VI. Development of Beach and Inlet Management Strategies

A. Background and Historical Perspective

In 1974, the General Assembly enacted the state's Coastal Area Management Act (CAMA) which created the North Carolina Coastal Resources Commission (CRC) and established a framework for land use planning and regulation of development in the state's coastal region. CAMA directed the CRC to identify Areas of Environmental Concern (AECs) in the 20 coastal counties and gave the CRC the authority to develop policies and guidelines for development activities in these critical areas. CAMA also required development of county-wide land use plans in the coastal counties. The Division of Coastal Management (DCM) serves as staff to the CRC and implements other provisions of CAMA by working to protect, conserve and manage North Carolina's coastal resources through an integrated program of planning, permitting, education and research.

The state's policies allow for multiple strategies to be used along North Carolina's beaches and inlets. With the exception of temporary sandbags and a limited number of "grandfathered" pre-existing permanent hardened structures, North Carolina's coastal management policies allow only "soft" solutions (*e.g.*, beach nourishment, inlet dredging/bypassing/management, setbacks, and structure relocation). The policy against permanent erosion control structures is intended to avoid downdrift impacts, such as increased erosion, that can be associated with these structures. Coastal zone management strategies developed by the CRC also include oceanfront building setbacks based on long-term erosion rates calculated by DCM, as well as limits on development adjacent to dynamic inlet areas. These policies have limited construction of buildings and infrastructure in the most high hazard areas, helping to mitigate public spending for disaster response. In addition, the publication of maps showing erosion rate setback factors as well as inlet hazard area boundaries provides current and prospective coastal property owners with information that may allow more informed decisions regarding their property and coastal hazards in general.

As part of a comprehensive strategy to manage the state's coastal area, the North Carolina coastal program includes provisions for natural area preservation and public access to the state's coastal waters. The N.C. National Estuarine Research Reserve and Coastal Reserve Program manages 10 sites encompassing more than 40,000 acres for research, education and traditional uses. Since 1981, the Public Beach and Coastal Waterfront Access Program has awarded more than $10 million in grants to local governments to establish more than 280 public access sites along the coast.
State policies governing dredging and dredged material management provide additional support for "soft management" strategies. The State Dredge and Fill Law (G.S. 113-229(h)(2) states that "(c)lean, beach quality material dredged from navigational channels within the active nearshore, beach or inlet shoal systems shall not be removed

permanently from the active nearshore, beach or inlet shoal system. This dredged material shall be disposed of on the ocean beach or shallow active nearshore area where it is environmentally acceptable and compatible with other uses of the beach." In addition, House Bill 1840 (2000), stated that the goals of a Beach and Inlet Management Plan shall include full utilization of sand resources and use of beach nourishment, sand bypassing, and other strategies to protect critical resources. HB 1849 also recommends the use of structure relocation where it serves the public interest.

While DCM enforces the provisions of the state Dredge and Fill Law, the Division of Water Resources (DWR), as the non-federal sponsor of dredging activities such as the Wilmington Harbor, Morehead City Harbor, and the Manteo (Shallowbag Bay) projects, has been actively working with the USACE to achieve the beneficial use of dredged material where feasible. For the Wilmington Harbor Project, this includes placing dredged material on Kure Beach, Oak Island, Caswell Beach, and Bald Head Island. For the Morehead City project, activities included placing dredged material on beaches at Fort Macon State Park, Atlantic Beach, Pine Knoll Shores, and Indian Beach. The Manteo (Shallowbag Bay) project, involved placing material on beaches along the National Wildlife Refuge on Pea Island and at the entrances to Wanchese Harbor.

B. Policy Considerations

The BIMP was developed within the framework of existing coastal management rules and policies. Listed below are the major policy considerations that must be considered when developing potential beach and inlet management strategies in North Carolina.

1. Setbacks

The majority of the oceanfront setback determinations are found in 15A NCAC 07H.0306. Grandfather provisions to these setbacks are addressed in 15A NCAC 07H.0104 and .0309.

a) Current Setback Policy (effective August 11, 2009)

- ALL structures <5,000 sq. ft. are setback a distance of 30 x erosion rate, with a minimum setback of 60 feet (Figure VI-1)
- ALL structures > or = 5,000 but < 10,000 sq. ft. are 60 x erosion rate (Figure VI-1)
- ALL structures > or = 10,000 but < 20,000 sq. ft. are 65 x erosion rate (Figure VI-1)
- ALL structures > or = 20,000 but < 40,000 sq. ft. are 70 x erosion rate (Figure VI-1)
- ALL structures > or = 40,000 but < 60,000 sq. ft. are 75 x erosion rate (Figure VI-1)
- ALL structures > or = 60,000 but < 80,000 sq. ft. are 80 x erosion rate (Figure VI-1)

- ALL structures > or = 80,000 but < 100,000 sq. ft. are 85 x erosion rate (Figure VI-1)

- ALL structures > or = 100,000 sq. ft. are 90 x erosion rate (Figure VI-1)

- The maximum setback for linear infrastructure, including roads, is 30 x erosion rate.

- Total square footage of a structure is calculated by heated space and does not include the area associated with covered decks and porches.

- Cantilevering (extension beyond support of pilings or footings) oceanward of the appropriate setback is not allowed.

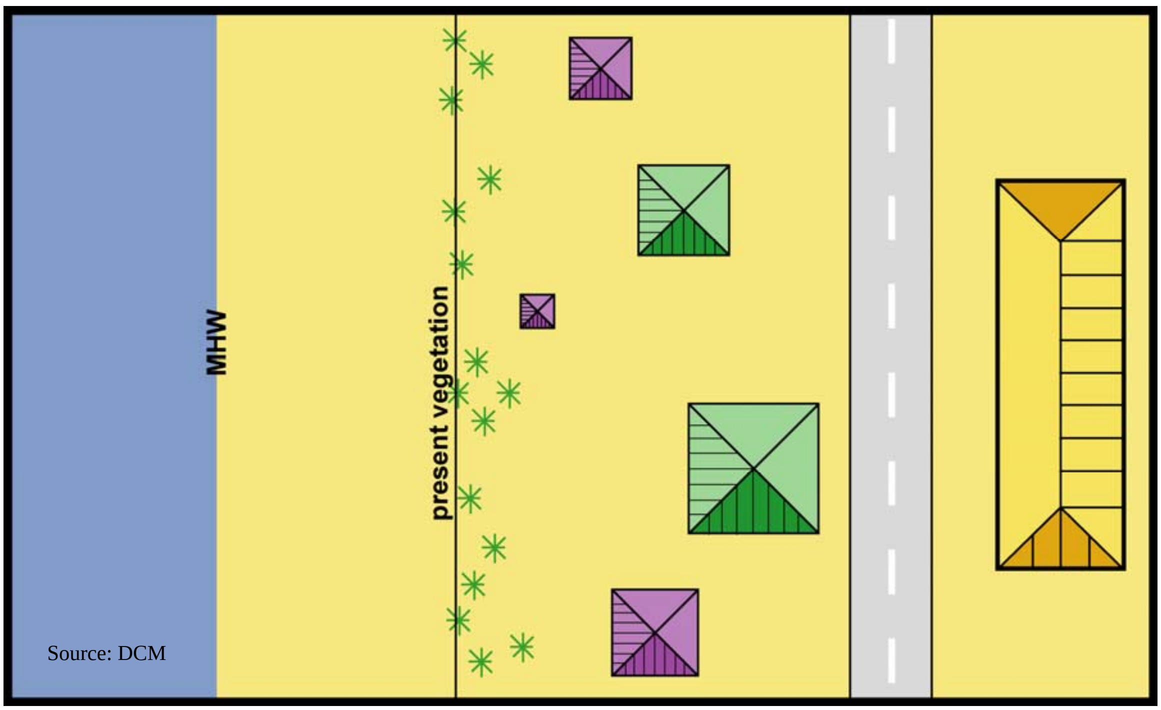

Figure VI-1. Current Setback Policy (Increased Graduated Setbacks for Larger Structures)

b) Setback Policy Exceptions

Recent revisions to 15A 07H.0104 (effective Aug. 1, 2010) require that development on lots created on or after June 1, 1979 shall use the current erosion rate in calculating the building setback. If application of the current erosion rate precludes development on lots created on or after June 1, 1979, then the setback can be calculated using the erosion rate in effect at the time that the lot was created, subject to additional building restrictions (including a total floor area limitation of 2,000 square feet, a footprint limitation of 1,000 square feet, being as far landward on the lot as feasible, and being no further oceanward than the landward-most adjacent building). If application of the current erosion rate precludes development on lots created prior to June 1, 1979, the minimum setback and conditions are outlined in 15A 07H.0309 (effective June 1, 2010). Development subject to the 15A 07H.0309 exception can occur if it is located as far landward on the lot as feasible and meets a minimum setback of 60 feet (30 x minimum erosion rate of two feet per year). The size of development utilizing this exception is limited to a footprint that is no greater than 1,000 square feet (including roofed decks and porches that are structurally attached to the primary structure) and a total floor area of no greater than 2,000 square feet. The exception cannot be used in Inlet Hazard or Unvegetated Beach Area of Environmental Concern.

