Environmental Quality

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MEMORANDUM

TO: JT. LEG OVERSIGHT COMMITTEE ON AGRICULTURE AND ECONOMIC AND NATURAL RESOURCES
The Honorable Pat McElraft, Co-Chair
The Honorable Roger West, Co-Chair
The Honorable Brent Jackson, Co-Chair

FROM: Mollie Young, Director of Legislative Affairs, NCDEQ

SUBJECT: Beach Nourishment Studies

Pursuant to S.L. 2016-94, SECTION 14.22.(a) "*The Division of Coastal Management and the Department of Environmental Quality shall study and provide an executive summary of readily available data and existing studies on the physical and economic, storm mitigation, and public safety benefits of out-of-state coastal storm damage reduction and beach nourishment projects. Specific items benefitted by coastal storm damage reduction shall include, at a minimum, public infrastructure, public property, private property, small businesses, and tourism. The results of the study shall be reported no later than November 1, 2016, to the Joint Legislative Oversight Committee on Agriculture and Natural and Economic Resources.*"

In addition, pursuant to SECTION 14.22.(d) *"The Department of Environmental Quality shall include the studies required by each subsection of this section as appendices to the Beach and Inlet Management Plan required by Section 14.6(b)(4) of S.L. 2015-241."*

The following attachments should satisfy these statutory requirements. If you have any questions or need additional information, please contact me by phone at (919) 339-9433 or via e-mail at mollie.young@ncdenr.gov.

Cc: Don Van der Vaart, Secretary, NCDEQ
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Beach Nourishment

EXECUTIVE SUMMARY

A Report to the North Carolina General Assembly
Joint Legislative Oversight Committee on Agriculture, Natural and Economic Resources

Session Law 2016-94 (House Bill 1030), Section 14.22.(a)

NOVEMBER 2016

North Carolina Department of Environmental Quality
Division of Coastal Management

Introduction

Coastal areas along the eastern seaboard of the United States are not only popular places to live and work, they also provide recreational opportunities favored by millions of vacationers each year. According to one 2013 study (Houston, 2013), the nation's beaches generate $225 billion a year for the national economy and contribute approximately $25 billion in federal tax revenue, which not only makes them valuable to our nation's and state's economy, but also critical to local coastal economies. Since 2008, North Carolina has been ranked sixth in the nation in terms of travel volume by the North Carolina Department of Commerce (NC DTFSD, 2008-2014).

Based on most recent NC statistics (NC DTFSD, 2014), tourism statewide generates $1.0 billion in state tax revenue and $601.2 million in local tax revenue. In 2013, 3 of the top 10 counties in terms of travel expenditures were coastal counties, with Dare County (#4) generating $957 million, New Hanover County (#8) $478 million, and Brunswick County (#10) $471 million. Dare County alone provides 5% of North Carolina's travel income, with 17.7% of overnight visitors to the state reporting beach recreation as their leading activity during their stay.

Coastal economies continue to transition from traditional economic pursuits, such as fishing, agriculture and forestry, to tourism. With this transition, North Carolina's barrier island communities need to address the growth associated with accommodating more visitors and residents. Tourists and new residents are drawn to the "pristine" beaches of the coast, and the wider the beach, the better (Jones & Mangun, 2001).

Coastal communities, particularly oceanfront communities, also experience stresses associated with seasonal storms (short-term and variable), changes in sand supply, and relative natural changes (longer term). Barrier island beaches provide storm protection for both developed and natural areas, while also providing recreational opportunities for millions of people each year. Beaches are highly dynamic, and constantly shift with tides, currents, wind and wave action. Over the long-term, beaches evolve in response to changes in sea-level and sand supply. Relative to a shifting ocean shoreline, homes, businesses, and infrastructure are geographically static – thus requiring property owners and communities to either relocate or mitigate interactions between public trust lands and private property interests.

There are several factors that must be considered when mitigating beach erosion hazards; including the local and regional beach ecology, economic significance, public and private investments (homes, infrastructure, and businesses), and levels of risk in the face of rising social, environmental, and economic stakes. Living in coastal areas requires a systematic, proactive and resilient approach to managing risks associated with beach erosion. A variety of strategies should be evaluated, including the potential relocation of vulnerable structures from erosional "hot spots," inlet stabilization, inlet channel relocation, and beach nourishment programs.

"Shore protection" has been part of the U.S. Army Corps of Engineers (USACE) mission since 1930 (USACE, 1984). Beach nourishment has been accepted as the shore protection method of choice in the United States, Australia, and Europe (NRC, 1995; NC, 2016). The USACE defines beach nourishment as "the process of mechanically or hydraulically placing sand directly on an eroding shore to restore or form, and subsequently maintain, and adequate protective or desired recreational beach" (USACE, 1984). These projects are designed to retain and rebuild natural systems such as dunes and beaches to protect structures and infrastructure. Various studies have documented that a wide, healthy beach reduces risk of property and infrastructure damage as a result of coastal storms and floods (NRC, 2014). Not only can beach nourishment reduce a storm's potential physical and economic damages from waves and storm surge, it can also mitigate coastal erosion and help to restore valuable ecosystems that may have been lost (beaches, wetlands, and nesting areas) and provide critical habitats for sea turtles and shore birds. Beach nourishment is the only approach to shore protection that adds sand to an existing coastal system. Engineered and designed to function like a natural beach, placed sand is naturally distributed over a period of time and when complete, the wider beach gently slopes below the water while taller sand dunes act as natural buffers (NRC, 2014).

In addition to considering the environmental impacts associated with beach nourishment, coastal managers and decision-makers also have to consider the fiscal "costs" and "benefits." Economists are specifically interested in a projects "economic efficiency" and "distributional" implications; each of which requires an assessment of who benefits from a given project, and who pays for it (NRC, 1995). In determining the efficient use of resources, all of the social, economic, and ecological benefits from a project should be compared to the cost of the project; where the social costs are the benefits foregone – that is, a measure of the benefits that could have been produced for society by using these resources in a different way (NRC, 1995). Opponents of nourishment point to the sacrificial nature of the projects and argue that the money spent is wasted, especially where erosion rates are high. Despite arguments in favor of or in opposition to beach nourishment, an accurate understanding of costs and benefits is of considerable importance (NRC, 1995).

Review of Costs and Benefits Identified in the Literature

Environmental Concerns

A sandy beach represents a productive and unique habitat supporting the seasonal nesting of threatened and endangered sea turtles, and dense concentrations of benthic invertebrates that feed surf fishes, resident and migrating shorebirds and crabs (Brown and McLachlan 1990). During a beach nourishment project, the nourished part of a beach is considered the "subaerial beach," and can be divided into two major zones: 1) the "supralittoral" (dry) portion of the beach, extending from Mean High Water (MHW) to the primary dune; and 2) the intertidal (wet) zone, located between MHW and Mean Low Water (MLW). Because the primary purpose of beach nourishment is to restore eroded portions of the subaerial beach, most of the fill material is placed in these two zones.

Restoration of an eroded beach can provide new, quality habitat for a variety of shorebirds and sea turtles. However, in the process of sand placement, burial of shallow subaqueous habitats also occurs as the beach is widened. This can disturb indigenous biota inhabiting the subaerial habitats, which may in turn affect the foraging patterns of the species that feed on those organisms, creating the potential to disrupt species that use this area for nesting, and breeding. In some cases, sizeable impacts on several beach ecosystem components (microphytobenthos, vascular plants, terrestrial arthropods, marine zoobenthos and avifauna) can occur (Speybroeck et al., 2006). The projects may also cause undesirable side effects, including ecological impacts on offshore dredging sites and unnatural sand/sediment types at project sites. In addition, if a project results in steep berms and scarps, sea turtles cannot reach preferred nesting sites, and as a result, eggs may be laid closer to water where they are more likely to be swept away by incoming tides (Bagely et al., 1994). The sediment of a nourished beach can also be more compacted than on natural beaches, causing sea turtles to abandon attempts at digging nests for laying eggs (Nelson &

Dickerson, 1989). Depending on location, a nourished beach may not become suitable for turtle nesting in the middle beach zone until two or three years after the project (Steinitz et al., 1998). Negative ecological impacts associated with beach nourishment projects can be reduced or avoided by placing dunes as far landward as possible, using sediments of appropriate size (compatible with native sand on the recipient beach), and minimizing project activity during peak reproductive and nesting periods. For nourishment and dune projects in or adjacent to nesting habitat for protected shorebirds and turtles, design specifics (the slope and height of the beach/dune), time of year for construction, and density of vegetation planted can be modified to allow for successful nesting (Mass.gov, 2013).

