Audubon NORTH CAROLINA

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October 12, 2015

Via U.S. and Electronic Mail
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Re: SAW-2011-01914 Holden Beach East End Shore Protection Project

Ms. Hughes:

Please accept these comments on behalf of the National Audubon Society's North Carolina State Office regarding the draft Environmental Impact Statement (DEIS) for the project known as "Holden Beach East End Shore Protection Project."

The Town of Holden Beach's preferred alternative is to construct a ~1,000 foot-long terminal groin on the east end of Holden beach and a beach nourishment regime that would place ~120,000-180,000 cy of sand on the East End beach extracted from Lockwood Folly AIWW Inlet Crossing borrow site. This alternative, as well as other alternatives that include the construction of a terminal groin or any other hard structure (Alternative 5), the stabilization of the inlet through channelization (Alternative 4), beach nourishment activities (Alternatives 1, 3, 4, 5, and 6), or the dredging or other removal of sand from Lockwood Folly Inlet or the associated ebb and flood tidal deltas (Alternatives 1, 3, 4, 5, and 6) will have significant and lasting negative direct, indirect, and cumulative impacts on birds and other wildlife that depend on the dynamism of mid-Atlantic coastal inlets at critical points in their life cycles. Additionally, for the applicant's preferred alternative (Alternative 6), the models used in the DEIS show that East End beach will continue to experience erosion even with the construction of a terminal groin.

The DEIS takes the "make them go somewhere else" approach when addressing the impact of the preferred alternative and most of the other alternatives on birds. It perpetuates the common misconception that breeding and non-breeding shorebirds and waterbirds have alternative places to go when habitat is lost and that, because birds have wings, they will simply move somewhere else. The truth is, the birds are already occupying alternative locations. They have been relentlessly forced to abandon high-quality habitats throughout their range because of habitat loss and degradation. Shorebirds like Piping Plovers, as well as terns and skimmers are now confined to a small fraction of the habitat once available to them, and if alternative locations were available, the birds would already be there. This is reflected in the elevated conservation status of many of the species that depend on inlets and barrier islands, including those that depend on Lockwood Folly Inlet; nearly all are state listed, federally listed, listed as species of conservation concern, or similarly designated in documents such as the U.S. Shorebird Conservation Plan (Brown *et al.* 2001).

<u>Geophysical Impacts of Terminal Groins, Other Hard Structures, and Beach Renourishment</u>: In order to assess environmental impacts, it is necessary to accurately describe how terminal groins and other coastal engineering projects affect inlets and adjacent beaches. The DEIS fails to cite the applicable, most recent scientific literature and fails to accurately describe the impacts a terminal groin, beach renourishment, and inlet channelization would have on Lockwood Folly Inlet and adjacent areas. Some of the impacts that are insufficiently addressed are the narrowing of downdrift oceanfront beach, loss of sediment from the inlet system, impacts to spits at ends of adjacent islands, loss of critical wildlife habitat, and cumulative impacts of the alternatives.

Terminal groins are designed to interrupt longshore transport of sand. It is well documented that terminal groins actually accelerate erosion of the shoreline downdrift of the structure (McDougal *et al.* 1987, Kraus *et al.* 1994, Bruun 1995, Cleary and Pilkey 1996, Komar 1998, McQuarrie and Pilkey 1998, Pilkey *et al.* 1998, Brown and McLachlan 2002, Greene 2002, USACE 2002, Morton 2003, Morton *et al.* 2004, Basco and Pope 2004, Speybroeck *et al.* 2006, Rice 2009, Riggs *et al*. 2009, Riggs and Ames 2011, Ells and Murray 2012, Knapp 2012, Pietrafesa 2012, Berry *et al.* 2013), which in turn requires regular replenishment of sand to compensate for sand loss (Hay and Sutherland 1988, Bruun 1995, McQuarrie and Pilkey 1998, French 2001, Galgano 2004, Basco 2006, Riggs *et al.* 2009, Riggs and Ames 2011, Pietrafesa 2012).