c) Minimum Erosion Rate

Shoreline change trends (erosion and accretion) are calculated for the oceanfront by the DCM, and CRC policy sets the minimum setback at 60 feet (30 x 2 feet per year erosion rate). Therefore, by default, the state uses a minimum erosion rate of two feet per year even in areas with erosion rates less than two feet per year or with accreting shorelines.

d) The Static Vegetation Line

In areas within the boundaries of large-scale beach fill projects, the oceanfront setback is measured from the location of the first line of stable and natural vegetation as surveyed prior to the large-scale beach fill. A large-scale beach fill project is defined as a beach fill project that is greater than 300,000 cubic yards, or a storm protection project constructed by the USACE. For communities that received large-scale beach fill prior to the CRC rules *(e.g.*, Wrightsville Beach, Carolina Beach, Atlantic Beach), static vegetation lines were established by DCM using aerial photographs, survey maps, and other pertinent data. Because the impact of Hurricane Floyd (September 1999) caused significant portions of the vegetation line in the Town of Oak Island and the Town of Ocean Isle Beach to be relocated landward of its pre-storm position, the static line for areas landward of the beach fill construction in these municipalities which occurred in 2000, is defined by the general trend of the vegetation line established by DCM from June 1998 aerial orthophotography.

By using a static vegetation line, the point used for measuring oceanfront setbacks becomes fixed in perpetuity. The static vegetation line policy (15A NCAC 07H.0305), recognizes the fact that a large-scale beach fill project may result in the natural vegetation line moving oceanward in response to an artificial (and oceanward) expansion of the beach profile. If the beach receiving sand is not maintained by subsequent beach fill maintenance, the shoreline and vegetation line will return to its pre-fill conditions. Therefore, the implementation of a static vegetation policy prevents development from encroaching oceanward onto the engineered beach. It should be noted that in all cases, the first line of stable and natural vegetation supersedes the static line where the actual vegetation has moved landward (and is therefore more restrictive) of the static line.

Communities that have static lines for setback measurement are: Ocean Isle, Oak Island, Caswell Beach, Bald Head Island, Kure Beach, Carolina Beach, Wrightsville Beach, Emerald Isle, Indian Beach, Salter Path, Pine Knoll Shores, and Atlantic Beach.

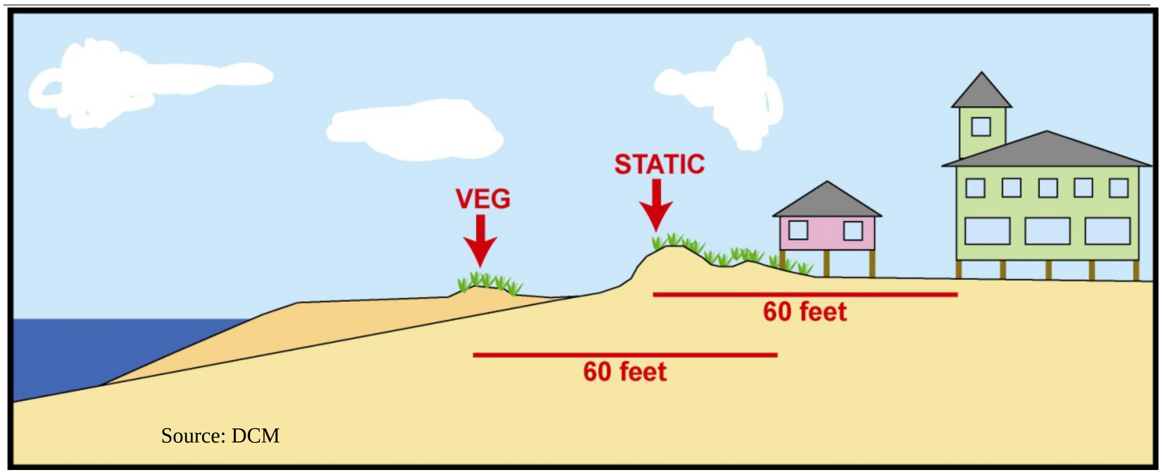

Figure VI-2. Static and Stable Vegetation Lines (DCM)

e) The Static Line Exception

The CRC has established an exception to the static line setback (15A 07H.0306) and set forth procedures for petitioning the CRC for an exception (15A 07J.1200). The CRC can grant a static line exception to a town or county based on three conditions: 1) the community has a long-term (at least 25 years), large-scale beach fill program in place (the community must wait at least five years after the first large-scale fill project that triggers a static line exception before applying for an exception); 2) the community has identified beach compatible sand (in line with the CRC's sediment compatibility rules in 15A NCAC 07H.0312); and 3) the community has a plan to pay for the beach fill program.

Under the exception, a structure that cannot meet the setback from the static vegetation line may be permitted as long as the structure can meet the appropriate setback from the first line of stable and natural vegetation and aligns with the most landward adjacent structure. The exception limits structures to a total floor area of no greater than 2,500 square feet. The exception takes into account the mitigating factors associated with long-term, large-scale beach fill programs as well as new development constructed with modern materials and under current building codes. With a five-year waiting period and a minimum 25-year beach fill program in place, a community would essentially have a 30-year beach management program. Static line exceptions will be approved for 5-year intervals and renewal of the exception can only be done if the community continues to meet the three criteria listed above (a plan, a sand source, and funding mechanism).

The following local governments have received static line exceptions (expiration date follows in parentheses): Ocean Isle (expires Jan 25, 2015), Carolina Beach (expires Sept 9, 2014), Wrightsville Beach (expires Sept 9, 2014), Emerald Isle (expires April 5, 2015), Indian Beach / Salter Path (expires April 5, 2015), Pine Knoll Shores (expires April 5, 2015), and Atlantic Beach (expires April 5, 2015).

1. Sediment Criteria

With the exception of Florida, North Carolina is the only state with rules that establish sediment compatibility criteria for beach fill projects (15A NCAC 07H.0312). The rules require a characterization of the sediment grain size relative to the native beach and proposed borrow area sediments, as well as standards to determine whether the proposed borrow area sediment grain size distribution is compatible with the recipient beach. The rules require geotechnical data prior to construction to reduce the possibility of incompatible material being placed on the beach. Borrow sites must not have fine-grained and coarse-grained sediments greater than five percent over the native beach characterization. Sediment and shell material with a diameter greater than three inches shall be considered incompatible if it has been placed on the beach during the beach fill project, is observed between mean low water and the frontal dune toe, and is in excess of twice the background value of material of the same size along any 50,000-square foot section of beach. Carbonate (*i.e.*, shell material) is to be no greater than 15 percent over that of the native beach. The driving factor in the development of the criteria was concern about changing the nature of the recipient beach by allowing too much deviation from the high and low end of the grain size distribution (the fine and coarse fractions around the mean).

2. Inlet Hazard Areas

Inlet Hazard Areas (IHAs) are defined in 15A NCAC 07H.0304 as natural hazard areas that are especially vulnerable to erosion, flooding, and other adverse effects of sand, wind, and water due to their proximity to dynamic ocean inlets. Although North Carolina has 19 active tidal inlet complexes (Drum Inlet has three individual inlets), 12 of these inlets with designated IHAs since they are flanked by development on one or both sides. Due to the extremely hazardous nature of IHAs, all development within these areas is subject to the following standards (15A NCAC 07H.0310):

- All development should be set back from the first line of stable vegetation a distance equal to the setback required in the adjacent ocean erodible area.

- Permanent structures are permitted at a density of no more than one commercial or residential unit per 15,000 square feet of land area on lots created after July 23, 1981.

- Only residential structures of four units or less or non-residential structures less than 5,000 square feet are allowed (also allowed are access roads to these areas and maintenance and replacement of existing bridges).

- Public rights of access to public trust lands and waters are not to be restricted and development is not to encroach upon these public access ways or limit their intended use.

- The single-family exception from oceanfront setback requirements (15A NCAC 07H.0309) is not applicable in IHAs.