Beach Nourishment Longevity

Beach nourishment is not a single event erosion mitigation alternative, and without regular maintenance, the benefits can be ephemeral (Pompe and Rinehart, 1995). For long-term management of beaches and sand resources, careful consideration should be given to the frequency of projects as well as effects of borrow sites located within the closure depth (the water depth at which no appreciable movement of sediment by wave action occurs) of the beach profile, or at a shoal site on adjacent beaches that normally feed the downdrift beaches, and are critical to the success of the nourishment efforts. The impacts of creating a local depression in the sea bottom on offshore sand movement from the nourished beach and the quality and quantity of sand are particularly important. Borrowing sands within closure depths should be done mainly as a sand bypass operation designed to mitigate the effects of any geographical feature or structure that interrupts the littoral movement of sand (ASMFC, 2002).

Success of a beach nourishment project is often determined by how long the project lasts before maintenance is required, and/or how much property damage was prevented (measured in dollars) as a direct result of the project. Longevity is certainly inherent to a well-designed project, but storm frequency will heavily influence a project’s long-term effectiveness against storms.

Given the physical volume of fill placed on a beach system, managers and engineers will often examine what percentage of fill is retained in the littoral cell after a given period of time. How a beach fill project performs with time is a function of the interaction of several conditions and properties which include local wave and current conditions, technique and location of fill placement, and the reliability of the monitoring method. These interactions will determine if a fill remains in the system longer or shorter than expected. Performance of beach fill is also determined by the physical compatibility between the fill material and the “native” material of the beach where the fill is to be placed. “Compatibility” refers to the degree of similarity of the two materials and includes the size, type (mineralogy), color, density, and shape of the component sediment grains (ASMFC, 2002).

Monitoring was not a routine aspect of beach nourishment projects before the 1980s (Leonard et al., 1989; Komar, 1997). Up to the end of the 1980s, performance data for projects on the Pacific Coast were less prevalent than those on the Atlantic Coast (Lenard et al., 1989). For instance, most of California’s nourishment projects before 2000 were historically pursued as local, rather than regional projects, and were dominantly “opportunistic” projects, meaning that beach restoration was not the primary purpose of the placement of fill. Only in recent years (post-2004) have regional projects become more common. Since 2000, there has been a more coordinated effort to explore regional approaches to protecting beaches with a key aspect of this process including the institution of monitoring programs. One example is the Regional Beach Monitoring Program of San Diego Association of Governments (SANDAG), which began in the middle 1990s (Hearon & Humphreys, 2004). The Regional Beach Sand Project of SANDAG is the first regional beach nourishment program on the Pacific Coast of the United States. In North Carolina, Carteret County has been the first to establish a Beach Commission (2001), in addition to a Shore Protection Office tasked with taking a regional approach to planning and managing its beaches and resources (Rudolph, 2016).

To date, the overall results of beach nourishment projects based on long-term monitoring data have been mixed. As an example, the Coastal Frontiers Corporation (2004) reported results from monitoring of a major nourishment program in San Diego County, where twelve beaches received nourishment in 2001. During the 2003 monitoring year, the performance of the individual fill at the twelve beaches reportedly varied considerably; at some beaches, previous gains in shore-zone volumes persisted, while at others, the gains were short-lived. This was not the first effort in California to measure “successes” through monitoring. An earlier study (Leonard et al., 1989) also determined that the overall success of various projects (starting in the late 1980s) were mixed as well. As part of this determination, this study also evaluated how five physical parameters (1) project length, 2) density, 3) grain size, 4) hard structures, 5) storm intensity & frequency might influence the success of fill episodes as measured longevity, or “durability,” of the placed fills. Some of their major conclusions for Pacific Coast beaches (nearly all are in southern CA) were (Leonard et al., 1989):

- Longevity of fills at Pacific Coast beaches has overall been higher than those at Atlantic Coast and Gulf Coast beaches.
- Of those beaches measured, 48% were successfully maintained, 15% were not, and 36% were unknown.
- The Pacific Coast management philosophy of nourishment by periodic “maintenance” was advantageous over the Atlantic/Gulf Coast management philosophy of nourishment by “crisis.”
- Project monitoring must be a mandatory part of each replenishment project.

To get the most physical benefit, sediment management should be viewed on a regional basis, rather than on a project-by-project basis (NRC, 2014). Federal and state agencies have documented offshore sand deposits, but not all are of optimal quality or conveniently located, which can increase costs. Coastal projects can minimize sediment losses by retaining dredge material or emphasizing reuse, as in sand back-passing or bypassing operations. Use of a sediment source that is compatible with a beach fill project site also decreases ecosystem recovery time and enhances habitat value in the nourished area. Projects that also include strategies that reduce the consequences of coastal storms, such as hard zoning (use of hard structures permitted), building elevation, land purchase, and setbacks, have high documented benefit-cost ratios between 5:1 and 8:1 for nonstructural and design strategies that reduce the consequences of flooding. However, between 2004 and 2012, federal funds for such strategies only averaged five percent of disaster relief funds (NRC, 2014).

Economic Benefits

Houston (2013) determined that for every $1 invested annually, the federal government receives $320 in tax revenues from beach tourism. The USACE requires that the cost of nourishment projects involving any federal government funding be justified; however, this justification is solely based on the benefits achieved from reduced storm damage even though the USACE recognizes that there are also other gains (e.g., recreation benefits). Since benefits from less storm damage are not derived from transactions in the marketplace, their value must be estimated indirectly. The USACE estimates storm damage reduction benefits by estimating the value of property that likely would be destroyed from storms if no sand were added to the beach (Pompe & Rinehart, 1995).

Restoring beaches through beach nourishment can greatly increase their attractiveness to tourists (Houston, 2013). For example, in 1989, 74% of those polled in New Jersey said the New Jersey shore was "going downhill." By 1998, only 27% thought New Jersey beaches were in decline, with 86% saying that the shore was one of New Jersey's best features (Zukin, 1998). The difference between 1989 and 1998 was construction of the beach nourishment project from Sandy Hook to Barnegat Inlet, New Jersey (Houston, 2013). Not only did the project bring more tourists, it also provided critical protection during Hurricane Sandy.

In one California survey (King, 2002), those polled said they spend 2/3 of their time at the beach during vacation, and 60% of the respondents said that they would go out of state if California's beaches ceased to exist. This same study examined the fiscal impact of San Clemente's beaches in an attempt to see if benefits outweighed the costs of maintaining its beaches. At the time of the study, it was determined that the city averaged 1.9 million visitors each year and spent approximately $1,557,800 to maintain beaches (beach maintenance, lifeguard services, police). Through various revenue mechanisms (transient occupancy & sales taxes, parking fees, and city concessions), the city generated a total revenue of approximately $1,650,600. The net revenue from beaches was therefore estimated at just over $90k ($0.05 per visitor). The study concluded that while the economic benefits and tax revenues may not have been as high as previously projected, existing sources of revenue in San Clemente were sufficient to cover the long-term costs of beach maintenance.

An economic study of beach nourishment in Florida (Klein & Osleeb, 2010) concluded that beach nourishment projects can have a "dramatic impact on the tourism sector." The impact was seen in ". . . *visible discontinuities and increases in the slope in . . . tourism-sector earnings*" after beach nourishment. They noted that tourism earnings at Miami Beach increased 56% the year after completion of a beach restoration project. This one-year increase in tourism income of $290 million was more than five times the $51 million cost of the beach nourishment. Miami Beach is a good example of the potential economic benefits of beach restoration since the city virtually had no beach by mid-1970 (Wiegel, 1992). Prior to nourishment, many facilities were becoming run down due to a poor economy and by 1977, *Time* magazine reported: "*So rapidly has the seven-mile-long island degenerated that it can be fairly described as a seedy backwater of debt-ridden hotels*." Beach nourishment in the late 1970s rejuvenated Miami Beach and opened its beaches to the public. From 1978 to 1983, estimated beach attendance grew from 8 to 21 million (Wiegel, 1992).

