For a given <u>wave climate</u>, there is an equilibrium profile at which a particular beach will not exhibit significant changes (assuming no significant net sediment losses or gains). As wave energy varies, the beach profile will change in response to the variation. The critical factor, the rate of delivery of wave energy to a beach, is described in terms of wave steepness, H/L, the ratio of the wave's deepwater height to its length. As low steepness waves (e.g., normal sea swells with low heights and relatively long distances between crests) move onto shore, sand grains are picked up and moved landward a short distance. Drag against other sand grains and non-turbulent flow in the near bottom region prevent the grains from flowing back an equal distance seaward with the reciprocal offshore motions associated with wave circulation (Bascom 1964). The result is a net movement of sand on shore, steepening the nearshore profile and shifting the subaerial portion of the beach (the berm) seaward. The elevation of the berm is increased and widened as waves top it and transport sand over its crest. On the shore winds can, in turn, carry this sand into the dune zone.

As wave steepness and frequency increase, as is common under winter storm conditions, increased turbulence in the surf zone is encountered, keeping the sand in suspension. Material is eroded out of the beachface and berm and is transported offshore where it is deposited as an offshore sand bar or series of bars. The shore profile is flattened, causing waves to break further offshore dissipating their energy and slowing beach erosion. Thus, the beach responds to high wave stress by acting to relieve that stress. Summer waves being generally longer and lower (except during storms) are less steep and will transport the sand placed in the offshore bars back to the shoreface. The berm acts as a temporary storage area between the offshore bars and the dune field (Figure 2) and provides the mechanism by which the beach zone can withstand high-energy wave regimes (Dean 1972). Man-made structures frequently interfere with this equilibrium by attempting to maintain a constant profile. They may initiate harmful conditions which neither man nor the natural system can cure.

In addition to grain size and wave climate a third factor, that of sediment input, is critical to the beach profile. High rates of sediment input usually allow a beach to prograde (i.e., build seaward). Beaches which experience a net loss of sediment, on the other hand, tend to erode and retreat. Whether a particular section of coastline is undergoing a net gain or loss of sediment depends upon a large number of interrelated factors that vary in time and importance, which are not accurately understood. The general trend along the N. C. coast, however, is erosion, a significant portion of which is produced by major, aperiodic storms (Langfelder *et al*. 1968).

Since grain size is essentially uniform along North Carolina's barrier islands, the major controlling factors on changes in the shape and the integrity of the beach are wave climate and sediment input. The manner in which the water and sediments interact is described in the following section.

I.A.2. Water-Sediment Transport

I.A.2.a. Normal Processes of Sediment Transport--The dominant sediment transport mechanism in the beach system is the longshore (or littoral) transport of which there are three basic modes: beach drift, suspension and bedload. Beach drift is the movement of sediments along the beach by waves in the direction of the current. Suspended sediments are carried directly by the water and the bedload is pushed along the bottom. The direction and magnitude of wave energy

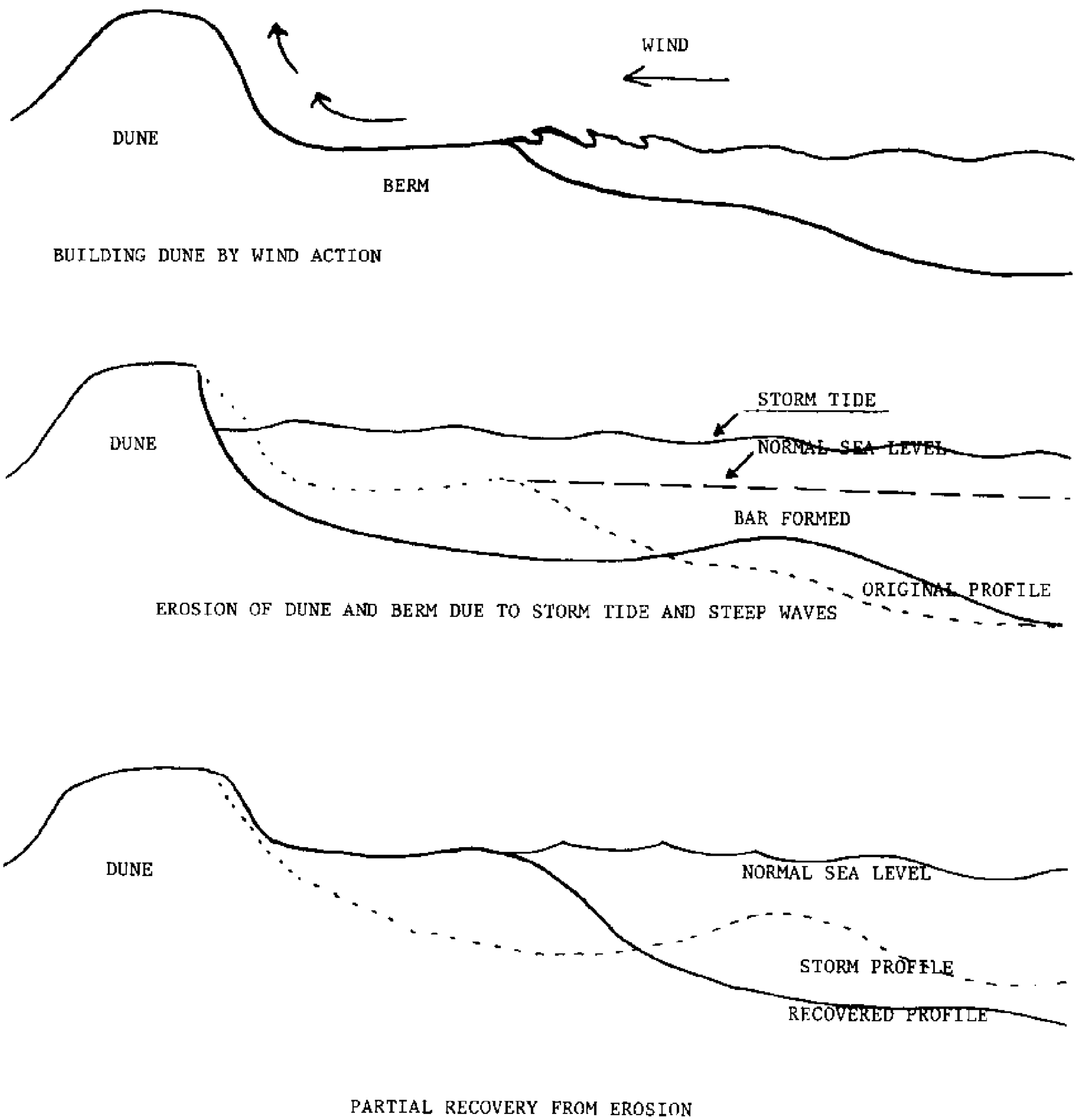


Figure 2. Diagrammatic representation of shoreface profile under normal and storm conditions (adapted from Dean 1972).

will determine the amount of sediment carried (U.S. Army 1966). The average annual rate of longshore transport is fairly regular in a certain area unless man modifies the shore or otherwise reduces the supply of sand. There may, however, be significant variation in sediment transport from place to place, even within a relatively short distance (U.S. Army 1966).

Most longshore currents are generated by wave fronts striking the beach at an angle. As a wave shoals, refraction tends to force it parallel to the beach, but this refraction is never complete. The result is a residual longshore component of flow as a wave breaks on the bar or beach. The cumulative effect of a procession of wave fronts is a steady longshore current. Since the waves depend on wind, however, there may be a change in these currents in response to storms and hurricanes (Shepard and Wanless 1971). There also may be regular seasonal variation in these currents (U.S. Army 1966).

Currents are able to move tremendous quantities of sand that are suspended by turbulence beneath breaking waves. Ingle's (1966) tracer studies showed that sand released on either side of the outermost breaker will move into it and then in the direction of the longshore transport (Figure 3). The sand on a windward coast may travel in a moving ribbon up to 100 or more meters wide and 5 to 10 centimeters thick, at rates of above 100-1000 cubic meters per day.

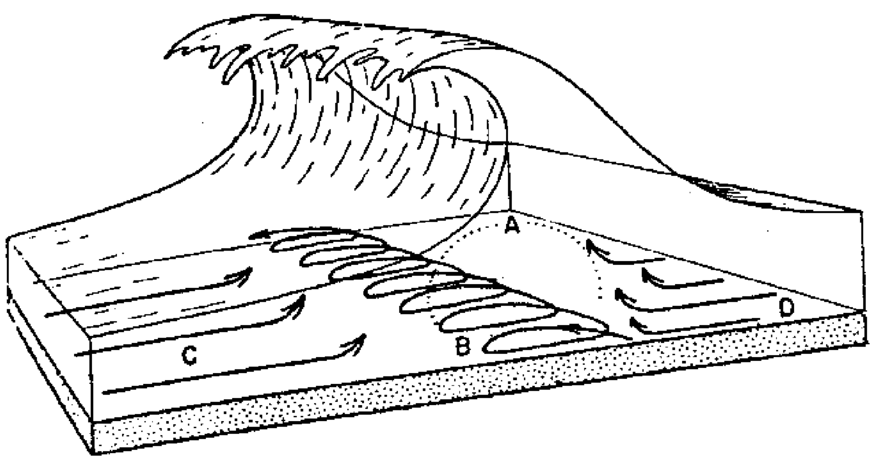


Figure 3. Movement of sediment in the surf zone (from Ingle 1966).

The wave energy driving this littoral "conveyor belt" is considerable. For average weather conditions along the California coast, energy associated with littoral transport has been estimated at 500,000,000 foot-pounds per foot per day or about 50,000 horsepower per 100 miles of coastline (Bascom 1964). Since the wave front angle determines the direction of transport, offshore topography and the location of wave-generating weather systems are important. The effect of offshore topography may have a particularly important effect in the cape-shoal regions of North Carolina.

When waves break on a shallow underwater bar in rapid succession, water may be built up inside the bar because its return flow is hindered by following waves, a phenomenon termed "wave set-up." Seeking to return to sea level this excess water will flow laterally along the beach until enough water is added to it in order to force a flow seaward, termed "surf beat." The result (Figure 4) is complex horizontal and vertical circulation patterns associated with the formation of rip current (Bascom 1964; Swift 1969). Beyond the breaker zone the current dissipates into a rip head. Rip currents may recycle beach sands offshore.

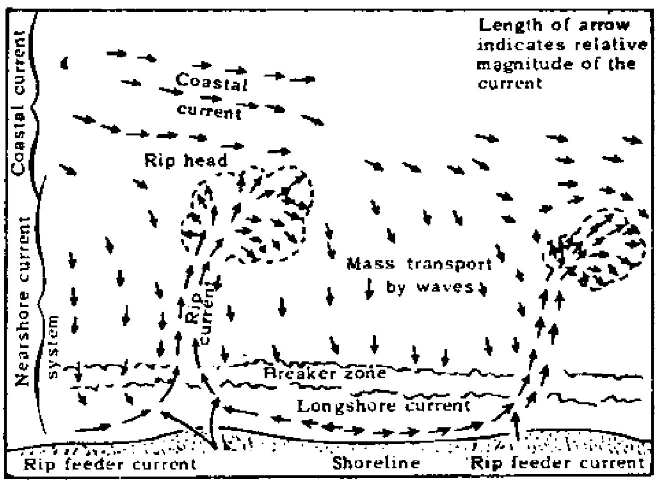


Figure 4. Nearshore circulation: plane view (from Swift 1969).

I.A.2.b. <u>Sediment Transport Associated With Storms</u>--The heightened wave and sea level conditions associated with storms, termed storm surge, are important mechanisms for sediment cycling and are certainly of critical concern to the beach front dweller. Storm surge is the storm-induced rise in water level above the normal tidal range. Fore-runner swells associated with a storm several hundred miles offshore may reach the beach well in advance of the storm and cause unusually high surf. As the storm approaches, a low pressure system may cause an additional sea rise, termed the "inverted barometer wave." This component is absent in hurricanes, however, since they are high pressure systems. Wind-generated wave set-up is the most important and heightens the surge considerably as wind velocities increase. Stillwater sea levels commonly reach 3 to 4 meters above normal and wave heights reach even higher (Swift 1969; Table 1). In 1970 hurricane Camille produced an 8-meter surge along coastal regions and 25-meter waves over the deep shelf. These storm surges can have dramatic consequences, both onshore where they cause flooding and erosion and offshore where they may effect sand transport at depths and distances unaffected by normal climates.

Table 1. Storm Stillwater Surge Levels and Breaking Depth of Waves for One in a Twenty-Five, Fifty, and One Hundred Years Storm Return Frequency, Respectively (from Swift 1969).

Location	Surge level(s) (+Ft. MSL)			Breaking depth(Hm) (-Ft. MSL)		
	1/25	1/50	1/100	1/25	1/50	1/100
Virginia to Cape Hatteras	7.43	8.20	8.80	7.06	7.79	8.36
Cape Hatteras to Cape Lookout	7.10	7.63	8.00	6.75	7.25	7.60
Cape Lookout to New River Inlet	7.63	9.33	10.95	7.25	8.86	10.40
New River Inlet to Cape Fear	8.80	10.55	12.05	8.36	10.02	11.45
Cape Fear to South Carolina	9.67	11.23	12.45	9.19	10.67	11.83

I.A.2.c. Overall Sediment Budget--The overall sediment budget of a barrier island system is controlled by a large array of factors and will vary greatly depending on the time over which the observations are made. Pierce (1968) studied the section of the Outer Banks from Hatteras Inlet to Cape Lookout and through the use of historical records over the past 100 years estimated that accretion (net deposition of sand) in this segment has exceeded erosion. Yet, about one-half of this area is eroding, even though there is a net gain of sediment over the entire sector. The major losses from this system occur through inlets, washovers, and onto Cape Lookout and Lookout Shoals. The major inputs are longshore transport from the northeast and a postulated continental shelf sediment movement into the nearshore area. This offshore sediment source is a matter of speculation and the exact mechanism for its transport onshore is unknown. Under erosional conditions, however, material may be transferred from the lower shoreface to the adjacent shelf trangressive sand sheet (i.e., offshore). This occurs as a storm-induced wind causes downwelling along the shoreface, although this process is also poorly understood (Swift et al. 1975).

Figure 5 summarizes the major components of sediment and water transport in a hypothetical coastline sector. The unknown nature of these processes serves to point out that geologists cannot yet fully describe the sediment budgets and transport mechanisms for the barrier island systems even for the relatively long-term or gross changes.

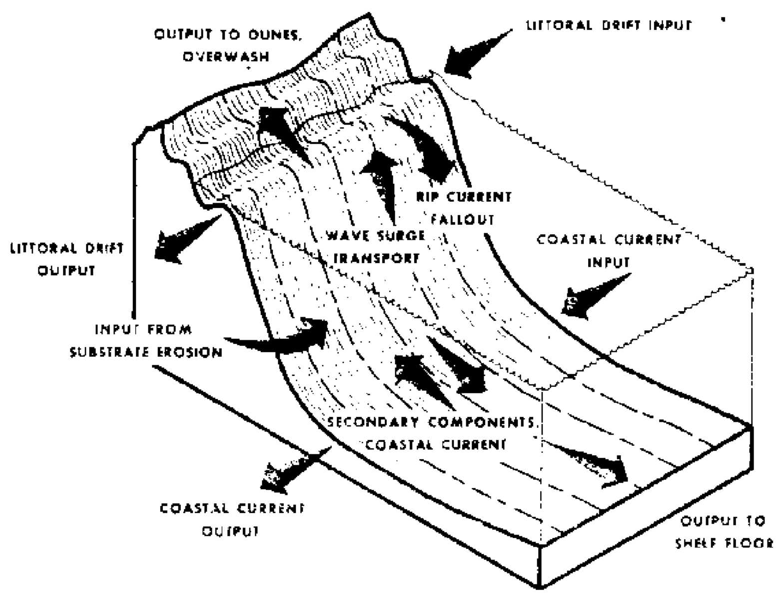


Figure 5. Unit volume of coastal water column and its substrate (from Swift 1975). Arrows indicate components of sediment and water transport.

Underlying the seasonal and aperiodic variations in wave climate and sediment transport is the phenomenon of sea level rise. This rise, while very slight, may be affecting the barrier islands in a very important way, resulting in long-term changes in barrier island morphology. One possible effect is discussed in the following section.

I.A.3. Barrier Island Migration

A long-term behavior of an island during a marine transgression (i.e., a sea level rise) depends upon the balance between fair-weather accumulation and storm erosion (Swift 1975). This net balance may depend largely on the net import of sand into the system. With a relatively constant amount of sediment being supplied by longshore transport, the island can maintain itself in place as sea level rises by building upward (Figure 6), and may even translate seaward by the outward growth of beach ridges (Curray 1969; Swift 1975). This sand must come from somewhere, however, and many sections of the North Carolina coast are not receiving sediment inputs, but are closed sand-sharing systems. Net littoral import is negligible or negative. Sediments coming down the rivers no longer reach the shore zone. Sea level rises have flooded inland river valleys and sediments from rivers are trapped in coastal estuaries. Under the circumstances of zero sediment gain or net sediment loss, an island faced with rising sea level must retreat back up the coastal plain to maintina a constant elevation and prevent submergence. For a given rise in sea level, an island may need to retreat a distance two or three orders of magnitude greater than that rise. With the current rate of marine transgression of about 1 foot per century, this process obviously entails significant movement (Pilkey _et al_. 1975), on the order of 100 to 1000 feet per century.

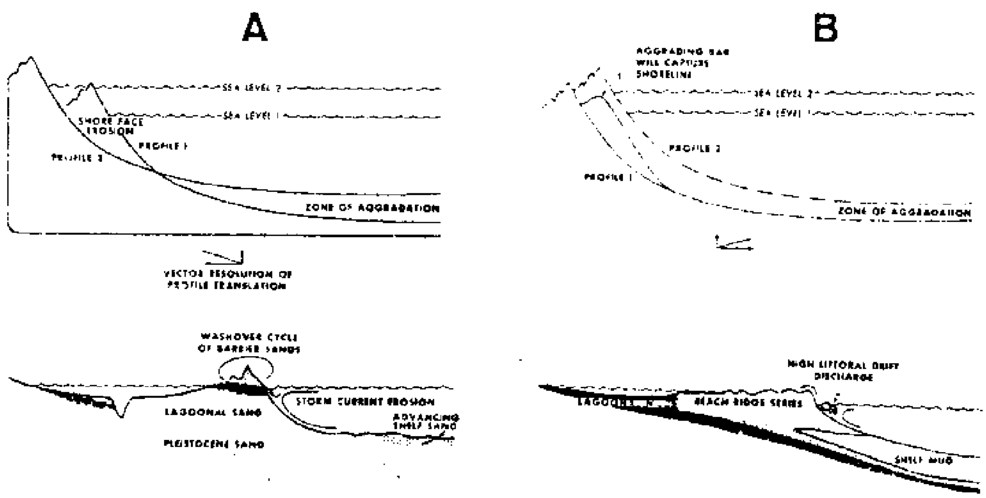


Figure 6. A) Erosional shoreface retreat after Bruun 1962; and B) depositional advance of the shoreface in response to an excess of coastwise sand imports over exports (from Swift 1975).

Storm surge washovers provide one mechanism by which sediment is recycled landward allowing the island to roll over on itself and crawl slowly up the coastal plain (Figure 6). Some barriers, however, are reasonably stable, being perhaps slightly more erosional than constructional. Pierce and Colquhoun (1970) showed that 40% of the barrier still sit on Pleistocene (old) soils indicating no overall retreat. Washovers in these cases act as sand sinks. After a storm the beach repairs itself, the dunes rebuild again, and the dynamic shoreface equilibrium is maintained.

I.A.4. Capes and Cuspate Forelands

Three prominent capes or cuspate forelands exist on the North Carolina coastline: Capes Hatteras, Lookout, and Fear. Associated with each is an extensive underwater shoal of major proportions; Diamond Shoals, Lookout Shoals and Frying Pan Shoals, respectively. The near right-angle bend in the coastline at the capes distorts littoral transport so that it loses sand-carrying capacity and the shoals prograde onto the inner shelf. At the same time the barrier is responding to transgressing sea levels by retreating landward; hence, these shoals are called cape retreat massifs.

The real picture is not always quite so simple. Cape Hatteras and its associated retreat massif are aggrading on their south sides and eroding on their north sides (Fisher 1967). It appears, therefore, that the Cape is moving southward and rotating slightly. The presence of this vast ridge of sand does indicate that the retreating Cape Hatteras has been a <u>net</u> sink rather than a source for longshore transport throughout recent geologic time (Swift 1975). Frying Pan Shoals has experienced an average annual accretion of approximately 30,000 cubic yards (El-Ashry and Wanless 1968). The presence of these vast shoals certainly affects the wave climate impinging on the nearby coast. Wave fronts, especially the larger ones, will be refracted as they cross these shoals. Should storm waves alter significantly the shape of these shoals, nearby coastlines may experience new dominant wave patterns and sediment transports may shift. While the dynamics and hydraulic mechanisms active on these massifs have been the subject of some investigation (Tanner 1961; Curray 1964; El-Ashry and Wanless 1968), they are, to date, largely unexplained.

I.A.5. Washovers

Although the beach, inlet and dune systems are discussed separately, the washover is one major feature that cuts across all three of these barrier island environments. A washover connects beach with sound or lagoon, transects the dune field in the process, and may become an inlet either permanently or temporarily. Washovers are easily recognizable as low, usually broad, passes running across the island from the ocean to the sound. These passes and the processes which cause them are critical components in the dynamics of the barrier island ecosystem.

Occasionally the wave climate associated with an exceptional storm exceeds the ability of the beach zone to absorb it. Wave heights may carry over to the beach ridge or erode the foredunes to the point where they can be over-topped. Water and sand is then carried down across the island by its increased elevation above the still water level in the lagoon. If this flow is constricted and fractional losses are minimal, a channel may be cut. According to Pierce (1970), where the barrier is wide, low and extensive adjacent barrier flats are present, the most likely result is the formation of a washover fan (a delta-like feature spilling out into the lagoon). Because of the low profile and the distance required to cross a wide barrier, the water usually does not attain a very high velocity, frictional losses dissipate most of the energy and erosion is considerably lessened. As the water slows, entrained sediments drop out onto the washover passes. Tidal flats at the rear of the barrier build up and further reduce the back barrier slope. A series of distributaries is formed on the fans which distribute additional surges over a larger area, lessening the chance of erosion below still water levels. When these washover fans overlap a washover terrace is formed.

Washover passes and fans support a sparse grassland of _Spartina_ and _Solidago sempervirens_ (Figure 7). The standing crop is usually low, approximately 0.05 kg/m^2 (Godfrey and Godfrey 1974). Toward the back of the washover terraces a more productive closed grassland, dominated by _S. patens_, _Fimbristylis spadicea_ and a number of other associated species, is often present. Standing crop here may be up to 1.5 kg/m^2. At the back fringe of the island, washover deposits often cover old marshes, new marshes then develop on top of the old. Where the deposits are flooded by spring tides, a high salt marsh of _S. patens_, _Fimbristylis_ and _Juncus roemerianus_ forms.

Godfrey and Godfrey (1974) point out the importance of washover and inlet closing in the formation and maintenance of new and more productive marshes. Older marshes which have built up peat over the years have grown vertically and are often bordered by an erosional scarp where waves are cutting away at the substrate. Lateral growth in these marshes is

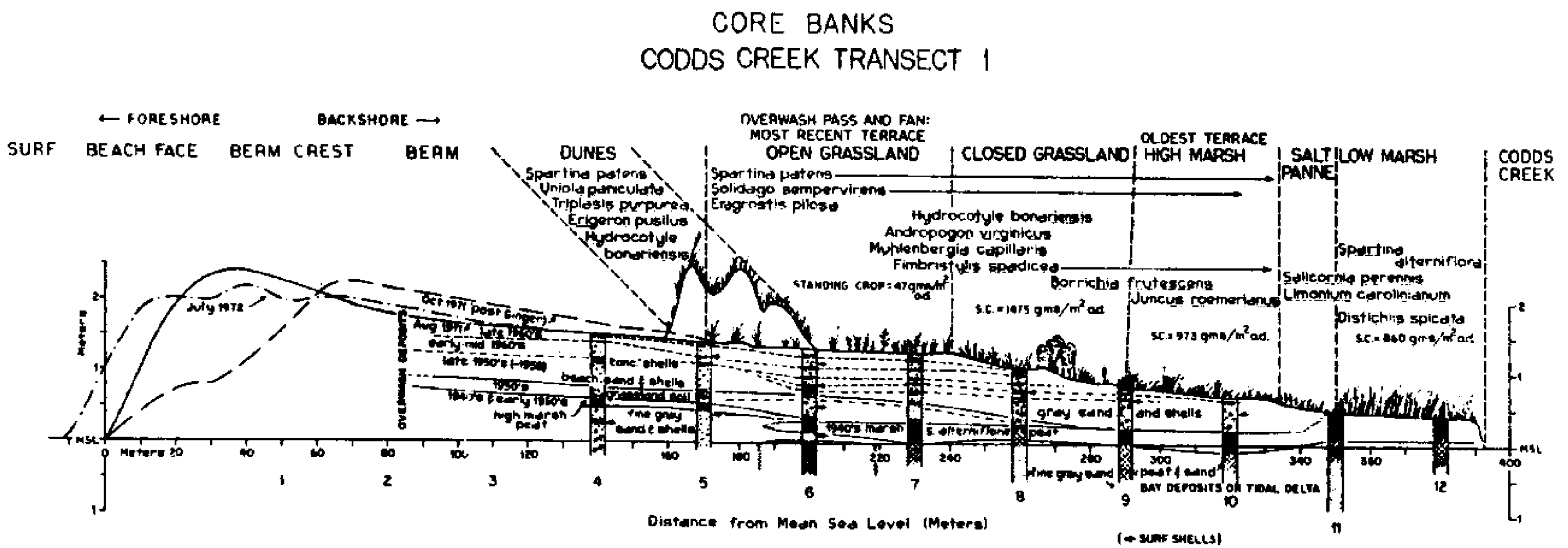


Figure 7. Stratigraphic and vegetation profile across Core Banks at Codds Creek (from Godfrey and Godfrey 1974). Dated lines are probable surfaces: solid line = August 1971; dashed line = September 30, 1971; and the third line = July 1972.

effectively halted. The area is dominated by the short form of Spartina alterniflora and standing crop is only about 0.7 kilogram per square meter. Tidal flooding is less frequent and less nutrient-rich detrifal organic material is able to reach the estuary.

In contrast are the newer marshes formed from oceanic washover. Here the sediment grades into the lagoon allowing lateral growth. The S. alterniflora grows in its tall form and standing crop may reach 1.9 kilograms per square meter. Regular tidal flooding carries nutrients into the estuary and allows many organisms to inhabit the marsh. Dunes protect the marshes from excessive washovers, but do not halt the process of barrier island retreat. The natural process of washover, therefore, serves to dissipate high storm wave energies and maintain the elevation of the island in face of rising sea level. It also serves to assure the growth of highly productive marshes and maintain a link between the barrier island and lagoon-estuary ecosystems.

I.B. Inlets

Val Klump and Johanna Smith

Sections of the barrier island system are dominated by inlets and their associated processes. Figure 8 shows these areas along the North Carolina coast, the majority of which lie in the southern half of the State. The inlet area is highly unstable, giving rise to rapid and large-scale erosional and depositional changes in response to long-shore and tidal currents, waves and storms (Tilley 1973). Such changes can result in the opening, closing or migration of inlets. These natural processes are many times in conflict with man's actions and desires. Thus, he often dredges and attempts to stabilize inlets against the forces of nature. The dynamic nature of inlets, however, must be considered in the framework of the entire barrier island system and its gradual retreat shoreward in response to rising sea level. Viewed in this way, the cycle of inlet formation, migration and closure plays an important part in widening the island (Godfrey and Godfrey 1973).

I.B.1. Physical Characteristics

Physically, the tidal inlet consists of a channel, an ebb-tidal delta, a flood-tidal delta, the barrier island shoals and swash bars. Most of the depositional structures are dynamic features, changing in response to currents and waves. The barrier island boundaries on either side of the

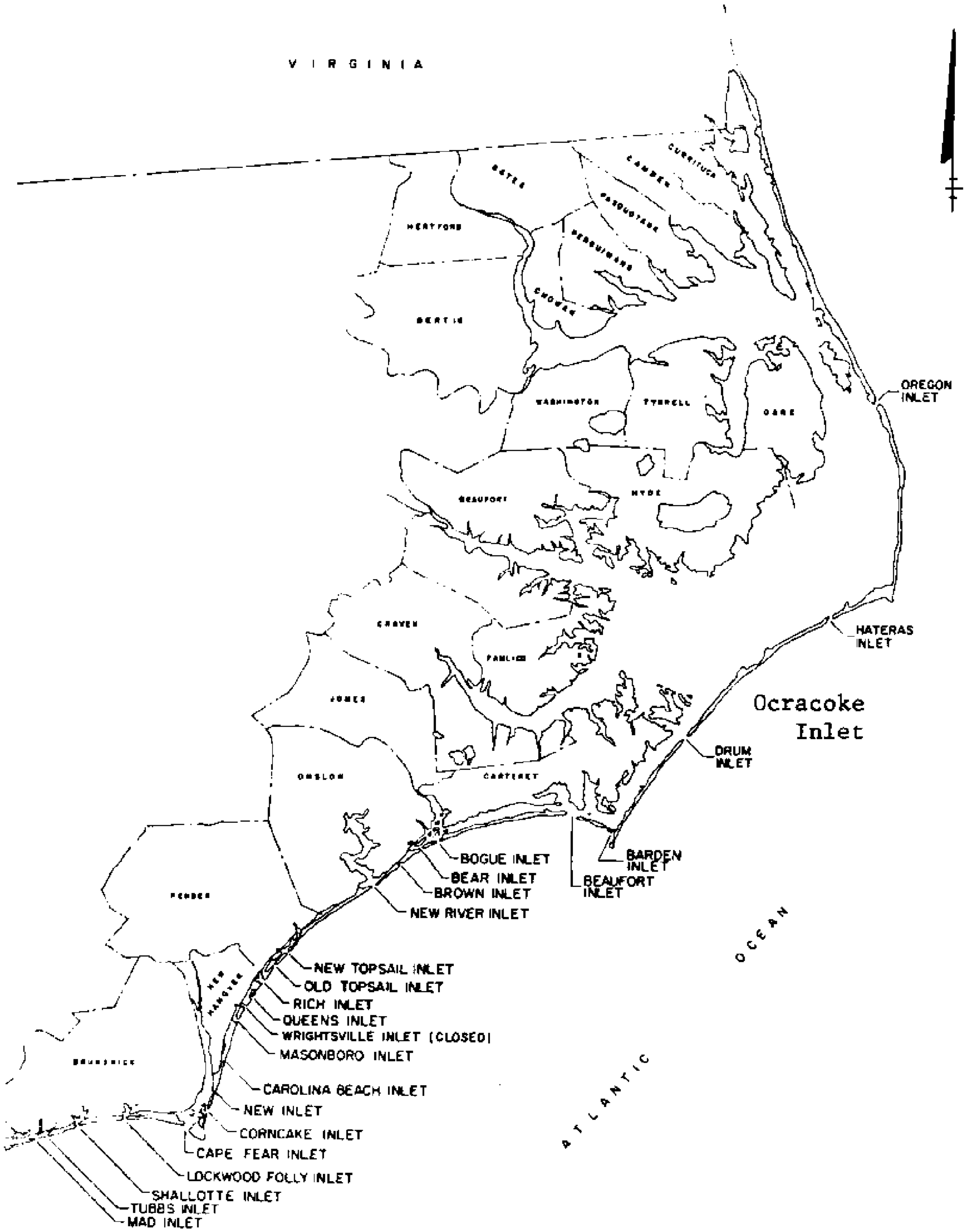


Figure 8. Location of North Carolina's inlets (from Langfelder et al. 1974).

inlet are constantly being modified by erosion and deposition. Usually, one side is building up while the other is eroding, causing an offset of the barrier (i.e., one side extending farther down-drift over the inlet entrance). The flood-tidal delta is formed on the lagoon side by sediments carried in on the flood tide. It is a very broadly lobed delta, transected by channels and distributaries and often having areas exposed to waves and is, therefore, variably modified by the wave energy of the system (Bruun and Gerritsen 1959). Both deltas have certain channels which are definite ebb-flow and flood-flow channels (Bruun and Gerritsen 1959). The various offshore shoals are very important as storage areas for sediment crossing the inlet opening (U.S. Army 1966). These shoals and wash bars are formed in response to local current conditions and waves (Hayes *et al*. 1973).

I.B.2. Dynamic Characteristics

The tidal inlet is in a state of dynamic equilibrium due to the interaction between sediments and the processes moving these sediments. Since inlets connect the open ocean with the lagoon, they are subject to tidal currents. And because they exist along the barrier island, they are subject to the longshore currents. The processes of importance, then, are erosion and deposition as influenced by tidal, longshore and local currents.

I.B.2.a. Tidal Currents--Tidal range along the North Carolina coast is approximately 3 feet. Variations occur, however, due to weather conditions and lunar cycles. The tides are diurnal, having two tidal cycles a day. This cyclic oscillation results in flood currents which enter the lagoon through the inlet and ebb currents which return to the ocean. The tidal current will define the tidal prism, or how much water moves in and out through the channel. The width, depth and length of the channel also directly control the amount of flow and indirectly control the speed of flow (Oertel 1975). Any changes of flow due to sedimentation will affect subsequent flow and sedimentation. Thus, through erosion and deposition, the inlet is constantly working toward an equilibrium between the length, width and depth of the channel and the tidal prism (Bruun and Gerritsen 1959).

I.B.2.b. Longshore Currents and Transport--Longshore currents are formed in response to wave energy directed against the shore as previously discussed.

I.B.2.c. Deposition--When considering deposition, it is important to remember that the system is always changing. Therefore, although an offshore bar may remain in approximately the same position, it is not made of the same sand.

Several types of depositional features are associated with the inlet. These are tidal-deltas, recurved spits, offset barrier and shoals. Brief mention has been made of some of these, but a more detailed discussion of their formation, dynamic state and relation to currents and waves will be given.

As sand carried by the longshore transport system approaches the inlet, various changes in currents and waves occur due to change in morphology (Hayes et al. 1973). Changes in wave refraction and current patterns cause the updrift barrier to grow as a recurved spit through sediment deposition. At the same time, removal of sediment by the longshore transport system causes the downdrift side to erode, resulting in larger barrier updrift or updrift offset (Figure 9).

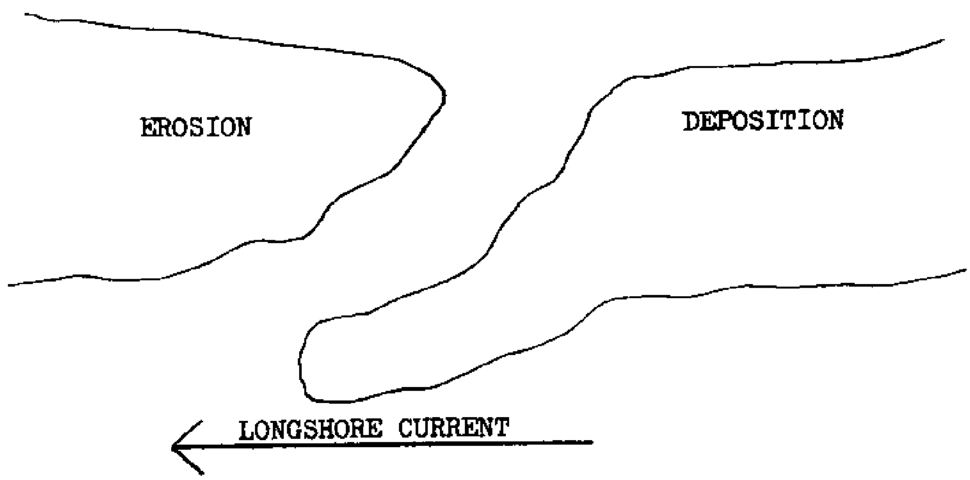


Figure 9. Effect of longshore current on erosion and deposition around an inlet.

Sediments carried to the mouth of the inlet will be moved by the flood tide currents. At flood tide, waves and currents are working together to produce optimum transport conditions (Hoyt and Henry 1965). As the water moves up the inlet, it loses much of its energy and, therefore, drops its sediment. The sand is deposited in relatively large floodtide deltas, which essentially store the sediment (Oertel 1972). Since the lagoon is a low-energy area, the floodtide delta is not as greatly affected by waves and currents and consequently develops a more intricate pattern of channels and shoals.

Most inlets are subject to shoaling. Anything that changes the equilibrium between the tidal prism and the physical form of the inlet will change the amount of water flowing in and out. This change in the tidal prism will cause further change in the depositional patterns (Bruun and Gerritsen 1959).

The general causes of shoaling are lengthening of the inlet channel, deposition of sediment during storms and splitting of the main channel. All serve to modify the balance between the channel and the amount of water flowing through it. Lengthening the inlet channel through deposition is an ongoing process while the other causes are associated with storms, therefore occurring less frequently. Obviously, these shoals are a danger in navigation of the channels.

As the water moves out of the lagoon on the ebb-flow, an ebb-tidal delta is formed. Hayes et al. (1973) gave the following model:

> The ebb-tidal delta consists of 5 major components; 1) major ebb channel, 2) channel margin linear bars, 3) terminal lobe, 4) marginal flood channels, and 5) swash bars. These features are maintained by a balance of three hydrodynamic forces; wave action, flood currents, and ebb currents (with the ebb currents being the dominant factor). The channel margin linear bars are apparently built by the interaction of ebb currents and waves; swash bars are the result of wave action; the major ebb channel and terminal lobe are maintained by ebb currents; and marginal flood channels are a response to flood currents.

Inlets tend to interrupt normal littoral transport of sediment since the longshore current is affected by the tidal current. Natural inlets, or those not modified by man, have offshore bars by which sand moves across the inlet, through a process called sand-bypassing (U.S. Army 1966). This is not simply a matter of sand moving directly from the longshore current to the offshore bars and then to the other side. Rather, it involves a reworking of the sediments influenced by tidal currents over the entire area.

Several variables are involved as the sand moves across the inlet; the most important to the downdrift side is the supply of sediment. Since this supply is not constant, the downdrift shore is not stable and is subject to erosion (U.S. Army 1966). Another factor involved in the smooth bypassing of sediment is constancy of wave action (Brown 1928). A change in wave patterns due to storms or seasonal change will, therefore, affect the sand bypassing system. If there is more sediment than the ebb-tidal current can effectively flush back into the longshore transport system, the inlet will eventually be closed off.

I.B.3. Temporal Characteristics

I.B.3.a. Migration and Stability--Two important characteristics of inlet development are migration and stability. Through processes previously discussed, an inlet will go through a cycle of various morphological changes. Development proceeds such that the channel begins to meander, may eventually fill with sediment and close off completely (Langfelder et al. 1974). Meandering may proceed to such a point as in Mad Inlet, where a long narrow channel runs almost parallel to the beach (Tilley 1973). Those inlets that lie near the mouth of a major river, such as Beaufort Inlet, will remain open longer since a much stronger current continuously flushes the channel. If an inlet is maintained artificially, the entire dredging process will have to move more sediment and so become more expensive (Pilkey 1972). Since the tidal deltas are growing, the channel must be maintained at greater and greater lengths. The stability of inlets is also subject to seasonal reversals in winds and currents which will change patterns of sand transport and deposition (Brown 1928).

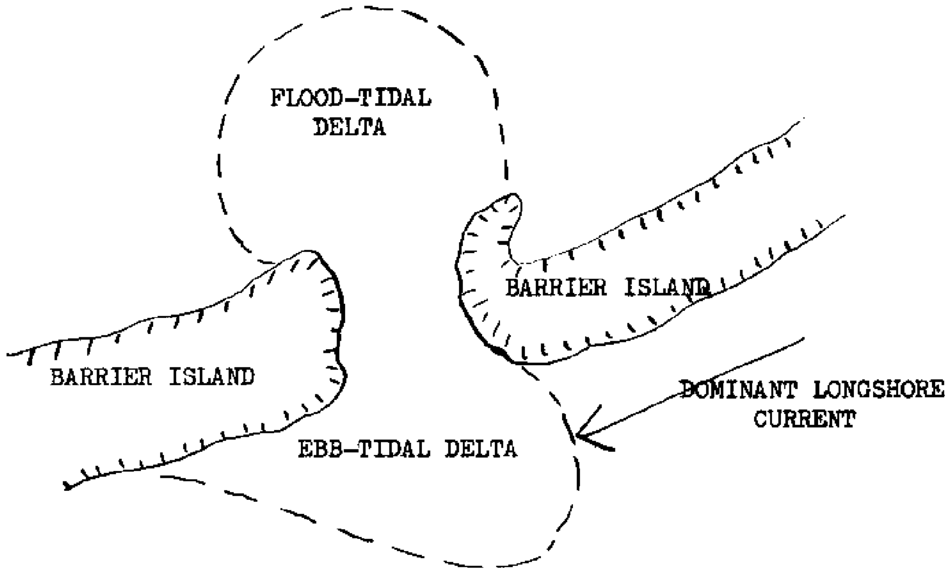
The process of migration also occurs in response to wave forces, longshore currents and tidal currents, and tends to occur in the direction of the dominant longshore current. Inlets in North Carolina, therefore, move from north to south except where local currents cause variation. A shoreline area up to 6-8 miles may be affected by an inlet (Hoyt and Henry 1965). Sediments are deposited on the updrift barrier and erosion occurs downdrift (Figure 9). The updrift barrier may develop several recurved spits on the lagoon side (Figure 10). The rate of migration depends on the magnitude of the littoral drift and the velocity of tidal and longshore currents (Bruun and Gerritsen 1960).

The movement of inlets up to 1948 has been studied and documented in the "North Carolina Beach and Erosion Study, 1948." An extensive report covering inlets of North Carolina, their description, migration trends and future sedimentation trends has also been written by Langfelder et al. (1974).

I.B.3.b. Formation--Over a broad time scale, inlets progress through a cycle of formation, migration, development and closing. Inlet areas and these processes are important in widening the island and, thus, the overall maintenance of the barrier island system.

The formation of inlets is caused by the tidal surge associated with storms. It can occur in several ways depending on the configuration of the barrier, the depth of the lagoon and the direction of the storm surge (Pierce 1970).

DEPOSITIONAL PATTERNS OF A GENERALIZED TIDAL INLET



DEPOSITIONAL PATTERNS OF A TIDAL INLET WITH A FILLED-IN LAGOON

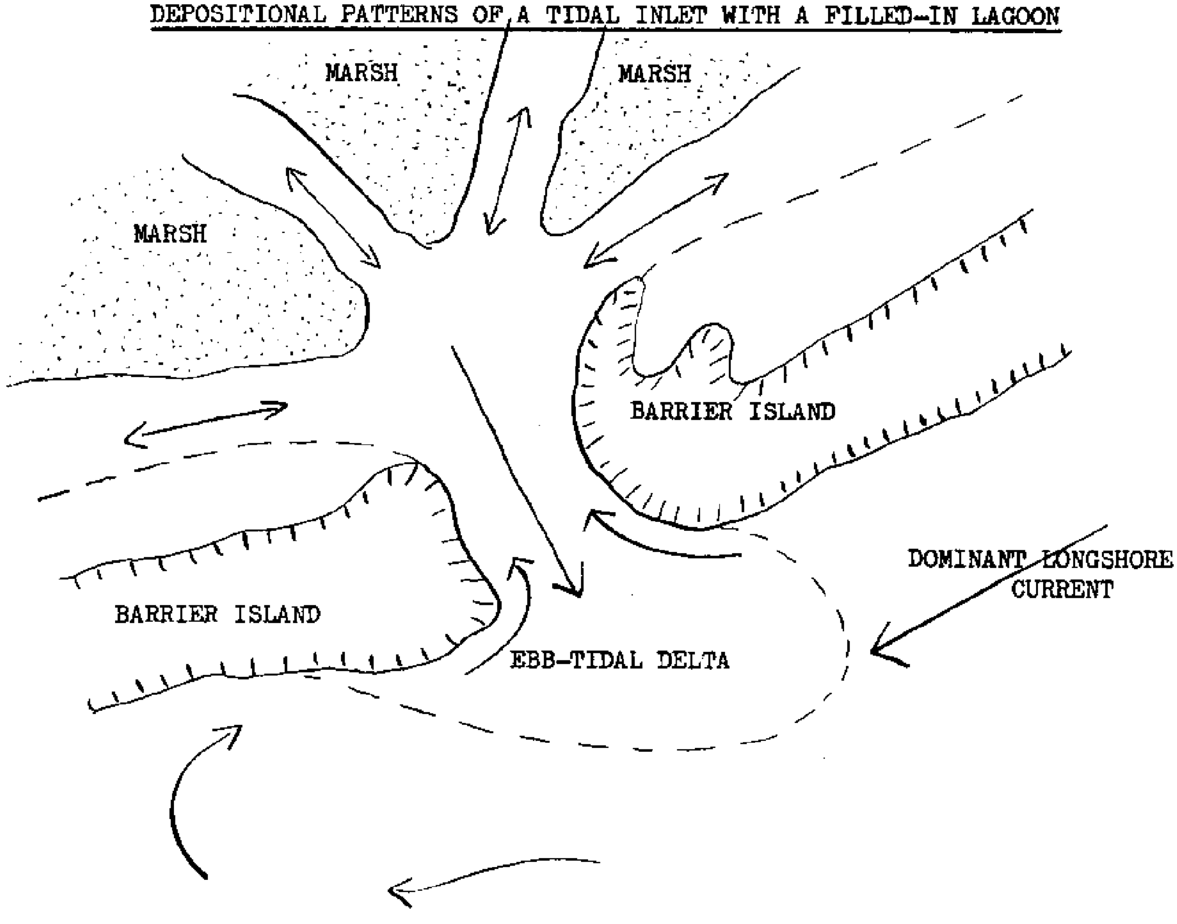


Figure 10. Major depositional patterns and water-flow components.

Inlets will not be formed by normal wave action, since the energy from these waves is not concentrated in a small enough area and the system is adapted to the normal energy regime. Storm waves overtopping a barrier island will result in either a washover fan or a tidal inlet, depending on how the energy is concentrated. If the barrier is wide with a relatively flat slope into the lagoon, the energy will tend to dissipate. This will result in formation of a washover fan with many small distributaries to carry the water and, thus, the energy. If, however, the storm surge is concentrated in a small area, across a narrow barrier, frictional losses will not be as great and an inlet can form. Steeply sloping lagoonal sides do not allow the dissipation of energy and the water tends to cut through (Pierce 1970).

During a storm, water can pile up on the landward side of the lagoon due to the force of the wind and the increased runoff from rains. During tropical storms, which have a definite reversal in wind direction, this initial build-up can be rapidly reversed. As tides and storm energies ebb, the water rushes back toward the barrier island. If the energy is sufficiently concentrated, it may move sediments and cut a channel as waters breach the island to escape the lagoon. The length of time that an inlet remains open depends on the frequency of storms, the rate of sediment transport by longshore currents, the tidal range and the prevailing winds (Godfrey and Godfrey 1972).

I.C. Dunes

Val Klump and Johanna Smith

Although the dunes are intimately associated with the entire sand-sharing system over long time periods, several other processes are of major importance to their maintenance. These will be discussed below.

I.C.1. Physical Characteristics

Dunes and dune fields are formed by the eolian transport (wind transport) of sands and the growth of dune vegetation. Sand moves by saltation, a process whereby sand lifted by wind energy bounces along a loose sand surface setting other grains in motion by its impact. The wind velocity necessary to initiate sand movement is known as the threshold velocity. Under normal conditions the threshold velocity is about 10 mph (4.5 m/sec) (Ranwell 1972). Threshold velocities will increase with increasing grain diameter, humidity, surface slope and salt spray.

The instability, lack of nutrients and lack of soil moisture of the foreshore sand deposit washed by tides make colonization by plant life practically impossible. Tidal litter, left behind at the high water mark in strandlines, provides the niche for the initiation of plant growth necessary for dune formation. Vegetation that establishes itself in a strandline or on a dune begins to accumulate sand by reducing the wind velocity at the surface well below the threshold level. Plants, such as Uniola paniculata (sea oats) and Ammophila (American beach grass) are able to develop extensive horizontal and vertical rhizome systems which act to capture moisture from rainfall, and to bind sand and stabilize sand surfaces. These plants flourish under conditions of moderate burial and are, thus, superbly adapted to growing in the unstable dune environment. Ammophila seedlings will establish themselves on the shore or dune particularly after periods of heavy rainfall, which yield sufficient moisture and stability for growth to begin. Rhizome fragments off toppled clumps from eroded areas are a major means of reestablishing new embryo dunes. Shoot elongation and branching occur rapidly in the spring, creating a cluster of shoots that is loose and open in accreting areas and denser clumps in stable areas (Ranwell 1972). Embryo dunes may coalesce to form a band which grows upward.

I.C.2. Dynamic Characteristics

Growth of a dune is initially parallel with the strandline. If the coastline is prograding, a series of parallel dune ridges may form as alternating ridges and hollows stabilize in situ. If onshore winds are strong and persistent (or if vegetation is destroyed), a dune may grow to maximum height, then erode, moving about with the winds. Maximum wind velocities over a dune are experienced at the dune crest, the height of which is controlled by wind, rain and vegetation. Behind the crest, in the lee of the dune, an air circulation vortex (or eddy) creates an area of reduced velocity where the effect of gravity exceeds the transport capacity of the wind and sand is deposited. This sheltered area extends to the leeward of the dune and allows the formation of a dune slack where deposition is minimal, since the wind has lost most of its sand. Beyond this point, higher wind velocities reach the surface and may carve the sand down to nonerodable damp sand just above the water table (Ranwell 1972).

Dunes migrate and shift their position frequently through continuous windward erosion and leeward deposition and through occasional dune "blowouts" and parabolic dune formation (Figure 11). In doing so there is a constant alternation between dune and slack. The "ghost forests" of dead trees and stumps witnessed in the barrier island dunes attest to this fact, as forests are covered and then uncovered by moving sands.

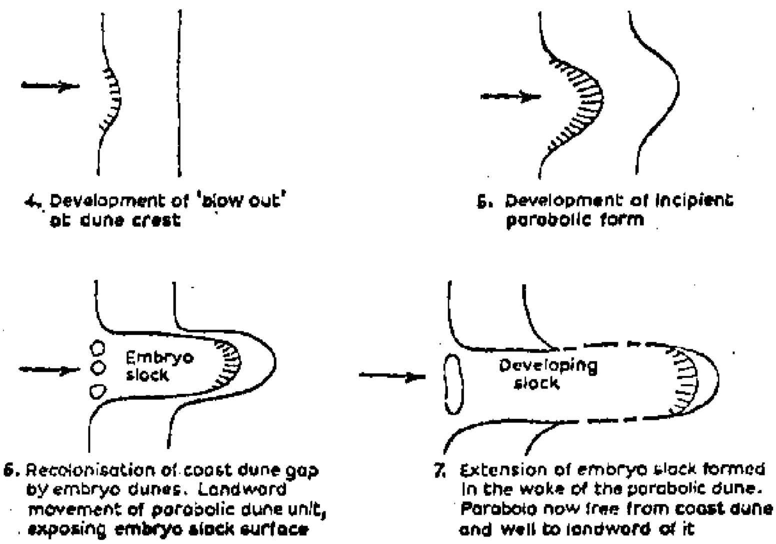


Figure 11. The formation and development of a parabolic dune unit (from Ranwell 1972).

The relative orientation, stability, distance inland and topography are all factors that may affect the ecology of the dune zone environment. Solar slopes, shade slopes, windward slopes, leeward slopes, hollows, slacks and plateaus include some of the topographic variations that can affect ecological adaptations. Salt spray has been shown to be an important factor in determining dominant dune species, as some plants are well adapted to frequent spray and may receive certain growth requirements in that form (Oosting 1954; Boyce 1954). The dunes are thus the result of fragile environmental balances (many plants may be living at the extreme of environmental tolerances and are easily disrupted). The fact that natural dune fields are constantly shifting, burying and uncovering attests to the transient nature of individual existence in this environment.

I.D. Maritime Forest

Vincent Bellis and Edward Proffitt

A significant portion of North Carolina's tourist income is derived from providing a pleasant beach experience for Tar Heels and out-of-state visitors alike. Poets and artists find inspriation in the varied seashore landscapes which seem to elicit a wide spectrum of emotional responses. The Maritime Forest is a major component of the barrier island system and owes its existence and maintenance to sea forces. Maritime Forest soils are relict ocean sediments. Most of the mineral elements required for forest nutrition are derived from salt spray. Even the finely detailed sculptured appearance of the vegetation, which many visitors find aesthetically pleasing, is a direct response to salt blown in from the sea.

The Maritime Forest is thus directly important to the North Carolina economy because it contributes to visitors' enjoyment of the seashore. Other functions of the Maritime Forest may seem less obvious; but, in fact may be vital in holding the Outer Banks in equilibrium with erosive forces of the sea. These functions include retention of rainfall as subsurface groundwater, stabilization of loose sandy soils in the face of frequent strong winds, and conservation of scarce nutrients (potassium, calcium) from salt spray and rain.

The earliest settlements on the Outer Banks (Ocracoke, Portsmouth, Old Nags Head, Diamond City, etc.) were nestled among the trees of the Maritime Forest because island natives knew such places to be high, safe and not subject to the extremes of temperature found outside the forest. Recent realization of this fact by development interests, together with the scarcity of undeveloped front beach property, is causing developers to cast covetous eyes on property considered to be undevelopable thicket just a few years ago.

I.D.1. Definition and North Carolina Examples

Maritime Forest is a variant of the coastal evergreen forest, from which many species have been removed by salt stress and the surviving species exhibit an espalier or trimmed appearance caused by salt damage to growing branch tips. One arbitrary "working definition" considers the Maritime Forest to become coastal evergreen forest at that point where loblolly pines reach mature stature. This definition is probably too restrictive and oversimplified. For practical purposes one should consider all forested areas occurring on relict sand dunes either on the Outer Banks or immediately adjacent to permanently salty sounds to be Maritime Forest. Characteristic vegetation includes many evergreen and aromatic trees and shrubs. Dominant tree species in relatively undisturbed areas are usually live oak (*Quercus virginiana*), laurel oak (*Q. laurifolia*) or youpon (*Ilex vomitoria*). Associates usually include wax myrtle (*Myrica cerifera*), red cedar (*Juniperus virginiana*), red bay (*Persea borbonia*) and

American holly (*I. opaca*). Ground cover is usually partridge berry (*Michella repens*). Vines are catbriar (*Smilax* spp.) and poison ivy (*Rhus toxicodendron*).

In North Carolina the Maritime Forest is quite rare. It is virtually restricted to wider portions of the barrier islands. Excellent expressions of this forest type exist today in the Duck Woods, Nags Head Woods, Buxton Woods, Ocracoke Island, Portsmouth, and parts of Core Banks, Shackelford Bank, Bogue Island, Bear Island and Smith Island. With the exception of a portion of Buxton Woods, managed by the National Park Service, and Bear Island (Hammocks Beach State Park) most of the existing Maritime Forest in North Carolina is privately owned and subject to increasing development pressure.

I.D.2. Environmental Description

I.D.2.a. Stress Factors--The Maritime Forest originated by adaptation of salt-tolerant components of the Coastal Evergreen Forest to stresses imposed by proximity to the sea. The entire Outer Banks is geologically unstable and subject to frequent high winds sweeping in from the ocean. Sandy dune soils contain few mineral nutrients and such nutrients as are available tend to be very mobile and are readily lost from the root zone through leaching. Rainfall provides the only source of fresh water.

I.D.2.b. Adaptations to Stress--Wind impact and, consequently salt spray effects, are most severe along the seaward edge of the forest. Here the forest canopy is kept compact and low because apical dominance of the branches is destroyed whenever terminal buds are destroyed. This stimulates development of lateral buds and leads to a dense canopy consisting of many short branches arranged as a mosaic.

Such a canopy provides an effective wind barrier, but is readily permeable to water. This seemingly delicate filigree of small branches can resist even hurricane winds.

Leaves of salt-tolerant trees and shrubs are often small, thick and leathery. Presumably, such leaf characteristics represent adaptations to conditions of physiological drought (in this instance the water-drawing capacity of salt spray). There is also evidence that excess chloride is transported within the plant to terminal leaves or individual leaf tips. Subsequent death and fall of these leaves may remove excess salt from the plant.

Physiological drought may occasionally be accompanied by physical drought, depending upon the availability of rainfall. Much of the rainfall occurs during the late winter and spring, while water requirements are greatest during summer. Water conservation is a prime function of the Maritime Forest and we doubt that an "engineer" could appreciably improve the design employed by nature. Basically it consists of 1) an outer heat shield and reflector (the tight forest canopy), 2) a darkened dead air space (open shaded zone between canopy and the ground), 3) a layer of insulation (leaf litter and humus) and 4) a fine-grained absorptive bed which retains water by capillary adhesion (sandy soil of the relict dune). The freshwater level is kept nearly constant because this freshwater "reservoir" floats on deeper brackish water. The Maritime Forest is thus well adapted for water trapping and storage.

Most of the mineral inputs are derived from salt spray. Sodium, magnesium and chloride ions generally are present in far greater amounts than are required for plant growth. Nitrogen, phosphorus, calcium and potassium tend to be present in amounts approaching minimums required and often are tied up in the biomass. Once ions become soluble, they tend to be leached rapidly below the root zone if not immediately taken up or complexed out in the humus. The root zone of the Maritime Forest thus acts as an ion filter. Readily soluble excess ions are transmitted but scarce ions are conserved and recycled. Nitrogen enters the system via symbiotic nitrogen-fixing bacteria living within the roots of wax myrtle. This fragrant evergreen shrub is abundant in interdune thickets, as forest understory, and in swale ponds throughout the coastal area. The water fern (Azolla), with its nitrogen-fixing endocymbiont (Anabaena), sometimes forms an extensive red surface layer over swale ponds exposed to full sunlight.

I.D.2.c. Trophic Levels--Unlike the adjacent salt marsh, the Maritime Forest does not appear to be highly productive. Low biological productivity probably results from limited primary production which in turn is a function of salt stress and low mineral base. In any event, both flora and fauna lack diversity as compared to other inland sites. First level consumers include deer, rabbits, turtles (sliders) and various litter-inhabiting beetles. Frogs, dragonflies and other predatory insects form the second level of consumption. Snakes are often the top predators; black racers and copperheads inhabit drier sites (dune crests) while cane-brake rattlesnakes may be found along the swale ponds. Birds are not abundant in the forest, but myrtle warblers may be seasonally abundant as may other migratory species. Ospreys and pileated woodpeckers often nest in the Maritime Forest. To our knowledge, careful studies of southern Maritime Forest productivity and trophic structure have never been published. The Maritime Forest seems to be primarily a producer-decomposer system with rapid reentry of essential mineral nutrients back into the vegetation with excesses quickly leached out of the system. Both import and export of organic matter would seem to be minimal.

I.D.3. Geographic Variations

Beaches north of Cape Hatteras face northeast and bear the brunt of "nor'easters" during winter and spring. The zone of salt spray seems to carry much farther inland past the surf, producing a wide interdune in front of the Maritime Forest. Loblolly pine, American holly, red bay and southern red oak are conspicuous components of the vegetation. South of Hatteras the beaches face south or southeast. Maritime Forest begins just behind the primary dune, and live oak and youpon become increasingly abundant. Palmetto (*Sabal minor*) occurs frequently south of Hatteras, but is rare to the north. Carolina pink (*Silene carolinana*) can be found in the Nags Head Woods and Duck Woods, but otherwise is absent from the Maritime Forest. Likewise, false heather (*Hudsonia tomentosa*) reaches its southern limit in the same area. Along the south coast cabbage palm (*S. palmetto*) reaches its northern limit. Thus, the Maritime Forest varies in aspect as well as relative abundance of species.

I.D.4. Values of the Environment

The primary direct value of the Maritime Forest is that it helps stabilize a geologically unstable system. Direct benefits include 1) protection of loose sandy soils from wind erosion, 2) accumulation and storage of freshwater, 3) mineral ion filtration and 4) production of soil by trapping blowing sand and deposition of humus (island buildup is important since sea level is rising).

In the case of the Maritime Forest, aesthetic qualities are of direct economic importance because of its role in enhancing the beach experience for tourists. Birdwatching, fishing, hunting, hiking, nature photography and picknicking are human activities frequently observed in Maritime Forests. Although the Maritime Forest is a rare and interesting ecosystem, it has low ecological diversity and harbors few rare or endangered species. On the other hand, the fact that ecological interactions are relatively simple and exchange with other systems minimal makes the Maritime Forest an excellent system for scientific study. In fact it might be argued that further destruction of Maritime Forests along North Carolina's Outer Banks should be prevented until we have documentation concerning their role in barrier island formation and maintenance, and until we have a better idea of the long-term effects of forest removal on soil stability and groundwater quality.

I.D.5. Man's Impact on the Environment

The impact of human disturbance is likely to be cumulative and largely irreversible. Groundwater pollution by septic tanks may actually have a beneficial effect on the Maritime Forest; whereas, excessive human demands on the freshwater lens could result in lowering the freshwater table. Certainly, clearing of the forest interferes with its basic functions of nitrogen-fixation, water retention and soil stabilization. Loss of the Maritime Forest might destabilize relict dunes, with consequent impairment of human structures by shifting sand dunes. A critical, and as yet unknown, factor is the degree to which water can be pumped from forested dunes before they lose their vegetative cover and stability.

Construction of tall buildings along the duneline enhances development of vegetation on their lee side, while leveling of dunes for parking lots or trailer parks extends the zone of salt impact back into the forest. The safest place for man to occupy on the Outer Banks is the very area most critical for maintenance of system stability.

I.D.6. Management Implications

The stabilizing vegetative cover may be los through fire, salt damage or land-forming operations during development. Once exposed to wind erosion, deforested relict dunes may become active again and migrate over the remaining Maritime Forest. Effects of dune migration are especially evident in the Nags Head Woods. Along Bogue Banks it has been common practice to establish trailer parks by pushing the toe of parallel dune ridges into the intervening swale ponds. Destruction of the forest canopy during this process results in increased evaporative water loss from the soil, while subsequent removal of the litter layer by lot owners further increases evaporation. Filling of the swale ponds results in loss of water-holding capacity. Human population demands upon the freshwater supply increase even as man's activities function to reduce water trapping and holding capacity of the natural system.

Old, established villages all along the Outer Banks attest to the fact that man can live comfortably within the Maritime Forest without destroying it. Basically compatible use involves allowing roadways and public service lines to follow natural contours, develop only high land, avoid filling freshwater ponds, cut only those trees which directly interfere with home construction and access, and use native shrubs for ornamentation and stabilization. Of course the difficulty with the above recommendations is that if rigorously followed they would never permit the human population density desired. This simply drives home the point that the Maritime Forest is a low-production, low-density ecosystem delicately balanced in an unfavorable environment. Throughout the history of the Outer Banks, the "woods" have been used as a renewable resource--timber, hunting, firewood, etc., and public access for these purposes was accepted. With the influx of non-native homeowners the carrying capacity of the "woods" for even these uses was exceeded. Now the forest itself is being carved up into development lots and will cease to function as a renewable resource. Public access is prevented because of individual private ownership. The land area of North Carolina occupied by Maritime Forest is probably smaller than that of any other important coastal ecosystem. At current rates of development and loss, most Maritime Forest will be gone or functionally useless before we even know how it operates ecologically.

I.E. Barrier Island Values and Man's Impact

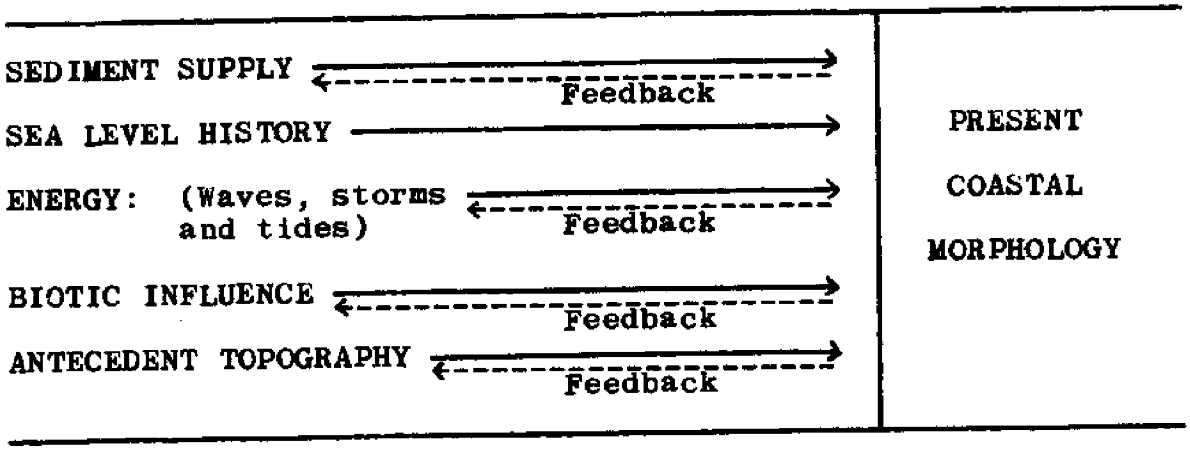
Val Klump and Johanna Smith

I.E.1. Barrier Island Model

The following simplistic model (after Swift 1969) can be applied to both prograding and eroding coastlines. The major processes contributing to the development of the present coastal morphology are shown, as well as the interactions between them. The final result, either prograding or eroding, depends upon the parameters in Table 2. However, in nature a mixture is usually found.

Table 2. Characteristics of Prograding and Eroding Barrier Islands (from Swift 1969).

Prograding coastline	Eroding coastline
1. Sediment supply large	1. No sediment supply
2. Slow sea level rise	2. Rapid sea level rise
3. Sufficient wave energy to transport sand along-shore--not catastrophic storms	3. Many storms
4. Plant growth sufficient to stabilize, hold sand	4. No plant growth
	5. Depressions to trap sand (lost to system-estuaries)



I.E.2. Values

I.E.2.a. Primary--The tremedous value of North Carolina's Outer Banks is realized in the burgeoning tourist and recreational industry. It is the ever-increasing demand for the recreational and commercial use of this resource which has caused many of the problems currently in need of resolution. In trying to maximize these uses, however, commercial or direct value considerations may ignore a larger number of critical environmental externalities--those indirect values of a barrier island system which do not show up on a public accountant's ledger.

I.E.2.b. Secondary (Indirect)--The greatest indirect value of the barrier islands is as a "barrier." The islands act as a shield for the mainland coast against the extremely high ocean-derived energy regimes indigenous to the North Carolina coast. The value here is not so much in dollars gained as costs not incurred. Perhaps a more accurate description would be "buffer islands," since the Outer Banks are not a total barricade to ocean forces but merely take the brunt of the blow. The islands themselves "roll with the punch" through the processes of shoreface changes and island migration.

Particular values are also associated with the tidal inlet area, the most obvious of which is in providing a channel for navigation from open ocean to the more protected lagoonal area. Also, these channels provide migratory routes for important adult and juvenile commercial and sport fish species.

The development of the tidal inlet is important in maintaining the barrier island as a whole. Through the deposition of sediment on the tidal deltas, as well as overwash across the barrier island, a major source of physical substrate for marshes is provided (Godfrey and Godfrey 1974) and ecological succession of plant communities can begin. These plants will stabilize the sediments, eventually leading to the development of a salt marsh area and providing a mechanism for widening the island. Often, storm waves can develop inside the sound and, unless the deposition of sediment continues around this newly developing salt marsh area, it will tend to erode quickly. Such erosion would reduce the area of the younger, more productive salt marsh (Godfrey and Godfrey 1973).

Once the inlet closes, marsh areas can develop on the shallower shoals. These marsh islands can be connected by overwash and deposition, further stabilizing and widening the island (Godfrey and Godfrey 1973). Thus, the island is retreating shoreward as the sea level rises and the various ecosystems are maintained. Drum Inlet, which was open from 1933 to 1971, shows the ecological succession patterns of a closed tidal inlet.

As another important indirect service, the inlets maintain the sounds as protected estuary systems for many species of commercially valuable fish, shellfish, crustaceans and a variety of other plant and animal life. The daily flux provides cycles of salinity and temperature for these estuarine species.

I.E.2.c. Aesthetic--The islands themselves may contain important and unique biological ecosystems. The biota in the beach may act as a giant filter for seawater. Dune flora is often unique and may represent an invaluable gene pool of primitive strains. Beach grass has been crossed with feed grains, like wheat and barley, to produce very rigorous and highly productive new hybrids (Ranwell 1972).

The aesthetic value of the islands is unquestioned. It is the beauty of the Outer Banks which attracts so many to them and increases development pressures. The shore is a public resource and belongs to future generations as well as the current one. Thus, it is valuable simply as a unique natural environment. The complex dynamic forces which mold it are a part of the attraction the islands have for scientist and lay public alike.

I.E.3. Man's Potential Impact

I.E.3.a. Activities Intrinsically Dangerous--The folly of building one's house on storm-tossed sands has been recognized for as long as men have built houses (*see* Matthew 7: 24-27). The hazards of building on the shoreline, in front of the foredunes, in a washover pass, on an eroding spit or headland or in a shifting dune field are obvious. Knowles *et al.* (1973) have developed a model predicting storm-induced shoreline recession along the North Carolina coast, with the goal of determining the distance from the toe of the primary dune within which any structures might be considered to be in danger (Table 3). Local features such as dune field structure, overwash potential, and long-term erosion and migration should be studied before decisions are made or structures and construction declared safe.

Long-term erosion and island migration are severe problems on the Outer Banks. Such processes are inevitable during a period of rising sea level. Built in the 1860's, the Cape Hatteras Lighthouse was more than 1000 meters from the active surf-zone. Today, despite millions spent to halt erosion, it is less than 100 meters from the water's edge (Dolan 1972c). There is really no erosion "problem" until man builds on the shore. He may then go to great lengths and expense to protect his structure from the natural processes operating in the system. Often these protective measures only serve to accelerate erosive processes; thus, enhancing and escalating the possibility of a real disaster.

Table 3. Recommended Range of Recession Lines from the Dune Toe for One in Twenty-Five and One in a Hundred Years Storm Return Frequency (from Knowles *et al*. 1973).

Location	Range of recession lines (ft) 1/25 frequency	1/1000 frequency
Virginia to Cape Hatteras	40-100	80-120
Cape Hatteras to Cape Lookout (one value)	50-100	70-120
East-west portion to Carteret County	70-100	100-170
Onslow County	100-160	130-230
Pender County	100-140	180-230
New Hanover County	120-170	180-270
Brunswick County	120-190	150-260

I.E.3.b. Beach Stabilization and Protection Measures-- During the 1930's the WPA and CCC, under the direction of the National Park Service, erected almost 3,000,000 feet of sand fencing to create a continuous barrier dune along the Hatteras, Pea and Bodie islands. This was followed by an extensive dune stabilization program by the National Park Service in the late 1950's, when 2,500,000 trees, shrubs and grass to protect 47,280,607 square meters (3,254 acres) were planted. Today, almost a continuous blanket of vegetation covers the barrier islands from South Nags Head to the southern tip of Ocracoke Island. Robert Dolan (Dolan 1972a; Dolan *et al*. 1973) and Paul Godfrey (Godfrey 1970; Godfrey and Godfrey 1974) have given excellent accounts of the effect of this stabilization program on the barrier island system. Their findings are summarized in Figures 12 and 13 and the brief discussion below.

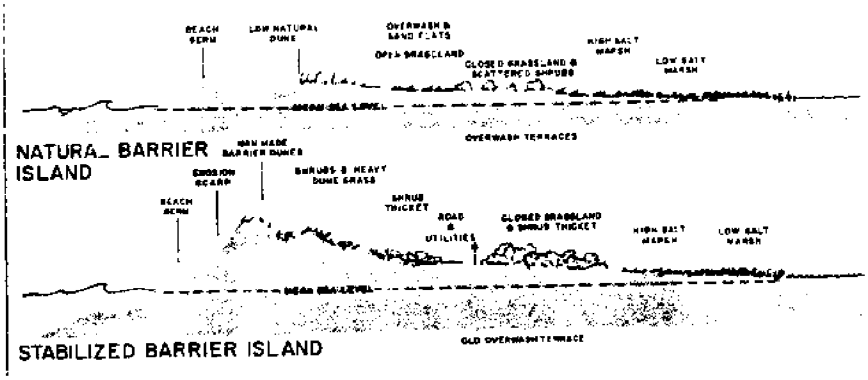


Figure 12. Comparison of natural barrier island profile and an artificially stabilized barrier island profile (from Dolan 1972a).

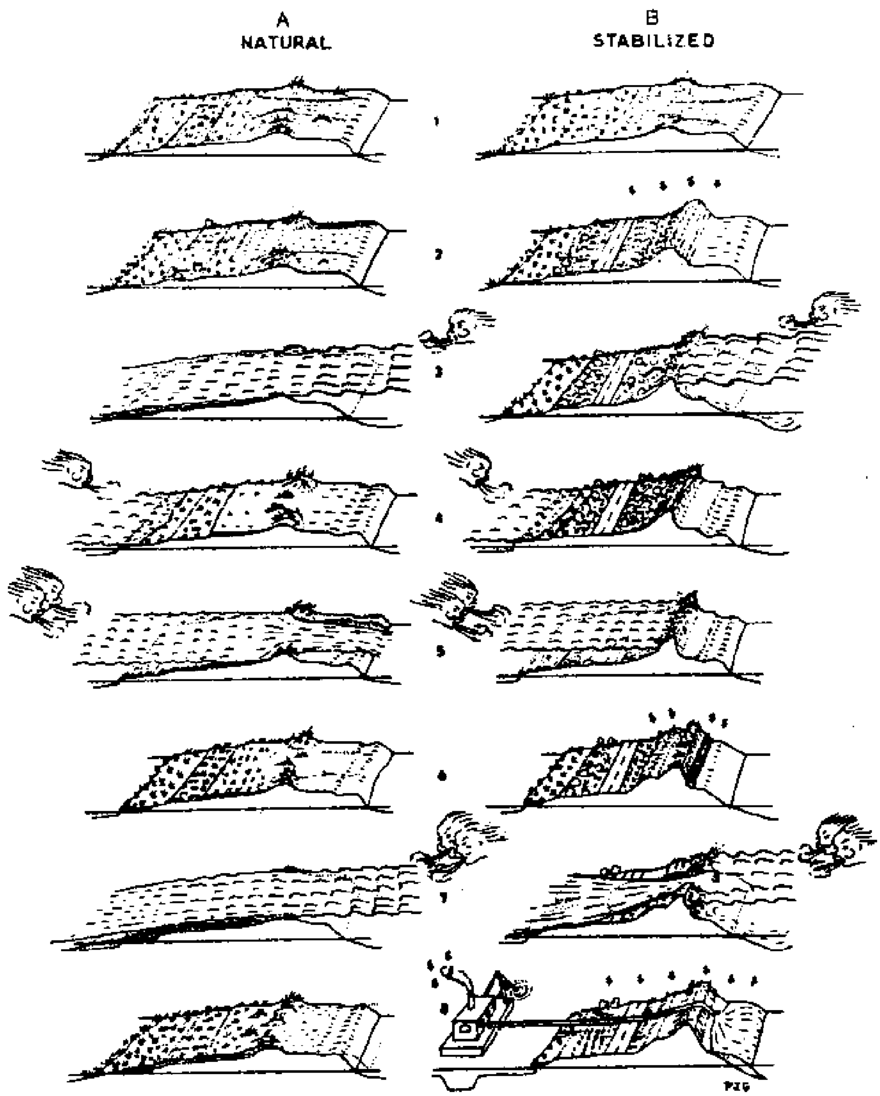


Figure 13. Sequence of events showing barrier island profiles for a natural and stabilized system under different conditions (from Godfrey and Godfrey 1974).

In short, the construction of a high (often up to 30 feet in height) foredune has had two effects: 1) it has prevented the natural process of oceanic overwash, halting barrier migration, and 2) it has introduced an artificial, temporary stability to the zone behind the dunes. Unable to retreat in response to rising sea levels, the islands have begun to erode on both sides. The beach profile has steepened, narrowed and become coarser to maintain its dynamic equilibrium (see Figures 12 and 13). The active sand zone has been compressed by stabilizing the dunes behind it. The high stabilized dune has become a sand seawall and increased erosion due to wave reflection is common. The results are summarized in Table 4.

Table 4. Changes Along the Outer Banks of North Carolina Since High Barrier Dunes Were Constructed (from Dolan 1972a)

Topographic zones	Ratio × 100 (%)	
	January 1945	August 1969
Beach to active sand zone	51.5	54.5
Beach to island width	20.2	10.9
Active sand zone to island width	42.1	22.0
Dune to island width	21.9	11.2

The great height of the stabilized dune has also provided protection from salt spray and flooding. Vegetation is no longer limited by salt spray tolerance and the extreme conditions in the vicinity of the beach. The shrub community normally found only in the higher, well-protected areas at the back of the island in older dune fields and terraces has spread seaward, often forming impenetrable thickets 10 to 15 feet high. These shrubs and other "out-of-place" species are not well adapted to flooding, burial or salt spray. Should the dune line be breached these species will be killed. This artificially stabilized system may not recover nearly as quickly as the natural ecosystem.