Currently, DCM and the Science Panel are working to redefine the current IHA boundaries and draft new development standards for the new boundaries. A new draft report titled "Inlet Hazard Area Boundary Update: Recommendations to the North Carolina Coastal Resources Commission" was completed on May 11, 2009 for internal DCM review, revised, and distributed on May 20, 2009 to the CRC Science Panel (Warren, J.D. and Richardson, K.R., 2009). The report is available online: http://tinyurl.com/34z49t9. In November 2010, draft use standards for IHAs were made available for comment and DCM conducted a number of stakeholder meetings to solicit input. After consideration of the comments, the CRC has placed further development of the use standards on hold until updated erosion rates can be calculated for the entire coast, including inlet shorelines.

3. COBRA Zones

In 1982, the Coastal Barrier Resources Act (COBRA) eliminated Federal development incentives associated with building and development in undeveloped portions of designated coastal barriers (COBRA Zone units). Federal restrictions include new property development, highway construction, beach nourishment, inlet stabilization, disaster relief, and flood control. Also banned was the sale of federally subsidized flood insurance for any structures built or improved upon after October 1, 1983. Exceptions to the COBRA rules include existing navigation projects; dredge disposal for federal projects; maintenance (not expansion) of public roads, structures, and facilities; shoreline stabilization; and energy resources mining. Since 1982, several issues have surfaced regarding the initial delineation of the COBRA Zone units such as mapping resolution and allowances for expansion of COBRA units. A pilot study was begun in 2000 to explore the possibilities for converting the COBRA Zone delineations from hand drawn hardcopy to electronic digitization. This study was expanded in 2006 to include electronic digitization of all COBRA Zone units. The pilot study revealed geomorphic changes since the 1982 delineation, and as a result North Carolina could possibly have an additional 8,712 acres (242 acres dry land, 8,469 acres aquatic) of COBRA Zones areas.

The existence and location of COBRA Zones greatly affects beach and inlet strategies when it comes to dredging and beach nourishment activities. For example, issues that may arise include placement of material dredged from a non COBRA to a COBRA Zone which is disallowed with federal funds.

4. Sea Level Rise

Relative sea level is rising along the North Carolina coast is a combination of global sea level rise and regional land subsidence. Long-term tidal water level recording stations estimate the rate of this rise as approximately 1 to 1.5 feet per century along the North Carolina coast.

Figure VI-3 shows Magnitude of SLR resulting from differing rates of acceleration from the CRC Science Panel Sea Level Rise Assessment Report, March 2010. The mean sea level rise trend is 1.22 feet per century with a standard error of 0.21 feet per century based on monthly mean sea level data from 1973 to 1999. The upper and lower hindcast lines indicate the upper and lower 95 percent confidence interval, respectively. Short-term sea-level rise from 1980 to 2000 at Duck, N.C. (Dare County), based on tide level readings, is estimated to be 1.5 feet per century (Riggs, 2008). Other studies show estimates of sea-level rise for the Outer Banks of 10.5 inches per century (Pietrafesa *et al.*, 2005). All of these estimates are based on extrapolation of measurements less than 100 years.

In the federal Coastal Zone Management Act (CZMA) 16 U.S.C. § 1452 (Section 303) Congressional Declaration of Policy (http://coastalmanagement.noaa.gov/about/czma.html#section303), Congress declared that it is the national policy that state coastal management programs should provide for (among other things):

> "(B) the management of coastal development to minimize the loss of life and property caused by improper development in flood-prone, storm surge, geological hazard, and erosion-prone areas and in areas likely to be affected by or vulnerable to sea level rise, land subsidence, and saltwater intrusion, and by the destruction of natural protective features such as beaches, dunes, wetlands, and barrier islands,"

The U.S. Environmental Protection Agency (US EPA) has identified North Carolina as one of the three continental states most vulnerable to sea level rise, the others being Louisiana and Florida. Under the U.S. Climate Change Science Program (CCSP) the U.S. EPA, U.S. Geological Survey and the National Oceanic and Atmospheric Administration collaborated in preparing a report titled "Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region" that was released in January 2009 (http://www.climatescience.gov/Library/sap/sap4-1/final-report/default.htm). The report identifies North Carolina as highly vulnerable to "threshold" events such as rapid barrier island migration, breaching and segmentation, as well as extensive inundation and erosion along mainland shorelines. The report notes that those responsible for managing public natural and infrastructural resources, as well as private property, will have to adapt to rising sea levels regardless of efforts to control greenhouse gas emissions.

DCM has prepared and begun to implement a Framework for Action, consisting of the following steps:

- Part 1: Scoping Survey (Completed)
- Part 2: Science Forum (Completed)
- Part 3: Policy Development (Target Date: Fall 2011)
- Part 4: Mitigation & Adaptation Recommendations to Executive Branch (Target Date: Summer 2012)
- Part 5: Amendments to Coastal Management Program Regulations & Land Use Planning Guidelines (Target Date: Ongoing)
- Part 6: Coordination with State Agencies & Local Government Planning Efforts (Target Date: Ongoing)

More information about this effort can be found in "Planning for Sea Level Rise - Mitigation and Adaptation in North Carolina: A Framework for Action" prepared by DCM in July 2009.

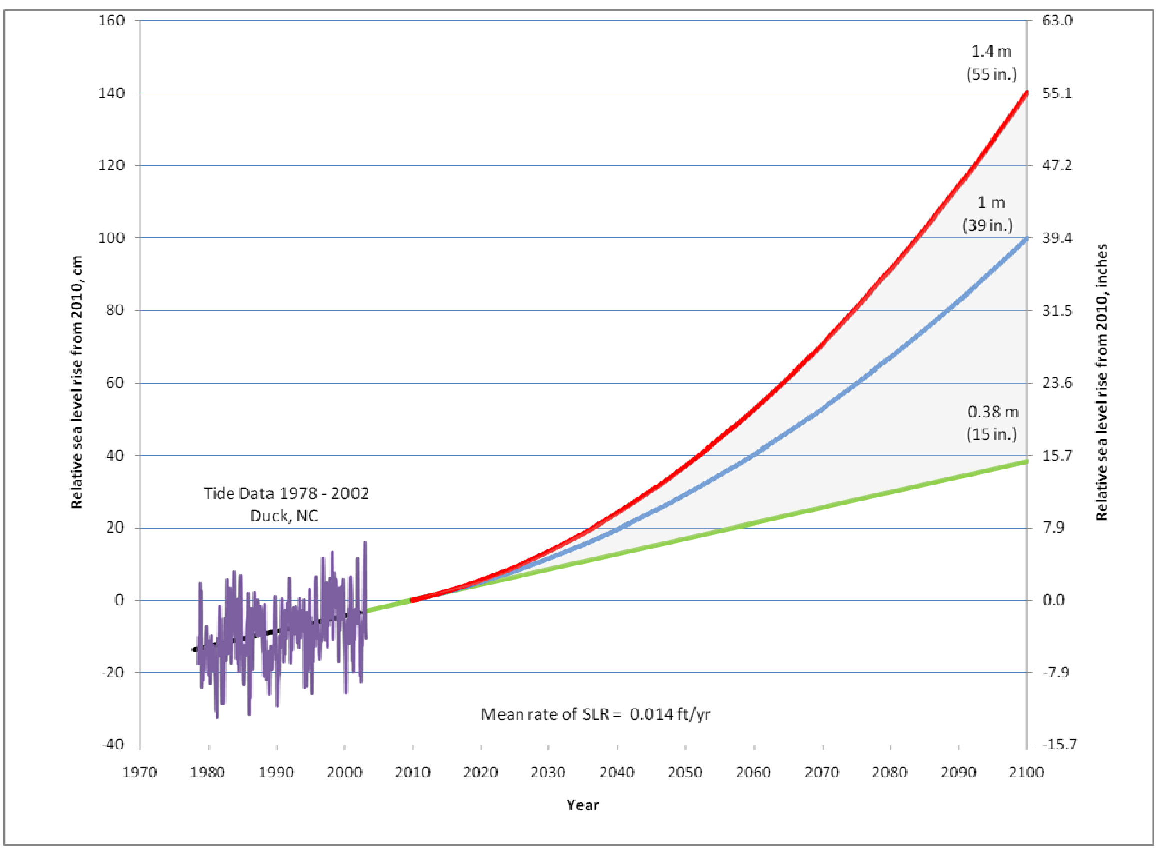

Figure VI-3. Magnitude of SLR resulting from differing rates of acceleration. From the CRC Science Panel Sea Level Rise Assessment Report, March 2010.