The following is a summary of how communities have benefited (economically and physically) from beach nourishment (Houston & Dean, 2013):

- California (Santa Monica Bay Beaches)
  - In 1925, Venice Beach was 100 feet wide
  - In 2013, almost 90 years later, Venice Beach was 500-700 feet wide, and was the most visited beach in U.S (Houston & Dean, 2013).
- California (Coronado/Silver Stand – San Diego)
  - In 1905, beaches were being starved due to the damming of rivers
  - In 2012, beaches were 500-700 feet wide, and reported to be California's leading tourist destination with "*the beach the marquee attraction*" (*San Diego Business Journal*, *U.S. News Travel*, 2012)
- Florida (Delray Beach)

- In the 1960s and 1970, emergency protection of the eroded beach ultimately required construction of hardened structure made of an interlocking concrete blocks, which failed at many locations.
- In the early 1970s, the revetment was covered by beach nourishment
- Following a series of beach nourishment projects, in 2013, ASBPA gave Delray Beach the "*Best Restored Beach Award*," and 2012 Rand McNally/*USA Today* named Delray Beach the "*Most Fun Small Town in America*"

- Florida (e.g. Atlantic Beach, Jacksonville; Captiva Island Beach; Ft. Myers Beach)
    - Have benefited from a consistently-funded, State-led program of beach nourishment
    - Florida has more beach tourist visits (810 million) annually than any other state or country, and more visits than all theme parks and National Parks combined (Houston, 2013)
    - Florida beaches have an estimated annual recreational value of $50 billion (Houston, 2013)
- New Jersey – Sea Bright – Protection
    - 1995, following attempts to mitigate erosion using a rock revetment (there was no dry sand beach), a 21-mile long beach nourishment project was constructed, which only lasted 1-2 years.
    - In 2001, and after nourishment, the beach was approximately 400 feet wide
    - In 2012, during Hurricane Sandy, an estimated 30-40 feet of beach was lost. Without a nourished beach, damage and losses would have been greater.
- New Jersey – Storm Damage Reduction (Houston & Dean, 2013):
    - Mayor Mancini estimated that had beach nourishment been in place at Long Beach, New Jersey, like at Brant Beach (only six miles away), that damage caused by Hurricane Sandy would have been reduced by approximately $500 million
    - On 18-mile Long Beach Island, only Brant Beach had a USACE beach nourishment (1-mile long) placed just before Hurricane Sandy
        - Long Beach suffered "complete destruction"
        - Brant Beach reported "no overwash or wave damage"
    - Atlantic City, New Jersey, was welcoming tourists four days after Hurricane Sandy
    - Ortley Beach, New Jersey was still recovering from major damage six months after Hurricane Sandy
- Mississippi – Harrison County
    - From 1925 to 1950, a 26-mile sea wall was constructed, and was damaged multiple times
    - In 1951, six million cubic yards of beach fill was placed along the 26 miles to protect the sea wall from being undermined by waves. Fill withstood Hurricanes Camille and Katrina
    - In 2013, beaches have continued to last and made tourism Harrison County's number one business.
- National Statistics (Houston & Dean, 2013):
    - Beaches help generate $225 billion a year for the national economy, contributing about $25 billion in federal tax revenue.
    - 85% of all tourism-related revenue in the U.S. is generated in coastal states, where beaches are the leading tourist attraction
    - Beaches drew an estimated 2.2 billion visits in 2010, more than twice the number of visitors to all federal and state parks.
    - For every $1 the federal government spent on beach nourishment in 2013, it collected an estimated $570 in beach tourism revenues.

Economic benefits linked to beach nourishment projects can be calculated using a variety of methods depending on the beneficiary. Cost-share ratios for projects in which there is federal involvement do not necessarily describe the actual distribution of the benefits or adequately account for the impacts that navigation projects might have along Atlantic shorelines. Interactions between the costs and benefits have historically not been effectively correlated, and in 1995 it was recognized that nourishment needs of beaches affected by navigational projects were not adequately recognized or accommodated in the planning and implementation of navigational projects (NRC, 1995). To conserve and use sand resources optimally, beach-quality sand dredged from navigational projects should be placed in the littoral system from which it was removed, rather than placed offshore. The cost of offshore disposal is greater than has been estimated when only the direct cost of offshore disposal is considered. A preferred approach would be to consider accounting for the economic value of sand and the effects caused by a deficit in the sand budget in the littoral system (NRC, 1995).

Benefit-cost analysis, constrained by acceptable risk and social and environmental dimensions, provides a reasonable framework for evaluating coastal risk management investments (NRC, 2014). Investments in coastal risk reduction should be informed by net benefits, which include traditional risks reduction benefits (e.g., reduced structural damages and reduced economic disruption) and other benefits (e.g., life-safety, social, and environmental benefits), minus the costs of investments in risk reduction and environmental costs. However, because it is difficult to quantify and monetize some benefits and costs, it is important to expand the analysis to include considerations of difficult-to-measure benefits or costs through constraints on what is considered acceptable in social, environmental, and risk reduction dimensions (NRC, 2014). Such unacceptable levels of risk may include a level of individual risk of fatality, the risk of a large number of deaths from a single event, or adverse impacts on social and environmental conditions that may be difficult to quantify in monetary terms (NRC, 2014). Establishing societally acceptable risk standards requires extensive stakeholder engagement, and setting such a standard requires judgements, on which not all individuals or groups will necessarily agree (NRC, 2014).

A 2004 report titled, "*Economics of the Shoreline – An Annotated Bibliography for the National Shoreline Management Study* (NSMS)" (Lent, L.K., 2004) provides a useful summary review of 100 studies and reports pertaining to economic consequences of shoreline change and related issues. One objective of the NSMS was to assess the economic impacts of shoreline change (erosion and accretion) along the nation's coast. Of the studies reviewed, the author concluded that there was no single comprehensive economic analysis that could be used to directly guide national policy. Additionally, the author found that methods conducted at the regional level tended to address a varied range of questions about shoreline use and management, and also used different techniques. Furthermore, even when two studies addressed the same questions, the analytical techniques employed still often differed. As a consequence, although there are many regional studies evaluating the benefits of beaches, the extent to which study results can be compared is limited (Lent, L.K., 2004).

Storm Mitigation Benefits

Beach nourishment has proven to be successful and beneficial in terms of damage reduction resulting from storms (Houston & Dean, 2013). Wider beaches seaward of structures perform as effective energy dissipaters during storm conditions. These benefits can be enhanced by increasing beach widths through nourishment projects. Beach nourishment projects completed with high quality sand will interact existing erosion and accretion process occurring within the project area in a manner that retains it within the active nearshore region and provide continuing storm damage reduction and recreational benefits (Dean, 1988).

When Hurricane Sandy struck in October 2012, the storm exceeded the design criteria for many beach fill projects along the North Atlantic coast. As a result of Hurricane Sandy's winds, surge and waves, most of the shoreline protection features sustained damage. Nevertheless, features such as barrier dunes helped to soften the storm's impact on the property and infrastructure located behind these risk reduction projects (NJCRC, 2012).