As the beach erodes and the island narrows, the potential for storm surge destruction increases. When the stabilized foredune gives way, it will be like the bursting of a dam. Water will pour across the narrow, steep backslope with considerable force. There is no gently sloping, wide washover terrace or fan to dissipate its energy. The false sense of security and safety given by the stabilized dune has encouraged development in highly hazardous areas (Figure 14).

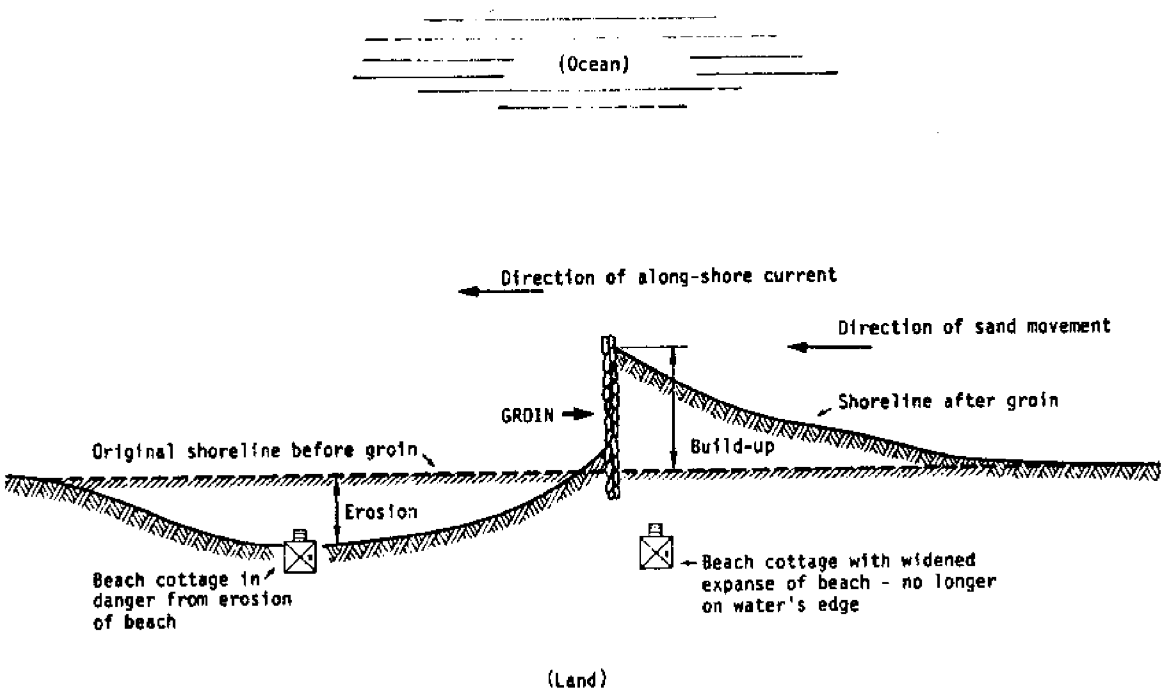


Figure 14. Effect of a groin on the shoreline (from Pilkey et al. 1975).

All along the coast other beach protective schemes are used where shoreline development is threatened. These schemes fall into three basic categories: 1) devices to trap longshore transport (e.g., groins and jetties), 2) devices to prevent shoreface flattening and erosion (e.g., seawalls, revetments, sand bagging and bulkheads), and 3) artificial beach nourishment. Devices to trap sand drifting down the coast are often merely "robbing Peter to pay Paul." Sand trapped behind a groin or jetty destroys the longshore balance of sediment flux, and erosion occurs on the down-drift side of the structure.

Seawalls, revetments and bulkheads are used as an attempt to prevent shoreface flattening and effectively increase the "coarseness" of the beach. As a result, the beach profile is steepened and loss of sand from the beach is accelerated by deflecting wave forces downward into the beach deposit. A seawall is capable, through wave reflection, of increasing the longshore current by up to 18% (Dean 1972). Eventually, the beach can disappear altogether (Figure 15).

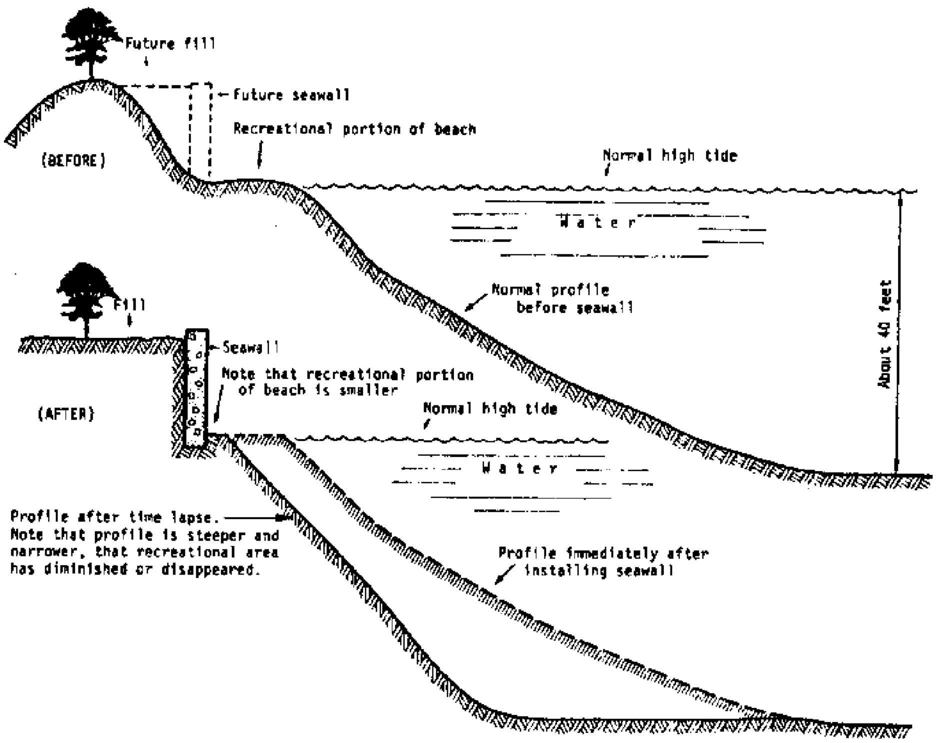


Figure 15. Effect of a seawall on the profile of a beach (from Pilkey et al. 1975).

Artificial beach nourishment is regarded as the least undesirable method of protection (Dolan 1972c). Effectively, it increases the sediment input side of the dynamic shoreface balance; but unfortunately, nearby sand sources are not always available. In the past sediments have often been dredged from the lagoon and added to the beach, which not only disrupts the estuarine ecosystem but may increase erosion on the lagoon side of the island. Lagoonal sediments are usually very fine and are quickly carried off, since they are dynamically unstable on medium and high-energy beaches. The best sources of sand are coarse offshore relict sediments on the shelf outside the nearshore sand-sharing system.

The economic implications of a beach nourishment program are considerable. Costs may average as much as $700,000 per kilometer of nourished beach (Dolan et al. 1973). The U.S. Army Corps of Engineers recently estimated that about $20,000 is necessary for restoration of the average 50-foot beachfront lot along the Outer Banks, with an additional $1000 to $2000 per year to maintain stability (Dolan 1972c). Millions of dollars have already been spent, all in an effort to halt the inevitable processes of barrier island evolution.

I.E.3.c. Construction and Development in the Dunes--The dunes serve as a barrier or buffer to climatic energies and are a necessary part of the natural system. Construction techniques too often ignore this fact. Instead of building within the system and adapting structures and roads to dune topography, dunes are often leveled to provide a platform with a nice view. The result may be enhanced washover potential, salt spray kill-off and wind erosion. Site preparation and construction activities may disrupt fragile dune vegetation, often resulting in de-stabilization and blowouts.

Buildings constructed on solid foundations in the wind-blown sand environment act in much the same manner as do groins along a beach. Sand accumulation occurs on the upwind side and erosive scour on the downwind side. This process is occurring constantly in the dune zone itself and is the mechanism that forms dune slacks.

Dunes are a diminishing resource. The processes by which they are formed are limited by sediment supplies and their rate of destruction through developments of various kinds almost certainly exceeds their regenerative capacity (Ranwell 1972).

I.E.3.d. Vehicular and Foot Traffic--Traffic across the dunes, in gaining access to the beach, disrupts fragile dune vegetation. As few as one or two passes per week by a vehicle or by 10 to 15 pedestrians along the same route through beachgrass will kill it (Godfrey 1972), which can result in blowouts and parabolic dunes. Constant traffic will not allow the normal process of embryo dune formation to heal a blowout. The path to the beach continues to widen, causing a major gap in the dunes where once only a foottrack existed. The solution is elevated walkways and restricted access rights-of-way.

I.E.3.e. Groundwater Extraction--The groundwater aquifer under a barrier island exists as a lens-shaped body of fresh water floating on salt water that has intruded into deeper sediments. Excessive extraction of groundwater poses a real threat of saltwater contamination. Lowering water tables below a critical point may kill off stabilizing vegetation and dry up dune slacks (McHarg 1969). The high porosity of the soil also leads to the risk of groundwater pollution from septic systems. Inadequate, old or systems set too near wells can be a real problem since wells here are not deep. Fresh water is a limited resource on the barrier islands and should be used with care.

I.E.3.f. Other Activities--Nearly everything man does has some impact. He is an exporter and importer of all manner of things. Litter, grazing animals and non-native plant species are some of the common things introduced by man that may crowd out or disrupt the local species and ecosystem. Golf courses, artificial reefs, docks, piers, parking lots, roads, buildings of all kinds and service utilities are common peripherals associated with the influx of man. Mismanagement of any of these can produce problems.

I.E.4. Management Implications

A system in equilibrium may be defined as one which, when stressed, reacts in such a way as to relieve that stress. Whether or not one sees a system in equilibrium depends almost entirely on the time period and area over which one observes it (Swift 1975). The barrier island system is one of the most dynamic systems in nature. To the coastal engineer it appears to be in a state of constant change, not equilibrium. The geologist, on the other hand, looking at shoreline and island changes over geologic time sees a slowly evolving system in equilibrium with the ocean it faces. The coastal zone manager, however, can afford to take neither the view of the engineer nor solace in the term equilibrium. Rather, he must come to grips with the potential for rapid, dramatic variations in the system and the way in which those variations form a complex, permanent system. His planning decisions must reflect an accounting for both the short-term local effects and the role they play in maintaining the long-term balance.

Each man's activities will impose stresses on the environment. The magnitude and nature of these stresses will depend upon: 1) the type of activity, 2) the number of activities, 3) the density of activities, 4) the frequency of use, 5) the duration of use and 6) the intensity of use (Olsen and Grant 1972). The response of the environment will vary accordingly and in proportion with the island's capacity to relieve the stress. Some of man's impacts will have irreversible effects and natural ecosystems will be lost. Alternative management strategies should be investigated and the value of the activity weighed against both the direct value of the land and the considerable indirect value of the particular environment within the entire system.

With this in mind, perhaps a few general principles can be extracted from the above. First, since sand movement plays such an important role in the barrier island system the sand budget should be studied over a significant time period. The relationship between sand-sharing systems should be investigated and predictions concerning aperiodic storm erosion effects should be made. Once the sources, sinks and fluxes of sand along the coast are explained, predictions of the impact of natural and man-made events can be given. This is of particular importance in the case of tidal inlets. The many offshore shoals and changes in deposition of sediment will cause serious problems in navigation. Historically, these problems have been resolved through construction of jetties and groins to trap sediment as it proceeds downdrift, preventing blockage of the inlet. This, however, is an example of man's modification of a basic process. By stopping sediment transport and thereby preventing the movement of sand downdrift, it is being removed from the sand budget and setting the stage for erosion elsewhere. This must be further remedied through the use of a costly sand-bypassing system (U.S. Army 1966). Dredging, with the deposition of this sediment offshore beyond the reach of the longshore transport system, will also affect the sand budget. Any such change in the relationship between the physical structure of the inlet and currents will cause changes in depositional and erosional patterns. Careful study of all the effects and factors involved should be undertaken before attempting such a modification.

Secondly, activities and uses must be adapted to the natural system. A barrier island is an integrated system and all parts play an important role in its totality. The building of permanent structures in unstable areas is to be avoided. Since the boundaries of the tidal inlet are constantly growing and eroding, leading to migration, these areas are unsuitable for any permanent development. Due to the frequency of storms that hit the North Carolina coast, building in those areas that may be subject to washover, and, therefore, inlet formation will be hazardous.

Thirdly, it is important to realize that common land-use management techniques may not be the best solution in this particular environment. Traditional zoning, for example, relies on spatial separation to avoid conflicting uses. This creates discrete zones of uniform use that may not necessarily conform to the processes occurring in the particular area. On a barrier island, the system acts as a whole and these spatially separated, seemingly unrelated processes may be critical to maintaining the entire system. Zoning is also often tied to tax revenue schemes. Thus, pressure to increase tax revenues through multiple, "taxable" uses may ignore the considerable indirect values inherent in the natural system.

Fourthly, it is reasonable to say that some areas should be left entirely in the natural state. Washovers perform a valuable function in widening the island and absorbing storm energy and so should not be prevented or obstructed. The beach should not be altered so as to disrupt the shoreline equilibrium between waves, currents and sediments.

Fifthly, building codes and other use regulations should take into account the rigorous environment one faces on the North Carolina coast. Foresight in development could save the taxpayer millions in terms of hurricane disaster relief.

Finally, it should be understood that no matter how carefully one plans, houses will occasionally fall into the sea--it is unavoidable and should be considered such. The intent should be to minimize these losses as much as possible through rational siting and planning decisions, rather than through self-defeating and expensive protective measures. The recognition of natural processes and their function in maintenance of the barrier islands would save considerable energy and expenditure in ultimately futile attempts to stabilize a dynamic system.

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II. LAGOON-ESTUARY SYSTEMS

II.A. Brackish Water Systems

B. J. Copeland

Where large flows of freshwater meet salt water, extensive brackish water estuarine systems have developed. The principle areas in North Carolina that fall under this category are Currituck and Albemarle Sounds in the north, the upper Pamlico and Neuse River estuaries in the middle of the State and several smaller brackish areas south of there. Although no line of demarcation can be drawn to separate clearly the brackish water systems from those of higher salinity (discussed under the Mid-Salinity section), the brackish water systems discussed here will be those that are 8 ppt or less salinity (Odum and Copeland 1974).

II.A.1. Environmental Description

The dominating physical pattern in these systems is the fluctuating, and sometimes large, flow of freshwater via rivers from the land. When the unidirectional flow of the river reaches the shallow, wide expanse of the coastal zone, the water fans out and the flow changes to the slowly mixing circulation of an estuary. This water is characteristically turbid and contains large amounts of nutrient, organic and soil materials coming in from the river. The income of materials from the rivers is a most important driving force for the maintenance of the brackish water system productivity.

Because of seasonality of freshwater flows, the salinity in these brackish water systems varies considerably during the year (Hobbie 1970a, 1971, 1974; Copeland and Hobbie 1972). Although vertical stratification in the shallow, wide areas is only slight, there is horizontal distribution where circulation is pushed by the wind. Most organisms living there are adapted to the wide salinity fluctuations and the relatively large deposition of suspended matter.

In spite of the high turbidities at times of the year there is considerable productivity in brackish water systems by attached grasses, chiefly *Potamogeton*, *Najas* and *Ruppia* (Copeland *et al*., 1974). Primary productivity is also contributed by small diatoms and dinoflagellates (Hobbie 1971), with blooms occurring during the winter when high concentrations of nitrate nitrogen come downstream (Hobbie *et al*. 1975). The basis of the food chains in brackish water systems is substantially supplemented by large amounts of organics coming downstream from the land (Cooper and Copeland

1973), which are used directly by some of the benthic organisms as well as the migrating schools of larvae, post-larvae and early juveniles of many commercial and sports fishing organisms.

Perhaps one of the most important roles of the brackish water systems is in the form of nursery grounds for the young of most of the sports and commercial species found in North Carolina. The abundance and distribution of these animals are highly seasonal (Hester and Copeland 1975), generally as a result of migrations and spawning times. The migratory movements are related to times of freshwater input (Figure 16) and the nursery productivity is related to freshwater and its contents (Copeland 1966; Cooper and Copeland 1973). The nursery areas are dominated by small spots and croakers during the winter and spring months; menhaden, trout and brown shrimp dominate the spring and summer; while the fall populations are dominated by the juvenile white shrimps. Shad, alewives and striped bass move through the system on their way to river spawning areas in the spring, with the young moving back through the system on their way out to the ocean later in the year. Important freshwater species move down into the brackish water systems during the spring, such as the white perch and catfish.

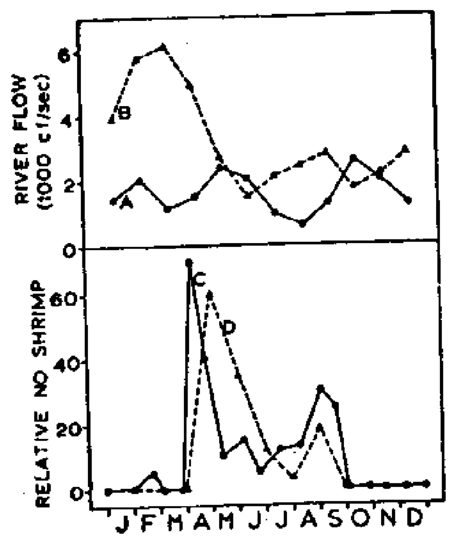


Figure 16. Relative number of postlarval shrimp entering bays and river flows. A) Guadalupe River, Texas, 1953-1962; B) Neuse River, N. C., 1955-1964; C) brown shrimp (Penaeus aztecus) entering Aransas Pass Inlet, Texas; D) peneid shrimp post-larvae entering Brunswich-Onslow Bay, N. C. (from Copeland 1966).

II.A.2. Values of the Environment

A significant primary value of the brackish water systems would be in the role of nursery ground supporting the North Carolina commercial and sport fisheries. Of the 10 leading species in the commercial catch, all but one are estuarine-dependent species with a total value of almost $16 million in 1973 (Easley and Sossamon 1974). The major brackish water system of North Carolina, Albemarle Sound, supports a sizable commercial fishery within the Sound; but, by and large the value of the brackish water systems is in terms of nursery grounds.

Secondary benefits are derived from stimulations of the coastal economy for operations such as are required for commercial and sport fisheries, marinas, boatyards, repairs and supplies and processing operations. Statistics are not complete to allow adequate evaluation of these secondary benefits in terms of monetary value, but it must be sizable. In addition, there is considerable nonmonetary value associated with aesthetics, recreation and tourism. Perhaps more importantly is the interrelationship of brackish water systems to the ecology of the whole coastal zone, which is important to the general well-being of all North Carolinians.

II.A.3. Man's Impact on the Environment

The key to the maintenance of brackish water systems is the input of materials from the rivers (Copeland 1966; Cooper and Copeland 1973). As a matter of fact, about one-half (or more) of the organic utilization in these systems is attributed to the organic materials flowing in from the rivers (Figure 17). Thus, if upstream development significantly decreases the flow of freshwater downstream and the import of organic matter to the estuary, drastic reductions can occur in estuarine productivity. Although this has not reached widespread occurrence in North Carolina yet, vivid demonstrations of this impact have been shown for Texas (Copeland 1966), California (Kelley 1966; Turner and Kelley 1966) and Russia (Zenkevitch 1963). If water development structures occur too close to the estuary, the spawning runs of organisms like shad and striped bass may be seriously limited (Walburg and Nichols 1967). An area in North Carolina currently in danger of suffering such fates is Currituck Sound with its rivers feeding from Virginia. As shown in Figure 18, when the nitrate values in the Pamlico River estuary were above about 20 μg-at/liter (which occurred in the winter), dinoflagellate blooms built up in the receiving estuary. This problem is critical in the Neuse River estuary, Pamlico River estuary and in the upper part of the Albemarle Sound estuarine system.

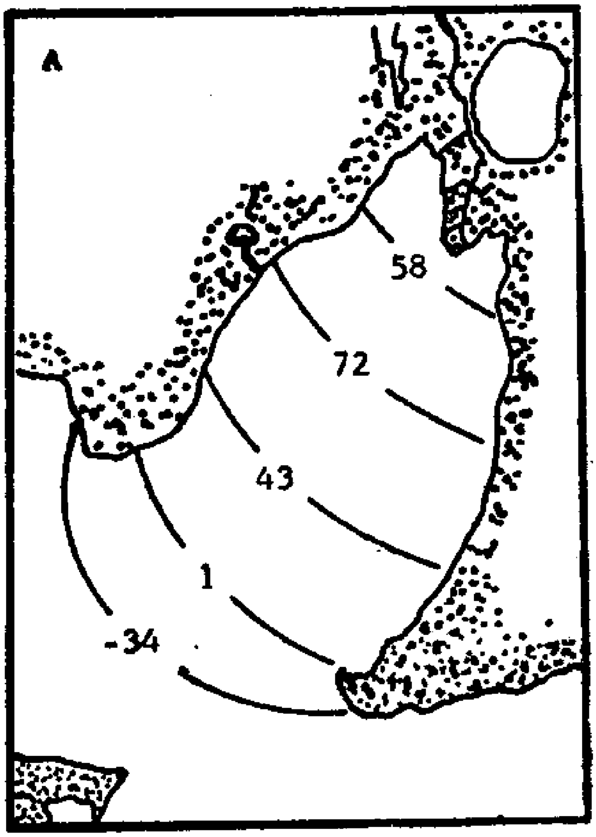
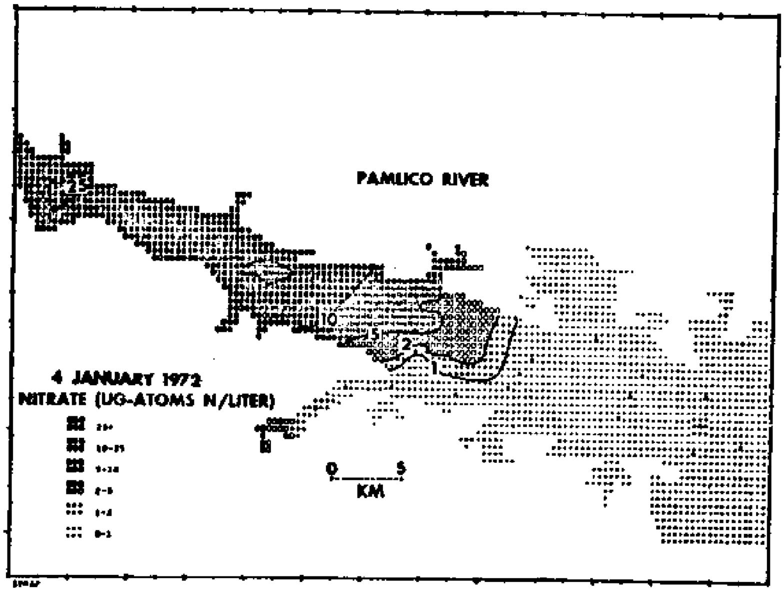


Figure 17. Percentage of estuarine respiration (use of organic matter) attributed to river flow in Trinity Bay, Texas (from Cooper and Copeland 1973)

Physical alterations within the brackish water system can also be detrimental to the well-being of its ecology. The construction of dikes, causeways and bridges interrupts the critical circulation patterns of brackish water systems, resulting in stagnation of some areas, interruption of transport of materials from one place to another and the normal migration of the young of many species. Examples of this situation have occurred in Tampa Bay, Florida (Sykes and Finucane 1966), and Lake Ponchartrain, Louisiana (Gunter 1957). These problems have not become prevalent in North Carolina, although proposed roadways across the Pamlico River estuary could be such a problem.

Since the loose and rapidly changing sediments of the brackish water systems are inextricably tied to the cycles of materials between the river and estuary, its transport to storage in the sediments and recycling back to the water, stirring of the waters could result in detrimental effects.



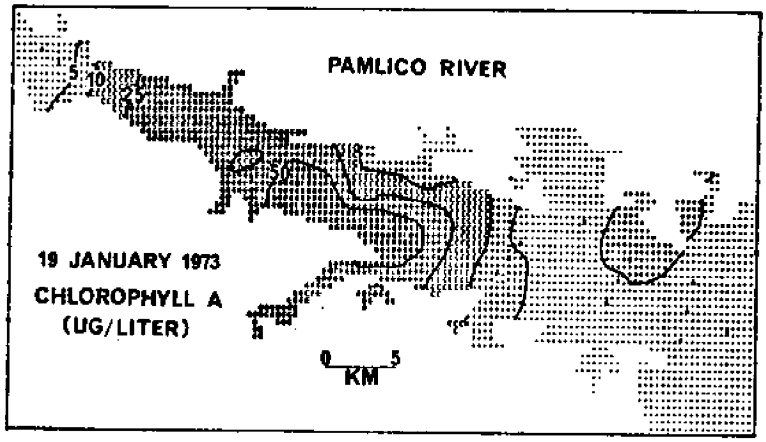


Figure 18. Nitrate nitrogen and chlorophyll a in the Pamlico River estuary, 1972-1973 (from Hobbie 1974)

Wolff (1972), for example, indicated that trawling activities could be a destructive force in the well-being of these shallow brackish ecosystems by bringing the laden sediments in suspension and thereby increasing re-solution of stored elements. Frankenberg and Westerfield (1968) indicated that the sediments in the brackish water area in a Georgie estuary required 10 to 1530 cc of oxygen per cubic centimeter of sediment per day when they were stirred into the water column. This increased oxygen demand could be critical to the ability of the water to support oxygen-requiring organisms. There is also some evidence that increases of organic loading to the estuary from the streams could also create large oxygen demands, thereby lowering the oxygen reservoir to critical levels.

II.A.4. Management Implications

Brackish water systems, being at the end of rivers draining large land areas and the "filtering zone" before the sounds, are integral parts of a large coastal system. Thus, any management scheme devised for brackish water systems must also include management of the river basins and surrounding land use. Activities in the estuary must be closely tied to actions and regulations of water quality and land use in the river and its basin.

Brackish water systems have a relationship to the sounds similar to farm relationships to cities. Just as food production on farms provides the basis for city productivity, nursery ground production is the basis for commercial and sports catch in the sounds and nearshore ocean. Thus, fisheries stock management and commercial fisheries development must have their genesis in the maintenance and management of estuarine nursery grounds.

Brackish water systems, due to rapid sedimentation and unique adaptations of bacteria, plants and animals, serve to some large extent as free "treatment plants" for much of the riverborne wastes of man's activities. Thus, management must include consideration for overloading and geochemical changes.

II.B. Mid-Salinity Systems

R. Wilson Laney

North Carolina's convoluted coastline encompasses one of the largest areas of estuarine water in the continental United States. Surpassed in size only by estuarine areas in Louisiana and Alaska, it constitutes 55 percent of the total estuarine area in the South Atlantic region (Shalowitz 1964). Much of the 2,500 to 3,432 (estimates vary) square miles (Adams 1966; Cooper 1975) of enclosed bays, sounds and river mouths is mid-salinity in nature.

"Mid-salinity" by definition means that the salinity of the water is 8-30 parts per thousand on the average (Odum and Copeland 1974). No line of demarcation can be drawn which clearly separates this region of an estuary from the low salinity and freshwater upstream or from higher salinity coastal waters, but there are certain characteristics which it possesses that will enable us to distinguish it from these other sections and make it useful as a concept for discussion (Bellis 1974).

Mid-salinity sounds in North Carolina range from Pamlico Sound in the north (the largest), through Bogue and Core Sounds and a long string of smaller bays and sounds to the Cape Fear River estuary in the south, the last large estuary north of the South Carolina border. Differences in size, amount of freshwater input, and access to the sea produce varying acreages of mid-salinity waters in each of these areas. Hydrographic data indicate that the shaded areas in Figure 19 fall into the mid-salinity classification (Schwartz and Chestnut 1973; Williams et al. 1973; Copeland et al. 1974). Bogue and Core Sounds and those south of them to the Cape Fear all receive relatively little direct freshwater input and have average salinities above those of the larger sounds to the north and south. Albemarle and Currituck sounds, renowned for fishing and duck hunting, are both brackish, leaving the Pamlico and Cape Fear River systems as the two largest areas of functional mid-salinity water in the State. Smaller areas of mid-salinity water exist at the mouth of every North Carolina river and all of these are influenced by the same physical patterns and biological cycles we shall discuss below.

II.B.1. Environmental Description

All estuaries are influenced by physical factors, often in dramatic fashion, to produce characteristic patterns common to many of them. The physical conditions present in mid-salinity areas are the result of interactions between tidal currents, river flow, temperature, wind, rainfall, sunlight and the physical shape of the estuary itself. Most of these exhibit a great deal of variation daily as well as seasonally.

Salinity within mid-salinity systems varies both horizontally and vertically, contributing to the basic instability of the system. It decreases in an upstream direction because of freshwater input at the landward end. Because salt water is denser than fresh, it also decreases from bottom to surface. Tidal influence causes the salinity at any given point within the system to change at least twice daily, since coastal water moves further upstream during flood tide and recedes downstream during ebb tide, being pushed and shoved by the freshwater head from the river all the while. Average salinity also changes seasonally due to differences in the amount of freshwater input from the river to the

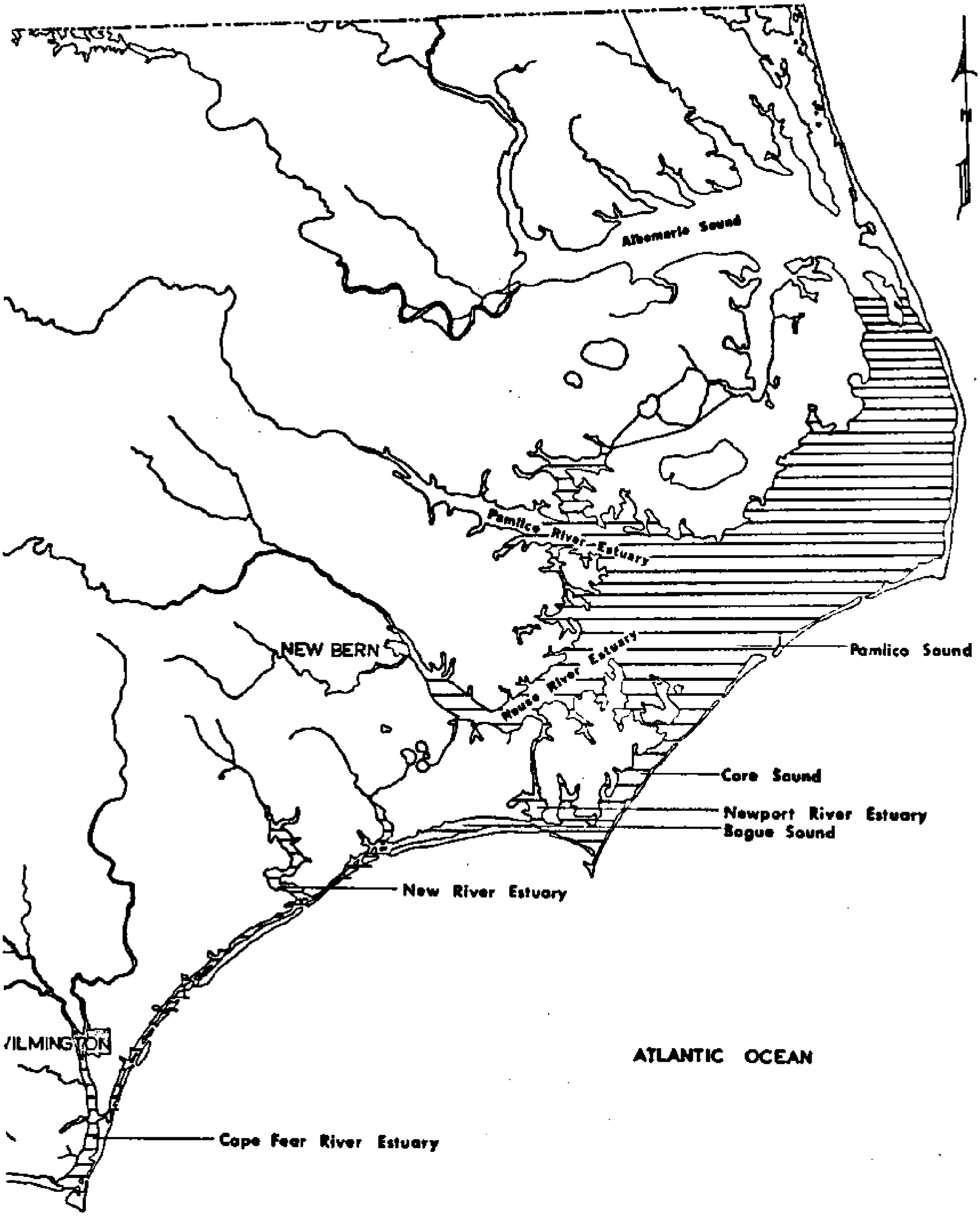


Figure 19. North Carolina coastal zone. The hatched areas indicate the extent of mid-salinity systems.

estuary. In North Carolina river flow is usually higher in the fall and spring, when rivers are swollen by prolonged rainfall from thunderstorms or tropical depressions, causing correspondingly lower average salinities during these seasons.

The combination of river flow and tidal currents produces a two-layered system of circulation within most estuaries, a system vital in transporting those organisms which utilize the estuary as a nursery area (Cronin and Mansueti 1971). Denser salt water, energized by the tides, moves upstream underneath the lighter river water flowing downstream, creating a net downstream movement at the surface and a net upstream movement along the bottom. This circulation pattern transports larval and juvenile organisms from both offshore and upriver, carrying them into the nutrient-rich marshes and distributaries. When they leave the estuary as elder juveniles or sub-adults, they ride the high-velocity surface currents out into the ocean. It is evident when looking at salinity profile data for Pamlico Sound and the Cape Fear River estuary (Williams *et al.* 1973; Schwartz and Chestnut 1973; Copeland *et al.* 1974) that these vital transport systems are probably functioning in mid-salinity areas of North Carolina.

River waters carry sediment from land runoff or from erosion downstream into the estuary along with nutrients and other materials both beneficial and adverse. At points where the estuary deepens sediments will usually begin to drop out and blanket the bottom. Permanent deposition of fine sediments occurs in the deeper channels. Highest levels of suspended sediments occur in the broad, shallow reaches of estuaries, where river input spreads out and where wind and wave action create havoc with the bottom (Cronin and Mansueti 1971). All sediments act as a trap for nutrients and trace metals, which may in turn be "sprung" free again by dredging, biological activity or wind and wave action.

Wind, temperature and sunlight account for much of the daily chaotic variation in environmental conditions within the system. Wind obviously wreaks more havoc in broad, shallow areas than in narrow deep ones. Shallow systems which afford a long fetch to the wind usually are extremely well mixed and more turbid due to sediment re-suspension, while deeper ones are less affected. The annual decrease and increase in water temperature is apparent to everyone, especially those hardy souls who venture in swimming during winter months, intentionally or otherwise. Temperature fluctuations on a daily basis can be very extreme also, especially in shallow areas where intense sunlight or dark bottom sediments can combine to produce differences of as much as 10°F or more between morning and afternoon.

Sunlight is one of the most important components of the system from an energy production standpoint. The intensity and degree to which it penetrates the water column directly influence the rate at which the phytoplankton and eelgrass in the water reproduce and store energy. In a nutshell, as light decreases with depth, production also decreases. In effect, therefore, water depth and light combine to produce a certain degree of horizontal stratification in the system. Shallow areas along the edges where light may be reflected off the bottom are more conducive to habitation by eelgrass; while central areas, where bottom lies below the depth to which enough light can penetrate for eelgrass production, play host to hordes of phytoplankters. The intensity and duration of light reaching both plants and sunbathers is dependent upon season, being higher in summer and lower in winter. The depth to which it penetrates is dependent upon water clarity and turbidity. Turbid, muddy waters from rain-swollen rivers reduce the effective depth to which production can occur to a narrow surface layer.

All of these factors taken together, ". . . produce a dynamic, variable and highly stressful environment for life, and they have many important effects on the selection and abundance of successful plant and animal species" (Cronin and Mansueti 1971).

II.B.2. Biological Patterns

Those organisms present in mid-salinity systems are regulated by and adapted to the physical cycles discussed above. They are also influenced by biological factors such as predation, food availability, disease and toxic substances in the water. Almost all of them are interrelated by food chains or webs to an incredibly complex degree.

The major base of all the mid-salinity system food chains is the primary producers (phytoplankton, eelgrass and rooted aquatic plants). Rooted aquatic plants are important in North Carolina systems. The base areas of salt marsh adjacent to our mid-salinity systems contribute large amounts of energy in the form of detritus due to the annual breakdown and decay of the stalks and leaves (see section on Salt Marshes). Eelgrass in North Carolina has been estimated to contribute up to 60% of the total production by plants in the area from Atlantic to Swansboro (Thayer 1975). Phytoplankton is a characteristic part of all mid-salinity systems (Bellis 1974), which with detritus from eelgrass and salt marshes forms the principal food source for many estuarine invertebrates and larval forms of commercially important species.

Phytoplankton in North Carolina estuaries exhibit cyclical patterns of abundance and are usually dominated by diatoms, at least in those systems which have been intensively studied (Williams 1966; Carpenter 1971; Thayer 1971; Campbell 1973). Two peaks of abundance usually occur, in the spring and fall, which are thought to be largely due to increased availability of nutrients at those times (Thayer 1971). Thayer (1971) found that temperature, salinity and light were not limiting factors, but that nitrogen and phosphorus (both nutrients required by phytoplankton) could become limiting factors at different times of the year.

Bacteria, though often overlooked, are undoubtedly an important component of estuarine ecosystems. Work on their role in the system has begun only recently, but it is speculated that they form an important source of food for organisms who strip them from the surfaces of detrital particles (Adams and Angelovic 1970). They probably serve an important function by breaking down detritus and aiding chemical cycling and recycling processes (Cronin and Mansueti 1971).

Zooplankton are the chief predators of the phytoplankton, along with benthic molluscs. In those North Carolina systems examined copepods were the dominant component, followed closely by the larval forms of fish and invertebrates (meroplankton) (Williams et al. 1968; Copeland et al. 1974; Thayer et al. 1974). Again, a cyclic pattern was evident with highest numbers and biomass in the early fall and late winter (Thayer et al. 1974). Williams et al. (1968) found that zooplankton were numerically and energetically unimportant in shallow estuarine systems near Beaufort. Thayer et al. (1974) found that while zooplankton were scarce in the Newport River estuary, they constituted a major source of food for larval pinfish, spot and menhaden. They could, therefore, control larval fish survival ". . . during their transition from larvae to juveniles . . ." (Thayer et al. 1974), at least in the Newport River estuary. Data from other North Carolina estuaries regarding correlations between zooplankton and larval fish are incomplete at this time.

Benthic animals probably take the place of zooplankton as the major herbivores in the relatively shallow North Carolina estuaries, especially the clams, oysters and mussels. They are not merely important consumers of phytoplankton. Ribbed mussels, found scattered among oysters in shallow areas, are important in recycling phosphorus within the system (Kuenzler 1961; Pomeroy et al. 1969). Oysters, scallops and clams produce pseudofeces which are colonized by bacteria and ingested by shrimp and other invertebrates. By pumping large quantities of water they help maintain nutrients in suspension in the water column. Clams may pump as much as 6 liters per hour; scallops an average of 14 liters per hour and oysters (New England) from 6 to 15 liters per hour (Rice and Smith 1958). Although clams were most important from an energetic standpoint in a benthic study done in Beaufort, annelid worms were the most numerous (Williams and Thomas 1967). Such worms are very important as forage for estuarine shrimp, crabs and fish. Tenore (1970) found that annelid worms and several small species of clams were dominant in the mid-salinity areas of the lower Pamlico River estuary. Benthos in this estuary underwent seasonal changes due to recruitment of young in the spring and fall. All the benthic fauna serve as nutrient traps by removing phytoplankton and other food particles and storing them for use by man and other predators (Cronin and Mansueti 1971).

The larger, more mobile and visible estuarine organisms which can move independent of currents are collectively labeled nekton. These include the fish, shrimp, squids and crabs. Much of the primary value of the mid-salinity system stems from the fact that it serves as nursery area or temporary home for many commercially important species (Bellis 1974). Anadromous species such as striped bass, American and hickory shad, blueback herring and alewife all pass through the mid-salinity system on their way to spawning grounds upstream. The eggs hatch upstream and the larvae transform into juveniles which utilize mid-salinity areas as nursery grounds. Catadromous species (American eel) pass through the system on their way to offshore spawning grounds and their young utilize the system on their return trip upstream. Species which show migratory patterns, but fall into neither of the above categories, are shrimp, blue crabs and some species of fish. Menhaden, shrimp and blue crabs are especially dependent upon the estuary. The larval forms of all three enter the estuary via inlets and transform to post-larvae, doing the majority of their growing in the mid-salinity portion and leaving as juveniles. The life cycles of all these species are given in detail in the section on Migrating Organisms.

Studies on nekton done in the Neuse River estuary (Hester and Copeland 1975), the Newport River estuary (Turner and Johnson 1973) and the Cape Fear River estuary (Hobbie 1970b; Copeland and Birkhead 1972, 1973a, 1973b; Copeland _et al._ 1974) all reveal the importance of North Carolina's mid-salinity areas as nursery grounds. Seventy-five, 66 and 50 percent, respectively, of the dominant nekton in each system were commercially important species which are migratory in some respect.

Seasonality in nekton catches was largely a result of migratory and spawning patterns. Catches in the Neuse River estuary were highest during the spring and were composed largely of immigrating juvenile spots, croakers, blue crabs and anchovies. The spring peak was also evident in the Newport River estuary due to juvenile menhaden, spots, striped mullet and bluefish. There also seemed to be a smaller fall peak composed largely of white shrimp. Distributaries of the Cooper River in South Carolina exhibited the same sort of seasonality, with as many as 503,000 organisms per acre present during the summer peak (Turner and Johnson 1974).

Not all of the nekton which utilize the mid-salinity system are migratory. Permanent residents whose entire life cycle takes place within the estuary are relatively few, but most are small species which are numerous and provide forage for migratory species. Examples of these are rough and Atlantic silversides, mummichog and grass shrimp. Some commercial species are entirely estuarine-dependent, such as white perch and spotted seatrout (Cronin and Mansueti 1971; Tabb 1966).

The benefits derived from the mid-salinity system are protection from predators during juvenile stages and an abundant food supply. The efficiency of energy transfer between plants and animals is higher in this system than in land-based systems because of the diatoms in the phytoplankton (Bellis 1974). The oils and fats which they produce as storage products are energy-rich and become concentrated as they pass through the food chain, ultimately becoming the oil which in part makes menhaden so commercially valuable. The largely shallow system provides easy access to organic-rich bottom sediments, while the adjacent marshes and some eelgrass beds afford protection and provide an abundant amount of bacteria-enriched detrital particles (Adams and Angelovic 1970).

Utilization of the system by migrating nekton has evolved based on the seasonal availability of nutrients and food organisms and on seasonal cycles of temperature. Anadromous fish "key" on freshwater runoff to locate their home rivers. These factors combine to bring the eggs and larvae together in the mid-salinity system at a time when spring runoff has enhanced phytoplankton growth and caused an abundant food supply to be ready at hand. Since most of these components are not visible unless specialized collecting gear is employed, the high value of the system in protecting and nurturing the most critical life stages of many commercial species is often not obvious.

Many aquatic birds also use the mid-salinity systems in North Carolina. At least 80% of the colonial seabirds nesting in North Carolina use dredge-spoil islands located within mid-salinity areas. Though land-based, they feed in and contribute waste products to the estuary (Parnell and Soots 1975).

Predator-prey relationships in mid-salinity systems are usually extremely complex (Figure 20). Their complexity is increased by the fact that most organisms occupy different levels (feed on different things) at different stages in their life cycles. The resultant relationships may even result in adults of a given species feeding on their own offspring.

It is important to note that if one component of such a relationship is damaged or destroyed, the entire relationship could be altered or affected in ways which could be irreversible. The same applies to the entire combination of physical factors which make the mid-salinity system such a suitable habitat for so many valuable species.

II.B.3. Values of the Environment

North Carolina's commercial fisheries are ultimately totally dependent on the welfare of the mid-salinity estuarine areas. Of the 10 leading species in the commercial catch in 1973, all but one were estuarine-dependent species having a total value of almost $16 million (Easley and Sossamon 1974). This figure does not include those fish taken by sport fishermen, nor does it include commercial species taken by private individuals.

Secondary benefits are revenues derived from operation and maintenance of the gear required for the commercial and sport fisheries, marinas, boatyards and other repair and supply facilities, and processing operations. Data for vessels and persons employed are incomplete. Four coastal counties (Hyde, New Hanover, Onslow and Pamlico) in 1971 had 210 motor vessels operating with a gross tonnage of almost 5,000 tons. These vessels employed among them a total of 428 persons. Surveys in these counties during the same year (plus Martin, Pasquotank and Pender) revealed 659 motorboats with 1,150 attendant fishermen. No figures are available for the amount spent in maintaining and fueling these vessels, or on lodging for sport fishermen visiting the coastal areas. Processed fishery products in 1972 in North Carolina were worth some $13.25 million. Processing facilities employed approximately 1,200 persons (Easley and Sossamon 1974).

No one can assess the nonmonetary value associated with the pleasure derived from using the mid-salinity system for recreational purposes. Fishing, water-skiing, sailing, swimming and birdwatching all are aesthetically pleasing

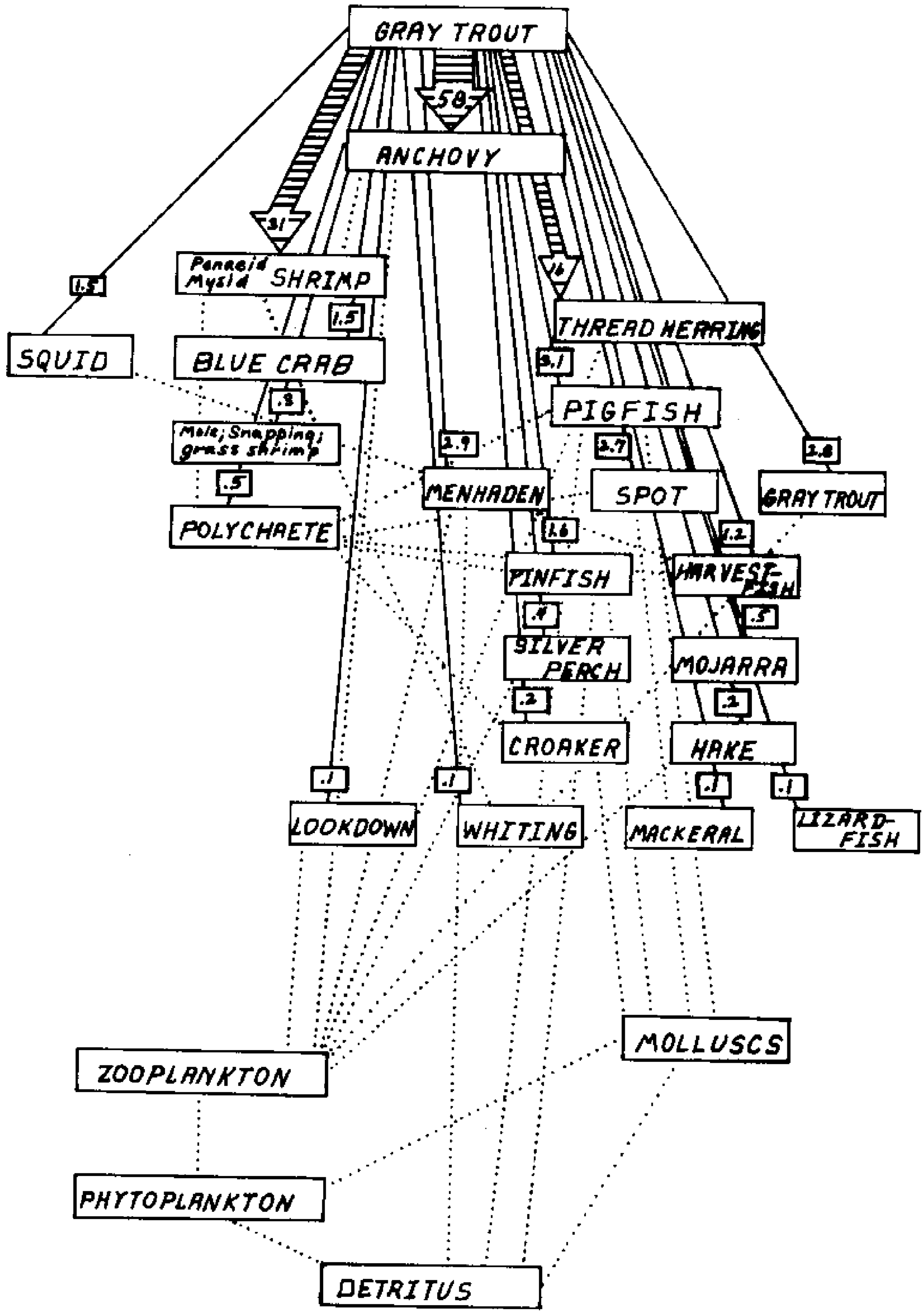


Figure 20. Food-web of the grey trout (from Merriner 1975). Numbers are percentage occurrence in diet of grey trout from 817 stomachs taken in North Carolina waters. Dotted lines indicate food preferences.

to the participants to an extent which only they can assess. Some indication of how much they are enjoyed is evident from the number of visitors the coastal plain receives each year and the increasing revenues which arise from their visits.

II.B.4. Man's Impact on the Environment

Most of the activities which man engages in that have an effect on mid-salinity systems are listed in Table 5, along with their potential adverse and beneficial effects.

One other important activity, trawling, produces adverse effects in North Carolina's mid-salinity systems. Wolff (1972) felt that trawling is potentially "one of the more destructive forces in our estuarine areas." The same study indicated that "possibly 35 times more scrap fish were destroyed during shrimping operations than (were) landed during finfishing operations."

II.B.5. Management Implications

There is one singlemost important consideration to remember when discussing management of any coastal zone system: no matter to what extent we may be able to characterize individually any one component of an estuary, they are all completely interdependent and ultimately require management as a unit. Any alteration, however slight, in a given system may result in unforeseen consequences in other apparently totally unrelated areas of the system. North Carolina's estuaries may be maintained in pristine ecological condition by stringent legislation and vigorous enforcement, all of which is to no avail if organisms cannot reach upstream spawning areas in the Piedmont or are overfished by foreign fleets offshore. Such perturbations in "separate" systems not covered under protective legislation could render the estuary's function as a nursery area obsolete. A case in point is North Carolina's continued loss of shellfishing acreage. Twenty-seven thousand acres closed in 1964 ballooned to almost 700,000 in 1974, representing almost 30% of the total estuarine water in the State (Brown 1974). The additional closures were due to pollution largely from outside of the system in the form of improperly functioning septic tanks and runoff from cattle and swine-producing farms located in estuarine watersheds (Brown 1974).

Table 5. Various Types and Likely Consequences of Man-Induced Modifications of the Mid-Salinity System as a Habitat for the Young of Commercially Important Organisms (Modified from Kutkuhn 1966).

Feature	Example	Expected effects	Probable results in terms of resource productivity	
			Adverse	Beneficial
I. Change in Basin Configuration:				
Bulkheading and Filling	Coastal Zone, North Carolina	General reduction in acreage of desirable shore-zone and marsh habitat; alteration of marsh drainage patterns (Hutton *et al.* 1956).	Decreased productivity due to loss of carrying capacity through destruction of plant cover and food sources.	None
Dredging of Navigation Channels	Intercoastal Waterway; Wilmington ship channel; State part of Morehead	Partial deepening of bays, alteration of marsh drainage patterns; increased exchange of oceanic, bay and marsh water; change in circulation and hence distribution of salinity, temperature, etc.; temporary increase in silt load (Rounsefell 1964; Reid 1956, 1957; Ross *et al.* 1974a).	Possible sea-water intrusion, reducing carrying capacity through reduction of plant cover and food sources.	Increased carrying capacity through provision of access for small organisms to previously inaccesible estuarine and marsh areas; deepened areas offer haven or escape routes from effects of sudden cold fronts. (Deposition of spoil islands allows nesting by seabirds.)
Segmentation by Spoil Banks as Well as by Rail and Highway Grades	Oregon Inlet bridge	Lessening of average depth through shoaling due to structure's influence on circulation; reduced exchange of fresh and salt water.	Slight loss of bottom acreage, disruption of flow patterns, and impedence of organism movements would have nominal effect on productivity.	None
Ditching of Marshes	Coastal North Carolina (Carteret County)	Lowered water table; gross change in vegetative cover; loss of nutrient material from marsh areas (Bourn & Cottam 1950; Kuenzler & Marshall 1973; LaSalle & Knight 1973).	Loss in productive potential attributable not only to loss of plant cover and food sources, but to reduction in nursery acreage as well.	Increased access to marsh areas by juvenile organisms.
II. Protective Works: Sea Walls, Dikes, Levees	Coastal North Carolina	Restricted influx of salt water; loss of tidal-exchange benefits; change in salinity regime.	Generally lowered productivity because of diminished access to broad estuarine areas for young organisms.	None

Table 5 (continued)

Feature	Example	Expected effects	Probable results in terms of resource productivity: Adverse	Probable results in terms of resource productivity: Beneficial
III. Change in Volume and Seasonal Distribution of Freshwater Inflow:				
Inhibition and Removal of Water Flow	Upstream dams and flood control structures on N. C. rivers & streams; removal of water for municipal & agricultural uses; removal of water by power plants (B.S.E.P.)	Generally heightened salinity; increased concentration of downstream pollutants; reduced influx of terrigenous nutrient material (Chapman 1966; Copeland 1966). Entrainment of organisms by power plants.	General deterioration of environment which is a vital link in organisms' survival strategy would mean a measurable loss in production.	None
Channelization	Coastal North Carolina streams	Erratic, sudden freshwater input; pulses of pollutants; increased siltation due to loss of gradual flow.	Destroys benthic habitat through increased siltation and pollutants.	None
IV. Polutions:				
Domestic	Untreated wastes (Cape Fear River system?)	Change in water chemistry; increased biological demand for oxygen.	Superenrichment could induce suffocation and loss of productivity.	Increased fertility; limited enhancement of productivity.
Industrial	Port cities (Wilmington, Morehead), pulp & textile mills on N. C. rivers	Change in water chemistry; presence of toxic or suffocating compounds (Steed & Copeland 1967).	In cases of inadequate dilution, decreased survival and productivity.	None
Agricultural	Pamlico River estuary and tributaries	Introduction through sheet runoff of pesticides, herbicides and nutrients (from fertilizer) (Warlen 1974).	Accumulation of toxic substances by shellfish, resulting in closing of shellfish areas, etc.	Possible enhancement of system due to increased fertility.
Thermal & Nuclear	Brunswick Steam Electric Plant, other possible power plants on N. C. estuaries	Increased temperatures in area of thermal plume on a year-round basis except for shutdowns; radioactive compounds released (Hoss et al. 1971; Hoss et al. 1974b).	Fish kills due to sudden shutdown during winter; possible death of larval organisms.	Possible enhancement of system due to warm temperatures providing extended growing season (Copeland & Davis 1972).

II.C. Mud and Sand Flats

John B. Williams

Located between high and low tide levels throughout North Carolina's coastal zone are sandy and mud bottom areas called "flats." They got this name due to their flat, level appearance (Eltringham 1971). Flats are exposed at low tide and include the areas extending out from the permanent shoreline as well as shoals and bars separated from the mainland by water (Figure 21). The extent to which mud and sand flats are found in our different sounds depends largely upon the physical and geological characteristics of each basin (Eltringham (1971).

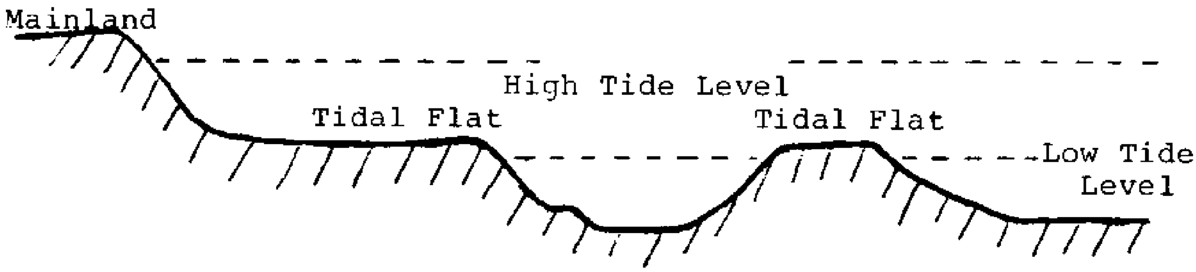


Figure 21. Location of tidal flats.

Often these apparently barren mud flats contain an abundance of animal life, crustaceans, clams and worms hidden away beneath the sediment surface (Eltringham 1971). They can, therefore, serve as important feeding grounds for two different groups of prospective dinner guests--fish and crabs at high tide and birds and mammals at low tide (Eltringham 1971). The closeness of these flats to man's activities on the mainland makes them especially vulnerable to shoreline development and different forms of pollution.

II.C.1. Environmental Description

The presence of sand flats or mud flats along a particular shore is largely dependent upon bottom topography and the speed of water currents carrying suspended sediments. As currents begin to slow down, sand drops to the bottom first, but clay and silt (mud) only settle out when the current is very slow (Figure 22; Eltringham 1971). Thus, sand deposits are found in faster current areas than mud. If the bottom is shallow enough and gently sloping, not steep, these bottom areas can become exposed flats at low tide.

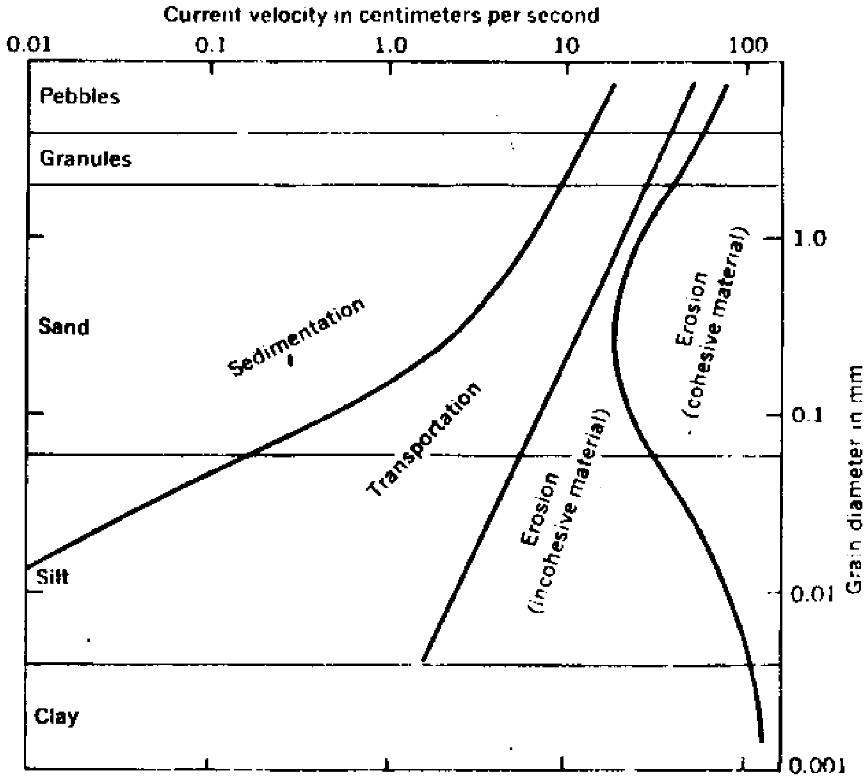


Figure 22. Relationship of sedimentation, transportation and erosion of different particle sizes to different current velocities (from Heezen and Hollister 1971).

Just how shallow the bottom has to be is determined by the tidal amplitude for a particular body of water. Deeper bottom areas can become flats in sounds with larger tidal ranges than those with smaller ones. In North Carolina the normal tidal range at Beaufort is just over 3.0 ft (Kirby-Smith and Gray 1971), while in the Albemarle and Pamlico Sounds it is less than 0.5 ft (Saila 1973). Tidal range varies over the lunar cycle and is also greatly affected by the wind, especially in the Pamlico (Hobbie *et al*. 1972). At Beaufort, the range varies from 0.7 m at neap tides (first and third moon quarters) to 1.3 m at spring tides (new and full moon). Here spring tides are greatest in April-May (2.0 m) and least in October-November (1.0 m) (Kirby-Smith and Gray 1971). The horizontal extent of any given mud or sand flat will therefore vary as the tide ranges.

Like stomachaches and budget planning, current systems in estuaries are often complicated (Friedrich 1969). Channels eroded by swifter currents often border or cut through tidal flats and transport material away from their edges. Shifting current patterns may change the shape and location of these flats.

Decaying plant and animal matter, often called detritus, is an important food source for animals living in mud and sand flats (Eltringham 1971). These organic particles are very light and only settle out in very quiet waters, so muddy bottoms tend to have a higher organic content (Eltringham 1971). As the waters recede at low tide, water trickling down through the mud or sand tends to lose its oxygen content partly as a result of the respiration of microorganisms feeding on detritus and partly through the oxidation of chemical substances within the sand. Eventually, all the oxygen is used up at a depth which may vary from a few millimeters to nearly a meter, depending on organic content (Eltringham 1971). The sediments below the level where oxygen is used up are black in color, while those above are yellow or light brown. The upper oxygen-rich zone is often called the aerobic layer and the black layer is called the anaerobic layer. In the black layer are high levels of hydrogen sulfide (Figure 23; Eltringham 1971). When this black layer is dug up, hydrogen sulfide gas is given off, creating a "rotten egg smell."

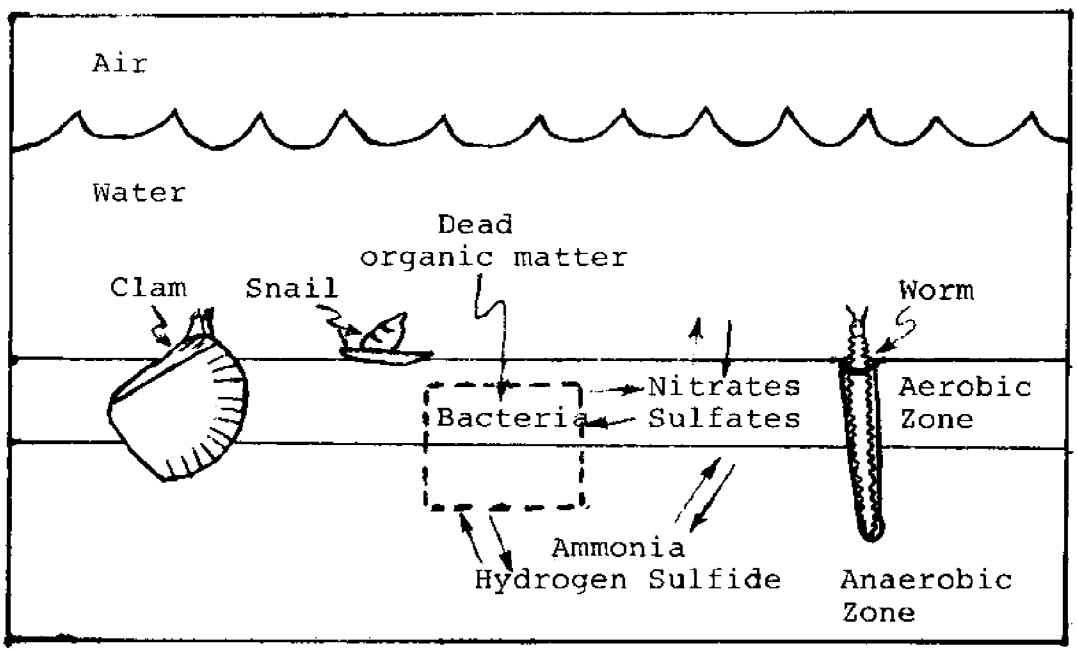


Figure 23. Chemical zones and general locations of animals found in mud flats. Pathways of organic decay are indicated by arrows.

Basically, animals composing mud and sand flat communities can be divided into two major groups--temporary and permanent members (Eltringham 1971). Permanent members such as snails, worms and clams spend their whole adult lives on the flats, while temporary members move on and off the flats during high and low tides in search of food. Below is an outline of members of tidal flat communities (Table 6) from Eltringham (1971).

Probably the most important community members are also the smallest, the bacteria. Bacteria feed on dead plant and animal material and recycle nutrients back to overlying waters (Figure 21) to be used by phytoplankton (Odum 1971). They also serve as an important food source for large deposit feeding animals and meiofauna (Eltringham 1971). Other small members are the microscopic plant life, diatoms and blue-green algae found in the surface sediments (Eltringham 1971). The productivity of these plants can be quite high (Cadee and Hegeman 1974) and serves as another food source for deposit feeders and meiofauna (Eltringham 1971).

Living between the sand grains are peculiar, tiny animals, usually long and slender, called meiofauna. They have strong body walls to protect themselves from being crushed and adhesive organs for clinging to the sand grains. Meiofauna are usually more numerous on sand flats than mud flats due to increased interstitial space (Eltringham 1971). Meiofauna have been found to be far more numerous in summer and live nearer the surface sand, but their numbers drop and they move deeper down in winter (Harris 1972).

The more commonly known animals living in tidal flats are the macrofauna, worms, clams and crustaceans. Their most important adaptation for living here is the ability to burrow (Eltringham 1971). Burrowing keeps a sediment "roof over their heads" which buffers these organisms from stressful conditions at low tide, dessication and freezing, and helps to hide them from predators. It also aids many deposit feeders in their feeding activities (Eltringham 1971).

Polychaete worms have been found to be more abundant on tidal flats than in bottom areas below low tide (Pearse et al. 1942). These worms are mainly deposit feeders and feed by taking in mouthfuls of sediment and utilizing the organic matter and bacteria in them. Arenicola, a common sand flat worm, burrows by swallowing muddy sand and digesting its organic contents (Eltringham 1971). Polychaete densities of 252 per m^2 are recorded for an English flat (Eltringham 1971) and these worms serve as important food for estuarine fish such as pinfish, spot and flounder (Pearse et al. 1942; Hansen 1969).

Table 6. The fauna of mud and sand (from Eltringham 1971).

Name	Definition	Examples
1. <u>Permanent Members</u>		
1a. Epifauna (= Epipsammic spp.)	Species which spend long periods moving on the surface of the soil but which may at times bury themselves.	Snails
1b. Infauna	Species which spend all or the vast majority of their time under the surface.	
1b.i. Macrofauna (= Endopsammic spp.)	Species which move or occupy space by displacing or swallowing beach particles.	Clams and worms
1b.ii. Meiofauna (= Mesopsammic spp. interstitial fauna)	Species which live within the interstitial spaces or which are within the size range of 50-5000 μ.	Gastrotrichs, Nematodes and Harpacticoid copepods
1b.iii. Microfauna	Protozoans less than 50 μ in length.	
2. <u>Temporary Members</u>		
2a. Marine	Species which visit the beach from below low tide mark when the tide is in.	Many fish, plankton and crabs
2b. Terrestrial	Species which visit the beach from above high tide mark when tide is out.	
2b.i. Facultative spp.	Species which occur in other habitats and which are not dependent on the beach.	Many mammals (otters, rats). Some birds, raccoons.

Table 6 (continued)

Name	Definition	Examples
2b.ii. Obligate spp.	Species which are dependent on the intertidal zone for some essential resource, usually food.	Many seabirds and ducks

Clams are one of the most important macrofauna in sand and mud flats serving as food for birds, crabs, fish and man (Saila 1973). At low tide clams are well-protected by remaining burrowed in their tightly closed shells. At high tide they feed by extending their siphons up through the sediments to filter out food, phytoplankton and detritus suspended in the water column. Some clams, such as Macoma balthica, can also function as deposit feeders and use their siphons like vacuum cleaners to draw food in from surface sediments (Eltringham 1971). Some of the more important species in North Carolina waters are Mercenaria mercenaria, Lellina alternata, Spisula solidissima, Mulinia lateralis, Rangia cuneata and Dinocardium robustum. Clams such as Rangia reach very high densities in the Pamlico and Albemarle Sounds (Porter and Tyler 1971).

Small crustaceans (mainly amphipods) are also found in abundance burrowing in tidal flats. These animals are more dense in sandy areas than muddy ones and reach numbers of 144 per m^2 on English sand beaches (Eltringham 1971). Deposit feeding and suspension feeding are both utilized by members of this group (Eltringham 1971) and amphipods are preyed upon by birds and fish (Friedrich 1969).

Epifauna crawling around on North Carolina's mud and sand flats consist primarily of snails. Ilyanassa obsoleta, the common mud snail, is very abundant in muddy areas and feeds by scavenging for detritus (Morris 1973). Common snails on sand flats include Terebra dislocata, Nassarius vibex and Ilyanassa sp. (Porter and Tyler 1972). Snails are preyed upon chiefly by birds such as the black duck (Saila 1973) and to a lesser degree by blue crabs (Tagatz 1968).

During high tide the mud and sand flats are submerged and become feeding grounds for temporary members of this community, fish and crabs. Predators feeding on flats near

Beaufort, North Carolina, included silversides, killifish, pinfish, blue crabs, flounder and spot (Pearse et al. 1942).

Predators on the flats at low tide include raccoons (Pearse et al. 1942), rats, otters and especially birds (Eltringham 1971). Some of the more important birds using tidal flats in North Carolina are listed in Table 7, along with their time of occurrence and food.

Table 7. Some important birds using tidal flats (from Saila 1972).

Bird	Season	Food (from tidal flats)
Great Blue heron	N. C. resident year-round	Crustaceans
Canada goose	Abundant winter resident	Crustaceans, molluscs
Mallard	Winter resident	(Not listed)
Black duck	Winter resident	Small clams, snails
White-winged scoter	Winter resident	Molluscs
Plover	Coastal migrant (spring)	Worms, clams, crustaceans
Sandpiper	Coastal migrant (May-October)	Crustaceans, worms, snails
Dowitcher	Common migrant (April-May; July-September)	Worms, molluscs, crustaceans

It is important to remember that the living patterns of tidal flat organisms are closely connected to the tides and without a regular submergence they could not survive. Clams and some of the worms and amphipods can only feed or reproduce at high tide (Barnes 1968), and the flooding tide helps to flush wastes out of the animals' burrows. Seasonal patterns are also evident with different species showing maximum abundance at different times of the year (Eltringham 1971). The seasonality of birds has already been mentioned. Blue crabs are reported to move out into deeper waters during colder months and in general most tidal flat residents become more inactive during winter (Pearse et al. 1942). Seasonal migrations of fish predators also occur (Cronin and Mansueti 1971).

II.C.2. Values of the Environment

North Carolina's mud and sand flats may be of slight commercial value in some counties where the commercial hard clam, Mercenaria mercenaria is dug by hand. In 1967, 7,900 pounds worth $4,177 were harvested. This catch dropped to 100 pounds worth $51 in 1969 and no catch was reported for 1970 (Chestnut and Davis 1975).

Of greater importance is the indirect value of tidal flats as feeding grounds for the birds, crabs and fish mentioned earlier. Some flounder and spot (commercially important fish) and blue crabs depend partially on food from these flats for their survival (Pearse et al. 1942). Clams, snails and small crustaceans are also staples in the diets of several ducks and shorebirds which search for their meals on tidal flats at low tide (Saila 1973). Indirectly, the usefulness of these feeding grounds to game birds ties them to another commercial group, the hunting industry. Hunters bring money into the North Carolina coastal area for food and lodging as well as equipment.

Mud and sand flats, along with submerged bottom areas, are also of indirect value due to their role in trapping and cycling nutrients (Odum 1971). This helps supply necessary amounts of nitrogen, phosphorus and other nutrients to the overlying waters to be utilized by phytoplankton, microscopic plants vital to most estuarine food chains (Odum 1971). Nutrient cycling is performed by sediment bacteria breaking dead plant and animal matter down to basic nutrients which then diffuse back into the water (Figure 21). Much of the nutrients do not get back into the water immediately, but are buried. This results in some bottom sediments having up to 100,000 times the concentration of a nutrient-like phosphorus compared to the water above (Martin 1970). Phosphorus coming into our sounds from rivers can also become absorbed onto suspended sediment and later fall to the bottom to further enrich these bottom deposits (Martin 1970).

Although mud is not very pretty to look at, there is an aesthetic value to tidal flats. This comes from their interesting low tide bird populations which attract birdwatchers to our coastal zone. Both native and migratory birds use these flats and their continued presence along our shores is dependent upon adequate mud and sand flat feeding grounds (Table 7).

II.C.3. Man's Potential Impact

Probably the most serious impact man can have on our coastal intertidal flats is through dredging. Directly dredging away these flats removes habitat essential for the existence of many prey species important to avian and fish food chains. Similarly, expanding the permanent shoreline by fill operations can eliminate these areas. Dredging also alters the sediment composition which can reduce the number and variety of species living along the bottom (Sykes and Hall 1970). Even if flats themselves are not dredged, operations in nearby areas can suspend silt and clay particles which are then deposited on the tidal flats, suffocating their inhabitants (Giannio and Wang 1974). The effects of this suspended silt are generally limited to a distance of about one-quarter of a mile from the dredging site and can be reduced by using canvas silt screens (Copeland and Dickens 1974).

Dredging can also suspend organic matter and other substances which cause reduced oxygen levels in nearby areas (e.g., from 94% oxygen-saturated down to 52.5%), but these conditions may only last a few months and have negligible effects on bottom animals (Leathem _et al_. 1973). A further dilemma is that sewage enhances the growth of algal mats on top of the flats and this can smother out the inhabitants (Perkins and Abbot 1972).

Another danger to these flats comes from disposing of gypsum spoil, a product of the phosphate industry. If this spoil drains into the estuary, it can form a crust over the bottom and virtually eliminate all macro-benthic organisms (Taylor _et al_. 1970).

Insecticides like DDT used near the shore can get into the water and be taken up by clams and concentrated in their tissues (Woodwell _et al_. 1967). Birds eating these polluted clams can have poor breeding success, due mainly to egg shell thinning (Salia 1973). This could cause a gradual decline in North Carolina shorebird populations.

Clams can also become contaminated by concentrating petroleum hydrocarbons filtered from the water. These hydrocarbons can enter the water from sewage, oil spills, small boat operation and street runoff (Farrington and Quinn 1973).

II.C.4. Management Implications

Two extreme views about mud and sand flats can be taken. Some developers might regard them as mud wastelands (Giannio and Wang 1974), only useful when dredged or filled; while other people might regard all flats as vital natural resources and oppose any form of development. Proper management programs must consider both viewpoints.

Before direct development of any tidal flat is undertaken, studies should be made to assess the value of that particular flat in the areas mentioned in Section II.C.3. Since the abundance and diversity of animals using the flats change with tide and season, these studies should be broad enough to consider these temporal changes. Hopefully, this approach could establish whether any or all of a tidal flat could be developed. Considerations must also be made about what effects development in one area (i.e., dredging) may have on tidal flats nearby. Silt screens should also be used during dredging to reduce siltation problems.

II.D. Oyster Reefs

Ronald Fiore

One of the most dominant estuarine organisms found along the coast of North Carolina is the eastern oyster, *Crassostrea virginica*. Other species of oyster such as *Ostrea virginica* and *O. elongata* are also found in these waters, but are neither as prolific nor as economically important.

Approximately 65% to 75% of all oysters harvested annually in North Carolina are obtained from the Pamlico Sound area, while the rest are gathered from coastal areas south of Cape Lookout (Munden, DNER, personal communication). The total area of estuarine bottom capable of supporting oysters has been estimated by A. F. Chestnut (Unpublished) as approximately 377,720 acres, with about 200,000 acres actually under cultivation in 1969 (Spinner 1969).

II.D.1. Reef Description

Oysters are reef organisms which grow on their own shell substrate. Under suitable conditions of temperature, salinity and water flow, a single oyster will attach itself to any solid material such as a rock, stick or underwater structure. Other oysters then continue to attach to the substrate and to one another until the cluster gradually increases in height, width and length. This involves attachment not only to other living oysters, but also to the empty shells of preceding generations, forming a reef, bar or oyster bed.

Fossil deposits of oyster shells have been observed, indicating the enormous size of reefs developed in past ages. Large reefs provide the basis for multimillion dollar farming operations, as those living singly and widely dispersed do not offer much commercial value.

The reef not only offers a solid substrate to which oysters may attach, but other organisms such as many forms of algae, hydroids, bryozoans, barnacles, mussels, tube building worms and forms known as epifauna dwell upon the reef surfaces. Numerous animal forms also find shelter in the crevices that are created by reef growth (Wells 1961). Thus, an entire community made up of a collection of species evolves, finding a balance which provides everything necessary for the growth and perpetuity of each species (Table 8).