The CRC Science Panel on Coastal Hazards released a report based on a review of the published literature, of the known state of sea-level rise for North Carolina. The intent of this report is to provide North Carolina's planners and policy makers with a scientific assessment of the amount of SLR likely to occur in this century. The report does not attempt to predict a specific future rate or amount of rise because that level of accuracy is not considered to be attainable at this time. Rather, the report constrains the likely range of sea-level rise and recommends an amount of sea-level rise that should be adopted for policy development and planning purposes. The Science Panel found the most likely scenario for 2100 is a rise of 0.4 meter to 1.4 meters (15 inches to 55 inches) above present, and recommended that a rise of one meter by 2100 be adopted for planning purposes.

Increasing sea level over time will flood some low lying coastal areas and also, during elevated storm water levels, allow waves and currents to travel farther up the beach and into the inlets. This may result in greater wave-induced erosion of the beaches and shifting of the inlets and associated sediments.

A recently authorized study will provide even more insight into sea-level rise and its potential impacts. FEMA's FY 2009 Budget Appropriation (PL 110-329) included $5 million for the state of North Carolina to conduct a North Carolina Sea Level Rise Risk Management Study, with final scenarios expected in mid-2011. Specifically, P.L. 110-329 provides $5 million for the state of North Carolina to perform a risk assessment and mitigation strategy demonstration of the potential impacts of sea level rise in that state associated with long-term climate change, as discussed in the House report (http://www.ncsealevelrise.com/). FEMA is directed to use the study results to assess the long-term fiscal implications of climate change as it affects the frequency and impacts of natural disasters, and to disseminate information from the study to other states to inform their climate change mitigation efforts. This study is being performed by the North Carolina Office of Geospatial and Technology Management's (NCGTM) Division of Emergency Management, who will be responsible for the risk assessment of sea-level rise and increased flooding associated with long-term climate change in North Carolina as required by PL 110-329. Aspects of flooding to be evaluated are: 1) sea level rise, 2) increasing frequency and/or intensity of coastal flooding (surge, wave heights), and 3) erosion. The study will develop reasonable scenarios of potential sea level rise and demographic conditions in North Carolina for four "time slices" through 2100: near-term (2025), medium-term (2050), long-term (2075), and end of the century (2100).

Many other stakeholders at the state level, including local governments; marine contractors and engineers; conservation organizations; and university researchers have become focused on sea level rise. The NOAA lab in Beaufort is conducting sea level rise research in the state.

In the broader area of climate change science, the US EPA also issued in April 2009 its Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the Clean Air Act (http://epa.gov/climatechange/endangerment.html).The proposed findings set the stage for the EPA for the first time to contemplate adopting regulations to target a suite of gases as public health hazards and environmental pollutants contributing to global climate change. The findings suggest that these gases have also contributed to accelerated rates of relative sea level rise in the mid-Atlantic region, outpacing the global average rate.

The Intergovernmental Panel on Climate Change (IPCC) released its Fourth Assessment Report (AR4) and Synthesis Report (http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf) in 2007. The AR4 Report earned global recognition for its findings concerning the strong scientific consensus about the reality of global climate change, sea level rise and the anthropogenic contribution to these phenomena. The AR4 Report includes what are regarded as conservative projections for global average sea level rise by 2100, since the report does not account for contributions from melting land ice. Most of the scientific evidence acquired since the AR4 research shows net melting that exceeds what models were projecting at that time. The IPCC has begun outlining its Fifth Assessment Report (AR5). The AR5 Report could incorporate melting data and modeling, and provide a more complete picture of potential sea level rise.

C. Beach and Inlet Management Strategies

Beach and inlet management strategies are often interrelated. For example, material dredged to maintain an inlet for navigation might be placed on the beach. Some general strategies and considerations are given in the following table (Table VI-1) and outlined in further detail below.

Table VI-1. Potential Beach and Inlet Management Strategies

BEACH	INLET
▪ Nourishment (size, frequency, location, method, …) ▪ Coastal Zone Management Practices (setbacks, structure relocation, public access, …) ▪ Storm Recovery (dune reconstruction, planting, beach dozing, breach fill, …)	▪ Dredging (size, frequency, location, method, …) ▪ Sand Bypassing (size, frequency, location, method, …) ▪ Inlet Management/Relocation

1. Beach Nourishment

Beach nourishment is a term that describes a process by which compatible sediment is placed on a beach. It involves the transport of the nourishment material (beach fill) from an outside source to the affected area (usually by dredging although upland sediment sources can also be utilized by trucking). Beach nourishment adds sand to the beach system thereby widening a beach and advancing the shoreline seaward. Beach nourishment is frequently used as part of a coastal storm protection and/or recreational access scheme. Beach nourishment projects are generally designed and engineered to work like natural beaches, allowing sand to shift in response to changing waves and water levels.

Once a beach is nourished, it is necessary to periodically renourish the beach on a schedule determined by local erosion rates and storm factors. Renourishment is designed to maintain the beach to provide the desired level of storm protection and recreational access. Figure VI-4 illustrates an example of beach nourishment with sand being pumped onto a beach.

Figure VI-4. Beach Nourishment in Carteret County

2. Shoreline Management Practices

As mentioned previously, DCM has calculated long-term shoreline change rates based on changes in beach width from the earliest digitized shorelines archived by the state (typically the 1940s) compared to a recent shoreline. The last erosion rate update was completed in 2003 using ortho-rectified near vertical color photography acquired in 1998. Using these calculated shoreline change rates, the CRC established oceanfront setback factors which determine the minimum allowable distance between a structure and the first line of stable vegetation for locating development. A discussion of the setback policy can be found in Section VI.B.

Other shoreline management practices may include land use planning to reduce coastal risks and impacts; the inclusion of public access into beach projects; relocation of at risk structures; and land conservation.

3. Storm Recovery

After storms, some communities use beach bulldozing to repair their primary and frontal dunes, and to restore the beach profile. Beach bulldozing has been utilized in most regions of the state especially Regions 1 and 2b. Other storm recovery efforts may include dune reconstruction utilizing bulldozing and/or recovered overwash sand along with vegetative plantings and sand fencing.

4. Structures

Due to a prohibition on permanent erosion control structures (commonly referred to as hard structures) North Carolina's beaches and inlets are relatively free of engineered structures on the oceanfront. In 1985, the CRC banned seawalls and other similar permanent erosion control structures. In 2003, the General Assembly amended CAMA to incorporate the CRC's ban on these structures. Existing structures which pre-date the permanent erosion control structure ban may be repaired but not replaced. There are exemptions for structures that protect an erosion-threatened bridge that provides the only existing road access to a substantial population on a barrier island; maintain an existing commercial navigation channel of regional significance; protect a historic site; or an erosion control structure issued pursuant to a variance granted by the Commission prior to 1 July 1995. These structures may be repaired or replaced.

Temporary erosion control structures (sandbags) are allowed, but only for a limited period of time. The intention of the CRC's sandbag rules are to provide property owners with a temporary means of protecting their property until the beach can naturally repair itself; their building(s) can be relocated; or to allow time for a community to complete a beach fill or inlet relocation project. Sandbag permits (15A NCAC 07H.0308) are allowed for a period of two years if a structure is less than 5,000 square feet or up to five years if a structure is greater than 5,000 square feet or the community is actively pursuing a beach fill project. Property owners can also receive sandbag permits for up to eight years if the property is located within an inlet hazard area and the community is pursuing an inlet channel relocation project. Permits in Inlet Hazard Areas can be extended for an additional eight years if the structure is again imminently threatened and the community is actively pursuing an inlet relocation project. With the exception of Inlet Hazard Areas, the use of sandbags for temporary erosion control can only be permitted once regardless of changes in ownership of the structure being protected. Sandbags must be removed when the structure is no longer imminently threatened and many times removal of existing sandbags is a permit condition for a beach fill project. If sandbags become covered with sand and stable, natural vegetation, they do not need to be removed. However, if the sandbags become exposed or are no longer covered and vegetated then they must be removed.

5. Dredging and Sand Bypassing

Dredging and sand bypassing are the two primary inlet management strategies utilized in North Carolina. The majority of the inlets are shallow draft inlets (6-14 feet deep) with only the Cape Fear Inlet (Wilmington Harbor) and Beaufort Inlet (Morehead City Harbor) being deep draft inlets for port navigation.

Dredging is vital to the maintenance of transportation routes through state waterways and for providing safe, reliable access to the Atlantic Ocean. Dredging of shallow draft navigation channels supports commercial fisheries and public transportation (ferries, recreational boaters) and helps ensure boater safety (elimination of shoals and inlet dredging can reduce breaking wave hazards).