In the aftermath of Hurricane Sandy, the New Jersey Coastal Research Center reported that damage to beaches, dunes and public and/or private property was significantly worse on the north side of the storm's zone of coastal landfall in Atlantic City (NJCRC, 2012). Southern Cape May County faired best with limited overwash, dune scarping and loss of beach elevation. Many Cape May coastal communities were beneficiaries of either USACE or New Jersey State co-sponsored Shore Protection Projects that yielded wider beaches and dunes designed with specific storm resistance in terms of elevation and width. Damages increased towards the region of landfall with moderate dune breaches, especially in the Southern Ocean City area, and damages to the southern Absecon Island's oceanfront properties. Dune breaches, loss and scarping of dunes, and decreased beach width and elevation continued north into Brigantine. From the natural area of Holgate on Long Beach Island, north along the remainder of the Jersey coast, the intensity dramatically increased for dune breaching and overwash and/or complete erosion of the dunes, drastically lowering of the elevation on beaches with substantial sand transport onto and across Long Beach Island or Northern Ocean County's spit. In Monmouth County, the major observation was that Sandy's waves were dramatically higher upon breaking than they were further south, especially south of the storm's center of rotation. Damage seen in Deal and Elberon resulted from waves calculated at exceeding 30 feet in NAVD 88 elevation levels on breaking on the bluff. These huge breakers essentially bulldozed the berm, beach and irregular dune system all along the Monmouth County Atlantic shoreline. Damages to oceanfront property (public and private) increased dramatically northward (NJCRC, 2012).

Even with successes, there is no shoreline stabilization method that can permanently stop all erosion or storm damage. The level of protection depends on the option chosen, project design, and site-specific conditions such as exposure to storms. All options require maintenance, and many require steps to address adverse impacts to the shoreline system (mitigation) over long periods of time (NC, 2016).

In 2004, Florida experienced four major hurricanes and 1 tropical storm impacting more than 695 miles (about 84%) of its beaches. At the time, 17 beach restoration projects lost approximately 7.6 million cubic yards of material between August and September of that same year. Federal shore protection projects prevented $54 million in average annual damages, and there was little or no damage from the storm surge upland of restored beaches.

The damage reduction attributable to a beach nourishment project can be approximated by using existing risk analysis methodologies. It should be noted, however, that the level of protection is not absolute due to the significant uncertainties that exist regarding the frequency of storm conditions that may affect project performance. The level of protection can be reduced rapidly following a major storm and is also progressively diminished if a previously nourished beach is not maintained by subsequent renourishment. In addition to uncertainties associated with performance, there are uncertainties related to the continuing financial means to support a renourishment program when not formally required to do so; as well as the long-term availability of beach-quality sediment resources (Houston and Dean, 2013).

The following is a summarized list of storm protection benefits, strengths, weaknesses, and uncertainties associated with beach nourishment projects:

Storm Surge Damage Risk reduction:

- Breaking of offshore waves (USACE, 2013)
- Attenuation of wave energy (USACE, 2013)
- Beaches, when combined with sand dunes, reduce the risk of storm surge-related wave attack and flooding on barrier islands and the mainland (NRC, 2014)

Strengths Associated with Beach Nourishment:

- Reduces erosion, flooding, and wave attack and may reduce the likelihood of forming new inlets (NRC, 2014)
- An increase in the sediment budget downdrift of fill areas enhances the likelihood for landforms to evolve, increasing topographic diversity in a way that is more natural than by direct nourishment (NRC, 2014)
- Beach fill might protect not only the beach where it is placed, but also downdrift stretches by providing and updrift point source of sand (USACE, 2006)
- Coastal risk reduction projects can be designed to provide increased ecological value (NRC, 2014)

Known Weaknesses Associated with Beach Nourishment:

- Requires periodic to continual sand resources for renourishment.
- Can be eroded by extreme event surge and waves; no high water protection.
- Possible impacts to regional sediment transport.
- Can lead to removal of large volumes of offshore sand. (NRC, 2014)
- Does not address back-bay flooding. (NRC, 2014)
- Can lead to steeper beach profiles, which can increase wave energy on the beach, increase beachside erosion, and preclude wave overwash. (Green, 2002)
- The lifetime of beach nourishment projects is often short, requiring frequent re-nourished.

Uncertainties about utility for risk reduction & resilience

- The level of risk reduction afforded by a beach nourishment project varies over time, as the beach and dunes are eroded by natural processes, requiring periodic renourishment (varying by location) (NRC, 2014).
- Erosional hot spots may develop from a variety of causes, including material composition and the presence of adjacent structural erosion control measures. (Kraus and Galgano, 2001)
- There are several recognized failure modes associated with beach fills (USACE, 2006):
    - Failure to protect upland property or structures during storm events.
    - Movement of fill material to undesired locations, such as into inlets or harbors.
    - Loss of fill material at a rate greater than anticipated for some reason other than design wave exceedance.

Hurricane and coastal storm related economic losses have increased substantially over the past century, largely due to the expanding population and development in the most susceptible coastal areas. The U.S. has experienced extensive and growing losses from natural disasters. Dollar losses due to tropical storms and floods have tripled over the past 50 years (accounting for inflation; Gall et al., 2011), and currently comprise approximately half of all natural disaster losses. There are two primary reasons for the dramatic increase in natural disaster related losses: an increase in population and property in harm's way, and an increase in the frequency or severity of the hazard events (NRC, 2014).

Eight U.S. cities (Miami, the New York-Newark region, New Orleans, Tampa-St. Petersburg, Boston, Philadelphia, Virginia Beach, and Baltimore) rank among the world's top 20 in terms of estimated potential average annual losses from coastal flooding. Awareness of these vulnerabilities became more apparent following Hurricane Sandy (2012) and Katrina (2005) (NRC, 2014).

Full protection from coastal hazards and related damages is typically impractical at community and national scales. Even the largest levees or surge barriers could be overtopped by a large storm or suffer from structural failures. Thus local, state and federal governments are increasingly recognizing the importance of becoming more resilient to hazards and disasters. "Resilience" is defined as the ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events (Rose et al., 2007). Resilient communities are able to assess and manage risks, are generally well informed of threats, and are clear about the roles and responsibilities of individuals and organizations in the community with respect to risks (NRC, 2012b). Resilient communities take into account both pre-disaster mitigation measures and post-disaster recovery measures to determine an appropriate allocation of resources to improve resilience within budgetary constraints. Pre-disaster mitigation can prevent property damage and some business and infrastructure impacts, but resilience can also be improved by strategies to recover more quickly (Rose et al., 2007).

Currently, justification of USACE Coastal Storm Risk Management (CSCRM) projects is based on cost-benefit analysis. The "benefit" of a proposed project is the difference between the estimated annual damages that would occur if that project was in place versus the estimated annual damages that would occur without the project. That cost-benefit analysis is used to compare alternatives at a project site. An estimated reduction in damages is based on the modeling of future storms that are expected to occur over the life of the project. Each of these storms is anticipated to produce specific levels of damage depending on the frequency of the event. Those damages are aggregated over the project life, and expected annual damages are estimated for both the with- and without-project conditions. The difference between the with- and without-project benefit streams is the benefit attributable to the project. The average annual cost of the proposed project is subtracted from the benefits estimate—that is, the change in expected annual damages—to generate average annual net benefits. The benefits estimate is arrayed over the average annual cost of the proposed project to generate the benefit-cost ratio (BCR) (USACE, 2015).

As part of the North Atlantic Coast Comprehensive Study (NACCS), the study-team determined that an important element of the Coastal Storm Risk Management Framework to "address flood risks to vulnerable coastal populations impacted by Hurricane Sandy" would be to gather missing data and refine the analyses that USACE uses to estimate benefits for CSRM projects. The NACCS study team began a year-long effort to capture and document the actual economic damages that occurred in Hurricane Sandy to provide field teams with the data they need to properly assess the benefits in the future. Better quantifying the actual effects of the event will also help planners to adequately and cogently discuss and communicate risk. This data collection effort focused on four subcategories of National Economic Development (NED) benefits (USACE, 2015):

- Assessment of damages to structures and their contents

- Loss-of-life projection
- Emergency costs
- Secondary and tertiary effects

The 2013 federal guidance for water resources planning titled, “Principles and Requirements for Federal Investments in Water Resources,” provides an effective framework to account for life safety, social impacts, and environmental costs and benefits in coastal risk reduction decisions.