II.D.2. Environmental Factors Affecting Oysters

II.D.2.a. Water Movement--The existence of oyster reefs is dependent upon a number of environmental factors. Perhaps the most important of these is free exchange of water. Since oysters are sessile animals, they depend on moving water to provide oxygen and food as well as to carry away the waste products of their metabolism. It has been calculated (Galtsoff 1964) that an average oyster will filter approximately 15 liters of water per hour, and a volume of water at least equal to this amount must be provided to each living oyster on the reef in order that the reef be maintained. Oysters will not grow, fatten or reproduce in areas where current velocity is low. Conversely, turbulent currents of high velocities may dislodge and carry away not only the young oysters, but also some of the adults not attached to the bottom. Those which are attached to the bottom or the surfaces of rocks may suffer damage to valves caused by the influx of sand and small pebbles acting as abrasive material.

Ideal current conditions are represented by a steady nonturbulent flow of water over the oyster bed. This is not only necessary for influx of food and egress of waste, but is also essential in the expansion of existing reefs. Both this expansion and the creation of new reefs are accomplished by the carrying of oyster larvae on the current to other suitable substrates within the estuary.

Since water currents tend to flow faster along the sides of oyster reefs (perpendicular to the direction of daily tidal flow) the growth rate on these sides tends to accelerate, leading to the elongation of reefs perpendicular to the tidal currents (Figure 24).

Table 8. Composition and Characteristics of an Oyster Community, Beaufort, N. C. (from Chestnut 1974).[a]

Taxa	Total species	Soft-bodied	With preservable hard parts[b] Ca	Ch	Si	Ph	Possible redundancy
Porifera	5	--	--	--	5	--	3
Coelenterata	6	5	1	--	--	--	--
Platyhelminthes	1	1	--	--	--	--	--
Nemertea	2	2	--	--	--	--	--
Bryozoa							
Ectoprocta	7	4	3	--	--	--	--
Annelida							
Polychaeta	13	13	--	--	--	--	4
Mollusca							
Gastropoda	9	--	9	--	--	--	1
Pelecypoda	13	--	13	--	--	--	2
Arthropoda							
Crustacea	19	10	4	5	--	--	5
Arachnida (?)	1	1	--	--	--	--	--
Insecta	1	1	--	--	--	--	--
Chordata							
Tunicata	2	2	--	--	--	--	--
Vertebrata	1	--	--	--	--	1	1
Totals	30	39	30	5	5	1	15
Percentages of total community	100	49	38	6	6	1	19

[a](Data from Wells 1961) Among the arthropods, only decapod crabs with relatively well-calcified and/or well-tanned exoskeletons have been included with the organisms with hard parts.

[b]Ca = calcareous; Ch = chitinous; Si = siliceous; Ph = phosphatic.

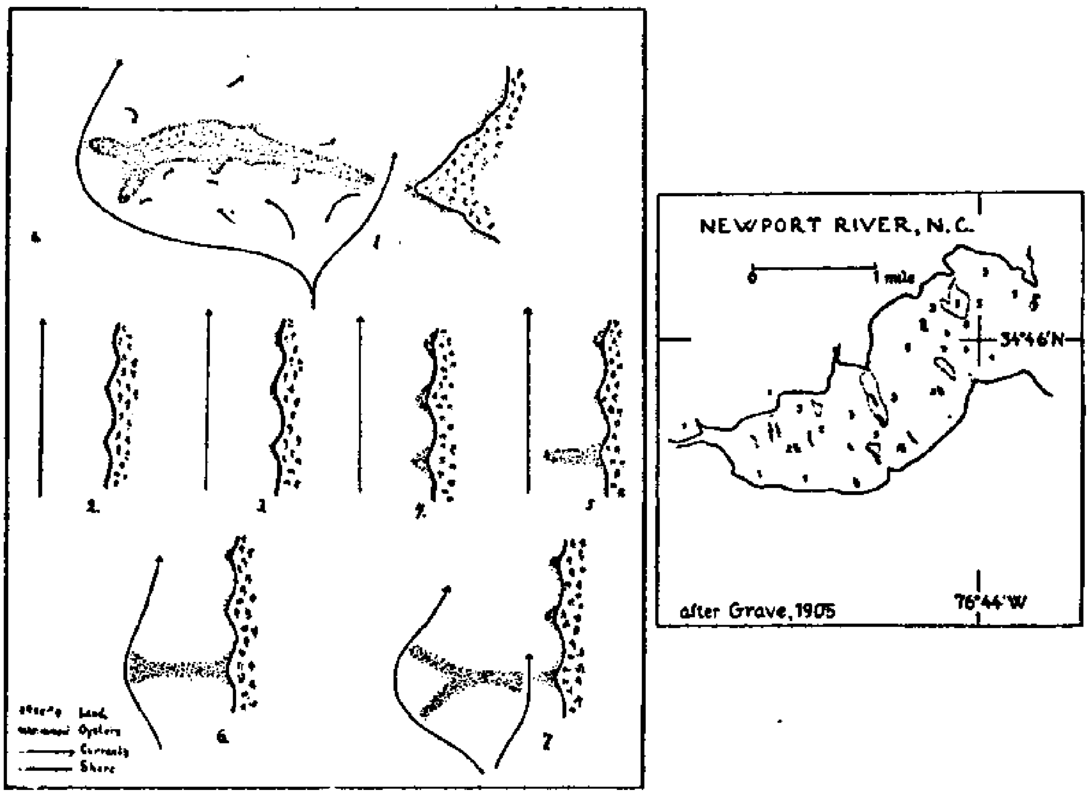


Figure 24. Elongation of oyster reefs in relation to prevailing currents (from Chestnut 1974).

II.D.2.b. Salinity--Oysters are so-called euryhaline organisms and, as such, can live in seawater which varies in salinity. The eastern oyster, C. virginica, thrives best in two zones; the polyhaline, from 30 to 18 ppt, and the mesohaline, from 18 to 5 ppt (Galtsoff 1964). Populations found outside of these limits are usually marginal, in that growth and gonad formation are inhibited (Butler 1949; Loosanoff 1952). An unstable pattern of salinity with diurnal, seasonal and annual fluctuations is an important ecological factor in areas inhabited by the eastern oyster. The effect the changes actually have upon the oysters is dependent upon their suddenness as well as the range of fluctuation.

Continued exposure to salinities above 32 ppt has taken its toll upon oyster populations. During a six-year drought in Texas, from 1948 to 1953, salinities increased to 36 ppt (at times 40 ppt) causing C. virginica to be supplanted by Ostrea equestris, an oyster species of no commercial value (Parker 1955). Oysters inhabiting areas where salinity is below 10 ppt are more seriously affected by incursions of freshwater. Numerous instances of heightened rainfall and river flow have brought oyster mortalities close to 100% (Galtsoff 1930; Butler 1949, 1952; Andrews _et al._ 1959). However, the introduction of some freshwater may be beneficial to oyster reefs under certain conditions. Some species of oyster predators, such as starfish, carnivorous gastropods and flatworms, cannot adapt to lowered salinity and die in brackish water. Periodic flushing thus wipes out predators and restores reef productivity.

II.D.2.c. _Temperature_--Within the range of the eastern oyster there is a great deal of temperature variance. In the northern states species may tolerate a minimum temperature of 1 C during the winter, and in southern states survive up to a maximum temperature of 36 C as occasionally evidenced in Florida, Texas and Louisiana. The temperature regime may affect oyster populations in various ways, by influencing their rate of water pumping, feeding, reproduction and growth. The maximum rate of water transport carried on by the eastern oyster is usually accomplished at about 25 C, with a rapid decline at about 32 C (Galtsoff 1964). _C. virginica_ ceases feeding in the 6 C to 7 C range (hibernation) and successful mass spawning and setting of oysters is hampered at temperatures below 20 C. During the hot summer months, the growth rate has been observed to be markedly reduced in shallow North Carolina waters, while oysters colonizing low tidal zones for short durations have been killed by freezing in winter. The seasonal variations of the water temperature in two areas are plotted in Figure 25, indicating periods of hibernation and spawning.

II.D.2.d. _Food_--There is little existing information regarding the exact nutrient requirements of oysters; however, it has been established that they filter plankton, detritus and other tiny particles from the water in order to meet their energy requirements. According to Jorgensen and Goldberg (1952, 1953), oysters filter 10 to 20 liters of water for each milliliter of oxygen consumed and about two-thirds of the energy they absorb can be used for growth.

Food gathering may be influenced by several factors. During periods of hibernation, at temperatures below about 8 C, the food-gathering process is interrupted. Some types of phytoplankton, such as _Chlorella_, secrete antibiotic substances harmful to oysters. It has also been shown that high concentrations of several phytoplankton species which occur during blooms (_Nitzschia closterium_, _Prorocentrum triangulatum_, _Euglena viridis_) may be harmful, as the rate of water transport is reduced and feeding ceases (Loosanoff and Engle 1947).

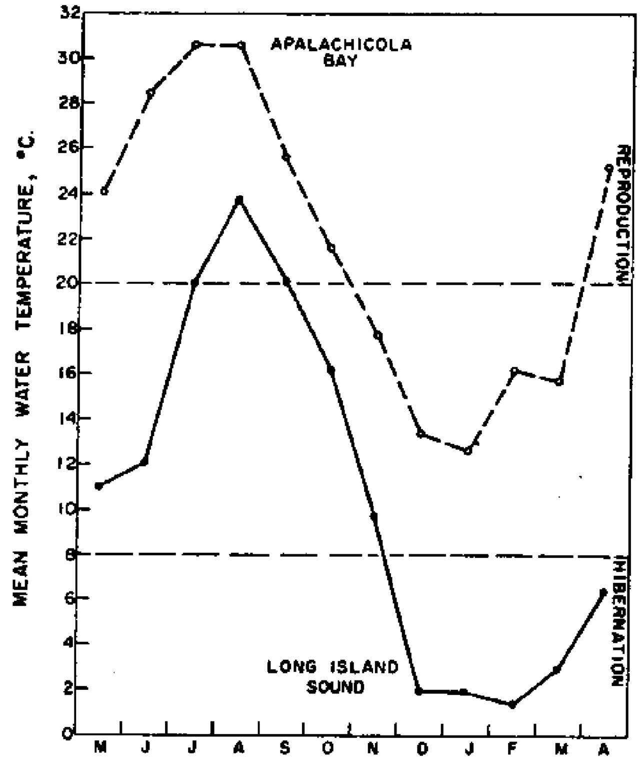


Figure 25. Mean monthly temperature in degrees Centigrade of water in Apalachicola Bay (upper curve) and Long Island Sound (lower curve) (from Chestnut 1974).

Periods of "red tides," where the development of the dinoflagellate Gymnodinium breve becomes excessive, are responsible for extensive fish mortalities and also poison many oysters growing along the shores of affected areas (Galtsoff 1948, 1949).

Oysters may incur additional problems by filtering foods which contain only a minimal amount of nutritive value or may come across organisms which they are unable to filter due to pecularities of size and shape.

It has been noted that there are changes in nutrient values in oyster meat itself. This seems to be a seasonal factor in that during spring protein and mineral matter decrease sharply, while carbohydrate content reaches its maximum (Figures 26 and 27). Glycogen storage peaks during late fall, making the oysters "fat" (Figure 27).

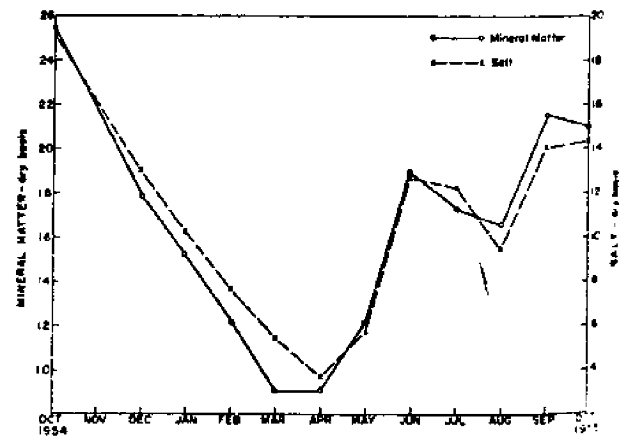


Figure 26. Average mineral matter and salt content in the monthly samples of southern oysters (unwashed) in percent of dry weight (from Chestnut 1974).

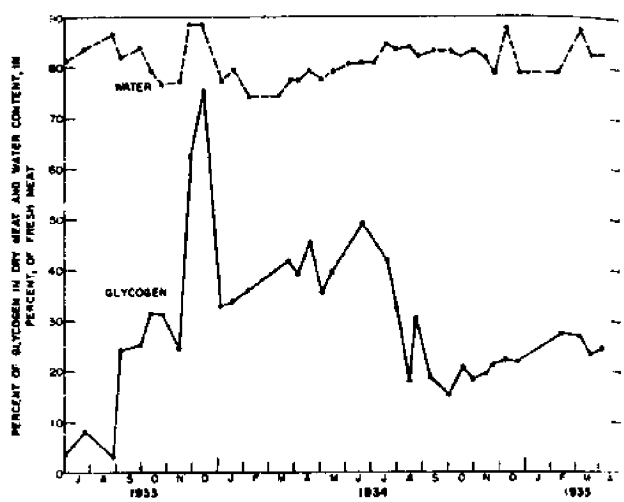


Figure 27. Glycogen and water content of adult oysters (5 years old in 1933) from commercial oyster bed off Charles Island, Long Island Sound (from Chestnut 1974).

II.D.3. Character of the Bottom

Oysters thrive on a hard, rocky or semihard mud bottom, firm enough to support their weight. They cannot grow on shifting sand or soft mud bottoms. However, between these extremes, they can adapt to a wide range of bottom conditions. The oysters themselves are capable of converting a soft bottom by depositing oyster shells and making a hard mass suitable for the further setting of oyster larvae. In fact, the mud bottoms of the south Atlantic states, including North Carolina, are only marginally suited for oyster production (Galtsoff 1964). They have, however, been much improved by the planting of oyster shell and the deposition of marl (Munden 1975).

The rapid settling of suspended material or sedimentation may be highly destructive to the oyster community. Estuary currents are the forces which usually transport sediment particles to and from the reef. When the amount of sediment picked up by a turbulent water flow exceeds the amount it deposits, the estuary bottom becomes eroded. Conversely, when deposition exceeds the amount picked up, the bottom is rapidly covered by sediment. Oyster reefs themselves may alter current patterns and velocities. By creating a kind of damming effect, the reef may cause an increase in sedimentation (Grave 1901).

Sedimentation is harmful to oysters in that the deposition of a thin silt layer, 1 to 2 mm, covering the hard surfaces upon which oyster larvae attach, usually renders these surfaces unsuitable for both the setting and development. Many formerly productive oyster bottoms once found in the Atlantic coastal regions of the United States have been destroyed by high sedimentation rates. Although the effects of sedimentation are first evident in the areas of setting development, adult oysters may eventually become buried and the entire reef killed by deposition. Bearing witness to the devastating effect of heavy sedimentation are dead reefs as long as 25 miles and as wide as 1 mile, which are buried some 4 to 10 feet below the surface along the coasts of Texas and Louisiana (Norris 1953).

II.D.4. Parasites, Commensals, Competitors and Predators

Oysters are adversely affected and sometimes killed by a variety of parasites and diseases. All oyster-producing areas are considered endemic for one or more diseases and disease is perhaps one of the greatest causes of oyster mortality (Mackin 1961). Oysters may be parasitized by many organisms such as protozoans, nematode worms or small crabs. Other species such as boring sponges and clams, mud worms, perforating algae and several more are not considered parasites as they do not use the oyster as a food source, but do share the food gathered by the oysters (i.e., commensals and competitors).

There are also many species of predators which attack and often devour both young and adult oysters. Listed among these are several varieties of marine snails or drills, large conch, starfish, flat worms, leeches, blue and rock crabs, black drum and three species of ducks.

Any and all of the negative effects brought about by disease, competition and predation must be considered in relation to how many oysters are affected, their mortalities and the resultant decrease in marketable value.

II.D.5. Man's Potential Impact

Of all the influences affecting oyster populations, perhaps the most profound are related to the activities of man. These activities can be divided into three basic categories: overfishing, the dumping of pollutants and dredging operations.

By the activity of overfishing, man has proven himself to be the most dangerous of oyster predators. Since the Stone Age, man has gathered oysters for food. Primitive methods of wading and handpicking eventually gave way to the use of oyster dredges and suction devices which soon depleted oyster bottoms in the northern United States. As early as colonial times, New Englanders tried to preserve dwindling oyster reserves by passing restrictive legislation limiting the size of catches as well as their sale outside of local areas. Unfortunately, in spite of these efforts many oyster bottoms, especially in northern New England, were destroyed. Similarly, a more gradual and less complete depletion took place in the Chesapeake Bay oyster grounds. Legislation banning the use of power dredges slowed the decline, but was not effective enough to maintain the productivity of the grounds.

In order for any natural resource to be maintained, the amount of it which is harvested must not exceed the amount regenerated annually and overfishing will continue to be a problem as long as this basic principle is ignored.

Pollution, the introduction of material or alteration of the environment to the detriment of organisms, is perhaps man's most important negative influence on oyster populations. Pollutants containing highly toxic substances may cause mortalities among marine populations. Those less toxic are not lethal to adult organisms, but may decrease the rate of larvae survival, the growth of juvenile forms and the population's reproductive capacity. Furthermore, sublethal concentrations may destroy links in the food chain and thus affect the population's food supply.

As applied to oysters, there are usually three types of pollution affecting reefs; domestic sewage, pesticides and trade wastes. In general, oysters accumulate pollutants to concentrations many hundreds of times greater than the levels found in the surrounding environment. In natural waters, these pollutants gradually undergo changes which lead to some purification, but at the same time deposit sediments which cover oyster beds and change the character of the bottom. In the case of some detergents and radioactive wastes, natural purification has virtually no effect and these pollutants consequently constitute a growing menace to the safety and purity of coastal waters.

The discharge of untreated domestic waste has a threefold effect upon oyster reefs. It covers the bottom with sludge that smothers the oyster bed, affects normal functions by decreasing the amount of oxygen in the water and greatly increases the water's bacterial and viral content. In common with other water-filtering mollusks, oysters retain and accumulate these bacteria and viruses. This type of contamination eliminates the grounds as a commercial fishery because it creates a health hazard to humans using oysters as a food source. However, the growth and development of the oysters themselves may not be materially affected (Chestnut 1974).

The most common industrial pollutants found in oyster-producing areas are introduced primarily from the oil, paper, steel, chemical, paint, plastics and leather industries.

Oil pollution of the open sea is an international problem and many of the bays and harbors of the United States are heavily polluted by oil discharges. Through surface tension, oil spilled on the surface of water spreads rapidly, forming a thin surface film or oil stock. In muddy waters, suspended clay particles may absorb the oil and then sink, only to resurface and create other slicks in shallow areas when disturbed by wave action. Thus, secondary oil slicks may appear several miles away from the primary source of pollution. Toxic water-soluble extracts of oil adversely affect oysters as they build up concentrations of them by disturbing ciliary beat to cause a decrease in the pumping capacity of the gills, as well as causing the valves to stay closed for longer periods of time. When closed, water transport for feeding, respiration and discharge of waste ceases (Galtsoff 1964).

Pulp mill wastes containing red and black liquors possess toxic substances which affect oyster populations. Similar to the effects of crude oil, pulp mill effluents increase the number of hours valves remain closed and black liquor causes depression of ciliary activity and respiration (Galtsoff _et al_. 1947; Figures 28 and 29). Red liquor, as

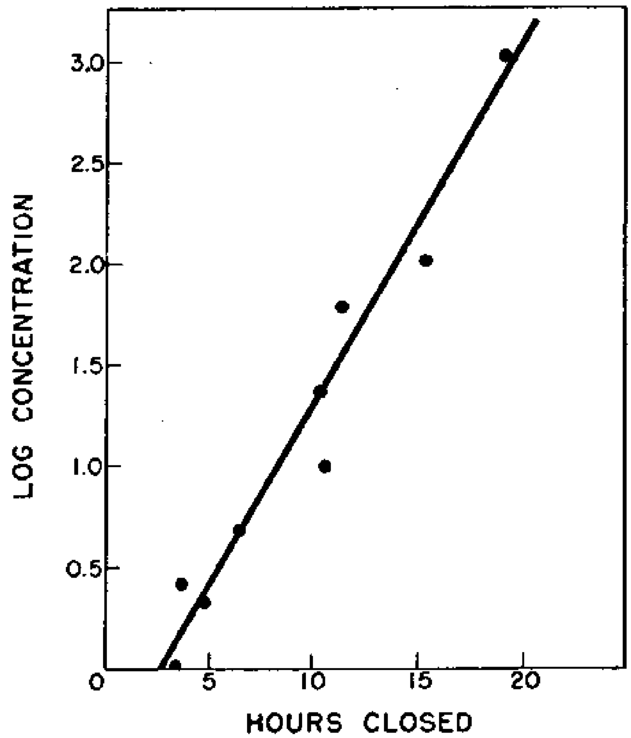


Figure 28. Effect of concentration of pulp mill effluent discharged into the York River on the number of hours oysters are closed during every 24-hour period (from Galtsoff et al. 1947).

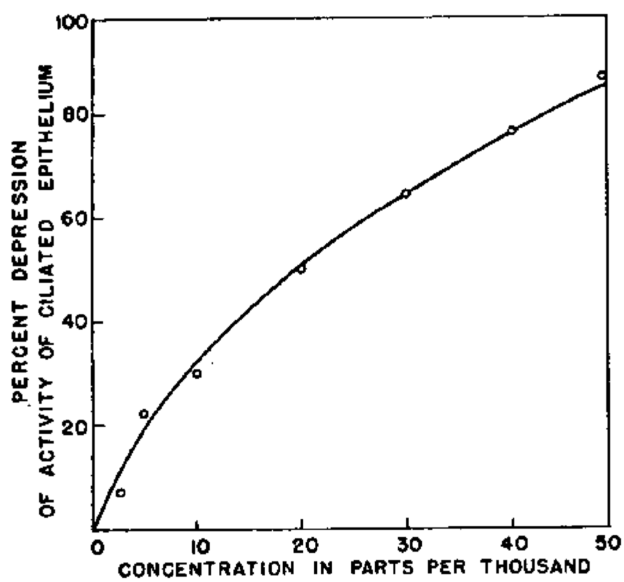


Figure 29. Depression of the activity of ciliated epithelium of oyster gill by increased concentration of pulp mill effluent (black liquor) of specific gravity 1.0028 (from Galtsoff et al. 1947).

observed by Odlaug (1949) may stop reproduction in oysters completely, and these oysters are usually of poor taste and quality. Ecological studies in the Shalton Bay, Puget Sound, further show that discharge of red liquor may increase the production of Melosira, a fouling plant found on oyster reefs. These pulp wastes are also oxidizable; however, only in cases of the most extreme pollution will they lower the oxygen content of the water to such a degree that bodily functions of oysters are suppressed.

The ability of oysters to concentrate pollutants to levels hundreds of times those in the actual environment makes the presence of heavy metals an important source of contamination. Copper dramatically affects oysters by actually turning them green and the depth of color varies with the content of copper, making it easy to observe. In a study of oysters located near the outfall of an electric generating station that used river water to cool copper condensors, Roosenburg (1967) showed that there was an inverse relationship between the condition of the oysters and the copper content of the water. Where copper content was highest the condition of the oysters was worse, and a gradient of oyster condition existed from points closer to pollution sources to areas farther away. Therefore, besides making the oyster unfit for human consumption, copper affects the organism itself. Fujiya (1960) found that copper actually causes necrosis and desquamatization of oyster stomach tissue as well as decreasing growth rates.

Radioactive zinc (Zn^{65}) is rapidly accumulated by oysters, clams and scallops. In a study done by Chipman *et al.* 1958), the gills of oysters were shown to contain large amounts of Zn^{65}. Oysters concentrate Zn^{65} faster than clams (Duke 1967) and on the basis of a single or short-term dosage of radioactivity, would be more affected.

Much recent work in the area of pollution monitoring on shellfish grounds has concerned itself with the effects of pesticides on rates of growth, reproduction and development. Oysters are able to concentrate many different types of chlorinated hydrocarbons (Bugg 1967) and can also release these accumulated residues, but only when placed in unpolluted waters (Butler 1966). However, exposure to some of these pesticides in concentrations of as little as one part per billion may decrease growth rates as much as 20% (Butler 1966). Usually, the residue is accumulated in the ovaries (Chestnut 1974). Oyster eggs and larvae seem to be affected by some pesticides more than others. Davis and Hidu (1969) tested a variety of pesticides for their effects on oyster development and found that most affected embryos more than larvae, but some had the reverse effect. This study emphasizes the need to selectively utilize pesticides because of overall differences in toxicity. Butler (1961) has pointed to the difficulty in evaluating the effects of pesticides in sublethal concentrations because of the wide variance of tolerance within each species.

Other modes of pollution, such as thermal pollution and the dumping of detergents, also have had adverse effects upon oyster populations. In a study to determine the effects of hot water relased by power plants into shellfish-producing areas, it was found that normal development of oyster embryos was impaired in 1-6 hour exposures when the water reached 30-34 C (Roosenberg et al. 1970). Calabrese and Davis (1967) and Hidu (1965) demonstrated that detergents produced significant negative effects on the development of oyster eggs, larvae and embryos.

As population and commerce have increased so have the demands and pressures for harbor improvement and canal construction. These projects involve the movement of large quantities of estuarine bottom by means of heavy dredging equipment. Dredging for the purpose of digging a channel or harbor or filling in a marshland may obliterate an oyster population by depositing a fine coat of sand and silt over the shells. This process interferes with the setting of oyster spat. However, it has been determined that controlled dredging operations taking place at least 400 yards from live oyster reefs is possible without creating too much harm. In a study of dredging operations conducted at Great Point Clear, Alabama, Ingle (1952, 1953) concluded that the momentary variations of the tide, speed of current and rate of dredging are all factors which combine to make each separate instance of dredging a unique situation meriting its own specific considerations.

II.D.6. Values of Oyster Reefs

The oyster harvesting industry in North Carolina provides the State with amounts of monetary, cultural and aesthetic values. The turn of the century marked peak landings of oysters; in 1902 (5.6 million lb) and 1903 (4.2 million lb), oysters accounted for the largest amount of any edible species caught. Annual oyster landings remained upwards of 1 million lb until 1962, but have not reached that figure since. The quantity landed in 1973 was only 548,351 lb valued at $446,485 (Table 9). In the same year, species at least partially dependent on oysters for food valued at more than $1.5 million were landed, including 29,000 lb of black drum and 12,009,000 lb of blue crab.

Table 9. Quantity (lb) and value ($) of oysters landed in North Carolina, 1880-1973 (from Chestnut 1974).

Year	Quantity	Value
1880	938,400	60,000
1887	1,175,650	48,353
1888	1,129,960	46,129
1889	5,528,942	194,272
1890	4,456,075	175,567
1897	4,740,675	241,099
1902	5,645,928	268,363
1908	4,159,320	227,300
1910	1,834,058	63,405
1918	1,197,630	70,280
1923	3,089,146	229,576
1927	2,397,750	200,742
1928	2,286,610	167,490
1929	2,828,420	245,533
1930	2,205,674	155,148
1931	1,500,571	92,061
1932	1,201,356	51,339
1934	1,160,700	53,092
1936	2,480,500	160,631
1937	1,940,900	112,051
1938	1,426,900	98,468
1939	1,055,600	72,964
1940	690,400	52,560
1945	1,707,100	400,210
1950	1,322,100	555,686
1951	1,531,900	632,122
1952	1,620,900	600,238
1953	1,525,300	536,015
1954	1,008,400	395,870
1955	731,000	286,395
1956	1,318,000	563,777
1957	1,086,500	395,870
1958	1,041,500	434,311
1959	1,311,000	587,607

Table 9 (continued)

Year	Quantity	Value
1960	1,216,200	560,442
1961	1,209,100	616,467
1962	961,400	485,589
1963	694,000	356,705
1964	727,209	398,993
1965	863,700	473,549
1966	726,209	398,993
1967	518,514	316,379
1968	402,959	268,743
1969	369,928	259,600
1970	381,978	269,138
1971	423,675	288,800
1972	470,112	344,217
1973	548,351	446,485

In addition to the ex-vessel values quoted, the oyster harvesting industry also generates revenues in other areas. Oyster shell is collected and crushed then sold to the State and used for roadbed. It is also sold to chicken feed producers as an ingredient in their product. This raises the possibility of actual reef mining, especially in the eastern Albemarle and Croatan Sounds where fossil reefs exist (Riggs and O'Conner, unpublished). Still other areas where oyster harvesting yields revenue are shucking houses, boat sales and equipment, gasoline, harvesting equipment, transportation and the wholesale, retail and commercial activities carried on by markets and restaurants throughout the State.

Oyster reefs yield certain benefits which cannot be valued in terms of money. They sometimes provide the solitary fisherman with an independent life style, sustaining him in the work he likes best. They also help to maintain the cultural aspects of lazy little harbor towns visited by tourists attracted to historical sights, ships and seafood bars featuring fresh oysters.

II.E. Salt Marshes

Karen Bolster

Salt marshes are fairly flat beds of salt-resistant vegetation that are alternately flooded and drained by salt or brackish water. The frequency, duration and salinity of the water that floods a marsh often determine the plant species and the characteristics of that marsh. Marshes typically form in the temperate zones in shallow intertidal areas that have gentle land gradients. In North Carolina, marshes are often found behind barrier islands, along the fringes of embayments and sounds, and along creeks, streams and rivers under tidal influence.

The marsh forms a unique environment because of its position between the land and sea. In a sense, it is part of both, although conditions found within it are found only there. These characteristic environmental conditions in the marsh, in turn, have created a unique assemblage of plants and animals. The marsh, then, is marked by a particular range of physical, chemical, geological and biological characteristics which differ widely from those of its surrounding environments. Many of the important values of a salt marsh are a consequence of the interaction between the uplands and the marine environment across the marsh. Wherever salt marshes occur, the vegetation is usually dominated by a few grasses, rushes and succulent plants. Many plants of the same genus are found in widely scattered geographic areas and monospecific communities often dominate large local areas (Adams 1963). This situation is created because of the physical stresses that exist in the marsh area. Plants and animals must be able to adjust to stresses caused by abrupt changes in water level due to tidal flooding and freshwater runoff. Thus, salt marsh plants and animals must be able to withstand submersion and drying out, salinity changes, exposure to the sun, sedimentation and many other factors tied to the variable marsh environment. Because few organisms can adjust to this environment, diversity is low and the same type of organisms are found in similar systems throughout the world.

II.E.1. Environmental Description

II.E.1.a. <u>Horizontal Interactions</u>--Horizontal patterns in the marsh environment result primarily from horizontal differences in the tidal inundation pattern. Tidal inundation influences the distribution of marsh flora and fauna, and marshes are often classified on the basis of the frequency of their flooding (Shaw and Fredine 1971). Adams (1963) states that there are two outstanding characteristics of marshes that are immediately apparent upon study. The first is the universal influence of saline tides and the second is the zonation of marsh vegetation.

In North Carolina, salt marshes are often classified into two basic groups, the regularly and the irregularly flooded marshes (Marshall 1974). The vegetation dominating each marsh differs, as may perhaps be expected since they have very different physical characteristics. Irregularly flooded marshes in North Carolina are usually dominated in lower elevations by Juncus roemerianus (black needle rush), and by Spartina patens (salt meadow hay) and Distichlis spicata (spike grass) at higher elevations. Regularly flooded marshes are dominated by Spartina alterniflora (salt marsh cordgrass) near the water, and by S. patens, D. spicata and J. roemerianus toward high land.

Irregularly flooded marsh is found behind the Outer Banks south to Cape Lookout and fringing the inner shores of the brackish water sounds between the mainland and the Outer Banks. In general, tidal amplitudes are fairly small (approximately 1 foot), and large differences are found between the groundwater salinity and the salinity of the flooding water. The ground (substrata) is usually firm sand or peat (Marshall 1974).

From the Cape Lookout area south, the majority of the salt marshes are regularly flooded Spartina marshes. Tidal amplitudes are somewhat greater (2-5 ft) and the sediments are characteristically soft grey muds (Marshall 1974).

There are no recent inventories detailing the types and distributions of salt marshes in North Carolina. The most complete recent inventory was that by Wilson (1962). Obviously, the extent of marsh areas has changed in the 14 years since this report. Several studies have since been undertaken to assess the alteration and loss of marshlands, but were not complete in regard to geographic distributions. On the basis of the information available, Table 10 gives the approximate overall acreages and the distribution of wetlands in North Carolina.

Zonation patterns are found in upland plant communities, but transition zones are frequently gradual and occupy broad geographic areas. Transitions between plant communities in the marsh are usually distinct and abrupt. Zonation within the marsh, although believed to be primarily due to flooding and the height of the marsh surface relative to sea level,

Table 10. Marsh Areas in Acres by Coastal County (from Wilson 1962)

County	Irregularly flooded	Regularly flooded	Shallow fresh marshes
Beaufort	450	--	4,050
Bertie	--	--	--
Bladen	--	--	--
Brunswick	--	18,000	3,500
Camden	--	--	1,600
Carteret	38,600	10,000	--
Chowan	--	--	--
Columbus	--	--	--
Craven	--	--	3,100
Cumberland	--	--	--
Currituck	--	--	23,600
Dare	15,500	500	5,200
Edgecomb	--	--	--
Gates	--	--	--
Greene	--	--	--
Halifax	--	--	--
Harnett	--	--	--
Hertford	--	--	--
Hoke	--	--	--
Hyde	29,900	1,600	3,400
Johnston	--	--	--
Jones	--	--	--
Lenoir	--	--	--
Martin	--	--	--
Nash	--	--	--
New Hanover	--	7,850	2,500
Northampton	--	--	--
Onslow	1,000	11,350	--
Pasquotank	--	--	--
Pender	--	9,100	--
Perquimans	--	--	--
Pitt	--	--	--
Robeson	--	--	--
Sampson	--	--	--
Scotland	--	--	--
Tyrrell	--	--	550
Washington	--	--	--
Wyane	--	--	--
Wilson	--	--	--
Total	100,450	58,400	46,900

is actually dependent upon an enormous number of interacting physical parameters; any one of which may become the dominant influence in determining what species grows where. Close to the water's edge, along stream banks, and where tidal inundation by water of fairly high salinity is frequent, Spartina alterniflora (salt marsh cordgrass) is the characteristic vegetation. Three different growth forms of salt marsh cordgrass are often found and are differentiated by the height of the mature plants. The distribution of tall, medium and short salt marsh cordgrass is believed to be a result of land elevation, tidal inundation and nutrient availability (Adams 1963). In general, as distance from the water source increases, plant height decreases (Odum 1971). Primary productivity of the different growth forms varies, with the short form being least productive. Animal associations may also be different between the three (Odum 1971). Juncus roemerianus (black needle rush) is usually found in areas that are less frequently inundated--either above the salt marsh cordgrass zone or in areas where the tidal amplitudes are small and therefore do not flood the salt marsh to any great extent. Spartina patens (salt marsh hay) and Distichlis spicata (spike grass) are usually found mixed together at elevations slightly higher than that of black needle rush (Cooper 1974). Above these grassy zones is frequently found a shrubby band that blends into the vegetation more characteristic of the uplands. Because the physical stresses of this high marsh region are not as severe as those closer to the water, a large variety of plants are found here. Among the most common species are Iva frutescens (marsh elder), Baccharis halimifolia (high tide bush) and Borrichia frutescens (sea oxeye). In marshes that are flooded by waters of lower salinity, several different species occur since the physical stress of the environment is decreased. Spartina cynosuroides (big cordgrass) often assumes the position occupied by salt marsh cordgrass in these brackish marshes. Phragmites communis (giant reed or feathergrass) is also found at higher elevations, and, since it is more resistant to man's impact, in areas physically disturbed by man or subject to pollution. General diagrams of plant zonation are given in Figures 30, 31, 32 and 33.

Animal distributions on the marsh are not as distinctly zoned as those of plants. Most species can, however, be divided into high or low marsh species.

The variety of life in the marsh is relatively low as compared to other ecosystems, because the marsh environment is difficult to adapt to and live in. In general, it is thought that fewer species inhabit the irregularly flooded marsh than inhabit the regularly flooded marsh farther seaward. Little insect diversity was found in black needle

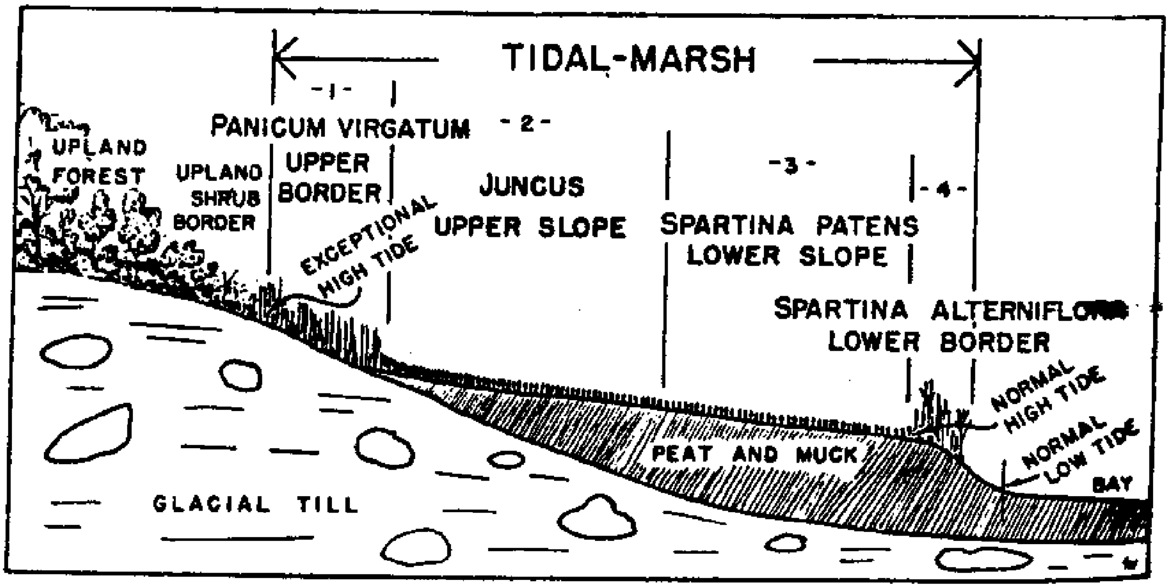


Figure 30. Cross-sectional diagram of New England type salt marsh (from Miller and Egler 1950).

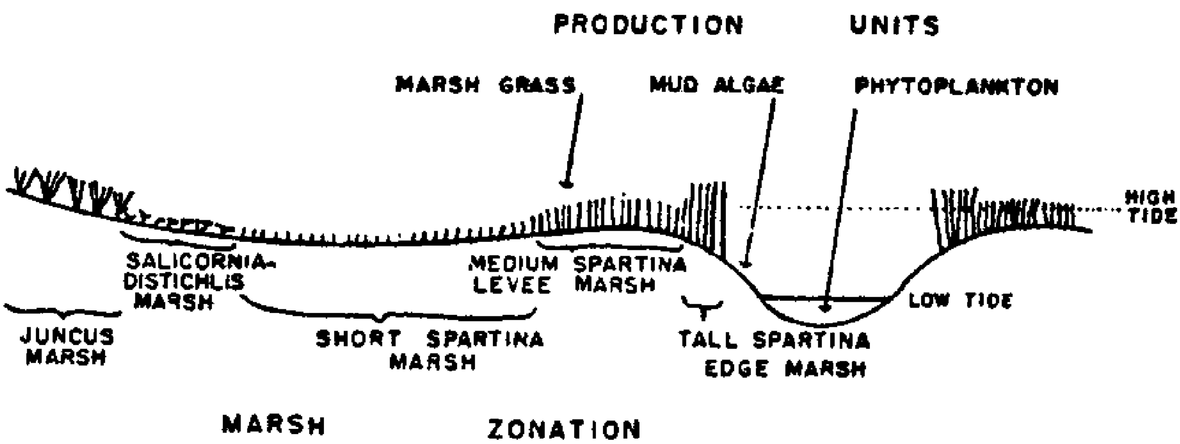


Figure 31. Zonation of a Georgia salt marsh, showing three distinct types of plant producers (from Odum 1971).

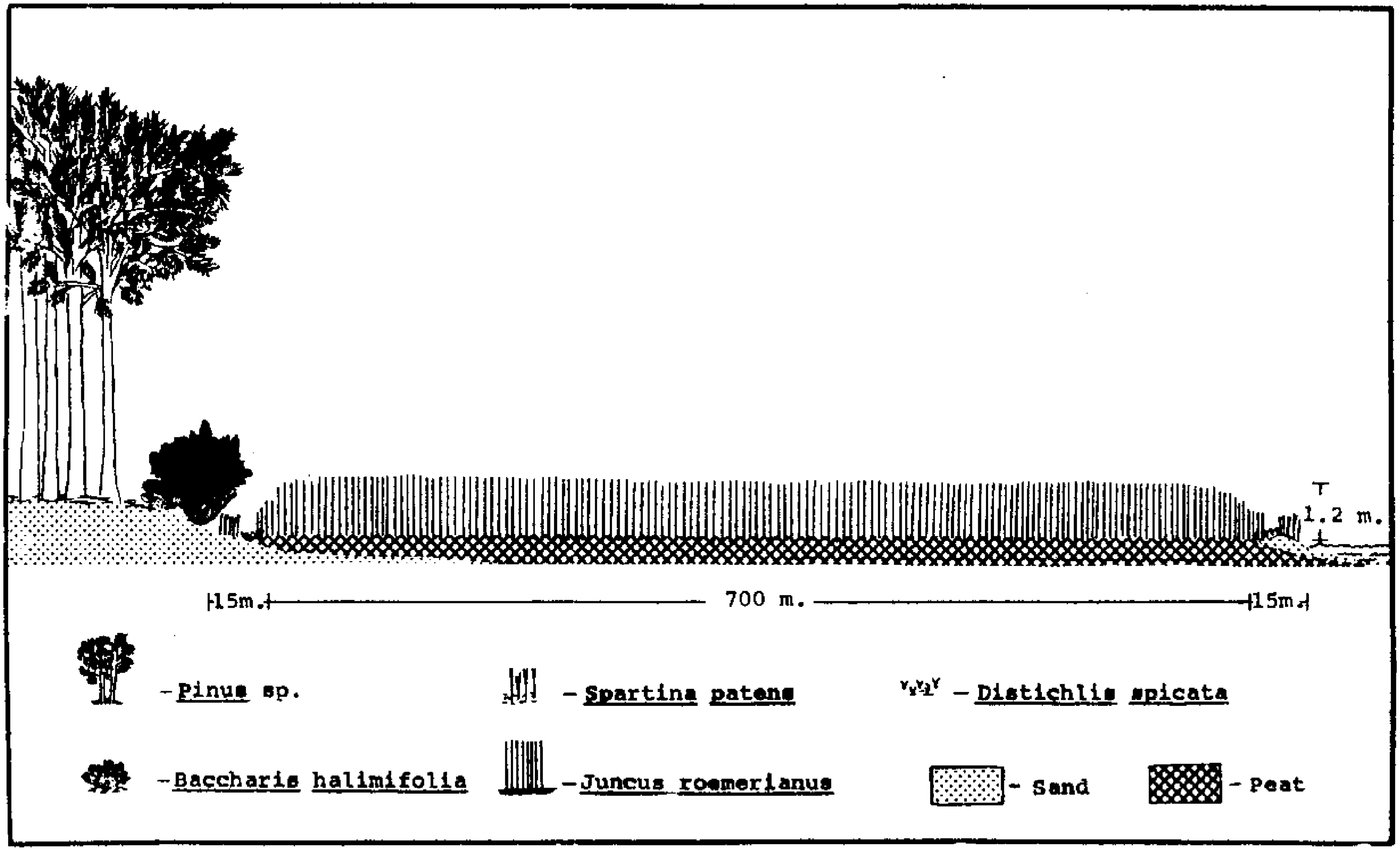


Figure 32. Diagrammatic cross section through a Juncus roemerianus marsh on North River, near Beaufort, North Carolina. Vertical scale exaggerated.

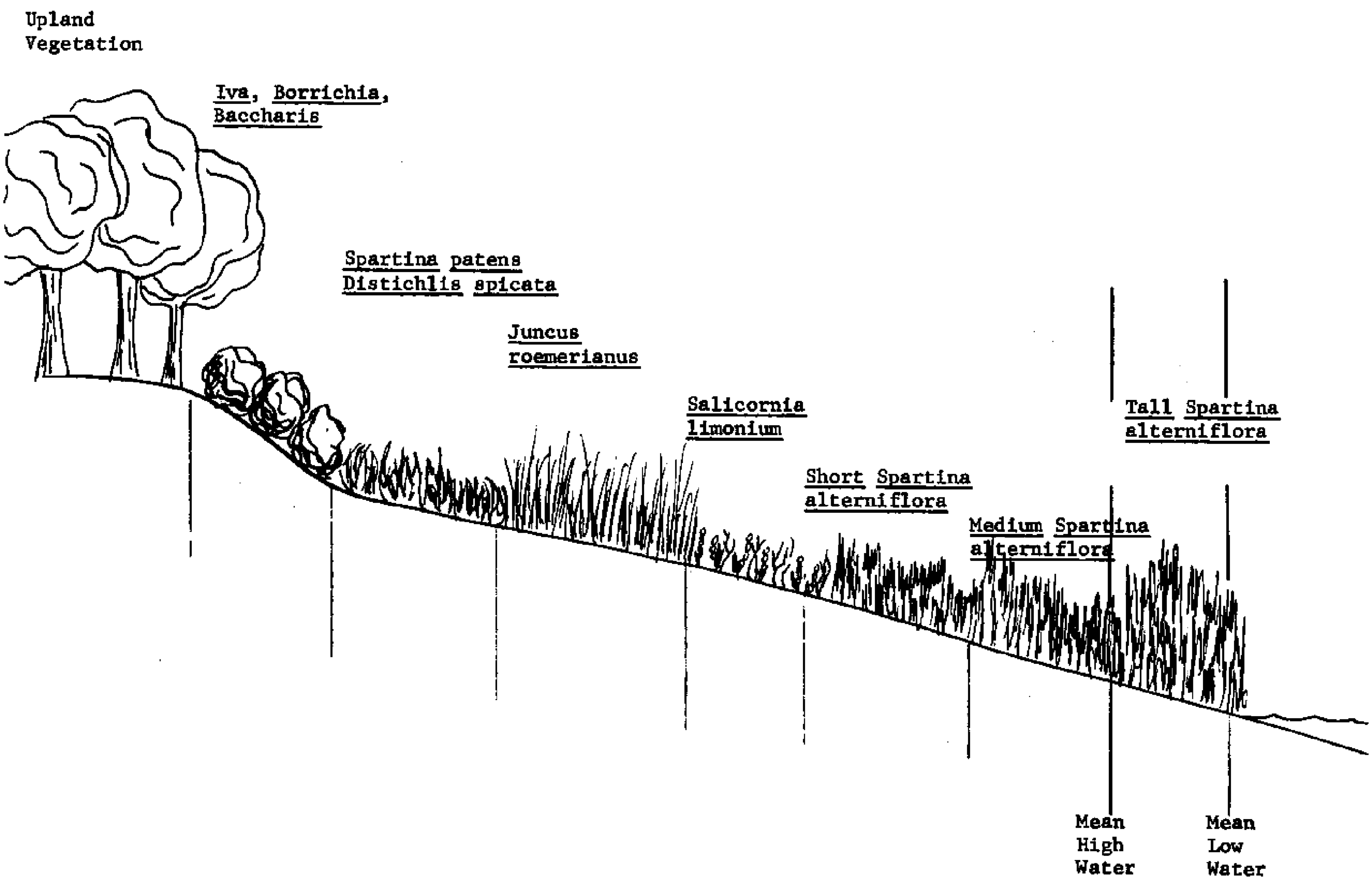


Figure 33. Idealized salt marsh zonation typical of North Carolina.

rush marshes by Davis and Gray (1966), who suggest that the growth form of the plant may be responsible. They hypothesize that the thin fibrous leaves provide little protection from winds or predators and supply little food for grazers. Despite the general paucity of animal life in the irregularly flooded marsh, the production of biting flies and mosquitos has been found to be highest in areas such as irregularly flooded *Juncus* marshes and the high marsh zones of *Spartina patens* and *Distichlis spicata* (Dukes *et al*. 1974a). Mosquito production in the *Spartina alterniflora* zone increases as the distance from the water source increases (Dukes *et al*. 1974b). Much work has been done to attempt to discover ways to decrease and control the populations of these annoying insects, and vast acreages of marsh have been physically altered to prevent their breeding.

Associated with the marsh surface in the salt marsh ecosystem are the tidal creeks or distributaries that carry the flooding waters in and out of the marsh. Frequently in older, well-developed marshes, these distributaries are extremely convoluted and meander over broad areas of marsh. The creeks carry both water draining from the uplands and water from the estuary, serving as a vital habitat for many species of animals. The distributaries are a habitat for animals such as oysters and blue crabs and are also extensively used as nursery or rearing grounds for a variety of animals that are found in the estuary or open sea as adults (Figure 34). These fish include the menhaden, striped bass and mullet in addition to the commercially valuable species of shrimp (Teal and Teal 1969).

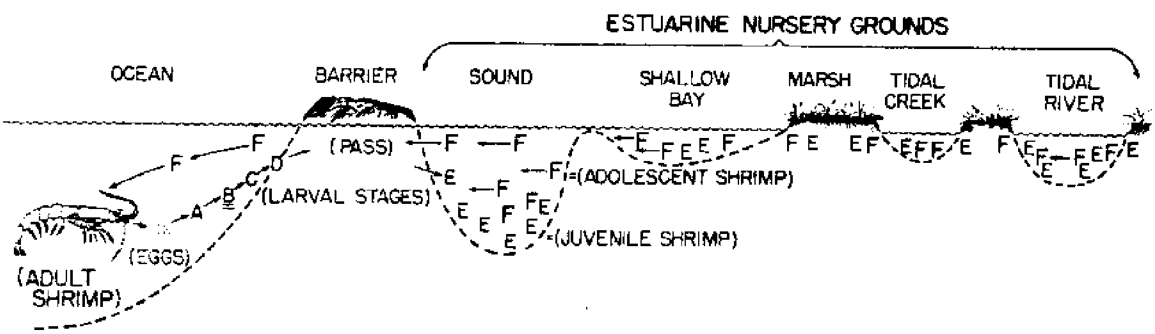


Figure 34. Role of salt marsh in the life history of grooved shrimp (from Teal and Teal 1969).

Several small species of fish (such as silversides, killifish and mummichogs) are characteristically found in marsh distributaries. These forage fish are preyed upon by larger carnivorous fish that are frequently species of commercial importance (Teal and Teal 1969). The small fish are also preyed upon by birds, thus occupying an important place in the marsh and estuarine food chains.

The marsh surface also serves as valuable habitat for a variety of animals. Several species of mammals either feed or live in the marsh and therefore provide a link between the marsh and the upland area. These mammals include mice, rats, muskrat, mink, otter and nutria. Several of these species are commercially trapped for their fur and populations vary widely from marsh to marsh. Factors that are thought to influence the distribution and density of the muskrat include salinity, the plant species present (used for food and nest construction), the depth and frequency of inundation and local weather conditions (Palmisano 1972). Population levels (and therefore catches) vary from year to year (Table 11).

Table 11. Summary of Fur Trapping Reports of Marsh Species for 1957-1975 (N. C. Wildlife Resources Commission).

Year	Muskrat	Mink	Otter	Nutria
1957-58	90,026	5,897	992	33
1958-59	119.598	8,212	1,029	96
1959-60	146,744	11,071	1,337	536
1960-61	184,647	13,230	1,130	36
1961-62	164,676	11,260	1,234	0
1962-63	170,214	14,517	1,456	0
1963-64	136,917	11,561	1,739	475
1964-65	122,171	9,868	1,328	966
1965-66	153,244	10,194	1,443	1,033
1966-67	112,869	9,207	1,354	948
1967-68	126,356	10,386	1,658	2,752
1968-69	126,356	10,386	1,658	2,752
1969-70	127,348	5,738	948	3,617
1970-71	89,846	4,386	0	6,617
1971-72	96,997	3,270	1,606	15,014
1972-73	153,369	5,331	1,407	11,900
1973-74	135,266	3,647	968	11,693
1975-75	105,882	3,643	893	17,070

II.E.1.b. Vertical Interactions--In its function as a buffer zone between high ground and the estuary, the marsh is believed to act in many cases as a moderating factor on the impacts of the two environments on each other. Thus, the marsh serves to protect the uplands from storm and flood damage by the estuarine water (Silberhorn et al. 1974), since growth form of the marsh vegetation (sense stalks perpendicular to the marsh surface) is believed to slow the velocity of the water and therefore dissipate wave energy. Research at the Virginia Institute of Marine Science reports that many marsh soils (primarily peats) can absorb large amounts of water flooding the marsh. The soils are likened to "giant sponges" and serve to decrease the amount of water that could flood the high ground (Silberhorn et al. 1974).

Because the marsh slows the velocity of water movement, it also serves as a "sediment trap" for the estuary. The size and, to some degree, the amount of particulate matter such as sediment suspended in the water are controlled by the speed of that water. The greater the speed, the larger the particle that can be carried by the water. Thus, as the water is slowed by passing over the marsh, particles fall out of the water and are deposited on the marsh. In this way, the marsh cleanses the water by decreasing its turbidity or particulate load.

Sediments in the marsh, although often very fine, are stabilized by the dense and extensive root development of the marsh vegetation. In most species the amount of root material is as great as or greater than the amount of material evidence above the ground (Reimold et al. 1974). The marsh is therefore highly resistant to erosion and serves to reduce the erosion of the higher ground (Silberhorn et al. 1974).

II.E.1.c. Energy Pathways--Marshes and estuaries are believed to be among the most productive areas of the world (Table 12) in terms of the growth of plant matter (primary production) (Odum 1971). Several different types of plants contribute to this productivity. The majority of it is believed to come from the marsh grasses, with phytoplankton and benthic mud algae along the creek banks being less important. Studies have shown, however, the mud algae production can be approximately one-third of that of the vascular plants (Pomeroy 1959).

High productivity appears to occur for several reasons, most of which are related to the position of the marshes between the uplands and the estuary. Because of the tidal flux, new water is constantly brought to the plants and harmful

Table 12. Estimated Gross Primary Production (Annual Basis) of the Biosphere and Its Distribution Among Major Ecosystems (from Odum 1971).

Ecosystem	Area (10^6 km^2)	Gross primary productivity (Kcal/m^2/yr)	Total gross production (10^{16} kcal/yr)
Marine			
Open ocean	326.0	1,000	32.6
Coastal zones	34.0	2,000	6.8
Upwelling zones	0.4	6,000	0.2
Estuaries and reefs	2.0	20,000	4.0
Subtotal	362.4	--	43.6
Terrestrial			
Deserts and tundras	40.0	200	0.8
Grasslands and pastures	42.0	2,500	10.5
Dry forests	9.4	2,500	2.4
Boreal coniferous forests	10.0	3,000	3.0
Cultivated lands with little or no energy subsidy	10.0	3,000	3.0
Moist temperate forests	4.9	8,000	3.9
Fuel subsidized (mechanized) agriculture	4.0	12,000	4.8
Wet tropical and subtropical (broad-leaved evergreen) forests	14.7	20,000	29.0
Subtotal	135.0	--	57.4
Total for biosphere (not including ice caps) (round figures)	500.0	2,000	100.0

accumulations of waste products are carried away. Thus, the plant does not exhaust its nutrient supply (necessary for growth) and damaging chemicals are taken away before they can inhibit growth. The interaction of fresh and salt water in the marsh tends to precipitate nutrients from the fresh water, thus providing the plants with large amounts of these necessary compounds. The nutrients are not "locked up" in organic structures for many years as may happen in forests. Because the grasses, algae and bacteria do not live for long periods of time, the nutrients they contain are frequently recycled and can soon be used by other organisms (Teal and Teal 1969).

Marshes are also productive because plant growth takes place all year round. The growth of algae on the marsh muds has been found to be fairly constant throughout the year in Georgia (Pomeroy 1959). The vascular plants such as *Spartina* and *Juncus* have reduced growth in the winter, but total production never completely stops.

It is also thought that the growth form of the marsh plants (vertical to the marsh surface with little horizontal extension) may permit dense growth because there is little shading of a plant by its neighbors (Palmer 1941).

The primary productivity of marshes varies from marsh to marsh depending upon the plant species that are present, the amount of nutrients, the frequency of inundation and the geographic location. Much research has been done in this area, but because of the technical problems and the amount of variation between marshes from year to year few generalizations can be made. There would appear to be a trend within each plant species of increasing productivity with decreasing latitude. This is believed to be due to the lengthening growing season as one moves south (Keefe 1972). Some plant species are just more productive than others, as may perhaps be expected. In general, plants of the irregularly flooded or high marsh are less productive than those that are regularly flooded by the tides (Silberhorn *et al*. 1974). Some scientists believe that the tides provide an "energy subsidy" (or source of extra energy) that permits marsh plants to have higher production rates than normal grasses (Odum and Fanning 1973). Estimated productivity by regular and irregularly flooded marshes for coastal counties in North Carolina (Table 13) was calculated by integrating productivity values previously found for North Carolina marshes and attempting to fit a reasonable curve to the data points.

Table 13. Predicted Annual Net Primary Productivity (NPP) (10^6 kilograms/year) for each North Carolina county (from A. E. Stiven, unpublished data).

County	Regular marsh Ha[a]	Irregular marsh Ha	Regular flooded marsh NPP	Irregular flooded marsh NPP	Total NPP for county
Brunswick	7,285	--	71.7	--	71.7
New Hanover	3,177	--	29.7	--	29.7
Pender	3,683	--	8.0	--	8.0
Onslow	4,593	405	28.9	2.0	30.9
Carteret	4,047	15,621	36.5	108.6	145.1
Beaufort	--	182	--	0.4	0.4
Pamlico	--	6,070	--	28.8	28.8
Hyde	647	12,100	3.0	43.1	46.1
Dare	202	6,273	2.1	48.9	51.0
Total					421

[a]From Wilson (1962).

The amount of primary production in a marsh is important because it provides a base upon which all of the higher organisms and trophic levels depend. Plant material is the basic food for all animals and the amount of it largely determines the amount of animal material or biomass that can be supported. One of the most important characteristics of the salt marsh is that very little of the plant material that is produced is grazed upon while alive by herbivores, estimated at only about 5% (Smalley 1960).

Because the majority of the primary production in the marsh is not consumed by herbivores, the decomposer food chain is extremely important in the marsh. Bacteria and fungi break down the plant material and in turn die or are eaten, thus releasing the nutrients that were not previously available for utilization. This decaying organic material is called detritus and serves as a major food source both in the marsh and in the estuary. Some work (Teal 1962) has been done to attempt to quantify energy pathways in the salt marsh (Figures 35 and 36). Because of the difficulties inherent in such work, however, the complete food and energy web for the salt marsh is not known and large gaps remain in our knowledge. Little work of this type encompassing the entire marsh has been reported for North Carolina.

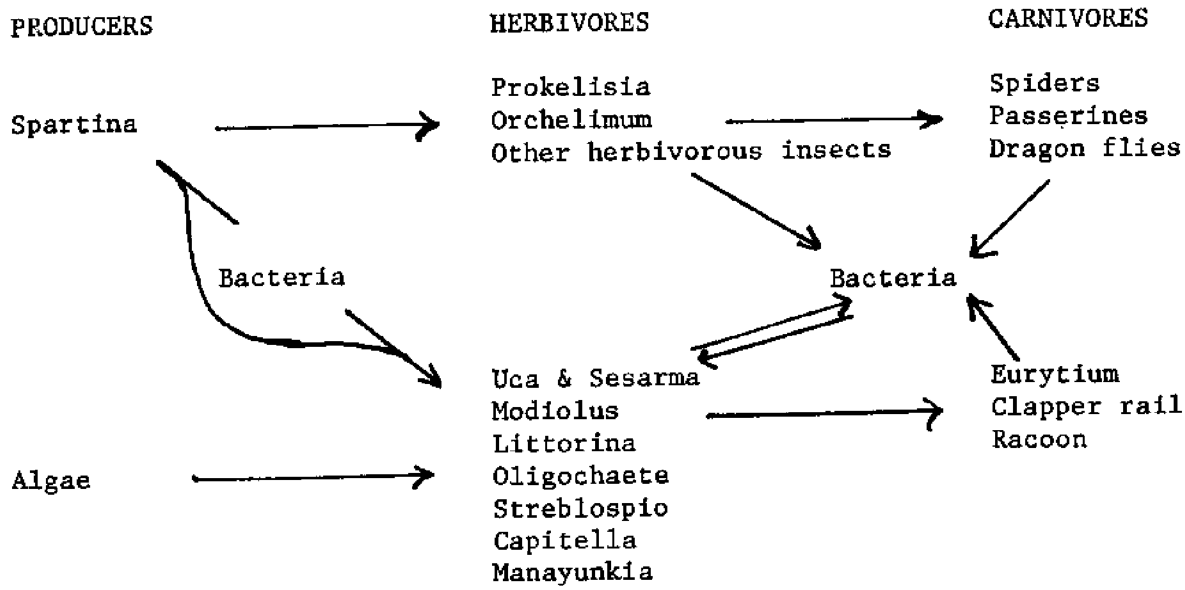


Figure 35. Food web of a Georgia salt marsh (from Teal 1962).

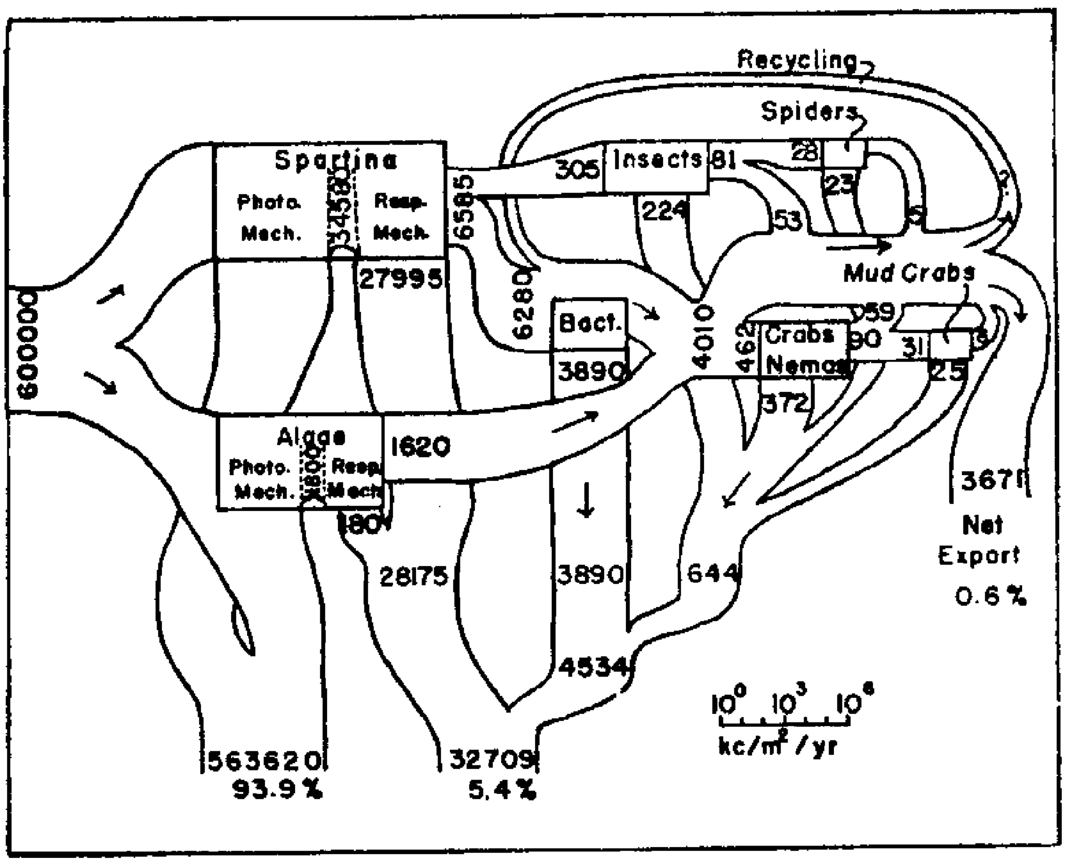


Figure 36. Energy flow diagram from a Georgia salt marsh (from Teal 1962).

One of the most important characteristics of the marsh is the fact that it is not a self-contained system. There are both gains and losses of materials and energy to the estuary and to the uplands, as has been discussed previously. Flooding water brings in phytoplankton, zooplankton, grazers and predators, and is believed to serve as an energy subsidy for the marsh. Ebbing waters remove some of the phytoplankton and zooplankton, the grazers and predators that have fed, detritus and nutrients. Recent studies have raised questions of whether the function of the salt marsh is an overall source or sink of materials, nutrients and energy, apparently varying from location to location with no hard and fast rule for marshes as a whole (Woodwell et al. 1973; Heinle et al. 1974).

Materials and energy also flow between the uplands and the marsh. Mosquitos and biting flies often move off the marsh to feed while several species of birds and mammals that normally live on high land move onto the marsh to feed on the insects, plants, molluscs and fish living there. Man also removes energy from the marsh ecosystem when he traps the fur-bearing mammals and hunts the water fowl and wildlife.

Salt marshes are also believed to act as nutrient and chemical filters of water coming from higher ground (Silberhorn et al. 1974). This water is often of higher nutrient content than the estuarine waters as a result of mineral erosion, sewage and industrial pollution. As the water moves across the marsh, many of these nutrients are taken up by the growing vegetation. Thus, high nutrient levels are reduced before they reach the estuary. Without salt marshes, the high level of dissolved nutrients in runoff water would stimulate blooms of algae that might lead to eutrophication of the estuarine system. The exponential growth of the phytoplankters could create oxygen-poor conditions that would produce highly undesirable effects on the estuary. Examples of these types of situations are common today (Lake Erie, Potomac River and many sewage disposal sites).

The marsh, then, is a nutrient trap that gradually releases the nutrients contained within it at a rate manageable by the estuarine system. This situation also prevails for nutrients that are produced on the marsh itself by the decomposition of plant material. Nutrients such as phosphates and nitrates are bound up in organic structures and must be broken apart and released by decomposer organisms to become available again. When the marsh is flooded, these nutrients are carried into the estuary where they promote growth. Because a lack of nutrients often limits the amount of primary productivity in the estuary, this source is believed to be extremely important. The salt marsh, then, is believed to be an active site of nutrient recycling due to the rapid turnover rates of the vegetation and the associated processing of organic materials.

Again, the frequency of inundation influences the amount of material exported and it appears that irregularly flooded marshes export lower amounts of nutrients than regularly flooded marshes. Recent work (Woodwell et al. 1973) seems to indicate that all regularly flooded marshes may not be equally important as nutrient and detritus sources. More work has to be done to determine the situation in North Carolina, although it may be hypothesized that the amount of material exported may be correlated with latitude, increasing as one goes south.

Because many of the functions of salt marsh are dependent upon the degree of its interaction with the estuary, some of the characteristics of regularly and irregularly flooded marshes may be expected to differ. Since detritus is transported to the estuary by tidal flushing, less detritus is carried out of the irregularly flooded marsh and more tends to stay in the marsh where it becomes part of the sediments. This is an important distinction between regularly and irregularly flooded marshes because it is believed that much of the productivity of the estuary (fish, shellfish, crabs, etc.) is dependent upon the flow of detritus from the marsh. Teal (1962) estimated that in Georgia, 45% of the primary productivity of regularly flooded marshes is exported to the estuary. Heinle et al. (1974) estimated that for marshes subjected to low tidal amplitudes in Chesapeake Bay, less than 10% of the annual production was exported out of the marsh. The salt marsh, then, cannot be rationally isolated from the surrounding environments impinging on it.

II.E.2. Temporal Patterns

There are several cyclical patterns of different periods of time in the salt marsh. Not all of these patterns are present in all marshes, however. Perhaps the most obvious cycle in the regularly flooded marsh is that connected with the tides. The conditions in the marsh are very different when it is flooded than when it is exposed. Both food (such as phytoplankton and zooplankton) and predators come in with the tide. Special behavioral adaptations have been developed by organisms in the marsh to avoid both the rising water and the influx of predators. Snails such as *Littorina irrorata* and *Melampus bidentatus* that cannot stand long submersion have developed a type of internal clock that informs them when the tide is beginning to flood so that they may climb the marsh grasses and avoid the water (Teal and Teal 1969). Fiddler crabs (*Uca* spp.) retreat to their burrows in the mud when the sediment around them begins to become moist (Teal and Teal 1969). In this way they can escape the predatory fish that would otherwise consume them as the tide came in.

Another cyclical pattern in the salt marsh is related to monthly variations in tidal range. Spring tides caused by the reinforcement of the sun and moon create exceptionally large tidal ranges. These tides are the only ones that flood the irregularly flooded marsh. Thus, the flow of food and predators into the black needlerush marsh and the flow of detritus and nutrients out are linked to the spring tides.

A seasonal cycle is also pronounced in the salt marsh, especially to the north where marsh grasses almost completely cease growth during the winter months. In North Carolina, some growth continues during the winter, although it is sharply reduced (Marshall 1974). During winter the primary productivity of mud algae becomes particularly important to the marsh food chain. The export of detritus and nutrients varies from season to season. Storms are more frequent during the winter, so the irregularly flooded and high marshes are flooded more frequently. Heinle *et al*. (1974) found that the majority of the material annually exported from the irregularly flooded marshes occurred at this time and was primarily due to ice scouring the marsh surface, a mechanism probably of little importance in North Carolina. In regularly flooded marshes, however, little production occurs during the winter and detritus produced during the summer has generally been washed out. Thus, exportation is thought to decrease over the winter.

The overall geological evolution of the marsh also forms a pattern through long periods of time. Marshes are created through hundreds of years of sediment deposition. Generally they form on shallow mud flats through gradual accumulation of sediments. As the water level becomes shallow enough to permit the growth of *Spartina alterniflora*, colonization begins and water velocities are slowed by the plants to allow sedimentation to proceed at an accelerated rate. Colonization continues and the level of the immature marsh begins to rise through the accumulation of sediments, roots, rhizomes and detritus. This accumulation of peat continues and eventually the older landward side of the marsh has risen to such a point that *S. alterniflora* is replaced by other grass such as *Juncus roemerianus*, *Spartina patens* or *Distichlis spicata*. The basic zonation patterns in the marsh are created in this way. Tidal creeks are evolving simultaneously from simpler drainage canals. The process of accumulating material and raising the level of the marsh is the primary mechanism for marsh evolution. The marsh continues to expand into the estuary and be converted into uplands toward the land side (Redfield 1972). Basic evolutionary processes are complicated by the fact that the level of the sea relative to the land is not constant. On shores that are emerging from the sea, the process is similar to that previously explained, only seaward marsh expansion occurs at an accelerated pace.

On submerging coasts, however, this mechanism works almost in reverse; as the more water-tolerant vegetation encroaches on less tolerant forms and the marsh system as a whole moves back over the land. Examples of this situation are seen when old tree stumps are found in the marsh or when marsh peats are revealed on beaches below the sand after a large storm.

II.E.3. Organism Adaptations

Because the physical stresses of the salt marsh are large, most organisms resident in the marsh have developed unique adaptations to permit life there. Table 14 details these stresses, their effects, and some of the adaptations marsh invertebrate species have made to them.

Perhaps one of the most important adaptations made by a marsh species is that of salt secretion by *Spartina alterniflora*. The plant is usually in salt water with a higher salt content than in its cells. In such a situation, water from inside the plant would tend to move outside due to osmotic pressure and the plant would die. *S. alterniflora*, however, has developed special "salt glands" on its leaves that help it to excrete excess salt and control the water content of its cells (Teal and Teal 1969). The ability to live in salt water permits the establishment and expansion of the marsh into the estuary.

Spartina alterniflora has also made adaptations to allow growth in the oxygen-poor marsh muds. Roots demand oxygen for growth, but because little oxygen is found below a few centimeters into the mud the species has developed air passages in the stem to permit the diffusion of oxygen from the plant surface to the root system. Large gas spaces are also found in the roots (Teal and Teal 1969).

II.E.4. Values of the Environment

II.E.4.a. Primary (Direct)--The direct values of an environment are the values harvested directly from the environment itself. By this definition, marshes have little obvious direct value and have often been regarded as wasted land. The marsh does have a direct value, however, as a habitat for commercially important species, such as the muskrat, nutria, otter, mink and oyster. Muskrat are most common in brackish water marshes (Stearns and Daigh 1939) and in higher elevations of the marsh (Penfound 1952; Palmisano 1972).

Table 14. Problems Faced by Tidal Stream and Marsh Invertebrates and Adaptations for the Situations.

Stress	Unfavorable general effects	Invertebrate adaptations
Strong Currents	Dislodgement, difficult setting, loss of larval populations, feeding difficulties, increased predators.	Large number of larvae, settlement of new populations, protective burrowing or strong attachment as byssal threads.
Salinity Changes	Radical daily fluctuations.	Osmoregulation, release of water, absorption of salts, protective closing as mussels or burrowing.
Exposure to Air	Desiccation.	Burrowing and sealing against air. High level O_2 in blood system.
Decrease of Light	Decrease of phytoplankton activity to thin surface layer.	Utilization of marsh grass debris, incoming plankton and organic detritus as food.
Sedimentation Slow Currents	Clogging of filter feeders and resp. apparatus. Decreased O_2. Increased predators.	Locomotion, burrowing, preference for detritus feeding animals. Increased O_2 in hemoglobin.
Variable Temperature	Desiccation faster if exposed to air, death beyond tolerance ranges due to drastic increase or decrease of metabolic reactions (Q_{10} factor).	Poikilotherms, flushing with available water, sealing in water before tide recedes, burrowing.

II.E.4.b. Secondary (Indirect)--The indirect values of an environment are those services that an environment provides that allow monetary gain in areas outside the environment. The vast majority of the services and functions the marsh provides for man fall into this category. The marsh serves as a nursery grounds for commercially valuable species such as shrimp, mullet, menhaden and striped bass. It also serves as a habitat for small fish species that are important as food items for larger, commercially valuable forms.

The productivity of the estuary is supported by detritus and nutrients that are exported from the salt marsh. The amount of exportation appears to be variable from marsh to marsh, however, depending primarily upon its frequency of inundation. Without the marsh acting as a source of nutrients and detrital material, the high productivity levels typically found in estuaries could not be maintained. Man harvests various aspects of this productivity when he fishes, hunts and gathers shellfish from the estuary. The marsh, then, supports an enormous amount of commercial and recreation business along the seacoast.

Because of the efficient nutrient recycling that occurs in the marsh, it is believed to act in a manner similar to a tertiary sewage treatment plant and the effects of sewage disposal are therefore moderated. The expense of building tertiary treatment plants to function as the marshes are believed to would be enormous. In a sense, therefore, the salt marsh provides an expensive service for little to no cost (Odum 1973).

Marshes act as "sediment traps" by slowing the water flowing over them and causing particulate matter to drop out of the water column. Protection from flood damage and erosion control are also provided to the uplands by the marsh. Salt marsh peats are not easily eroded by wave action and are believed to be able to absorb large amounts of water. Because the marsh forms a barrier between the estuary and the uplands, wave energies are first spent there before they reach the high land. If no marsh were present, the uplands would be the site of the entire expenditure of wave energies.

II.E.4.c. Tertiary--The tertiary values of an environment may be defined as those properties of an environment that are difficult to evaluate in a monetary scheme, but that contribute to the overall quality of life (Odum and Odum 1972). This may include such things as aesthetic and recreational value and scientific and educational use.

Perhaps the most evident tertiary values that may be assigned to marshes are those of aesthetics and birdwatching. How much "green space" man needs in his environment is impossible to say until there is too little and the need is realized. In addition, much of the money spent in the coastal zone on recreation and tourism is for the simple purpose of enjoying the outdoors and the aesthetic environment of the undisturbed coastal areas.

Because there are few obvious and direct monetary values that can be assigned to the salt marsh, the traditional cost-benefit analysis would seem to indicate that indeed marshland is just wasteland and that it will achieve its most constructive use when developed by man. As we have seen, the extremely valuable services that the salt marsh does provide for man are of an indirect type and not readily apparent. In recent years, some scientists have been attempting to generate more realistic values for marshland by incorporating indirect values as well as direct in their computations. Such calculations are open to argument, but provide a much more realistic evaluation. One such evaluation (Table 15) was made for marshes in Georgia in 1973 (Odum 1973).

Table 15. Marsh-Estuary Dollar Values as Determined by Various Methods of Evaluation (from Odum 1973).