Dredging in North Carolina is performed by the Wilmington District of the USACE, the DWR, the NCDOT Ferry Division, and by private interests. The Wilmington District of the USACE maintains 308 miles of federally mandated channels including the Atlantic Intracoastal Waterway, rivers, small harbors, and seven major inlets along the coast.

a) Dredge Types and Capabilities

Different beach and inlet strategies require varying types of equipment and dredging techniques. Dredging equipment can be broadly divided into two categories, mechanical dredges and hydraulic dredges.

Mechanical dredges are analogous with land-based excavating machinery and include shovel-type excavators such as clamshells, buckets, ladders, and draglines. These dredges generally are unable to transport dredged material over long distances, lack a means of self-propulsion, and have relatively low production rates. Their main advantage is the ability to operate in tight spaces along docks and jetties. Mechanical dredges can be land based or mounted on barges. Figure VI-5 illustrates a typical “clamshell” mechanical dredge with material placed in a bottom dumping barge.

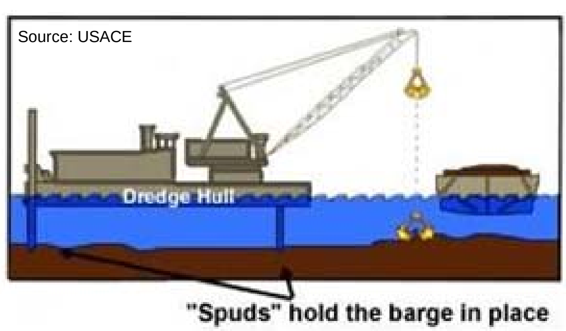

Figure VI-5. Typical Mechanical Dredge (Clamshell Bucket) with Bottom Dumping Barge

Hydraulic dredges are characterized by the use of a centrifugal pump that produces a high velocity stream of water in a pipeline in which solids are entrained and transported to a discharge area. Hydraulic dredges are further categorized by their method of excavation, method of placement, and the nature of the intake element that is in contact with the material to be dredged.

Hopper dredges are the most common hydraulic dredge used offshore, consisting of a self-propelled, ocean-certified vessel that is capable of storing dredged material onboard in hoppers and transporting it to a disposal site. The material is pumped into the hoppers through a pipe and draghead. The draghead configuration varies depending on the material being dredged but is frequently a trailing suction configuration with a draghead supported by drag arms trailing the ship. The bottom sediment is entrained like a vacuum cleaner by plain suction. The dredged material can be dumped through bottom doors onto the seafloor at a given placement location or some hopper dredges have pump off capabilities where the material can be pumped via pipeline from the hoppers to the shore. Hopper dredges can be readily moved and can operate in wave conditions that are not feasible for other dredge types.

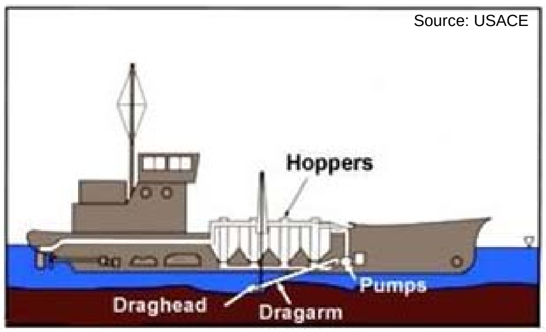

Figure VI-6. Typical Hopper Dredge

Some trailing suction dredges, called sidecasters, do not have hoppers and instead discharge the dredged material through extended, cantilevered arms (Figure VI-7). Sidecaster dredges dispose of the dredged material back into the region from which it is dredged. The dredged material is cast off to the side of the dredging vessel (which is following natural deepwater channels) through a boom some distance from the channel from which it was removed. This method allows continuous operation and limited increase in draft during operation since the material is not carried on the vessel as with hopper dredges. Since the dredges are smaller and do not move the material a great distance, dredging is usually required multiple times per year.

Figure VI-7. Sidecaster Dredge

Pipeline dredges use pipelines to pump material from the location of dredging to a disposal area. The dredging action may be by plain suction, cutterhead, bucket wheel, or dust pan. Cutterheads have a rotating cutter which loosens bottom materials at the suction intake of the pipeline. Different cutters can be employed for various bottom materials. A bucket wheel is essentially as the name suggests; a rotating wheel of buckets which excavates the material. A dustpan received its name from the shape of the suction head, which resembles a dustpan or vacuum cleaner head. Pipeline dredges usually are not self-propelled and consist of a large centrifugal pump mounted on a specially designed barge. The bottom material is pumped through a suction pipe to the barge and then through a pipeline to the placement area. The pipeline is floated by pontoons and can extend thousands of feet. Booster pumps can be used to achieve increased distances. Pipeline dredges can move large volumes of material in relatively short time. The placement area, however, must be relatively close to the dredge site and the wave and wind conditions must allow for the operation of the dredge and maintaining the pipeline.

The most common and most versatile hydraulic dredge is the cutterhead, which is equipped with a rotating cutter (excavator) surrounding the intake of the suction line. (Turner, 1996). A conventional cutterhead dredge is held in position by two spuds at the stern (Figure VI-8). One spud is pushed into the bottom and the dredge is moved in a sideways arc to dredge the channel width using two swing anchors. It can operate continuously and discharge the dredged material directly by pipeline to water, beach, or upland disposal areas. One of its limitations is its inability to work in severe wave climates (even heavier pipeline dredges with special equipment cannot operate in seas greater than six feet).

A comparison of the various dredge types is presented in Table VI-2.

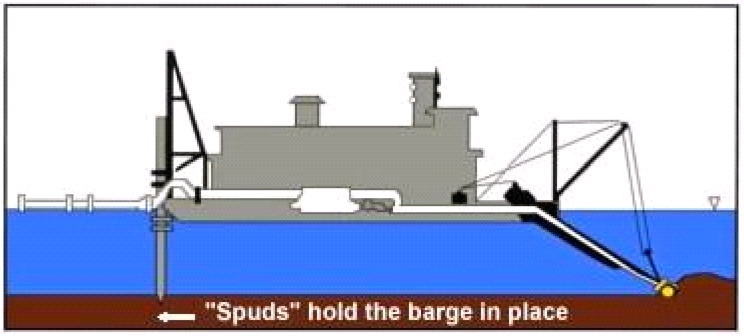

Figure VI-8. Typical Cutterhead Hydraulic Dredge

Dredged material can be placed upland, in-water, or on the beach. Dredged material in the past was often thought of as waste material or "dredge spoil" and disposed of in the cheapest and quickest manner possible. Current thinking views dredged material along the coast as a resource to potentially restore beaches, build habitat areas through wetland/environmental restoration, and protect shorelines. One of the fundamental objectives of the BIMP is to advocate best management practices with respect to dredged sediments. Beach quality material should be returned to the beach, or utilized to create habitat (non-beach compatible sediments), and should remain in the system except if contaminated.

Table VI-2. Comparison of Various Dredge Types

Factor	Dredge Type			
	Mechanical	**Sidecaster**	**Hopper**	**Pipeline**
Common Excavation Method	Scooping	Trailing suction	Trailing suction	Suction with cutterhead
Material Placement	Into barges	Discharges to side of channel	Into hoppers which are bottom discharged at disposal site	Pump directly to nearby disposal site, in water or on land
Common Use	In harbors around docks	Exposed channels and inlets	Exposed channels, larger rivers and inlets (mobile so can operate where other traffic is present)	In wider channels with deep shoals (lower traffic areas since floating pipeline maybe a navigation obstruction)
Usage Conditions	Relatively protected calm areas	Relatively rough seas	Relatively rough seas	Relatively calm seas (floating pipeline can break apart)
Common Material Dredged	Consolidated, hard-packed, debris	Loosely compacted, coarse-grained	Heavy sands	Sediment that can be broken up and mixed with water forming pumping slurry

The USACE Wilmington District maintains the small draft dredging fleet for the Atlantic coast. Currently, this includes operation of three dredges suitable for shallow draft navigation channel and inlet dredging. These specialized dredges are capable of operating in ocean-exposed inlet conditions and shallow draft waters. There are no readily available commercial dredges with the combination of ocean certification and the capability of shallow water operation. This combination is optimal to dredge the shallow inlets along the North Carolina coast due to wave conditions at the inlets. These dredges are also outfitted with specialized trailing suction heads to avoid turtle impacts and allow for nearly year-round operation. One of the dredges is a small split-hull hopper dredge and is capable of placing sediment in the nearshore littoral zone (sand bypassing) in less than eight feet of water. Dredging of the interior, sheltered channels is primarily accomplished by the USACE through contracts with commercial dredging firms.