Summary

A recent literature review (Cunniff & Schwartz, 2015) found that there is sufficient confidence in the ability of natural infrastructure and nature-based measures (i.e., beach nourishment) to reduce impacts of coastal storms and other natural changes to coastal communities such that these approaches should be routinely considered as a viable option by decision-makers. The value of natural infrastructure and nature-based methods does not rest solely in risk reduction as these solutions offer other valuable ecosystem services – co-benefits which are generally absent from traditional hardened infrastructure. Incorporation of ecosystem services into cost-benefit and environmental impact analyses will advance more informed decision-making on the part of communities regarding how they wish to approach increasing their resiliency. As ecosystem service evaluation becomes more broadly accepted and integrated into investment decision-making, natural infrastructure solutions should be more highly valued for their economic, environmental and risk reduction contributions (Cunniff & Schwartz, 2015).

Whether the focus is storm mitigation or economic such as tourism and community growth, beach nourishment has been shown to be a viable and economically feasible approach to erosion control (Jones and Mangun, 2001). Most coastal states, territories, and commonwealths have some mechanisms and/or policies in place that address their own degrees of erosion hazards. However, additional benefits could be realized through further planning. Ideally, states should comprehensively examine their specific needs and issues in order to develop long-term beach management programs, which include the benefits and costs of various management options. Much of the need for beach nourishment can be met if planned in conjunction with navigational projects. Beneficial use many not be ideal for every nourishment scenario, but it is an option worth investigating for meeting long-term needs (NOAA, 2000).

References Cited:

ASMFC, 2002. Atlantic States Marine Fisheries Commission (ASMFC), Greene, K., "ASMFC Habitat Management Series #7, Beach Nourishment: A Review of Biological and Physical Impacts." Washington, D.C., November 2002

Baca, B.J., and T.E. Lankford. 1988. Myrtle Beach nourishment project: biological monitoring report – years 1, 2, 3. Report R-11 to City of Myrtle Beach; Columbia, SC, 50 pp.

Bagley, D., Cascio, T., Owen, R., Johnson, S., and Ehrhardt, L., 1994. Marine Turtle Nesting at Patrick Air Force Base, Florida; 1987-1993: Trends and Issues, In Bjorndal, K.A.; Bolten, S.B.; Johnson, D., and Elizar, P. (compilers), Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. Technical Memorandum NMFSSEFC-351, NOAA, Washington, D.C., pp. 180-181.

Brown AC, McLachlan A*. 1990. Ecology of Sandy Shores. Amsterdam: Elsevier.*

CUES, 2005. "Economics of Beach Tourism in Florida" Center for Urban & Environmental Solutions (CUES), prepared for the Florida Department of Environmental Protection Bureau of Beaches and Coastal Systems, DEP Contract No. BS014, March 2005.

Cunniff, S., A. Schwartz. 2015, "Performance of Natural Infrastructure and Nature-based Measures of Coastal Risk Reduction Features" Environmental Defense Fund, September 2015

Dean, Robert G., 1988. "*Realistic Economic Benefits from Beach Nourishment*" ASCE, Proceedings, 21st International Conference on Coastal Engineering.

Deis, D.R., K.W. Spring, and A.D. Hart. 1992. Captiva Beach restoration project – biological monitoring program. Pp. 227-241 in New Directions in Beach Management: Proceedings of the 5th Annual National Conference on Beach Preservation Technology. Tallahassee, Florida: Florida Shore and Beach Preservation Association.

Goldberg, W.M. 1988b. Biological effects of beach nourishment in south Florida: the good, the bad and the ugly. In: Proceedings of Beach Preservation Technology 1988. Tallahassee: Florida Shore and Beach Preservation Association.

Green, K., 2002, Beach Nourishment: A Review of the Biological and Physical Impacts, *in* Commission, A. S. M. F., ed., Volume Habitat Management Series # 7: Washington, DC, Atlantic States Marine Fisheries Commission, p. 179.

Hall, C. and M. Staimer 1995. "Concerns about the coast." USA Today, Page 1A, 9 August 1995.

Hearon, G.E., and B. Humphreys, 2004, "Cost-Effective Shoreline Monitoring in a Small California Coastal Community – The San Clemente Experience", Shore and Beach, Vol. 72, No. 3, pp. 26-31, Summer 2004

Houston, James R., The Economic Value of Beaches – a 2013 update" *Shore & Beach*, 81(1), 3-11. January, 2013.

Houston, James, 2013. “The economic value of beaches — a 2013 update.” *Shore & Beach*, 81(1), 3-11.

Johnson, R. 1982. The Effects of Dredging on Offshore Benthic Macrofauna South of the Inlet at Fort Pierce, Florida. Florida Institute of Technology, June 1982.

Jones, S. R., W.R. Mangun, 2001. “Beach nourishment and public policy after Hurricane Floyd: where do we go from here?” *Ocean & Coastal Management* 44(2001) 207-220

King, P.G., 2002. “Economic Analysis of Beach Spending and the Recreational Benefits of Beaches in the City of San Clemente.” San Francisco State University

Klein, Y.L., and J. Osleeb 2010. “Determinants of Coastal Tourism: A Case Study of Florida Beach Counties.” Journal of Coastal Research., 26(6), 1149-1156. http://www.jcronline.org/doi/abs/10.2112/JCOASTRES-D-09-00152.1

Kraus, N. C., and Galgano, F. A., 2001, Beach Erosional Hot Spots: Types, Causes, and Solutions, *in* USACE, ed., Volume CHETN-II-44: Vicksburg, MA, U.S. Army Engineer Research and Development Center.
Leonard, L., Clayton, T., and Pilkey, O., 1990, An Analysis of Replenished Beach Design Parameters on U.S. East Coast Barrier Islands: Journal of Coastal Research, v. 6, no. 1, p. 15-36.

Lent, L.K. 2004. “Economics of the Shoreline, An Annotated Bibliography for the National Shoreline Management Study” for the Institute for Water Resources, IWR Report 04-NSMS-5, USACE. March, 2004.

Lupino, Paolo, Riccardi, Ciro, Piergiorgio, Scaloni; “*Cost-Benefit Analysis for Beach Nourishment Work,* Osservatorio Regionale dei Litorali Laziali, Regione Lazio, Italy, 2007

The Coastal Research Center, Richard Stockton College of New Jersey. “An Assessment of Cape May County Beaches at the New Jersey Beach Profile Network (NJBPN) Sites After Hurricane Sandy – Related to (DR-NJ 4086). 2013

Mass.gov 2013. 2013 “StormSmart Properties Fact Sheet 1: Artificial Dunes and Dune Nourishment.” Massachusetts Office of Coastal Zone Management, Storm Smart Coast Program, Boston, MA. December 2013. http://www.mass.gov/czm/stormsmart

McCauley, J.E., R.A. Parr, and D.R. Hancock. 1977. Benthic Infauna and Maintenance Dredging: A Case Study, Water Research, XI 233-242.

NJCRC, 2012. “Beach-Dune Performance Assessment of New Jersey Beach Profile Network (NJBPN) Sites at Atlantic County, NJ After Hurricane Sandy Related to FEMA Disaster DR-NJ 4086” New Jersey Coastal Research Center, Richard Stockton College of New Jersey, December 21, 2012

National Research Council (NRC). 1995. Beach Nourishment and Protection. National Academy Press. Washington, D.C.

NC DTFSD, 2008-2014. “The Economic Impact of Travel on North Carolina Counties 2013,” prepared by NC Division of Tourism, Film, and Sports Development for U.S. Travel Association, Washington, D.C., Annual Reports from 2008-2014. https://www.nccommerce.com

NC, 2016. “Coastal Erosion Study,” North Carolina Division of Coastal Management, Department of Environmental Quality, Raleigh, NC, February, 2016.

NOAA, 2000. State, Territory, and Commonwealth Beach Nourishment Programs, A National Overview. Technical Document No. 00-01 OCRM Program Policy Series. U.S. Department of Commerce, National Oceanic & Atmospheric Administration. March 2000

NRC, 2007, Mitigating Shore Erosion along Sheltered Coasts, Washington, DC, The National Academies Press, 188 p.:

NRC, 2014, Reducing Coastal Risk on the East and Gulf Coasts, Washington, DC, The National Academies Press.