Basis for evaluation	Annual return per acre	Income-capitalization value per acre (at interest rate 5%)
(1) Commercial & sport fisheries	$ 100	$ 2,000
(2) Aquaculture potential		
(a) Moderate oyster culture level	630	12,600
(b) Intensive oyster raft culture	1,575	31,500
(3) Waste treatment		
(a) Secondary	280	5,600
(b) Phosphorus removal	950	19,000
(c) Adjusted tertiary	2,500	50,000
(4) Maximum noncompetitive summation of values		
(a) 1 + 3c	2,600	52,000
(b) 2b + 3c	4,075	81,000
(5) Total life-support value	4,100	82,000

II.E.5. Man's Impact on the Environment

Few activities undertaken by man in the marsh are truly dangerous. Perhaps the most obvious danger is that of building in or immediately behind a marsh or a submerging coastline. Such construction is subject to erosion or flooding and in the case of the submerging coast invasion of the uplands by the marsh.

Many of the potential uses of the marsh environment are mutually exclusive, and almost all uses to which a marsh is put by man radically change the marsh and eliminate the services it provides. Filling or bulkheading a marsh changes it to an upland area. As such, the vital exchanges with the estuary are cut and the marsh can no longer serve as a habitat, nursery area or buffering zone. The land defined as valuable and upon which structures are built is thus more open to wave attack, erosion and storm damage (Odum 1971). Such man-made alterations also destroy marsh vegetation, eliminating an important source of nutrients and detritus for the estuary. This is believed to lead to decreased estuarine productivity (Teal and Teal 1969). The same effect occurs when spoil is deposited on the marsh. In this case the whole marsh is not usually used, but the deposition of material changes drainage patterns in the marsh causing different plant species to become important (Metzgar 1973).

Dredging a marsh to create a marine, lagoonal type residential development or navigational routes is also destructive. The marsh is removed and the uplands area is exposed. Deepening the marsh creeks increases erosion as well as the sediment load of the creeks. Spoil deposition along stream banks normally associated with this channeling stops water flow from the marsh surface to the creek. The elimination of water exchange encourages mosquito production and cuts off part of the marsh from interaction with the creek and ultimately the estuary. Lagoonal "fingers" that are often dredged into marshes have been found generally to be biologically unproductive (Daiber _et al_. 1975). These channels are usually poorly flushed and often tend to develop stratified and anoxic conditions.

Ditching a marsh for mosquito control is another technique by which marshes are altered. Effects of ditching are similar to those of dredging and filling, but because only a limited area of the marsh is physically altered the effects are not as severe. In North Carolina, ditching is usually confined to the irregularly flooded marshes where mosquito production is greatest (Marshall 1974). Ditching is undertaken to eliminate standing pools of water on the marsh that encourage mosquito production and is accomplished by lowering the water level. This essentially transforms the marsh into an area more typical of the uplands. Shrubby plants (e.g., *Iva*, *Baccharis* and *Hibiscus*) become more common (Bourne and Cottam 1950). These plants are, in general, not as extensively used by wildlife as the lower marsh vegetation.

Kuenzler and Marshall (1973) found that ditches in North Carolina *Juncus* marshes increased the area of aquatic habitat in the marsh by a factor of about five. These ditches were found to be inhabited by large numbers of juvenile fish, crabs and shrimp--especially from late winter through early summer. The function of the marsh as a nursery grounds was thus increased in areas where irregularly flooded areas were ditched. Concern was expressed, however, over the erosion of spoil piles and the formation of levees that retained the standing water that the ditches sought to eliminate.

Impounding a marsh to create shallow freshwater ponds is often done to increase waterfowl use. This technique is usually successful in its goal, but exchange with the estuary is ended by the construction of dikes to keep out the salt water. Marsh vegetation is usually eliminated and a more hydric plant community often develops. The impoundment still serves a limited function as a barrier between the marine environment and the uplands, but its efficiency is considerably reduced. Most other functions that the natural marsh provides are eliminated by the cessation of interactions with surrounding systems. Impoundments do support a considerable amount of wildlife and diversity is often increased over that of the natural marsh (Catts *et al*. 1963).

In general then, most destruction in a marsh is caused by man-made changes in water level or drainage patterns. Such destruction occurs because vegetation and the integrity of the functions of the system are largely controlled by the position of the water level relative to the marsh surface.

II.E.6. Management Implications

Marshlands should not be regarded as worthless in the light of the many indirect services they provide to man. The costs in losses of services or decreases in the quality of services must be realistically evaluated before a marsh is altered from its natural state.

Most of the functions and services of the marsh are provided by the nature of its large area. Therefore, if these aggregate services are desired, the acreage of the marsh should not be significantly decreased. The impact of one marina or one housing development is often difficult to see.

The effect of the development of an entire coast may, however, be devastatingly clear. Thus because the value of each acre of marsh is hard to pinpoint, each must be regarded as valuable. Because the "minimum amount" of marsh necessary to retain the status quo is unknown, all of it should be maintained.

If destruction is believed necessary, it may be preferable to alter an irregularly flooded marsh than one that is regularly flooded. If a marsh has been destroyed through spoil disposal, construction, etc., all possible effort should be made to replace it through the replanting of marsh vegetation in suitable circumstances. The technology to do this is available (Seneca 1974), but it must be realized that reestablishment will take from 5 to 25 years and may be difficult.

II.F. Swamp Forests

Nancy Tomkovick

Swamps make up half of the 5,885,000 acres of North Carolina's wetlands. Since swamps are a type of wetland, any definition must start with an understanding of the general concept of wetlands. Wetlands have been defined in a variety of ways by scientists, legislators, forestry experts, wildlife conservationists and farmers, depending upon their special interests. In general, though, wetlands are "land-water edge areas and submerged bottoms of no greater depth than can support extensive growths of either submerged or emergent aquatic plants" (Black 1974). Since plant communities are an easily recognizable characteristic, many areas are described by the dominant plant types, although other physical factors may be equally important in setting them apart. Swamps are characterized by the type of forest community which exists, as opposed to other wetland areas which have different, lower profile plant communities. Three distinct types of swamps are recognized, swamp forests, river flood plain swamps and pocosins. All three are primarily found in the Coastal Plains counties. Wilson (1962) lists their distribution and approximate acreage in Table 16. Much of the information for this section comes from student reports on North Carolina swamps in the Department of Environmental Sciences and Engineering (UNC-CH) during Spring 1973.

Historically swamps have been considered a nuisance, something to be drained or channeled to make way for agriculture, forestry or cities. Today attitudes are changing. Our increasing population makes it imperative that all land be put to its best use and, wherever possible, multiple uses. In order to use swamps wisely, coastal zone managers must know what swamps are, how they function as part of the ecosystem

Table 16. Approximate Acreage of Wooded Swamps, Pocosins and Flood Plains in North Carolina Coastal Plains Counties (Wilson 1962).

County	Swamp forests	Pocosins	Flood plains
Beaufort	21,850	119,700	--
Bertie	32,000	57,300	33,500
Bladen	34,950	135,400	22,500
Brunswick	42,000	107,100	--
Camden	46,000	28,900	--
Carteret	6,600	118,300	--
Chowan	4,300	10,150	--
Columbus	95,900	61,800	--
Craven	31,400	126,000	--
Cumberland	6,200	31,300	20,500
Currituck	28,400	13,750	--
Dare	4,050	138,200	--
Duplin	100,200	89,200	--
Edgecomb	450	4,300	26,900
Gates	39,600	--	--
Greene	3,550	10,500	15,400
Halifax	--	250	35,800
Harnett	2,800	--	13,500
Hertford	14,800	--	7,400
Hoke	6,500	10,700	5,600
Hyde	34,600	216,700	--
Johnston	--	1,450	52,950
Jones	18,900	127,500	--
Lenoir	18,800	23,800	8,900
Martin	29,500	43,700	16,800
Nash	--	--	24,700
New Hanover	9,250	6,000	--
Northampton	3,100	--	36,400
Onslow	59,000	120,700	--
Pamlico	3,450	40,300	--
Pasquotank	22,100	27,200	--
Pender	43,500	198,000	--
Perquimans	10,250	18,850	--
Pitt	44,200	30,000	--
Robeson	100,200	19,500	--
Sampson	3,000	30,000	63,200
Scotland	13,700	4,100	--
Tyrell	24,400	138,500	--
Washington	55,000	11,200	--
Wayne	2,400	3,000	28,400
Wilson	1,100	--	16,200

and what they do for man. The following is an attempt to describe the three types of swamps, first in a descriptive way and secondly through consideration of the dynamic processes at work.

II.F.1. Environmental Description

II.F.1.a. Swamp Forests--The 985,500 acres of swamp forest are found within 60 miles of the coast (Wilson 1962). They are characterized by a long hydroperiod, although they may be dry during the growing season. Usually a swamp forest is flooded with 1 to 4 feet of water. The water tends to be brown stained and acidic, with a pH between 5 and 6. There are little data available on water quality, but several studies by the U.S. Geological Survey and North Carolina Department of Water Resources show that swamp water is similar in softness, dissolved solids, nitrate, iron and potassium to other surface waters of eastern North Carolina.

Most wooded swamps have a peaty or mucky soil made up of several layers. At the surface is a loose leaf litter, followed by a peat layer of shallow semi-decomposed organic matter. The next layer is a sticky mud containing plant fragments which is underlain by fibrous peat or peat and mud. The last layer is coarse peat or clay grading to sand. The pH of the soil is low (approximately 4) which limits microbial activity and nitrification processes. The soil is low in calcium, phosphorus and occasionally potassium, and therefore infertile as compared to tilled soil (Woodwell 1958). The soil is probably anaerobic when it is covered with water.

Very little sunlight penetrates beyond the overhead vegetation. The light intensity is between 1.9 and 3.1% of full sunlight (Buell and Cairn 1943), preventing growth of shorter herbaceous plants and shrubs.

The dominant hardwood tree serves to name the swamp forest type (e.g., cypress swamp, tupelo gum forest, etc.). The four most common canopy trees are black gum (*Nyssa sylvatica*), tupelo gum (*N. aquatica*), pond cypress (*Taxodium ascendens*) and cypress (*T. distichum*), alone or in combination. Other components of swamp forests are red maple (*Acer rubrum*), water ash (*Fraxinus caroliniana*), red bay (*Persia forbonia*) and sweet bay (*Magnolia serginias*), although they rarely reach canopy height. Spanish moss occurs as an epiphyte on cypress. Most of the trees support vines or lianas, the commonest of which are supplejack (*Berchemia scandens*), pepper vine (*Ampelopsis arborea*), cross vine (*Anisostichum copreolata*) and *Decumaria barbara*.

The animals of a wooded swamp are generally not confined to it but may be found in other habitats as well. Squirrels, raccoons, mallards, minks and muskrats belong to this group. They frequent swamps for water, sanctuary and food. Other animals such as the black bear, bobcat and wood duck require the seclusion of the swamp. Still others such as the prothonatary warbler, parula warbler, swamp rabbit, slider turtle and cottonmouth water moccasin are physiologically adapted for swamp life.

II.F.1.b. River Flood Plain Swamps--North Carolina contains 458,950 acres of river flood plain swamps (also known as bottomlands) which are found along streams in counties 50 to 100 miles from the coast (Wilson 1962). Examples can be found along the Neuse, Roanoke and Cape Fear rivers. River flood plain swamps are characterized by short hydroperiods, although the length and frequency of inundation vary from swamp to swamp. Most are flooded in the winter, although some may also be flooded during summer months. At present, little is known of the water quality but it may be similar to swamp forests. The soil is alluvial (i.e., it is deposited by the river during floods) and is moist to waterlogged when not flooded. These areas are more fertile than swamp forests because the river supplies fresh nutrients with every flood. Because of its fertility some North Carolina bottomland is used for farming.

The plant communities are more diverse in the flood plain than in the wooded swamp. The dominant trees are river birch (*Betula nigra*), sycamore (*Platanus occidentalis*), black willow (*Salix nigra*), ironwood (*Carpinus caroliniana*), box elder (*Acer negundi*), American elm (*Ulmus americanus*), red ash (*Fraxinum pennsylvatica*), overcup oak (*Quercus lyrata*) and hackberry (*Celtis laevigata*). Many shrubs and herbaceous plants are found in areas where sufficient light penetrates the overhead vegetation.

The river flood plain swamps support many species of animals. The trees provide dens and food for many game animals including squirrels, rabbits, raccoons, wood ducks, deer, turkey, mallards, minks and muskrats. The stream itself supports large fish populations. Meanders in the swamp provide a rich and varied environment with pools, undercut banks, oxbows, roots and logs.

II.F.1.c. Pocosins--North Carolina has 2,262,950 acres of pocosins located within 40 miles of the coast (Wilson 1962). They are usually flooded during winter months and waterlogged during the rest of the year. The only data on water quality shows that it is very similar to swamp forests with low pH and high color. The soil of pocosins is shallow peat, usually dark brown, grey or black in color. The surface layer is ooze underlain with coarse peat or a mat of tree roots and shrub rhizomes. This peat layer may be very shallow or up to one meter thick, under which is clay, sand or silt. The basement layer is always the quartz sand characteristic of the coastal zone. The soil is low in phosphorus and nitrogen, but may be high in potassium. Pocosin swamp soil is considered low in fertility when compared to tilled soil (Woodwell 1958). Since it is waterlogged most of the year, the soil probably is anaerobic and tends to be colder than drained soil (Teate 1967). The air over a pocosin is more humid than an upland pine forest and has a slower rate of evaporation (Caughey 1945).

The dominant tree in a pocosin is pond pine (*Pinus serotina*), which is scattered through a dense undergrowth of broad-leaved evergreen shrubs. Other common trees are sweet bay (*Magnolia virginica*), red bay (*Persia borbonia*) and inkberry (*Ilex glabra* and *Zyonia mariana*).

Pocosins do not have the abundance or diversity of wildlife found in other swamps, but do harbor deer and black bear.

II.F.2. Pathways and Processes

II.F.2.a. Nutrient Cycle--Very little information is available on nutrient cycling. Some information is available on soil nutrients in both pocosins and river flood plain swamps due to reclamation of these lands for forestry and agriculture. Waterlogging reduces the availability of nutrients and combined with low pH reduces remineralization of nitrogen by bacteria. The draining of pocosins has proved beneficial to the growth of timber (Maki 1974).

Although agricultural studies show availability of nutrients is low, swamp vegetation is adapted to these conditions and nutrient cycling by plants is rapid. Plants utilize elements from the deep soil and process them into foliage which may be up to 60% of the annual plant production (Ovington 1965). At the end of the growing season the foliage becomes part of the surface litter and through decomposition and microbial action the nutrient elements are returned to the soil at a lesser depth where they can be used by shallow-rooted plants.

Very little is known about nutrient import and export to the swamp system. However, inundation of river flood plain swamps carries large amounts of nutrients into them in the form of organic matter and sediments which support a diverse population of microorganisms. These microorganisms make food available to other species through synthesis and decomposition (Wharton 1970). Wharton (1970) proposes a hypothetical food web for a river flood plain swamp (Figure 37).

II.F.2.b. Hydrological Cycle--In the course of a year the water level in all three swamp types fluctuates from flood level to drought. These fluctuations are known as the hydrological cycle. Wet periods bring in nutrients and dry periods allow seeds to germinate and grow. It has been shown that cypress and gum seeds will not germinate when submerged, but will germinate and grow quickly when waters recede (Shunk 1939; Naylor 1972; Demdree 1932). Most swamps are flooded in the winter when vegetation is dormant and is, therefore, uninjured by the water.

The hydrological cycle is also very important in relation to man:

> The hydrological cycle is one of the most important cycles as far as man is concerned. Indeed, the future of man is directly dependent on the availability of sufficient quantities of water in usable form. Wetlands have been recognized as an important aspect of this global cycle. The main focus in analyzing the role of wetlands in the hydrological cycle is their ability to displace flooding peaks and their contribution to groundwater supplies. (Black 1974)

II.F.2.c. Absorption and Sedimentation--Swamps may act as both sponges and filters. The peaty soil soaks up water when water levels are high and releases it when levels are low. In this way river flood plain swamps provide a steady flow to adjacent rivers and aquifers (Wharton 1970). As filters, they contribute to the ability of a natural aquatic system to cleanse itself. Nutrient material from the water is absorbed into the swamp soil and decomposed by bacteria. An example of this occurs in pocosins where phosphorus, a growth-limiting nutrient, is absorbed and bound by soil microorganisms (Woodwell 1958). Swamps are also settling basins for particulate matter. As water moves slowly through a swamp, particles settle out, at which point they are stabilized by vegetation (Black 1974).

II.F.3. Temporal Patterns (Succession)

As well as yearly cycles involving seasonal weather changes and water fluctuations, the swamp must be considered in a broader time frame. These long-range patterns deal with succession which varies in each habitat according to the degree of alteration. Alteration can be either natural (such as erosion, aggradation or gradual drainage) or artificial

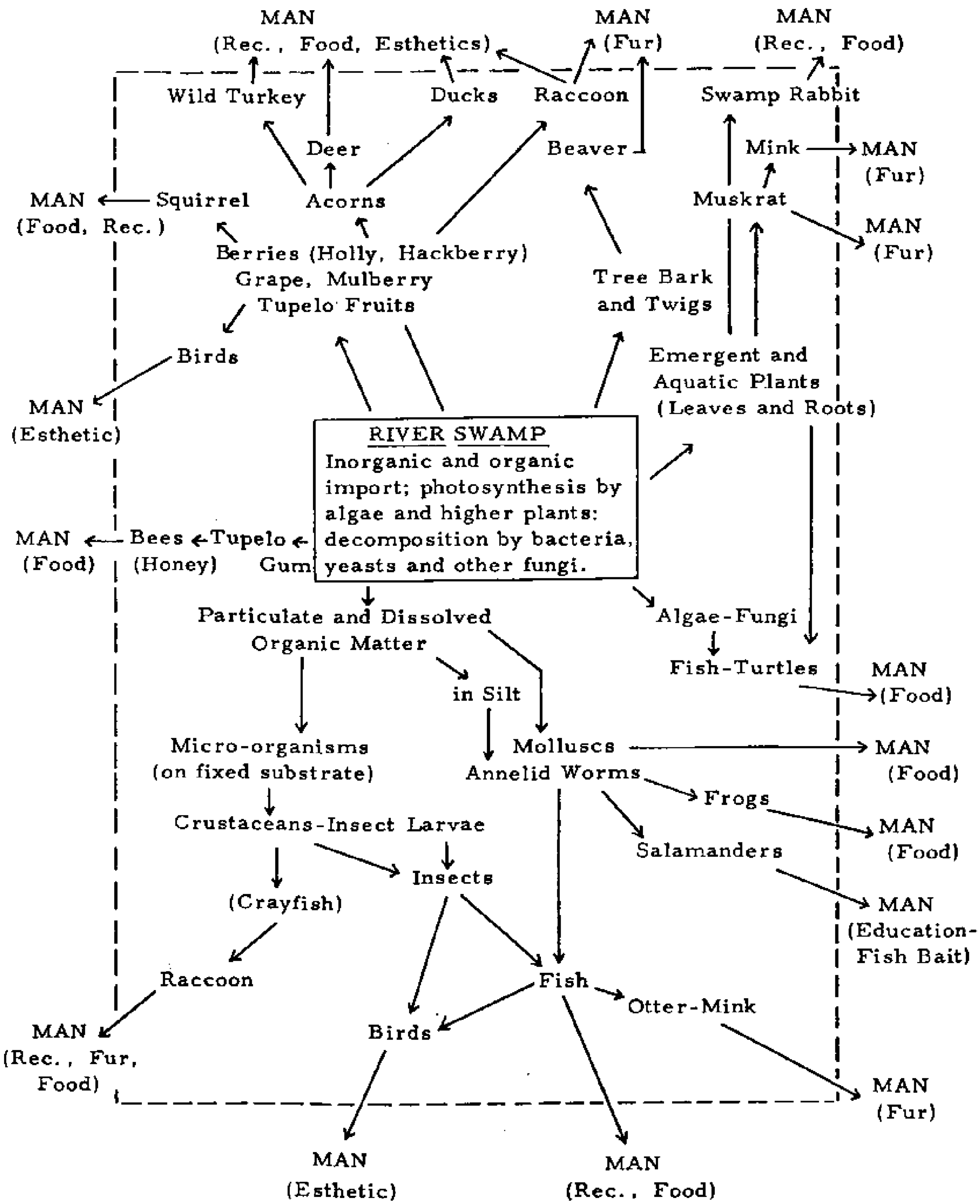


Figure 37. Probable food web for a river flood plain swamp (from Wharton 1970).

(such as man-made drainage, logging or burning). In the swamp forest, natural succession leads an aquatic environment to a cypress-gum community by slow aggradation of organic matter. Cypress becomes established when water levels are low, then islands form around the cypress knees. Other trees and shrubs grow on these high areas. Vegetation also advances from the edges of the lake by spreading of superficial roots characteristic of swamp plants. These form mats and grow out over the water. Fine matter washed from the mats combined with fallen logs and trees help fill in the lake. Selective logging of cypress at this stage produces a tupelo gum swamp. Tupelo is more successful in seed reproduction than cypress and any cypress seedling produced will not tolerate shade from the tupelo gum.

Succession in pocosins varies with environmental conditions, occurring generally in three steps. First, a broad non-drained upland accumulates muck through aggradation of organic matter, eliminating sweet bay and wax myrtle. At this point sphagnum moss becomes prominent. If sphagnum is destroyed by fire, cane (Arundinaria gigantea) will dominate, forming an upland pocosin. Erosion will shift the area to a lowland pocosin with a longer hydroperiod and titi (Cyrella racemeflora) as the dominant tree. If drainage is introduced, sweet bay will again dominate. Fire will produce a white cedar swamp forest.

In the river flood plain, swamp succession is related to topography. Willows grow at the water's edge, birch and sycamore farther away and oak-hickory communities on high ground. The system is stable and will remain undisturbed for long periods.

II.F.4. Organism Adaptations

Most swamp-dwelling organisms are adapted to alternate wet and dry periods. Cypress and gum seeds only germinate during dry periods. Young seedlings are killed or stunted by long periods of submergence (Hook et al. 1971). Thus, dryness is necessary to establish a forest. Not germinating in water is a protective adaptation assuring the seeds are not wasted by developing during periods when the seedlings would be submerged. The most common river flood plain trees germinate in water. The seedlings can tolerate saturated soil for more than a month, but longer submersion is always fatal (Hosner 1958). Mature trees survive submergence for very long time periods without harm, because they are adapted to low pH and low oxygen around the roots. For example, tupelo gum can tolerate waterlogged soil by transporting oxygen to the roots, tolerating and regulating ethanol produced by anaerobic respiration and tolerating high carbon dioxide concentrations

(Hook et al. 1971). Some trees may return oxygen and amino acids to the soil to support microorganisms, which make nutrients available to the roots.

Just as plants are adapted to swamp conditions, some animals have adaptations to swamp life. The swamp rabbit is a good example with its large feet and slightly splayed toes for traveling over the muck. It can also swim and dive, which is highly advantageous during periods when most of the swamp is flooded. In the Coastal Plains the parula warbler builds its nest exclusively from Spanish moss and is, therefore, confined to swamp forests. The prothonotary warbler is another bird adapted to swamp forests, nesting in the hollows of cypress and gum trees. A last example is the pygmy sunfishes (the blue-spotted sunfish and banded sunfish) which grow only 1.5 inches long and are able to swim easily through roots and vegetation. These are only a few of the many animals that depend on swamps for survival.

II.F.5. Values of the Environment

II.F.5.a. Primary--Primary uses are things man does in the environment such as recreation, hunting and forestry. Recreation includes fishing, swimming, canoeing, hiking, bird-watching, nature walking and photography. Such things are hard to value in money because each one is a personal experience. Black (1974) summarized the data available on recreation values for all wetlands, including marshes. He reports that a study by Georgia State University estimates non-consumptive wildlife use in the southeast at $12.4 billion per year. When fishing is added to this the value increases to $18.5 billion. The amount contributed by swamps is not known, but they are very important wildlife habitats in the southeast. Wharton (1970) considers river swamps the last green belts in many areas and places the value of recreation and hunting on the Alcovy River swamp in Georgia at $4,080,000 per year.

According to Black (1974), waterfowl hunting in North Carolina swamps and marshes is worth $2,643,911 per year. In 1971-72 the main wetland furbearing animals (mink, otter, raccoon and muskrat) brought in $382,172. All this cannot be attributed to swamps because some of these animals are also found in marshes. However, other furbearers such as foxes, wildcat and weasel occur mainly in swamps and are not included in the value. Black (1974) did not report data on big game hunting in North Carolina, but stated that big game hunters spent $100,894,000 in the South Atlantic region in 1970. Black bear, deer and bobcat, the main big game species in the South, are found in swamps which provide seclusion and protection. Swamps, especially river flood plains, also harbor small game such as rabbit, squirrel, turkey and others that are hunted by many people (although no dollar values are available). Recreation and hunting provided by swamps not only bring pleasure and relaxation to thousands of North Carolina residents and tourists, but also add a considerable sum to the State's economy.

Another important primary value of swamps is forestry. Wooded swamps and river flood plains both contain large stands of hardwood timber valuable in North Carolina's furniture and hardwood veneer industries (Black 1974). However, the three types of swamps do not support timber of the same type nor to the same degree. Wooded swamps contain principally cypress, tupelo gum and black gum, which are adapted to standing water. These trees are highly prized, but the difficulties of logging in a swamp combined with the trees' slow growth rate make them less valuable than hardwoods in the river flood plain swamp (Black 1974). Flood plain terraces that are not frequently covered by water and have a silty soil are the best areas for hardwood growth. Less desirable species grow on the frequently flooded areas or first bottoms of flood plains which have clay or sandy loam for soil.

Black (1974) reported values estimating the value of North Carolina's hardwood timber. Swamp forests produced 24,818,000 board feet of cypress and 37,343,000 board feet of gum that year. At $32 per 1000 board feet, swamp forests were worth $1,989,152 in timber. River flood plains were more productive, producing 47,728,000 board feet of tulip poplar and 52,001,000 board feet of sweet gum. At $45 per 1000 board feet, $4,937,805 worth of timber was produced.

Pocosins are often drained to produce pine forests. Under natural conditions stunted pond pine is scattered over the pocosin. Drainage not only produces better growth in pond pine but allows loblolly pine to grow (Maki 1974). This is planted and intensively cultured in commercial forests.

II.F.5.b. Secondary-- Major secondary values of swamps are maintenance of flood regimes, maintenance of the water table and water purification. They are important for flood control because the peaty soil collects water and releases it slowly, preventing downstream flooding (Wharton 1970).

Swamps also help maintain the level of the water table. Groundwater is an underground reservoir which supplies water to streams during dry periods. Swamps recharge groundwater when stream flow is high by absorbing water from the stream and allowing it to percolate into the water table (Wharton 1970). Along the coast, saltwater will intrude into the aquifer if the hydraulic force produced by groundwater is not sufficient. Swamps contribute to this hydraulic head by recharging the water table and thus retarding saltwater intrusion (Heath 1975).

Swamps purify water by sedimentation, absorption and dilution. Swamps associated with streams act as settling basins, thereby reducing the quantity of sediment entering the aquatic environment (Black 1974). When the stream enters the swamp water spreads over a greater area and its flow slows as it meets resistance from vegetation, allowing particulate matter to settle out. Once sedimentation occurs, swamp vegetation stabilizes the sediment by trapping it in a newly forming mat of roots (Wharton 1970).

Swamps also purify water by selectively absorbing nutrients and pollutants. As previously mentioned, microorganisms in pocosins bind phosphorus. Plants also absorb various nutrients from the water. Tupelo gum and sweet gum accumulate cobalt, zinc, copper and manganese (Beeson 1955). Wharton (1970) gives an example of a Georgia stream polluted with human wastes and chicken offal that is completely cleansed after only 10 miles of swamp. The large surface area of a swamp also increases the concentration of dissolved oxygen, a step in water purification (Wharton 1971).

II.F.5.c. Tertiary--Tertiary swamp uses include education, aesthetic values and preservation of endemic species.

Schools make use of swamps for field trips to teach ecology, zoology and botany. Wharton (1970) says:

> Wetlands are excellent outdoor laboratories where fundamental interrelationships of physical (climate, water, rock and soil) and biotic (plants, animals and man) components of an ecosystem may be conveniently explored by classroom field trips or by individual use. The swamp ecosystem has several advantages over typical terrestrial communities. It is not as easily damaged by classroom use, it harbors a reasonable amount of animal life even in mid-winter, it simulates certain special climatic conditions important to evolutionary theory, and it often supports faunal and floral elements in large numbers.

Wharton (1970) estimated the value of the Alcoy River swamp in Georgia at $1,215,917 a year for public school system, $55,000 for colleges and $50,000 for graduate student research. Of course these figures depend upon the number of students within reasonable driving distance of the swamp, although in Coastal Plains counties of North Carolina distance should not present a problem due to the abundance of swamp environments.

The aesthetic value of a swamp is harder to define, but quiet, green non-polluted wilderness is beneficial to mankind. As they disappear their benefit is becoming more highly appreciated. Black (1974) combined aesthetic and recreational qualities as "visual-cultural values." His visual criteria included "visual contrast (variables of landform contrast, water body size or length, surrounding land use contrast and internal wetland contrast) and visual diversity (landform diversity, wetland edge complexity and wetland type diversity)."

Dollar values could be attached to aesthetic qualities of swamps only with great difficulty, and they would be subjective at best. Wharton (1970) feels that economic values are not important. Swamps "provide a true wilderness experience. Where else in this mechanized, modern world can we so quickly lose outselves in wilderness without evidence of the massive civilization that surrounds us? We need such places--some qualities that they provide reach far beyond any concept of economic values."

Another tertiary value of swamps is preservation of species dependent on the swamp. Many plants such as cypress, tupelo gum and black gum are swamp endemics, physiologically adapted to the habitat and not able to survive elsewhere. The prothonotary warbler and parula warbler described previously also depend on the swamp. The wood duck, which is North Carolina's only nesting waterfowl, is becoming swamp-dependent as other forests are cut down because it nests in tree cavities abundant in swamps.

Two large animals, the black bear and bobcat, have been forced into swamps as other land was settled and cleared. These animals need a secluded wilderness area where they can range freely without troubling man. In North Carolina, swampland is their last refuge. Several species of shrew, the bog lemming, ord-wood rat, red-shouldered hawk, alligator and various snakes and turtles are endangered swamp species in North Carolina (Black 1974). Some of the organisms depending on the swamp are economically important, although there are more than economic reasons for preserving and protecting wildlife. Black (1974) states it very well:

> As the rate of extinction accelerates, in response to the demands of man, the ecosystem becomes increasingly fragile through loss of its components. The resulting simplification multiplies the susceptibility to catastrophe; man, by his own devices, has become more the manager of everything and must therefore assume the role of the extinct species in maintaining <u>homeostasis</u>. . . . Irregardless of man's enormous ego, it seems unlikely that man is ready to assume the burden of maintaining balance.

II.F.6. Man's Potential Impact

The largest impact on the swamp comes from draining and clearing swamplands and channelizing the streams running through them. Channelization is the widening, deepening and straightening of a river. Usually trees and other vegetation along the channel are destroyed by bulldozer and the dredge spoil is deposited as a levee (Wharton 1970). Draining, clearing and channelization are done for insect and flood control and to produce land for agriculture and forestry.

Draining of land encourages development on the flood plain, which can be dangerous. Even the best flood control programs do not stop floods, only reduce their frequency. The very large floods cannot be controlled at all (Wharton 1970).

Draining and channelizing increase the rate of streamflow which impairs the swamp's ability to absorb water into the aquifer when streamflow is high and release it when streamflow is low, therefore floodwaters are not retarded and the frequency of downstream floods increases (Wharton 1971). The water table falls and can no longer recharge streams during periods of drought (Wharton 1970, 1971; Black 1974). Lowering of the water table has one other effect in coastal regions. The hydraulic head which retards seawater is reduced and the rate of saltwater encroachment on the Coastal Plains water supply accelerates (Wharton 1971; Heath 1975).

Drainage of swamplands also increases the volume of runoff from the land. When pocosins are drained for pine forest production, ditching results in a measure of horizontal flow that is not normally present (Maki unpublished). In the Albemarle-Pamlico peninsula large farms occupy what was once swamp and marsh, where drainage has increased runoff during wet periods (Heath 1975).

Along the coast, runoff enters estuaries that are among the most productive ecosystems known (Odum 1971). They are spawning areas for commercially valuable fish and shrimp and many contain oyster beds. These organisms are sensitive to changes in salinity and water quality which are determined by the quantity and quality of freshwater entering an estuary (Heath 1975). An increase in runoff may therefore be detrimental to fish and shellfish by decreasing estuarine salinity.

The quality of runoff entering an estuary will change when there are no swamps to trap sediments and nutrients. In a study of the large farms in the Albemarle-Pamlico region, Heath (1975) says:

> It is expected that the runoff will not only have a significant effect on salinity of the estuarine waters adjacent to the peninsula but will also contribute substantial amounts of bacteria, nutrients, pesticides and sediment. In fact, the effect of runoff from the region on the quality of the nearby estuarine waters may be the most important problem posed by the agricultural developments.

The major effect of increased nutrients on estuarine water quality is eutrophication (an increase in the production of algae and aquatic plants), which leads to a decrease in the oxygen available to other organisms. Runoff from cultivated wetlands contains more nutrient than runoff from uncultivated wetlands (MacCrimmon and Nichols 1974).

Drainage and channelization also affect the swamp environment directly. Channelization changes the stream bottom, removing oxbows, undercut banks, snags, aquatic vegetation and deep holes. Widening of the stream combined with cutting canopy trees along the bank increases water temperature. This wholesale destruction of habitat reduces the fish population. Channelized streams have only one-fourth the poundage of game fish per surface acre as unchannelized streams (Tarplee et al. 1971). Channelization destroys terrestrial habitat through right-of-way clearing. In Hertford County, 1250 acres of tupelo gum were destroyed in 2 years by such cutting (Barick 1965). Spoil banks are eventually covered with tangles of briars and honeysuckle vines which afford little cover for wildlife (Barick 1965). In addition, more trees are destroyed by ponding (permanent standing water accumulated behind levees), because many swamp trees must have dry periods to survive. Ponding can be eliminated by cutting drainage channels through the spoil banks (Wharton 1970).

Excessive wetness is damaging to all swamp timber, but drying has variable effects. Pine grows better when pocosins are drained (Maki 1974). Drainage may also increase cypress growth (Lowells 1965), although Barick (1965) states that cypress knees rot a few years after draining. Tupelo gum does not respond well to draining and may die (Lowells 1965). In any case, drainage alters the habitat and succession will ultimately lead to the replacement of swamp timber with upland forest types. There is little data available from North Carolina, but studies in Finland record upland species becoming established in about 50 years (Maki 1960).

Drainage has an undesirable effect on organic soils. Peat shrinks as it drys, causing the land to subside. Drained peat compacts further through slow oxidation, making it highly susceptible to fires. In 1973 fire burned 300 acres of peat drained for agriculture north of Lake Phelps (Heath 1975).

II.F.7. Management Implications

Several management implications are apparent, but three are very important. First, hardwood sites should not be drained for conversion to pine forests. According to Lyell Hicks of the Division of Forestry, we have an adequate number of pine-growing sites that should be managed for full production and management of hardwood sites should concentrate on increasing the production of hardwoods. Secondly, the quality and quantity of runoff from large farms must be controlled. If they are allowed to affect the estuaries, fishery harvests will suffer (Heath 1975). The third management implication is the most important. Multiple uses must be considered instead of single uses:

> The old concept of single-purpose use (as in using artificial channels to remove floodwaters) must give way to the concept of multiple use such as involves water quantity, water quality, productivity, educational and public use (recreation). The single purpose cannot be allowed to impair or destroy the multiple uses even though they be less well defined, for the multiple uses may be important to the survival of society for the next 100 years. (Wharton 1971)

To implement the multiple use concept, the continuity of swampland must be taken into account. Swamp function is based upon the amount of continuous swampland present, especially in such areas as water control and wildlife habitat. To effectively control water quality and quantity, swamps must be large enough to filter the volume of water passing through them. Preserving only parts of swamps will adversely affect this function. A swamp will be an effective wildlife habitat only if it meets the range requirements of its inhabitants. Big game animals such as black bear and bobcat have retreated to the swamps as the last large tracts of wilderness. These animals need extensive ranges which will be destroyed if swamps are cut into small tracts of land with developments between them.

II.G. Migrating Organisms

Edward Pendleton

Some of North Carolina's most valuable coastal resources are not measured in acreage and not restricted to any particular coastal environment. These resources, migrating populations of fish, shrimp, crabs and birds, move routinely and regularly throughout the year through rivers, mid-salinity and low-salinity estuaries, marshes and sounds, inlets and nearshore ocean regions during their life cycles. Their movements, and the resulting utilization and redistribution of food and energy resources, make them a link and a common denominator between environments and increase their value. Migrating organisms take advantage of the naturally high abundance of food of the coastal zone by feeding upon it when they are juveniles and rapidly growing. Man, in turn, capitalizes on migrating fish, shrimp and crabs through commercial and sport fisheries. Migrating birds, particularly migratory waterfowl, provide hunting and birdwatching recreational value. Thus, the worth of many coastal environments is intrinsically enhanced, and often in part justified, by the presence of migrating organisms.

Most aquatic organisms move around in search of food or better environmental conditions such as optimum water salinities or temperatures. What sets migratory aquatic animals apart is the regularity of their movements in each season and the regular use of different environments for specific events in their life histories. Three general types of life cycles occur in our coastal zone: offshore spawning and inshore migrations to estuarine nursery grounds, upstream adult migration from the sea for freshwater spawning (anadromy), and downstream adult migrations from freshwater and oceanic spawning (catadromy). These aquatic migrations are controlled by seasonal environmental factors such as salinity, temperature, and water flow, and habitat factors such as food availability, food type and bottom types. Overwintering and other seasonal migrations of birds form a fourth migratory cycle.

II.G.1. Migrations of Offshore Spawners (Nursery Utilizers)

Every year, our estuaries teem with millions of young shrimp, crabs and fish that were born at sea off our inlets and migrated to brackish water for protection, favorable growing conditions and food. They live here for the first months of their life and migrate back to the ocean as juveniles and young adults. The vital role of estuaries in the life cycle of these organisms is one of the best reasons for the judicious use and planning of the coastal environment.

II.G.1.a. Shrimp--Three species of commercially important shrimp are found in North Carolina and form the State's single most valuable fishery resource. The life cycles of brown, white and pink shrimp are essentially the same, but are carried out at different times of the year and in slightly different areas, allowing a very efficient utilization of different coastal habitats (Williams 1965; Farfante 1969). In North Carolina, all three species are found from Pamlico Sound south, with the Pamlico Sound, Core Sound, and Cape Fear rivers being particularly important for commercial shrimping.

Each year, brown shrimp appear first in the estuaries. They are spawned during the winter by adults living offshore in water depths of 50 feet or more, where the bottom terrain is too rough for commercial fishing. Eggs hatch and larvae develop in the ocean. Postlarval stages, recognizable as shrimp, begin to enter the sounds in October and reach a peak immigration rate in late March and early April. Once in the sounds, they migrate to shallow estuarine nursery areas where they take advantage of the spring increase in food supply; worms, mollusks and crustaceans living in the bottom sediment, aquatic vegetation and marsh plant detritus. After about 11 to 12 weeks, the young brown shrimp reach the minimum commercial size of 70 headless shrimp per pound (McCoy 1968); 50 per pound count is reached in another 17-18 days. At about this time they begin moving on ebb tides toward inlets and river mouths at a rate of about one-half mile per day (McCoy and Brown 1967). Those reaching the ocean begin moving toward the south and deeper waters, and are soon lost to shrimpers. At least in Pamlico Sound, brown shrimp remain longer and grow to a larger size than other shrimp before they emigrate.

Pink shrimp follow the same life cycle and use the same nursery areas as browns, but timing differences generally prevent much overlapping. Postlarvae enter the estuary from late May through November after hatching and larval development of about 2 to 3 weeks in the ocean. Influx is related to the lunar tidal cycle (as is probable for all shrimp) and more enter the estuaries on the spring tides (Copeland 1965). Pink shrimp can withstand lower temperatures than brown or white shrimp and many of the fall arrivals overwinter in Pamlico Sound and perhaps other estuarine areas. They remain active until water and substrate temperatures cool to about 12 C (54 F), then burrow into the bottom and remain there until temperatures rise in the spring (McCoy 1972; Purvis and McCoy 1972). Juvenile shrimp then migrate out in May and June.

White shrimp are spawned in the ocean from May through September, arriving in the estuaries in June to July as postlarvae about 2 to 3 weeks after hatching. They can tolerate lower salinities than other shrimp and thus move farther upstream to nursery areas. At about 100-120 mm they begin their return journey to the sea. Like other shrimp, they migrate south during the fall and winter. There is a northern migration of adults during the late winter and early spring.

The life cycle of shrimp is affected by food availability, tidal and day/night cycles, temperature, salinity and bottom substrate type (Williams 1965; Farfante 1969). Food is abundant in the nursery areas; coupled with the omnivorous feeding habits of juvenile shrimp, it is not a limiting factor. Tides act as aids to immigration and emigration. Shrimp appear to move in and out of the estuary according to a lunar cycle, the most abundant numbers moving in and out during spring tides. Daylight and darkness affect shrimp activity. White shrimp are more active during the day, but may migrate at night. Pink shrimp are nocturnal, and are more active at night or on cloudy days and in turbid water. Brown shrimp occupy a middle (10-20 ppt) salinity range; pinks prefer higher salinities. Immature shrimp migrating in tend to drop out of the water column and burrow in the mud when salinities decrease on ebb tides, and rise again and travel upstream when salinities increase (Farfante 1969). When salinities decrease juvenile and pre-adult shrimp routinely swim downstream.

II.G.1.b. Blue Crabs--Blue crabs begin their life history by spawning in the ocean, relatively near shore and near inlets, with the greatest amount of spawning in late spring (Williams 1965). At 26 C, eggs hatch in about 2 weeks in the laboratory. After hatching the larvae live in nearshore areas. In the laboratory, larval development in the last larval stage (the megalops larva) takes place in 31-49 days, depending on salinity (Costlow and Bookout 1959). In 6-20 days the megalops transforms to the first crab stage and begins migrating to the estuaries. Some megalops larvae may also migrate or be dispersed by physical factors up the rivers (Williams and Deubler 1968). The young crabs migrating into the estuaries in summer and fall remain there for a year, burrowing in the mud during winter cold spells but otherwise feeding and growing in the estuaries. Blue crabs mature in 12-14 months. The females molt and mating occurs, mainly from July to September in low-salinity water and the eggs are laid in the ocean 2-9 months later when the females are approximately 2 years old. The males remain in low-salinity waters. The eggs are attached to the female's abdomen in a mass, giving them the name "sponge crabs" at this time. After migrating, females generally stay in the ocean, but those that do return tend to migrate back to the same estuary, rather than move up or down the coast (Fischler and Walburg 1963). Crab spawning and larval development occur over a long period, so developmental stages are apt to be found simultaneously throughout much of the year (Williams 1965; Nichols and Keney 1963; Dudley and Judy 1971). Adult migrations appear to be due to changes in adult females' abilities to withstand low salinities as they mature, mate and lay eggs (Tan and Van Engel

1966; Tagatz 1961). All crabs are better able to withstand temperature extremes in higher salinity waters, and take relatively long times to acclimate fully to temperature changes (Tagatz 1969).

II.G.1.c. Fish (Menhaden, Flounder, Spot and Croaker)-- Although not as dramatic as other fish discussed later, many of North Carolina's most abundant coastal and estuarine fishes migrate during their life cycles. As with shrimp and crabs, these migrations typically involve offshore spawning and migration of the young to the estuary nursery grounds, the growth there of the young throughout the first year or first summer of their life and subsequent emigration out of the estuaries as adults. Some adults and juveniles over-winter, and many adults move in and out of the estuaries on feeding forays.

Menhaden utilize our coastal zone extensively during their life cycle (summarized in Reintjes 1969). Adults school offshore at the surface in the spring and move slowly north-ward as ocean waters warm. In the fall, in response to cool-ing water temperatures, the schools, which may contain tons of fish, move southward, and on the North Carolina coast, off-shore. A large menhaden fishery, centered in Beaufort-Morehead City and Southport, operates much of the year, peak-ing in June (1952-67 summary). In addition, large schools of bluefish follow the menhaden and feed on them, and become the basis for a sport fishery themselves. Spawning takes place in the winter months among these offshore fish and somewhat earlier in fish that have remained in the sounds (Wilkens and Lewis 1971). Larvae (10-30 mm) migrate into the estuaries in late winter and early spring where they live 6 to 8 months. To facilitate getting into the estuaries, they ride in on flood tides. The larvae are carried back and forth in the es-tuaries where tidal currents are strong, but a net movement up the estuary is made by swimming on the incoming flood tides. Larval movement is directed toward freshwater where transformation into a prejuvenile stage (30-40 mm) takes place. The tiny menhaden may need a nearly freshwater habitat to transform, or food may be more abundant in low-salinity areas (Wilkens and Lewis 1971). During transformation their bodies and feeding habits change. Larvae eat copepods; but when their mouths, gill arches and digestive tracts change shape during transformation, they feed almost exclusively on phyto-plankton and plant detritus (June and Carlson 1971). Juve-nile fish may travel extensively in freshwater rivers and sound areas, where they are fed upon by striped bass, summer flounder, weakfish, ospreys and gulls (Reintjes 1969). As long as temperatures remain above 4 C (39 F) and salinities around 10-20 ppt, menhaden juveniles and adults feed in the sounds and estuaries in the fall; eventually, though, they leave through the inlets and form migrating schools. Their movements are influenced by tides, rainfall and winds, which act through their effects on salinity and temperature of water.

Many other fishes besides the menhaden use the coastal sounds and rivers of North Carolina year-round except during periods of extremely cold weather. Among the more important fishes in this group, both in terms of population size and commercial value, are flounder, spot and croaker. Adults of these fishes migrate out of our inlets regularly and spawn a few miles offshore. The young are brought into the sounds by tidal currents, and as they grow and are able to swim in the currents, continue migrations upstream to the nursery grounds.

Three species of commercial flounders occur in our waters. Although flounder migrations are less pronounced than other species, adults will move to the ocean to spawn from September to May, with peak spawning in November and December (Hildebrand and Cable 1930). Tiny juvenile flounder migrate in during the colder winter months at water temperatures of 8-16 C (Williams and Deubler 1968), where they live on the bottom and feed on fish and small crustaceans. Salinity is one of the main factors in determining the behavior of flounders (Deubler 1960; Deubler and White 1962; Stickney and White 1973), salinity tolerances changing during different stages of the flounder's life cycle. Adult flounder stay offshore during warm periods to feed.

Spot and croaker are among the most abundant fish in North Carolina waters, comprising as much as 90% of bottom-dwelling fish in one study in Pamlico Sound (Roelofs 1954). They are closely related and have similar life cycles. Both spawn offshore when they are about two years old, spot from November through February and croaker from October until March (Hildebrand and Cable 1930). Little fish move in, riding bottom currents to the limit of saltwater intrusion by tidal action (Haven 1957) and spend much of the first year of their lives in marsh creeks and other shallow areas. While there, they grow to a length of 130-150 mm, feeding on small bottom organisms such as worms, nematodes and copepods (Roelofs 1954). Adults and juveniles move offshore in the fall, the spot schooling until winter (Hildebrand and Cable 1930) and some of the croaker perhaps migrating southwardly (Haven 1959).

II.G.2. Anadromous Fish

Each spring, an extremely interesting group of fish known as anadromous fish enter our sounds and estuaries to swim into the freshwater rivers of our coastal zone to spawn. Typically, millions of eggs are laid from late March to mid-May when the river water warms to specific temperatures. The young hatch and begin to drift in the river currents, feeding on insects, zooplankton and bottom-dwelling crustaceans. They spend their first summer in the rivers feeding, growing and slowly moving down toward the saltier portions of sounds and rivers. In the fall, responding to gradually cooling water temperature, they move offshore into the ocean, where they remain for several years, perhaps traveling from Florida to Maine in a series of adult migrations that follow water masses of desired optimum temperature. When males are 2 or 3 years of age and females are 3 or 4, they become sexually mature and complete the cycle by making a spawning run, generally to the stream of their birth by homing in on temperature, smell, water quality and current clues that interact in great complexity with one another and are still not fully understood. Fish south of North Carolina may die after they spawn; however, here many return to the sea to resume a migratory life in the ocean.

There are seven species of anadromous fish in North Carolina: the American shad, the hickory shad, the alewife, the blueback or glut herring (often combined with alewives under the name "herring" or "river herring"), the striped bass, the Atlantic sturgeon and the shortnosed sturgeon. Of these, the striped bass and American shad provide the most widespread and profitable anadromous sport and commercial fishery. Habitats and occurrences of these fish have been studied on a river-by-river basis by the North Carolina Wildlife Resources Commission (see bibliography by Street and Hall 1973).

A summary report for the coastal zone (Baker 1968) permitted several generalizations to be made about the anadromous fisheries in our rivers. Almost all streams on the North Carolina coast contained some of the species of anadromous fish during some part of their life cycle. The Chowan and Roanoke rivers contributed most heavily to the herring fishery in North Carolina, although alewives and blueback herring are found distributed all along the coast. The Neuse and Tar rivers were most heavily utilized by fishermen. The Neuse yielded more American and hickory shad than all other rivers combined in 1968. The Cape Fear River provided a sport fishery for American shad and a minor fishery for other anadromous fish. The Pamlico River and some of the smaller rivers of our central coast were more important fishing grounds for mullet and sea trout than anadromous fish.

Striped bass were caught by sport fishermen primarily in the Roanoke River, Albemarle Sound and Chowan River. Larger striped bass are also caught by sportsmen and commercial haul-seiners off the Outer Banks. It is probable that the Outer Banks fish and the Albemarle Sound fish represent two separate populations (Capotan and Sykes 1961). The Albemarle Sound fish ascend the Roanoke River for their spring spawning runs, spawn near Weldon, North Carolina, and return to Albemarle Sound to remain there and in adjacent waters year-round as adults. Fish in this population are small, the adults ranging from 1 to 6 pounds. The fish caught on the Outer Banks are much larger (6-75 pounds) and may be part of a population that migrates up and down the coast, spawning primarily in the Chesapeake Bay region. They feed off the North Carolina coast and their presence is probably determined by food availability and favorable water temperatures.

The majority of striped bass spawning in North Carolina takes place on the Ronaoke River near Weldon, North Carolina (Baker 1968). Important spawning areas for other anadromous fish are likewise restricted to a few rivers. Alewives and blueback herring spawn primarily in the Chowan and to a lesser extent in the Cashie and Neuse rivers. The Neuse River is important for American and hickory shad spawning, the Cape Fear for American shad and the Tar for striped bass (second in the State behind the Roanoke).

The period of spawning migration and spawning is the weakest link in the life cycle of the anadromous fish, the time when they are most vulnerable to the environment. What are the controlling factors to which these fish are most sensitive? Chemical clues in the water and offshore water currents are hypothesized to be important in the homing instincts of the American shad, which returns to the stream of its birth to spawn (Dodson and Leggett 1974). This ability to home is not known in striped bass, but probably occurs among other members of the shad family. The shad's migrations in the ocean are stimulated by water of a specific temperature which it follows generally up the coast in the spring. When in the vicinity of its spawning river, it picks up characteristic odors in the waters being discharged and orients itself toward them. Approaching the river, and in the river, the fish responds to changes in tidal and river flow currents to get to the spawning ground. There may also be some visual clues.

Temperature is one of the most powerful triggers to spawning activity. American shad enter estuaries and freshwater rivers to spawn when water temperatures are 13-16 C (55-61 F) (Walburg and Nichols 1967). Peak spawning occurs around 18-20 C (63-68 F) for Roanoke River striped bass (Amundsen 1975), 17-18 C (62-66 F) for Neuse River hickory shad (Pate 1972) and 13 C (55 F) for alewives in Lake Mattamuskeet (Tyus 1971).

Temperature continues to affect egg hatching success and larval growth rate.

Of great importance to spawning is an adequate spawning environment, particularly water flow and habitat. Striped bass require streams of large cross-sectional area (Baker 1968). Since the eggs of the striped bass are not buoyant, flowing water is necessary to keep them afloat, otherwise they may sink to the bottom and suffocate in the bottom sediment (Bayless and Smith 1965). Hickory shad, American shad and the herrings, on the other hand, use small tributaries or shallow swamp areas of low water discharge (Pate 1972; Tyus 1975). Their eggs are broadcast over the bottom.

Timing is important to spawning migrations and anadromous fish are well adapted to North Carolina streams in this respect. The fish arrive in the spring when river flow is greatest and swamps have filled. Runoff water from early spring rains contains many dissolved nutrient chemicals that stimulate the growth of one-celled algae or phytoplankton, which "bloom" in the spring, with millions being found in the water column. The algae are grazed by copepods and other smaller animals called zooplankton and these too increase their population sizes in characteristic spring "blooms." These sources of food are available both to young and adult fish, and high flow helps the young fish move down the rivers.

II.G.3. Catadromous Fish

There's more to the eel than just being a fisherman's nightmare. The American eel is North Carolina's only example of a more uncommon life cycle, one that is the opposite of the cycle of the anadromous fish. Eels make spawning migrations into the sea rather than freshwater, traveling from our coastal zone to the Sargasso Sea, south of Bermuda. Spawning occurs there after the eels have congregated and the young larvae begin traveling back to the coast on ocean currents. As they reach our coast, they have grown to a larval stage known as a leptocephalus, which looks so unlike the adult eel that they were once thought to be an entirely different species of organism. The leptocephalus transforms into a small unpigmented "glass eel" which migrates further upstream. Male eels remain in the lower, more brackish sections of our rivers and sounds, but females travel to freshwater and grow to a larger size. They remain in these areas for many years and eat benthic invertebrates and particularly young fish of other species.

II.G.4. Birds

Many animals visit our coast only during certain seasons of the year for overwintering or breeding purposes. Chief among these are birds, particularly migratory waterfowl (Tables 17-20), which are the most important group from hunting and recreational birdwatching standpoints. Prevalent wind and weather patterns shunt birds down our coast in a broad pathway known as the Atlantic Flyway. On the way down the coast are many water indentations which tend to block birds from flying farther south, with land margin areas subsequently becoming sites for great concentrations of both water and land birds (Heppner and Gould 1973). The major water barriers in North Carolina are the Albemarle and Pamlico sounds, and the major concentration points are Hatteras, Ocracoke and Bodie islands, and mainland areas now mainly designated as National Wildlife Refuges: Mackey Island, Pea Island, Mattamuskeet, Pungo, Swanquarter and Cedar Island.

Table 17. Winter Waterfowl on the North Carolina Coast (Adapted from Heppner and Gould 1973).

Species	Dates present
American coot	Sept-May
American widgeon	Oct-May
American woodcock	Year-round
Black duck	Year-round
Blue-winged teal	Sept-Nov
Brant (rare)	Oct-Apr
Bufflehead	Nov-Apr
Canada goose	Sept-Apr
Canvasback	Oct-May
Clapper rail	Year-round
Common loon	Oct-May
Common merganser	Oct-Apr
Common scoter	Dec-Apr
Gadwall	Year-round (mainly Oct-Mar)
Greater scaup	Oct-May
Green-winged teal	Aug-Apr
Hooded merganser	Oct-Apr
Horned grebe	Oct-May
King rail	Year-round
Lesser scaup	Oct-Apr
Mallard	Year-round
Oldsquaw	Nov-Mar
Pied-billed grebe	Year-round (mainly Sept-May)
Pintail	Sept-Mar

Table 17 (continued)

Species	Dates present
Red-breasted merganser	Dec-Jun
Redhead	Oct-Feb
Red-throated loon	Nov-Apr
Shoveler	Nov-Jan
Snow goose	Oct-Feb
Sora rail	Year-round
Surf scoter	Nov-May
Whistling swan	Oct-Mar
Wood duck	Year-round

Table 18. Average Spring Arrival and Fall Departure of Bird Groups Common on the North Carolina Coast (from Heppner and Gould 1973).

Group	Avg spring arrival	Avg fall departure
Blackbirds	Mar,Apr,May	Sept-Oct
Chickadees, nuthatches, wrens, creepers	Apr	Oct
Flycatchers, swallows	Apr-May	Aug-Sept
Gulls, terns	Mar-Apr	Oct
Kinglets, vireos, warblers	Apr-May	Sept-Oct
Mimics, thrushes	Apr-May	Sept-Oct
Raptors	Mar-Apr	Sept-Oct
Shorebirds	Mar,Apr,May	Sept-Oct
Tanagers, buntings, finches, sparrows	Apr	Sept,Oct,Nov
Wading birds	Apr	Oct-Nov
Waterfowl	Mar-Apr	Sept-Oct

Table 19. Average Annual Duck Harvest on the North Carolina Coast, 1961-1970 (from Critcher 1975)

County rank	County	Number of ducks harvested
1	Currituck	19,187
2	Dare	8,983
3	Pamlico	5,500
4	Craven	4,812
5	Columbus	3,186
6	Carteret	2,832
7	Robeson	2,693
8	New Hanover	2,563
9	Hyde	2,549
10	Beaufort	2,350

Table 20. Species of Ducks Most Commonly Harvested on the North Carolina Coast, 1961-1970 (from Critcher 1975)

Rank	Dabbling ducks	Diving ducks
1	Wood duck	Ring-necked duck
2	Mallard	Lesser scaup
3	Black duck	Bufflehead
4	Widgeon	Hooded merganser
5	Green-winged teal	Ruddy duck
6	Pintail	Canvasback
7	Gadwall	Greater scaup
8	Shoveler	Redhead
9	Blue-winged teal	Red-breasted merganser
10	Fuluous tree duck	Common goldeneye

Birds migrate during the winter to feed and to escape unfavorable weather conditions. If these two factors are adequate farther north, the majority of birds will settle in the more northerly regions. Better management of food resources in the New York-Pennsylvania-Massachusetts and Delmarva peninsula areas has been cited as the chief cause of decreasing Canada goose populations on the North Carolina coast (Donnelly et al. 1973). Abundances of other birds are probably also mainly determined by weather and food conditions as well as yearly breeding success.

II.G.5. Man's Potential Impact

It is evident from their life cycles that migrating organisms are extremely hardy, being able to travel great distances and survive the strains of differing environments. Most are well adapted to a wide range of salinities and temperatures, or are timed in their life cycles to be in the optimum salinity and temperature for a particular life stage. Most are omnivorous, surviving well on a wide variety of foods. Because of their timing and mobility they are able to exploit coastal waters of great food abundance. Furthermore, most produce great numbers of eggs and young each year to ensure survival of their populations.

Coupling their hardiness with a large intrinsic capacity of most of our coastal environments to absorb and dilute man's perturberances, it might be expected that migrating organisms are able to cope with the potentially distructive activities of man. This is so in many instances. Spot, flounder, croaker and menhaden larvae were shown to be able to survive in extracts of sediments that simulated conditions of dredging (Hoss et al. 1974b). Likewise, striped bass eggs were not adversely affected by suspended sediment levels likely in dredging operations (Schubel et al. 1974). While pulp mill effluents have caused striped bass kills in the past by acute poisoning and lowering oxygen supply (Nicholson 1942; Fish 1963), the most recent information suggests that when levels of pulp mill wastes were lowered, they were tolerated by stripers and herring.

Many power plants operate in estuaries, but there is evidence that thermal effluents are not a hazard to many migrating organisms. Shad and herring eggs exposed to elevated temperatures and lengths of time probable around present power plants in thermal effluents showed normal hatching success (Schubel and Auld 1973; Schubel 1974). No detrimental effects were seen in populations of blue crabs near a power plant outfall in Galveston Bay, Texas (Gallaway and Strawn 1975). On the other hand, entrainment and passage through a plant of young anadromous fish larvae resulted in heavy mortalities (Marcy 1971). Mechanical damage resulting from being passed through a power plant at a young and fragile age may thus be more harmful than the elevated temperatures produced while making electricity.

Although migrating organisms are among the most resilient of aquatic animals, even they have trouble with some of the byproducts of man's civilization. Copper retarded the hatching of striped bass eggs and copper and zinc caused mortalities in fry (O'Rear 1973). Striped bass are sensitive to low levels of insecticides (Korn and Earnest 1974); dieldrin accumulates in the bodies of spot and pink shrimp and causes mortalities if the animals are not able to escape (Parrish et al. 1974). Mercury is taken up and accumulated in striped bass (Alexander et al. 1973). Shad died when subjected to gasoline, fuel oil and bunker oil pollution, both from acute toxicity and lowered oxygen levels (Tagatz 1961). Most of these studies were concerned with establishing acute toxicity levels; the more subtle and more long-range effects of pollutants are still scarcely understood.

Many of these pollutants are not currently even approaching crisis levels in our coastal zone. Yet many populations of migrating organisms in North Carolina are steadily declining from their former abundances. Overfishing can be pointed out as a cause in some cases; this has been a particular concern in the menhaden fishery. Overfishing by foreign fleets may have contributed to poor yields of herring in recent years, although adequate proof of this is lacking. Sturgeons are now scarce, at least partly because of overfishing many years ago.

The problem of overfishing can be alleviated by carefully managing fishery harvests. One of North Carolina's graver problems is not so readily solved. Alteration of coastal lands has often destroyed vital spawning and nursery grounds. Chief among detrimental alterations has been flood control by impounding rivers with dams and stream channelization. The amount of river basins historically used by anadromous fish stocks in North Carolina rivers has been drastically eliminated by dams (Table 21; Walburg and Nichols 1967). Locks are now being used in the Cape Fear River in an effort to restore part of the river to the fish (Nichols and Louder 1970). Channelization alters streams used as spawning grounds by changing the shallow, slow-moving stream area needed for spawning by some species into a deeper, swifter flowing stream which may exhibit excessive siltation, rapid water fluctuations and less spawning area (Bayless and Smith 1967; Tyus 1975). In many cases fish will only spawn in their home streams; if they are destroyed, the stream will be eliminated from future fish usage. This apparently has happened in the New River (Godwin 1975). Most of the nursery and spawning area of this river above Jacksonville, North Carolina, was channelized. The unchannelized White Oak River nearby still supports a blueback herring run and small populations of other anadromous fish. Although the impacts of the town of Jacksonville and other factors are unknown, it is suggested that the virtual elimination of the anadromous fish populations of the New River may be attributed in large part to channelization.

Table 21. The Effect of Damming North Carolina Rivers on Shad Runs (from Walburg and Nichols 1967).

River	Limits of shad runs		
	Original	1896	1960
Cape Fear	Haywood (210 mi)	Smiley Falls (181 mi)	Lock No. 1 (65 mi)
Neuse	Headwaters (340 mi)	Fish Dam (300 mi)	Milburnie (165 mi)
Pamlico-Tar	Rocky Mount (157 mi)	Rocky Mount	Rocky Mount
Roanoke	Weldon (249 mi)	Weldon (249 mi)	Spring Hill (215 mi)

Just as spawning and nursery grounds are vital for the maintenance of anadromous fish stocks, salt marshes and other rich, low-lying areas are necessary to maintain our productive populations of shrimp, crabs and brackish water fishes. Draining, ditching and filling marshes eliminate these valuable nursery areas forever.

If North Carolinians can control industrial loading and habitat alteration in our coastal zone, many benefits accumulate. Migrating organisms make up essentially the bulk of our commercial fisheries (Table 22; Figure 38). In 1974, they comprised 89% of the total North Carolina fishery catch by weight and 80% of its monetary value. Much of the State's sport fishery is based on anadromous fish. Sport fishing, hunting and birding bring in tourist revenue to our coast and have great entertainment value for all their participants. Finally, the aesthetic value of our migrating animal resources is best measured in the quiet satisfaction we feel from the awareness that we are part of the many cycles of life that continually ebb and flow along our coast.

Table 22. Commercial Importance of Migrating Organisms.[a]

Species	Total catch 1974 (lb)	Total N. C. fishery[b] (%)	Value (dollars)	Total N. C. fishery value[c] (%)
Nursery utilizers:				
Menhaden	121,197,640	62	2,886,563	17
Blue crabs	13,196,850	7	1,396,629	8
Flounders	11,812,924	6	2,841,869	16
Shrimp (heads-on)	8,440,203	4	4,606,313	27
Croakers	6,072,108	3	599,175	3
Spots	5,606,952	3	624,919	4
Total	166,326,677	85	12,955,468	75
Anadromous fishes:				
Alewives[d]	6,209,542	3	246,753	1
Striped bass	1,016,191	e	624,919	4
American shad	368,833	e	393,187	2
Sturgeon	93,418	e	15,483	e
Hickory shad	41,725	e	2,635	e
Total	7,729,809	4	763,726	4
Catadromous fish:				
American eel	451,956	e	187,997	1
Total migratory fishery	174,508,342	89	13,907,191	80

[a]From North Carolina Landings, Annual Summary 1974.

[b]Based on a total 1974 commercial catch of 196,049,202 lb.

[c]Based on a total value of $17,324,437.

[d]The term "alewives" includes both alewives and blueback herring.

[e]Less than 1% of total fishery or total fishery value.

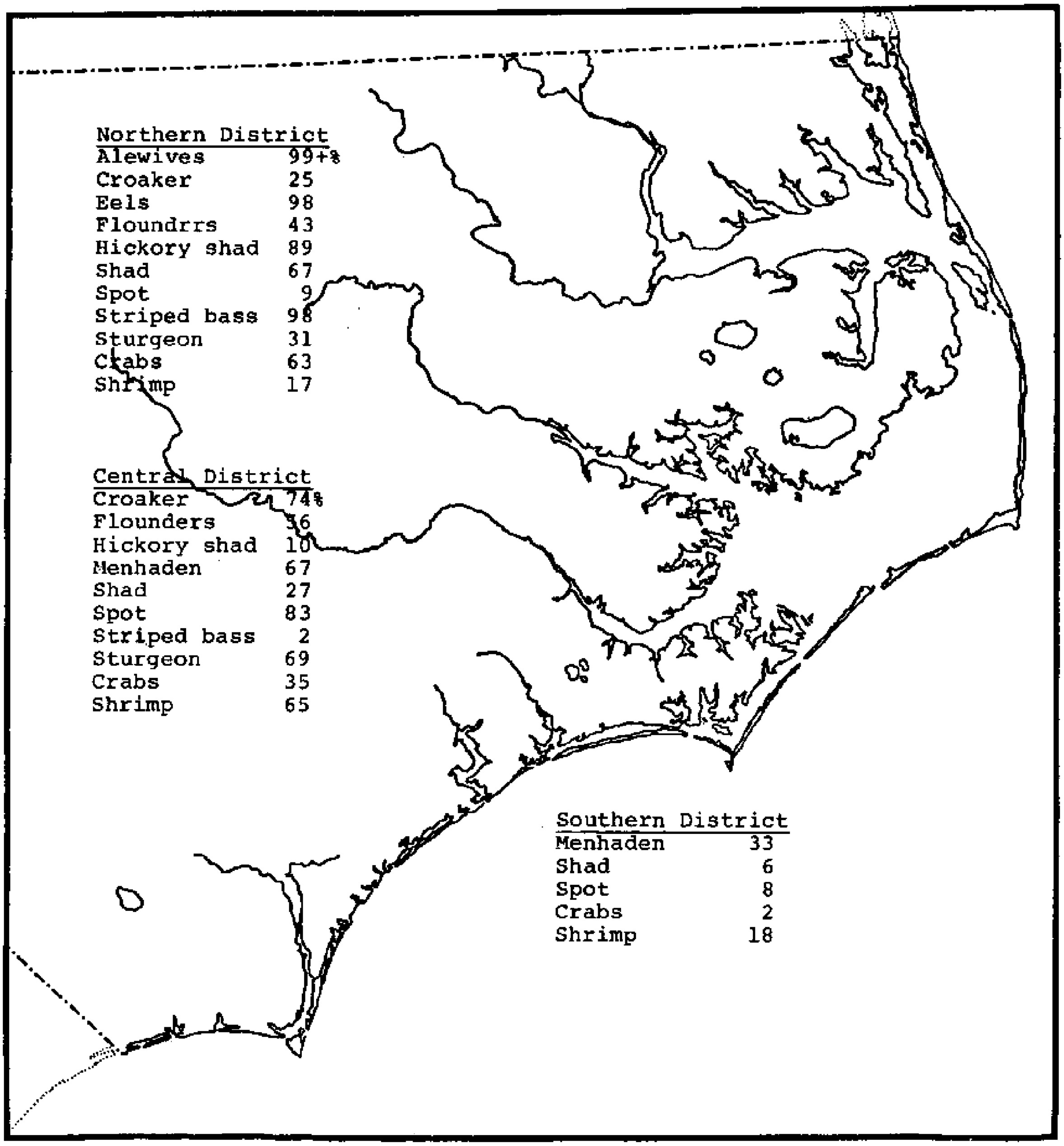


Figure 38. Commercial fisheries of North Carolina by district. Numbers indicate percentage of total North Carolina catch.

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A P P E N D I X   T W O

TOOLS AND TECHNIQUES
FOR
COASTAL AREA MANAGEMENT

Contributing Authors

Candace Carraway .	Joint Degree in Law & Planning Program, UNC
Edwin Chester . . .	Joint Degree in Law & Planning Program, UNC
Glenn Dunn	Joint Degree in Law & Planning Program, UNC
Roger Pratt	Department of City & Regional Planning, UNC
Mary Joan Pugh . .	Department of City & Regional Planning, UNC

Supervised by

David Brower, Principal Investigator
Center for Urban and Regional Studies
University of North Carolina at Chapel Hill

Francis Parker, Co-Principal Investigator
Department of City and Regional Planning
University of North Carolina at Chapel Hill

Preface

The purpose of Appendix Two is to identify those tools and techniques by which development in the coastal area may be guided or controlled, in order to reduce the impact of that development on the natural systems described in Appendix One. The appendix concentrates on those techniques which may be useful to planners and policy-makers at the local level, and which may help them in devising implementation programs to carry out the purposes of the Coastal Area Management Act. Some state and federal regulatory programs are also included, since these form part of the framework within which local planning and management will occur. In some cases they form constraints on local action; in other cases they are available to augment or strengthen the power of local implementation programs.

The specific techniques fall into four major groups: land acquisition, public spending, taxation, and regulation. This last group is the largest, and is divided into developmental regulation (primarily local in nature) and environmental regulation (a mixture of local, state and federal). A final section discusses a specific tool for regulating development within Areas of Environmental Concern, provided in the Coastal Area Management Act.

Individual techniques were identified from several sources, and include probably the great majority of those techniques which have been discussed in recent years as being applicable to growth management at the local and regional level. One important starting point was a list of such techniques identified in a study of urban growth control systems done at the University of Minnesota.[1] To this list have been added tools of known coastal area applicability, while some tools of marginal relevance have been deleted. As it stands, the list does not pretend to be exhaustive, but it does cover all of the most important approaches available for growth management in the coastal area.

All tools are presented according to a common format, beginning with a brief description of the tool and its statutory or legal authority, if any. The viability of the tool is discussed next, including an assessment of political validity (does the tool appear unconventional, or run counter to popularly accepted ideas of property or other rights?) and

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[1]Michael E. Gleeson _et al._, _Urban Growth Management Systems: An Evaluation of Policy Related Research_, Vol. I (Minneapolis: School of Public Affairs, University of Minnesota, 1974).

technical viability (does the tool require sophisticated administration or large implementation staffs which may not exist at the local level?). Next is a section telling where the tool has been used, and with what results. This is particularly important where the tool is a new one or relatively unknown. A section on legal issues tries to anticipate some of the questions which may be raised concerning the constitutionality of each tool, and cites legal cases where these questions have been addressed. A final section discusses the specific applicability which each tool may have in the coastal area of North Carolina.

The list of tools is long, although not exhaustive. Some of the tools included in the report are not yet being used in North Carolina, and some would require additional enabling legislation before they could be used. Although such techniques would not be immediately relevant as part of coastal area programs, they are included here to indicate some of the promising directions which may be taken in the future. If planners and officials are aware of innovative techniques, and if those techniques appear to serve a need in managing coastal resources, that awareness can lead to changes in laws which will help to make the techniques a reality.

A concluding cautionary note is in order. All too often communities have taken ordinances and other policies from other jurisdictions and applied them locally without really attempting to understand them and modify them for local use. The results are often disastrous. It is very important to look at planning and plan implementation as a system responding to a set of unique local conditions, and to evaluate the addition of any tools and techniques within that context.

I. LAND ACQUISITION

I.A. Introduction

In general a local government may acquire land by purchase, devise, gift or condemnation but not without statutory authority to do so. The power to acquire land is granted to municipalities expressly by specific acts of the legislature or implicit where it is necessary to the exercise of specifically conferred powers or powers essential to the purpose for which the municipality was created. The power of a local government to acquire property by condemnation is more limited than the power to acquire by other means. Authority to use the power of eminent domain will generally not be implied.[1]

In addition, a local government may not acquire land unless it is for a public purpose or use. It is common for a statute which authorizes acquisition to include a section which states that land acquired under the act is for a public purpose. Such legislative determinations of public purpose are given great weight but are not conclusive. What constitutes a public purpose is ultimately determined by the courts.[2]

Two tests have evolved as limits to the public purpose doctrine: the "use by public" test and the "public benefit" test. Early North Carolina cases rejected the public benefit test[3] which permits acquisition as long as it tends to promote the welfare of the community.[4] Under the more stringent use by the public test, the acquired property must actually be used or employed by the public.[5] For example, acquiring land for an industrial park which would eventually be purchased from the government by private industries would probably meet the public benefit test but would not meet the use by the public test.[6]

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[1]Chester J. Antieau, Municipal Corporation Law (New York: Matthew Bender, 1974), Vol. 2A, p. 6.

[2]Jack Goodman, "Note," 52 North Carolina Law Review 863 (1974).

[3]Cozard v. Hardware Co., 139 N.C. 283, 51 S.E. 932 (1905).

[4]Lawrence Senn, "Note," 46 North Carolina Law Review 668 (1968).

[5]Ibid., p. 664.

[6]Ibid., p. 668.

I.B. Land Banking

I.B.1. Advance Site Acquisition

Advance site acquisition involves the purchase of land for public facilities in advance of actual need. This technique has enabled state and local governments to: (1) forestall rising land prices caused by inflation, and (2) preempt private development from developing those sites best suited for public use.[1]

I.B.1.a. Authority--This technique is used under the authority of state and local governments to acquire property. No additional enabling legislation is required prior to its use.

I.B.1.b. Viability--The viability of this technique involves considerations identical to those discussed below in Section I.E., Fee Simple Acquisition.

The technical limitations on the use of this technique are funding and expertise. The main element of expertise involved (in addition to those discussed under Section I.E.) is comprehensive planning capability. Localities that lack this capability will not generally be able to use this technique effectively.[2]

If the advance acquisition program is administered properly, the cost of acquisition (including holding costs) can be reduced.[3] This technique reduces the monetary barriers to fee simple acquisition, but nonetheless requires large expenditures.

As shown below, all levels of government use this tool and are equally able to use it effectively.

I.B.1.c. Where It Has Been Used and to What Effect--A survey conducted in 1966 indicated that about one-third of American cities with populations over 50,000 used advanced acquisition programs.[4] Some examples which demonstrate the cost savings aspect of the technique are listed below.

Richmond, Virginia's master plan designates sites that will eventually be acquired by the city. The city may acquire the designated property whenever private construction is contemplated for the parcel. The city's power to block new construction in designated sites means that it need not purchase and demolish recently constructed buildings. According to a HUD study, the program produced a benefit cost ratio of 2:1.[5]

The Board of Education of Montgomery County, Maryland operates an advance acquisition program for school sites which has saved an average of $37,000 for each of 17 sites included in a HUD study.[6]

The State of California, through the Division of Highways, has financed advanced acquisition of highway rights-of-way. It is estimated that the land purchased between 1952 and 1966 for $62.5 million would have cost $380.5 million if acquired when actually needed.[7]

I.B.1.d. Legal Issues--The courts have generally upheld the localities' right to acquire land well in advance of actual need.[8] Advance acquisition (condemnation for a future use) was recognized by the U.S. Supreme Court as early as 1923 in the case of Rindge v. Los Angeles County, 262 U.S. 700 (1923).[9] A decision by the North Carolina Supreme Court, which upheld the taking of land for construction of a public airport when there were only seven privately owned planes in the county and no commitment from commercial airlines to use the airport,[10] indirectly supports this idea. There the court said: "If the taking is in reality for the purpose of making the property available for use by the public, it is immaterial that in the immediate future, only a small segment of the public will be likely to make actual use of it."[11]

The concept of advance acquisition is indirectly supported in N.C.G.S. 160A-372 which allows a board of education to reserve school sites in advance of actual need when school sites are included in the local government's comprehensive land use plan. Whenever a subdivision is submitted for approval which includes part or all of the school site, the board can prevent it from being subdivided by acquiring it within 18 months.