6. Inlet Management/Relocation

As part of inlet dredging, a number of inlet management/relocation projects have been completed to assist with navigability and inlet stability as well as beach protection. Both the Wilmington and Morehead City Harbor channels have undergone improvements (deepening and channel realignment) to alleviate navigation constraints and improve inlet stability. The sediment dredged from channels associated with the Morehead City Harbor is now also being placed on the beach more frequently than in the past when sediment was routinely dumped offshore at the ODMDSs (Ocean Dredged Material Disposal Site). Similar methods are also now being employed at Oregon Inlet where compatible sands are placed on downdrift Pea Island. These projects are good examples of reconnecting sediment pathways.

Other shallow draft inlets (in addition to Oregon Inlet) have also undergone inlet management/relocation that was completed for inlet navigability/stability as well as beach protection. These projects include Carolina Beach Inlet opening (1952), Tubbs Inlet relocation (1970s), Mason Inlet relocation (2002) and Bogue Inlet channel realignment (2005). Inlet management/relocation projects are currently being planned for other areas as well (Rich Inlet, New River Inlet, and New Topsail Inlet). Finally, the recently completed USACE study for the Brunswick County beaches (Region 1), suggests that the inlets in this area may be the only reliable cost effective sediment source (Frying Pan Shoals may also be used to supplement overall needs).

While inlets can be seen as sediment sources for beach nourishment projects, concerns have been raised with utilizing inlets and the flood/ebb shoals as a sediment resource. The ocean policy report recently completed by DENR (http://dcm2.enr.state.nc.us/opscreport.pdf) stated as one of its recommendations that:

> "Inlet tidal deltas (ebb-tide and flood-tide; ocean and estuarine side, respectively) are an important component to the health of the barrier island system. While large quantities of beach compatible sand located in inlet deltas are attractive, lower cost sand sources for beach nourishment projects, allowing excessive mining of inlet tidal deltas destabilizes the associated inlet, diminishes the quantity of sand available to the backside of barrier islands and interrupts the natural deposition-erosion dynamics on adjacent barrier islands. Destabilization of inlet deltas can result in the increased erosion and narrowing of adjacent barrier islands. It is the steering committee's recommendation that additional studies of inlet tidal deltas should be conducted to assist the CRC in developing policies and rule language concerning where excavation may occur within these areas, and what are the appropriate limits on the total volume of sand removed."

In light of this recommendation, adequate study and investigation should be completed to verify that sediment volumes removed from these areas will not cause undue impacts from future inlet management/relocation projects.

7. Environmental Considerations for Strategies

While beach and inlet projects do provide benefits of storm protection, increased recreation, and other features, it is important to note that there are environmental impacts and concerns that must be studied and assessed before a project is permitted. Extensive monitoring may also be required.

a) Potential Impacts

The N.C. Marine Fisheries Commission's policies for the protection of marine and estuarine resources from beach dredging, filling, and large-scale coastal engineering projects (MFC 2000), found that the cumulative effects of these beach and inlet management projects have not been adequately assessed. The potential impacts include effects on public trust marine and estuarine resources, use of public trust beaches, public access, state and federally protected species, state-designated critical fisheries habitat, and federally-designated essential fish habitat. A review by the Atlantic States Marine Fisheries Commission of available monitoring studies and scientific literature (Greene, 2002) also concludes that impacts to fisheries and wildlife from nourishment projects have not been thoroughly defined, and that more experimental research is required to determine actual impacts. A recent study by Peterson and Bishop (2005) assessed 46 projects and similarly concluded that cumulative effects have been inadequately documented for beach nourishment projects. The overwhelming majority of the projects evaluated (89 percent) failed to assess natural spatial and temporal variation before and after the project at both the impact site and control site(s). Most (56 percent) also were reported to have reached conclusions not adequately supported by the data.

The N.C. Marine Fisheries Commission (MFC 2000) found that large-scale beach dredge and fill activities have the potential to cause impacts in four types of habitats: 1) waters and benthic habitats near the dredging sites; 2) waters between dredging and filling sites; 3) waters and benthic habitats near the fill sites; and 4) waters and benthic habitats potentially affected as sediments move subsequent to deposition in fill areas. These habitats are included within the six coastal fish habitat types defined in the Coastal Habitat Protection Plan (CHPP) as essential to the integrity of the coastal system. The six CHPP habitat types are water column, shell bottom, submerged aquatic vegetation, wetlands, soft bottom, and hard bottom. The policy of the MFC is that the overall goal of its marine and estuarine resource protection and restoration programs is the long-term enhancement of the extent, functioning, and understanding of these resources.

Developing a strategy for beach nourishment in terms of extent and frequency of projects that minimizes impacts to fisheries and wildlife resources, particularly long-term impacts to soft bottom habitats and associated water column will require better documentation than what is currently available.

Based on a limited review of the literature, the following should be considered for developing beach nourishment strategies to minimize direct, indirect, and cumulative impacts:

- Recovery time – sufficient time is needed for the beach to return to pre-nourishment conditions (physical habitat conditions as well as faunal diversity and population levels) before renourishment. Recovery time is affected by several other factors and varies by organism. Recovery time for some organisms may be a matter of months for some, several years for others.
- Seasonality – timing of projects affects survivorship and recovery time of species affected. Seasonality can also interfere with critical life stages for different organisms. In general, beach zone organisms have higher abundance in summer and lower abundance in winter.
- Extent of project – direct emplacement and transport of sand following placement affects organisms. Projects that cover extensive reaches of beach can inhibit recovery by organisms with limited mobility or limited recolonization ability. Projects within shorter reaches that allow sufficient spacing between projects can maintain undisturbed populations of organisms to serve as sources for recolonization.
- Compatibility of material – material should be matched to physical characteristics of native beach material; material finer or coarser than native material can have greater impacts on organisms and extend recovery time.
- Depth of deposited material – in general, projects involving thicker depths of deposition have more direct impacts by smothering organisms and require longer recovery time than projects involving deposition of shallower depths of material.
- Physical configuration – nourishment resulting in escarpments can hinder movement of organisms between the intertidal area and upper beach. Steepening of the foreshore area reduces habitat for beach zone invertebrates and shorebirds that prey on them.
- Source of material – potential sand sources in inlets, swash and surf zones, beach-associated offshore bars and unconsolidated bottoms onshore and offshore have been identified as Essential Fish Habitat by the South Atlantic Fishery Management Council and Mid-Atlantic Fishery Management Council (MAFMC).
- Location of deposition – recent research (Bishop *et al*. 2006) suggests that deposition of dredged material on subtidal shoals may be effective in achieving beach renourishment through subsequent natural processes while minimizing impacts on beach zone organisms compared to direct deposition on beaches. Additional study is needed to further assess this strategy.

b) Moratoria for Various Species and Habitats

In addition to the potential impacts of a beach nourishment project, there are direct moratoria which impact the time of year that dredging and beach nourishment can take place. The moratoria for specific species and habitats are listed below.

Sea turtles (nesting areas): May 1-November 15 [USFWS moratoria]

Onsite surveys should be conducted to identify potential nest sites and any identified nest sites should be reported to NC Wildlife Resources Commission (WRC), and marked according to WRC guidance. The permittee may be required to establish a post-construction monitoring program. USFWS prefers that work be done between November-May to avoid the months with the highest probability.

Piping plover (nesting areas): April 1-July 15 [USFWS moratoria]

The U.S. Fish and Wildlife Service (USFWS) prohibits all activities that have the potential to disturb nesting plovers during the moratoria period. Nesting areas must be designated by wooden stakes and rope or tape with signage designating the nesting area as off-limits. Although this typically serves to adequately protect the nesting area; once the eggs hatch, the chicks often run from the nest to the water's edge to cool off. This has the potential to take the chicks out of the designated nesting area. Deep ruts in the beach can also become an obstacle between the nest site and the water. Additional best management practices include: management of non-motorized recreation use, motor vehicle management, and site specific management guidance obtained from USFWS. The USACE has published a website with mapping of general piping plover habitat areas at http://www.saw.usace.army.mil/plover/index.htm.

West Indian manatee (In-water work): June 1-October 31 [USFWS moratoria]

The USFWS has developed recommendations for general construction activities in aquatic areas that may be used by the species (July 1996 document). USFWS prefers that work be done between November-May to avoid the months with the highest probability. The following points summarize the USFWS recommendations that should be implemented throughout the year:

1. Contractor will educate all personnel about the possible presence of manatees in the work zone.
2. Contractor will advise all applicable personnel that there are civil and criminal penalties for adversely affecting a manatee.
3. Appropriate protection measures will be taken if a manatee is spotted within 100 yards of the operation. If the manatee comes within 50 yards of the operation, all activities will cease until the manatee has left the area.
4. Any collision with or injury to a manatee will be reported to USFWS and N.C. Wildlife Resources Commission immediately.
5. Cautionary signage will be posted on all vessels associated with the project.