An open letter on the subject of downdrift erosion signed by 43 of the leading coastal geologists in the U.S. states:

The negative impact of groins and jetties on downdrift shorelines is well understood. When they work as intended, sand moving along the beach in the so-called downdrift direction is trapped on the updrift side, causing a sand deficit and increasing erosion rates on the downdrift side. This well-documented and unquestioned impact is widely cited in the engineering and geologic literature (Young *et al.* undated).

Fenster and Dolan (1996) found that inlets in Virginia and North Carolina exert influence over adjacent shorelines up to 5.4-13.0 km away and that they are a dominant factor in shoreline change for up to 4.3 km. Permanently modifying Lockwood Folly Inlet through construction of a terminal groin, or through channelization (Nordstrom 2000), will significantly increase the erosion rate on the downdrift shoreline of Holden Beach. Longshore currents run predominantly westward in the area of East End beach, placing nearly all of the oceanfront homes on Holden Beach in danger from accelerated erosion, should a terminal groin be built.

The DEIS forecasts a four-year interval for beach renourishment for all alternatives that include a terminal groin (Alternatives 5 and 6). Despite the well-known downdrift impact of terminal groins, the DEIS does not address the likelihood that in response to the terminal groin, the beach will narrow farther to the west and require additional and more frequent beach renourishment over the years. The proposed four-year interval for beach renourishment is also questionable given that Wrightsville Beach, Masonboro Island, Mason Inlet, southern Figure 8 Island, Oregon Inlet, and Ft. Macon, just to name a few, are dredged and replenished more frequently than four-year intervals. **The near certainty that Holden Beach will need to mine sand from Lockwood Folly Inlet and replenish the downdrift beach on Holden Beach more frequently than every four years has not been accurately assessed in the DEIS**.

Downdrift effect can be seen elsewhere in North Carolina where terminal groins have been installed. At Fort Macon, three years after the completion of the terminal groin a beach renourishment project occurred because the groin itself was exacerbating erosion, and from 1973-2007, seven renourishment projects have occurred at Fort Macon at the cost of nearly $45 million (Pietrafesa 2012).

Riggs and Ames (2011) also provide an excellent review of the impacts of the modifications to Oregon Inlet. To minimize impacts of the Oregon Inlet terminal groin on the downdrift shoreline of Pea Island, sediment from routine Oregon Inlet channel dredging has been placed either directly on the Pea Island beach or in shallow nearshore disposal area near northern Pea Island (Riggs and Ames 2011). Human efforts have only temporarily slowed the process of shoreline recession in a small portion of northern Pea Island by the regular addition of dredged sand at a very high cost, but each new beach nourishment project has quickly eroded away (Riggs and Ames 2009, Riggs *et al.* 2009). Based on several studies, the data strongly suggests that the terminal groin itself is contributing to the accelerated erosion and shoreline recession problems on Pea Island (Riggs and Ames 2003, 2007, 2009; Riggs *et al.* 2008, 2009; Mallinson *et al.* 2005, 2008, 2010; Culver *et al.* 2006, 2007; Smith *et al.* 2008).

In addition to impacts on downdrift shorelines, hard structures at inlets permanently remove sand from the inlet system, reducing or eliminating shoal systems from affected inlets (Pilkey *et al.* 1998) and accelerating the loss of saltmarsh in the vicinity of the inlet (Hackney and Cleary 1987). The loss of saltmarsh at Lockwood Folly Inlet would have significant negative impacts on fisheries, other wildlife, recreation, small businesses, and the local economy. **These impacts and the loss of saltmarsh resulting from removal of sand from Lockwood Folly Inlet have not been assessed for the preferred or other alternatives in the DEIS.**

The loss of ebb and flood tidal shoals is illustrated clearly by the case of Masonboro Inlet. A terminal groin was installed on the north end of Masonboro Island; construction of the groin was completed in April 1981 (Cleary and Marden 2009). At the time, the north end of the island featured an extensive sand spit, wide beach, and extensive flood and ebb tidal deltas (Figure 2). In less than one year following the completion of the terminal groin, the spit at the north end of Masonboro Island vanished, and the amount of intertidal shoals in the inlet, already diminished by other coastal engineering projects, had decreased as well. Downdrift of the terminal groin, Masonboro Island's oceanfront beach formed the expected fillet immediately adjacent to the terminal groin, while narrowing significantly along the downdrift beach.