I.B.1.e. Coastal Application--This technique is very valuable in the context of general growth management, but has no characteristics which make it peculiarly applicable to coastal zone management.

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[1]David Brower et al., Growth Management Through Development Timing (Chapel Hill, N. C.: Center for Urban and Regional Studies, 1974), pp. 119-121.

[2]Ibid., p. 124.

[3]See, e.g., discussion of Richmond, Virginia's system (Sec. I.B.1.c.).

[4]Brower *et al.*, p. 120.

[5]Ibid., pp. 122-123.

[6]Ibid., p. 122.

[7]Ibid., p. 123.

[8]Ibid., p. 135.

[9]Robert J. Eckert, "Acquisition of Development Rights: A Model Land Use Tool," 23 *University of Miami Law Review* 352 (1969).

[10]Vance County v. Royster, 271 N.C. 53, 155 S.E.2d 790 (1967).

[11]Ibid., p. 60.

[12]Brower *et al.*, p. 120.

I.B.2. Growth Management

Land banking for the purpose of managing growth involves the public acquisition of land for eventual use by the government or resale to the private sector in order to influence the character and timing of growth.[1] The land bank accumulates a stock of real estate, and growth is influenced by decisions involving when to sell parcels, to whom they should be sold, and what restrictions should be placed on the use of the parcel.

I.B.2.a. Authority--There are no restrictions in the North Carolina Constitution which limit the authority of the state to create a land bank or engage in land banking. Local governments would require enabling legislation by the N. C. General Assembly in order to create a land bank because they have only those powers expressly conferred and those necessarily implied from express powers[2] which do not include the power to engage in land banking.

I.B.2.b. Viability--The political viability of land banking to control growth has been stated as follows:

> There are just too many people who have a legitimate vested interest in maintaining the present pattern of private land ownership, or who believe that they have such an interest, or who are just philosophically opposed to a vast expansion of the public role in the economy.[3]

Opposition to this technique centers on the following features of land banking:

1. Land banking captures for the public appreciation in land values[4] which otherwise would go to landowners or speculators.

2. Land banking reduces the cost of raw land not owned by the land bank by eliminating the possibility of land scarcities which are contrived by developers and by disposing of property in the land bank at below market prices.[5]

This tool requires an extremely high level of expertise, particularly in the areas of estimating impacts of the program on the overall land market, optimizing investment policies, land acquisition and financing.

In addition, lack of sufficient funds may preclude the use of this technique by many local governments. The amount of land required to carry out the objectives of the land bank depends on the objectives themselves, as well as the physical, economic and social characteristics of the area,[6] but will often require more money than local governments are willing to invest.

During the start-up period, revenues from the sale of previously acquired parcels will be below expenditures. Funds must be provided by other sources, the most likely being state and federal sources or debt financing. The problem with debt financing is that in order to secure it, a land bank must pursue policies that are likely to generate at least enough revenue to service the debt. These policies in some instances might conflict with other policies and objectives (such as keeping land prices low).[7]

The problem of finances bears directly on the choice of the appropriate land banking entity which is discussed below.

There are four types of entities capable of land banking. The following discussions outline some of the advantages and disadvantages of each.

1. Public purpose corporations can be set up to operate in a broad geographical area, are not restrained by the constitutional limits on state and local debt, and are relatively autonomous with no direct voting constituency.[8] On the negative side, it is argued that public corporations do not have sufficient accountability to the public and that the primary legal responsibility of a public purpose corporation is to its stockholders rather than the general public.[9]

2. Regional or metropolitan-wide agencies are advocated because land markets and growth problems are often regional in scope. Unfortunately, no governmental bodies exist which have both a regional perspective and the necessary power to implement a land bank. It is unlikely (for political reasons) that councils of government will be empowered to carry out a land banking function.[10]

3. Municipalities face several problems which limit the possibilities of land banking at the local level. First, the problems that land banking tries to deal with are often regional. A municipality's power of eminent domain is often restricted to its jurisdictional boundaries. Second, most municipalities do not have the financial resources to initiate an effective land banking program.[11]

4. The pros and cons of land banking at the state level have been described as follows:

> The major advantage of a statewide land bank is its ability to allocate substantial resources throughout a large region, and the power to relate regional planning to

those areas of the state which do not contain urban concentrations but which are obviously vital to the economic or environmental welfare of the entire state. Its drawbacks, of course, are its potential to spread itself too thinly throughout the state and to deal with insufficient sensitivity to local problems.[12]

I.B.2.c. Where It Has Been Used and to What Effect--So far, none of the states have adopted general purpose land banking schemes. Most foreign land banks have been successful but are carried on in such different economic, social, and political climates that their experiences are generally not considered to be transferable.[13] The preeminent example of European land banking is Stockholm, which has followed a policy of large-scale acquisition since 1904. Public land banking has been instrumental in establishing the 18 planned communities in the Stockholm area. Over half of the city's population lives in areas acquired by land banking.[14]

Saskatoon, Saskatchewan has been able to keep land prices down through land banking despite great population increases. Land prices there are substantially lower than in comparable Canadian cities.[15]

I.B.2.d. Legal Issues--Land banking for the purpose of managing growth was challenged in the U.S. courts in Commonwealth v. Rosso.[16] The use of the power of eminent domain by a Puerto Rican land banking agency was challenged under the United States and Puerto Rican constitutions.

The legislation under attack created a public corporation which was authorized to acquire land and keep it in reserve for the public benefit, without any particular use being designated for the land at the time of taking. The landowners in the Rosso case claimed that the government was prohibited from condemning private property until there was a specific use for the land and a clear public necessity for doing so. In upholding the legislation, the court stressed the need to regulate land, given the large population and small size of the area.[17] (The particular land conditions of the Commonwealth are cited as a reason why the decision has little relevance to the continental United States.[18])

The fact that the United States Supreme Court dismissed the appeal of the Rosso case is an indication that the court agreed with the decision. But, assuming that land banking is permissible under the U.S. Constitution, the technique is still subject to challenge under the North Carolina Constitution.

Whether or not land banking for the purpose of growth management will be upheld in North Carolina will be directly affected by the North Carolina Supreme Court's treatment of the "public purpose" requirement. (See previous discussion of public purpose in Section I.A., Acquisition: Introduction.) The direct resale of public land to private developers has been upheld in the case of urban renewal as a valid public purpose, and urban renewal cases will undoubtedly be relied on in arguments for the validity of land banking.

I.B.2.e. Coastal Application--Once the feasibility problems (including legal and funding problems) are worked out, this tool could become the backbone of a local government's environmental protection and growth management plans. Controlling the rate and location of growth through disposition of the property in the land bank would be even more effective if used in conjunction with capital programming. Because the local government owns and sells a good portion of the developable land in the area, it does not need to rely as heavily on regulation as would otherwise be necessary. The restrictions put on the use of property that is sold can be designed to ensure that the use is compatible with the environment. The restrictions can be as stringent as the local government wants because the taking problem is not raised when the government is selling the land rather than regulating it.

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[1]David Brower et al., Growth Management Through Development Timing (Chapel Hill, N. C.: Center for Urban and Regional Studies, 1974), p. 120.

[2]Town of Grimesland v. City of Washington, 234 N.C. 117, 66 S.E.2d 794 (1951).

[3]Sylvan Kamm, "The Realities of Large Scale Public Land Banking," Management and Control of Growth, III (Washington, D.C.: Urban Land Institute, 1975), 87.

[4]Brower et al., p. 128.

[5]Ibid., pp. 127-128.

[6]Richard P. Fishman, "Public Land Banking: Examination of Management Technique," Management and Control of Growth, III (Washington, D.C.: Urban Land Institute, 1975), 73.

[7]Ibid., p. 77.

[8]Ibid., p. 67.

[9]Brower et al., p. 132.

[10]Ibid., p. 131.

[11]Fishman, p. 68.

[12]Ibid., p. 68.

[13]Kamm, p. 64.

[14]Brower *et al.*, p. 125.

[15]American Law Institute, *A Model Land Development Code*, Advisors' Proposed Official Draft No. 1 (Philadelphia, 1975), p. 256.

[16]Commonwealth v. Rosso, Opinion No. 67-172, El Tribunal Supremo de Puerto Rico, Decembre 7, 1967, *Appeal dismissed*, 393 U.S. 14 (1968).

[17]Fishman, p. 72.

[18]Kamm, p. 89.

I.C. Transferable Development Rights (TDR)

The basic concept underlying TDR is that ownership of land gives the owner a bundle of rights, each of which may be separated from the rest and transferred to someone else. The right to develop the land is one of these rights.[1] Under a TDR system, an owner can sell this development right to another property owner who is required by statute to collect a specified number of development rights before developing his or her own property.

Under a typical TDR system, the government awards development rights to each parcel of developable land in the community based on acreage or value of the land. The system is set up so that no owner possesses enough development rights to develop all of his or her property without buying some rights from someone else. Persons sell their development rights on the open market because they do not want to develop or are prohibited by some regulation from developing their property. Land for which development rights have been sold cannot be developed.

The system would work in the following way. Suppose A owns four acres of land and the land has been allocated two development rights. If A is required (by a regulation) to have one right per acre in order to develop the land for commercial purposes, A has two choices. First, A can develop just two acres and use up all the allocated development rights. In that case the remaining two acres cannot be developed because their rights have been transferred. Alternatively, A can buy two more rights on the market and develop the entire four acres.

The basic rationale for TDR is that it eliminates the inequities involved in present zoning schemes which create and destroy massive increments of land value with no effort being made to adjust the highly disproportionate land valuations that are produced.[2]

The use of TDR is predicted to eliminate substantially the value shifts and inequities of zoning[3] by allowing the market to compensate owners who under a normal zoning scheme would have the development potential of their land restricted with no compensation.

In addition to being proposed as a basic land use system that can replace zoning, TDR has been suggested as a means of preserving open space, preserving landmarks, preserving ecologically sensitive areas, and managing growth.[4]

I.C.1. Authority

Most of the proposals for the TDR recognize that enabling legislation will be required as authority for the system. New York City has based one of its modified TDR systems on existing zoning enabling legislation. That system, which is discussed below, was overturned by a New York trial court (though not for lack of statutory authority). It would appear that enabling legislation would be needed in North Carolina prior to the implementation of a TDR system.

I.C.2. Viability

TDR runs counter to traditional notions of property rights. The newness and novelty of the concept would appear to render it politically unacceptable in North Carolina at present. TDR requires a high level of expertise and staffing in designing as well as administering the system. One proposal for TDR suggests that in preparation major studies would be required to investigate the costs and wastes of present development practices, to document and analyze the desirable ends to be gained by better regulations, and to outline the rights of landowners as they are presently served by zoning and as they might be better served by TDR. An interdisciplinary team of economists, experienced land developers, financiers, planners, lawyers, and physical scientists should be assigned the task of developing several model structures for the creation and precise legal and technical definition of development rights, including a thorough analysis of tax consequences and recording problems, and the management of the market place structure for the sale and exchange of development rights.[5]

I.C.3. Appropriate Level of Government

At present TDR is implemented only at the local level, but there are proposals to allow state agencies to operate TDR systems.

I.C.4. Where It Has Been Used and to What Effect

TDR is currently in use in St. George, Vermont, and New York City. St. George, a small town of under 500 residents, is located in a rapidly growing urban area. It is using TDR as a means of controlling its growth. The town purchased 48 acres of land where the town will attempt, through zoning and TDR, to focus its growth.

To develop the land designated as the village center (which includes the 48 acres of town-owned land), a developer must purchase development rights from landowners outside the village center. As explained by one observer:

> The net effect of this plan is that the development will be concentrated in the designated area and the owners of land outside the village will be compensated by the sale of their development rights for the loss of their right to develop their own land. The rate of the development of the village will be regulated by the rate at which the Town issues the certificates of development rights.[6]

As of March 1974, negotiations were underway, and private developers were indicating an interest in developing property in the village.

New York City designed a plan to preserve historic landmarks on the TDR principle and a plan to preserve parks. Historic landmarks are almost never as large as their zoning would permit. Often it is more profitable for a landmark owner to tear down the building and construct a larger structure. The New York ordinance authorized landmark owners to sell the square footage allowed by zoning which has not been utilized to owners of nearby lots. The purchasers of the development rights can then exceed the bulk allowed by the zoning regulations by the amount of square feet they purchased. The purchase price compensates the landmark owner for preserving the building.

After four years no transfers under the system had taken place. The reasons postulated for the failure of the system to win the confidence of landmark owners and developers are (1) inadequate analysis of the economic burden of landmark ownership and of the urban design consequences of the transfer system, (2) onerous administrative controls of dubious necessity, (3) general uncertainty of the program's legality, and (4) reliance on voluntary participation by landmark owners.[7]

A second New York City ordinance which uses TDR principles resulted from public opposition to a developer's proposal to build on two small private parks. The City Planning Commission responded by creating a special park district prohibiting development on designated parks and requiring that the development rights of those parcels be transferred to owners of land in another separate area of the city. Owners of parcels who bought development rights were to have their floor area ratio increased by as much as 20 percent.[8] This system was struck down by a New York trial court. For details, see the discussion below.

I.C.5. Legal Issues

The New York system designed to preserve parks was invalidated in Fred R. French Investing Co. v. City of New York, 77 Misc. 2d 19, 352 N.Y.S. 2d 762 (1973). The court ruled that the zoning regulation destroyed the economic value of the park property and was therefore unconstitutional. The city's attempt to transfer the development rights to another area was invalidated because it did not give tenants and property owners in the transfer district an opportunity to voice their objections in a public hearing as is required for zoning changes.

The taking problem is not the only legal problem that TDR faces. TDR conflicts with accepted interpetations of the uniformity provision in typical zoning enabling legislation, i.e., that all regulations shall be uniform for each class or kind of building throughout each district. Some of the proposals are also likely to be challenged on equal protection grounds by property owners who feel the system has unfairly discriminated against them and on substantive due process grounds by those who claim that the purposes of TDR are not legitimate governmental objectives and/or that the means are not rationally related to the objective.

In spite of the legal problems the concept faces, TDR's advocates claim that the legal precedent exists and that judicial approval, while not assured, is a good possibility.

I.C.6. Coastal Application

If the legal problems involved with TDR were worked out, this tool could be very useful in the coastal area. Development pressure which is required before TDR becomes feasible is obviously present in the coastal area. TDR could be used to prevent development in environmentally sensitive areas of the coast if owners of such land were allocated development rights and other landowners were required to buy development rights from them in order to develop.

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[1]Jerome G. Rose, "Transfer of Development Rights: A Preview of an Evolving Concept," 3 Real Estate Law Journal 331 (1975).

[2]John J. Costonis, "Development Rights Transfer: An Exploratory Essay," 83 Yale Law Journal 96 (1973).

[3]Rose, p. 337.

[4]Ibid.

[5]Donald M. Carmichael, "Transferable Development Rights as a Basis for Land Use Control," 2 Florida State University Law Review 35 (1974).

[6]Leonard V. Wilson, "Precedent Setting Swap in Vermont," American Institute of Architects, 59 (March 1974), 52.

[7]Costonis, p. 96.

[8]Donald Elliott and Norman Marcus, "From Euclid to Ramapo: New Directions in Land Development Controls," 1 Hoffstra Law Review 76 (1973).

I.D. Acquisition of Less Than Fee Interests

Ownership of property consists of a bundle of rights, which may be purchased in whole or in part. Fee simple ownership includes the entire bundle of rights, while a less than fee interest constitutes some lesser bundle of rights. An easement is an example of less than fee interests in land. Easements convey some set of legal rights over land to a second party, while retaining basic title and ownership with the first party.

Easements may be affirmative or negative. An affirmative easement is a right to use land. A governmental body which wants to establish a system of hiking trails may purchase an easement from the property owner which would grant to the public the right to hike on certain parts of the property. A negative easement will prevent the owner of land from using it in certain ways. A local government may buy a scenic easement in order to prevent the owner from doing anything which would destroy the aesthetic attractiveness of the property.[1] Easements are particularly useful tools when regulation will not do the job and fee simple acquisition is not necessary or desirable. This section concentrates on negative easements because they are less well known and offer greater potential for environmental protection than do affirmative easements.

I.D.1. Authority

North Carolina counties and municipalities are authorized to acquire easements "in order to preserve, through limitation of their future use, open spaces and areas for public use and enjoyment" (Open Spaces Acquisition Act, N.C.G.S. 160A-401 _et seq_.). In most cases, the types of easement obtained under the Open Space Acquisition Act will be easements in gross, which means that there is no adjacent property which is benefited by the easement. The North Carolina Supreme Court has held that easements in gross are interests which are personal to the grantee (the party to whom the easement is granted) and terminate at the death of the grantee. However, when the grantee is a local government, the easement would presumably continue as long as the local government exists.[2] Many states have found it desirable to enact legislation that has the effect of reducing the property tax on land for which an easement has been granted. The North Carolina Trails System Act (N.C.G.S. 113A _et seq_.) allows changes in value which are the result of an easement (granted to the Department of Administration pursuant to the Act) to be taken into consideration in the assessment of the land for tax purposes. The Open Space Acquisition Act does not contain a similar provision. However, there is a strong argument that property tax relief is available in the absence of such legislation:

> G.S. 195-317(a)(1) requires the appraiser to consider several items, including zoning and "any other factors that may affect its value." A conservation easement resembles in some ways a zoning restriction, which is specifically mentioned in the statute, and it is clearly another "factor that may affect" the value of the land. In a revaluation year, then, the grant of an easement would have to be taken into account by the appraiser and would result, in many cases, in a reduction of the tax value of the property. . . . In nonrevaluation years, the situation is somewhat more difficult. . . . It can be argued that the grant of a conservation easement by the landowner and the acceptance of the grant by the governmental unit should be treated the same as a zoning change--as a "circumstance external to the property" requiring reappraisal under G.S. 105-287(b)(6).[3]

I.D.2. Viability

The political viability of this technique is essentially the same as that of fee simple acquisition. A more important impediment to the effective use of this technique is the fact that a large part of the general public is not familiar with easements and is reluctant to get involved in a transaction with the local government due to their uncertainty about the technique.[4]

The technical limitations on the use of this technique are money and expertise. The cost of acquiring an easement that restricts development in an area that is developing will be almost as great as buying a fee simple interest.[5] There are several attributes of easement acquisition which reduce the overall cost. When a fee simple interest in property is purchased by a local government, the land is taken off the tax rolls. When an easement is purchased, the property is still taxed. Even when the taxes are reduced on the property subject to the easement, the government may come out ahead for two reasons. First, property restricted by this kind of an easement may not require many municipal services. Second, the lower taxes are commonly recouped through increased valuations on nearby property which is made more valuable by the assurance that nearby property will not be despoiled by development.[6] Another attribute which makes this technique cheaper than fee simple acquisition is that the owner of the property has the responsibility for maintenance.

Easement approval increases the likelihood that a landowner will donate an interest in the property. Relatively few landowners are wealthy enough or public-spirited enough to give away title to their property, but many may be willing to give an easement, particularly if the valuation of their property is decreased for tax purposes. A gift of an easement to a local government can also enable the owner to deduct the value of the easement from his or her income tax as a charitable gift.[7]

North Carolina legislation does not include provisions for penalties to be imposed when the conditions of the easement obtained under the statute are violated. Local governments must enforce the easement by suing the landowner. The cost of enforcing an easement (through a civil action) is a cost not incurred in fee simple acquisition.

The expertise required to make the most effective use of this technique is the ability to anticipate development pressure.[8] Once development pressure exists, the cost of acquisition approaches that of fee simple acquisition. Legal expertise is also required for easement acquisition. Easements often must be tailored to the individual parcel of land. The terms must be explicit in order to give the landowner sufficient notice of what rights have been relinquished. Failure to spell out the rights of each party may result in renegotiation with the landowner over some use not excluded but not specifically allowed for in the agreement or litigation resulting from a misunderstanding.[9] Both results are costly.

I.D.3. Where It Has Been Used and to What Effect

This technique has been used throughout the United States. An example of the cost saving aspect of this technique is provided by the Wisconsin Highway Commission which has purchased scenic easements along many miles of highway at about one-half of the price of fee simple acquisition.[10] The Blue Ridge Parkway in North Carolina is also protected in some areas through scenic easements.

I.D.4. Legal Issues

The validity of this technique will not be successfully challenged if there is enabling legislation and if the public purpose test is met. The public purpose test was discussed earlier in Section I.A., Introduction.

I.D.5. Coastal Application

Easements or less than fee interests could be purchased in the coastal zone as an alternative to regulation in some cases. Negative easements could be purchased as a way of preventing development in critical areas while permitting other rights, such as hunting or fishing rights, to remain with the landowner. Conversely, affirmative easements might be acquired in some cases as a means to provide access between public highways and the publicly owned beach. Since easements are expensive, it will probably be desirable to reserve their use for situations where the same purpose cannot be achieved through regulation, but where it is not essential that the public retain entire title to the land. In some cases, owners of critical or scenic environmental areas may be willing to donate negative easements to the public in return for lower tax assessments on the property. For some owners this could be an attractive way of performing a public service while at the same time guaranteeing themselves a buffer of open space to protect their remaining property.

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[1]William A. Campbell, "Conservation Easements: An Effective Tool in the Environmental Kit," Popular Government (Chapel Hill, N. C.: Institute of Government, April 1973), p. 37.

[2]Ibid.

[3]Clyn Smith, "Easements to Preserve Open Space Land," 1 Ecology Law Quarterly 737 (1971).

[4]Ibid., p. 741.

[5]M. Moore, "The Acquisition and Preservation of Public Lands," 23 Washington and Lee Law Review 283 (1966).

[6]Ibid., p. 272.

[7]Smith, p. 741.

[8]Ibid., p. 737.

[9]Ibid., p. 735.

[10]Campbell, p. 37.

I.E. Fee Simple Acquisition

Fee simple acquisition means acquiring full or absolute title to the property. This technique is used when full use of the property by the public is required.[1] When the full use of the property is not required to achieve the public goal, municipalities generally look to some less expensive way to achieve their objectives, such as acquiring a less than fee interest (see above, Section I.D.) or compensable regulation (see below, Section I.F.).

I.E.1. Authority

The general authority to acquire interest in real property is granted to North Carolina counties and municipalities in N.C.G.S. 153A-158 and 160A-11. Arguably, in light of the broad construction to be applied to these chapters, these general grants of authority are sufficient to empower a local government to acquire land for a public purpose without a specific statutory authorization. For example, the general grant of authority would probably empower a local government to acquire areas of environmental concern designated under the North Carolina Coastal Area Management Act.

N.C.G.S. 15A-444 and 160A-353 authorize local governments to purchase property for parks or recreational purposes. The legislation would appear to allow a local government to protect some areas from development by converting the land to recreational use (which by definition does not have to be intensive use).

I.E.2. Assisting Authority

The Department of Housing and Urban Development is authorized to make 50 percent grants for acquisitions and development of open space,in urban areas to local and state governments if needed to carry out a comprehensive plan element (U.S.C.A., Title 42, 1500 (a)(b)).

Grants can also be given to local and state governments for the acquisition of open space in undeveloped areas which will guide future urban development. The limit of such grants is 75 percent of the cost of acquisition (U.S.C.A., Title 42, 1500 (c)(2)).

I.E.3. Viability

The political viability of purchasing fee simple interests in property is largely determined by the local political climate and the use for which the property is purchased. Land acquisition is in itself a sensitive operation due to the amounts of money generally involved and the complicated nature of transactions between a local government and its citizens.[2] The use of condemnation proceedings to acquire property is, of course, more politically volatile than acquisition by conventional purchase.

The expense of fee simple acquisition seriously reduces the utility of this technique. The level of expertise of the local government can influence the cost of acquisition. Expertise in securing state, federal and private grants for acquisition; in stimulating donations of property from private sources; and expertise in all phases of the acquisition procedure (including appraisals and negotiation) can reduce acquisition expenditures.[3]

All levels of government use fee simple acquisition and are equally suited to using this tool, depending on the purposes for which the land is acquired.

I.E.4. Where It Has Been Used and to What Effect

Virtually all local governments use fee simple acquisition, usually to acquire locations for public facilities such as fire stations, schools or parks. Some programs that are designed to achieve less traditional objectives are:

1. Boca Raton, Florida started a land acquisition program for the purpose of expanding public access to the beach front. By November 1973, almost 74 acres of beach front had been obtained. The city had spent about $17 million for acquisition as of July 1974.[4]

2. Boulder, Colorado initiated a greenbelt program in 1967 which is purchasing foothills land on the outskirts of the city for scenic preservation.[5] As of 1973, it had bought or optioned more than 2,700 acres.[6]

3. Palo Alto, California allocated $4 million to begin an acquisition program of foothills surrounding the city. The program is the result of a development study which concluded that it would be cheaper for the city to buy the land than to allow it to be developed.[7]

I.E.5. Legal Issues

Challenges to a local government's authority to purchase (rarely litigated) or condemn property are infrequent. The big issue is generally price and not authority. When the authority to condemn is challenged, it is usually on the basis of the "public use" clause in both the North Carolina and U.S. constitutions. (See above, Section I.A., Introduction, for a discussion of the public use doctrine.)

I.E.6. Coastal Application

As mentioned previously, it would appear that local governments could acquire AEC's under their general grant of authority to acquire land. Several of the North Carolina statutes which grant authority to purchase property for specific purposes and which appear to be most relevant to growth management in the coastal area are mentioned here. N.C.G.S. 153A-438 authorizes counties to acquire property "for preserving or restoring facilities and natural features that afford protection to the beaches and other land areas of the county and to the life and property of the county." N.C.G.S. 160A-491 authorizes cities and towns to make similar acquisitions.

N.C.G.S. 160A-401 <u>et seq</u>. authorize municipalities to acquire "open space," which is broadly defined as:

> . . . any space or area (i) characterized by great natural scenic beauty or (ii) whose existing openness, natural condition, or present state of use, if retained, would enhance the present or potential value of abutting or surrounding urban development, or would maintain or enhance the conservation of natural or scenic resources.

This definition appears to be sufficiently broad to encompass objectives of scenic protection as well as resource conservation.

The status of open space as a public purpose has been clarified by Article XV, Section 5, of the North Carolina State Constitution which declares that it is the "policy of this State to conserve and protect its lands and water for all its citizenry." Among the types of open space mentioned are parks, recreational areas, forests and wetlands, estuaries, beaches, historical sites, open lands and places of beauty. In addition the amendment states that to fulfill this public purpose, the State and all local governments may acquire the fee simple or lesser interest in properties by purchase or donation. After acquisition the land can be placed in the newly established "State Nature and Historic Preserve" by dedication to and acceptance by the General Assembly. Thus a public purpose for open space does exist. Land that qualifies as open space can be acquired by local governments.

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[1]Michael E. Gleeson *et al.*, *Urban Growth Management Systems: An Evaluation of Policy Related Research* (Minneapolis: School of Public Affairs, University of Minnesota, 1974), p. III-2.

[2]Charles E. Little, *Challenge of the Land* (New York: Pergamon Press, 1968), p. 38.

[3]Ibid., pp. 33-41.

[4]Gleeson *et al.*, p. II-18.

[5]Ibid., p. II-23.

[6]Robert Cahn, "Where Do We Grow from Here?" *Management and Control of Growth*, I, ed. R. W. Scott *et al.* (Washington, D.C.: Urban Land Institute, 1975), 73.

[7]Ibid., p. 71.

I.F. Compensable Regulation

A system of compensable regulations provides compensation to landowners whose property values have decreased due to land use regulations (usually zoning regulations). There are two basic kinds of compensatory systems.

The first type of system is designed to save restrictive regulations from being struck down by the courts. While property may be regulated to a certain extent, if the regulation is too restrictive it will be recognized by the courts as a "taking" of property by the government. When a court finds that a particular regulation has taken the property involved, the regulation is usually struck down. To avoid that result, compensable regulation legislation is drafted to give the government the option of compensating the landowner for the taking to prevent the regulation from being held unconstitutional.

The second type of compensatory system is designed to provide compensation to landowners even when the regulation falls short of taking the property. For example, a proposal developed in Oregon would compensate landowners when the value of their land is reduced by more than 20 percent as a result of land use regulation.

Theoretically, this technique assures equitable treatment of property owners while permitting more flexibility in the government's choice of regulatory or acquisition strategies.

Supporters of this technique claim it has the following advantages:

1. A system may be devised so that compensation need not be paid in advance.

2. Compensation could be paid only to persons who have specific development plans thwarted by regulations.

3. If the compensation becomes too financially burdensome, the government can modify the regulation.

4. A case-by-case system of assessing and awarding damages can be developed.

On the other hand, objections to these techniques are that:

1. There simply is not sufficient money in public treasuries to support such a program.

2. A system of compensable regulation will deter governments from enacting and enforcing desirable land use restrictions.

3. The system is subject to misuse as an exclusionary zoning tool.[1]

Chart A[2] describes various systems of compensable regulation, most of which have not been tried but are in the proposal stage.

I.F.1. Authority

It is not clear under North Carolina law whether specific enabling legislation is required for either type of compensatory scheme. It is probably necessary even for the type that compensates only for takings (where the compensation is already constitutionally required). Absent some legislation, there is no guarantee that the courts will not strike down the land use regulation that the government wants to save.

Proposals for the type of system that awards payments for decreases in land value that are less than takings invariably include enabling legislation. Arguably though, if the payment for the decrease in land value is viewed as the condemnation award of an interest in land which the government has taken (similar to a negative easement), the power of eminent domain is sufficient authority for the payment. The power of eminent domain exercisable by North Carolina municipalities, however, is more limited than the power to acquire by purchase. The regulations could be used only in those instances where the power of eminent domain is authorized.

I.F.2. Viability

Neither type of compensatory system is in use in North Carolina, but neither appears to be politically infeasible. To the extent that this technique is viewed as a way of allowing more extensive land use regulation as opposed to compensating landowners for regulations currently in effect, this technique will probably arouse some hostility among some property owners.

Funding is a major problem for compensatory systems, particularly those like the Oregon proposal which awards payments for decreases in value where there has been no taking. Proposals for compensable regulations are often accompanied by proposals for a tax or unearned increments in land value. The theory behind the tax is that land appreciates due to public activity and public improvements. The public is allowed to capture the appreciation in value which it generated

TECHNIQUE	WHAT IS COMPENSABLE	HOW COMPENSATION IS DETERMINED	WHEN COMPENSATION IS PAYABLE	WHO ADMINISTERS	REPAYMENT PROVISIONS	FUNDING SOURCES
Guarantee of preregulation market value	Lands preserved as open space lands	Owner receives difference between guaranteed price (assessed value prior to regulation) and the sale price, adjusted to reflect changes in the value of the dollar	After sale of the regulated property	Local government		
Compensation for a fixed loss of value	Regulated property interests diminished by at least 20% of its preregulated value	Loss in land value in excess of 20% as measured before and after enactment of the regulation	Request for compensation must be made within one year of enactment of the regulation	Local government with some review by State Review Commission	Government may require owner to repurchase the interest if the regulation is repealed or amended so that the government need not retain the interest	State Revenue Bond; a land value increment tax; the proceeds from sale of public lands
Compensation for loss of any use permitted by zoning	Any zones uses precluded by federal, state or local government restrictions	Amount of monetary injury caused by the restriction, not to exceed amount of ad valorem property taxes paid for fiscal year preceding year in which claim is filed	Not clear	State government		5% transfer tax levies on unearned value of transfer land
Zoning by eminent domain	Property value losses caused by zoning, restricted to residential districts	Two possibilities: difference in value between authorized use under zoning and the value for all other uses OR value for uses specifically restricted	After land is zoned	Local government	Special assessments against land increased in value by zoning	Special Revenue Bonds, special assessments
Compensation after judicial determination of invalidity of regulation	Any land use regulation held invalid as a taking which could be held valid if compensation is paid	Market value of development right or interest purchased or condemned necessary to constitutionally validate the regulation	After judicial determination of regulation's invalidity	Courts; local government		
Denial of development permits	Loss in value due to denial of development permit	Difference between actual value of the interest and the value had the development been permitted or had no conditions been attached or value of entire parcel if purchased by government	After denial of development permit or attachemnt of conditions	Local and federal governments	Compensation may have to be refunded if certain types of new development are carried out	Local and federal government revenue

Chart A. Compensable Regulation Systems (from Robert M. Rhodes, "Property Rights: Yours, Mine, Ours . . . ," <u>Florida Environmental and Urban Issues</u>, II (August 1975), 5) through taxes and spends the tax to compensate landowners whose land value was decreased by a regulation for the benefit of the public.

It is not easy to generalize about the administrative requirements of implementing the regulations. As Chart A shows, administration can be simple or complicated, depending on how compensation is computed and awarded.

I.F.3. Where It Has Been Used and to What Effect

Although a few states have old statutes on the books which permit compensation in very limited circumstances, there appears to be only one modern instance in which a compensatory scheme was developed. Dayton, Ohio passed an ordinance restricting most of the land surrounding a nearby airport to low-density uses, but provided an administrative procedure whereby claims can be filed alleging an unconstitutional taking. If the taking is proved, the city must either raise sufficient funds to compensate the landowner or allow the proposed development to take place.[3]

Most proposals are geared to implementation by local governments, but the appropriate level of government would vary with the type of system (see Chart A).

I.F.4. Legal Issues

There is no case law on compensable regulations. However, potential challenges to the regulatory aspect could be based on any of the grounds used to challenge traditional zoning ordinances and should be disposed of in the same way. The compensatory aspect could be challenged as an invalid expenditure. It is uncertain how this issue will be resolved by the courts.

I.F.5. Coastal Application

This technique would be useful in the coastal area in two situations: (1) where the local government wants to increase the extent to which it can regulate and (2) where the local government wants to even out the hardship caused by land use regulations. Because of the lack of funds in coastal counties, it is assumed that the local governments will want to use compensable regulations only in the first situation.

It is not possible to develop a list of when this tool should be used, but the following determinations should be made before the tool is used:

1. That other regulations do not go as far as the local government would like. (Given the broad authority to regulate AEC's and the other available regulatory mechanisms, in most cases compensable regulation would not be warranted at least in terms of environmental protection.)

2. That the regulation is worth the expenditure necessary to validate it. (The amount and method of computing this expenditure will vary depending on how the system is set up. See Chart A.)

3. That enough parcels of land are affected to warrant an approach other than a case-by-case use of condemnation or court proceedings.

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[1] Robert M. Rhodes, "Property Rights: Yours, Mine, Ours . . . ," _Florida Environmental and Urban Issues,_ 11 (August 1975), 4.

[2] Chart A is reprinted from Rhodes, p. 5.

[3] Fred Bosselman _et al_., _The Taking Issue_: _An Analysis of the Constitutional Limits of Land Use Control_ (Washington, D.C.: U.S. Government Printing Office, 1973), p. 303.

I.G. North Carolina Land Conservancy Corporation

The purpose of the North Carolina Land Conservancy Corporation is to acquire and develop land in the State in its natural and unaltered condition for recreational and historical purposes.[1] More important, it is to provide a mechanism for quick movement on desirable tracts of land.

I.G.1. Authority

The authority is vested in the North Carolina Land Conservancy Corporation by N.C.G.S. 113A-135.

I.G.2. Viability

The corporation is governed by a nine-member Board of Trustees appointed by the Governor, Lieutenant-Governor and the Speaker of the House. The Board has power to acquire land but cannot spend funds without approval of the Department of Administration, the Governor and the Council of State. The Corporation is also dependent on State-appropriated funds, since it cannot issue bonds. Thus, with its present structure, the Corporation seems incapable of effectively acquiring lands for preservation. So far the Board of Trustees has not been appointed.[2]

I.G.3. Coastal Application

At present this resource is unavailable to local governments in the coastal area. The basic purposes of the Corporation appear sound, and if the present administrative problems could be solved the Corporation would have significant coastal applications.

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[1] N.C.G.S. 113A-135.

[2] Conversations with Robert Teulings, Natural Areas Studies, State Parks Section of the Division of Recreation Resources, July 1975.

I.H. Land and Water Conservation Fund

Sixty percent of the Land and Water Conservation Fund is used to provide 50 percent grants to states and through states to local governmental units for the acquisition and development of public outdoor recreation areas and facilities. To be eligible the state must have a comprehensive outdoor recreation plan which is revised and updated continuously. The plan is used to determine the capital investment priorities for acquisition, development and protection of all types of outdoor recreation resources. Projects identified as high priority are eligible for funding and can include bicycle paths, hiking trails, roadside picnic areas, swimming pools, city parks and state parks. In addition the applicant must agree to maintain the area and facilities.[1]

I.H.1. Authority

The Bureau of Outdoor Recreation is authorized to administer the Fund set up by the Land and Water Conservation Fund Act of 1965 as amended (P.L. 93-303).[2]

I.H.2. Assisting Authority

The State agency participating in the grant program is the North Carolina Department of Natural and Economic Resources, Division of Recreation Resources, State Parks Section. North Carolina does have a comprehensive outdoor recreation plan and so is eligible for the grant program. To date 12,900 acres at a cost of $6.2 million have been acquired in North Carolina with the aid of the Fund.[3]

I.H.3. Viability

State assistance to local governments in North Carolina has been by land acquisition, technical and advisory services, education and training, recreation and cultural programs and planning, but not by purchase of recreation equipment or recreation facilities. State assistance to private sector has been by technical and advisory service, education and training and planning, but not by grants, loans and credit assistance, tax incentives or promotional assistance.[4]

I.H.4. Coastal Application

This resource should be tapped by any local government that wants to maintain public outdoor recreation areas and facilities. Picnic areas and beach front parks would appear to be high priority projects in which local governments in the coastal area should be especially interested.

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[1]Land and Water Conservation Fund Fact Sheet.

[2]Land and Water Conservation Fund Act of 1965, as amended by P.L. 93-303 (1974).

[3]"North Carolina's Coastal Resources," North Carolina Marine Science Council, Raleigh.

[4]"Outdoor Recreation--A Legacy for America," Bureau of Outdoor Recreation, 1973, Tables 4-7 and 4-8.

I.I. The Nature Conservancy

The Nature Conservancy, established in 1954, is a national conservation organization supported by public contributions, foundation grants and membership dues. Its purpose is to preserve ecologically and environmentally significant land. The Nature Conservancy acquires land through purchase using its General Fund, through donations by private individuals and organizations, through cooperative programs involving other public and private conservation groups, and through special programs of advance acquisition for local, state and national parks, forests and wildlife refuges.[1]

I.I.1. Authority

The Nature Conservancy is a charitable organization and tax exempt under Section 501 (c)(3) of the Internal Revenue Code.[2] The national office is at 1800 North Kent Street, Arlington, Virginia 22209.

I.I.2. Coastal Application

In the past North Carolina has relied upon the Nature Conservancy to purchase and hold land until the State could obtain the funds to acquire title.

In December of 1975 the Nature Conservancy purchased 19 barrier islands off the coast of Virginia for preservation in their natural state. Land transactions in coastal North Carolina include Chowan Swamp (Gates County), Great Dismal Swamp (Camden County), Cape Lookout (Carteret County) and Jockey's Ridge (Dare County).[3]

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[1] The Nature Conservancy, "The Nature Conservancy News," Release No. 46-74 (1975).

[2] The Nature Conservancy, "The Ten Most Asked Questions" (pamphlet).

[3] The Nature Conservancy, "The Nature Conservancy News," 1972, p. 22.

I.J. Estuarine Sanctuaries

Under the Estuarine Sanctuaries program, matching grants are given to coastal states for one-half the cost of acquisition, development and operation of estuarine sanctuaries for research and educational purposes.[1]

I.J.1. Authority

The Office of Coastal Zone Management in the National Oceanic and Atmospheric Administration is authorized to administer this program by the Coastal Zone Management Act of 1972 (P.L. 92-583).[2] No estuarine sanctuaries to date have been acquired by North Carolina under this program.

I.J.2. Legal Issues

It is unclear whether the grant program includes actual estuarine waters or surrounding estuarine land or both. The State owns all waters below the mean high tide so most likely this program would increase marshes and other adjacent estuarine lands in State ownership.

I.J.3. Coastal Application

It seems clear that if the State wishes to acquire unique marshes and other estuarine lands, this grant program should be utilized. Interested local governments should contact the State concerning the acquisition of especially valuable estuarine areas in their jurisdiction and inquire about the grant program.

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[1]William Brennan, "Balancing Man's Demands of the Sea and Shore," NOAA 4 (October 1974). Reprint.

[2]Coastal Zone Management Act, P.L. 92-583 (1972).

II. PUBLIC SPENDING

II.A. Introduction

The power to spend is not specifically granted to the General Assembly in the North Carolina Constitution, or to the cities by the General Statutes, although that power has clearly been exercised and is considered valid.

The major limitation on the city's right to expend municipal revenues is that the expenditures must be for a public purpose. The requirements for satisfaction of the public purpose test under the spending power are generally the same as those discussed under the taxing power.[1] Although the question of public purpose is usually decided on the specific facts of a particular case, two basic tests are often used: that the expenditure is reasonably related to the operation of the city government, and/or that the expenditure promotes the general welfare of the community. The first standard may be met when the city can demonstrate that it is doing something it is authorized to do under the General Statutes.

The second standard may be a little more difficult to define. The public welfare is not confined to public necessity, but may mean public convenience as well.[2] The use need not be for the benefit of every citizen in a community, but may be for inhabitants of a restricted area, so long as use and benefit are not for particular persons, interests or estates.[3]

Due in part to a lack of specific definition of public purpose, the courts give substantial weight to the legislative declaration of public purpose,[4] and will generally contradict that declaration only where the purpose is clearly private or manifestly incorrect.

The major challenges with regard to the spending power, however, may result from a city's decision not to spend. Most of the services provided by a city are extremely expensive and are essential to the growth and development of the community. The North Carolina statutes and case law relevant to this question are discussed below in Section II.E., Utilities Extension, and that is the situation in which statutory challenges most commonly arise. Broader constitutional issues are discussed below in Section II.F., Development Timing, as these comprehensive regulations are most often the context in which the constitutional issues are raised. The discussion of these issues in specific sections by no means indicates, however, that they are relevant only to those specific topics.

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[1]Green v. Kitchin, 229 N.C. 450, 50 S.E.2d 545 (1948).

[2]Keefer v. Town of Lake Lure, 246 N.C. 252, 141 S.E.2d 252 (1965).

[3]Ibid.

[4]Dennis v. Raleigh, 253 N.C. 400, 116 S.E.2d 923 (1960).

II.B. Capital Programing

A capital program is usually a timetable by which a city indicates the timing and level of municipal services it intends to provide over a specified period of time. Generally, the program is laid out for a 5 to 10-year period, although it may be shorter or longer according to a town's confidence in its ability to predict its future needs. For example, the town of Ramapo, N. Y. (see below, Section II.F., Development Timing) put together a capital program which extends for 18 years and is supported by 6-year capital budgets, which take into account the short-term city revenues projections.

Capital programing can be used by itself as a growth management technique. By tentatively commiting itself to a timetable for the provision of capital for the extension of city services the city can control its growth to some extent, especially where the surrounding area is of such a nature that provision of on-site sewage disposal and provision of water are not unusually inexpensive. Few developers will be able or willing to put up sufficient capital to develop land according to a schedule different from that of the city's capital program. Both developers and planners can benefit from the relative certainty that such a program provides.

The capital program is far more effective, however, as a part of a more comprehensive growth scheme. A utilities extension policy (see below, Section II.E.) in accord with strict zoning plan will allow a city to control development more precisely with regard to time and place, than would a simple capital program.

II.B.1. Authority

The power to draw up a capital program is not explicitly granted to cities by the General Statutes of North Carolina, although the authority is granted to issue revenue bonds under N.C.G.S. 159-83, and general obligation bonds under N.C.G.S. 159-48. The requirements for the preparation, filing, and content of the city budget are found in N.C.G.S. 159-11 to 159-13. A capital program would merely require the use of these powers in conjunction with one another and a city's engineering and planning officers.

II.B.2. Viability

Capital programing generally requires some staff and expertise to engage in long-range planning.

II.B.3. Where It Has Been Used and to What Effect

Many North Carolina municipalities, particularly the larger ones, use capital programing.

II.B.4. Legal Issues

In and of itself, a capital program is subject to challenge only if its elements fail to meet the procedural and substantive requirements of the Local Government Finance chapter of the North Carolina General Statutes (Chapter 159). Where the program proposes to restrict growth to any substantial degree, it may be challenged on constitutional grounds (see below, Section II.F., Development Timing).

II.B.5. Coastal Application

A capital program would be very useful in the context of a growth management plan for a coastal area. Because coastal soils and topography are generally not well suited to development, more elaborate precautions are necessary to minimize environmental damage. If a town offers to provide the necessary infrastructure in a certain location at a specific time, development will tend to gravitate around that infrastructure because of the lower cost of using community-provided facilities.

The capital program itself may not be enough to control development in many coastal areas, however, because demand tends to be strong, and individuals may very well be willing to spend the substantial extra sums necessary to provide an infrastructure. Where this is the case, the use of other tools such as environmental regulations, zoning and acquisition may be necessary for adequate control of development.

II.C. Urban and Rural Service Areas

The designation of urban and rural service areas is one way in which a city or county may generate its tax revenues on a more equitable basis. The taxing authority classifies each parcel of land within its jurisdiction according to whether it is slated to receive services or not (i.e., as an urban or rural service area), and imposes a higher tax rate on those parcels which are to receive services.

The logic behind the use of this tool is that those areas which are receiving minimal or no services are not putting as heavy a burden on the governmental revenues as are those areas which do receive services. User fees paid by the heavily serviced areas do not compensate for the enormous expenditure of capital for the initial provision of facilities, and arguably, the nonserviced areas should not be forced to bear the additional costs until services are extended.

This tool is probably most equitable and least open to constitutional challenge if applied in conjunction with a capital program and sewer extension policy which will assure that the benefit of services will be conferred only on those who have borne their share of the burden of increased taxes

This tool will probably be most effective if used in conjunction with a regulatory program which restricts development to the serviced or designated areas. Without such regulatory scheme it is possible that the land which is designated "rural" will become more attractive for development due to lower tax bills, and thus, lower land costs.

II.C.1. Authority

There is no authority in the North Carolina General Statutes for the designation of urban and rural service areas, to which different tax rates might apply. Under Article V, Section 2 (2) of the North Carolina Constitution, however, the General Assembly does have the authority to specify classifications of real property to which different tax rates may apply. That authority is non-delegable with regard to real property, and so clearly cities and counties do not have the authority to set up classifications systems on their own.

II.C.2. Where It Has Been Used and to What Effect

This tool is used in the Nashville, Tennessee Metropolitan government. It has not been in effect long enough to assess accurately its effectiveness.

II.C.3. Legal Issues

This type of tool is open to challenge as violative of the uniformity of taxation language found in most state constitutions. It has been upheld, however, by the Tennessee Supreme Court, with regard to its use in the Nashville Metropolitan area.[1] The Nashville city and Davidson County governments were merged with the consent of the voters. In lieu of the previous property tax system, in which the county levied an additional tax on its own residents, the county was divided into a general service district and an urban service district, and a separate tax rate was applied to each. The court found the new system to be substantially the same as the previous entity. Thus, the court found no reason why a different tax rate could not be administered to the new system as it had been under the old system, based on the provision or lack of urban services. The court seemed to put substantial emphasis on the intent of the framers rather than the actual construction of the constitutional provision involved, which may limit the usefulness of this decision in other jurisdictions or under a different set of facts.

II.C.4. Coastal Application

Urban and rural service area designation could be particularly useful in the coastal areas because of their ability to distribute equitably the high cost of services provision, and because they allow a town to guide development away from environmentally sensitive areas such as marshes and washover areas. Where development pressures are particularly strong, as they are in many coastal regions, this tool allows a government to set general limits on its population growth during a specific period in order to facilitate planning for that growth.

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[1]See Frazier v. Carr, 210 Tenn. 565, 360 S.W.2d 449 (1962).

II.D. Annexation

Annexation is the means by which a city increases its land area. The procedure for annexation is controlled by statute. Generally the area to be annexed must be contiguous to the city, but provision is often made for the annexation of noncontiguous areas under certain conditions. As a precondition to annexation a North Carolina city must demonstrate that it has a plan to extend services to the area (see N.C.G.S. 160A-47). Annexation procedures may originate with the city, or the residents of the area to be annexed if that area is not contiguous to the city. The city's power to annex is not absolute, however. If 15 percent of the qualified voters residing in an area which a city proposes to annex sign a petition calling for a referendum, a city must call that referendum and a majority of the so qualified residents must approve.

The use of annexation policy as a land use control is fairly clear. Because the decision to annex is discretionary, a city may control the direction of its growth, favoring that land area which is best able to support development, is closest to transportation routes, etc., and disfavoring development in areas of environmental sensitivity. Further, a city may control the timing of its growth to ensure that municipal facilities are capable of bearing the additional load. Annexation is particularly effective when used in conjunction with a utility extension policy, as the primary difference between annexed and non-annexed land is the duty to provide utilities service.

II.D.1. Authority

Power to annex is granted to the cities by N.C.G.S. 160A-24 to 160A-58.6. The statutes generally cover the rights of a city to annex, the duties of a city which attempts to annex and the procedures to be followed in the annexation process.

II.D.2. Viability

The difficulty of compiling the annexation report required by statute which includes maps and plans for the provision of services will vary from situation to situation. However, the procedural prerequisites to annexation are probably less of a stumbling block than political opposition to annexation.

II.D.3. Where It Has Been Used and to What Effect

Virtually all municipalities at some point exercise their annexation powers. There is a lack of information on how annexation can be used in the coastal area to further land management objectives.

II.D.4. Legal Issues

Most of the challenges to annexation in North Carolina have been based on procedural defects. Constitutional questions might arise on an Equal Protection ground if a city were to select arbitrarily those areas it would annex, but a city must only show a rational basis for its annexation policy. Thus it would seem that a city with a comprehensive plan and growth policy based on an evaluation of the relevant environmental and social factors involved in annexing specific areas would be able to pass constitutional muster.

II.D.5. Coastal Application

Annexation can be particularly useful in the context of coastal development. The environmental sensitivity of many coastal areas requires that development be carefully regulated, and annexation allows a city to apply a broad range of regulatory and other powers to the annexed area. But as noted above, annexation of land creates a duty in the municipality to provide services to that land. Thus, annexing a swamp or marsh may not protect, but actually encourage development of that area if services will have to be provided. If the land is capable of supporting some minimal development, the municipality may restrict the zoning to that type of development, but if the land will not support any development, the city may be forced to acquire the land in order to avoid the "taking" issue.

II.E. Utilities Extension

The provision of sewer treatment and water supply facilities is one of the most important and expensive services that a municipality provides. These services are essential to the growth and development of the city, and because of the time and expense involved, capital programs are usually developed well in advance of their actual implementation. Because the existence of those services is a key element in the developer's decision process, control over the extension process provides the city with a powerful means of controlling the type and location of development

In general, the manipulation of utility extension policy has two types of effects. A decision not to extend services to a specified area or not to expand current facilities can make development prohibitively expensive or put a limit on the growth of the city as a whole. By coordinating its utility extension policy with its comprehensive plan, a community may control the location and type of development that will occur in specific areas.

There are a number of advantages in the use of a utilities extension policy to control growth. It is generally less expensive than land acquisition and less subject to legal challenges. By making the serviced land more attractive for development than generally less expensive land in outlying areas, it reduces the necessity of county or area-wide land use regulation. It is less subject to change over time than are zoning regulations. And finally, it puts a limit on the growth potential of the community without opening up the broad constitutional challenges available under more thorough development timing and permit limitation schemes.

II.E.1. Authority

Authority to construct and maintain electric power generation, transmission and distribution systems, water supply and distribution systems, and sewage collection and disposal systems is granted to cities under N.C.G.S. 160A-312. Cities are further granted the authority to finance the construction of such systems by N.C.G.S. 160A-313, to fix and enforce rates to be charged for use of the systems by N.C.G.S. 160A-314, and to require that landowners within the city limits connect to the system under N.C.G.S. 160A-317.

II.E.2. Viability

The political viability of this technique depends upon the extent of the restrictions imposed by it. A moderately restrictive program will be far more palatable to developers and residents than will a very restrictive policy. To the extent that the restrictions increase the value of the homes of the current residents, however, those residents may be inclined to support them.

A fair amount of technical expertise is necessary to design a utilities extension policy, although much of it is available in moderate sized communities. Consideration must be given to the projected demand for facilities, capability of the current system, projected revenues and expenses within the city budget and the environmental constraints affecting the system.

In most states, only municipalities are given control over utilities extension policy, although a few states (e.g., Maryland) require county approval of municipal decisions to extend utilities services.

II.E.3. Where It Has Been Used and to What Effect

The use of utilities extension as a part of a growth control strategy is common. It has been used with varying success in a number of areas, including Montgomery and Prince George's counties in Maryland; Ramapo, New York; and Boulder, Colorado. It is difficult to evaluate the success of this tool in particular, because it is almost always used in conjunction with such other tools as capital programing, access to existing facilities and general zoning restrictions. In 1974, the City of Durham, North Carolina enacted a utilities extension policy, the effects of which cannot yet be determined.

II.E.4. Legal Issues

The use of utility extension policy as a tool for controlling the growth of a city is somewhat limited by the statutory and case laws of North Carolina. Within the city limits a city is required to provide equal service to all inhabitants, once it provides service to any inhabitants,[1] and the city may require inhabitants to connect to the city systems.[2]

The city may extend utility services beyond the town line, but only within reasonable limits and for the public benefit,[3] but is under no duty to do so.[4] A city must consider, in extension beyond the town boundaries, the amount of territory to be serviced, its distance from the town and the effect extension will have on customer rates and the town's capital debt structure.[5]

If a city decides to extend services beyond the town line it has a certain amount of discretionary power to condition the provision of those facilities, and to set the rates to be charged for those services. Because the agreement to provide services to extraterritorial areas is of a contractual nature, the city, in its proprietary capacity, may require that specific conditions be met, it would seem. And because the city is under no duty to provide services, those conditions may vary substantially with the particular circumstances, absent equal protection problems.

Although the city is also allowed to set rates for the use of its services, this aspect is perhaps subject to greater restraint in that rates charged to all extraterritorial customers must be substantially similar to avoid equal protection problems. Charging substantially higher rates will not be held discriminatory when it applies alike to <u>all</u> extraterritorial customers, and so the city may only use this method to discourage all growth outside the city limits and may not simply discourage or encourage growth in a particular direction.

With regard to areas which the city intends to annex, it has little discretionary power with regard to the provision of services. Under N.C.G.S. 160-453.15 the city must make plans for the extension of services to an area which it proposes to annex, and those plans must set forth the proposed method of financing such extension. That duty cannot be delegated.[6]

II.E.5. Coastal Application

This tool may be particularly useful in coastal environments in which the soils and topography are not well suited to provision of on-site sewer and water facilities. The availability of city water and sewage disposal facilities may be crucial to the development of areas such as marshes or washover areas because of the cost involved in providing on-site facilities which will meet state and local health regulations. When demand for development is strong, however, it is likely that the extra expense of providing adequate on-site facilities will not prevent development. In such cases, other regulatory and acquisition tools may be required to control development.

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[1]Fulgham v. Town of Selma 238 N.C. 100, 76 S.E.2d 368 (1953).

[2]G.S. 160A-317.

[3]Town of Grimesland v. City of Washington, 234 N.C. 117, 66 S.E.2d 794 (1951).

[4]Fulgham v. Town of Selma.

[5]See generally Public Service Co. of N.C., Inc. v. The City of Shelby, 252 N.C. 816 (1960).

[6]In re Annexation Ordinance, 255 N.C. 633, 122 S.E.2d 690 (1961).

II.F. Development Timing

Development timing is designed to put limits on the physical and demographic growth of a town which is under substantial pressure to expand its services to provide housing for an expanding population. The ordinance is usually set up to coordinate that expansion with the town's fiscal ability to provide services, and further, is connected with a town's comprehensive plan in order to control the quality of the development.

The power of a development timing ordinance lies in the fact that certain services essential to the development of new housing, i.e., sewage disposal, water supply and roads, are so expensive that a developer must usually rely on a municipality to provide the capital for them. Thus, a municipality can exert substantial leverage on the location of and timing of growth as well as the absolute limits of growth, through the denial or provision of municipal services.

Development timing ordinances are enforced by means of the municipality's control over the permit-letting process, and justified by its connection with a comprehensive plan. These ordinances require that a permit be issued for each dwelling constructed, and that the municipality may condition, or, absent constitutional restraints (see below, Section II.F.4, Legal Issues), completely deny any development on land within its jurisdication on the basis of the current or anticipated lack of services, even though the municipality would generally be held responsible for their provision (see above, Section II.E., Utilities Extension). Using a comprehensive plan to delineate the location and type of development desired and a capital program to schedule the provision of services, the city can make available to the developer with reasonable certainty information concerning when the development of a special parcel will be allowed and the type of development that will be allowed.

The development timing ordinance could be extremely useful in channeling development into areas best suited to support it. The comprehensive nature and extended duration of the ordinance offer a far more stable atmosphere in which a city may protect those land-related assets which are most precious. The thorough research and survey work which are necessary for the application of an ordinance to a specific area should provide the city with substantial justification for its judgment as to ability of specific areas to support various degrees of development. Phasing the development allows the city to assess the validity of its judgments in time to prevent environmental damage on similar sites elsewhere in the community.

II.F.1. Authority

Municipalities in North Carolina have been granted the authority to regulate development within their jurisdications by the General Assembly. Under N.C.G.S. 160A-381 a city is empowered to regulate the development which takes place within its jurisdiction through the general police power, and in the issuance of permits, a building inspector is required to follow the provisions of those regulations literally.[1]

Cities are further empowered to regulate the subdivision of land within their jurisdiction. Under N.C.G.S. 160A-372, a city may enact a subdivision control ordinance to provide for orderly growth and development. Although the statute appears to stress the positive regulation of subdivision development, it recognizes the right to condition development on the provision of community service facilities in accordance with municipal policies and standards. N.C.G.S. 160A-373 allows the city to condition further the right to develop on the approval of either a planning agency or the city council, or both.

While the above statutes have been sufficient to grant cities the power to enact general Euclid type zoning ordinances, the comprehensive power granted by a development timing ordinance is arguably not within the statutory grant of authority. There is no relevant case law in North Carolina, but a development timing ordinance has been challenged in Ramapo, New York, as an exercise of power not granted to the city by the state legislature.[2] The plaintiffs argued that there was no grant of authority to control the timing of development, and that the purpose for which the ordinance was enacted was not authorized by law. The highest court in the State of New York held that although the State Zoning Enabling Act did not specifically authorize a development timing ordinance, such power was implied in the legislation.[3] The New York enabling legislation is substantially similar to that found in the North Carolina statutes. Further, under N.C.G.S. 160A-4 the legislature indicated that the provisions of that chapter be broadly constructed "to include any additional and supplementary powers that are reasonably necessary or expedient to carry them into execution and effect."

II.F.2. Viability

As discussed below in Section II.F.4., Legal Issues, the level of staffing and expertise required to implement a development timing ordinance is beyond that which is available to most municipalities. In addition to technical problems, the political viability of this tool is questionable. In some cities where this tool has been implemented, developers and construction interests have strenuously fought these ordinances.

II.F.3. Where It Has Been Used and to What Effect

Development timing ordinances have been enacted in two cities in the United States--Ramapo, New York, and Petaluma, California. Both ordinances have been challenged in the courts and a discussion of the results of those challenges can be found below in Section II.F.4.

II.F.4. Legal Issues

Constitutional objections to development timing ordinances are generally based on four grounds: substantive due process, the taking issue, the right to travel, and equal protection of the laws.

II.F.4.a. Substantive Due Process--The substantive due process argument is based upon language in the Fifth and Fourteenth Amendments to the U.S. Constitution, and contains two elements; first, that the objective of the ordinance must be a legitimate governmental objective, and second, that the regulations imposed by the ordinance must be rationally related to the objective.

Two recent cases concerning development timing ordinances have involved such due process issues, and have been decided in favor of the municipalities. The case of Golden v. Planning Board of the Township of Ramapo[4] involved the town of Ramapo, New York, which is located about 25 miles from New York City, and which had come under substantial growth pressures in the middle and late 1960's. Following extensive studies on the capacity of the land within the town boundaries, the public services available, population trends in the area and other factors related to the population growth in the area, the township adopted a Master Plan which sought to keep the town's population increase at a moderate level, and to preserve the rural, semirural and suburban character of the community. A Comprehensive Zoning Ordinance was then enacted designating over 90 percent of the available land for residential use, much of it with large minimum lot sizes.

The third step consisted of the adoption of a six-year Capital Budget based on studies of the sewer and drainage systems, and the demands of the Master Plan. The township further adopted a Capital Program which provided for the location and timing of the basic services for the subsequent 12 years, which would put the township at its maximum desirable development capacity. To tie development to the Capital Program, the township further enacted an Amended Zoning Ordinance which required the developer to obtain a special use permit from the Town Board before he could begin construction. The permit would be issued only when a certain number of public facilities were available in the area. The developer could either wait until the township had put in the facilities, or show evidence that he had provided them himself.

The ordinance was upheld by the highest court in New York State. The court found that the purpose of the ordinance, directing the growth of population through a phased development ordinance, was within the scope of the traditional zoning purposes recognized as valid in Euclid v. Ambler.[5] Recognizing the usual presumption of validity granted to a legislature's judgment as to the sufficiency of the relationship between the regulations and the permissible governmental objective, the court upheld the ordinance as a valid means of serving the welfare of the community.

The case of Construction Industry Association of Sonoma County v. City of Petaluma[6] involved a small town near San Francisco which found itself under growth pressures similar to those in Ramapo. Following studies by the city planning department, the city council adopted an official growth policy in 1971. The plan created an "urban extension line" beyond which the city would not annex land or extend services for the next 15 years. Within the line the number of building permits to be issued yearly was limited to 500, approximately one-third to one-half of the estimated market demand. As in Ramapo, permits were issued to a developer on the basis of a competition in which various proposals were rated according to an "intricate" system which is apparently not as forthright as the Ramapo system.

The Federal District Court held the ordinance to be unconstitutional, primarily because it violated the plaintiff's right to travel, but also noted that the purpose of the ordinance was to exclude prospective residents, and thus, was illigitimate in the absence of showing of a compelling state interest.[7] The Ninth Circuit Court of Appeals reversed, however, finding that the plan was not exclusionary, and furthered a legitimate state purpose, and that the plan bore a rational relationship to that purpose.[8] The U.S. Supreme Court has declined to review the Circuit Court decision.[9]

There is no statute in North Carolina recognizing the control of growth as a legitimate state purpose, and there have been no cases decided on that issue.

II.F.4.b. The Taking Issue--The taking issue is based on the Fifth and Fourteenth Amendments of the U.S. Constitution which prohibit the taking of private property by government for a public use without just compensation. Where a regulation on the use of certain parcels of land is so restrictive as to constitute a confiscation of the land, the courts will require that the owner be compensated.

The taking issue was litigated in *Ramapo*, as the plaintiffs contended that the development of some land within the area was prohibited for as long as 18 years, and that such strict regulation amounted to a taking. The court disagreed, however, holding that the land was not permanently prohibited from development, but only temporarily denied that right. Although the court opinion did not discuss the matter, it should be noted that the ordinance allowed development where the developer was willing to provide the necessary services, and that during the period in which the land could not be developed, that land could be revalued for tax purposes to reflect the decreased value caused by the regulations.

Two aspects of the *Ramapo* situation deserve further attention in light of the North Carolina situation. First, the court in *Ramapo* may have been willing to uphold the ordinance because of the extensive planning powers which preceded it and the attempt to mitigate the adverse economic impact of the plan. Elements of that process were: the use of professionals in the analysis of problems and proposal of solutions; a positive commitment by the town to assure the provision of lower income housing; an affirmative commitment by the town to assimilate growth; a capital facilities plan and budget which reflected the commitment to growth; tax relief for property temporarily enjoined from development; retention of economic uses for property despite the deferral of the right to develop; and a definite time period for the vesting of development rights. Clearly a great deal of manpower and money went into the creation of the plan, and most North Carolina cities will not have such resources available.

Second, the *Ramapo* ordinance was based on an 18-year time period which was justified because of the enormous development pressure that it was under. It is doubtful that pressures of similar magnitude will be present near North Carolina cities, and so the time period will need to be shortened accordingly.

II.F.4.c. Right to Travel--The Supreme Court has recently held that the right to travel, although not specifically mentioned in the Constitution, is a fundamental individual right, and that it includes the right to migrate, resettle and find a new job. Phased development ordinances, by placing restrictions on the rate and absolute limits of growth of a town will necessarily restrict the right of an individual to move into the area so restricted. This issue was not discussed by the court in Ramapo, but the District Court in Petaluma based its decision to invalidate the ordinance on the restrictions which the plan placed on the right to travel. That court refused to accept any of the justifications offered by the city as sufficiently compelling to justify the restriction on a fundamental right. The Circuit Court avoided the right to travel issue, holding that the plaintiff construction association did not have a right to travel, and could not assert a claim on behalf of a group of low-income plaintiffs who had themselves been denied the right to be parties to the suit.

II.F.4.d. Equal Protection--Although the Equal Protection argument was not raised in either the Ramapo or Petaluma cases, an argument can be constructed that development timing ordinances create arbitrary and unreasonable classifications, and are therefore prohibited under the Fourteenth Amendment. Such an argument would have to show that similarly situated developers were treated differently and that that treatment was arbitrarily or unreasonably applied. This was clearly not the case in Ramapo and Petaluma, where permit competitions were judged according to standards which measured the availability of services in the proposed development area, or the quality of the development proposed.

II.F.5. Coastal Application

Development timing is useful in coastal areas in which environmental problems are often acute and development pressures strong. The scarcity of fresh water and the inability of the soil to support on-site sewage disposal are good reasons (within and outside of the court system) for the use of this tool in developing areas of the coast. The expense of provision of environmentally adequate facilities in beach areas, marshes, etc., will make it difficult for a developer to build housing in those areas which can compete economically with housing constructed in municipally serviced areas. On the other hand, coastal property is prime land for development, and developers and landowners can be expected to be particularly stubborn in their opposition to such an ordinance. Furthermore, the expense of providing a staff competent to do the preliminary work is likely to be greater than most coastal governments can afford.

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[1]Lee v. Board of Adjustment 226 N.C. 107, 37 S.E.2d 128 (1946).

[2]Golden v. Planning Board of the Township of Ramapo 334 N.Y.S.2d 138, 285 N.E.2d 291, appeal dismissed 409 U.S. 1003.

[3]334 N.Y.S.2d 138, 146.

[4]See fn. 2, supra, for full citation.

[5]272 U.S. 365 (1926).

[6]522 F.2d 897 (1975), rev'g 375 F.Supp. 574 (N.D. Cal. 1974).

[7]375 F.Supp. 574, 582-3.

[8]522 F.2d 897, 906.

[9]______ U.S. ________ (1976).

II.G. Access to Existing Facilities

Regulation of access to facilities can be an effective tool insofar as a town can control the number of users that can connect to its water and sewage disposal systems, and the number of entry points to its streets and highways. Access is especially important to the timing of growth in that through the use of the permit-letting power a city can coordinate the actual provision of services with its fiscal capability to expand.

The tool is especially powerful if used in connection with a capital improvements program and comprehensive plan.

II.G.1. Authority

The authority to regulate public facilities such as water supply and distribution systems, sewage collection and disposal systems, and electric power generation, transmission and distribution systems is granted to cities by N.C.G.S. 160A-312.

II.G.2. Viability

This is not a complex technique to set up or operate. It requires that reasonable guidelines be drawn up on which decisions about access will be based.

II.G.3. Where It Has Been Used and to What Effect

This technique is used in Pinellas County, Florida, which has limited water supplies. The Board of County Commissioners requires that all building permit applications be reviewed by the County Water Department if a development is located in an unincorporated area and proposes to hook up to the county water system. The developer must apply for a water allocation as part of the building permit application; a water allocation must be granted before the building permit can be issued.[1]

In the Salem, Oregon area, to gain access to the sewage treatment facilities of Salem, the development must be located in or be annexed to the City of Salem or one of the two sewer sevice districts in Marion County.[2]

II.G.4. Legal Issues

Regulation of access to public enterprise facilities is limited by case law in North Carolina. Within the city limits a city owes a duty to provide equal service to all inhabitants.[3] Outside city limits, however, a city has no duty to provide service, and the provision of service is enacted under the city's proprietary function. As such, the provision and access can be absolutely denied or conditioned and the city may control the timing of development provided that similarly situated land is treated uniformly. The city may be subject to equal protection challenges if it fails to allow access to a developer after it has granted access to a similarly situated developer. Thus, a city should restrict access only in accordance with a comprehensive growth plan, and a record should be kept of the reasons for acceptance or denial in each case.

II.G.5. Coastal Application

This tool is particularly useful in coastal areas because of the difficulty and expense of providing services to developed areas. By limiting access to its facilities a town under severe development pressure can to some extent control the location and amount of new growth in order to protect its fiscal resources and to protect those environmentally sensitive areas which might be subject to development pressures.

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[1] Michael E. Gleeson et al., Urban Growth Management Systems: An Evaluation of Policy Related Research (Minneapolis: School of Public Affairs, University of Minnesota, 1975), p. II-68.

[2] Ibid., p. II-95.

[3] Fulgham v. Town of Selma, 238 N.C. 100, 76 S.E.2d 368 (1953).

III. TAXATION

III.A. Introduction

Taxation, while not a land use control per se, may have significant impact upon land use decisions. Its primary function is to distribute the tax burden so as to complement a town's land use regulation and development scheme.

A municipality in North Carolina may levy a tax only if specifically authorized to do so by the General Assembly.[1] The General Assembly has authorized cities to levy property taxes[2] and a number of taxes of much less importance.[3] Cities also have the power to levy special assessments[4] if specific procedures are followed.[5]

There are four basic constitutional restrictions on the power to levy local and county taxes: the tax must be levied for a public purpose; the tax must not be arbitrary, capricious, unreasonable, prohibitive or confiscatory; all taxpayers must be treated with substantial equity under the law; and the tax must be applied uniformly within each class of taxable persons or things.

III.A.1. Public Purpose

Article V, Section 2, subsection 2 of the North Carolina Constitution states: "The power of taxation shall be exercised . . . for public purposes only." Although it is discussed here, the major challenges based on the public purpose requirement are filed when the money is actually spent, rather than when the tax is levied. The definition of public purpose is not static, but may change as various aspects of society change.[6] Thus, the legislative declaration of what constitutes a public purpose is entitled to great weight in a court's consideration, though such declaration is not conclusive.[7] A public purpose is usually one which benefits the town as a whole and not specific persons or estates,[8] or one which is for the support of the government or for any of the recognized objects of the government.[9,10]

III.A.2. Arbitrary, Capricious . . .

Article V, Section 2, subsection 2 of the North Carolina Constitution states: "The power of taxation shall be exercised in a just and equitable manner." This requirement basically reflects the due process clause of the Fourteenth Amendment of the U.S. Constitution. The test is usually whether the tax has some fiscal relation to the protections, opportunities, and benefits given by the local government, or whether the local government has contributed anything for which they can fairly ask a return. This test rests on the theory that the taxpayer is to be justly compensated by governmental benefits for the taxes he pays.[11] The legislative body has freedom in deciding the amount of the tax, and it will usually be upheld by the courts as long as there is some possible fiscal relation between the benefits provided by the government and the return sought.

III.A.3. Substantial Equity

The substantial equity requirement recognizes that the Equal Protection clause of the Fourteenth Amendment to the U.S. Constitution demands that all persons in a specific class, or similarly situated, must be treated in a substantially similar manner. Article V, Section 2, subsection 2 of the North Carolina Constitution grants the General Assembly a non-delegable power to classify property, and requires that each class be treated similarly throughout the State. The General Assembly has delegated the classification power to cities with regard to other taxes, and the cities are subject to similar restraints. The power of a legislative body to classify is flexible, and the dominant limitation is that the classification not be unreasonable or arbitrary,[12] and the burden appears to be on the challenger to demonstrate the alleged unreasonableness.

III.A.4. Uniformity

The uniformity requirement is met when the rules discussed with regard to the classification of taxable persons or property are applied to the individuals within those classes. That is, the tax must be applied uniformly to all members of a class and cannot be indiscriminately applied to certain members of the class.[13] Uniformity must be coextensive with the jurisdiction in which the classification has been made, and thus, a state tax must be applied uniformly across the state, and a city tax must be applied uniformly throughout the city.[14]

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[1]N.C.G.S. 196A-206, Person v. Board of State Tax Commission, 184 N.C. 499, 115 S.E.2d 336 (1922).

[2]N.C.G.S. 160A-209 grants the power and N.C.G.S. 195-271 through N.C.G.S. 105-395 delineates the rules and procedures to be followed in the administration of the tax.

[3]N.C.G.S. 160A-210 through 160A-214.

[4]N.C.G.S. 160A-216.

[5]N.C.G.S. 160A-217 through 160A-236.

[6]Martin v. North Carolina Housing Corp., 277 N.C. 29, S.E.2d 665 (1970).

[7]Ibid.

[8]Ibid.

[9]Green v. Kitchin, 229 N.C. 450, 50 S.E.2d 545 (1948).

[10]For further discussion of public purpose see 25 N.C. Law Rev. 504 (1947), and Mitchell v. N.C. Industrial Development Financing Authority, 273 N.C. 137, 159 S.E.2d 745 (1968).

[11]State of Wisconsin v. J. C. Penney Co., 311 U.S. 435 (1941).

[12]Southern Grain Provision v. Maxwell, 199 N.C. 661, 155 S.E. 557 (1930).

[13]See Article V, Section 2, subsection (2) of the North Carolina Constitution.

[14]Hajoca Corp. v. Calyton, 227 N.C. 560, 178 S.E.2d 481 (1971).

III.B. Income Tax-Excess Profits Tax

As a regulatory tool a local income tax on corporate and individual taxpayers offers a great deal of flexibility. Through an already well-defined system of exemptions and deductions (as found in the federal and most state systems), a taxing authority can provide incentives to conform to locally determined, socially desirable goals. For instance, the value of pollution control equipment could be exempted from taxation, and the costs of maintenance of that equipment could be deducted from gross income. Where the taxpayer chooses not to buy the equipment and deduct the cost, the city may treat the proceeds of the business as the result of an excess profit. The tax on this excess profit would be used to reimburse the local area for the gain which the taxpayer has realized at the community's expense.

New York State has granted authority to municipalities to levy a corporate income tax[1] and has allowed subtraction from the gross income of a corporation, expenditures paid or incurred for air and water pollution control equipment.[2] Five other states (Pennsylvania, Maryland, Ohio, Michigan, Kentucky) have granted municipalities the authority to levy income taxes on corporations, though not all have enacted the specific types of deductions found in the New York statutes. All the above states and three more (Kansas, Missouri, Delaware) allow local governments to levy personal income taxes.

The corporation tax would be especially useful in areas where some development could be permitted but only on the condition that the environmental effects of that development were mitigated. The tax could then be calibrated to the point where the corporation could install and maintain the protective apparatus necessary, or would pay sufficient tax so that the local government could provide and maintain the equipment. Clearly the tax would be a cumbersome tool to use in areas which should not be developed at all, as the tax would have to be prohibitively high.

The personal income tax could provide some minimal support perhaps for policies of environmental protection, through the taxation of any income from securities in nonconforming corporations, but such an indirect measure would probably have little impact on a corporation's decision process.

III.B.1. Authority

Authority to levy a local income tax would have to be granted by the state legislature. The North Carolina General Assembly has forbidden cities, towns and counties from levying income and inheritance taxes by N.C.G.S. 195-247.

III.B.2. Viability

This type of tax would be relatively easy to administer, as the form of administration of the tax is already quite well defined, and taxpayers are used to dealing with it. It might be very difficult, however, to accurately calibrate the tax to match environmental damage.

III.B.3. Where It Has Been Used and to What Effect

No evidence was found of the use of the local income tax as a land use control measure.

III.B.4. Legal Issues

There may be consitutional problems involved in the use of a local income tax in North Carolina. If the General Assembly were to provide the authority to levy a local income tax, a local government would have to be careful to classify the type of activity it considered harmful, and to apply the tax uniformly to all members of that class.

III.B.5. Coastal Application

This tool is especially well suited to coastal areas because of their environmental sensitivity. Industries which locate in coastal areas often use disproportionate amounts of scarce resources (such as fresh water) and present substantial problems of waste disposal. The excess profits tax offers an opportunity for what tend to be poorer jurisdictions, to require that industry compensate for any environmental damage it may cause.

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[1]Gen. City App. Section 3, McKinney 1968.

[2]Tax Law 612, subsection 622, McKinney 1975.

III.C. Cost-Benefit Taxation (User Service Charges, Land Service Charges)

The model for cost-benefit taxation is the user fees commonly charged by cities for such things as garbage collection, utilities fees, etc. This system would attempt to charge each parcel of land for the municipal services it actively uses (garbage collection and utilities), and those services which are maintained but may never be used directly by a given parcel (police and fire protection).