6. Contractor will maintain a report documenting all sightings, collisions, or injuries to manatees. The report will be submitted to USFWS after the construction ends.

The following conditions will only be required for construction during the period of June 1 – October 31:

1. All vessels will operate at no wake/idle speed where there is less than 4 foot clearance from the bottom. Deep water routes will be used when available.
2. Any necessary siltation barriers placed in shallow water must be secured and regularly monitored to ensure no manatee entanglement.

Shortnose Sturgeon: February 1-June 15 [NMFS moratoria]

Comprehensive population dynamics data for the shortnose sturgeon does not exist for North Carolina. Permittees must assume that the species has the potential to be in the coastal waters of North Carolina during the moratoria period. Shortnose sturgeon can become entrapped in dredge drag arms and impellor pumps. BMPs to avoid potential impacts include alternate dredge types (i.e. clamshell, hydraulic pipeline). Specific permit conditions may be required by USACE to ensure compliance with the Endangered Species Act and to satisfy NMFS criteria.

Colonial Waterbird Nesting Areas: April 1-August 31 [WRC moratoria]

NCWRC biologists should be contacted for site specific data and protection guidance during project planning/permitting.

Primary and Secondary Nursery Areas: February 15-September 30

[NMFS/NCDMF moratoria]

The NMFS/NCDMF require protection of primary and secondary nursery areas during the fishery nursery season.

In conclusion, the combined effect of the various moratoria is to require that most beach and inlet projects take place between late November and early April. The sidecaster dredges that the USACE utilizes are allowed to operate all year given their small dragheads and the fact that the material is not placed directly on the beach. Given the restricted time window that beach nourishment projects are allowed, it is important that the plans for potential beach nourishment projects are bid as early in the year as possible. This allows the private dredging companies to schedule their dredges in advance and generally leads to lower construction costs for the project. Local sponsors should be aware that placement costs can vary significantly depending on when the project is bid during the year due to competition for the limited private dredging fleet.

c) Monitoring & EA/EIS Development

A significant amount of monitoring and data collection for development of Environmental Assessments and Environmental Impact Statements has been completed for numerous projects along the North Carolina coast. While not entirely inclusive, the project and contact list below provides local project sponsors with a starting point in determining what level of study may be required, potential issues, and if previously completed monitoring can be utilized for a given project.

Wilmington Harbor Deepening Project (Region 1)

- http://www.frf.usace.army.mil/capefear/mon_all.stm
- http://www.saw.usace.army.mil/wilmington-harbor/main.htm

Bald Head Island (Region 1)

- http://www.olsen-associates.com/beach1.htm

Mason Inlet Relocation (Region 2a)

- http://www.ericksonconsultingengineers.com/services/Mason%20Inlet%20Relocation%20Project_New%20Hanover%20Co_ECE.pdf
- http://www.lmgroup.net/Mason-Inlet
- http://www.gba-inc.com/pages/projects/13_Mason_inlet.html

Topsail and North Topsail Beach Projects (Region 2b)

- http://www.saw.usace.army.mil/WETLANDS/Projects/TopsailBeach/index.html
- http://www.saw.usace.army.mil/WETLANDS/Projects/NorthTopsailBeach/index.html

Carteret County Beach Nourishment Projects & Bogue Inlet Relocation (Region 2c)

- http://www.protectthebeach.com/Monitoring/monitoring.htm
- http://www.saw.usace.army.mil/WETLANDS/Projects/BogueInlet/index.html

Dare County (Region 4b)

- http://www.frf.usace.army.mil/darecounty/darecounty.shtml

Other USACE Projects

- http://www.saw.usace.army.mil/environmental/index.htm

8. Socio-economic Considerations for Strategies

As presented in Section IV, the socio-economic value of North Carolina's beaches and inlets is substantial, with an annual impact on the state's economy of more than $4.8 billion. While the socio-economic benefits are impressive, it is important that the potential costs of the strategies required for implementation of a statewide BIMP be determined so that the level of funding is justifiable.

9. Land Use Considerations

North Carolina is unique in that a substantial portion of its coastline is not developed. Table VI-3 shows the approximate breakdown of developed, undeveloped - but could potentially be developed, and the undeveloped - in conservation miles of coastline.

Table VI-3. Regional Shoreline Development Lengths (mi)

REGION	DEVELOPED	UNDEVELOPED		TOTAL
		Developable	In Conservation	
1	33	0	7	40
2a	16	1	14	31
2b	23	15	0	38
2c	25	0	20	45
3a	0	0	41	41
3b	8	2	20	30
4a	11	0	24	35
4b	28	0	15	43
4c	18	1	4	23
Total	162	19	145	326

A further breakdown of ownership shows a similar trend. Table VI-4 shows the approximate municipal, state, federal and private shoreline jurisdiction mileage for the coast. This provides an idea of the amount of coastline that may require management, and thereby potential state investment.

Table VI-4. Shoreline Jurisdiction by Length (mi)

Region	Municipal	State	Federal	Private	Total
1	33	7	0	0	40
2a	13	12	0	6	31
2b	23	0	12	3	38
2c	25	4	16	0	45
3a	0	0	41	0	41
3b	5	0	25	0	30
4a	11	0	24	0	35
4b	28	0	15	0	43
4c	19	1	3	0	23
Total	157	24	136	9	**326**

Table VI-5 shows an approximate breakdown of the coastline that is currently receiving beach fill (managed) versus areas which are currently not receiving beach fill (not managed). Roughly half of the state's shoreline is developed and roughly half of the developed shoreline is periodically nourished.

Table VI-5. Regional Managed and Not Managed Shoreline Lengths (mi)

Region	Managed	Not Managed	Total
1	30	10	40
2a	16	15	31
2b	0	38	38
2c	25	20	45
3a	0	41	41
3b	0	30	30
4a	0	35	35
4b	6	37	43
4c	0	23	23
Total	77	249	**326**

D. Statewide Beach and Inlet Management Strategies

In order to determine potential funding that may be needed to support beach and inlet management strategies in the regions as well as coast-wide, preliminary estimates of short- and long-term costs for beach nourishment for the developed portion of the coast were compiled. In some cases, project costs were available within the datasets. If not, nearby similar projects with cost data were utilized as a proxy. This initial base-level funding assumes that beach nourishment, would be the initial strategy that all the regions could support with local cost-share. While a dedicated fund will consider additional strategies such as relocation and conservation easements, public access assessments, this first estimate, combined with a regional approach, provides a financial starting point for a more cost-effective and environmentally sound management program. Detailed information on costs can also be found in the individual chapters that summarize the regions.

The BIMP identified approximately 112 miles of developed oceanfront shoreline that either 1) have received public funding for past beach fill projects or for current USACE beach fill projects (storm protection, habitat restoration, beneficial use of dredged material placement); or 2) are actively involved in a USACE-sponsored investigation to study the viability of a long-term beach fill project. Figure Eight Island is also included below because it is part of the New Hanover County tax base and continues to receive beach fill via private funding sources (Table VI-6).

Table VI-6. Communities Involved In Beach Fill Projects

PREVIOUS BEACH FILL	ONGOING BEACH FILL	PLANNED BEACH FILL
Ocean Isle Beach	Ocean Isle Beach	Holden Beach
Holden Beach	Kure Beach	Oak Island
Oak Island	Carolina Beach	Caswell Beach
Caswell Beach	Wrightsville Beach	Bald Head Island
Bald Head Island	Atlantic Beach	Figure Eight Island*
Kure Beach	Fort Macon	Topsail Beach
Carolina Beach		Surf City
Wrightsville Beach		North Topsail Beach
Figure Eight Island*		Emerald Isle
Topsail Island		Indian Beach / Salter Path
Emerald Isle		Pine Knoll Shores
Indian Beach / Salter Path		Nags Head
Pine Knoll Shores		Kill Devil Hills
Atlantic Beach		Kitty Hawk
Fort Macon		

**Figure Eight Island is included although it is not currently part of, nor is it being considered, for a USACE-sponsored project.*

Portions of the developed shoreline that have not received long-term beach fill placement (USACE or private monies) and are not part of USACE beach fill studies have been excluded from the analysis. These excluded areas are Sunset Beach (Brunswick County), the eastern beach of Bald Head Island (Brunswick County), Ft. Fisher (New Hanover County), Onslow Beach (Onslow County), the unincorporated areas of the Outer Banks (Hyde and Dare County), and all areas from Southern Shores to the Virginia state line (Dare and Currituck County). While the private community of Figure Eight Island receives no state funding (and is not projected to receive a state share), it is included in the analysis and the cost projections for local share only.