The DEIS also fails to address the cumulative impacts of sand mining and the proposed terminal groin at Lockwood Folly Inlet on the adjacent downdrift beach. The regular removal of sand from Lockwood Folly Inlet and the proposed terminal groin at the East End beach would disrupt the longshore transport of sand and potentially threaten Holden Beach—the adjacent downdrift shoreline—and the real estate thereon.

There are at least 100 published studies that address the impacts of terminal groins on inlets, beaches, and natural resources. The majority (78%) of peer-reviewed literature we collected regarding the impacts of hard structures at inlets concluded that terminal groins do not function in the manner presented in the DEIS and cause more harm than good. The wealth of literature on the impacts of terminal groins is not discussed nor cited in the DEIS. A complete review of the relevant literature is necessary to accurately and objectively evaluate all alternatives presented in the DEIS.

Impacts to Birds: Natural, unmodified coastal inlets are essential to many shorebird species (sandpipers, plovers, and their allies), as well as other coastal species because they provide the variety of habitat types these species require at critical times of their annual and lifecycles. Inlets have expansive, low-energy intertidal flats which are rich with invertebrate prey that wintering and migrating shorebirds require to fuel their migratory flights, sustain them during winter, and support adults and chicks during the nesting season. Inlets have open, sandy spits that serve as resting and roosting sites that shorebirds need to rest, digest, and conserve energy; and they have open or sparsely vegetated sandy habitat that many shorebird species, as well as terns and skimmers require for nesting. (Gochfeld and Burger 1994, Thompson *et al.* 1997, Elliott-Smith and Haig 2004, Nol and Humphrey 2012).

Shorebird communities require habitat heterogeneity to meet their basic and varied fundamental needs for survival, which is why unmodified inlets containing a mosaic of habitat types are essential to sustaining shorebird communities (VanDusen *et al.* 2012). Many shorebird species breed in the far north in order to exploit the seasonal abundance of food resources and they stopover around inlets during migration in order to refuel before continuing migration (Colwell 2010). Proximity between foraging and roosting sites has been found to be a key element in determining habitat suitability and use for shorebird species such as the Piping Plover (Cohen *et al.* 2008), Dunlin (*Calidris alpina*) (Dias *et al.* 2006), Red Knot (Rogers *et al.* 2006), and others. In short, natural inlets provide all the resources and habitats shorebirds require in a small geographic area and at the locations essential to meeting their spatial and temporal energetic needs. These resources are generally not available or not sufficient to meet the energetic needs of shorebirds at other coastal features.