The clear advantage of this model is that it would distribute the cost to the community of any particular service among all who benefit by it, and in proportion with that benefit. Such a system would clearly relieve a substantial proportion of the heavy tax burden imposed on land which remains undeveloped in the midst of a developing area. As long as the land had no structures on it, or persons inhabiting it, it would require minimum police and fire protection, minimal utilities use, etc., and thus it would pay very little tax. It would not be forced to subsidize development which occurred nearby because that development would be bearing its own share of the burden.

With accurate scientific data, the tax could be extended to cover environmental costs of development so that to the extent a specific development used a quantity of scarce resources, that parcel of land would pay tax sufficient to ensure adequate resources to the area as a whole. A parcel which lowered the water table to the detriment of other users, or the town as a whole (loss of vegetation, etc.) would be taxed to provide income sufficient to dig new wells, or build a reservoir and pipeline.

III.C.1. Authority

The application of the cost-benefit model would require a complete restructuring of the property tax assessment systems in use at present. The legislature of any state has the power to levy and collect taxes in any manner subject only to constitutional restraints. The uniformity of taxation language found in most state constitutions (including North Carolina's) would not be violated under a cost-benefit scheme, as the taxes would be levied according to the same standard regardless of the size or use of the parcel.

III.C.2. Viability

The cost-benefit system would be most amenable to cities which are relatively homogeneous in terms of the wealth of the residents and use of the land. It is likely that the lower income sections of a city could not support their share of the cost of services, and it is often the case that industrial and commercial uses do not fully pay for their share. To the extent that these groups are able to oppose cost-benefit taxation, it can be expected that they will.

The technical expertise necessary to administer such a system would be overwhelming. While user fees can be determined for services such as garbage collection and sewer and water connections, charges for police and fire service, road maintenance and the like are very difficult to assess with any precision (although, see The Costs of Sprawl, Real Estate Research Corp., 1974 as a reasonable starting point). Environmental effects are even more difficult to assess, and to associate them with a precise dollar figure would be extremely difficult to support if challenged.

III.C.3. Where It Has Been Used and to What Effect

This system is not used anywhere at present.

III.C.4. Legal Issues

As mentioned in the description of this tool, no legal problems are anticipated by the use of the tool. The uniformity of taxation requirement is met by this technique, and it follows that equal protection challenges would likewise be unsuccessful.

III.C.5. Coastal Application

This tool would be particularly useful in an area which has limited essential resources (such as fresh water). For instance, where an industry withdrew an inordinate amount of fresh water from the local aquifer, it could be charged for the cost of whatever measures were necessary to replenish the local water supply. While the tax would be fairly simple to administer, an understaffed government might have difficulty measuring the environmental damage in terms of prospective revenue required to mitigate it.

III.D. Special Assessment

The power to assess benefited property owners for a municipally provided benefit received lessens the burden placed upon a city which provides services to its residents. Thus, while the city as a whole may have the duty to install the necessary infrastructure, those directly benefiting from the improvements can be made to bear the major part of the cost. Special assessments seem to have little value as control over land use in developing areas, although within a town boundary the assessments may be used to finance the provision of those services a city deems necessary, and such decision is invalid only where a gross abuse of discretion can be shown.[1]

III.D.1. Authority

Authority to levy special assessments is granted to cities by N.C.G.S. 169A-217 through 160A-236. N.C.G.S. 160A-216 specifically authorizes a city to make special assessments against benefited property within its corporate limits for the provision and improvement of streets and roads, water lines, sanitary sewer lines, and storm sewage and drainage systems. Procedural requirements are specified in N.C.G.S. 160A-223 through 160A-231.

III.D.2. Viability

The procedural requirements for special assessment are fairly easy to comply with, and there are no major problems in using this technique, save political ones.

III.D.3. Where It Has Been Used and to What Effect

Most communities use some form of special assessment procedure to finance public services.

III.D.4. Legal Issues

Most challenges to the special assessments are based on procedural grounds and in these challenges, the burden is on the plaintiff to prove irregularity in the city's action.[2] Constitutional questions are less important because the assessments are collected for and applied to specific local purposes and are not open to the broad challenges which more common taxes for the general revenues must face.[3]

III.D.5. Coastal Application

This tool is useful in coastal areas generally.

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[1]Raleigh v. Mercer, 271 N.C. 114, 155 S.E.2d 551 (1967).

[2]Broadway V. Asheboro, 250 N.C. 232, 108 S.E.2d 441 (1959).

[3]See generally Southern Railway v. City of Raleigh, 9 N.C. App. 305 176 S.E.2d 21 (1970).

III.E. Preferential Assessment of Property (Use-Value Assessment Taxation)

Use-value assessment taxation is a system of taxation in which the tax assessor values a parcel of land solely on the basis of its current income-producing capacity. It is to be distinguished from the usual market-value assessment systems which generally included consideration of the zoning, potential for development and sales price for similar parcels in determining the value of a parcel. Preferential taxation is the term used when certain classes of property are assessed at a use-value rather than their market-value rate.

Currently, preferential assessment taxation of farmland has been enacted in 34 states including North Carolina.[1] Ten of those states have extended their statutes to include open lands (North Carolina has not). This legislation has as its immediate goal the reduction of the tax burden on lands subject to development pressure and on lands which cannot (due to regulation) or should not (for the health, safety and welfare of the community) be developed. By limiting the value of the land to a figure which is tied only to the income which that land currently produces, tax bills are kept at a level which will allow the owner a reasonable rate of return on his land and encourage him to continue his low-intensity use of the land.

In some states the preferential assessment alone is relied upon to counteract the tendency to develop land when it becomes profitable, but most states have recognized the fact that without further control the use-value assessment will provide a haven for the speculator who can now hold the land at a lower interim cost, and wait for the land to appreciate in value.[2]

North Carolina uses a deferred taxation system to increase the likelihood that the tax will have the effect of holding the land out of development. The deferred tax system requires that the tax assessor keep two sets of books for eligible lands, one containing the usual market-value assessment, and one containing the use-value assessment. The taxpayer pays according to the use-value assessment until the land is converted to a higher use, and the difference between the amount he pays under use-value and the amount which would be due under a market-value system is considered deferred tax. With the termination of eligibility all deferred taxes become due. State laws vary, but most require the payment of 5 to 10 years' deferred taxes, including interest. North Carolina requires the payment of deferred tax for the five years previous to termination of eligibility.[3]

There is some criticism of the deferred taxation control system in that: (1) it encourages the development of the best farmland, as it will have the highest income-producing capability and therefore a smaller accumulation of deferred tax; and (2) it encourages leap-frog development because land farther from the developed area will have a lower market value, and thus less deferred tax will accumulate.[4]

A second form of enforcing the preferential assessment system is through the use of "use restriction controls." "Use restriction controls" require that land be subject to some enforceable use restriction before use-value assessment can be applied. California's statute is typical, and requires that a landowner sign a contract with county or municipal officials restricting his right to develop the land for 10 years, before use-value assessment is allowed.[5] The contract is rescindable by either party, but a tax of approximately 12.5 percent of the market value is imposed on the landowner during the year of rescission.[6] The criticism of this method of enforcement is simply that it has not worked. Land which is contracted for does not have a high potential for development,[7] and landowners near expanding urban areas do not want to give up their right to develop at a substantial profit.[8] Further, when prime land is put under contract, the penalty for rescision is not a significant deterrent to conversion of the land after about seven or eight years.[8]

The major shortcoming of the preferential assessment taxation statutes as they presently exist, then, is that by themselves, they have not had much effect on the land use patterns near expanding urban areas.[10] A study in Maryland has concluded that "preferential assessment has little overall effect on the pattern and timing of development. . . . Most landowners will yield to the pressure of the market about the time when the land is ripe. . . . At the optimal conversion time it will be platted and will change uses."[11] Similar conclusions have been reached in California and Oregon.[12]

If use-value assessment is to be used in the coastal counties to assist in the protection of environmentally sensitive areas, it must be backed up by a more stringent enforcement system than is in effect for agricultural lands. Such a system should include a comprehensive regulation program that would require that environmentally sensitive areas be brought into the program. As an incentive to resist development pressures, use-value assessment is not effective--as a compensation for regulatory measures it has some value as a means of reducing the negative effects of those measures. The commentators seem to agree unanimously on this point.[13]

III.E.1. Authority

The state legislature is responsible for providing regulations governing the collection of taxes, and so it is the legislature which enacts the statute allowing use-value assessment for specific classes of property. In states where courts apply constitutional standards strictly, there might well be constitutional challenges on the basis of the uniformity of taxation language found in most state constitutions. A number of states have amended their constitutions either in response to or in anticipation of adverse court rulings (see below, Section III.E.4., Legal Issues). Most states have instituted the program on a statewide basis, requiring only that individuals apply to their assessor. Authority for preferential taxation of farmland in North Carolina is found in N.C.G.S. 195-277.4. A landowner whose land falls within the definition of agricultural or forest lands in N.C.G.S. 105-277.3 may apply to the county tax supervisor to have his land assessed at its current use-value. California, however, granted each county the authority to decide whether or not it would prefer to participate in the system, and thus has the individual landowner contract directly with the county or municipality.

III.E.2. Assisting Authority

In North Carolina the tax is administered by the tax supervisor with the right of appeal before the County Board of Equalization or the Board of County Commissioners. Further appeal can be made before the State Board of Assessment.

III.E.3. Viability

One of the major complaints about preferential assessment taxation is that it can have a severe impact on the fiscal affairs of local jurisdictions. Because the laws are not generally restricted to farmland in the path of development, the smaller rural counties stand to lose a substantial portion of their tax base under a preferential assessment system. A study done of the Williamson Act (preferential assessment for farmlands and open spaces) in California found that the average tax on land preferentially assessed under the Act in 1968-69 was reduced from $2.75 to $1.58.[14] This loss of revenue must be made up by other taxpayers, of course.

The revenue loss problem is attacked directly in New York and California, both of which take money out of general revenues to reimburse counties and school districts for money lost through their preferential assessment acts. New York will reimburse one-half of the revenue lost to the county and school districts as the budget allows,[15] and California reimburses counties on a per acre basis for farmland under contract with the county[16] and reimburses school districts where the tax rate exceeds specific limits.[17] North Carolina has no such program, and there is little need for it because of the minimal use of the preferential assessment statute. Applications for assessment at use value have been received from less than 5 percent of the land eligible for such treatment, but as counties complete their property revaluations, the program can be expected to become more popular.

III.E.4. Legal Issues

Most state constitutions contain language to the effect that "no class of property shall be taxed except by a uniform rule, and every classification shall be made by general law uniformly applicable."[18] And generally, the Equal Protection Clause of the Fourteenth Amendment of the U.S. Constitution requires that similarly situated individuals be treated in like manner unless the state can show a reasonable basis for the distinction. The question then arises whether singling out a particular class of land use for preferential treatment is an unreasonable classification, and whether the state can show good cause for the distinction. In many states (including North Carolina) the issue has not been raised, in part because use of the preferential assessment statutes is minimal. In those states where the laws have been challenged, they have been challenged as violative of state law (as opposed to constitutional claims), and they have frequently been overturned because the courts found preferential tax treatment of specific land uses to be arbitrary and unreasonable classification by the legislature.[19] More recently, however, the Supreme Court of Florida upheld a preferential assessment statute which treated agricultural lands as a special class. In Lanier v. Overstreet, 175 So.2d 521, (Fla. 1965), the court upheld the constitutionality of a Florida statute requiring that lands used solely for agricultural purposes be assessed on the basis of their value in agricultural use, and ignored the land's potential for other uses. The court found that Article IX of the Florida Constitution was actually an "organic mandate" to classify property so as to secure a just valuation of all property.

The most common way to enact preferential assessment, however, has been through the amendment of state constitutions to allow the legislatures to treat agricultural and open space land use as a special class for tax purposes. One recent reversal of this trend has occurred in California, where a provision of the state's constitution that authorized this technique was repealed in 1974, and subsequently enacted by statute.[20]

III.E.5. Coastal Application

The applicability of the use-value assessment system to environmentally sensitive lands in the coastal area would seem to be a logical extension of the open land and agricultural statutes. Like agricultural areas at the fringe of an urban area, many coastal areas are under severe development pressures, yet represent a valuable community asset in their undeveloped state. Use-value assessment would provide an incentive to landowners to hold land out of development, and where regulation of these areas had significantly decreased their value, it would relieve some of the financial burden of holding the land.

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[1]N.C.G.S. 105-277.4.

[2]"The fact that the land may have been purchased and was actually being held as a speculative investment is of no consequence provided its actual use is for a bona fide agricultural purpose," Smith v. Parrish, 262 So.2d, 238 (1972).

[3]N.C.G.S. 105-277.4 (c).

[4]Joseph T. Henke, "Preferential Property Tax Treatment for Farmland," 53 Oregon Law Review 117, 128 (1974).

[5]Cal. Gov't. Code 51240-51246 (West Supp. 1974).

[6]Cal. Gov't. Code 51282-51283 (West Supp. 1974).

[7]Hoy F. Carman and Jim G. Polson, "Tax Shifts Occurring as a Result of Differential Assessment of Farmland: California 1968-69," 24 National Tax Journal 449, 456 (1971).

[8]W. Gary Kurtz, "The Dilemma of Preserving Open Space Land--How to Make Californians an Offer They Can't Refuse," 13 Santa Clara Lawyer 284, 292-293 (1972).

[9]Averill Q. Mix, "Restricted Use Assessment in California: Can It Fulfill Its Objectives?" 11 Santa Clara Lawyer 259, 264-268 (1971).

[10]Kurtz, p. 291.

[11]Henke, p. 123.

[12]Id., p. 124.

[13]See especially Henke, p. 130, and Kurtz, pp. 302-303.

[14]Carman and Polson, p. 456.

[15]New York Agricultural and Markets Law, 503(f) (McKinney 1974).

[16]Cal. Gov't. Code, 16107 (West Supp. 1972).

[17]Cal. Gov't. Code, 16113-16114 (West Supp. 1972).

[18]N.C. Const., Art V, 2(2).

[19]State Tax Commission v. Wakefield, 161 A.2d 676 (Md. 1960); Boyne v. State, 390 P.2d 225 (Nev. 1964).

[20]Cal. Gov't. Code, 65560 _et seq_., Cal. Rev. and Tax Code 421 _et seq_.

III.F. Land Gains Taxation

The land gains tax applies to gains realized from sale or exchange of land held by the seller for a short period of time (for example, Vermont's tax applies to land held less than six years). Exceptions can be made for sales clearly not motivated by speculative gain, such as sales of less than one acre, or the sale of a principal residence. When a structure is attached to the land sold, the proceeds are apportioned between the land and the structure and only the land portion is taxed.

The tax schedule applied may vary in magnitude depending upon the extent of the problem, but generally the tax rate would increase directly with the percentage of profit realized, and inversely with the length of the holding period.

The tax serves a number of interconnected regulatory objectives. First, it tends to make land speculation much less attractive, and thus slows the increase in property values and taxes which would follow short-term speculation. Second, it reduces the financial pressures to develop land in advance of the normal cycle. Short-term trading is usually financed by high-interest loans, and the burden of those loans in addition to the increase in property taxes provides a powerful incentive to make the land "productive" as soon as possible. Third, the tax removes the injustice of individual benefit at common expense. Land speculation increases the wealth of the speculator primarily as a result of the social pressures and demands for the limited commodity in which he deals, and the numerous transfers and attendant problems are far more harmful to the community at large than to the speculator as a single individual.

The tax also serves valuable revenue-gathering objectives. It provides an entirely new basis for taxation, and as such, may take the weight off some of the more burdensome and less socially desirable forms of state taxation. Because the tax is levied at the time of transfer, it does not have to depend on the speculator's residence to tax the gain realized. And because the tax only applies to gains from the sale of land, it applies only to those who have actually benefited from the fluctuation in land prices.

The tax has specific advantages over other systems which attempt to take advantage of increased land value, primarily the use-value assessment systems in effect in 34 states. The land gains tax applies to all transfers of land not held for a specific period, and is not tied to specific types of uses, and so may have a broader impact on land development pressures. While the use-value assessment system keys on removal of pressure to sell land, it is effective only to the extent that the prospective seller is not tempted by the attractive offers he receives. The land gains tax is not so dependent and applies its disincentive to the speculator, who generally instigates the transfer. The use-value assessment system also tends to depress the tax base of a community while a land gains tax appears to increase revenues, though it may be that the depressing effect which the land gains tax would have on the local market as a whole would be equally harmful to the local tax base.

III.F.1. Authority

The authority to levy a land gains tax is vested in the General Assembly in North Carolina, but no such tax has been enacted.

III.F.2. Viability

It may be desirable to do some sort of cost/benefit analysis on a proposed land gains tax prior to its enactment. The administration of the program would be in the hands of the tax offices so that this technique would require no extra staffing on the part of local governments.

III.F.3. Where It Has Been Used and to What Effect

The tax has been in effect in Vermont since 1973[1] and is expected to generate more than $1 million per year in revenue. Although the effects of the tax on land speculation are difficult to discern after such a short period of time, it appears that the tax has had substantial effect in discouraging out-of-state land speculators from investing in Vermont, and further seems to have depressed the second-home market in Vermont. For a summary of the effects of the tax as of 1974, see Note, "State Taxation, Use of Taxing Power to Achieve Environmental Goals: Vermont's Taxes Gains Realized from the Sale or Exchange of Land Held for Less Than Six Years," 49 Washington Law Review 1159, 1177-1182 (1972-73).

III.F.4. Legal Issues

The Vermont Supreme Court has upheld a land gains tax instituted in that state in 1973. In Andrews v. Lathrop,[2] the plaintiffs charged that the tax violated the Equal Protection clause of the Fourteenth Amendment by arbitrarily discriminating against sellers who have held land for less than six years. The court found the objective of deterring land speculation to be permissible and that the distinction between short and long-term trades had a rational relationship to the problem of land speculation. With regard to the six-year standard, the court deferred to the judgment of the state's legislative body.

III.F.5. Coastal Application

Land gains taxation can be an extremely useful tool in coastal areas. It provides a strong disincentive to speculators who might be interested in development properties and provides a community with some dollar benefit for any increases in land values when the land is actually sold for development.

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[1]Vt. Stat. Ann. tit. 32, Section 10001-10010 (1973).

[2]32 Vt. 256, 315 A.2d 860 (1974).

IV. Development Regulation

IV.A. Introduction

Regulatory tools applied by local governments to guide land use and protect environmental values are all subject to a range of legal challenges. These challenges will be discussed at some length here and referred to only briefly, if at all, in discussing the individual tools. When a tool is particularly vulnerable to a specific challenge or has been subjected to a unique legal objection, that circumstance will be discussed at more length under the heading for the specific tool.

All local regulatory powers are derived from the police power of the state.[1] A regulatory power may not be exercised by localities until the state has, through enabling legislation, described the nature of the power and authorized its use by the locality. Thus local regulations are subject to several general types of legal challenge: (1) constitutional challenges--state or federal--which prescribe limitations on the state and its laws; (2) challenges that the local governments' application of the authorized power is "ultra vires," that is, outside of the authority given the local government through the enabling legislation; (3) challenges that the regulating body has not adhered to the laws of procedural fairness required by the enabling legislation, constitutional guarantees, or other state legislation prescribing minimum requirements for such procedural safeguards as notice and hearing.

IV.A.1. Constitutional Challenges

Constitutional challenges may be divided into general categories.

1. The first challenge is based on the due process clause that zoning regulations must have some "reasonable tendency to promote" or "substantial relationship to" the public health, safety, morals or general welfare.[2] This concept includes at least four ideas.[3] First, the regulations must be designed to promote some public interest that may legitimately be supported by the police power of the state. Secondly, there must be an actual or substantial relationship between the regulation and the legitimate goal. Thirdly, even though there is a legitimate goal, if the collective hardship to individuals outweighs the public benefit, the regulation may be invalidated. Fourthly, the regulation must be adopted in pursuit of public, rather than private, interests.

2. The second constitutional principle is that the zoning ordinance must not discriminate among landowners, and must respect the equal protection clauses of the state and federal constitutions.[4] Although it is clear that regulations will often treat property differently, these differences must have some rational justification which relates back to the purpose of the regulatory scheme itself.

3. The third constitutional constraint requires that the regulation not be confiscatory.[5] That is, it must not amount to a taking of private property for public use without compensation. Pecuniary loss is permissible, but "if the application of the (regulation) has the effect of completely depriving an owner of the beneficial use of his property by precluding all practical uses or the only use to which it is reasonably adapted, the ordinance is invalid."[6]

4. A fourth and more recently applied constitutional constraint involves infringement on the fundamental right to travel.[7] It is recognized that the right to travel may be legally regulated, and the courts will balance the extent to which the regulation interferes with the right to travel against the governmental interest involved. This right is not specifically mentioned in the federal constitution, but has its roots in English common law and the Articles of Confederation, and has thus long been considered a "fundamental" constitutional right.[8] Furthermore, the right to travel has been associated with First Amendment rights, and is therefore afforded protection against interference by both governmental and private sources.[9] The doctrine has been found to include both interstate and intrastate travel.[10]

The right to travel may have legal implications for local regulation schemes that systematically operate to restrict mobility, such as comprehensive growth management efforts plans which limit the number of new residents who may move into the area. But the reasonable use of planning tools, especially when carefully related to natural environmental features that constrain growth, should not run afoul of the right to travel.

5. A fifth constitutional issue involves the unlawful delegation of legislative powers.[11] This prohibition is given substance by the concomitant rule that all statutes delegating legislative powers must be accompanied by "adequate standards" to describe the limits of that power and its application. This concept applies clearly to grants of power to administrative agencies, and somewhat less clearly to local legislative bodies. In states that have not granted broad home-rule powers to local governments, these governments may be partially analogous to administrative agencies and must therefore

operate within the powers granted by the state. In local land use and environmental regulation decisions, agencies that are delegated such powers by the local governmental body must be provided with adequate standards in that grant. The unlawful delegation challenge will therefore turn on the issue of adequate accompanying standards to ensure that the body to which the delegation is made is not free to restrict, either capriciously or arbitrarily, the rights of individuals.

It should be mentioned at this point that the four types of due process inquiries are generally "substantive" in nature. Although the guarantee of due process is found in both the state constitution[12] and the federal constitution,[13] the inquiry about the above-mentioned substantive aspects of the public purpose of the legislation is left to the state courts. The Equal Protection guarantee and the prohibition against taking of property without just compensation have their basis in both the state[14] and federal[15] constitutions. The right to travel is based on the federal constitution.[16]

IV.A.2. Challenges Based on Inadequate Authority

Challenges that the application of the regulatory power is outside of the authority of the enabling legislation are based on the principle that the police power lies ultimately in the state, and therefore sub-state regulatory bodies may exercise only those powers delegated to them by the state.[17] The issue will generally turn upon the care with which the local ordinances and regulatory actions thereunder are conformed to the legitimate purposes set forth in and the powers delegated by the enabling legislation. This formula for avoiding actions which are "ultra vires," or outside legitimate authority, is deceptively simple in that the limits of the powers delegated are not always clear. This is especially true under the general enabling legislation for zoning because of problems in defining special zoning techniques for the purpose of determining whether they fall within the permitted powers. Court decisions have been of little aid in clearing up these definitional problems.

IV.A.3. Procedural Due Process Challenges

Challenges that a regulating body has not adhered to the laws of procedural fairness (or procedural due process) may rest on several bases. Many of the decisions concerning local land use and environmental regulations are made by bodies consisting of appointed, rather than elected officials. The decision-making procedures of these bodies have been subjected to increasingly great procedural safeguards and rules because of their quasi-judicial nature.[18] Other decisions, such as original ordinances and zoning amendments, are determined through legislative processes by elected officials, and are therefore not necessarily required to follow such procedures.

However, regardless of the legislative or administrative label, these regulatory processes are almost invariably accompanied by requirements that public notice be provided and that interested parties be given an opportunity to be heard at public hearings. The nature of the general requirements for notice and public hearing is set forth in general statutes and may be referred to by the enabling legislation. In some instances, special requirements may be set out within the enabling legislation itself.

Procedural requirements are generally uniform, and will not be discussed in relation to each regulatory procedure unless special provisions make them different for that procedure.

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[1]Donald G. Hagman, Urban Planning and Land Development Control Law (St. Paul, Minn.: West Publishing Company, 1971), p. 76.

[2]Robert C. Einsweiler *et al.*, Urban Growth Management Systems, ASPO Planning Advisory Service Reports Nos. 309 and 310 (Chicago: American Society of Planning Officials, 1975), pp. 58-68.

[3]Michael Brough, "Flexibility Without Arbitrariness in the Zoning System: Observations on North Carolina Special Exception and Zoning Amendment Cases," 53 North Carolina Law Review 925 (June 1975).

[4]Einsweiler *et al.*, pp. 68-70.

[5]Peter Glenn, "The Coastal Area Management Act in the Courts: A Preliminary Analysis," 53 North Carolina Law Review 303 (December 1974).

[6]Ibid.

[7]Einsweiler *et al.*, pp. 70-72.

[8]Aptheker v. Secretary of State, 378 U.S. 500 (1964).

[9]Shapiro v. Thompson, 394 U.S. 618 (1969).

[10]King v. New Rochelle, 442 F.2d 646, 648 (2d Cir. 1971). Cert. denied 404 U.S. 863 (1971).

[11]Hagman, pp. 164-168; Glenn, pp. 314-327. For general discussion of the relationship between local and state governments, see Philip P. Green, Jr., Planning Law and Administration (Chapel Hill: Institute of Government, Univ. of North Carolina, 1962), pp. I:14-I:37.

[12]N.C. Const. Art. 1, Sec. 19.

[13]U.S. Const., Amend. XIV.

[14]N.C. Const., Art. 1, Sec. 19.

[15]U.S. Const., Amend. V, XIV.

[16]Ibid., Amend. I.

[17]N.C. Const., Art. 1, Sec. 1; Green, pp. I:14-I:37.

[18]Humble Oil and Refining Co. v. Board of Aldermen, 284 N.C. 458, 470, 202 S.E.2d 127, 138 (1973).

IV.B. Interim or Temporary Development Regulations

Development moratoria do not always entail absolute prohibition of development. The term is often used to describe a scheme of temporary or interim regulations designed to substantially retard development. Development moratoria can be of at least two general types.

First, planning moratoria may be used to slow or freeze development in a certain area until a permanent scheme of controls can be devised and implemented. Planning moratoria are usually accompanied by interim development regulations, and, because complete prohibitions on development have met legal difficulties, a major problem arises in determining what types should be allowed or prohibited. Interim development controls are designed to serve three functions: they permit planning and ordinance writing to proceed relatively free of development pressures; they prevent uses that will be contrary to the eventual regulatory and planning scheme from being initiated before that scheme becomes operational; and they allow time for public debate on issues relevant to development of the permanent control system.[1]

Environmental moratoria can be used to restrict development during a period in which extreme pressures are being put on community resources. These moratoria are most commonly called for in periods of rapid community growth and expansion, and to be effective must generally be tied to programing of facilities related to the environmental problem. Inability to provide sewer service at a rate to keep pace with demand is the most common example of a situation which might justify environmental moratoria.[2]

IV.B.1. Authority

The power to use interim moratoria on development is not explicitly granted by North Carolina enabling legislation. Total prohibition of development is not likely to be found legal.[3] However, interim controls, if reasonably related to the needs of the community, may be accomplished through use of permissible processes such as the special use permit and zoning amendment.

IV.B.2. Viability

The political viability of any moratorium would depend on its comprehensiveness and duration. An attempt to prohibit most or all types of development is likely to be unpopular unless obvious and extreme conditions exist to warrant the moratorium. Any scheme to control growth should better rely upon guidance rather than prohibition, except in hazardous or fragile areas.

A moratorium presents no technical or administrative problems, except in the assimilation of data to justify the prohibition of development.

Moratoria and interim controls have generally been imposed at the local level. More recently, these tools have been administered on both the national and state level for a limited number of areas that are considered, usually for environmental reasons, critical and of greater than local concern.

IV.B.3. Where It Has Been Used and to What Effect

Interim development controls have been adopted in several states to protect critical areas. In California, planning agencies for both the Lake Tahoe and San Francisco Bay areas have been authorized to use interim ordinances during the formative period of their plans. In New York, the Hudson River Valley and the Adirondack Park are the subjects of interim regulation proposals. In New Jersey, interim zoning legislation lasting for two years has been used to protect the Hackensack Meadowlands.[4]

At the local level, moratoria have been used in Fairfax County, Virginia and in other places to prohibit temporarily connections to sewage facilities.[5]

Moratoria and interim controls have generally been successful in their purpose of slowing development. The one application of an environmental moratorium in North Carolina's coastal area was in Currituck County, which instituted a 15-month moratorium on approval of new subdivisions in 1972, thus providing time for land use planning and replatting of gridiron subdivisions which had laced the Outer Banks with total disregard for topography.[6]

IV.B.4. Legal Issues

Local interim controls are most likely to be challenged on the basis that the regulations are not permitted by enabling legislation and are therefore "ultra vires" or outside of local authority. Constitutional attack may be based on the claim that the controls constitute a taking of property without compensation. (This has been claimed by developers in

Livermore and Pleasanton, California.) Judicial decisions in other states have held that interim controls are constitutional and within the Standard Zoning Enabling Act.[7]

To be valid, short-term moratoria must be temporary and reasonable, and not place the community's burden on the individual.[8] An indefinite moratorium is especially questionable, unless the community can demonstrate a good faith effort to establish the balance between growth and environmental considerations, which is the rationale for the moratorium in the first place.

IV.B.5. Coastal Application

Temporary or partial moratoria on development may be appropriate in coastal areas where development pressures are great and pose an identifiable immediate threat to the environment. For example, in the Surf City area of Pender County, North Carolina, studies show that excessive septic tank discharge is having a detrimental effect on local water quality. Because the capability to handle waste discharge in some other manner is not yet available, some temporary check on growth seems justifiable. Areas for which controls already exist, such as salt marshes, navigable waters, beaches, and dunes, may not call for a moratorium. Other areas, such as swamp forests, maritime forests, acquifer areas, and washover and inlet areas may be appropriate subjects for moratoria while effective controls are being developed. Local planning has, in most coastal areas, just been initiated under the impetus of the Coastal Area Management Act, and formulating well-devised plans requires much time. Interim moratoria may be justified until the locality and the Coastal Resources Commission can build a management scheme sufficient to protect the vital coastal ecosystem.

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[1]Robert H. Freilich, "Development Timing, Moratoria, and Controlling Growth: Preliminary Report," in Management and Control of Growth: Issues-Techniques-Problems-Trends, II, ed. by R. W. Scott et al. (Washington, D.C.: The Urban Land Institute, 1975), 363-364.

[2]Id., pp. 364-365.

[3]For example, in Westwood Forest Estates v. Village of South Nyack the court ruled "such restraint must be kept within the limits of necessity and may not prevent permanently the reasonable use of private property"--23 N.Y.2d 424, 244 N.E.3d 700 (1969).

[4]Michael E. Gleeson et al., Urban Growth Management Systems: An Evaluation of Policy Related Research, ASPO Planning Advisory Service, Nos. 309 and 310 (1975), p. 47.

[5]Id.

[6]James R. Hinkley, "A State's Approach to Land Use," Water Spectrum 6, No. 2 (Reprint 1974), 4.

[7]Steelhill Development, Inc. v. Town of Sanborton, 469 F.2d 956 (1st Cir. 1972), Monmouth Lumber Co. v. Ocean Township, 9 N.J. 64, 87 A.2d 9 (1952).

[8]Gleeson et al., p. 47.

IV.C. Zoning

IV.C.1. Conventional Zoning

Conventional zoning is probably the most commonly employed device for guiding development at the local government level.[1] It is normally used to control the use of land and structures thereon, as well as for more detailed regulation concerning the area of the lot which may be developed (setbacks and separation of structures), the density of the development (minimum lot sizes, etc.) and the height and bulk of buildings and other structures. The general purpose of zoning is to avoid undesirable side effects of development by segregating incompatible uses and by maintaining adequate standards for individual uses.

Many variations and extensions of zoning have been proposed or instituted under the general zoning power. These include the control of development timing, the requirement of environmental and public service impact studies for proposed uses, and others. The legality of these variations differs from state to state, depending on the wording of the enabling legislation and on court interpretations of that original grant of power, as well as situational issues.

IV.C.1.a. <u>Authority</u>--In North Carolina, authority to zone has been given to municipalities under N.C.G.S. 160A-381 and to counties under N.C.G.S. 153A-340. The zoning power is administered by the elected legislative body of the locality, although certain aspects may be delegated. The permissible purposes for zoning are set out in the statute as lessening congestion in the streets; securing safety from fire, panic and other dangers; promoting health and general welfare; providing adequate light and air; preventing overcrowding of land; avoiding undue concentration of population; and facilitating adequate provision of transportation, water, sewerage, schools, parks, and other public requirements. Any zoning technique applied by the local government which is found not to serve legitimately these purposes is considered illegal, because the locality may not exceed the authority granted to it by the state.

Conventional zoning has been found to be a constitutional exercise of the police power since the landmark case <u>City of Euclid v. Ambler Realty</u>.[2] Federal judicial activity has increased with the recent employment of new zoning variations, and the results have been mixed, depending on the particular technique.

IV.C.1.b. <u>Viability</u>--Zoning has long been politically accepted as a method of regulating and segregating uses of land. Protection of property values is probably the main motive for public acceptance. Aesthetic amenities and orderly development have come to be associated with segregation of uses as promoted by zoning, and these purposes seem to have received what might best be characterized as tacit acceptance by the courts when accompanied by any other cognizable public-purpose rationalization.[3]

Zoning has traditionally been rather arbitrary, guided by a few general principles such as placing commercial uses along major thoroughfares and insulating industrial uses from residential areas. In theory, zoning should be based on a well-designed comprehensive plan--but in practice this is seldom the case. However, traditional zoning, especially in combination with some of the more flexible variations, offers great potential to control the environmental impacts of development.

Zoning has been traditionally applied by municipalities. More recently, some counties have implemented zoning. Generally, zoning has been applied to smaller and more densely populated jurisdictions, yet countywide zoning for broad use classifications may be effective for protecting the natural environment.

IV.C.1.c. Where It Has Been Used and to What Effect--Zoning, as the most common of all regulatory tools, has been used throughout the nation. The results have been greater segregation of uses, and consequently more orderly patterns of development. Whether this has been a benefit to the community at large is not always certain. Allowances for variances and other legal means of deviating from the zoning ordinance have given zoning very broad political dimensions, and therefore some potential for abuse.

Traditional zoning has not often, however, been based on the environmental characteristics and constraints of the land being zoned. The potential applications of zoning to protect environmental values in the coastal municipalities and counties are fairly obvious.[4] More intensive uses, in respect to potential for environmental damage, should be permitted only in compatible use zones, which is simply to say those areas that are least environmentally vulnerable or critical. Such processes as large-lot zoning or cluster zoning are further extensions of the general zoning power that can be utilized to guide land development in a manner to minimize environmental damage. These and other variations of zoning are discussed in more detail later in this study.

IV.C.1.d. Legal Issues--The states' power to zone has been upheld by the U.S. Supreme Court as a legitimate exercise of the police power. Taking, equal protection, and right to travel problems are minimal for the practical reason that conventional zoning has not been so restrictive as to infringe on fundamental rights or to diminish grossly property values.[5] The U.S. Supreme Court has recently reaffirmed the broadness of local governments' power to regulate through zoning ordinances. An ordinance restricting land use to one-family dwellings, with family defined so as to preclude effectively more than two unrelated people living together, was upheld as reasonable, having a rational relationship to a permissible state objective, and not involving any fundamental rights.[6] However, recent techniques promoting flexibility in zoning have been exposed to such attacks. These will be discussed under the appropriate topic.

Zoning has been upheld in North Carolina against attacks of unlawful delegation of legislative power.[7]

Zoning is a broad tool, under which many individual techniques may be employed. Whether these techniques are within the grant of power by the enabling legislation will be discussed in relation to each of these techniques.

IV.C.1.e Coastal Application--Traditional zoning, if based on environmental considerations, can be used to some extent to protect vital coastal systems and environments. Uses, such as many industries, with potentially great impacts may be permitted only in those areas most able to absorb their impact. Particularly, they should not be allowed within or in close promimity to important environmental areas. Uses with fewer harmful environmental impacts may be allowed more broadly, but in some environments (for example, aquifer areas and maritime forests) their density may be controlled by lot size or similar requirements.

In some areas traditional zoning is limited in its applicability. More flexible techniques are required where development is to be allowed, but extensive controls over structure and site design are necessary to ensure that the development is compatible with the environment. These flexible techniques are not necessarily separate from conventional zoning, and their use may well be authorized under the general zoning power. As coastal jurisdications gain experience and confidence in traditional zoning, they may wish to move further in adopting the more sophisticated flexible techniques discussed in the sections that follow.

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[1]Donald G. Hagman, Urban Planning and Land Development Control Laws (St. Paul, Minn.: West Publishing Co., 1971), pp. 67-146; Philip P. Green, Jr., Planning Law and Administration (Chapel Hill: Institute of Government, Univ. of North Carolina, 1962), pp. XII-1-102.

[2]City of Euclid v. Ambler Realty Co., 272 U.S. 365, 47 S. Ct. 114.

[3]Appeal of Parker, 197 S.E. 706, 214 N.C. 51, _appeal dismissed_ Parker v. City of Greensboro, 59 S. Ct. 150, 305 U.S. 568

[4]Edward J. Kaiser _et al._, _Promoting Environmental Quality Through Urban Planning and Controls_ (Washington, D.C.: Office of Research and Development, U.S. Environmental Protection Agency, 1974), Sec. IV, pp. 107-182.

[5]For more thorough discussion, see Hagman, pp. 164-190.

[6]Village of Belle Terre v. Boraas, 416 U.S. 1 (1974).

[7]Jackson v. Guilford County Board of Adjustment, 275 N.C. 155, 166 S.E.2d 78 (1969).

IV.C.2. Exclusive Agricultural or Nonresidential Zones

This type of ordinance excludes residential use and thus has a direct limiting effect on housing and population. This technique prohibits subdivisions and their urban uses from expanding and is, in effect, a holding zone to contain and restrict urban areas.

The need to protect agricultural areas becomes evident when, due to the increased demand for commercial and residential development, property values begin to increase rapidly. The capital appreciation of land and increased costs of farm production force farmers to sell to developers. This results in scattered residential development that is detrimental to farming, to the long-range development potential of the land, and to the efficient provision of public facilities and services.[1]

A municipality cannot arbitrarily designate land for agricultural use if the land is not suitable for such use simply because the city wants to prevent further growth in the area. For this technique to be valid, the land must actually be agricultural in nature. If land in the urban fringe, which is in fact not agricultural land but in reality land ready for development, is zoned exclusively agricultural, the courts will probably invalidate the ordinance as a taking without just compensation.

The same problems are encountered in any attempt to zone an area exclusively industrial or other exclusively nonresidential uses.

IV.C.2.a. Authority--Authority for this technique is provided by the North Carolina zoning enabling legislation.

IV.C.2.b. Viability--When development pressure is strong this technique will be very unpopular with landowners and may generate lawsuits as well as hostility. No special technical expertise is required.

IV.C.2.c. Where It Has Been Used and to What Effect--This technique has been used in several states. Florida enacted a statute in 1959 which allowed exclusive agricultural zoning and provided for tax relief for land so zoned.[2] Santa Clara County, California and Lancaster County, Pennsylvania have both made extensive and effective use of agricultural zoning.[3]

The effectiveness of this technique is usually short-lived in the face of development pressures. Often, zoning ordinances of this type are eroded by the granting of variances and end with an amendment which replaces the exclusive agricultural zone.[4]

IV.C.2.d. Legal Issues--Exclusive agricultural zoning may be challenged on the ground that it does not further legitimate state objectives. However, the technique should survive such a challenge because arguably it promotes the general welfare. First, the technique avoids costly and uneconomical extensions of municipal services. Second, it segregates incompatible uses. Intruding residential concentrations could create problems by lowering the water table, and generating objections to some by-products of agricultural activities, such as noise. Third, exclusive agricultural zoning preserves the scenic value of the area.

The use of this technique also raises the taking problem. Since most land zoned exclusively for agriculture can be used profitably in agriculture, this technique is not necessarily confiscatory. As mentioned previously, the courts will have no trouble in finding a taking if the land is not really suited for agricultural use. Invalidation is likely when nearby lands have been developed and the property in question has acquired considerable value.[6] The crucial question is how burdensome the ordinance becomes to the particular landowners involved.

IV.C.2.e. Coastal Application--Agricultural land in the coastal area could be zoned exclusively for agricultural use, and at minimum, the zoning would delay development. Whether the ordinance would stand up in the North Carolina courts is not predictable. Thus, this designation may be useful only as a temporary holding zone.

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[1]Michael E. Gleeson et al., Urban Growth Management Systems: An Evaluation of Policy Related Research (Minneapolis: School of Public Affiars, Univ. of Minnesota, 1974), p. III-32.

[2]James S. Wershow, "Agricultural Zoning in Florida--Its Implications and Problems," 13 University of Florida Law Review 485 (1960).

[3]M. Moore, "The Acquisition and Preservation of Open Lands," 23 Washington and Lee Law Review 285 (1966).

[4]Ibid.

[5]Note, "Protection of Environmental Quality in Nonmetropolitan Regions by Limiting Development," 57 Iowa Law Review 143 (1971).

[6]Moore, p. 286.

IV.C.3. Minimum Lot Size

Minimum lot sizes or large lot zoning (one acre or more minimum lot requirements) can be used in two ways. First, the technique may be used to create a holding zone where intensive development is temporarily deterred. Areas on the outskirts of a community are zoned in this fashion to control the rate or timing of development and to prevent development in areas where the community is unable to provide services. The area is rezoned when growth can be accommodated. This technique is a relatively ineffective means of controlling the timing of growth,[1] but may sometimes lead to fiscal savings for the community. To be effective at all, a large portion of the vacant land in the community must be zoned for large lots. The technique does not necessarily relate to pressures on and capacities of individual parcels of land. Also, when a large area is subject to large-lot zoning the political pressures for individual rezonings can be overwhelming. If the increased lot size makes the area more attractive to potential homebuyers, the rate of growth may actually increase.[2]

Second, the minimum lot size can be used as a permanent designation. The purpose may be to protect agricultural land, to preserve open space, to protect environmentally sensitive areas, or to keep residential development at a low density.

The spatial effect of this type of zoning is to produce a largely inefficient form of development at a time when land is becoming a scarce resource. The economic effects of large-lot zoning vary with the situation. Although many municipalities think their fiscal situation will be improved through large-lot zoning, the increase in costs of services that must be provided often makes it a costly proposition.

The effect on the individual property owner is to drive up land and housing costs. The social implications of this rise in housing costs are that it may exacerbate problems of social and racial residential segregation.

If environmental protection, preservation of open space or similar objectives are paramount, there may be less costly and more effective means to achieve those objectives. They can be furthered through the limited application of large-lot zoning with varying success. Cluster housing ordinances, for example, would be more effective than large-lot zoning for either protecting the environment or preserving open space. The only situation in which this technique is more effective than other techniques is when the objective is simply to keep residential development at a low density.

IV.C.3.a. Authority--Authority to acquire minimum lot sizes exists in North Carolina pursuant to the State's zoning enabling legislation.

IV.C.3.a. Viability--Minimum lot sizes of one acre or less are used extensively. Once lot size requirements increase significantly beyond that point (2-10 acres) the use of the technique is problematic. Large-lot zoning often reduces the economic return to the landowner, and when used extensively, it reduces the supply of developable land which raises land prices and housing costs for all income groups and makes it difficult for one-owner income families to find housing in their price range. On the other hand, communities that wish to preserve the character of their community or to preserve open space areas may find that the objections to the technique are outweighed by its advantages. The political viability appears to depend upon the purposes of the zoning ordinance and its economic and social effects.

As mentioned previously, the use of large-lot zoning might not have the effect which is intended. Careful planning and study of the spatial, social, and economic impacts in the particular community setting are vital. The impacts will vary with the pressure for growth in the community, the minimum size of lots used, the relative amount of land so zoned, the length of time the land is left in such zones and a number of other localized factors.[3]

Cities and counties are equally able to utilize this technique.

IV.C.3.c. Where It Has Been Used and to What Effect--Large-lot zoning is used all over the nation. As mentioned previously, it has been used for varied purposes. It can, however, have undesirable consequences, particularly if carried to an extreme. Below are illustrations of some of the negative results of large minimum lot requirements.

One survey (completed prior to 1968) found that in St. Louis County, Missouri, there was a 350-year supply of 1-acre lots, but only a 4-year supply of 1/3-acre lots. Large-lot zoning in that area had been estimated to impose on home-buyers costs of $1 million per year for land in excess of their needs.[4]

In parts of Decatur, Illinois, some neighborhoods go without sanitary sewers and street repair. The effect of the low-density development is to make it so expensive to provide services that the residents cannot afford the improvements.[5]

IV.C.3.d. Legal Issues--Because of the wide array of purposes served by this type of ordinance, many of them valid public purposes, this technique has been challenged with less success than have minimum floor area ordinances. There is now a national trend toward judicial invalidations of excessive minimum lot requirements, at least where it appears that the primary purpose of the requirement is exclusionary (i.e., to prevent certain groups of people from finding homes in the community).

The fate of large-lot zoning in the courts will depend on the purpose and whether large-lot zoning is a valid means of accomplishing the purpose. For example, in Steel Hill Development, Inc. v. Town of Sanbornton, 469 F.2d 956 (1st Cir. 1972), a six-acre minimum was upheld as a valid means of preserving the natural resources of the area where no exclusionary effect existed. In Salamar Builders Corp. v. Tuttle, 29 N.Y.2d 221, 325 N.Y.S.2d 933 (1971), an increase in minimum lot size was upheld because it was needed to prevent septic tank pollution. A four-acre minimum was held void in National Land and Investment Co. v. Kohn, 419 Pa. 504, 215 A.2d 597 (1965). The township argued that the zoning was needed to prevent the overburdening of existing municipal services and facilities. The court said that the four-acre minimum was neither a necessary nor reasonable method of accomplishing the township's objective.

Challenges to large-lot zoning are usually based on the argument that the ordinance has taken the property affected by it without just compensation. The taking problem involved is more pressing in areas subject to development than in rural areas. Large-lot zoning in nonrural settings therefore faces a greater likelihood of being struck down as an invalid taking.[6]

IV.C.3.e. Coastal Application--Because the coast is subject to more development pressure than most areas, this tool has special relevancy in the coastal area. As mentioned previously, large-lot zoning can be used as a holding zone to deter development temporarily.

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[1]David Brower et al., Growth Management Through Development Timing (Chapel Hill: Center for Urban and Regional Studies, Univ. of North Carolina, 1974), p. 36.

[2]Ibid., p. 56.

[3]Ibid., p. 55.

[4]Stephen Sussna, "Residential Densities: A Patchwork Placebo," 1 Fordham Urban Law Journal 132 (1972).

[5]Ibid., p. 132.

[6]Michael E. Gleeson et al., Urban Growth Management Systems: An Evaluation of Policy Related Research (Minneapolis, Minn.: School of Public Affairs, Univ. of Minnesota, 1975), p. III-40.

IV.C.4. Height Restrictions

Regulation of building heights is used to control the density of development, and to minimize the effects of tall buildings which often cut off light and air, generate increased traffic and cause difficulties in providing fire protection and other municipal services.

IV.C.4.a. Authority--The North Carolina zoning enabling statutes authorize the regulation of building heights.

IV.C.4.b. Viability--Regulating building heights is an acceptable practice and is in widespread use. Virtually all North Carolina zoning ordinances contain height restrictions.[1]

This technique does not raise technical problems and is easy to administer.

IV.C.4.c. Where It Has Been Used and to What Effect--As mentioned previously, height restrictions are used all over the nation to prevent tall buildings from cutting off light and air, to allow for the orderly provision of municipal services and to control the density of development.

IV.C.4.d. Legal Issues--As early as 1909, the U.S. Supreme Court upheld building height regulations. There is little doubt about the constitutionality of this technique in principle.[2] Of course a maximum height regulation may be invalid as applied. This technique is subject to challenge on due process, equal protection and taking grounds, as is any zoning ordinance.

IV.C.4.e. Coastal Application--The use of this technique may be particularly applicable in the coastal area where tall beach front buildings can cut off the view of the ocean from residents and visitors in the area. While zoning usually controls the density of residential development, height restrictions may be the most appropriate way to control the density of commercial development.

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[1] Phillip P. Green, Jr., Zoning in North Carolina (Chapel Hill: Institute of Government, Univ. of North Carolina, 1952), p. 174.

[2] Ibid.

IV.C.5. Mandatory Low Income Housing Construction Ordinance

The mandatory low income housing construction ordinance requires developers to include a minimum amount of subsidized or lower cost housing in their conventional projects (both sale and rental). Although the details of the enacted and proposed ordinances vary, they are similar in certain essential features: (1) the ordinances usually apply only to large developments (often 50 or more units); (2) the typical required percentage of low and moderate income units is small (10-15 percent); (3) the ordinances attempt to make the requirement economically feasible by tying it to the availability of federal subsidies or increasing allowable densities for the development.

The objectives of the ordinances are: (1) to produce enough low and moderate income housing to meet the needs of the area's residents; (2) to avoid an overconcentration of low cost housing in particular areas of a community; and (3) to stimulate better quality construction and maintenance of subsidized housing.[1]

Inclusionary ordinances should not be viewed as a solution to all of the housing problems of a community. Because these ordinances are often tied to federal subsidies, the number of low income units produced is often not sufficient to meet the community's needs. Other approaches such as housing rehabilitation and increased state and local funding may be necessary to attack the full range of housing problems facing many communities.[2]

Inclusionary ordinances will probably not be useful in areas where the demand for new housing is weak, or where the profitability of housing construction is relatively low. The reduced profitability of construction under these ordinances may be enough to prevent development. In areas of high profitability, the rate of return even with the ordinances may be high enough to stimulate development.[3] There are incentives for developers (particularly local developers) to remain in an area, even though they do not approve of this type of ordinance. Developers have a knowledge of the local housing market, reputations in the area, and experience in dealing with the local officials which would be lost by transferring out of the area. These factors may induce a developer to accept a lower rate of return. In addition, the developer can pass at least some of the loss along to purchasers of the conventional units.[4]

IV.C.5.a. Authority--Whether or not additional enabling legislation is required in North Carolina to authorize a mandatory low income housing construction ordinance depends on how broadly the North Carolina courts are willing to interpret existing enabling legislation. It is conceivable that this type of ordinance could be justified as promoting the general welfare of the community and that municipalities are empowered by the zoning enabling legislation to enact ordinances for inclusionary purposes. A local government, however, would be unwise to count on the North Carolina courts' accepting this reasoning. Similar extended arguments can be made with respect to other grants of police power authority, but it is doubtful that they would receive judicial approval. A better approach may be to enact express enabling legislation to authorize the adoption of inclusionary ordinances.

The inclusionary ordinance of Fairfax County, Virginia was enacted under traditional zoning enabling legislation, and was invalidated because the court thought the ordinance exceeded the authority granted by the enabling legislation. The Montgomery County, Maryland and Los Angeles ordinances enact the percentage requirements under local charter authority rather than state enabling legislation.[5]

IV.C.5.b. <u>Viability</u>--In terms of political viability, this technique faces the same obstacles as any other program designed to aid the poor. A favorable aspect of the technique may be that the ordinance imposes no direct cost on the local government. Developers can be expected to strenuously oppose this type of ordinance.

Before this technique is used, serious study should be given to local housing market and housing needs to determine the probable effects of the ordinance. In addition, the housing studies will be valuable in defending the use of the ordinance if it is later challenged in court. Great care should be exercised in preparing, drafting and defending the ordinance.

IV.C.5.c. <u>Where It Has Been Used and to What Effect</u>--Inclusionary ordinances have been passed in several areas including Fairfax County Virginia; Montgomery County, Maryland; Los Angeles, California; and Cherry Hill, New Jersey. It is difficult to evaluate the effectiveness of these ordinances. The Fairfax County ordinance was invalidated before it had any impact. Montgomery County's program has not been tested because a state-imposed sewer moratorium has blocked virtually all new housing. The moratorium on federal housing subsidy programs excused compliance with the Los Angeles ordinance for most of 1974.[6] The Philadelphia suburb of Cherry Hill appears to have had some success with its ordinance. The ordinance requires that 5 percent of the rental units in projects of 25 dwelling units or more in multifamily zones be rented at below market rents. The township has issued building permits for 2,000 units subject to the 5 percent low-rental requirement.[7]

The most appropriate level of government to use this technique is the county level. The purpose of the technique may be thwarted if developers have the option of building in the next town under no similar restraints. If an entire area subject to growth pressures is covered by an inclusionary ordinance, the market for new construction is less likely to be affected by the ordinance, and in addition, the ordinance represents a fair way to allocate responsibilities for housing low income families throughout the region.

IV.C.5.d. Legal Issues--The Fairfax County mandatory low income housing construction ordinance was invalidated in Board of Supervisors of Fairfax County v. Degroff Enterprises, Inc., 214 Va. 235, 198 S.E.2d 600 (1973). The Virginia Supreme Court recognized that providing low and moderate income housing serves a legitimate public purpose, but held that this public purpose could not be accomplished by the zoning ordinance which the county had enacted because the ordinance exceeded the authority granted by the zoning enabling legislation. A second ground for invalidating the ordinance was the court's conclusion that it violated the guarantee of the Virginia Constitution that no property will be taken or damaged for public purposes without just compensation because it fixed rents and sale prices at below market rates.

Most commentators conclude that this decision is an aberration and that the court's reasoning is questionable at best. Nonetheless, it is a precedent that must be overcome if an inclusionary ordinance is challenged

Inclusionary ordinances will probably face substantive due process attacks. In order to be upheld the ordinance must have a valid public purpose and must be rationally designed to achieve it. Even the court which struck down the Fairfax County ordinance recognized that providing low income housing was a valid public purpose. The choice of means to achieve this objective is more troublesome. The developer is used to solve a communitywide housing problem and to the extent that the cost cannot be passed on, is singled out to bear an economic burden.[8] On the other hand, other professions (doctors, attorneys, etc.) are called upon to serve less than profitable clients and are expected to absorb the loss or spread it among other clients.

The use of provisions to reduce potential economic loss to the developer (such as density bonuses) will bolster the argument that the means are reasonable and will also help to avoid the taking problem which is closely related. One commentator has concluded that under any of the four types of tests for determining when a taking has occurred, these ordinances will be upheld if appropriate steps are taken to minimize the economic loss to the developer[9] Another has concluded that whether or not cost saving approaches offset the losses caused by the ordinance will depend on features of the ordinance and local conditions and, if losses are not offset, communities must make direct cost payments to developers to account for the difference.[10]

Despite the pressing need for new means of coping with the problem of low income housing in North Carolina, this technique is a risky way of approaching the problem. It is uncertain at best whether or not the North Carolina courts would validate inclusionary ordinances of this sort.

IV.C.5.e. Coastal Application--The coastal area like other parts of North Carolina has an obligation to provide housing for its low income residents. If legal problems are worked out, this technique may be a means of fulfilling that obligation which could be used by any local government. This technique has no special relevance for growth management in the coastal area.

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[1]Thomas Kleven, "Inclusionary Ordinances . . . Policy and Legal Issues in Requiring Private Developers to Build Low Cost Housing," 21 U.C.L.A. Law Review 1448 (1974).

[2]Ibid., pp. 1470-1473.

[3]Ibid, p. 1482.

[4]Ibid.

[5]Ernest Erber and John Prior, "The Trend in Housing Density Bonuses," Planning , 60 (November 1974), 7.

[6]Herbert Franklin et al., In-Zoning: A Guide for Policy Makers on Inclusionary Land Use Programs (Washington, D.C.: The Potomac Institute, 1974), p. 132.

[7]Erber and Prior, p. 7.

[8]Franklin et al., p. 139.

[9]John A. Baade, "Required Low-Income Housing in Residential Developments: Constitutional Challenges to a Community Imposed Quota," 16 Arizona Law Review 445 (1974).

[10]Kleven, p. 1528.

IV.C.6. Conditional and Contract Zoning

Under contract zoning a landowner contracts with the local government to subject his property to deed restrictions in exchange for a desired zoning change. Conditional zoning involves similar limitations on and concessions from the developer, but there is no reciprocal obligation on the local government to change or forego any part of its regulatory power.[1]

Both conditional and contract zoning may be distinguished from special use permits that are accompanied by conditions in two ways: first, criteria that must be met before a special permit is issued are spelled out in the ordinance and apply equally to all property owners in the jurisdiction. Second, special permits require no concessions or commitments from the community; the applicant needs only to demonstrate that he meets the required conditions for the permit to be granted.

The purpose of these two techniques is to provide for flexibility in making decisions concerning individual parcels of land. By their use officials may reconcile various interests affected by land reclassifications and allow for utilization of property which is suitable for development but has been somehow poorly classified in zoning.

IV.C.6.a. Authority--Conditional or contract zoning must be authorized by zoning enabling legislation. In North Carolina, conditions may be attached to special use permits and variances, and certain concessions may be gained from developers through subdivision regulations. However, these are particular techniques which may be utilized only when certain predetermined circumstances are found to exist (only certain types of uses explicitly described in the zoning ordinance in the case of special permits; only when undue hardship results to the landowner due to zoning in the case of a variance; and only when a developer voluntarily subdivides his property in the case of subdivision regulations). Attempts to indulge in broad practices of contract or conditional zoning are almost certain to encounter legal differences. Although it is not clear that the practices are per se illegal, the North Carolina courts do seem to apply the terms in a pejorative manner to describe situations where rezoning has been granted to an individual tract of land based on assurances that the land will be developed in accordance with restricted plans and where there is no showing as to why the land should be opened to use which is not allowed on surrounding land.[2]

IV.C.6.b. Viability--Viability is difficult to assess. The general principle of flexibility to prevent arbitrary restraints on property caused by static zoning ordinances must be balanced against the need for consistency in land use decision-making. It seems likely that planners and large-scale developers would favor some degree of flexibility, while small property owners would prefer predictability.

Technical viability is dependent upon the degree of analysis which would accompany conditions and contracts. To determine thoroughly the impact of each project could become a burden on technological capability. Nevertheless, incremental determinations certainly can be more within technical capacity than long-range planning decisions. They do in fact provide for decision-making in a continually updated context.

The level of government to administer contract and conditional zoning is the local level, due to the detailed nature of negotiating, analyzing and setting conditions.

IV.C.6.c. Where It Has Been Used and to What Effect--Zoning with conditions has been found valid in New York since the early 1960's.[3] More comprehensive use has been made of conditional zoning in Sacramento County, California.

Research revealed no qualitative evaluation of results from local jurisdictions that have implemented zoning with conditions, although the observation has been made that contract zoning deals with problems on a piecemeal basis. Although it may yield satisfactory results for the owner of the parcel in question and for the municipality, neighboring property owners may not be protected from adverse consequences.

IV.C.6.d. Legal Issues--Legal problems may be of several types. First, the municipality may be accused of abrogating its police power by entering into a private contract with a landowner. This may be avoided if the city makes no binding promise to rezone. The agreement would thus be more in the form of a "unilateral contract" in which the city acts to rezone in return for the landowner's promise (a rather dubious distinction).

A second issue is the failure to meet the uniformity requirement. Although contract zoning has elsewhere been upheld against such claims, North Carolina courts are not likely to uphold rezoning subject to a proviso.[4]

Conditional zoning, if not explicitly illegal itself, may be collaterally attacked as spot zoning.[5] Contract zoning as such is almost certainly invalid in North Carolina.

IV.C.6.e. Coastal Application--Conditional or contract zoning offers the same advantages in coastal land-use management as do other flexible zoning tools, in that development may be analyzed and controlled on a case-by-case basis. This can be important in areas where development is to be permitted, but where good site design practices are desirable to protect the environment (for example, in aquifer areas and maritime forests). Conditional zoning can be more pervasive than PUD ordinances or subdivision regulations in that the former could be applied to all proposed structures while the latter are only applicable to large planned development or tracts that are subdivided.

But legal problems clearly limit applicability, as do practical problems of adequate staff to inspect every proposed structure. A limited application, perhaps through the special use permit, is more feasible.

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[1]Regardless of academic legal distinctions, courts have usually dealt with both under the general category of zoning with conditions. Michael E. Gleeson _et al._, _Urban Growth Management Systems: An Evaluation of Policy Related Research_ (Minneapolis: School of Public Affairs, Univ. of Minnesota, 1974), p. III-59.

[2]Allred v. City of Raleigh, 178 S.E.2d 432, 277 N.C. 530 (1971).

[3]Church v. Town of Islip, 8 N.Y.2d 354, 168 N.E.2d 580, 203 N.Y.S.2d 866 (1960).

[4]Michael Brough, "Flexibility Without Arbitrariness in the Zoning System: Observations on North Carolina Special Exception and Zoning Amendment Cases," 53 _N.C. Law Review_ 927, 949-958 (1975).

[5]Id.

IV.C.7. Special Exception

The special exception is one of the principal devices explicitly allowed in North Carolina which may allow flexibility to a land use control system. It is employed in areas where certain activities are found to be permissible, but require special control and/or scrutiny because of the particular problems they pose. Typically, the specified use is allowed by right in the area in question (often the entire zoning jurisdiction) if certain conditions or criteria are met by the applicant. These conditions must be specified in the ordinance.

This technique has been used recently as a rather comprehensive tool for growth management.[1] This was accomplished by designating all or almost all new development a special exception rather than a use by right. This approach has generally been found illegal.[2] However, where such broad application of the special use permit is used in connection with interim zoning, during times of study and decision on permanent zoning, it is more acceptable to the courts.[3] The criteria for gaining a special use permit may be conditioned upon prior existence of adequate municipal facilities or findings of no adverse environmental impact. Although requiring special use permits throughout an entire jurisdiction might be too extensive to be feasible, special use permits for most types of development in environmentally sensitive areas may be legally and practically acceptable regulatory tools.

IV.C.7.a. Authority--Authority to use the special exception exists in North Carolina pursuant to N.C.G.S. 160A-381 to 392 (for cities) and N.C.G.S. 153A-340 to 347 (for counties). The grant of power provides that the Board of Adjustment or the City Council may issue special use permits or conditional use permits, and may impose reasonable and appropriate conditions and safeguards upon these permits. Thus the Board of Adjustment is specifically authorized to attach additional conditions to a special exception permit.

IV.C.7.b. Viability--The special exception has been used extensively and seems politically acceptable for regulating types of development, the location of which poses particular problems or cannot be reasonably provided for in a static zoning ordinance or plan. The technique seems therefore politically acceptable in recognition of the need for flexibility in location decisions concerning certain types of development. When more comprehensively used, as for all new development in a particular area, the special exception could possibly encounter political resistance as excessive infringement on individual property rights and an excessive burden on development.

Technical viability would depend on at least two factors. First, the nature of the criteria which the special use must meet will affect the degree of technical information that would be required in processing a permit. Second, the number of cases or uses which are required to receive a permit would further determine the extent of the burden on technical, as well as administrative, staff capability.

The appropriate level of government to use the special exception is the local level, either city or county. This is because the process by definition requires detailed evaluation of permits on a case-by-case basis. A decision-making body would have to be familiar with the local situation and readily available to consider applications.

IV.C.7.c. Where It Has Been Used and to What Effect--The special exception has been used in North Carolina for many years. The result of its use, along with the variance and amendment techniques, has been a high degree of flexibility in varying from original zoning ordinances and moving toward *ad hoc* land use decision-making. Although flexibility is desirable in responding to rapidly changing circumstances, it also opens the decision-making process to greater pressure from special interests. Therefore, it is important that the criteria for granting special use permits be as reasonable and objective as possible, and that procedural safeguards be carefully provided to ensure fair decision-making.

IV.C.7.d. Legal Issues--The special exception has generally been upheld as constitutional where applied to a limited number of uses. But where every or almost every use is handled by special permit, the courts are likely to find the scheme invalid. The basis of attack is usually that it constitutes an unconstitutional delegation of legislative power. However, application of the special exception to all uses was recently upheld when tied to interim or holding zoning or the prior existence of adequate facilities. Specifically, existence of sewage systems, drainage, and access roads has been found to be an acceptable basis for special exception zoning.[4] The special exception has not been so broadly applied in North Carolina. Constitutional challenges have been based on the unconstitutional delegation theory,[5] and such decisions have turned on whether or not the administrative body based its decisions only on those considerations set forth in the ordinance. To allow decision by a nonlegislative body to be based on its own determination of a public purpose would be to allow an unlawful delegation of a legislative power.

There are no decisions in North Carolina which clarify how broadly the special exception may be used and still remain within the delegated power. The purpose of the special exception has been found to be "the amelioration of the rigors of necessarily general zoning regulations by eliminating the necessity for a slavish adherence to the precise letter of the regulations."[6]

The special exception process is administrative and therefore must follow the strengthened procedural requirements recently set forth by the North Carolina Supreme Court.

IV.C.7.e. Coastal Application--The special use permit allows flexible case-by-case guidance of development in two major ways: first, the location of the development may be controlled by the decision concerning issuance of the permit; second, the impact may be controlled by attaching conditions to the permit when issued. The comprehensiveness of the permit requirement should correlate with the degree of fragility or importance of the area involved. This both increases legal acceptability and keeps administrative burdens within bounds. For example, all development in beaches, dunes, washovers and inlet areas could be allowed only by permit. In maritime forests and parts of dune areas behind the shore protection line, all uses other than large-lot residential could be required to get a permit (to control density). Then, all uses which have a particularly great potential impact on the environment could be required to get a permit to locate anywhere within the jurisdiction.

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[1]Donald Hagman, Urban Planning and Land Development Control Law (St. Paul, Minn.: West Publishing Company, 1971), p. 207.

[2]Id.

[3]Id., p. 208.

[4]Robert H. Freilich, "Development Timing, Moratoria, and Controlling Growth: Preliminary Report," in Management and Control of Growth: Issues-Techniques-Problems-Trends, II, ed. by Randall W. Scott et al. (Washington, D.C.: The Urban Land Institute, 1975), 363-364.

[5]Keiger v. Winston-Salem Bd. of Adjustment, 178 S.E.2d 616, 278 N.C. 14, appeal after remand 190 S.E.2d 175, 281 N.C. 715 (1972).

[6]Lee v. Board of Adjustment, 226 N.C. 107, 37 S.E.2d 128 (1946).

[7]Humble Oil and Ref. Co. v. Bd. of Aldermen, 17 N.C. 458, 202 S.E.2d 129 (1973).

IV.C.8. Variance

The variance is found in almost all zoning ordinances. Its purpose is to grant a property owner relief from the strict requirements of the zoning ordinance when those requirements cause him undue hardship. Such an undue hardship is usually based on the unique attributes of the particular piece of property, and the decision-making body is granted the power to vary the permit to the extent necessary to allow reasonable use of the property.

IV.C.8.a. Authority--Authority to issue variances exists in North Carolina pursuant to N.C.G.S. 160A-387 (d) (cities) and N.C.G.S. 195-345 (d) (counties). This statute states that when practical difficulties or unnecessary hardships result from carrying out the zoning ordinance, the board of adjustment may modify or vary any regulations relating to the use, construction or alteration of buildings on the land.

I.V.C.8.b. Viability--The variance has been used extensively and would seem highly acceptable in recognition of the necessity to prevent undue hardship on individual landowners. However, used indiscriminately, it can allow increased influence-peddling in the land use decision-making process.

There are no great technical problems in the variance process if it is not overused. The only burdens are determining whether the hardship does in fact exist and then allowing minimal changes to allow reasonable use of the property.

The level of government suited to use the variance is the local level because the information and knowledge necessary to make decisions are site-specific and often small scale.

IV.C.8.c. Where It Has Been Used and to What Extent--Variances have been used for many years in North Carolina and practically all other states. The result has been that, although the criteria for granting a variance may be vigorous, they are granted liberally by administrative bodies.[1] Thus, landowners are protected from hardship and some flexibility is introduced into the zoning ordinance. Yet results are inconsistent application of the zoning ordinance and influence-peddling. The variance is best viewed as an escape valve rather than a planning tool.

IV.C.8.d. Legal Issues--Constitutional attacks have generally been in state courts and the challenge is usually based on the claim that the grant of power to the board of adjustment is an unlawful delegation of legislative power. The variance has been upheld against these attacks, except where the board has strayed to allow or deny it on the basis of the general public interest rather than undue hardship,[2] or to permit a type of use not allowed by the zoning ordinance rather than merely varying permitted uses.[3]

The issuance of variances seems not to be successfully challenged on any substantive basis other than as an unlawful delegation. The variance process is considered quasi-judicial and therefore must follow the procedural requirements recently set forth by the North Carolina Supreme Court.[4]

IV.C.8.e. Coastal Application--The variance has no particular coastal applicability other than its general function of providing an outlet where a land use regulation causes excessive or undue hardship on a landowner. Coastal jurisdictions which permit variances under their general zoning powers should be careful not to grant too many variances within or near critical environmental areas, lest the cumulative impact of these variances be to harm the natural processes of the areas. However, where new forms of regulation are being applied, the variance may be used to reduce excessive hardships caused by those regulations, thereby reducing the possibility of taking claims.

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[1]Donald G. Hagman, Urban Planning and Land Development Control Law (St. Paul, Minn.: West Publishing Co., 1971), p. 197.

[2]Keiger v. Winston-Salem Bd. of Adjustment, 178 S.E.2d 616, 278 N.C. 17, appeal after remand 190 S.E.2d 281 N.C. 715 (1972).

[3]Lee v. Board of Adjustment, 226 N.C. 107, 37 S.E.2d 128 (1946).

[4]Humble Oil and Ref. Co. v. Board of Aldermen, 17 N.C. App. 624, 195 S.E.2d 360, rev'd on other grounds 284 N.C. 458, 202 S.E.2d 129 (1973).

IV.C.9. Minimum Floor Space Requirement

The minimum floor space requirement technique has been used to promote the health and safety of the community by preventing overcrowding. Requiring residential construction to meet minimum floor space standards also has been used as a means of guaranteeing a minimum sized property and therefore a favorable tax base for a community.[1]

IV.C.9.a. Authority--Local governments are authorized to regulate the size of buildings and other structures by N.C.G.S. 153A-340 (counties) and 160A-381 (cities and towns), the general zoning enabling statutes.

IV.C.9.b. Viability--This type of regulation is not commonly used in North Carolina. Local governments have usually chosen to control population density by regulating lot sizes as opposed to residence sizes.[2] This type of ordinance requires no special technical expertise.

IV.C.9.c. Where It Has Been Used and to What Effect--This technique has a direct effect on housing prices. In Amherst, New York, where minimum requirements are 1,200 to 1,700 square feet, the corresponding minimum housing prices range from $22,000 to $29,320 (1970 figures).[3] In the Twin Cities (Minnesota) area, large floor area requirements are a serious constraint on the development of even moderate income housing.[4]

IV.C.9.d. Legal Issues--Minimum floor area requirements will be invalidated when they are not rationally related to a legitimate police power objective, in which case the ordinance will have violated the due process requirement. Challengers often argue that the purpose is invalid when the minimum floor area is enlarged beyond minimum health standards. There are older cases which hold that preserving the tax base is not sufficient justification for requirements in excess of those demanded by health and safety considerations. There are also cases which have upheld this type of regulation on the grounds that it preserves the tax base and adds aesthetically to the community.[5]

A leading recent case, Oakwood at Madison, Inc. v. Township of Madison, 117 N.J. Super. 11, 283 A.2d 353 (1971), involved a zoning ordinance which restricted new multi-family housing construction and for most of the remaining vacant land in the community required one and two-acre lot minimums with minimum floor space of 1,500 and 1,600 square feet, respectively. The lowest purchase price of housing to which these requirements corresponded was within the reach of only 10 percent of the population. The entire ordinance was invalidated for failure to promote a balanced community in accordance with the general welfare.

IV.C.9.e. Coastal Application--Minimum floor space requirements have no special applicability to coastal areas.

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[1]Michael W. Gleeson et al., Urban Growth Management Systems: An Evaluation of Policy Related Research (Minneapolis: School of Public Affairs, Univ. of Minnesota, 1974), p. III-37.

[2]Philip P. Green, Jr., Zoning in North Carolina (Chapel Hill: Institute of Government, Univ. of North Carolina, 1952), pp. 185-189.

[3]Richard F. Babcock and Fred P. Bosselman, Exclusionary Zoning: Land Use Regulation and Housing in the 1970's (New York: Praeger Publishers, 1973), p. 16.

[4]Ibid., p. 11.

[5]Gleeson et al., p. III-37.

IV.C.10. Regulation of Multi-Family Housing

The amount of multi-family housing in a community is often regulated by zoning. Regardless of the motive, the effect is to exclude lower and moderate income families from the community. Common justifications for such restrictions have been based on (1) the preferences of existing residents, preservation of the character of the community, protection of property values, and the maintenance of homogeneity of housing types and styles; (2) the idea that multi-family housing will generate more costs than revenues; and (3) environmental concerns.[1]

IV.C.10.a. Authority--The authority to regulate the number of multi-family units in a community exists pursuant to North Carolina zoning enabling legislation.

IV.C.10.b. Validity--The acceptance of this technique, if used in a non-exclusionary manner, is virtually universal. When the technique is used to limit the number of housing units available to lower and moderate income families, the device may be opposed by prospective residents and developers of multi-family housing.

IV.C.10.c. Legal Issues--Lower income and minority plaintiffs have been successful in challenging the validity of this type of zoning ordinance. Courts have begun to look at the exclusionary effect of such ordinances. Plaintiffs have had the best results in the courts of Pennsylvania and New Jersey.

In re Appeal of Girsh, 437 Pa. 237, 263 A.2d 395 (1970) held that an ordinance which had the effect of totally prohibiting multi-family apartment use within the town was invalid. The court reasoned that it was an impermissible use of the police power to use zoning to avoid the increased responsibility and economic burden which natural growth invariably brings. The court found that the town had in effect decided to zone out the people who would be able to live there if apartments were available.[2]

The New Jersey Supreme Court invalidated an amendment to a multi-family regulation which had the effect of totally excluding construction of low cost housing in Molino v. Borough of Glassboro, 116 N.J. 195, 281 A.2d 401 (1971). The amendment required that 70 percent of the units have no more than one bedroom, and required, among other things, the construction of tennis courts and swimming pools and the installation of air conditioning. The ordinance was struck down as inconsistent with the general welfare of the community (which violates due process of law) and was held to violate equal protection.

A zoning ordinance which had no provision for apartments and was amended to regulate apartment use was held invalid--both before and after its amendment in Township of Williston v. Chesterdale Farms, Inc., 7 Pa. Cmwlth. 453, 300 A.2d 107 (1973). The court concluded that a community must make provisions to accept its fair share of types of housing and income groups from within the metropolitan area.

There is no case law in North Carolina similar to these exclusionary zoning cases. It seems unlikely that the North Carolina courts would be as sympathetic to challenges of this type as were the more liberal state courts mentioned above.

IV.C.10.d. Coastal Application--Regulation of the quantity of housing is more important in coastal areas where resources (such as water supply) are not so plentiful as in other parts of North Carolina. Multi-family housing typically generates more demand per acre for services and resources than do other residential uses. Regulating the quantity of multi-family housing through zoning is one way of regulating the overall number of dwelling units. The basic issue is how much of each type of residence is needed before the area reaches its full development potential. The fact that multi-family housing uses space more efficiently and provides housing at a lower cost compared to single family dwellings should be considered when this decision is made.

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[1] Fair Housing and Exclusionary Land Use (Washington, D.C.: Urban Land Institute and National Committee Against Discrimination in Housing, 1974), pp. 57-58.

[2] Summaries of this and the following cases were taken from Fair Housing and Exclusionary Land Use, pp. 40-41.

IV.C.11. Bonus and Incentive Zoning

The bonus and incentive zoning technique allows the community to obtain amenities in a development in exchange for certain agreed upon concessions which will benefit the developer. It is generally used as an overlay to conventional zoning. For example, a landowner may be allowed to build at a higher density if the owner will agree to sequence development over a time period. This kind of zoning can be used to help assure that low income housing, adequate waste treatment facilities or other community necessities will be developed.

Usually the builder is allowed an exception from the zoning ordinance to build a way that would not be allowed under that ordinance. In return, the builder must agree to provide the desired amenity. For example, a builder may be allowed to exceed the prescribed height restriction if in exchange he provides a greater amount of open space around the building.

IV.C.11.a. Authority--Bonus and incentive zoning are not explicitly permitted by North Carolina zoning enabling legislation. The most analogous technique that is permitted is the variance, which allows minimal variation from zoning restrictions in cases of hardship. The variance may be accompanied by conditions. The requirement of undue hardship seems, however, to invalidate the analogy, and it seems likely that bonus or incentive zoning would be found illegal on the same grounds as contract zoning.

IV.C.11.b. Viability--Bonus or incentive zoning may be affected by the same problems that concern other flexible zoning tools. Case-by-case decisions raise the spectre of influence-peddling and political maneuvering. However, bonus and incentive zoning, if applied only for limited uses which have been determined to be in the public interest, would probably not affect the majority of landowners. Thus public resistance to this tool might be lowered.