Nelson, D.A. and D.D. Dickerson. 1989. Effects of beach renourishment on sea turtles. In: Eckert, S.; K. Eckert, and T. Richardson, (compilers), Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology, NOAA Technical Memorandum NMFS-SEFSC-232, Miami, Florida, pp. 125-127.

Oliver, J., Slattery, P., Hulberg, L., and Nybakken, J. 1977. Patterns of Succession in Benthic Infauna Communities Following Dredging and Dredged Material Disposal in Monterey Bay. Technical Report D-77-27, October 1977. U.S. Army Corps of Engineers Waterways Experimental Station.

Peterson, C.H. and L. Manning. 2001. “How beach nourishment affects the habitat value of intertidal beach prey for surf fish and shorebirds and why uncertainty still exists,” Proceedings of the Coastal Ecosystems & Federal Activities Technical Training Symposium, August 20-22, 2001. Gulf Shores, AL

Peterson, C.H., H. Bishop, J. Melanie, 2005. “Assessing the Environmental Impacts of Beach Nourishment,” Oxford Journals – BioScience Volume 55, Issue 10, Pp. 887-896, October 2005

Pullen, E., and Naqui. 1983. Biological Impacts on Beach Replenishment and Borrowing. Shore and Beach, April 1983.

Pompe, Jeffrey J., Rinehart, James R., The Value of Beach Nourishment to Property Owners: Storm Damage Reduction Benefits, Review *of Regional Studies*, 25(1995) 271-286.

Rudolph, G. 2016. Carteret County North Carolina Shore Protection Office, electronic communication, http://www.carteretcountync.gov/295/Shore-Protection, September 2016.

Schaffner, L.C., Hobbs, C.H., III, and Horvath, M.A., 1996. Effects on Sand-Mining on Benthic Communities and Resource Value: Thimble Shoal, Lower Chesapeake Bay. Technical Report, Virginia Institute of Marine Science, Gloucester Point, VA 46p.

Speybroeck, J., Bonte, D., Courtens, W., Gheskiere, T., Grootaert, P., Maelfait, J.-P., Mathys, M., Provoost, S., Sabbe, K., Stienen, E. W. M., Lancker, V. V., Vincx, M., and Degraer, S., 2006, Beach nourishment: an ecologically sound coastal defense alternative? A review: Aquatic Conservation: Marine and Freshwater Ecosystems, v. 16, no. 4, p. 419-435.

Steinitz, M.J.; Salmon, M., and Wyneken, J. 1998. Beach renourishment and loggerhead turtle reproduction: A seven-year study at Jupiter Island, Florida. Journal of Coastal Research, 14(3), 1000-1013.

USA Today, Logan. G., 2011 "About Tourism in North Carolina," March 2011, http://traveltips.usatoday.com/tourism-north-carolina-37835.html

USACE, 1984. Shore Protection Manual Volume 1, Washington, D.C.: U.S. Government Printing Office

USACE, 2006, Corps Engineering Manual - Types and Functions of Coastal Structures.
-, 2013, Coastal Risk Reduction and Resilience: USACE Civil Works Directorate.

USACE, 2014. Committee on USACE Water Resources Science, Engineering, and Planning: Coastal Risk Reduction; Water Science and Technology Board; Ocean Studies Board; Division of Earth and Life Sciences; National Research Council; "*Reducing Coastal Risk*" The National Academies Press, 2014

USACE, 2015. North Atlantic Coast Comprehensive Study (NACCS): Resilient Adaptation to Increasing Risks, Appendix B, Economic and Social Cost Analyses, *in* USACE, and NOAA, eds.: Washington, DC., January 2015

USACE, and NOAA, 2015, Natural and Structural Measures for Shoreline Stabilization, *in* USACE, and NOAA, eds.: Washington, DC.

Welker, J.R. 1974. Some Effects of Dredging on Populations of Macrobenthic Organisms. Fishery Bulletin. LXXII (April 1974) 445-480

Wiegel, R.L., 1992. "Dade County, Florida, Beach Nourishment and Hurricane Surge Study." Shore & Beach, 60(4), 2-26

Zukin, C., 1998 "New Jerseyans, Summer and Shore Features: A Long Term Look, The Shore – Looking up (Save the Beach Passes). "The *Star-Ledger*/Eagleton-Rutgers Poll http://slerp.rutgers.edu/retrieve.php?id=119-3

Commerce

JOHN E. SKVARLA, III
Secretary

Coastal Counties' Economic Overview

LEGISLATIVE MANDATE

SECTION 14.22.(c) The Department of Commerce shall study and provide an executive summary of readily available economic data related to the 20 coastal counties of the State for the purpose of quantifying the contribution of the coastal economy to the economy of the State as a whole, considering, at a minimum, the benefits of travel and tourism, small businesses, job creation and opportunity, and tax revenues, including property, sales, and income taxes. The Department shall report the results of the study no later than November 1, 2016, to the Department of Environmental Quality and the Joint Legislative Oversight Committee on Agriculture and Natural and Economic Resources.

COASTAL REGION

The Coastal Region of North Carolina was defined by the federal Coastal Zone Management Act (CZMA) in 1972, and the Coastal Management Act of 1974 (G.S. 113a-103). The twenty counties are:

1. Beaufort	**6. Chowan**	**11. Hertford**	**16. Pasquotank**
2. Bertie	**7. Craven**	**12. Hyde**	**17. Pender**
3. Brunswick	**8. Currituck**	**13. New Hanover**	**18. Perquimans**
4. Camden	**9. Dare**	**14. Onslow**	**19. Tyrrell**
5. Carteret	**10. Gates**	**15. Pamlico**	**20. Washington**

Dare County is the largest county in the region with 1,562mi^2, but land area is only 25 percent of its total area, as the remaining 75 percent is water. Hyde and Carteret Counties are the second and third largest respectively, with more water than land area. Pender County is the largest by land area, followed by Brunswick, Beaufort, and Onslow Counties. Chowan County is the smallest with 233.3mi^2, followed by Pasquotank, and Camden Counties.

The majority of the counties in this region are predominately rural, with five identified as completely rural by the U.S. Census Bureau: (1) Gates, (2) Hyde, (3) Pamlico, (4) Perquimans, and (5) Tyrrell Counties. New Hanover County is the most urban at 97.8 percent, followed by Onslow and Craven Counties.

2010 Rural Percentage

Beaufort	65.6%	**Chowan**	67.6%	**Hertford**	68.6%	**Pasquotank**	41.3%
Bertie	83.2%	**Craven**	27.7%	**Hyde**	100.0%	**Pender**	68.8%
Brunswick	43.0%	**Currituck**	98.3%	**New Hanover**	2.2%	**Perquimans**	100.0%
Camden	99.6%	**Dare**	29.0%	**Onslow**	26.4%	**Tyrrell**	100.0%
Carteret	32.6%	**Gates**	100.0%	**Pamlico**	100.0%	**Washington**	67.8%
	Region 38.2%				NC 33.9%		

Source: United States Census Bureau.

POPULATION

The Coastal Region accounted for about **10 percent of the state's population**, consistently growing since 2010. New Hanover County had the largest population with over 200,000, followed by Onslow, Brunswick, and Craven Counties with over 100,000 people each from 2010-2015. The Coastal Region's population density averaged 73 people per square mile compared to the state's average of 139 people per square mile. This region has consistently grown since 2010, at a similar rate to the state as a whole.

Population

	2010	2011	2012	2013	2014	2015
Region	**992,925**	**997,898**	**1,009,500**	**1,018,914**	**1,037,034**	**1,036,500**
NC	9,558,979	9,651,025	9,747,021	9,845,432	9,940,387	10,042,802

Source: United States Census Bureau. *(See appendix for county-level data.)*

Population Density (land only)

	2010	2011	2012	2013	2014	2015
Region	**106.5**	**107.0**	**108.3**	**109.3**	**110.1**	**111.2**
NC	138.5	139.9	141.3	142.7	144.1	145.6

Source: United States Census Bureau. (Population/Miles^2) (*See appendix for county-level data.)*

Population Growth Rate (base year 2010)

	2010	2011	2012	2013	2014	2015
Region	**-**	**0.5%**	**1.7%**	**2.6%**	**3.4%**	**4.4%**
NC	-	1.0%	2.0%	3.0%	4.0%	5.1%

Source: United States Census Bureau. *(See appendix for county-level data.)*

It is important to note that population in this region varies throughout the year due to seasonality of the vacation destinations. Most of these counties experience an influx of population between May and August, where many stay and/or work in these counties during the summer months.