Refinements were made to the developed shoreline considered for nourishment such as excluding the northern most two miles of Carolina Beach because of the lack of development (it is a city park) and the fact that this stretch is outside of the USACE long-term projects. Similar scenarios *(i.e.,* town areas outside of USACE shore protection reaches) were included (Ocean Isle Beach, Kure Beach, and Wrightsville Beach) because of the developed nature of the shoreline (however, cost share projections for these stretches reflect a State/local cost-share scenario with no federal contributions).

Six miles of the total 6.06-miles shoreline along Atlantic Beach and Fort Macon were assumed to be covered entirely by federal funds as part of the least-cost dredged material placement of beach compatible sand from USACE dredging operations associated with Beaufort Inlet and the Port of Morehead City. However, 0.06 miles of shoreline for the western-most portion of Atlantic Beach historically not managed as part of USACE dredging operations was included in federal/state/local cost-share scenarios as part of the larger island-wide investigation by the USACE. This assumption might need to be revisited based on the final dredged material management plan being developed by the USACE, in conjunction with Carteret County and local governments, for the Port of Morehead City (which may exclude Brandt Island as a holding cell for beach compatible material and place material directly on the beach in greater frequency than the historical trend of 10-year pumpouts of the island). A small portion of the shoreline in Indian Beach / Salter Path is part of Roosevelt State Park and was considered to be managed solely by State funds (relative to beach fill) with no local cost-share burden.

The BIMP adjusts projected beach fill sand volumes and related placement cost to reflect ten-year cycles. In this decadal approach, the costs reflect maintenance on a three-, four-, or five-year cycle, with the ten-year period representing at least two maintenance efforts.

The projected costs associated with future federal beach protection projects uses the current cost-share ratio employed by the USACE, wherein the federal government pays 65 percent and the remaining 35 percent is shared by the state and local governments. The state has historically paid 75 percent of the 35 percent share (26.25 percent), and the local government is responsible for the remaining 8.75 percent. For a non-federal beach protection project, the state can fund up to 75 percent of the project cost, although the actual state contribution has historically ranged between 25 and 30 percent of the total cost.

Costs estimates are based on the assumption that projects would be implemented regionally to achieve cost-savings in mobilization and demobilization (dredging, berm construction, etc.). Costs are shown below based on groups of adjacent communities that correspond to the BIMP regions. In this way, beach fill projections consider beach fill maintenance on a five-year schedule rather than a per year cost (currently, no community in the state receives beach fill every year but, rather, on a maintenance cycle of between three and five years).While storm impacts and other coastal processes may require more frequent beach fill maintenance over the life of the project, the five subregion clusters are assumed to receive beach fill maintenance once every five years (Table VI-7).

A verification of the accuracy of the volume and cost projections above, was compiled from recent and projected beach fill needs from seven Static Line Exception application reports (which chronicle in detail past and future beach fill needs) prepared in 2009 by the following oceanfront communities: Wrightsville Beach, Carolina Beach, Ocean Isle Beach, Emerald Isle, Indian Beach / Salter Path, Pine Knoll Shores, and Atlantic Beach.

Table VI-7 Beach Nourishment Needs by BIMP Region and Costs by Project Partner

Community	Managed Shoreline length	Beach fill volume	*Total Cost Per decade*	Federal Share millions	State Share *millions*	Local Share *millions*
REGION 1	***31.2***	***5,641,214***	***$54,713,132***	***$29.4***	***$14.2***	***$11.1***
Ocean Isle Beach	5.6	459,720	$4,445,470			
Holden Beach	8.2	1,897,470	$18,633,120			
Oak Island	9.3	745,730	$10,820,520			
Caswell Beach	3.6	440,990	$3,616,150			
Bald Head Island	4.5	2,097,304	$17,197,872			
REGION 2a	***17.3***	***3,886,729***	***$33,022,839***	***$18.9***	***$8.2***	***$5.9***
Kure Beach	3.4	381,393	$5,137,423			
Carolina Beach	2.7	2,428,236	$19,741,556			
Wrightsville Beach	4.1	895,610	$6,555,840			
Figure Eight Island	5.1	181,490	$1,588,020			
REGION 2b	***22.3***	***2,370,627***	***$24,655,778***	***$11.0***	***$6.4***	***$7.2***
Topsail Beach	5.1	604,070	$4,911,050			
Surf City	6.1	623,770	$8,202,570			
North Topsail Beach	11.1	1,142,787	$11,542,158			
REGION 2c	***23.8***	***3,773,368***	***$48,052,803***	***$38.4***	***$7.2***	***$2.5***
Emerald Isle	10.3	981,968	$13,747,573			
Indian Beach / Salter Path	2.6	353,780	$4,952,970			
Pine Knoll Shores	4.8	545,000	$7,771,740			
Atlantic Beach (includes Ft. Macon)	6.1	1,892,620	$21,580,520			
REGION 4b	***19.6***	***2,745,080***	***$30,694,980***	***$15.3***	***$8.0***	***$7.4***
Nags Head	11.3	1,859,230	$21,325,380			
Kill Devil Hills	4.8	327,520	$3,579,760			
Kitty Hawk	3.5	558,330	$5,789,840			
TOTAL (all regions)	***112.2***	***18,417,018***	***$191,139,532***	***$113.0***	***$44.0***	***$34.1***
Total per/yr Avg.		***1,841,702***	***$19,113,953.2***	***$11.3***	***$4.4***	***$3.4***

Accounting for storm impacts and other areas of the coast that may require management in the future, there is an estimated coast-wide need of approximately 1.8 million cubic yards of beach nourishment to be completed annually (may fluctuate due to storms) at a combined average cost of $19.1 million per year. It must be noted that beach fill and dredging projects may not occur every year or in any given year. The average annual project cost ($19.1M) is intended as a planning number for gauging the annual outlay for beach and inlet projects over the decadal cycle illustrated in the above table. The annual costs could also be affected by the extent to which the state pursues the regional approach and the resulting grouping of projects.

Assuming the current federal cost share for navigational dredging of the state's deep- and shallow-draft inlets continues into the future, the total state cost share for dredging is projected to be $33.4 million per decade ($3.3 million per year) with a federal cost share of $198.6 million ($19.9 million per year). There are no records of local cost sharing that has occurred for inlet navigation projects (Table VI-8).

Adding existing inlet dredging costs for shallow and deep draft inlets ($23.2 million per year) increases the overall total to $42.3 million per year. This total cost includes federal, state, and local participation in current beach and inlet projects. While this estimate includes the AIWW inlet crossings, the AIWW as a whole is not.

Finally, under the current federal cost-sharing models for both beach fill and inlet dredging, the total state funding required for these projects per decade is projected to be $77.4 million ($7.7 million per year). This projection is based on a projection of $44 million for beach nourishment and $33.4 million for dredging.

Table VI-8 Dredging Needs by BIMP Region and Costs by Project Partner

REGION	Shallow Draft Inlet Dredging *(total cost per decade)**	Deep Draft Inlet Dredging *(total cost per decade)**	*TOTAL Inlet Dredging (cost per decade)**
1	$9 million	$51 million	$60 million
2a	$10 million	$0	$10 million
2b	$20 million	$0	$20 million
2c	$20 million	$17 million	$37 million
3a	$5 million	$0	$5 million
3b	$10 million	$0	$10 million
4a	$0 million	$0	$0 million
4b	$25 million	$0	$25 million
4c	$65 million	$0	$65 million
TOTAL *(per decade)*	**$164 million**	**$68 million**	**$232 million**
TOTAL Cost Share	*90% federal cost share* **$147.6 million** *10% state cost share* **$16.4 million**	*75% federal cost share* **$51 million** *25% state cost share* **$17.0 million**	(total federal share) **$198.6 million** (total state share) **$33.4 million**
TOTAL Cost Share *(per-yr avg)*	*federal cost share* **$14.76 million**	*federal cost share* **$5.1 million**	(total federal share) **$19.86 million**
	state cost share **$1.64 million**	*state cost share* **$1.7 million**	*(total state share)* **$3.34 million**

*Values are from 1997-2007, adjusted for inflation (2009 dollars), and cost share data for dredging provided by Division of Water Resources