The level of government best suited to using bonus and incentive zoning is the local level (where zoning is employed) because the tool has no meaning except in combination with traditional zoning restrictions.

IV.C.11.c. Where It Has Been Used and to What Effect--Incentive or bonus zoning has been employed in Rosslyn, Virginia, where in order to receive a zoning change a landowner must link the new facility to a pedestrian path. In San Francisco density bonuses are given for provision of such amenities as direct access to rapid transit. In New York's

Theater District, the incorporation of a legitimate theater in the development can be rewarded with a 20 percent increase in permissible floor area.[1] The technique seems to have worked in encouraging the desired results where used in the metropolitan context but, despite its potential, has been used little in nonurban areas.[2] The tool is different and adds somewhat in the practical sense to what can be accomplished in more rural areas through subdivision regulation of PUD ordinances, because it applies to developers only on a voluntary basis.

IV.C.11.d. Legal Issues--Legal problems might arise for two reasons. First, when used without traditional zoning, incentive zoning deals only with density, and not use, in classifying land uses. There may be questions as to whether this is within existing enabling legislation. (Apparently no municipalities have used this tool without also using conventional zoning.) Secondly, if used in combination with traditional zoning, the technique might be attacked as unlawful contract zoning. On the other hand, incentive or bonus zoning is similar to dedication, and the use of dedication has been upheld when used as part of a subdivision regulation and in other contexts.

An ordinance will have a better chance of meeting constitutional requirements if it starts with a rational underlying regulation to which the incentive is added and if it bears a rational relationship to the police power, i.e., if it is a reasonable means to achieve a permissible objective. The latter requirement is more troublesome than the former. Most of the purposes for which a local government would want to use incentive zoning are recognized as valid public purposes, but commentators disagree about the importance of the relationship between the amenity provided by the developer and the bonus allowed in return. For example, an incentive ordinance may allow a smaller lot size in subdivisions in return for more open space than is ordinarily required. There is an obvious relationship between allowing smaller lots and providing more open space. A more difficult situation arises when an ordinance allows smaller lots in return for the provision of bikeways. It may be that incentive ordinances for noncontroversial purposes are not likely to be challenged, and there is no consensus that even a tenuous relationship between the amenity and the bonus will cause the ordinance to be invalidated.

IV.C.11.e. Coastal Application--Bonus and incentive zoning could be used to encourage such concessions from developers as: replacement of destroyed vegetation, providing boardwalks for access to the beach, providing waste treatment facilities or building on pilings. Other desirable site design features are mentioned in discussions of subdivision ordinances, PUD's and other tools. Any of these could be attempted through bonus and incentive zoning.

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[1] Robert C. Einsweiler *et al.*, *Urban Growth Management Systems*, ASPO Planning Advisory Service, Nos. 309 and 310 (1975), p. 47.

[2] "Bonus or Incentive Zoning--Legal Implications," *Syracuse Law Review* 21 (1970).

IV.C.12. Floating Zones

Floating zones are shown in the ordinance text, but not on the zoning map.[1] A floating zone may be employed when the local government recognizes that a particular type of activity is desired for a general area but the specific site has not been located in advance. Property intended to be used for that activity may be rezoned upon application if the owner can meet the conditions in the ordinance. Thus a floating zone is verbally described as a certain type of zone and then waits to be affixed by a second ordinance to a particular piece of land which fits that description. Uses typically designated in floating zones include shopping centers, light industry and mobile home parks.

IV.C.12.a. Authority--Floating zones are not explicitly authorized by enabling legislation in North Carolina. A floating zone may be held invalid where spot zoning has been held invalid. This would likely be the case in North Carolina where spot zoning, which has been held invalid, is judicially defined in terms which seem to incorporate the floating zone concept. Spot zoning arises where a small area, usually single or a few lots, surrounded by other property of similar nature, is placed arbitrarily in a different use zone from that to which surrounding property is made subject, and where such a small area is subject to different restrictions from those applicable to surrounding property of like kind.[2] The purposes of the floating zone may be better achieved through use of the special exception technique, by requiring more detailed conditions to be met and findings made before the special use is granted.

IV.C.12.b. Viability--Political viability would involve balancing the problems of unpredictability against the advantages of increased flexibility. Decisions concerning locating such zones would become open to influence of special interests and other political acitivity.

Technical viability is probably good in the sense that specific placement of floating zones may be deferred until such a need is clearly defined. The locational decision can be based on actual facts rather than on abstract future needs. Such incremental guidance decisions may be technically superior to long-range static plans.

IV.C.12.c. Where It Has Been Used and to What Effect--Floating zones have been used in New York to allow 10-acre or more sites to be rezoned to permit multiple family dwellings where certain standards of size and height are met. In these cases the technique can give greater control over site design and can allow flexibility in locating such facilites.

IV.C.12.d. Legal Issues--In applying the floating zone technique, legal issues can be avoided if it is implemented as an extension of the special use concept.[3] The legal issues would involve the reasonableness and clarity of standards imposed on the proposed development and the reasonableness and public purpose rationale for designating some types of development as subject to the floating zone concept.

IV.C.12.e. Coastal Application--Use of the floating zone seems to add little for protecting the coastal environment. The technique seems primarily aimed at deferring location decisions for particular types of uses, so that the eventual location remains flexible and can be made in view of current development patterns rather than anticipating those patterns on a static zoning map. In the coastal context, the areas most in need of protection are known in advance. In addition, location of development that has potentially great impact can be generally controlled by the special use permit or AEC permits.

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[1]Donald Hagman, Urban Planning and Land Development Control Law (St. Paul, Minn.: West Publishing Co., 1971), pp. 117-119.

[2]Zophi v. City of Wilmington, 160 S.E.2d 325, 273 N.C. 430 (1968).

[3]Rogers v. Village of Tarrytown, 302 N.Y. 115, 96 N.E.2d 731 (1951).

IV.C.13. Performance Zoning and Performance Control for Sensitive Lands

Performance zoning sets standards for each zone based on permissible side effects of a development rather than specifically enumerating the types of uses permitted. If the prescribed standards are met, any use is allowed in the zone. This technique has been used for some time in industrial zoning to set standards on noise, glare, dust, toxic emissions, vibration, heat, odors, electrical disturbance, radioactivity and so forth. More recently, the technique has been applied to a broader range of uses, with standards keyed to demands on support services such as sewerage, roads and other public facilities. Further application may involve protection of the environment by specifying maximum levels of permissible stress on natural resources. For example, a community may specify the amount of runoff before development.[1]

Performance controls for sensitive lands can be perceived as a system to protect natural processes in environmentally sensitive areas, such as aquifers, stream valleys, wetlands, shorelands and flood plains. These performance controls contrast with the typical zoning ordinance which specifies land uses that can occur in any given area. Under an ordinance based solely on performance standards, all development would be permissible so long as it did not interfere with the natural processes of aquifer recharge, stormwater runoff, and so on, for which a community has set a specific level of performance. The performance control ordinance is designed to preserve natural processes by permitting development which is in accord with these processes rather than by banning all development in sensitive lands. Under performance controls it is up to the developer to prove that his project is compatible with the natural processes before the project is approved. In practice, performance controls are generally used in conjunction with traditional zoning ordinances.[2]

IV.C.13.a. Authority--The power to zone by use of performance standards is not explicitly granted by state zoning enabling legislation, and there are no court cases dealing with the technique. It may be argued that performance standards, if rationally devised and consistently applied, could qualify as a comprehensive plan, and zoning in conformance to those standards could be upheld under the broad grant of zoning powers for the public health, safety and welfare. Performance standards would seem to be permissible when used less comprehensively, for areas of particular environmental concern, as defined pursuant to the Coastal Area Management Act, floodplain zoning or other existing state legislation.

IV.C.13.b. Viability--Political viability would seem to be questionable if performance standards are applied to an entire jurisdiction due to the resultant uncertainty as to whether a use will be allowed. Further problems might result from distrust or lack of faith in ability to set standards objectively and accurately, due to lack of understanding of the methods and criteria. However, performance controls do present an ecologically acceptable compromise between full-scale development of sensitive lands and banning development on these lands altogether.

Technical viability depends on the comprehensiveness with which standards are applied and whether or not the entire jurisdication is subjected to them. Performance of certain processes may be measured readily, while techniques to measure others are still crude. Case-by-case considerations of every development proposal would impose a tremendous information and work load which could only be met by a large staff and/or sophisticated equipment. This is not presently a realistic expectation in the coastal area. However, this technical burden could be placed on the developer, with the local government staff or an independent agency certifying the results. Simpler applications of performance standards that do not require quantitative analysis are frequently inexpensive and do not require special data systems or staff.[8]

IV.C.13.c. Where It Has Been Used and to What Effect--Although performance zoning has not yet been implemented for comprehensive use by any locality, variations of the performance standard approach have been used throughout the Nation. Bucks County, Pennsylvania is developing a Natural Resources Plan based on a grid network information system that contains a computer file on the natural features of the county.[4] From this file a land use intensity plan can be developed according to the relative environmental sensitivity of each planning cell in the grid. From this a performance standard ordinance could be based on such calculations as the percentage of open space to be maintained in each planning district, the maximum permissible ratio of impervious surface to gross acreage or a maximum feasible density.[5]

Collier County, Florida has recently implemented a performance standard approach to protecting sensitive coastal lands such as mangrove swamps and coastal beaches. Development proposals in these areas must meet a number of environmental standards aimed at preserving natural drainage patterns and water quality levels.[6]

IV.C.13.d. Legal Issues--Legal issues center around the issue of vagueness of standards and/or their strictness. Thus the taking issue, due process and equal protection would be the major challenges. Courts have allowed some and disallowed other performance zoning ordinances, and the legal problems would be essentially the same as those for regulation of areas of environmental concern and wetlands.[7] Although predictability is difficult, regulations based on clear and rational performance standards would probably be legally acceptable in the coastal area when related to environmentally sensitive areas. Local authority to apply a performance standard approach in regulating development in AEC's is almost certainly granted in the Coastal Area Management Act.

IV.C.13.e. Coastal Application--Performance zoning has definite and specific applicability to the coastal area, but the feasibility is limited by the sophisticated techniques required for implementation. Standards of permissible impact on recharge in aquifer areas, sand transport in dune areas, vegetation in maritime forests, sedimentation and pollution discharge into waters, and changes in water flow, temperature, etc., are specific performance standards which could be used. Standards could be initially set for those impacts which are easier to measure (for example, destruction of vegetation or amount of runoff into waters).

The performance zoning approach is particularly appropriate for regulation of development in Areas of Environmental Concern designated under the Coastal Area Management Act. The authority exists to issue permits for development in AEC's based generally on a finding that the development will not be detrimental to that AEC's unique characteristics. Performance standards reasonably related to those unique characteristics may be set for all development. If the standards are not met, the permit should be denied. As long as the standards are reasonable, no legal problems should be encountered by such a system.

Application of performance standards in AEC's seems administratively feasible because the frequency of development in many AEC's will be low.

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[1]Michael E. Gleeson et al., Urban Growth Management Systems: An Evaluation of Policy Related Research, ASPO Planning Advisory Service, Nos. 309 and 310 (1975), p. 40.

[2]Id., p. 37; Charles Thurow et al., Performance Controls for Sensitive Lands: A Practical Guide for Local Administrators, prepared for the U.S. Environmental Protection Agency (Washington, D.C.: U.S. Government Printing Office, 1975), pp. 440-450.

[3]Thurow *et al.*, p. 2. Simple use of performance standards would be similar to North Carolina's sand dune protection ordinances and sedimentation control ordinance (see below, Section V.A.2., Sand Dune Protection Ordinances, and Section V.B.17., Regulations Pursuant to Erosion and Sedimentation Control Plans).

[4]Edward J. Kaiser *et al.*, *Promoting Environmental Quality Through Urban Planning and Controls* (Washington, D.C.: Office of Research and Development, U.S. Environmental Protection Agency, 1974), pp. 145-147.

[5]Bucks County Planning Commission, *Performance Zoning* (Doylestown, Pa.: The Commission, 1973).

[6]John Clark, *Rookery Bay: Ecological Constraints on Coastal Development* (Washington, D.C.: The Conservation Foundation, 1974), and Neno J. Spagna, "Can 'ST' Save Collier's Unspoiled Lands?" *Florida Environmental and Urban Issues*, 2 (June 1975), 4-6.

[7]See, for example, Just v. Marinette, 56 Wis.2d 7, 201 N.W.2d 761 (1972) and Sibson v. State, 336 A.2d 339 (1975).

IV.D. Regulation of Development

IV.D.1. Planned Unit Development (PUD) and Cluster or Average Density Zoning

Planned unit development and cluster or average density zoning combine elements of zoning and subdivision regulation in permitting flexible design of large and small-scale developments which are planned and built as a unit. Specific plans for the development are required in advance, and must be approved by the administering body. This concept eliminates the lot-by-lot approach common to zoning and subdivision regulations, and can be used as an incentive for better development by enabling complete schemes to be planned and approved.[1]

In its simplest form, planned unit development takes the shape of cluster development. An example might involve a developer with 100 acres of land which he could divide into 400 quarter-acre lots according to existing local ordinances. Cluster zoning would give him the alternative of clustering units closer together in one part of the site, provided that overall number of units does not exceed 400. The open space saved by clustering is left for the common use of the residents.[2] From this simple "density transfer" planned unit development builds into complex forms. In its most advanced stage, planned unit development allows a variety of housing types as well as commercial, agricultural and industrial uses.

Typically, developers are permitted to develop under PUD provisions when the proposed development exceeds a minimum specified number of acres or housing units. Planned unit developments are usually subject to zoning ordinances, although they are not actually mapped, and must therefore comply with the use restrictions within the zones where they occur. Increasingly, however, some mixing of uses and increases in density are permitted.

The PUD technique generally allows developments to concentrate structures in clusters, in order to retain the rest of the land in open space. The technique provides flexibility because the actual design is a matter of negotiation between the developers and planning authorities. PUD's are generally attractive to developers of large tracts of land, and generally, though not necessarily, to higher priced development.

IV.D.1.a. <u>Authority</u>--PUD ordinances are not specifically authorized by enabling legislation in North Carolina. However, many local jurisdictions, some of them in the coastal area, have such ordinances. Their validity has not been tested in the courts. Although the possibility exists that PUD ordinances may be upheld even in the absence of a zoning enabling provision, such enabling legislation is needed on the State level to remove doubts as to their validity.[3]

IV.D.1.b. Viability--Political viability would seem to be rather high in view of local passage in many jurisdictions of PUD ordinances despite lack of assurance of their validity. Technical viability will vary because past experience shows that the PUD process has generally been undertaken in jurisdictions having long experience with planning and zoning techniques and large and competent staffs. The PUD technique should therefore be considered as a primary tool for only those coastal counties with well-developed experience in the field of development control.[4]

The level of government best able to use the PUD technique is local because of the necessity for detailed information and specific negotiation between the regulatory agency and the developer.

IV.D.1.c. Where It Has Been Used and to What Effect--PUD ordinances have been used in Montgomery County, Maryland; Prince George's County, Maryland; Boulder, Colorado; Chapel Hill, North Carolina; and many other places. The tool relates primarily to larger developments, which generally will be located on fringe areas where large tracts of vacant land are likely to be found. Smaller developments and individual unit construction will not be controlled by this tool. Requirements of more sophisticated planning and information, as well as greater staff requirements to analyze them, can raise the cost of development and local government administrative expenses. This is evidenced by the higher income homes that characterize PUD's. Planned unit development may, however, be a useful tool to allow preservation of environmental characteristics in nondeveloped areas where residential use is allowed. PUD can also conserve energy and more economically provide for needed urban services.[5]

The various forms of PUD have been frequently championed as measures to protect the coastal environment by clustering development around sensitive areas, dunes, marshes, etc.[6] Currituck County, North Carolina has made extensive use of a variation of the PUD process in developing a highly celebrated land use plan designed to enhance the county's coastal resources.[7] Critics of the Currituck Plan, however, assert that the plan offers heavy densities as an inducement to developers for cooperation, disguised as cluster development for environmental protection.[8]

IV.D.1.d. Legal Issues--A recent study by the American Society of Planning Officials revealed that two-thirds of local PUD ordinances used either the special exception/conditional use procedure or a zoning amendment--and thus did not rely on specific state enabling legislation.[9] In North Carolina, then, legal attacks on PUD would be similar to those involving the special exception in that it might be challenged that such a use of the special exception might be an unconstitutional delegation of power. Nevertheless, a recent North Carolina Supreme Court case held that such use of the special exception would be legitimate provided that procedural requirements are adhered to.[10]

Other attacks on PUD ordinances are most likely to be based on the equal protection requirement that regulation be uniform to all similarly situated property owners. PUD may also be attacked as spot zoning in that it usually relates to only one landowner and land parcel, allowing it to deviate from regulations applicable to others in the same zone. Although some early applications of PUD were rejected in the courts,[11] more recently PUD has been upheld in most state courts where it has been tested.[12]

IV.D.1.e. Coastal Application--PUD ordinances and cluster zoning have significant potential for application in the coastal area, but only where the implementing jurisdiction intends to have adequately trained staff to review and improve proposed development plans. Also, use of the technique is limited to large developments, and thus does not touch the incremental development that predominates in the coastal counties. Nevertheless, the tool may be used to allow clustering and thus reduce destruction of sand dunes, marshes or other critical environmental areas. It may also encourage continuity of undeveloped natural areas and vegetation buffer zones to reduce erosion, siltation or storm surge damage. Planned unit development may encourage placement of structures in areas not prone to flooding and minimize the destruction of trees and other recharge-facilitating characteristics in aquifer areas. Handled well, it can be an effective tool for permitting development while reducing the harmful effects of development to an acceptable level.

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[1] See generally Robert W. Burchell, Planned Unit Development--New Communities American Style (New Brunswick, N. J.: Rutgers University, 1972), and F. So et al., Planned Unit Development Ordinances, ASPO Planning Advisory Service, No. 291 (1973).

[2] Daniel R. Mandelker, Managing Our Urban Environment (2nd ed.; Indianapolis: Bobbs-Merrill Co., Inc., 1971), pp. 1075-1078.

[3]Lee A. Patterson, II, "Planned Unit Development and North Carolina Enabling Legislation," 51 N.C. Law Review 1455-1478 (1973).

[4]Thomas J. Schoenbaum and Ronald H. Rosenberg, "The Legal Implementation of Coastal Zone Management: The North Carolina Model," Duke Law Journal (1976), to be published.

[5]Real Estate Research Corporation, The Costs of Sprawl (Washington, D.C.: U.S. Government Printing Office, 1974).

[6]For example see Charles Thurow et al., "Quotations from Snohomish County, Washington Shoreline Management Master Program, June 1974," Performance Controls for Sensitive Land: A Practical Guide for Local Administrators, prepared for the U.S. Environmental Protection Agency (Washington, D.C.: U.S. Government Printing Office, 1975), p. 105; and Frank B. Barick and T. Stuart Critcher, Wildlife and Land Use Planning with Particular Reference to Coastal Counties (Raleigh, N.C.: Interagency Wildlife Coordination Section, N. C. Wildlife Resources Commission, 1975), p. 102.

[7]Robert V. Bode and William P. Farthing, Coastal Area Management in North Carolina (Chapel Hill: Institute of Civic Education, The Law Center, Univ. of North Carolina, February 1974), Appendix A.

[8]Gary Soucie, "Fare-Thee-Well, Currituck Bank," Audubon, 78 (January 1976), 34-35.

[9]So et al., p. 49.

[10]Humble Oil and Refining Co. v. Chapel Hill Board of Aldermen, 284 N.C. 458, 202 S.E.2d 129 (1974). See Frederick Carr, "The North Carolina Humble Case and Its Impact on Planned Unit Development," Carolina Planning, 1 (Summer 1975), 44-50.

[11]Hiscox v. Levine, 31 Misc.2d 151, 216 N.Y.S.2d 801 (1961)--for abuse of administrative discretion, lack of uniformity. Eves v. Zoning Board of Adjustment of Lower Gwynedd Township, 401 Pa. 211, 164 A.2d 7 (1960)--for spot zoning and lack of uniformity.

[12]Orinda Homeowners Committee v. Board of Supervisors, 11 Cal. App.2d 768, 90 Ca. Rptr. 88 (1970)--held PUD complied with uniformity provisions. Cheney v. Village 2 at New Hope, 429 Pa. 626, 241 A.2d 81 (1968) upheld all aspects of the PUD process. Orrell v. Planning Bd., 66 Misc.2d 843, 322 N.Y.S.2d 44 (Sup. Ct. 1971) essentially held Hiscox v. Levine was no longer applicable.

IV.D.2. Traditional Subdivision Regulation

Subdivision regulations control the process of converting raw land into building sites. They can establish effective requirements and standards for public improvements, including streets, drainage pipes, sewer outlets, and so forth. These standards may be enforced by requiring the developers to post performance bonds.

Dedications of a specified amount of land (usually for parks or schools) or money in lieu of land force the developer (and indirectly the residents) of the subdivision to provide for needs generated by the subdivision. In this manner new development is made to pay for itself. When the developer is allowed to pay in cash instead of in land, the community is given additional flexibility in meeting the needs of the subdivision. If, for example, a good park site is not available on the land owned by a developer, the cash contribution can allow the local government to purchase a nearby park site for the neighborhood.

Standards have recently been broadened in scope, and a subdivision plot may be refused approval where there is a fair or substantial showing that the subdivision will cause undesirable off-site problems such as creating hazards, environmental degradation or increasing the burden on already overloaded public facilities, such as roads and sewers. In this newer form, subdivision regulations can facilitate orderly municipal growth in accordance with a comprehensive plan by controlling the sequence and time of development. Subdivision controls relating to off-site facilities are covered in a separate section (see below, Section IV.D.3.).

IV.D.2.a. Authority--Cities have authority to regulate subdivision in North Carolina pursuant to N.C.G.S. 160A-371. The regulations are developed and administered by the local city council, the city council on recommendation of a planning agency, or a designated planning agency. County subdivision regulation is enabled by N.C.G.S. 153A-330 and may be exercised by the Board of County Commissioners or their appointed agency.

A "subdivision" is defined as "all divisions of a tract or parcel of land into two or more lots, building sites, or other divisions for the purpose of sale or building development (whether immediate or future) and includes all division of land involving the dedication of new street or a change in existing streets."

As part of the subdivision control, North Carolina municipalities can require the "dedication or reservation of recreation areas serving residents of the immediate neighborhood within the subdivision" pursuant to N.C.G.S. 160A-372. School sites may be reserved in accordance with a comprehensive plan but there is no authorization for the dedication of school sites. The use of fees in lieu of land is not expressly authorized.

IV.D.2.b. Viability--Political viability of subdivision regulation has already been established as it is probably second only to zoning as the most widely used development management tool.

In general, current residents of a city can be expected to support a dedication requirement because it makes new development pay for its own park or school land. Developers and holders of developable land may be expected to oppose these restrictions.

Technical viability is not a major issue in traditional use of subdivision regulations which concentrates on good engineering and physical design criteria. Fine tuning regulations to protect environmental values (other than just aesthetics) seems to be substantially feasible. The limits to what degree of regulation is permissible are not clear. In drafting the ordinance, clear and uniform standards must be used to put developers on notice of how large the dedication must be.

The appropriate level of government to use the tool is the local government level, i.e., municipalities and counties. However, there are plausible reasons for advocating that large-scale subdivisions be regulated on a regional basis, generally based on the desirability of assuring that the regional viewpoint is represented in decisions concerning location and regulation of developments of sufficient magnitude to be of more than local interest.

IV.D.2.c. Where It Has Been Used and to What Effect--Subdivision regulation has been extensively used throughout all states. The results have been the maintenance of minimal design standards in new subdivision, the level of which will vary depending on the thoroughness with which the administering local agency develops and applies regulations. Dedication requirements are widely used. The amount of land required for dedication varies, usually from 3-12 percent of the subdivision's gross area.[1]

IV.D.2.d. Legal Issues--Subdivision regulations may be challenged on due process and taking grounds, but most courts have upheld a certain degree of regulation as a permissible application of the police power to protect the public health, safety and welfare (Mansfield & Sweet Inc. v. Town of West Orange, 120 N.J.L. 145, 198 Atl.225 (1938)). Dedication of land for streets and utilities is commonly required and has been generally upheld (Ridgefield Land Co. v. City of Detroit, 241 Mich. 468, 217 N.W.58 (1928)). Curb and gutter requirements and similar design criteria accompanying street and utility requirements have been upheld (Petterson v. City of Naperville, 9 Ill.2d 233, 137 N.E.2d 371 (1956)). Dedication of school and recreational sites has met mixed judicial reception.

The challenges in the early 1960's came in Illinois and New York. In Pioneer Trust & Savings Bank v. Village of Mt. Prospect,[2] the court invalidated an ordinance requiring that one acre per 60 families be dedicated to recreational purposes because it found that the overcrowded condition of the city was the result of the "total development of the community," rather than the subdivision in question. The test it created was that, "if the burden cast upon the subdivider is specifically and uniquely attributable to his activity, then the requirement is permissible; if not, it is forbidden and amounts to a confiscation."[3] This language clearly put a heavy burden on the city to show the connection between the increment of burden produced by the subdivision and the exaction demanded of the subdivision. In Gulest Associates, Inc. v. Town of Newburgh[4] the court invalidated an ordinance which allowed the city to charge fees in lieu of land dedication for recreational purposes because the money could then be spent on any recreational purpose in the city, and was not specifically earmarked to benefit directly the subdivision which had provided it.

More recently, courts have begun to uphold mandatory dedication ordinances. In 1971, in Associated Home Builders v. City of Walnut Creek,[5] the California Supreme Court affirmed the constitutionality of a statute which allowed cities to condition their approval on the dedication of land or payment of fees in lieu thereof, for park or recreation development near the subdivision so long as "the amount and location of land to be dedicated or fees to be paid shall bear a reasonable relationship to the use of the park and recreational facilities by the future inhabitants of the subdivision."

In 1966, in Jordan v. Village of Menomee Falls,[6] the Wisconsin Supreme Court found no constitutional difficulties with a municipal ordinance which conditioned approval of a subdivision on the dedication of land or payment of fees in lieu thereof, for the expansion of parks and schools, even though the state enabling legislation did not specifically authorize such conditions. Using the provision that the statute should be construed liberally, the court allowed the city the authority to impose the conditions where it could show that subdivision in general had the cumulative effect of creating a need for services (parks, schools, recreation facilities). More important, however, the court held that in order to prove unconstitutionality, a developer would have to show that the conditions were unnecessary in his case because the city already had adequate facilities, or that the normal growth of the city without the addition of the subdivisions would have required the extra facilities.

There is no case law on this issue in North Carolina, although the enabling legislation discussed above in Section IV.D.2.a. is substantially similar to that of Wisconsin, on which the Jordan case was decided.

There is likewise no case law in North Carolina which sheds light on the extent to which subdivision ordinances may be used for purposes of environmental protection. Because the public purpose doctrine is the best rationale for subdivision regulations, local ordinance requirements for dedication of open space or other regulatory techniques for the purpose of environmental protection would seem to stand or fall on the demonstrability of the public purpose served by regulating such areas.

IV.D.2.e. Coastal Application--This technique is useful as a means of protecting the coastal environment in two ways. First, in some environments, a dedication requirement can be used to provide open space and recreational space which is less destructive of the environment than are residential uses. The local government which decides whether the dedicated area is acceptable can ensure that it is located in the most advantageous site from an environmental standpoint.

Second, a subdivision ordinance can protect the environment by requiring public improvements such as sewer outlets and storm drainage facilities. Ordinances can be designed with enough flexibility to require that these types of facilities be provided only where necessary. In addition, design standards can be incorporated into the ordinance to reduce adverse effects on the environment. For example, subdivision ordinances could include a limit on the amount of impervious surfaces (such as roads) that could be constructed in areas such as aquifers and parts of the barrier island where roads can act as floodways.

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[1] M. Moore, "The Acquisition and Preservation of Open Lands," 23 Washington and Lee Law Review 289 (1966).

[2] 22 Ill.2d 375, 176 N.E.2d 799 (1961).

[3]Ibid., pp. 380, 802.

[4]25 Misc.2d 1004, 209 N.Y.S.2d 729 (Sup. Ct.) aff'd 75 App. Div. 815, 225 N.Y.S.2d 538 (1962).

[5]4 Cal.2d 633, 484 2d 606, 94 Cal. 630, appeal dismissed 404 U.S. 878 (1971).

[6]28 Wis.2d 608, 137 N.W.2d 442, appeal dismissed 385 U.S. 4 (1966).

IV.D.3. Subdivision Controls Relating to Off-Site Facilities

This type of ordinance requires that there be adequate off-site facilities available (such as parks, fire and police protection) before a subdivision will be approved. This technique is similar to the development timing ordinance made famous by Ramapo, New York, which was discussed earlier in Section II.F., Development Timing. It is different from a development timing ordinance in that no effort is made to predict when certain facilities will be made available by the local government. The purpose of the ordinance is not to "time" development, but make sure that development takes place only if there are adequate facilities to support development.

This tool is to be distinguished from traditional subdivision regulations which have as their purpose the assurance that the city will not have to bear the burden of providing an adequate infrastructure (or on-site facilities) to the development. On-site facilities which are often required in traditional ordinances are adequate water and sewer conduits, a road system which will match city standards, and dedication or reservation of land for parks and school sites.

In enacting subdivision regulations which take into account off-site facilities, the city is recognizing that new developments require more services than those listed above--the city water and sewage system may have to be expanded to handle the additional flow, parks and school facilities may be inadequate, the neighboring roadways may be inadequate to support the additional burden. These types of problems affect not only the subdivision, but the rest of the city as well, and through the conditioning of subdivision permits upon amelioration of these effects, the city can protect its own revenues and force the development to carry the burden it produces.

IV.D.3.a. Authority--Authority for subdivision regulation is found in N.C.G.S. 160A-372. That statute recognizes as legitimate objects of regulation, the provision of a coordinated street system, the provision of community service facilities (sewer and water facilities), and the dedication of parks, recreational areas, and the reservation of school sites. Performance bonding is approved where necessary. The statute further recognizes two goals of subdivision regulation: "(to) provide for the orderly growth and development of the city" and "(to) provide for the more orderly development of subdivisions." Under the first of those, it would seem that a city would have the authority to condition its subdivision permits on the provision of adequate off-site facilities, especially in light of N.C.G.S. 160-4, which indicates that the legislature intended that the provisions of that chapter be broadly construed "to include any additional and supplementary powers that are reasonably necessary or expedient to carry them into execution and effect." The power to implement subdivision regulations is guaranteed to a city by N.C.G.S. 160A-373, by which a city is authorized to condition the granting of permits on the approval of the city council, the planning commission, or both.

IV.D.3.b. Viability--In general, current residents of a city can be expected to support this type of regulation, as it will protect their tax revenues, and to the extent that it increases the price of development, will make their property more valuable. Developers and holders of developable land may be expected to oppose these restrictions.

IV.d.3.c. Where It Has Been Used and to What Effect--This technique is not yet in widespread use. It has been used effectively in the cities mentioned below.

Brooklyn Park, Minnesota, a distant suburb of Minneapolis, uses this technique as the key to its growth management system. Its subdivision ordinance requires the avaiability or provision of off-site storm drainage facilities prior to development. The cost of providing such facilities has allowed the city to prevent virtually all development on vacant land in the northern two-thirds of the municipality. Without expensive, staged construction of a storm drainage collection system in this area, premature residential construction would be in danger of flooding and would create flooding problems for the developed area to the south.[1]

Loudon County, Virginia, which is within the Washington, D.C., metropolitan area, has a zoning ordinance that requires applicants who seek rezoning of their property to make up the difference in capital costs that would be created by the development of their property should the rezoning be approved. The ordinance sets out standards and definitions that result in a real dollar amount to be paid to Loudon County on a housing unit basis.[2] While this ordinance does not relate directly to subdivisions, it is included here because a similar type concept could be made applicable to subdivision ordinances.

IV.D.3.d. Legal Issues--While subdivision controls relating to off-site facilities have been challenged in a number of state courts, the U.S. Supreme Court has never ruled on their validity, and so the cases cited below are all the decisions of the highest state court.

After a favorable ruling in a 1949 case, challenges to this type of regulation in the early 1960's brought forth stringent standards with respect to the types of standards a city might insist upon before the permits would be issued. The California Supreme Court upheld a requirement that a developer dedicate larger rights-of-way than were necessary for the amount of housing he was constructing in order to accommodate future growth.[3] The court based its decision on the fact that it found such regulations would directly benefit the development in the long run, in that landowners would not have to be disturbed by taking proceedings in the inevitable case of the expansion of the roads.

Further support for the use of this type of tool may be found in Noble v. Chairman and Township Commissioner of Mendham Township,[4] in which the plaintiff was challenging a requirement that an adjacent road be widened as a precondition to the approval of a subdivision. The Appellate Division of the New Jersey courts found that the planning board owed a duty to present and future landowners and residents to so condition the permit, as the result of its mandate to act in the public interest.

The court decision that upheld the Ramapo development timing ordinance (see above, Section II.F., Development Timing) strongly supports the validity of off-site facilities requirements.

IV.D.3.e. Coastal Application--In a rapidly developing area with limited resources, such as the North Carolina coast, this technique offers a fair and rational means of slowing development until the local government feels growth can be accommodated and making development pay for itself. This tool is applicable to any environment for which development is anticipated.

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[1]Michael Gleeson et al., Urban Growth Management Systems: An Evaluation of Policy Related Research (Minneapolis: School of Public Affairs, Univ. of Minnesota, 1974), pp. II-28-30.

[2]Ibid., p. II-50.

[3]Ayers v. City Council of Los Angeles, 207 P.2d 1, 34 Cal.2d 31 (1949).

[4]91 N.J. Super. 111, 217 A.2d 335 (1966).

IV.E. Numerical Restraints or Quota Systems

IV.E.1. Total Population Charter Provisions

Total population charter provisions attempt to establish absolute limits on permissible population, either by setting a numerical limit on population itself or on the permissible number of housing units or related permits.

IV.E.1.a. Authority--There is no explicit statutory authority in North Carolina which allows regulation for the purpose of limiting absolutely the population within a local governmental jurisdiction. The only authority would flow from the broadest imaginable interpretation of the general permission to regulate for the "public health, safety, and welfare."

IV.E.1.b. Viability--Political viability would appear to be low in the coastal area of North Carolina. Economic growth is a goal and a legitimate need in most localities, and attempts to thwart absolutely such growth will meet powerful opposition from practically all sectors of the population. Absolute growth limitations seem very simple, involving no technical or administrative problems, unless efforts are made to be selective concerning growth that takes place prior to reaching the limit. However, to be legally acceptable, very thorough and sophisticated planning capacities are required to show persuasive reasons for regulating population growth.

The level of government at which abolute growth limits are likely to be imposed is the local level, in cases where there are clear and overwhelming constraints on the environmental capacity of the area.

IV.E.1.c. Where It Has Been Used and to What Extent--A population quota was proposed by a citizens group in Boulder, Colorado, but was rejected by referendum.[1]

IV.E.1.d. Legal Issues--Legal challenge is practically assured by including absolute limits on population growth in any community plan. The Boca Raton restriction has faced legal challenges.

The New York Supreme Court found that a quantitative quota system was invalid since the ordinance violated the constitutional prohibition against taking property without just compensation.[2] The court dwelt on the fact that the regulation was not in accordance with a comprehensive plan, indicating that the power to control growth was valid only for regulation made in accordance with a comprehensive plan.[3]

Further constitutional challenge is likely to be based on the claim that an absolute limitation infringes on the fundamental right to travel, therefore requiring that the locality show a compelling justification for the regulation. This intensifies the requirement that any limitations, if acceptable at all, must based on <u>very</u> compelling justifications arrived at by thorough planning.

Although there are no North Carolina cases on quotas, it seems safe to predict that any limits on growth would be required to be very flexible and capable of modification, and based on extremely careful planning studies on a regional basis.

IV.E.1.e. <u>Coastal Application</u>--This tool rests on doubtful legal ground, and should probably not be attempted. Temporary moratoria or other strict regulation would be a better choice of tool where strong growth control is required. Furthermore, a population limitation approach, per se, would be difficult to apply in the coastal area since most of the population and therefore most of the pressure on the sensitive environmental areas is seasonal rather than permanent in nature.

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[1]Robert C. Einsweiler <u>et al</u>., <u>Urban Growth Management Systems</u>, ASPO Planning Advisory Service, Nos. 309 and 310 (1975), p. 45.

[2]Albrecht Realty Co. v. Town of New Castle, 8 Misc.2d 255, 167 N.Y.S.2d 843 (1957).

[3]Eisenweiler <u>et al</u>., p. 46.

IV.E.2. Population and Employment Targets

Setting annual targets for new employment opportunities and population growth is an attempt to assure a balance between the growth of residences and the growth of jobs within a locality. The objective is to prevent the area from becoming a strictly residential community. Policies pursuant to these targets may be used as guides for capital improvement programing and for decisions on rezonings, subdivisions, sewage treatment access and building permits.

IV.E.2.a. Authority--There is no specific authority in North Carolina for setting employment and population growth targets. Presumably, any efforts to do so through nonregulatory means are not legally objectionable, but to use regulatory measures to enforce the targets would require that the entire scheme be based on a strong public rationale.

IV.E.2.b. Viability--Population and residential targets would probably be acceptable as a very general guideline for healthy local development, but political acceptance would likely be low for any scheme that forecloses to a great extent the ability of people to live in one area while working in another. The ability of a locality to predict effectively or to develop new sources of employment seems to be questionable, thus making it difficult to balance employment targets and residential development, unless the process were used simply to maintain the status quo or to limit growth severely.

The level of government best suited to use this technique is the county level. Most municipalities in the coastal area are too small geographically to attempt a "balanced growth" objective within their borders; regional governments have no power to implement effectively such a policy; and the state level is too far removed to be concerned with detailed local implementation schemes.

IV.E.2.c. Where It Has Been Used and to What Effect--Population and employment targets have been proposed in Prince George's County, Maryland, but have not been officially adopted at this writing.[1]

IV.E.2.d. Legal Issues--Legal challenges have not been made because no such system has yet been implemented. However, unless a strong relationship can be shown, any such system that has the effect of limiting growth will probably need to be keyed to some factors other than the mere desire to balance employment and residences in order to be found to bear a rational relationship to a legitimate public purpose.

IV.E.2.e. Coastal Application--Population and employment targets are not very useful approaches to coastal environmental planning, in either the practical, political or legal sense.

Practically, a large proportion of coastal development is for vacationers who live and work permanently in other areas. These people would not be affected by reduced employment opportunities. Politically, the intentional restraint of economic growth would be unpopular because the area is poor and in need of some economic stimulation. Legally, it is difficult to see how industries can be actually prohibited, although they can certainly be discouraged. This tool therefore seems relevant only to those few coastal areas where there has been significant industrialization and urbanization.

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[1]Robert C. Einsweiler _et al._, _Urban Growth Management Systems_, ASPO Planning Advisory Service Reports Nos. 309 and 310 (Chicago: American Society of Planning Officials, 1975), p. 46.

IV.F.3. Annual Permit Limits

Annual permit limits may be used to limit population growth and construction by setting an absolute quota on the number of building permits that are issued by a city or county. While not protecting specific environments, the result of such a quota is to reduce the overall pressure of new development, and indirectly to reduce the threat to specific environments. A similar, although not so rigid approach, is to dictate stringent conditions which must be met before a permit will be issued. These conditions could include specific environmental conditions.

IV.E.3.a. Authority--North Carolina's building laws set various standards for structures in pursuance of the public health, safety, and welfare. However, absolute limitations on the number of permits are not mentioned in enabling legislation. The enabling statutes do not clearly state how stringent the conditions precedent to permit issuance may be.

IV.E.3.b. Viability--Absolute limits or stringent conditions are by nature technically and administratively simple. But a scheme would probably be locally acceptable only if based on thorough and complex planning efforts, and on a clear perception that rapid growth is posing severe problems for the jurisdiction involved.

The level of government that has traditionally administered building codes and permits is the local level, either city or county.

IV.E.3.c. Where It Has Been Used and to What Effect--Annual permit limits have been used in Petaluma, California and Pinellas County, Florida.

Petaluma, a suburban city north of San Francisco, set a limit of 500 units per year to be distributed on a geographical basis throughout the city, with at least 10 percent for low and moderate income housing.[1] The City Council has the power to increase or decrease the quota by 10 percent within a given year, provided that the balance of housing is maintained. Included in the reasons for this quota system was environmental protection.

Pinellas County, Florida, limits the number of permits issued in unincorporated areas and in municipalities served by its county water system.[2] The number of permits issued is related to the availability of scarce water resources, using an equation which contains those four variables appearing to impact most directly on water resources and demand: population distribution, rate of growth, land area, and assessed valuation. This model assigns to each of the 18 municipalities obtaining water from the county a percentage of the water available for new growth. Unincorporated areas receive allocations as well. No community is allowed to issue more building permits than can be served by its water allocation.

IV.E.3.d. Legal Issues--The Petaluma building permit system was challenged in federal district court. The court held that the quota system was not supported by any compelling governmental interest and that it constituted a violation of the right to travel.[3] However, on appeal, the higher court reversed the decision, holding that the plan was not exclusionary in that it furthered a legitimate state purpose to which the plan bore a rational relationship.[4]

The Pinellas County system has not yet been tested in the courts. Research reveals no North Carolina cases concerning building permit limits. However, it is an established rule of law in this state that issuance of a building permit does not vest in the landowner a right to build in the face of a zoning amendment subsequent to the initial permit, unless the landowner has already begun construction in reliance upon the permit.[5] This may imply that the decision to issue a building permit may be tied to flexible land use decision techniques if those techniques bear a reasonable relationship to the public health, safety and welfare.

IV.E.3.e. Coastal Application--Annual building permit limits would seem applicable for certain jurisdictions in the coastal area where rampant growth has outdistanced the local government's capability to provide service, thereby posing a serious threat to the environment. Permit limits must be closely linked to a reasonable growth plan, and if no or very little new building is allowed, strong justification should be shown. Thus the tool seems most applicable on the Outer Banks, because of their delicate nature and because of the special problems in providing adequate facilities.

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[1]Robert C. Einsweiler *et al.*, *Urban Growth Management Systems*, ASPO Planning Advisory Series Reports Nos. 309 and 310 (Chicago: American Society of Planning Officials, 1975), pp. 18-19.

[2]Id., pp. 19-20.

[3]Construction Industry Association of Anoma County v. City of Petaluma 375 F. Supp. 574 (1974).

[4](CA 9) 335; U.S. Supreme Court review sought 503.

[5]Town of Hillsborough v. Smith, 1970 S.E.2d 904, 276 N.C. 48, 49 ALR3d 1.

IV.F. Official Mapping

An official map is a map, officially adopted, which reflects a municipality's fixed decision to locate streets, parks and other facilities at the places marked on the map and to acquire property later. The map is implemented by a prohibition against improvements in areas earmarked for acquisition and enforced by injunctive relief and denial of the right to compensation for unauthorized improvements.[1] Most systems have a variance procedure for landowners who are unable to make a reasonable economic return on either the restricted parcel or the legal plot as a whole.[2]

IV.F.1. Authority

Enabling legislation is required prior to the use of this technique. At present in North Carolina, the use of mapping by local governments is authorized only for school sites. N.C.G.S. 160A-327 allows the reservation of school sites provided the sites are included in the local government's comprehensive plan. The school board must agree to acquire the site within 18 months of a subdivision proposal in order to prevent the private development of the land.

IV.F.2. Viability

The political popularity of mapping will depend to a great extent on the uses for which land may be reserved (the larger the area reserved the less popular) and the number of years for which the land may be reserved.

The use of mapping requires long-range planning capabilities.

IV.F.3. Where It Has Been Used and to What Effect

Several states allow the use of official mapping. There is little written about the results of using the technique, but there is no reason to suspect that it does not serve its stated purpose.

IV.F.4. Legal Issues

The major legal limitation on the use of official mapping is the taking problem. A brief discussion of the way courts have dealt with the technique follows.

While some existing statutes authorize official mapping not only of streets but of future park and drainage systems, the constitutionality of official mapping for areas other than streets is as yet uncertain. Courts have generally invalidated regulations as applied to specific properties if the regulations prevent all structural development. Often the relatively narrow strips of land needed for streets occupy small portions of lots, with considerable building space remaining on each lot. On the other hand, official maps for parks, reservoir sites, wildlife areas or other uses will often affect whole properties. The Pennsylvania Supreme Court in the well-known case of Miller v. Beaver Falls, 368 Pa. 189, 82 A.2d 34 (1951) held invalid a statute authorizing a park mapping plan and an accompanying ordinance which froze development for three years prior to public purchase. The New Jersey court, in New Jersey Lomarch Corp. v. Mayor of Englewood, 51 N.J. 108, 237 A.2d 881 (1968), displayed a somewhat less critical attitude in upholding the constitutionality of a statute which granted a municipality a one-year period to decide to purchase mapped parks and playgrounds. However, the court read into the statute an obligation of the municipality to pay for this one-year "option" to purchase.[3]

IV.F.5. Coastal Application

At present this is not a useful tool because enabling legislation in required. Even if authorized, this technique would have no more relevance to the coastal area than to other parts of North Carolina. It is simply a device to identify in advance where public facilities will be located. This tool can make a minor contribution to a municipality's efforts to manage and guide future development, but it is not a tool of major significance.

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[1]Jan Z. Krasnowiecki and James C. N. Paul, "The Preservation of Open Space in Metropolitan Areas," 110 University of Pennsylvania Law Review 184 (1961).

[2]Michael E. Gleeson et al., Urban Growth Management Systems: An Evaluation of Policy Related Research (Minneapolis: School of Public Affiars, Univ. of Minnesota, 1974), p. III-52.

[3]Jon A. Kusler, "Open Space Zoning: Valid Regulation or Invalid Taking?" 57 Minnesota Law Review 74 (1972).

IV.G. Regional Anti-Exclusion Techniques

Many land use and environmental regulations may have the effect, deliberate or not, of discriminating against low income and minority groups. Courts have sometimes invalidated ordinances on the grounds that they were discriminatory, particularly when they appeared to discriminate on the basis of race. When a court finds that regulations are motivated by racial discrimination, they will be struck down as violations of federal and/or state constitutions and laws. Some courts have gone further than just prohibiting discriminatory policies and have imposed on localities an affirmative obligation to consider regional housing needs in the exercise of their land use regulations.[1] A regional perspective on housing needs would appear to be supported by a recent decision in which it was held that the Department of Housing and Urban Development (HUD) abused its discretion in permitting community development block grants to seven suburban communities in the Hartford area.[2] Six of the seven communities reported that housing needs of low income people expected to reside within their borders were "zero." The decision emphasizes the illicit nature of local planning approaches that are exclusionary.

Two of the basic techniques that have evolved to ensure that a locality meets its obligation to accommodate low income residents are fair share allocation plans and inclusionary housing ordinances (discussed above in Section IV.C.5., Mandatory Low Income Housing Construction Ordinance). These concepts have generally been applied to low income housing, but the motivating principle is also applicable to other planning approaches (including land use and environmental regulations) that are discriminatory.

Patent discrimination against minority groups is clearly unjust and illegal, but often discrimination is more subtly achieved by using regulation to increase the cost of development. Such "economic" discrimination may be to some extent inevitable where effective land use and environmental controls are instituted, but wise planning can keep these effects to a minimum. Furthermore, one objective of local planning should be to provide the necessary public facilities to ensure that all residents have access to the natural amenities that coastal environmental planning is designed to protect.

IV.G.1. Authority

Anti-exclusion measures are primarily voluntary and require no special legal authority.

IV.G.2. Viability

Systematic exclusionary practices are probably not a large-scale problem in the coastal area because there are no large urban areas. The political acceptability of affirmative efforts to provide housing or other lower income programs depends to a great extent on the availability of federal grants. Local governments are the primary actors in this area. In larger metropolitan areas, the regional approach sometimes becomes necessary.

IV.G.3. Where It Has Been Used and to What Extent

Most anti-exclusionary approaches adopted to date have been in large metropolitan areas. The Miami Valley Regional Planning Commission in Ohio and the Metropolitan Council of St. Paul, Minnesota have established housing allocation plans.[3]

IV.G.4. Coastal Application

As coastal cities and counties are stimulated to undertake comprehensive planning for environmental purposes, they should use the opportunity to plan for social problems also. Affirmative efforts should be made to provide housing and public facilities, and to see that new land use and environmental regulations do not cause hardship to any particular group.[4]

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[1]Southern Burlington NAACP v. Township of Mount Laurel, 119 N.J. Super. 164, 336 A.2d 465, U.S. Supreme Court review denied (October 1975).

[2]City of Hartford v. Hills, CA H-75-258 (1975).

[3]Herbert M. Franklin *et al.*, *In-Zoning* (Washington, D.C.: The Potomac Institute, 1974), pp. 164-169.

[4]For further discussion, see *Fair Housing and Exclusionary Land Use* (Washington, D.C.: Urban Land Institute and National Committee Against Discrimination, 1974).

IV.H. Building Inspection

All North Carolina cities are authorized to have a building inspection department and must appoint building inspectors, electrical inspectors, plumbing inspectors and other inspectors as appropriate to enforce State and local laws relating to: (1) the construction of buildings and other structures; (2) the installation of such facilities as plumbing systems, electrical systems, refrigeration systems and air-conditioning systems; (3) the maintenance of buildings and other structures in a safe, sanitary and healthful condition; and (4) other matters that may be specified by the city council.[1] Counties also are authorized to establish building inspection departments, but are not required to do so.[2]

IV.H.1. Authority

The authority for cities to enact building inspection departments is found in N.C.G.S. 160A-411 to 438, and for counties in N.C.G.S. 153A-350 to 375.

IV.H.2. Assisting Authority

The North Carolina Building Code Council is authorized to establish a North Carolina State Building Code, which has the force of law and must be conformed to by all localities having a building inspection program (N.C.G.S. 143-138). The Building Code Council also is responsible for making changes in the State Building Code and for reviewing building laws. The Insurance Commissioner, through the Division of Engineering of the Department of Insurance, is responsible for enforcing the State Building Code throughout the State (N.C.G.S. 143-139). A recent opinion of the Attorney General, however, stated that the Commissioner of Insurance did not have jurisdiction in those counties that had not established building inspection departments. Coastal communities without a building inspection department, however, are able to qualify for the emergency program of the National Flood Insurance Program (see below, Section V.C.2., National Flood Insurance Program) through a specially devised flood insurance permit program. It should be noted that this program is separate from the State Building Inspection program and does not fall under the jurisdication of the State Building Code.[3]

IV.H.3. Viability

Building code provisions are generally politically acceptable except in rural areas where governmental regulations of any type are frowned upon. Building inspection requires professional competence and the ability to recognize defective structures. In coastal areas this is especially important because of a number of provisions in the State Building Code that are particularly applicable to coastal areas. All structures built within 150 feet of the ocean, for example, must be constructed on pilings. In addition, the Code spells out precise standards for the size, spacing and means of structure attachment for pilings. The Code also details requirements for areas that are subject to winds of over 75 miles per hour.[4] Unfortunately, most coastal areas lack the staff to administer these provisions adequately.

Building inspection is carried out almost totally at the local level because it requires specific on-site evaluation of structures on a case-by-case, continuing basis.

IV.H.4. Where It Has Been Used and to What Effect

North Carolina has long recognized the importance of building code provisions in minimizing hurricane damage. A State report issued after a series of devastating hurricanes in the mid-1950's stated that: "Much of this destruction could have been prevented through proper placement and construction of buildings."[5] Nevertheless, of the 20 coastal counties, only 7 had building inspection programs as of February 1975.[6]

In the past, enforcement of building codes in coastal areas throughout the United States has been sporadic, and developers of second-home cottages have been notorious for shaving code requirements. The upshot of inadequate coastal construction has been that during heavy storms cottages have been separated from their pilings to float at the whim of the storm, inflicting damage on more stable structures.[7] Substandard cottage construction also increases community and private costs if, and when, these cottages are used as full-time residences.[8]

IV.H.5. Legal Issues

Legal challenges generally involve applications of the standards of the State Building Code that have led to denial of building permits. The State Building Code has the force of law--Drum v. Bisaner, 252 N.C. 305, 92 S.E.2d 189 (1956) and Lindstrom v. Chesnutt, 15 N.C. App. 15, 189 S.E.2d 749

(1972). Localities may not amend the State Building Code by their actions--Greene v. City of Winston-Salem, 213 S.E.2d 231 (1975).

IV.H.6. Coastal Application

Building inspection, of course, is not applicable to those coastal environments where permanent structures are prohibited or are unlikely to occur, as is usually the case on the beach and on the primary dunes. Strict enforcement of the North Carolina State Building Code's standards for coastal areas, however, can lessen storm damage in such flood hazard areas as washovers, the dune field, inlet lands and marsh-lands.

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[1]N.C.G.S. 160A-412.

[2]N.C.G.S. 153A-351.

[3]Conversation with Philip P. Green, Jr., of the Institute of Government, University of North Carolina at Chapel Hill, March 4, 1976.

[4]These standards are cited from the State Building Code in Orrin H. Pilkey, Jr., et al., How to Live With an Island: A Handbook to Bogue Banks, North Carolina (Raleigh: N. C. Department of Natural and Economic Resources, 1975), pp. 79, 95; Chapter V of this book has detailed drawings and information on building in the coastal zone.

[5]Milton S. Heath, Jr., and H. Glenn Dunn, Report to the Secretary of Natural and Economic Resources Concerning Coordination of Regulatory Permits Under the Coastal Area Management Act (Chapel Hill: Institute of Government, Univ. of North Carolina, February 1975), p. 59.

[7]Pilkey et al., p. 51.

[8]For an analysis of the problems resulting from leisure home development see Council on Environmental Quality, The Fifth Annual Report of the Council on Environmental Quality (Washington, D.C.: U.S. Government Printing Office, December 1974), pp. 21-26.

IV.I. Regulation of Mobile Homes

There are several ways to regulate mobile homes, including licensing, inspection, taxation and zoning. Uniform standards regarding the construction and sale of mobile homes are contained in N.C.G.S. 143-144 through 143-148. Local building inspectors are charged with enforcement of the statutes. The focus here is on the use of zoning and local ordinances relating specifically to the use of mobile homes and mobile home parks.

Due to the general feeling of hostility toward mobile homes, communities often enact ordinances which prohibit mobile homes in all areas except mobile home parks, or restrict the location of mobile home parks to nonresidential district.

IV.I.1. Authority

The authority to regulate mobile homes stems from the North Carolina zoning enabling legislation and from legislation granting counties and towns the power to enact ordinances which protect the general health and safety--N.C.G.S. 153A-121 for counties and 160A-174 for cities.

IV.I.2. Viability

In spite of the improvements in design and construction of mobile homes, they are not popular with residents who live in conventional housing. Local resistance to mobile homes may be diminished somewhat by requiring that they be located in mobile home parks. This technique does not require special expertise or staffing.

IV.I.3. Where It Has Been Used and to What Effect

Restrictions on the use of mobile homes for residential purposes are in widespread use.

IV.I.4. Legal Issues

The different types of mobile home ordinances face different legal problems. Ordinances that limit the use of mobile homes to mobile home parks have generally been upheld.[1] These provisions provide for easier enforcement of health and safety standards. In State v. Martin, 7 N.C. App. 18, 171 S.E.2d 115 (1969), the court upheld the validity of an ordinance prohibiting the location of a mobile home anywhere in the town except in a mobile home park and sustained a conviction for violation of the ordinance by placing a mobile home on a lot behind a service station.

Ordinances that restrict the number of mobile home parks that may be operated in the community are often upheld. The ordinance in State v. Martin restricted the number of parks to those in operation on the date that the ordinance was passed. If the ordinance has the effect of excluding all mobile home parks, it is subject to the same constitutional objections as a straightforward attempt to exclude all mobile homes.

A community may not ban the use of mobile homes. Neither the use of a mobile home for residential purposes nor the operation of a mobile home park is inherently a nuisance when in compliance with reasonable sanitary and safety regulations.[2] If the use is not inherently detrimental to the public welfare, its absolute prohibition is a denial of equal protection of law and due process of law.[3] The North Carolina decision in Town of Conover v. Jolly, 277 N.C. 439, 177 S.E.2d 879 (1970), held that a mobile home is not a nuisance, per se, and that the town could not prohibit the use of mobile homes as permanent residences when the homes were constructed, equipped, located and used so as to present no threat to the health or safety of its occupants or of any other person. The court found a lack of authority for the ordinance without reaching the issue of whether the ordinance violated the State Constitution's due process clause.

Often municipalities restrict the location of mobile home parks to nonresidential districts. The fundamental residential character of the use poses serious questions as to the reasonableness of such a zoning ordinance.[4] In City of Raleigh v. Morand, 247 N.C. 363, 100 S.E.2d 870 (1957), the court upheld as valid exercise of the police power an ordinance that prohibited the construction and maintenance of a mobile home park in an area zoned for residential purposes.

There are cases going both ways in other jurisdictions on whether a mobile home parked in a single-family detached zoning district is permissible.[5] There does not appear to be North Carolina case law on this subject.

IV.I.5. Coastal Application

Mobile homes are popular in coastal areas, and local government must decide on appropriate regulations for their use. The hazards posed to residents of mobile homes in terms of wind and storm damage and possible adverse effects on the environment due to their use should form the basis of their regulation. In some coastal areas, such as washovers, the susceptibility of mobile homes to flooding is so great that their use should be prohibited.

Most mobile homes are dependent on septic tanks. Where the soil is not suitable to septic tank use, development of a park or mobile home site can be denied or conditioned on the use or provision of sewerage facilities.

Where mobile homes are located in parks to facilitate health and safety regulation and where the environment can tolerate their use, there appears to be no valid reason for excluding mobile homes from a community.

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[1]Barnett Hodes and G. Gale Roberson, The Law of Mobile Homes (Washington, D.C.: Bureau of National Affairs, 1974), p. 172.

[2]Ibid., p. 113.

[3]Ibid., p. 116.

[4]Ibid., p. 191.

[5]Ibid., p. 230.

IV.J. Municipal Enforcement of Restrictive Covenants

Restrictive covenants are private agreements between the landowner and the person to whom the land is sold or transferred. Generally restrictive covenants create negative easements governing how the land may be used. When used on a large scale, restrictive covenants can become an important land use control mechanism even in the absence of municipal enforcement.

Restrictive covenants are often used by subdivision developers who set the terms of the covenants for all the property in the subdivision. Frequently the terms govern architectural requirements, cost of construction, maintenance of the lot and exterior of the home and other controls not normally found in zoning ordinances.[1] This technique is often used in areas where zoning regulations apply.

Normally, only the landowners who benefit from the covenants can enforce them. There appears to be only one state (Texas) that allows municipalities to enforce these private contractual agreements. Advocates of municipal enforcement view this technique as a replacement for zoning. They claim that the rigidity and centralized decision-making of zoning is eliminated through the use of this technique. The system is decentralized in that land use decisions are initiated at the neighborhood level and flow upward to a centralized city enforcement machinery. It permits unique neighborhood development rather than imposing uniformity. Municipalities take on the burden of enforcement because unless they are regularly enforced the covenants cease to be binding. If uses not allowed by the covenants are permitted to exist, the covenants lose their ability to restrict how the land may be used in the future.

Municipal enforcement provides for equal enforcement throughout the restricted areas, despite the financial capabilities of local residents who may not be able to afford going to court to enforce the restriction.[2]

Obviously this technique can be applied only when there is a widespread system of restrictive covenants already in force. It gives the local government very little control over the nature of new residential development, leaving most of the decision-making in the hands of the developer.

IV.J.1. Authority

North Carolina municipalities would not have the authority to enforce private restrictive covenants absent express enabling legislation. It would be ill advised to assume that the courts would find implied authority for this technique in the zoning enabling legislation.

IV.J.2. Viability

Developers will probably welcome the use of this tool as a replacement for zoning. In areas where there is strong resistance to any land use controls, this may be a politically acceptable alternative to zoning.

The legal resources required for enforcement are probably not great once the local residents are certain that the local government is serious about enforcement. There should be some coordination between the legal department and planning department which may try to influence the terms that developers write into the covenants.

IV.J.3. Where It Has Been Used and to What Effect

In Houston, Texas, citizens for generations have relied on restrictive covenants as a means of controlling land use and have refused to adopt zoning. The land use pattern of the city is not a great deal different from other cities. However, the city does have subdivision controls, a minimum housing ordinance and a building code.[3]

IV.J.4. Legal Issues

Because of the uniqueness of this technique, many of the legal questions surrounding its use are not resolved. The use of the technique can be expected to be challenged on many grounds even where statutory authority exists.

IV.J.4.a. Due Process--To withstand judicial scrutiny, the municipal enforcement of deed restrictions must bear a rational relationship to a legitimate objective. There is no argeement that the technique will survive this challenge. One argument is that since the objectives of enforcement are identical to the objectives of zoning, the technique will not be invalidated as having an impermissible objective. It is unlikely that a court would say there is no rational relationship between enforcement of the restrictions and the objectives.[4]

The countervailing argument is that enforcement of private restrictive covenants without planning or standards is haphazard. If zoning must be in accordance with a comprehensive plan, then enforcement of covenants must also be in accordance or it will not be reasonable. To circumvent this objection the city could, for example, specify a set of uniform requirements with which restrictions must comply before the city will participate in enforcement of the private covenants. It could also map out and draw the restrictions for different areas of the city and present these to the developers as the only restrictions that the city would be willing to enforce in that area.[5] Politically, this could present a problem in that if residents are generally opposed to zoning, they would probably find this too close to zoning to be acceptable.

IV.J.4.b. Public Purpose--The expenditure of public funds to enforce private deed restrictions raises the public purpose issue. The argument for upholding this technique as having a valid public purpose is that a benefit is given to the entire community when decay and deterioration of neighborhoods are prevented. On the other hand, if the dominant benefit is to relieve a neighborhood civic association or a private individual from the burden of paying for litigation to restrain breaches of covenants, municipal enforcement may be regarded as an expenditure for a private purpose.[6]

IV.J.5. Coastal Application

If authorized under North Carolina law, municipal enforcement of restrictive covenants can be used as an addition to or as a replacement for traditional zoning. This technique could be used to prevent environmental damage if landowners were persuaded to agree to covenants which restrict the uses of their property or incorporate design standards or simplified impact standards.

Where zoning is currently used, restrictive covenants may prove to be useful, even though the municipality does not try to enforce them. It may be possible for local governments to introduce this concept of private regulation (at least in addition to the traditional restrictive covenants that are used) to local landowners and developers. This would offer more protection than existed before, even though the system is haphazard.

In short, whether or not the municipality can participate in enforcement, local landowners can bind themselves to covenants that would be very similar to many of the regulatory tools discussed in this Appendix. Restrictive covenants would probably not be a good substitute for zoning unless there was a system of municipal enforcement.

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[1]Bernard H. Siegan, Land Use Without Zoning (Lexington, Mass.: Heath and Co., 1972), p. 34.

[2]John C. Allen, "The Municipal Enforcement of Deed Restrictions: An Alternative to Zoning," 9 Houston Law Review 838 (1972).

[3]Siegan, p. 24.

[4]Allen, p. 822.

[5]Thomas M. Susman, "Municipal Enforcement of Private Restrictive Covenants: An Innovation in Land Use Control," 44 Texas Law Review 764 (1966).

V. ENVIRONMENTAL REGULATION

V.A. Locally Administered Regulation

V.A.1. Local Health Regulation

The purpose of local health regulation is to protect and enhance the public health and to enforce state laws pertaining to public health, rules and regulations of the State Commission for Health Services and of local health boards. Public health services are provided on a county basis by a county health department, by a contract with the State or by a joint multi-county district health department.

V.A.1.a. Authority--Local health regulation is the responsibility of local health departments. Authority exists in North Carolina for the establishment of local health departments in N.C.G.S. 130-13 *et seq*. The Department of Human Resources, Division of Health Services is authorized to establish reasonable standards for governing public health services provided by local health departments (N.C.G.S. 130-9)

V.A.1.b. Administration and Enforcement--Local health departments have policy-making boards which make rules and regulations not inconsistent with state laws pertaining to the protection and advancement of the public health. According to the legislation, subject matter already covered by the rules and regulations of the State Commission for Health Services can be augmented by more stringent local board rules and regulations if there is an emergency or a condition peculiar to that locality that requires such action in the interest of public health. If a conflict exists between a local board and the Commission, however, the rules and regulations of the Commission prevail.

A local board can also enact rules and regulations pertaining to only one municipality within its jurisdiction if conditions peculiar to that municipality warrant more but not less stringent rules and regulations. If municipal ordinances deal with health matters already covered by rules and regulations of the local board, the municipality can enact an ordinance more but not less stringent than the rules and regulations of the board if an emergency or conditions peculiar to that municipality exist and require such action.

The administrative head of a local health department is the health director who performs duties prescribed by law, the local board of health, and the Department of Human Resources and the Commission for Health Services.

V.A.1.c. Coastal Application--Several localities in the coastal area do have more stringent rules and regulations for certain health problems than those of the Commission for Health Services. For example, septic tank regulations are more stringent in several areas. If would seem that the adoption of stricter rules and regulations governing health problems that are peculiar to the coastal area would be a viable regulatory tool for local governments to use in dealing with estuarine pollution problems caused by heavy reliance on septic tanks. However, the political feasibility of using this legal power may not be possible or desirable in areas where no other alternative sewage treatment method exists. (See below, Section V.G.7., Regulation of Septic Tanks.)

V.A.2. Sand Dune Protection Ordinances

The Sand Dune Protection Act is designed to enable coastal counties to prohibit destruction and alteration of sand dunes oceanward of a shore protection line unless a permit is obtained from the county. The Act also prohibits construction of groins, jetties, piers and other similar structures unless a permit is obtained from the Department of Natural and Economic Resources.

V.A.2.a. Authority--N.C.G.S. 194B-3 *et seq*. enable the local Board of County Commissioners to establish a shore protection line and to designate a shoreline protection officer to administer and enforce the permit system. Decisions made by the shoreline protection officer may be appealed to the County Commissioners (N.C.G.S. 194B-4). The Environmental Management Commission of the Department of Natural and Economic Resources is empowered to establish shore protection lines and to designate shoreline protection officers in any county that had not adopted a sand dune protection ordinance by December 31, 1971 (N.C.G.S. 194B-6). The Environmental Management Commission is also authorized to give assistance to counties in their shore protection program (N.C.G.S. 194B-15). The Department of Natural and Economic Resources is authorized to prohibit construction of groins, jetties, piers and similar structures without a permit (N.C.G.S. 194B-11).

V.A.2.b. Viability--Although coastal counties were first authorized to delineate shore protection lines and establish permit programs in 1965, only two counties had done so by 1971, which prompted the amendment that authorized the Office of Water and Air Resources--whose sand dune powers now lie with the Environmental Management Commission--to establish shoreline protection programs by December 31, 1971 in those counties that had not already done so.[1] Consequently, all remaining coastal counties hurriedly drew shore protection lines to avoid state intervention. As a result, generally, the shore protection lines were drawn narrowly by the counties to protect only the frontline dune in minimum compliance with the Act.[2] The effectiveness of the Act was further weakened because at the time most of the coastal counties had neither planning controls to complement the shoreline program nor criteria to follow in enforcing sand dune ordinances. In practice, shoreline protection officers are generally local building inspectors untrained in coastal ecology and sand dune dynamics and subject to pressures by developers to issue permits.[3] Consequently, the sand dune protection program has been applied inconsistently. This is not to belittle the positive achievements of the Sand Dune Protection Act, but to suggest that the tool could be given new life within the context of the Coastal Area Management Act. If counties elected to redraw and expand their shore protection lines and had trained personnel to enforce the ordinances, sand dune protection could take on greater significance in protecting coastal ecosystems.[4] The potential of the Environmental Management Commission's exercising its power of providing information and assistance to localities and developers could also affect the future viability of this tool.

V.A.2.c. Where It Has Been Used and to What Effect--The Sand Dune Protection Act is in effect in all counties bordering the ocean but has been enforced inconsistently from one coastal county to the next, depending upon the political will of the County Commissioners and the capabilities of the shoreline protection officer.

V.A.2.d. Legal Issues--To date the Sand Dune Protection Act has not been challenged. This might be explained partially by the conservative application of the Act by most coastal counties. Potential legal challenges would parallel those applicable to regulation of development in areas of environmental concern.

V.A.2.e. Coastal Applications--Sand Dune Protection ordinances are specifically directed toward preservation of beaches and sand dunes. It appears that designating most or all of the dune area behind primary dunes to be covered within an ordinance is legally sound. Preservation of the beach and dunes will also facilitate management of development in maritime forests, by maintaining protection provided by the dunes against windblown salt, on washover areas by maintaining only the natural buffer to storm surge, and depending on how far back the line is drawn, in inlet areas by direct control of proposed development.

Regulation under a dune protection ordinance can be very thorough, and such an ordinance has great potential to accomplish thorough environmental protection in the regulated areas.

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[1]Robert Morgan, "On the Legal Aspects of North Carolina Coastal Problems," 49 N.C. Law Review 865 (1971).

[2]The case of Dare County is typical. See U.S. Department of the Interior, Environmental Assessment Cape Hatteras National Seashore (Denver, Colo.: Denver Service Center, National Park Service, 1974), p. 4.

[3]For an anlysis of the limitations of building inspectors, see Mark L. Shaffer and Kenneth G. Silliman, Implementation of the Coastal Area Management Act (Northeastern Field Office: North Carolina Department of Natural and Economic Resources, August 8, 1975), pp. 18-20. For an

example of dune destruction that occurred despite the Sand Dune Protection Act, see Orrin H. Pilkey, Jr., et al., How to Live With an Island: A Handbook to Bogue Banks, North Carolina (Raleigh: N. C. Department of Natural and Economic Resources, 1975), p. 32.

[4]Carteret County has already moved in this direction by revising its sand dune protection ordinance to include the entire Outer Banks. See Pilkey et al., p. 101; and David R. Godschalk et al., Carrying Capacity: A Basis for Coastal Planning? (Chapel Hill: Center for Urban and Regional Studies, Univ. of North Carolina, June 1974), p. 50.

V.A.3. Local Environmental Impact Ordinances

The North Carolina Environmental Policy Act of 1971 enables North Carolina localities to require detailed environmental impact statements from developers of "major development projects."[1] (See below, Section V.B.21., North Carolina Environmental Policy Act of 1971.) Like the federal and state environmental impact statement requirements, local environmental statements must generally include a discussion of the environmental impacts of the proposed development, of measures to mitigate adverse environmental effects, of alternatives to the proposed actions, of relationships between short-term uses of the environment and long-term productivity and of irreversible environmental changes.[2] The purpose of such a statement is to give localities the authority to encourage environmentally sound land use patterns by requiring developers to account for environmental values in project design and site layout.

V.A.3.a. Authority--The North Carolina Environmental Policy Act of 1971, N.C.G.S. 113A-8 to 10, authorizes localities to require environmental impact statements from developers of major development projects.

The North Carolina Environmental Policy Act of 1971, N.C.G.S. 113A-1 *et seq.*, and procedures adopted to implement this act may affect local environmental impact statement requirements.

V.A.3.b. Viability--While the idea of a local environmental impact ordinance is appealing to many localities as a way to control large development projects, the use of the tool has not been widespread. Generally, this limited use reflects a lack of understanding of the potential flexibility and adaptability of the tool, as well as a fear that such an environmental impact ordinance might add yet another burdensome procedural requirement to the development approval process.

For a local environmental impact ordinance to be effective, a locality must have the professional capability to review impact statements and to assist developers in laying out projects that adequately account for ecological processes. This review process would not necessarily be cumbersome, however, and environmental considerations probably could be readily incorporated into the existing subdivision and planned unit development review process (see above, Section IV.D.1., Planned Unit Development, and Section IV.D.2., Traditional Subdivision Regulation).

V.A.3.c. Where It Has Been Used and to What Effect--Like the State's requirement of environmental impact statements, the enabling legislation for local environmental impact statements has been largely ignored, despite its potential for improving coastal land use patterns and involving the public in localities' decision-making process. Only one coastal county, Carteret, has passed a local environmental ordinance and it ultimately repealed the ordinance. The attempt is said to have foundered upon a misconception that the North Carolina Environmental Policy Act was useless for local purposes without specific statutory direction of what an environmental impact statement was to contain.[3] Here the confusion resulted largely because of the lack of state guidelines. There is no reason a locality could not adopt a simple, short-form environmental impact statement (EIS) format to comply with its needs as long as the major subject areas listed in the description above are covered.[4]

The only coastal locality that has an environmental impact ordinance in effect is the small community of Holden Beach, North Carolina, which passed the ordinance primarily as a way to control a State-approved development that the locality opposed. One analysis of the Holden Beach case contends that "the ordinance raises questions whether such a requirement is viable unless the local government has the staff expertise to monitor accuracy of any statement, the political will to enforce the requirements for comprehensive statement, or adequate land use standards."[5]

V.A.3.d. Legal Issues--Because of its limited application in North Carolina, no lawsuits have occurred involving local environmental impact ordinances. However, several other states require that local governments conform to environmental impact procedures.[6] The highest court of California, for example, has held that the local environmental impact ordinance procedure is required upon a locality's issuance of a special use permit where the project would significantly affect the environment.[7]

V.A.3.e. Coastal Application--The local environmental impact ordinance is most useful in those coastal environments or parts of coastal environments that are likely sites for major development projects, such as maritime forests, dune fields, marsh areas, and swamps. The local environmental impact ordinance could potentially assist in protecting coastal processes by mimimizing unnecessary alterations of coastal terrestial environments and by reducing the indirect adverse effects they have on the estuarine system.

[1]N.C.G.S. 113-9 (1) states that the term "major development project shall include but is not limited to shopping centers, subdivisions and other housing development, and industrial and commercial projects, but shall not include any projects of less than two contiguous acres in extent."

[2]See below, Section V.C.1., National Environmental Policy Act of 1969 (NEPA), for the requirements.

[3]Charles E. Roe, "The North Carolina Environmental Policy Act: Neglected Planning Tool," Popular Government 41 (Fall 1975), 46.

[4]Thomas Schoenbaum and Ronald Rosenberg, "The Legal Implementation of Coastal Zone Management: The North Carolina Model," Duke Law Journal (1976), to be published.

[5]Roe, p. 47.

[6]Nicholas C. Yost, "NEPA's Progeny: State Environmental Policy Act," Environmental Law Reporter 3 (1973), 50090-50098.

[7]Friends of Mammoth v. Board of Supervisors, 8 Ca.3d 247, 104 Cal. Rptr. 761, 502 P.2d 1049 (1972).

V.B. State-Administered Regulations

V.B.1. Regulation of Public Drinking Water Supplies

This tool provides for the regulation and inspection of all public drinking water supplies including watersheds where drinking water is obtained and for the prevention of contamination of these supplies by sewage and industrial waste.

V.B.1.a. Authority--Authority for regulation of water and sewer sanitation has been granted to the Department of Human Resources, Commission for Health Services by N.C.G.S. 130-157.

V.B.1.b. Assisting Authority--Under the Safe Drinking Water Act of 1974, EPA is authorized to establish national standards for drinking water for protection of public health. The states are supposed to enforce these standards and supervise water supply systems and sources. In addition, they may set secondary standards for taste, odor and appearance of drinking water.[1]

V.B.1.c. Administration and Enforcement--Before a water supply system can be constructed or altered, plans, surveys and information required by the rules and regulations of the Commission for Health Services must be submitted. The plans must be approved and the water supply system inspected by the Division of Health Services before a board, authority or person may enter into a contract for an existing or new water supply system.

Public water supply systems also must meet the standards, criteria and requirements adopted by the Commission to secure plan approval.

To prevent contamination of public drinking water supplies, all sewage and industrial wastes are required to be treated by a system of purification approved by the Commission for Health Services and the Environmental Management Commission before discharge in areas upstream from or affecting a public drinking water supply. The statute also prohibits anyone from damaging a public water supply.

Drinking water supply standards are set by the Commission for Health Services. These standards are enforced locally by the local health departments which are required to employ sanitary engineers and other specialists to inspect water supplies and approve plans.

V.B.1.d. Coastal Application--The quality of drinking water supply has been a problem in coastal areas where septic tanks have contaminated the groundwater supplies. To ensure high quality drinking water, localities should strictly enforce septic tank regulations. If a locality continues to have septic tank contamination problems with the drinking water quality, the local health boards should consider adopting more stringent regulations than those of the Commission for Health Services. Drinking water standards may provide an additional compelling reason for imposing limitations on septic tanks in many coastal areas.

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[1]Environmental Protection Agency, "The Safe Water Drinking Act of 1974," Environmental Information (Washington, D.C.: U.S. Government Printing Office, 1975).

V.B.2. Mosquito Control

This regulation is concerned with the control of mosquitos by maintaining mosquito control districts, by accepting and allocating federal grants-in-aid and state funds to local units for controlling mosquitos, and by administration of adopted rules and regulations for mosquito control programs, including inspection, spraying, draining, filling and dredging of land.