LABOR MARKET

The Coastal Region accounted for almost **10 percent of North Carolina's labor force**. New Hanover County has a significantly larger labor force due to its large population, making up 25 percent of the region's total labor force. The number of unemployed in the Coastal Region has dropped by 40 percent since 2010. Despite the drop in the unemployment number, the Coastal Region's unemployment rate has been higher than the state's rate since 2011.

Labor Force

	2010	2011	2012	2013	2014	2015
Region	**442,706**	**441,012**	**443,614**	**442,228**	**441,728**	**447,492**
NC	4,616,690	4,633,071	4,680,265	4,683,022	4,690,562	4,769,245

Source: Local Area Unemployment Statistics (LAUS), Labor & Economic Analysis Division (LEAD), NC Department of Commerce. *(See appendix for county-level data.)*

Employed

	2010	2011	2012	2013	2014	2015
Region	**396,948**	**395,348**	**401,167**	**404,800**	**411,768**	**419,511**
NC	4,115,628	4,157,543	4,247,139	4,310,817	4,396,286	4,495,473

Source: Local Area Unemployment Statistics (LAUS), Labor & Economic Analysis Division (LEAD), NC Department of Commerce. *(See appendix for county-level data.)*

Unemployed

	2010	2011	2012	2013	2014	2015
Region	**45,758**	**45,664**	**42,447**	**37,428**	**29,960**	**27,981**
NC	501,062	475,528	433,126	372,205	294,276	273,772

Source: Local Area Unemployment Statistics (LAUS), Labor & Economic Analysis Division (LEAD), NC Department of Commerce. *(See appendix for county-level data.)*

Unemployment Rate

	2010	2011	2012	2013	2014	2015
Region	**10.3%**	**10.4%**	**9.6%**	**8.5%**	**6.8%**	**6.3%**
NC	10.9%	10.3%	9.3%	7.9%	6.3%	5.7%

Source: Local Area Unemployment Statistics (LAUS), Labor & Economic Analysis Division (LEAD), NC Department of Commerce. *(See appendix for county-level data.)*

Job Openings for 2015 averaged 7.2 percent of the state's total, with a little over 50,000 openings. Almost 70 percent of the openings in the region were located in New Hanover County, Onslow County, and Craven County. The labor slack rate (the number of unemployed persons per job opening) was 0.6 for the Coastal Region and 0.4 for the state, meaning the Coastal Region had slightly more unemployed people per job opening than the state as whole.

Job Openings

	2015
Region	**50,333**
NC	702,533

Source: Wanted Analytics, Help Wanted Online, The Conference Board. *(See appendix for county-level data.)*

Labor Slack Rate

	2015
Region	**0.6**
NC	0.4

Source: Local Area Unemployment Statistics (LAUS), Labor & Economic Analysis Division (LEAD), NC Department of Commerce & Wanted Analytics, Help Wanted Online, The Conference Board. *(Number of unemployed divided by the number of job openings.) (See appendix for county-level data.)*

INDUSTRY

The Coastal Region averaged **8.5 percent of the jobs in North Carolina** between 2010 and 2015, with over 348,000 jobs in 2015. Almost 30 percent of the jobs in the region were located in New Hanover County alone. The growth rate for the region has grown consistently since 2012 but at half the rate of the state's. The average yearly wage for the Coastal Region was about 35 percent less than the state's average yearly wage ($46,563); but almost half of the counties were above the region's average.

Number of Jobs

	2010	2011	2012	2013	2014	2015
Region	**330,991**	**329,737**	**331,718**	**336,548**	**342,433**	**348,852**
NC	3,788,425	3,836,792	3,905,109	3,975,144	4,057,234	4,162,137

Source: Quarterly Census Employment and Wages (QCEW), Labor and Economic Analysis Division (LEAD), North Carolina Department of Commerce. *(See appendix for county-level data.)*

Job Growth Rate (base year 2010)

	2010	2011	2012	2013	2014	2015
Region	-	-0.4%	0.2%	1.7%	3.5%	5.4%
NC	-	1.3%	3.1%	4.9%	7.1%	9.9%

Source: Quarterly Census Employment and Wages (QCEW), Labor and Economic Analysis Division (LEAD), North Carolina Department of Commerce. *(See appendix for county-level data.)*

Average Yearly Wage (in 2015 dollars)

	2010	2011	2012	2013	2014	2015
Region	**$36,790**	**$36,400**	**$35,761**	**$35,671**	**$35,903**	**$36,675**
NC	$44,709	$44,394	$44,509	$44,548	$45,020	$46,563

Source: Quarterly Census Employment and Wages (QCEW), Labor and Economic Analysis Division (LEAD), North Carolina Department of Commerce. Wages are adjusted for inflation using the Bureau of Labor Statistics' Consumer Price Index. *(See appendix for county-level data.)*

The top three industry sectors (as measured by employment) for the Coastal Region in 2015 were: (1) retail trade, (2) healthcare and social assistance, and (3) accommodation and food services; two of which were the same as the state. As a region, these coastal counties have a higher concentration of employees in Retail Trade, Accommodation and Food Services, and Public Administration as compared to the state. Fourteen of the 20 counties had Retail Trade as the first or second largest industry sector, for example. Accommodation and Food Services is the number one industry by employment in Dare County, and the second biggest sector in Brunswick, Carteret, Onslow and Perquimans Counties. When compared to the state, manufacturing was far less concentrated, although still important for several counties including Beaufort and Washington.

Coastal Region Top 10 Industry Sectors

2015					
	Industry	**Employees**		**Industry**	**Employees**
1	Retail Trade	55,672	**6**	Administrative and Support and Waste Management and Remediation Services	19,732
2	Health Care and Social Assistance	49,548	**7**	Manufacturing	19,272
3	Accommodation and Food Services	46,368	**8**	Construction	16,167
4	Educational Services	31,293	**9**	Professional, Scientific, and Technical Services	14,552
5	Public Administration	30,108	**10**	Other Services (except Public Administration)	9,722

Source: Quarterly Census Employment and Wages (QCEW), Demand driven Data Delivery System (4D), Labor & Economic Analysis Division (LEAD), NC Department of Commerce. *(See appendix for county-level data.)*

NC Top 10 Industry Sectors

2015					
	Industry	**Employees**		**Industry**	**Employees**
1	Health Care and Social Assistance	590,275	**6**	Administrative and Support and Waste Management and Remediation Services	290,807
2	Retail Trade	490,823	**7**	Public Administration	239,235
3	Manufacturing	461,008	**8**	Professional, Scientific, and Technical Services	221,796
4	Accommodation and Food Services	396,622	**9**	Construction	189,169
5	Educational Services	370,929	**10**	Wholesale Trade	178,875

Source: Quarterly Census Employment and Wages (QCEW), Demand driven Data Delivery System (4D), Labor & Economic Analysis Division (LEAD), NC Department of Commerce. *(See appendix for county-level data.)*

Employment projections for the Coastal Region are not available at the county level. Instead, projections are available by NC's Prosperity Zones, a larger regional grouping used by the state for administrative purposes. The Coastal Region is split between the Northeast Prosperity Zone and the Southeast Prosperity Zone. In both zones, the top five major occupations expected to have growth were the same, just in slightly different order.