V.B.2.a. Authority--The Department of Human Resources is authorized to maintain control districts and allocate aid in accordance with the rules and regulations adopted by the Commission of Health Service by N.C.G.S. 130-206 *et seq*.

V.B.2.b. Administration and Enforcement--Mosquito control districts and local governments are generally responsible for direct regulation of mosquito control. Administration is the responsibility of the Division of Health Services.

V.B.2.c. Coastal Application--The rules and regulations adopted by the State Commission of Health Services enabled by the Mosquito Control Act of 1957 authorized the construction of wide, steep-sided, deep ditches in the coastal salt marshes to drain ponds which, when flooded, bred mosquitos. Those were later discontinued because of adverse effects on the environment surrounding these ditches in Pamlico, Carteret, Onslow and New Hanover counties. At the present time, the State Commission of Health Services has no plans to construct additional ditches.

V.B.3. Prohibited Discharges to Water

A permit must be obtained from the Environmental Management Commission to discharge either directly or indirectly or cause to mix with the "waters of the State" any waste which violates water quality standards of the stream classification or which violates the effluent standards established for the point source. "Waters of the State" are defined in N.C.G.S. 143-213(2) to include all bodies or accumulations of water, surface or underground, public or private, and natural or artificial which flow within or through the State. Thus the water quality of the State is regulated by the non-point source approach of water quality standards for each stream classification and by the point source approach of effluent standards for each type of point source discharge.

V.B.3.a. Authority--Authority is given in N.C.G.S. 143-215 to the Environmental Management Commission.

The effluent standards and stream classification standards are set by the U.S. Environmental Protection Agency in accordance with 33 U.S.C. 402. However, the regulatory power can be granted to the state if it meets the requirements of the National Pollutant Discharge Elimination System permit program.

V.B.3.b. Administration and Enforcement--North Carolina has met the requirements of the NPDES permit program and soon will have the authority to enforce federal water quality regulations along with State regulations. (See below, Section V.C.3., National Pollutant Discharge Elimination System.)

V.B.3.c. Coastal Application--The fragile and sensitive estuarine waters make water quality regulation essential to the coastal area. More shellfish areas are closed each year due to the poor quality of estuarine waters polluted by inland streams. Strict enforcement of point source discharge from businesses, industries, treatment plants and others can reduce the problem of point source pollution, leaving more time to deal with the more difficult problem of non-point source pollution from septic tank, stormwater and agricultural runoff.

V.B.4. Regulation of Solid Waste Disposal Sites

Regulation of solid waste disposal sites may take the form of standards for the establishment, location, operation, maintenance, use and discontinuance of sites and facilities. Regulation is for the purpose of preventing pollution of surface and groundwater, air pollution through burning and undesirable effects from special types of wastes.

V.B.4.a. Authority--The Department of Human Resources, Commission of Health Services is the designated agency for promulgating rules and regulations for disposal sites and for approving of sites pursuant to N.C.G.S. 130-166.16. The Department of Human Resources can also accept and distribute funds from sources including the federal government for providing solid waste disposal sites. In accordance with the Federal Solid Waste Disposal Act (P.L. 89-272), EPA has established standards for solid waste disposal sites. These federal standards are administered along with the State standards by the Department of Human Resources, Division of Health Services.

V.B.4.b. Administration and Enforcement--Statewide standards for the establishment, location and maintenance of solid waste disposal sites and facilities are set by the Commission of Health Services. Local governments and county health departments are generally responsible for direct regulation of these standards. Before a solid waste disposal site and facility can be utilized, the standards must be met and the site approved by the Commission of Health Services.

V.B.4.c. Viability--The rules and regulations adopted by the State Commission of Health Services have made open dumps illegal. Throughout the State, 469 open dumps have been replaced with 169 sanitary land fills. The State rules also require each county to develop a plan including an approved disposal site and a containerized system for rural areas. The plans are evaluated quarterly.[1]

V.B.4.d. Coastal Application--All 20 coastal counties have approved solid waste disposal plans, including a disposal site and containerized system. All plans are presently in operation except in Tyrell County, where the demand is not great enough to operate a system of its own. Waste disposal plans can be a tool to ensure that waste disposal sites are not located where they will adversely affect groundwater supplies or the quality of surface runoff into wetlands or productive estuarine areas.

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[1]Conversation with Jan Usry, Division of Health Services, N. C. Department of Human Resources, July 1975.

V.B.5. Prohibited Discharges (Ocean Disposal)

Discharges of waste including thermal discharges into the Atlantic Ocean are prohibited by statute. However, the Environmental Management Commission (DNER) has the power to adopt regulations to permit exceptions.

V.B.5.a. Authority--The Environmental Management Commission is given the regulatory authority in N.C.G.S. 143-214.2. On the federal level the Environmental Protection Agency has the regulatory authority for discharge from point sources under Section 402 (National Pollutant Discharge Elimination System) of the Federal Water Polution Control Act. This includes point sources such as ocean outfalls. Under the Marine Protection, Research and Sanctuaries Act of 1972 (P.L. 92-532), EPA has the authority to issue permits for ocean dumping of all waste based on criteria established by EPA, by the U.S. Army Corps of Engineers, and by the Office of Coastal Zone Management jointly.

V.B.5.b. Administration and Enforcement--So far the State Environmental Management Commission has not adopted regulations to permit exceptions to ocean disposal. The EPA has not yet set guidelines for either ocean outfalls under the National Pollutant Discharge Elimination System's effluent standards or for ocean dumping under the Marine Protection Research and Sanctuaries Act. The State's policy at present is to prohibit discharge to the ocean until EPA establishes guidelines. When EPA sets the guidelines, the State Environmental Management Commission will use them to issue permits under its National Pollutant Discharge Elimination System authority.

V.B.5.c. Coastal Application--Local governments do not have direct jurisdiction over ocean waters, and therefore must appeal to the state and/or federal agencies to regulate private activities of those waters. Although there is not yet substantial dumping of refuse in the ocean off the North Carolina coast, there is the possibility that this method of disposing of wastes will be increasingly used as an alternative to present methods which have proved to be damaging to the environment. Any locality that plans to use ocean dumping or wants to see that ocean dumping by private persons or nearby jurisdications is properly analyzed and regulated may need to invoke the state and federal ocean dumping permit process. (See below, Section V.C.4., Ocean Dumping Permit).

V.B.6. Regulation of Construction of Water Wells

This type of regulation may be used to control the construction of water wells with a withdrawal capacity great enough to affect significantly groundwater or wells of any size in an area where groundwater resources require special protection. Permits may be denied upon finding that a well is or may be a source or channel of contamination of underground water supplies or aquifers. Regulation may be extended to periodic inspection and/or monitoring of water resources to assure that the wells function without damage to those resources.

V.B.6.a. Authority--Statutory authority exists in North Carolina purusant to N.C.G.S. 87-88. The Division of Environmental Management in the Department of Natural and Economic Resources is responsible for administering this regulation.

V.B.6.b. Administration and Enforcement--A permit is required from the Division of Environmental Management for the construction of any well with a capacity of 100,000 gallons or greater, or any well in a hydrologically sensitive area. Before a permit is given, a water well must meet certain construction standards set out in rules and regulations adopted by the Environmental Management Commission. Specific requirements include testing and chlorination of water supply wells, equipping artesian wells with valves so they can be shut off when not in use, and prohibiting the use of wells for recharge or injection of waste without permission from the Environmental Management Commission with recommendations from the Commission for Health Services.

Violation of these regulations is subject to a penalty of $100. If violations are willful, a person may be fined for each day as a separate violation.

V.B.6.c. Coastal Application--Most of the water supply sources in the coastal area are water wells. The regulations concerning construction of water wells can be used to protect groundwater sources from excessive withdrawal which can increase saltwater intrusion. Regulations can also protect water sources from contamination by improper waste disposal and other pollutants.

V.B.7. Regulation of Septic Tanks

Regulation of septic tanks can ensure that these facilities are not permitted in areas where soil type, subsurface conditions, groundwater conditions or proximity of surface water dictate a high likelihood of malfunction, sanitation problems or environmental pollution.

V.B.7.a. Authority--Authority to regulate septic tanks exists in North Carolina pursuant to N.C.G.S. 130-160 *et seq*.

V.B.7.b. Administration and Enforcement--Owners of single or multi-family residences, places of business, and places of public assembly are required to provide sanitary systems such as an approved privy, an approved septic tank system or a connection to a public sewage system. The jurisdiction for regulation of sanitary systems, including septic tanks, is split between two different departments. The Commission for Health Services in the Department of Human Resources approves all sanitary systems with a capacity of less than 3,000 gallons. This would apply, for example, to all single-family systems. For systems with a capacity of 3,000 gallons or more, approval must be obtained from the Environmental Management Commission in the Department of Natural and Economic Resources.

For septic tank installment or improvement of a system of less than 3,000 gallons capacity, a permit must be obtained from the Commission for Health Services. Before such a permit is granted, a determination must be made that the land is suitable for the system, based on soil porosity, topography, depth to the water table and other appropriate factors. This permit must be obtained before the construction or improvement of a building can commence. Failure to obtain such a permit is a misdemeanor and is punishable by a fine not greater than $200.

V.B.7.c. Viability--In 1974 the Board of Water and Air Resources, now the Environmental Management Commission, adopted disposal and septic tank regulations of importance to the coastal area. The regulations apply only to septic tanks within the Commission's authority and so apply to sewage systems greater than 3,000-gallon capacity, which include many motels, restaurants, condominiums and industrial plants. Included in these adopted regulations is the prohibition of septic tanks in areas that produce more than 1,200 gallons of waste water per acre per day or in areas with a present density of three residences per acre. These regulations effectively broaden the powers of the Commission and give it the potential power to limit and control growth in the coastal area.[1]

V.B.7.d. Coastal Application--At present, septic tanks are an important concern of coastal local government. Much of the development in the area utilizes septic tanks and most of the coastal soil types are not suitable for septic tank disposal systems. New, stricter septic tank regulations have recently been adopted by both the Commission for Health Services and the Environmental Management Commission. However, because of the dependence on septic tanks for waste disposal and the few soil types suitable for their use, these new regulations will not be implemented until more studies are made. Through the local health boards (see above, Section V.A.1., Local Health Regulation), local government can adopt and enforce more stringent regulations on septic tanks than those of the Commission for Health Services if health conditions peculiar to that locality exist.

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[1]Robert Bode and William Farthing, Jr., Coastal Area Management in North Carolina: Problems and Alternatives (Chapel Hill: Institute of Civil Education, The Law Center, Univ. of North Carolina, 1974).

V.B.8. Obstruction of Navigable and Open Waters

The purpose of this tool is to regulate the dumping of waste and the erection of signs or other structures in navigable waters. Also prohibited without a permit is the willful obstruction of streams, creeks and drainage ditches resulting in the impedance of stream flow.

V.B.8.a. Authority--Authority for regulating coastal navigable waters is given to the Department of Natural and Economic Resources and inland navigable waters is given to the Wildlife Resources Commission pursuant to N.C.G.S. 76-40. Authority for regulation of streams, creeks and drainage ditches is found in N.C.G.S. 77-12 through 14.

Permits to dump waste or erect structures other than bridges in navigable waters must also be obtained from the U.S. Army Corps of Engineers pursuant to the Commerce Clause of the U.S. Constitution. Permits for erection of bridges must be obtained for the U.S. Coast Guard.

V.B.8.b. Administration and Enforcement--Before any structure can be built in State navigable waters a permit must be obtained from the Department of Administration subject to approval from the Department of Natural and Economic Resources concerning environmental effect. The purpose of the permit is to regulate structures in the water and to assign the responsibility for removal once the structures have been abandoned. Under the permit the holder is required to remove the structure 30 days after abandonment.

Violation of these regulations is a misdemeanor and is punishable by a fine not greater than $500 and/or imprisonment not to exceed six months.

V.B.8.c. Coastal Application--Both inland and coastal waters in the coastal area are used for fisheries activities. Those activities sometimes require fishnet stakes, small dams, piers and other structures that can obstruct the water causing degradation of downstream areas and difficulty in navigation. The permit for obstructing structures is necessary to prevent these adverse effects.

In addition, this permit prevents adjacent landowners from building restaurants, houses and other shelters over public waters.

V.B.9. Air Pollution Control Permits

Regulation of air pollution can be administered and enforced by a state agency and/or by local air pollution control boards. Regulation may be accomplished by monitoring sources of pollution and evaluating impacts on the environment. These effects are then related to ambient air standards which are developed by the Environmental Management Commission. Monitoring may involve sampling of ambient air and of smokestack emissions, and sampling of vegetation impacts of air pollution.

V.B.9.a. Authority--Authority has been granted to the Environmental Management Commission pursuant to N.C.G.S. 143-215.108.

The Environmental Protection Agency is responsible for setting the national air quality standards and administers the state implementation programs pursuant to the Clean Air Act of 1970 as amended.

V.B.9.b. Administration and Enforcement--The Division of Environmental Management in the Department of Natural and Economic Resources is responsible for administering the air quality permit program. This program is the enforcement mechanism for achieving national air quality standards, including classification of air contaminant sources, emission control standards, and motor vehicle emission standards. After these standards and classifications have been adopted, the Environmental Management Commission may issue a special order to any person found responsible for causing air pollution in an area where standards are established. Permits must be obtained from the Environmental Management Commission for establishing or operating a stationary air contaminant source, using equipment that may cause emission of air contaminants, altering the operation of a process or equipment that emits or may emit air contaminants, and altering the generation of a process or equipment of an air-cleaning device. The Commission is empowered to grant permits with conditions attached, grant temporary permits and adopt rules for the permit system.

Air pollution regulation can also be performed at the local level through air pollution control programs certified by the Commission. Before a local program can be certified, it must meet the requirements set forth in N.C.G.S. 143-215.112, including an ordinance compatible with state standards, rules and regulations; an adequate enforcement of such requirements; an adequate administrative staff; and other requirements set forth by the Commission.

Penalities for violation are stiff. Civil penalities may be assessed in the amount of $5,000 per day. Criminal penalties, for willful or negligent violation, may be assessed in the amount of $15,000 per day. Any person who knowingly makes any false statement, respresentation or certification to the EMC or tampers with an EMC monitoring device may be assessed a fine of $10,000 and a term of six months' imprisonment. Injunctive relief is also available (N.C.G.S. 143-215.6).

V.B.9.c. Viability--At this time several amendments to the Clear Air Act are being considered by Congress. Depending on which is passed, the State program will be altered to accommodate the changes. It is unlikely that the General Assembly will elect to legislate air quality standards more stringent than the federal standards.

V.B.9.d. Coastal Application--At this time air quality is not a major problem in the coastal area, except in the vicinity of specific power plants, fish-processing facilities, or other industries. Concern may increase if a deep-water oil terminal and its associated petroleum-based industries are located in the coastal area. Local governments concerned about maintaining good air quality should consider adopting a local air pollution ordinance to qualify for certification to enforce air pollution regulation locally. In this way localities can better control air pollution.

V.B.10. Licensing and Regulation of Pesticide Application

Regulation of pesticide application may be direct, by establishing regulations concerning both the type of pesticide and the method or use, or indirect, by licensing of applicators. Regulations concerning the method of application may be those deemed necessary to prevent damage to plants, wildlife, fish and aquatic life, and other persons, animals or beneficial insects. For further effectiveness in achieving these purposes, regulations should be related to such factors as the natural characteristics of affected land, the proximity of water, the properties of the pesticide itself, and the potential for runoff or mixing with groundwaters.

V.B.10.a. Authority--Regulation and licensing of pesticides and applicators exist in North Carolina pursuant to N.C.G.S. 143-434 et seq. These regulations are administered by the Pest Control Division of the North Carolina Department of Agriculture. The EPA Office of Pesticides registers all insecticides, fungicides and other economic poisons that are involved in interstate and intrastate commerce. It also establishes the "safe tolerance" or the amount of each pesticide that may safely be left on raw food crops. In addition, it can give technical assistance to state agencies for administering pesticide control programs and is responsible for approving state certification of applicators' programs.[1]

V.B.10.b. Administration and Enforcement--The Commissioner of Agriculture is responsible for the administration and enforcement of the North Carolina law. Regulations governing the use of pesticides placed on the "restricted use" list and the issuance of dealers' and applicators' licenses are determined by a Pesticide Board. The Board is empowered to adopt such regulations as will restrict or prohibit the sale and use of pesticides in designated areas during specified periods of time to prevent damage or injury by drift or misapplication to (1) plants, including forage plants, or adjacent or nearby land; (2) wildlife in the adjoining or nearby areas; (3) fish and other aquatic life in waters in reasonable proximity to the area to be treated; (3) other animals, persons or beneficial insects. Also, all pesticides distributed, sold, or offered for sale in the State must be registered with the Department of Agriculture.

Violators may have their applicator's license suspended or revoked, and violation of any provision of the act will be judged a misdemeanor and subject the violator to fines of $100 to $1000 per day.

V.B.10.c. Viability--Generally, pesticide use is spot-checked to assure proper licensing and application. The emphasis is on application conformance rather than the effects of pesticides on the environment.[2]

North Carolina has submitted its program for the certification of applicators to EPA for approval. When the program is approved, the North Carolina Pesticide Board will have the authority to license pesticide applicators.

V.B.10.d. Coastal Application--With the emphasis on application compliance rather than environmental effects of pesticides, it is virtually unknown what effects present pesticide use is having on estuarine, especially shellfish, waters. In the past before it was banned, DDT and other chlorinated hydrocarbon pesticides were found in high concentrations in North Carolina shellfish, making them inedible. However, nothing is known about the concentrations of the new pesticides in shellfish.[3]

Hope does exist in the new federal pesticide regulations which are supposed to consider effects on the environment as well as to the applicator.[4] (See below, Section V.B.11., Environmental Pesticide Control.)

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[1]John K. Gamman et al., Federal Involvement in the California Coastal Zone--A Topical Index to Agency Responsibility (Berkeley: Institution of Urban and Regional Development, Univ. of California, 1974), p. 137.

[2]Conversation with Pesticide Control Division of the North Carolina Department of Agriculture, July 1975.

[3]Ralph S. Heath, Hydrology of the Albemarle-Pamlico Region (Raleigh: Water Resources Institute, N. C. State University, September 1975), p. 78.

[4]Milton S. Heath, Jr., Materials Concerning Pesticide Control Law (Chapel Hill: Institute of Government, Univ. of North Carolina, 1975), Part III.

V.B.11. Environmental Pesticide Control

The purpose of this tool is to regulate the use of pesticides so as to protect human life and the environment. This can be achieved by registering pesticides, restricting their use and by licensing dealers and applicators.

V.B.11.a. Authority--Authority is vested in the Administrator of the Environmental Protection Agency by the Environmental Pesticide Control Act of 1972. The states are responsible for licensing applicators and may further impose restrictions on pesticides. North Carolina's Department of Agriculture, Pest Control Division is authorized to administer N.C.G.S. 143-452, 143-458 and 143-440(b). (See above, Section V.B.10., Licensing of and Regulation of Pesticide Application.)

V.B.11.b. Administration and Enforcement--The Environmental Pesticide Control Act of 1972 regulates the use of pesticides to protect humans and the environment. It also extends the authority of the Federal Insecticide, Fungicide and Rodenticide Act to regulate not only pesticides moving in interstate commerce, but also intrastate commerce. All pesticides must be labeled to prevent harm to man and the environment before they can be registered or sold. Use of the pesticide is prohibited if use is inconsistent with the labeling.

Pesticides are also classified for either (1) general or (2) restricted use. Restricted use pesticides can be used by or under the supervision of licensed applicators. Applicators are certified under approved State programs. Funds are also appropriated for the implementation of the Act.[1]

V.B.11.c. Viability--The 1972 Act has expanded the former authority to control over all pesticides and prohibition of misuse of pesticides. These additions seem to make regulation more effective in protecting both man and the environment.[2] The deadline for state programs to be submitted to EFP for approval was October 21, 1975. Thus, the state licensing of applicators is not yet in effect.[3]

V.B.11.d. Coastal Application--In the past before it was banned, DDT and other chlorinated hydrocarbon pesticides were found in shellfish in amounts sufficient to close several North Carolina shellfish waters. It is not presently known if the pesticides that replaced DDT and others are also accumulating in shellfish in concentrations sufficient to cause them to be inedible. So by the addition of regulations protecting both man and the environment, in the 1972 Act, it is hoped the contamination of shellfish can be brought under control.

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[1]Milton S. Heath, Jr., Materials Concerning Pesticide Control Laws (Chapel Hill: Institute of Government, Univ. of North Carolina, 1975), Part IV.

[2]Ibid.

[3]Comment by Donald Hayne of the North Carolina Pesticide Advisory Council, November 1975.

[4]Ralph S. Heath, Hydrology of the Albemarle-Pamlico Region (Raleigh: Water Resources Institute, North Carolina State University, 1975), p. 78.

V.B.12. Regulation of Oil Refineries

Regulation of oil refineries is based on recognition of their particularly high potential to pollute and possibly permanently damage environmentally fragile areas. Permits and regulations should take into consideration certain characteristics of the area for which the refinery is proposed, including proximity to fragile and valuable ecosystems, the assimilative capacity of and the load already placed on affected water, and other considerations appropriate in a general benefit-cost analysis.

V.B.12.a. Authority--Authority to regulate oil refineries exists in North Carolina pursuant to N.C.G.S. 143-215.99. The permit program is administered by the Division of Environmental Management in the Department of Natural and Economic Resources (DNER).

V.B.12.b. Administration and Enforcement--Under these statutes the Secretary of the DNER is given authority to issue or deny permits for construction of new facilities by N.C.G.S. 143-215.000 and for continuation of existing facilities by N.C.G.S. 143-215.101(3). The Secretary may impose appropriate terms and conditions and may deny permits upon finding that such facilities will have adverse effects on wildlife or freshwater, estuarine or marine fisheries; on air or water quality; or on the public health safety and welfare which outweigh the project's benefits. The Secretary may require the installation of such facilities and protective measures as are necessary to prevent oil discharges to waters or lands of the State. The statute assesses civil penalties in the amount of $10,000 per violation and criminal penalities for knowing violation in the amount of $10,000 and six months' imprisonment (N.C.G.S. 143-215.102).

V.B.12.c. Coastal Application--At this time, no permits have been issued.[1] However, should refineries desire to locate in the coastal area, this regulation does grant the power to ensure that the location chosen is compatible with the refinery. This could be important if the proposed location is not in an area of environmental concern and therefore not required by the Coastal Area Management Act to obtain a development permit, and if the local jurisdiction has not adopted land use controls which regulate the location of the refinery.

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[1]Conversation with North Carolina Division of Environmental Management official, July 1975.

V.B.13. Control of Coastal Wetlands Activities

This regulation allows the Secretary of Natural and Economic Resources to adopt, modify or repeal orders controlling activities in coastal marshlands and contiguous areas for the purpose of promoting public safety, health and welfare, and protecting property, wildlife and marine fisheries. Activities in coastal wetlands that can be affected by such orders include dredging, filling or other alterations such as removal of materials.

V.B.13.a. Authority--The Secretary of Natural and Economic Resources, with the approval of the Marine Fisheries Commission, is authorized by N.C.G.S. 113-230 to make such orders after holding a public hearing and giving notice to each affected landowner and interested state agencies.

V.B.13.b. Administration and Enforcement--This statute authorizes the Secretary of DNER, with the approval of the Marine Fisheries Commission, to adopt, amend, modify or repeal regulations restricting or prohibiting the dredging, filling or otherwise altering of coastal wetlands (primarily defined as marshlands) under N.C.G.S. 113-229 (n)(3). Violation of such regulations is a misdemeanor and carries a penalty of six months' imprisonment and $500. The statute also authorizes injunctive relief. Since its enactment, the statute has never been used by the Secretary.

V.B.13.c. Coastal Application--This statute adds in two significant ways to the State's power to require permits for development in coastal marshlands under dredge and fill regulations (N.C.G.S. 113-229). First, the Secretary or his agents may, through proper procedure, adopt more regulations or guidelines for activities in marshlands rather than reacting to proposed activities on a case-by-case basis. Second, such regulation is explicitly authorized to extend to "designated contiguous areas," thus giving additional geographical jurisdiction. The amount of such contiguous area that can be designated for regulation is, of course, limited by the ability to show that such regulation over an area of such size is reasonably necessary to protect the adjacent marshlands. This extension of the regulatory power to contiguous areas offers substantial potential for protecting coastal marshlands from damage due to septic tanks, sedimentation-producing projects, and other damaging activities adjacent to but not actually in the marshlands.

V.B.14. Dredge and Fill Permits

A permit must be obtained from the Marine Fisheries Commission before dredge and fill activities can begin in estuarine waters, including bays, sounds, rivers and tributaries seaward of the line dividing coastal and inland fishing waters; tidelands; marshlands, including "any salt marsh or other marsh subject to regular or occasional flooding by tides"; and State-owned lakes, including man-made as well as natural lakes.

V.B.14.a. Authority--The Marine Fisheries Commission is authorized by N.C.G.S. 113-229 to let dredge and fill permits. The U.S. Army Corps of Engineers is authorized by 33 U.S.C. 403, the Rivers and Harbors Act, to let permits for dredge and fill activities in navigable waters and by 33 U.S.C. 404 to let permits for discharge of dredged materials into navigable waters, so a permit from the Corps is necessary for dredge and fill activity in navigable waters.

V.B.14.b. Administration and Enforcement--This statute requires that before any person begins any excavation or filling project in any estuarine waters, tidelands, marshlands or State-owned lakes, he must obtain a permit from the Marine Fisheries Commission. Such a permit does not relieve that person from obtaining an Army Corps of Engineers permit as well--N.C.G.S. 113-229(2). The Commission may deny the permit where it finds that (1) there will be a significant adverse effect on the use of the water by the public; (2) that there will be a significant adverse effect on public health, safety or welfare; (3) there will be a significant adverse effect on the conservation of public and private water supplies; or (4) there will be significant adverse effect on wildlife or freshwater, estuarine or marine fisheries--N.C.G.S. 113-229(e). Issuance of the permit is deemed to be conclusive evidence of compliance with the statute and prevents any subsequent challenge. In addition, a certificate of water quality must be obtained from the Environmental Management Commission to show that stream classification and effluent standards will not be violated (see discussion above, Section V.B.3., Prohibited Discharges to Water).

Failure to comply with the Act leaves the operator open to suit by the Secretary of the DNER for injunctive relief and damages, and for the payment of a $500 per day fine.

V.B.14.c. Coastal Application--Administration of the dredge and fill permit program by the Marine Fisheries Commission is generally considered to be a successful program. The State program is coordinated with the federal Corps of Engineers program, although the latter is generally considered to have broader jurisdiction. In any event, this program covers practically all dredge and fill activities in the vast and very important marsh and estuarine areas of the coast, and is therefore important in protecting coastal wetlands, waters and wildlife. All the areas now covered by the State dredge and fill permit program are suggested for AEC designation by the Coastal Area Management Act guidelines. If these areas are not designated Areas of Environmental Concern under the Coastal Area Management Act, and the local regulatory scheme does not include a means of evaluating <u>every</u> project in these areas, then local cooperation with State officials in enforcing the dredge and fill regulations can help ensure protection of these critical wetlands.

V.B.15. Regulation of Water Capacity Use Areas

The purpose of regulating water capacity use areas is to detect areas that have limited groundwater supplies and to regulate water withdrawal according to those limitations. If an area is declared a water capacity use area, future water withdrawals above a specified amount will require permits. In deciding whether to issue a permit, consideration is given to the nature and size of the aquifer; the chemical and physical nature of any resulting impairment and the duration of any public injury resulting from that impairment; the importance and necessity of the uses and the kinds of activities to which they relate; diversion from other water courses or aquifers; and other relevant factors.

V.B.15.a. Authority--Statutory authority exists in North Carolina pursuant to N.C.G.S. 143-215.15. Administration is by the Environmental Management Commission of the Department of Natural and Economic Resources.

V.B.15.b. Administration and Enforcement--The Environmental Management Commission is empowered to delineate capacity use areas where it finds that the use of groundwater or surface water requires coordination and limited regulations for protection of public and private interests. Such interests are deemed to have been threatened when the aggregate uses of waters have been developed or threatened to develop to the point where there is a danger of impairment of the renewal or replenishment of such waters.

The Environmental Management Commission may hold a public hearing in the area in which it has reason to believe that the withdrawal of water or the discharge of pollutants into the waters is having an unreasonably adverse effect on those waters, whether in a designated capacity use or not. Where the Commission finds such adverse effects, it may prohibit by N.C.G.S. 143-215(d) the withdrawal of water in excess of 100,000 gallons a day.

Following the designation of a capacity use area, the Environmental Management Commission may issue regulations for the withdrawal of water from surface and groundwater sources and require the submission of reports on the activities of water users (N.C.G.S. 143-215.14).

With regard to enforcement, the Environmental Management Commission has the right to direct investigations necessary to carry out its duties, to enter upon private or public land for the purpose of investigation of withdrawal facilities, and to require written statements or the filing of reports under oath (N.C.G.S. 143-215.19). Civil and criminal penalties may be assessed and fines levied of between $100 and $1,000 per day, as authorized by N.C.G.S. 143-215.15(b). The Environmental Management Commission is further empowered by N.C.G.S. 143-215.15(c) to seek injunctive relief in appropriate circumstances.

V.B.15.c. Coastal Application--The only water capacity use area at this time is in Pamlico and Washington counties, covering the area in which large phosphate mining operations withdraw very large amounts of groundwater.[1] This regulation could be of increasing significance to the coastal area as groundwater problems are investigated and detected. However, its usefulness seems limited in that it comes into play late, after significant damage is done to water supplies in an area. Under present rules, only very large extractions of groundwater are regulated, thus leaving uncontrolled the aggregate damage due to smaller users.

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[1]Conversation with North Carolina Environmental Management Commission official, July 1975.

V.B.16. Dam Approval

Before dam construction, repair or alteration can begin, an application must be approved and a permit issued. While the purpose of this law is primarily to ensure the safety of persons and property directly threatened by the physical presence of impounded water, the legislation also recognizes the importance of the maintenance of minimum stream flows (N.C.G.S. 143-215.24). Thus, to be approved, applications must meet conditions which ensure safety and satisfy minimum stream flow requirements. Approval involves dam supervision and design by a qualified engineer, inspection, supervision over maintenance and operation and review by specified State agencies.

V.B.16.a. Authority--The Environmental Management Commission in the Department of Natural and Economic Resources is authorized by N.C.G.S. 143-215.28 to approve dam construction, repair or alteration.

V.B.16.b. Administration and Enforcement--An application to construct, modify or repair a dam must be filed with the Environmental Management Commission (N.C.G.S. 143-215.26 and 215.27), which has the power to approve or disapprove such application (N.C.G.S. 143-215.28). The Environmental Management Commission must provide for the final inspection of the project at its completion and certify that minimum stream flow requirements are being met (N.C.G.S. 143-215.30).

The Department of Natural and Economic Resources is authorized to inspect any dam upon receipt of a written request from any affected person or agency, or from the Environmental Management Commission. If the dam does not satisfy minimum stream-flow requirements upon inspection, the Commission may order the owner to take steps to alleviate the injurious condition (N.C.G.S. 143-215.32).

Criminal and civil penalties may be assessed for violation of any regulations under the Act, and fines assessed in the amount of $100 to $1,000 per day. Injunctive relief may be sought in appropriate circumstances (N.C.G.S. 143-215.36).

V.B.16.c. Coastal Application--The dam safety program has recently been given an augmented staff, which should permit effective enforcement of the program. Dam construction has not been a major activity in the coastal area, and this regulation may not be of great use to local planners. If extensive impoundment of marshes or wetlands threatens to alter the water mixing properties of the estuaries, the provisions of the dam approval program could perhaps be a way of limiting such modifications to acceptable levels.

V.B.17. Regulations Pursuant to Erosion and Sedimentation Control Plans

North Carolina General Statute 113A-54 authorized a Sedimentation Control Commission under the Department of Natural and Economic Resources which is to set up rules and regulations for the control of erosion and sedimentation from land-disturbing activities. The Commission is further charged with developing a local erosion control ordinance and assisting local governments in the development of their own ordinances. The Secretary of the Department of Natural and Economic Resources is responsible for the administration, implementation and enforcement of the Act.

V.B.17.a. Authority--Authority to regulate pursuant to erosion and sediment control plans exists in North Carolina under N.C.G.S. 113A-60 or N.C.G.S. 113A-61. The North Carolina Sedimentation Control Commission approves local erosion control projects and the sponsoring locality may then develop ordinances and other regulatory tools. The local ordinances must be at least as strict as the State statute. If the local government does not decide to adopt such ordinances, then the Division of Resource Planning and Evaluation in the Department of Natural and Economic Resources shall enforce the State statute.

V.B.17.b. Administration and Enforcement--The Act authorizes both general and mandatory standards. The general standards apply to all "land-disturbing activity," which is any use of the land that results in a change in the natural cover or topography and that may contribute to or cause sedimentation. The Act appears, however, to exclude agricultural and forestry activities (N.C.G.S. 113A-52(6)). The Act includes mandatory standards for land-disturbing activities (N.C.G.S. 113A-57), including: (1) leaving an adequate buffer between such activity and a natural watercourse or lake area; (2) the revegetation of sloped areas; and (3) erosion control on land adjacent to any land-disturbing activity undertaken on a tract of greater than one acre.

The Act specifically empowers both the State and local governments to sue for injunctive relief where there is a reasonable cause to believe that there has been a violation of a State or local program. In addition, civil relief is made available to any person injured in the violation of a State or local program (N.C.G.S. 113A-66). Finally, civil penalties in the amount of $100 per day may be assessed against a violator.

V.B.17.c. Viability--General standards to reduce erosion caused by land-disturbing activities can be developed with little technical difficulty. Surveillance and enforcement will require some additional administrative burden, but this should not be excessive if these duties are combined with the administration of other regulatory programs such as subdivision regulation and building permits. At any rate, it is clear that with the available work of the U.S. Soil Conservation Service, it is possible to estimate the runoff from any specific site under natural conditions.[1] Thus, the technical capability is available if organizational and administrative problems can be overcome.

The appropriate level of government for this tool is local, where individual site inspection is feasible. It would be difficult for the State to enforce this statute without great staff additions.

V.B.17.d. Where It Has Been Used and to What Effect--Many localities throughout the nation have employed various types of sedimentation and erosion control ordinances.[2] Most efforts seem to be so recent that analysis of effectiveness is not yet available. Some states have mandated such plans in coastal areas.[3] The potential effectiveness of erosion controls on maintaining the quality of coastal waters can be understood when it is understood that erosion yields from development sites are three to one hundred times greater than from natural areas.[4] In North Carolina's coastal area, New Hanover County has implemented an erosion control ordinance.

V.B.17.e. Coastal Application--Control of erosion and sedimentation is important in the coastal areas. The sandy and silty soils of this area are highly erodible and can cause much sedimentation in streams if proper controls are not employed. An increase in sedimentation could seriously disturb shellfish and highly productive plants in the tidal creeks, estuaries and marshes. Since the State staff is so small, enforcement of State standards will be almost impossible and coastal communities will stand to lose or damage valuable natural resources unless localities adopt erosion and sedimentation ordinances.

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[1]See Charles Thurow et al., Performance Controls for Sensitive Lands: A Practical Guide for Local Administrators (Washington, D.C.: U.S. Government Printing Office, 1975), p. 17.

[2]Id., pp. 12-18.

[3]Washington and Wisconsin.

[4]Paul McKee, Problems of the Potomac Estuary (Washington, D.C.: Interstate Commission on the Potomac River Basin, 1964), pp. 40-46.

V.B.18. Oil Pollution Control Program

The oil pollution control program allows the Environmental Management Commission (DNER) legally to enter facilities of any nature and inspect for unlawful discharges of oil into land or waters. It is unlawful for any person, regardless of fault or intent, to discharge oil into any lands, waters, sewers or surface water drainage systems unless a permit has been obtained as required under North Carolina water pollution laws.

V.B.18.a. Authority--Oil pollution inspection programs are administered by the Environmental Management Commission (DNER) under authority granted by N.C.G.S. Chapter 143, Article 21A. Oil discharge permits are required under N.C.G.S. 143-215.1 and are also administered by the Commission.

The U.S. Coast Guard enforces the oil spill controls, including accidental and deliberate actions and faulty construction. It also determines the responsibility for a spill and determines what actions are necessary for clean-up. The Fifth District, which includes North Carolina, has the Atlantic Coast National State Team for oil spill clean-up at its station in Elizabeth City, North Carolina. At this time the Oil Pollution Liability and Compensation Act has passed one house, is pending in the other and may pass this year or next.

V.B.18.b. Administration and Enforcement--In addition to investigating a discharge, the Environmental Management Commission can conduct any project or activity to contain, collect, disperse or remove any discharge or perform any restoration (N.C.G.S. 143-215.79).

Any discharge of oil or its by-products upon waters or land of the State is unlawful unless a permit has been issued under N.C.G.S. 143-215.83(c), or unless the discharge is due to circumstances such as an act of God or war (N.C.G.S. 143-215.83). Both the person having control over the oil discharged and the Environmental Management Commission are charged with the removal of discharged oil and restoration of the affected area to its former condition (N.C.G.S. 143-215.84). Any person who violates any provisions of the act is liable to the State for the cost of restoring all affected areas to their prior condition (N.C.G.S. 143-215.90) and civil penalties of up to $5,000 per day may be assessed (N.C.G.S. 143-215.91).

V.B.18.c. Coastal Application--This regulation constitutes a potent tool for deterring oil discharges and for financing the restoration of damaged areas to their prior condition. It thus has particular potential for protecting coastal waters from pollution, but this is a remedial power rather than a planning tool.

V.B.19. Regulation of Mining Operations

Regulation of mining operations, generally through a permit process, may be employed to prevent or minimize potential adverse environmental effects. Initial review of plans and periodic inspection of the mine perimeter drainage to adjacent land and/or waterways can determine whether erosion or other pollution is being induced by the operation.

V.B.19.a. Authority--The North Carolina Mining Commission in the Department of Natural and Economic Resources (DNER) is given the authority by N.C.G.S. 74-51 to issue or deny permits for any mining operation (defined in N.C.G.S. 74-49(7)). Under N.C.G.S. 74-50, all mining operations must have been issued such permits. The DNER may deny the permit upon finding, among other things, that: (1) the operation will have unduly adverse effects on wildlife or freshwater, estuarine or marine fisheries; (2) the operation will violate standards of surface water quality or groundwater quality that have been issued by the Environmental Management Commission (DNER); (3) the operation will have a significantly adverse effect on the purposes of a publicly owned park, forest or recreation area; and (4) previous experience with similar operations indicates a definite possibility that the operation will result in substantial deposits of sediment in streambeds or lakes, landslides or acid water pollution. No permit is granted until a reclamation plan is approved by the DNER.

The applicant is required to post a bond (N.C.G.S. 74-54) with the DNER and such bond is subject to forfeiture if at any point the operator violates the rules and regulations under the Mining Act (N.C.G.S. 74-59).

Further, criminal penalties may be assessed for willful violation of the statute and a fine of $100 to $1,000 may be levied against a violator.

V.B.19.b. Coastal Application--The Mining Act was written so explicitly that only one regulation has thus far been necessary to clarify its requirements. The permit process seems realistically functional, since it was devised and is administered by a balance of mining and conservation interests.[1] The primary impact of this regulation in the coastal area is on phosphate mining operations and other smaller open-pit operations for extracting sand, marl, etc. The authority provided is a broad one, allowing control of mining through environmental impact assessment on a case-by-case basis. Such project analysis can be vital when the local regulatory scheme does not provide for environmental impact analysis and regulation of individual projects.

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[1]Conversation with Craig McKensie, Land Quality Section, North Carolina Environmental Management Commission, July 1975.

V.B.20. Regulation of Oil and Gas Wells

Under a series of statutes, N.C.G.S. 113-378 *et seq.*, the Secretary of the Department of Natural and Economic Resources (DNER) is given a broad range of regulatory powers over oil and gas wells for the protection of the surrounding environment and resources during the exploration state or the operation stage, or both. More specifically, regulations and orders may be made to protect the surrounding environment from damage due to faulty drilling or operation.

V.B.20.a. Authority--Authority to regulate oil and gas wells at the exploration stage exists in North Carolina pursuant to N.C.G.S. 113-391. An applicant for a permit to drill is required to post bond and submit to inspection until the well is plugged and abandoned. This regulatory process is administered by the Division of Resource Planning and Evaluation in the DNER.

V.B.20.b. Administration and Enforcement--The Secretary of the DNER can require the drilling, operating and closing of wells to be done in such a manner as to prevent the pollution of freshwater supplies by oil, gas or saltwater, or to protect the quality of the water, air, soil or any other environmental resource against injury or damage. Monitoring and periodic inspection can be continued until the well is safely plugged and the threat of damage is terminated.

The DNER is empowered to maintain an action for injunctive relief, damages or any other legal or equitable remedy where violations have occurred (N.C.G.S. 113-399). Penalties may be levied in the amount of $1,000 per day per violation.

V.B.20.c. Coastal Application--This regulation has been rather successfully administered, mainly because there are so few wells to inspect in North Carolina. Although some exploratory drilling has been done in the sounds, few producing sites have been found. Unless oil is found in the coastal area, a prospect considered unlikely, this regulation seems to be of only minor value in that area.

V.B.21. North Carolina Environmental Policy Act of 1971

The North Carolina Environmental Policy Act is modeled after the National Environmental Policy Act of 1969 (see below, Section V.C.1., National Environmental Policy Act of 1969). Like the federal statute, the State Environmental Policy Act recognizes the value of the human environment and requires State agencies to prepare detailed environmental statements for every "recommendation or report on proposals for legislation and actions involving expenditure of public moneys for projects and programs significantly affecting the quality of the environment of this State."[1]

V.B.21.a. Authority--Authorization for the North Carolina Environmental Policy Act is found in N.C.G.S. 113A-1 to 10. The Act also specifies that copies of environmental statements, together with comments made by agencies with jurisdiction by law or special expertise, be submitted to the Governor, to agencies designated by the Governor, and to multi-county regional agencies, and that they shall follow the North Carolina clearinghouse review process (see below, Section V.B.22., A-95 Review). Copies must also be made available to localities, institutions and the public (N.C.G.S. 113A-4).

Authority to review State environmental statements was assigned to the Council on State Goals and Policy, an executive board of prominent citizens created by the Governor of North Carolina in 1972.[2]

V.B.21.b. Viability--Despite its potential for improving coastal planning through intergovernmental coordination and increased public participation, the North Carolina Environmental Policy Act has been largely ignored. Thus no guidelines or criteria were promulgated to assist State agencies in developing environmental statement procedures. The Council on State Goals and Policy reviewed only one project in 1972 and "has never again initiated a proposed review or has been asked to do so by a sponsoring agency."[3] Only two State agencies have elected to file environmental statements regularly--the Department of Natural and Economic Resources and the Department of Transporation. If the North Carolina Environmental Policy Act is to be revived, such action will have to develop prior to September 1, 1977, when the Act expires.[4]

V.B.21.c. Where It Has Been Used and to What Effect--In addition to North Carolina, 24 other states have environmental policy acts that require environmental impact statements. A recent review of state environmental policy acts by the Council on Environmental Quality concluded:

The status of state NEPA laws appears to be mixed. Efforts in some states to achieve compliance with the law are hampered by inadequate enforcement authority. Where adequate statutory authority does exist, lack of expertise in handling environmental affairs and inadequate funding frequently pose critical problems to effective implementation. In addition, some states are finding it necessary to make adjustments in both statutory requirements and administrative procedures to reflect the particular organizational, environmental, political, and other needs of their respective jurisdictions. In all cases, the next few years will witness important tests of the new state policies and procedures for environmental assessment.[5]

V.B.21.d. Legal Issues--In contrast to the large number of court suits involving the federal NEPA, only one suit has used the North Carolina Environmental Policy Act as a basis for a legal challenge. In *Lewis v. White*, the North Carolina Supreme Court ruled that nothing in the State Environmental Policy Act makes the filing of an environmental impact statement a "precedent to the commencement of construction of a building for which State funds have been appropriated."[6]

V.B.21.e. Coastal Application--The North Carolina Environmental Policy Act could serve as a mechanism for the State government to assert a leadership role in showing other levels of government and the public how coastal ecological processes can be protected through a coordinated public policy. The State has a myriad of programs and policies, ranging from construction of State facilities and roads to protection of marine resources, that directly or indirectly affect the coastal area. The comprehensive nature of the State Environmental Policy Act makes it a potentially important tool in all of the coastal environments. However, if the Act is neither enforced by the State nor monitored by the public, then the Act will remain a mere paper recognition of environmental values.

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[1]N.C.G.S. 113A-4(2).

[2]Maynard M. Hufschmidt, *Environmental Statements and Water Resource Planning in North Carolina*, Rpt. No. 94 (Raleigh: Water Resources Research Institute, Univ. of North Carolina, June 1974).

[3]Charles E. Roe, "The North Carolina Environmental Policy Act: Neglected Planning Tool," *Popular Government* 41 (Fall 1975), 45.

[4] Ibid.

[5] Council on Environmental Quality, _The Sixth Annual Report of the Council on Environmental Quality_ (Washington, D.C.: U.S. Government Printing Office, December 1975), p. 653.

[6] 287 N.C. 625, 216 S.E.2d 134 (1975).

V.B.22. A-95 Review

The A-95 review process is intended to provide a systematic opportunity for units of government to review and comment on a variety of programs and projects involving federal funding. The process includes four aspects. The first is Project Notification and Review of project applications to assure their consistency with state and local plans and programs. To achieve this review the State Clearinghouse contacts the appropriate Lead Regional Organization and state agencies affected by the proposed project and reviews their comments.

The second part concerns direct federal development. When the federal agency is planning or constructing a building, or is acquiring, using or disposing of land, it must consult the appropriate state and local officials by means of the Clearinghouse.

The third part is intended to assure that State Plans and Multisource programs are appropriately related to other federally assisted programs. This involves giving the Governor the opportunity to review and comment on State Plans in regard to other state, regional and local activities and allow state and Lead Regional Organization Clearinghouses to comment on multisource programs.

Coordination of planning for Multi-Jurisdictional Areas to avoid overlap, duplication and competition in federally assisted state and local planning programs is the fourth part. This involves a written agreement between the federal agency and the Lead Regional Organization to carry out planning and to divide the responsibilities of the planning activities.

V.B.22.a. Authority--The A-95 Review process is authorized by the 1969 Office of Management and Budget Circular A-95. The Clearinghouse for North Carolina is part of the Office of Intergovernmental Relations in the Department of Administration.[1] The Councils of Government act as the substate or Lead Regional Organization Clearinghouses.

V.B.22.b. Administration and Enforcement--The State Clearinghouse is administered by the Office of Intergovernmental Relations. In addition to the A-95 Review process, the State Clearinghouse handles all environmental impact statement drafts and final reviews by sending them to appropriate State agencies for comment. Environmental impact statements, public hearing notices and bid calls are published in the Environmental Bulletin. The Bulletin is published and distributed to interested persons and governmental agencies on request by the Office of Intergovernmental Relations.

To keep informed of projects proposed in the coastal area, each county and locality should make sure it is on the Clearinghouse's mailing list. If a locality is not on the mailing list, it should keep in close contact with its Council of Government or Lead Regional Organization so that it can review and comment on proposed projects that affect its jurisdiction.

V.B.22.c. Coastal Application--No clear standards exist for clearing projects, and many State officials admit that they only make perfunctory review comments. When county plans and environmental regulations are more clearly established in the coastal area, there will be a potential for the Coastal Resources Commission, local governments and other involved agencies to review porposed projects against more clearly delineated land use and environmental standards.

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[1]State Clearinghouse and Information Center, The A-95 Review Process in a Nutshell (Raleigh, N. C.: Office of Intergovernmental Relations, 1975).

V.C. Environmental Regulation (Federal)

V.C.1. National Environmental Policy Act of 1969 (NEPA)

The National Environmental Policy Act of 1969 recognizes the value that natural ecological systems provide and mandates that all federal agencies incorporate the consideration of environmental values into their administrative procedures. The Act mandates consideration of the environment by federal agencies by requiring that an environmental impact statement (EIS) be filed on all "major Federal actions significantly affecting the quality of the human environment."[1] In practice, the courts have held that federal licensing, permits, loan programs and construction activities as well as other actions are covered by the NEPA.[2] Environmental impact statements must include a detailed discussion on: (1) the environmental impact of the proposed action; (2) any adverse environmental effects that cannot be avoided should the proposal be implemented; (3) alternatives to the proposed action; (4) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and (5) any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented.[3]

V.C.1.a. <u>Authority</u>--The National Environmental Policy Act of 1969, P.L. 91-190, 42 U.S.C. 4321-4347, authorizes the Council on Environmental Quality to carry out the purposes of the Act, to prepare an annual report on the state of the nation's environment, and to issue guidelines to implement the requirements of the Act (Title II of P.L. 91-190. For "Preparation of Environmental Impact Statement Guidelines," see Code of Federal Regulations in Title 4, Part 1500). Title I of the NEPA authorizes federal agencies to incorporate environmental values into their decision-making process.

Environmental impact statements are reviewed by federal, state and local agencies, and by the public. Specific review varies according to special expertise needed and the environmental impact involved.[4] (See above, Section V.B.22., A-95 Review.) The Environmental Protection Agency (EPA) has the authority to review and comment on environmental impact statements with respect to air or water quality, noise abatement and control, pesticide regulation, solid waste disposal and radiation. Although the Council on Environmental Quality has the approval power, the EPA is relied upon for impact analysis in the above areas.[5]

V.C.1.b. <u>Viability</u>--The viability of the National Environmental Policy Act can be primarily attributed to the courts, which through lawsuits brought by public-interest groups have evolved as the prime enforcers of NEPA. The Council on Environmental Quality recently evaluated the effect the NEPA has had on public decision-making:

> Federal agency procedures to build NEPA into their planning and decision-making now affect all levels of government, from field and project planning and operating levels to agency administrator or department secretary. The resulting analysis of environmental effects and alternative proposals--and the public disclosure of such information--have proved workable and critical parts of environmental protection policies. The EIS itself is intended to be, and often is, the tip of an iceberg, the visible evidence of an underlying planning and decision-making process that is usually unnoticed by the public.[6]

V.C.1.c. Where It Has Been Used and to What Effect--Consideration of the requirements of the NEPA is a mandatory component of all federal agencies' planning process. The provisions of the Act, however, are not complied with uniformly by all agencies, and the effectiveness of the Act varies considerably on a case-to-case basis.

V.C.1.d. Legal Issues--As indicated above, the public interest lawsuit is the prime enforcer of NEPA, and not surprisingly the litigation concerning an environmental impact statement requirement of the NEPA has been considerable. Calvert Cliffs Coordinating Committee v. Atomic Energy Commission was the watershed case in determining the wide scope of judicial review for NEPA and ensuring that federal agencies consider environmental values "to the fullest extent possible" in their decision-making process.[7] Other major court cases have held that an EIS must be prepared when a federal agency grants permits and licenses or leases land to private parties,[8] approves and funds state and local projects,[9] or directly undertakes a project itself.[10] Environmental impact statements must give full consideration to all reasonable alternatives to proposed actions, and environmental impact statements should be prepared as early as possible in the design phase of a project.[11] Moreover, some courts have held that a mere paper compliance with the procedural requirements of an EIS is not sufficient to satisfy the mandate of the NEPA; i.e., "courts have an obligation to review substantive agency decisions on the merits."[12] Nevertheless, it is not the court's function to impose its opinions on a federal agency, and the contents of an EIS do not hold a veto power over any given project.[13]

V.C.1.e. Coastal Applications--NEPA applies to any federal actions in the coastal area that can have a dramatic effect on a locality's environmental quality and future development pattern. Many environmental statements involving the

North Carolina coast have already been undertaken. Such activities as the U.S. Army Corps of Engineers' beach and inlet stabilization and protection program as well as its dredge and fill permit program (see below, Section V.C.6., Permits for Dredge and Fill and for Structures Other Than Bridges in or over Navigable Waterways) have a great effect on both the barrier island and estuary-lagoon systems. The Department of Transportation highway program and the Farmers Home Administration funding program for community facilities are examples of other major federal actions that can have a significant direct effect on coastal ecological processes. Localities should make sure that their voices are heard when environmental impact statements are prepared. Frequently, federal agencies are not accustomed to dealing with the peculiarities and dynamics of the coastal environment, and unless localities monitor the environmental statements, an inadequate evaluation of the primary and secondary effects on coastal ecosystems may result.[14]

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[1]P.L. 91-190, Sec. 102 (C).

[2]For a review of NEPA interpretations, see Council on Environmental Quality, _The Fifth Annual Report of the Council on Environmental Quality_ (Washington, D.C.: U.S. Government Printing Office, December 1974), pp. 371-426; and Frederick R. Anderson, _NEPA in the Courts: A Legal Analysis of the National Policy Act of 1969_ (Baltimore, Md.: Johns Hopkins Press, 1973).

[3]P.L. 91-190, Sec. 102 (C).

[4]40 C.F.R. 1500.

[5]40 C.F.R. 1500.9.

[6]Council on Environmental Quality, _The Sixth Annual Report of the Council on Environmental Quality_ (Washington, D.C.: U.S. Government Printing Office, December 1975), p. 628.

[7]449 F.2d 1109 (1971); P.L. 91-190, Sec. 102 (C).

[8]Natural Resources Defense Council, Inc., v. Morton, 458 F.2d 827 (1972).

[9]Jones v. Lynn, 477 F.2d 885 (1973).

[10]Environmental Defense Fund, Inc., v. Corps of Engineers, 470 F.2d 289 (1972).

[11]Natural Resources Defense Council, Inc. v. Morton, 458 F.2d 827 (1972); Scientists' Institute for Public Information, Inc. v. Atomic Energy Commission, 381 F.2d 1079 (1973).

[12]Environmental Defense Fund, Inc. v. Corps of Engineers, 470 F.2d 297 (1972).

[13]Ibid., 293-296.

[14]Unless local concern for a project is shown, federal agencies may neglect to prepare an environmental impact statement or use the EIS to justify a project that has already been decided upon. See for example, General Accounting Office, Environmental Assessment Efforts for Proposed Projects Have Been Ineffective--HUD (Washington, D.C.: GAO Distribution Section, 1975).

V.C.2. National Flood Insurance Program

This program is designed to provide flood insurance at rates subsidized by the federal government where private insurance is either unavailable or unaffordable. Insurance is only available to individuals in flood-prone communities that will adopt and administer local flood control measures for new construction in identified places of special flood hazard. According to a Senate Report accompanying the Flood Disaster Protection Act of 1973:

> The initial land use measure required of a community under the program entails merely the adoption of a building permit system (if one does not already exist) and a commitment to evaluate flood hazards insofar as they are known locally at the time of the issuance of any local building permits.[1]

Communities must apply in order to qualify for the program. When a community qualifies for flood insurance under the "emergency program," then it receives insurance at subsidized rates. After a Flood Insurance Rate Map is completed, which defines the boundary lines of a flood having a 1 percent chance of occurring in any year (a 100-year frequency flood), and after additional land use controls are adopted, the community qualifies for the "regular program," which provides more comprehensive insurance at either a subsidized or actuarial rate.

V.C.2.a. Authority--The Flood Insurance Administration of the Department of Housing and Urban Development administers the flood insurance program pursuant to the National Flood Insurance Act of 1968 (42 U.S.C. 4001 *et seq.*) as amended by the Flood Disaster Protection Act of 1973 (P.L. 93-234 *et seq.*).

The State coordinating agency for flood insurance in North Carolina is the Division of Community Assistance in the Department of Natural and Economic Resources. The Regional Flood Insurance Specialist for North Carolina is: Region IV, 1371 Peachtree Street, N.E., Atlanta, Georgia 30390, (404)526-3291.

V.C.2.b. Viability--The National Flood Insurance Program is usually quite popular politically among those most likely to benefit from it, i.e., "property owners at risk in flood hazard areas; insurance agents; realtors; and lending agencies."[2] Some local governments, however, resent the land use controls imposed by the Program. Other coastal localities assert that the Flood Insurance Program, by subsidizing development in high-risk areas, contradicts their efforts to control development in those areas. In this vein, the Islip, New York Department of Planning, Housing and Development asserted that the Flood Insurance Program undermined their land use policies by

> . . . subsidizing the insurance of flood-prone housing. Ostensibly, the Flood Insurance Program attempts to protect otherwise uninsurable homes and businesses built in floodplains. What the program does on Fire Island, however, is to take the financial gamble out of building on the shifting sands of the Atlantic Ocean.[3]

Although the Flood Insurance Administration establishes minimum standards and land use controls for participation in the Flood Insurance Program, it is the responsibility of local communities to adopt and administer these standards. Consequently, if a locality lacks the personal and political will to enforce the required land use controls, then the purpose of minimizing flood damage of the Flood Insurance Program will not be achieved. In practice, most coastal communities are readily eligible for the emergency Flood Insurance Program, even if they have little planning capability or effective land use controls (see above, Section IV.H., Building Inspection).

Another technical issue involves the difficult business of drawing coastal flood hazard lines. A recent report of the National Academy of Sciences concluded that the present approaches used by the U.S. Corps of Engineers, the National Oceanic and Atmospheric Administration and the U.S. Geological Survey for determining the heights and areal extent of inland flooding from coastal surges are inadequate. The import of the report is to question the adequacy and accuracy of all coastal flood insurance rate studies, and to question the delimitation of flood hazard areas subject to coastal flooding.[4]

V.C.2.c. Where It Has Been Used and to What Effect--The Flood Insurance Program is now in effect throughout the United States. However, a clear distinction should be drawn between the inland applications of the program and the effect flood insurance has on coastal areas. There are special limitations to the applicability of flood insurance in the coastal area. Wharves, piers, bulkheads and roads, for example, are not eligible for coverage.[5] In addition, the Program:

> . . . is not intended to provide coverage for the losses incurred when properties built too close to shorelines are eventually damaged as a result of normal and continuous wearing away of land by ordinary wave action.[6]

Storm-induced coastal erosion, however, is covered by the acts.

A recent study of three Rhode Island coastal communities revealed a number of serious questions concerning the coastal Flood Insurance Program:

Among the causes for concern in coastal areas are that the availability of flood insurance sustains already hish demand for shore properties, substantially reduces the financial risks of property owners, tends to increase the value of property and of structures placed in such areas, and acts as a counterforce to effective floodplain management efforts in the area. The concern is fed also by the greater than normal potential for high percentages of structural damages to residences and other buildings from hurricanes, storm-driven waves, and erosion.[7]

B.C.2.d. Legal Issues--The major legal issue that emerges from the Flood Insurance Program concern whether the local land use controls used to implement the program effectively "take" private property without payment of just compensation (see above, general legal issues relevant to local regulatory techniques, Section IV.I., Regulation of Mobile Homes). Generally, if the local land use control is reasonably related to the promotion of a public purpose, the control will be upheld by the courts.[8] Thus, in McCarthy v. Manhattan Beach the court upheld a beach zoning district that prevented all but beach recreational uses in a flood hazard area.[9] In Spiegle v. Beach Haven the court sustained a building setback ordinance that prohibited construction of homes oceanward of a building line because such construction was "unsafe."[10] Nevertheless, in Dooley v. Town Planning and Zoning Commission of Fairfield, a "floodplain district" classification as applied to a marshland subject to tidal and hurricane flooding was invalidated because it prohibited all reasonable uses of the land.[11] In short, while floodplain ordinances to mitigate storm damage will generally be upheld, some applications of the police power may be held as unreasonable, depending on the individual circumstances of a case.

V.C.2.e. Coastal Application--The Flood Insurance Program potentially applies to all of the coastal area that falls within the flood hazard line of the Flood Insurance Administration. Thus, with the exception of those parts of coastal environments that occupy relatively high ground, such as maritime forests and swamps, the coastal environments should be eligible for flood insurance. The Flood Insurance Program, however, is geared primarily to the minimization of damage to structures from flooding, and as a result other management tools will be needed to complement it in order to protect ecological processes within these coastal flood hazard areas.

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[1]U.S. Department of Housing and Urban Development, "Major Provisions of the Flood Disaster Protection Act of 1973," National Flood Insurance Program (Washington, D.C.: U.S.

Government Printing Office, January 1974), p. 11, as taken from Senate Report No. 93583 (Committee on Banking, Housing and Urban Affairs), pp. 9-22. See 24 C.F.R. 1910-3 for details of required land use control measures.

[2]H. Crane Miller, "Coastal Flood Plain Management and the National Flood Insurance Program: A Case Study of Three Rhode Island Communities," Environmental Comment (November 1975), p. 6.

[3]In "Readers Write," Planning 42 (February 1976), 2. See also Orrin H. Pilkey, Jr., et al, How to Live With an Island: A Handbook to Bogue Banks, North Carolina (Raleigh: North Carolina Department of Natural and Economic Resources, 1975), pp. 92-93.

[4]Miller, pp. 13-14. See also Panel on Coastal Surges from Hurricanes, Methodology for Estimating the Characteristics of Coastal Surges from Hurricanes (Washington, D.C.: Building Research Advisory Board, National Academy of Sciences, 1975).

[5]U. S. Department of Housing and Urban Development, "Questions and Answers National Flood Insurance Program," HUD NEWS (March 10, 1975), p. 7.

[6]U.S. Department of Housing and Urban Development, "Major Provisions," pp. 6-7. See P.L. 90-448, Sec. 1302(g).

[7]Miller, pp. 2-3.

[8]United States Water Resources Council, Regulation of Flood Hazard Areas to Reduce Flood Losses (2 vols.; Washington, D.C.: U.S. Government Printing Office, 1972). See especially Volume II, Part VI, "Coastal Regulations to Reduce Flood Losses," which includes a discussion of legal issues and coastal flood problems as well as examples of local and state ordinances dealing with control of coastal flooding.

[9]41 Ca.2d 879, 264 P.2d 932 (1953).

[10]46 N.J. 479, 218 A.2d 129 (1966).

[11]151 Conn. 304, 197 A.2d 770 (1964).

V.C.3. National Pollutant Discharge and Elimination System (NPDES)

The Environmental Protection Agency is authorized through Section 402 of the Federal Water Pollution Control Act to set up and administer a permit program for point source discharge. This can be accomplished by certifying state permit programs or by a federal-level permit program. The EPA has published its regulations on the program components a state is required to have before it can receive approval to administer the NPDES permit program. These can be found in 40 C.F.R. 124. After a state's permit program is approved, it assumes the authority to issue federal permits subject to EPA veto.

V.C.3.a. Administration and Enforcement--When North Carolina is granted approval to administer the NPDES permit program, all present federal and state water quality permits will be granted by North Carolina through the NPDES permit system. Thus permits such as for water supply systems, sewage disposal systems greater than 3,000-gallon capacity, water well construction, oil spills, ocean dumping and point source discharge of pollutants will be administered by the Division of Environmental Management with rules and regulations adopted by the Environmental Management Commission, Department of Natural and Economic Resources. Each of these is discussed individually.

V.C.3.b. Viability--North Carolina has met most of the NPDES permit program requirements and soon will have the authority to enforce federal water quality regulations in addition to state water quality regulations.

V.C.3.c. Coastal Application--When North Carolina is certified to administer the NPDES permit program, the Division of Environmental Management will be able to move comprehensively to enforce water quality regulations in the coastal area where the potential for water pollution is high due to the sensitive shellfish waters and the potential for saltwater intrusion of water supply aquifers.

V.C.4. Ocean Dumping Permit

The purpose of the ocean dumping permit is to regulate ocean disposal of waste other than dredged material. The Environmental Protection Agency, along with the U.S. Army Corps of Engineers and the Office of Coastal Zone Management, is to establish criteria for reviewing and evaluating permits and site selection for ocean dumping. The EPA, in addition, is to develop and conduct a monitoring and enforcement procedure.[1]

V.C.4.a. Authority--The EPA is authorized to administer the permit system and the Corp of Engineers and Office of Coastal Zone Management are authorized to work with EPA on the establishment of criteria by the Marine Protection, Research, and Sanctuaries Act of 1972 (P.L. 92-532).[2]

Via the National Pollutant Discharge Elimination System, North Carolina's Division of Environment Management will administer the ocean disposal permit when the EPA has established the criteria and procedures.[3] North Carolina also has a statute regulating discharge to the Atlantic Ocean within its three-mile jurisdiction.

V.C.4.b. Viability--At present, an ocean outfalls study for North Carolina has been partially funded by EPA. From this study it is hoped that enough information will be obtained to develop ocean disposal regulations.

V.C.4.c. Coastal Application--Since many of the coastal waters are so fragile that little waste can be assimilated in them without damaging shellfish waters and since few coastal soils are suitable for septic tanks, ocean outfalls have recently been viewed as a possible alternative waste disposal system. Before ocean outfalls can be approved, EPA regulations concerning their use must be established.

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[1]Office of Management and Budget, Environmental Protection Agency, 1974 Catalog of Federal Domestic Assistance (Washington, D.C.: Executive Office of the President, 1974).

[2]Marine Protection, Research and Sanctuaries Act, P.L. 92-532 (1972).

[3]Conversation with Mr. Puett, Enforcement Officer, North Carolina Division of Environmental Management, July 1975.

V.C.5. Regulation of Bridges Over Navigable Waterways

This regulation involves the alteration of obstructing bridges above navigable waters and the location of bridges over navigable waterways.

V.C.5.a. Authority--The Coast Guard is authorized to regulate alterations of obstructing bridges and to approve the location of bridges in navigable waterways.

North Carolina also requires a permit from the Department of Administration for obstruction of navigable waters within the State by the authority of N.C.G.S. 76-40.

V.C.5b. Coastal Application--Bridges constructed in coastal waters may obstruct the natural flow of a stream enough to endanger estuarine wildlife. Thus the permit system provides a review process by which adverse environmental impacts to fragile waters can be avoided.

V.C.6. Permits for Dredge and Fill and For Structures Other Than Bridges in or Over Navigable Waters

A permit must be obtained from the U.S. Army Corps of Engineers for any structure in or over navigable water. Also required is a permit to dredge and/or fill, to discharge dredged materials, to alter the course or location of a port, harbor, canal or enclosure within a channel of navigable water.

V.C.6.a. Authority--Authority to regulate structures other than bridges in or over navigable waters and to regulate alterations of navigable water channels is found in the commerce clause of the U.S. Constitution. Authority for dredge and fill regulation is granted to the Corps of Engineers in Section 10 of the Rivers and Harbors Act. Authority for regulation of dredged material discharge is granted to the Corps of Engineers in Section 404 of the Federal Water Pollution Control Act as amended and to the Environmental Protection Agency to work with the Corps of Engineers on water quality aspects of dredged materials.

North Carolina has a similar dredge and fill permit program which applies to coastal waters and coastal wetlands. Coordination between federal and state dredge and fill permits does exist in cases where the two overlap.

V.C.6.b. Administration and Enforcement--Navigable waters are defined narrowly as traditionally navigable waters for each of the above except for discharge of dredged materials. The discharge of dredged materials permits are authorized by Section 404 of the Federal Water Pollution Control Act, which dedefines navigable waters broadly to include practically all coastal waters and adjacent coastal wetlands, all tributaries and adjacent freshwater wetlands. This definition of navigable waters virtually covers all waters. Since any dredge and fill activity involves discharge of the dredged material, the broad definition applies to almost all dredge and fill activities. Therefore, if an applicant is required to obtain a dredge and fill permit, he/she is also required to obtain a permit to discharge dredged materials. In addition, applicants who are not required to obtain a dredge and fill permit may be required to obtain a permit for discharge of dredged material because the latter defines navigable rivers more broadly than the former.

The Corps of Engineers plans to expand its authority in navigable waters as defined in the Federal Water Pollution Control Act using a three-phase schedule. By July 1, 1977, all navigable waters up to their headwaters will be regulated by the discharge of dredged materials permit. However, dredge and fill permits are required only for activities in traditionally navigable waters.

V.C.6.c. Coastal Application--The federal dredge and fill program depends on coordination with the similar state program for the field surveillance and reporting aspects of administration, and is thus less capable than the state of carrying out the program on its own. In fact, the Corps of Engineers reserves comment until the State Biologist has made a decision on the project. If the state denies a permit, the Corps of Engineers will also deny. But if the state allowed the permit, the Corps may analyze the project further by submitting it to several federal agencies for comment.[1] However, the jurisdiction of the Corps includes some areas not covered by the state program. This may becomes more significant as jurisdiction is increased under the Federal Water Pollution Control Act. Thus, where local capacity to regulate all development in wetlands is lacking, and the development is for some reason outside of state jurisdiction, local officials might invoke the federal dredge and fill permit process for the protection of wetlands. This may be the case, for instance, where the wetlands in question are landward of the line dividing coastal and inland fishing waters.

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[1]Conversation with the Wilmington (North Carolina) District of the U.S. Army Corps of Engineers and the Division of Marine Fisheries, July 1975.

VI. REGULATION OF DEVELOPMENT IN AREAS OF ENVIRONMENTAL CONCERN

VI.A. Introduction

Regulation of development in areas of environmental concern is a tool for mitigating or preventing the detrimental impacts of development on certain critical environmental areas. Such critical areas must be defined and delineated, and guidelines then set forth reasonably relating regulations on development procedures to the environmental characteristics of particular concern. A permit may then be required before the proposed development may proceed. A description of the proposed development is scrutinized by the administering agency or governmental body, and a permit may be denied, issued, or issued with conditions according to the ascertained effect on the critical area in question. Major and minor developments may be distinguished for the purpose of either exempting minor developments, or for the purpose of separating the power to regulate them.

VI.B. Authority

Authority to regulate development in areas of environmental concern exists in North Carolina pursuant to the Coastal Area Management Act.[1] This Act provides that major development in areas of environmental concern shall be required to receive permits from the Coastal Resources Commission, a regional administrative body made up of members appointed by the Governor.[2] Permits for minor development may be administered by the city or county in which the development is proposed, if that city or county has developed an approved enforcement program.[3] If an enforcement program has not been approved, the permit application is to be submitted to the Coastal Resources Commission. An application may be denied upon finding that the development would contravene certain existing orders concerning development of wetlands or estuarine waters; result in loss of long-range productivity; result in major or irreversible damage to historic, cultural, scientific, environmental or scenic values; jeopardize public rights; unreasonably endanger life or property; or be inconsistent with state guidelines (especially in areas impacted by key facilities) or local land use plans.[4]

The power to require permits will become effective when final designation of areas of environmental concern has been made, at which time the Secretary of the Department of Natural and Economic Resources shall designate the date for initiation of the permit procedure.

The Federal Coastal Zone Management Act of 1972 (P.L. 92-583) encourages the enactment and implementation of state and local coastal planning techniques by providing such incentives as financial grants for various planning activities and the promise that federal coastal management efforts will defer to states and localities that have developed acceptable planning programs.

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[1] N.C.G.S. 113A-128 (1974).

[2] For definition of major development, see N.C.G.S. 113A-118.

[3] Id., for definition of minor development.

[4] N.C.G.S. 113A-120.

VI.C. Viability

The process of regulating areas of environmental concern has at least initially proved its political acceptability as evidenced by its inclusion as one of the two major techniques for management in the Coastal Area Management Act. Popular acceptance at the local level may safely be said to depend on several factors, among which probably the most important are the total amount of area that is designated, and the demonstrability of the fragile nature and value of the designated areas.

The advantage of this tool is that it focuses directly on the natural characteristics of areas that are intended to be regulated. The biggest technical problems are likely to arise in formulating the regulations to affect the processes in the manner desired, and in delineating the areas so that the boundaries are recognizable and not arbitrary in relation to the ecological processes to be protected. But as more is learned about the natural characteristics of these areas, more accurate, reasonable and standardized guidelines can be applied to facilitate delineation and regulation. The problem is that this information is as yet only partially available.

The appropriate level of government to use the tool is somewhat debatable. Although in theory the designation of areas of environmental concern is a technique whereby an issue of "greater than local interest" may be identified, thereby justifying regional or state regulation, in practice local governments resist relinquishing to higher governmental level controls over the use of land. Localities are often not equipped with the staff or information to handle the technique, while higher levels of government are subjected to the not unfounded criticism of bureaucratic inefficiency and lack of understanding of local problems. Florida and North Carolina have placed much of the responsibility for administration in regional bodies created specifically for this purpose, but the experience thus far in North Carolina is that the responsibility has been substantially returned to the local governments. Local implementation and enforcement according to state guidelines seems to be a realistic approach. Experience indicates, however, that the initiative and authority, both legislative and administrative, must come from the state level.

VI.D. Where It Has Been Used and to What Effect

The regulation of Areas of Environmental Concern has been in effect for some two years in Florida. The experience there is similar to that encountered thus far in North Carolina, in that the following lessons have been learned: massive education of the public is needed; local governments must participate in designating the areas; more information is needed to formulate reasonable guidelines and boundaries; and staff needs are great, at least at the state and regional levels.[1]

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[1]Phyllis Myers, Slow Start in Paradise: An Account of the Development, Passage and Implementation of State Land Use Legislation in Florida (Washington, D.C.: The Conservation Foundation, February 1974).

VI.E. Legal Issues

Potential federal constitutional challenges are those which pertain to all land use regulations. "Takings" claims will be related to the degree of regulation of the land in question and the resultant reduction in the value of the regulated land, balanced against the degree of public benefit derived from the regulation.[1] Equal protection claims may result from inconsistencies in designating areas with similar ecological characteristics, thus failing to ensure that similarly situated landowners are subjected to similar regulations.[2]

If the method of regulating Areas of Environmental Concern involves delegating permit letting or other regulatory powers to regional or local nonelective bodies, the entire scheme may be attacked as an invalid delegation of legislative power.[3] The "non-delegation doctrine" is based on the requirement that legislative, executive, and judicial powers be kept separate and distinct, and that the legislative power of the State be vested in the General Assembly. There is no question that significant powers must be delegated to administrative bodies in order that any legislative scheme may be accomplished. Judicial determination of whether any such delegation of power is unconstitutional focuses on the adequacy of standards set forth by the legislature to guide the administrative body's use of the power. Simply put, the transfer of power to the agency must be accompanied by adequate "guiding standards" to govern the exercise of the power. The key to intelligent application of the doctrine is an understanding that such transfers of power must be closely monitored to prevent arbitrary and unreasonable decision-making by the agency. Decisions by the courts unfortunately have involved only superficial and inconsistent examination of verbal formulas without any significant effort to explain results in terms of underlying policy. The issue of nondelegation may arise concerning several aspects of AEC regulation, including the processes of determining what categories of areas shall be designated as AEC's, what the planning guidelines for these areas should be, and on what basis development permits should be approved or denied.

Other forms of legal attack will generally be based on the closeness with which the administering agencies or local governments adhere to the purposes and techniques of the enabling legislation. The areas must be of the types defined within the Coastal Area Management Act.[4] Delineation of the borders of the area must be recognizable and reasonably correlated with the natural characteristics which make the area one of environmental concern. The extent and nature of regulation in the area must be reasonably related to the protection of those particular characteristics. Regulations and guidelines must be promulgated and followed with some degree of consistency. Procedural requirements, including notice and hearing, must be adhered to.

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[1]Peter Glenn, "The Coastal Area Management Act in the Courts: A Preliminary Analysis," 53 N.C. Law Review 303, 327-338 (1974).

[2]Id., pp. 313-314.

[3]Id., pp. 313-327.

[4]N.C.G.S. 113A-113 (1974).

VI.F. Coastal Application

Designation and regulation of Areas of Environmental Concern (AEC) are already mandated by law and in process in the coastal area of North Carolina. The scope of their usefulness in accomplishing the desired level of protection of the vital coastal processes is affected by several factors and considerations.

The first consideration is that final designation of AEC is charged to the Coastal Resources Commission, and is thus not a local option. There is no way yet for the locality to determine, for purposes of establishing a regulatory scheme, just what the scope of the designations will be. It is therefore difficult to anticipate the potential of the tool for effecting the desired process.

Secondly, even if the broadest designations feasible under the Coastal Area Management Act are made, all of the impacts on the vital coastal systems and environments will not be covered. This is because the individual AEC are all linked with each other and ultimately with all aspects of the coastal environment. Therefore, management tools must be applied outside of AEC, even in their broadest application, to protect these vital systems and environments.

Finally, in spite of the above limitations, the AEC tool has much potential for coastal management. The Act does permit designation of large portions of the most critical areas in the coastal environment. Furthermore, the Coastal Resources Commission will certainly have an open ear for recommendations for AEC designation from local officials, planners and citizenry--and indeed all of these factions should make their opinions known. Regulation through the AEC permit system is the most pervasive and comprehensive tool available for those areas actually designated. Although other management tools consistent with permit guidelines may be used within AEC, the permit process itself is broad and powerful enough to accomplish substantially the purposes of any or all of these other tools. The capacity to review all development, whether major or minor, and deny a permit when that development is "inconsistent with State guidelines or the local land use plans" is a powerful and flexible tool.

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