Top 5 Occupations by Net Projected Employment Growth

Northeast Prosperity Zone	Actual 2012	Projected 2022	Net Change	Wage Annual Median
Food Preparation and Serving Related Occupations	20,228	24,818	4,590	$18,275
Healthcare Support Occupations	9,934	14,040	4,106	$19,317
Office and Administrative Support Occupations	28,798	32,326	3,528	$28,176
Healthcare Practitioners and Technical Occupations	13,697	16,667	2,970	$53,482
Construction and Extraction Occupations	7,477	10,121	2,644	$31,774

Source: Major Occupational Projections, Labor & Economic Analysis Division (LEAD), NC Department of Commerce. *(See appendix for county-level data.)*

Top 5 Occupations by Net Projected Employment Growth

Southeast Prosperity Zone	Actual 2012	Projected 2022	Net Change	Wage Annual Median
Food Preparation and Serving Related Occupations	39,818	47,670	7,852	$18,403
Office and Administrative Support Occupations	52,061	58,846	6,785	$28,260
Healthcare Practitioners and Technical Occupations	22,394	28,221	5,827	$52,407
Healthcare Support Occupations	15,082	20,739	5,657	$21,858
Construction and Extraction Occupations	17,033	21,152	4,119	$32,818

Source: Major Occupational Projections, Labor & Economic Analysis Division (LEAD), NC Department of Commerce. *(See appendix for county-level data.)*

SMALL BUSINESS

Small firms are defined as having fewer than 500 employees by the Small Business Administration. There were more employees at small firms than large firms in the Coastal Region. From 2010 to 2015, the region has consistently had a higher percentage of employees in small businesses than the state.

Percent of Workers at Small Firms

	2010 Q3	2011 Q3	2012 Q3	2013 Q3	2014 Q3	2015 Q3
Region	**66.7%**	**65.9%**	**65.4%**	**64.7%**	**64.1%**	**64.7%**
NC	49.6%	49.0%	48.2%	47.7%	47.6%	47.5%

Source: Longitudinal Employer–Household Dynamics (LEHD) at the U.S. Census Bureau. *(See appendix for county-level data.)*

TAX REVENUE AND PERSONAL INCOME

The Coastal Region collected, on average, **10 percent of all of North Carolina's sales and property tax revenues**. New Hanover County ($4 billion) reported more than two times the taxable sales as the second highest county, Onslow ($1.9 billion). Sales in the region grew consistently since FY 2009-2010, which paralleled the state's growth in taxable sales. New Hanover, Onslow, and Brunswick Counties lead the region in gross sales tax collections. Both the Coastal Region and the state repeatedly increased gross sales tax collections for five years (2011-2016). For property taxes, New Hanover ($255 million) collected over a quarter of the region's taxes.

Personal income per capita for the region was $3,000 less than the state's in 2014.

Taxable Sales **(in millions)**

	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Region	**$10,189.87**	**$11,087.39**	**$11,358.95**	**$11,621.12**	**$12,504.88**	**$13,262.39**
NC	$96,759.10	$102,830.05	$105,367.31	$110,350.58	$120,304.94	$128,156.85

Source: North Carolina Department of Revenue. *(See appendix for county-level data.)*

Gross Sales Tax Collections **(in millions)**

	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Region	**$586.93**	**$539.78**	**$541.66**	**$553.19**	**$595.74**	**$631.93**
NC	$5,567.95	$4,990.66	$5,016.41	$5,254.90	$5,731.24	$6,106.79

Source: North Carolina Department of Revenue. *(See appendix for county-level data.)*

Personal Income per Capita

	2014
Region	**$38,927**
NC	$39,171

Source: Bureau of Economic Analysis *(See appendix for county-level data.)*

Property Taxes **(in millions)**

	2014-2015	2015-2016
Region	**$983.71**	**$1,014.92**
NC	$9,607.54	$9,946.90

Source: North Carolina Department of Revenue. *(See appendix for county-level data.)*

TOURISM

Tourism expenditures fluctuated in the Coastal Region from 2010 to 2015, averaging **15 percent of North Carolina's total tourism spending**. Over a third of the region's expenditures occurred in Dare County ($1 billion), followed by New Hanover and Brunswick Counties. Local tourism tax collections for the region comprised **24 percent of local tourism taxes** collected in the state, and increased since 2012, paralleling the state. Dare, Brunswick, and New Hanover Counties collected the most local tourism tax revenue in the region. Also, the Coastal Region contributed **14 percent to North Carolina's state tourism taxes** in 2015.

Tourism Expenditures **(in millions, 2015 $)**

	2010	2011	2012	2013	2014	2015
Region	**$2,854.05**	**$2,916.37**	**$3,007.48**	**$3,077.78**	**$3,209.33**	**$3,290.40**
NC	$18,495.30	$19,410.17	$20,037.35	$20,570.95	$21,348.33	$21,961.21

Source: Economic Development Partnership of North Carolina (EDPNC) & Travel Economic Impact Model (TEIM), the Research Department of the U.S. Travel Association. Adjusted for inflation using the Bureau of Labor Statistics' Consumer Price Index. *(See appendix for county-level data.)*

Tourism Local Taxes **(in millions, 2015 $)**

	2010	2011	2012	2013	2014	2015
Region	**$143.79**	**$143.62**	**$143.48**	**$146.19**	**$151.99**	**$157.19**
NC	$591.06	$591.05	$598.11	$611.70	$637.03	$660.84

Source: Economic Development Partnership of North Carolina (EDPNC) & Travel Economic Impact Model (TEIM), the Research Department of the U.S. Travel Association. Adjusted for inflation using the Bureau of Labor Statistics' Consumer Price Index. *(See appendix for county-level data.)*

Tourism State Taxes **(in millions)**

	2015
Region	**$ 158.88**
NC	$1,125.54

Source: Economic Development Partnership of North Carolina (EDPNC) & Travel Economic Impact Model (TEIM), the Research Department of the U.S. Travel Association. *(See appendix for county-level data.)*

Tourism employment steadily increased from 2010 to 2015. The Coastal Region accounted for a little over **16 percent of North Carolina's tourism employees**. The majority of employees were located in Dare, New Hanover, and Brunswick Counties. With this increase in the number of tourism employees, tourism payroll expenses increased as well. The region averaged almost **13 percent of the state's tourism payroll expenses**, with Dare County ($223 million) paying almost double the amount of the next county, New Hanover ($121 million) in 2015.

Tourism Employment

	2010	2011	2012	2013	2014	2015
Region	**30,550**	**30,696**	**31,555**	**32,207**	**33,442**	**34,420**
NC	183,881	188,415	193,610	198,272	204,909	211,487

Source: Economic Development Partnership of North Carolina (EDPNC) & Travel Economic Impact Model (TEIM), the Research Department of the U.S. Travel Association. *(See appendix for county-level data.)*

Tourism Payroll **(in millions, 2015 $)**

	2010	2011	2012	2013	2014	2015
Region	**$552.78**	**$548.70**	**$563.74**	**$581.17**	**$612.73**	**$654.71**
NC	$4,343.24	$4,417.58	$4,533.23	$4,691.73	$4,928.45	$5,272.11

Source: Economic Development Partnership of North Carolina (EDPNC) & Travel Economic Impact Model (TEIM), the Research Department of the U.S. Travel Association. Adjusted for inflation using the Bureau of Labor Statistics' Consumer Price Index. *(See appendix for county-level data.)*

Urban/Rural Mix

	Total	Urban	Rural
Beaufort	47,759	16,429	31,330
Bertie	21,282	3,566	17,716
Brunswick	107,431	61,278	46,153
Camden	9,980	45	9,935
Carteret	66,469	44,798	21,671
Chowan	14,793	4,790	10,003
Craven	103,505	74,825	28,680
Currituck	23,547	397	23,150
Dare	33,920	24,097	9,823
Gates	12,197	0	12,197
Hertford	24,669	7,737	16,932
Hyde	5,810	0	5,810
New Hanover	202,667	198,178	4,489
Onslow	177,772	130,931	46,841
Pamlico	13,144	0	13,144
Pasquotank	40,661	23,860	16,801
Pender	52,217	16,315	35,902
Perquimans	13,453	0	13,453
Tyrrell	4,407	0	4,407
Washington	13,228	4,265	8,963
Region	**988,911**	**611,511**	**377,400**
NC	9,535,483	6,301,756	3,233,727

Urban/Rural Mix data was collected from the U.S. Census Bureau.