Reflecting this fact, the occurrence and numbers of shorebirds that use coastal habitats in the southeastern U.S. is greater at inlets than most other coastal features. Seven shorebird species: the Threatened Piping Plover (*Charadrius melodus*) and the Threatened Red Knot (*Calidris canutus rufa*), as well as Black-bellied Plovers (*Pluvialis squatarola*), Ruddy Turnstones (*Arenaria interpres*), Snowy Plovers (*Charadrius alexandrinus*), Western Sandpipers (*Calidris* *mauri*), and Wilson's Plovers (*Charadrius wilsonia*) are significantly more abundant at inlets indicating that Piping Plovers have a small home range during the non-breeding season and use a variety of habitats throughout the tidal cycle (Drake *et al.* 2001, Rabon 2006, Cohen *et al.* 2008, Maddock *et al.* 2009). Foraging activity is strongly associated with mud or sandflats (Nicholls and Baldassarre 1990), and roost sites are most used by Piping Plovers when located within close proximity to foraging areas (Cohen *et al.* 2008). Piping Plovers also exhibit strong site fidelity both during the same year and across several years (Drake *et al.* 2001, Noel and Chandler 2006). These characteristics demonstrate that Piping Plovers depend on very specific places that with these habitats, and that these places are important year after year as the same birds return to them every migration or winter. than other coastal habitats (Harrington 2008). Multiple studies support the significance of inlets to birds, designating inlets as essential habitat by Red Knots, as well as breeding and non-breeding Piping Plovers (Nicholls and Baldassarre 1990, Harrington 2008, Kisiel 2009a, 2009b, Riggs *et al.* 2009, Niles *et al.* 2010, Maslo *et al.* 2011, USFWS 2012a, 2013).

Piping Plovers: Piping Plovers are an excellent example of a species that relies on inlet-associated habitats throughout the year. During nesting, Piping Plovers are often associated with natural coastlines, including unmodified inlets and overwash fans. In New Jersey, Piping Plovers nest primarily near inlets, particularly those that were not stabilized with structures: 70.6% of all Piping Plover pairs nested closer to an unstabilized inlet than a stabilized inlet (Kisiel 2009a, 2009b). Piping Plovers in North Carolina also exhibit a pattern of nesting near inlets, and the majority of Piping Plover nests in Cape Hatteras National Seashore and Cape Lookout National Seashore were located near inlets (NPS 2014a, 2014b), largely because suitable nesting habitat does not exist elsewhere on the coast.

Piping Plovers spend up to nine months out of the year away from nesting grounds (Elliott-Smith and Haig 2004). During this time, Piping Plovers engage in two essential behaviors, foraging and roosting (resting). A core wintering area or stopover site must provide habitat suitable for roosting, typically backshore above the high-tide line, and foraging, typically wet sand in low-energy intertidal areas that support invertebrates such polychaetes which are an important prey item for wintering and migrating Piping Plovers (Elliott-Smith and Haig 2004).

There is a robust body of peer-reviewed scientific literature showing use of inlets and associated low-energy intertidal flats by Piping Plovers, particularly migrating or wintering Piping Plovers (Haig and Oring 1985, Johnson and Baldassarre 1988, Nicholls and Baldassarre 1990), indicating that Piping Plovers have a small home range during the non-breeding season and use a variety of habitats throughout the tidal cycle (Drake *et al.* 2001, Rabon 2006, Cohen *et al.* 2008, Maddock *et al.* 2009). Foraging activity is strongly associated with mud or sandflats (Nicholls and Baldassarre 1990), and roost sites are most used by Piping Plovers when located within close proximity to foraging areas (Cohen *et al.* 2008). Piping Plovers also exhibit strong site fidelity both during the same year and across several years (Drake *et al.* 2001, Noel and Chandler 2006). These characteristics demonstrate that Piping Plovers depend on very specific places that with these habitats, and that these places are important year after year as the same birds return to them every migration or winter.

Modification of Inlets and Beaches: Despite the importance of natural inlets to birds such as the Piping Plover, **inlets are one of the most anthropogenically altered features on the coast**. In North Carolina, 85% of inlets have been modified, and 57% of Atlantic coast inlets in the migration and winter range of the Piping Plover have been modified, including 43% that have been stabilized with hard structures (Rice 2012a). At least 32% of sandy beach habitat in the winter range of the Piping Plovers has received beach nourishment (Rice 2012b), which causes direct mortality of the infaunal prey these birds consume in order to survive.

The cumulative impacts of the preferred alternative has not been accurately assessed in the DEIS. A cumulative impact is the "…impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." The cumulative impacts of terminal groin construction along the coast of North Carolina and along the Atlantic Coast of the U.S. have been one of the most significant contributing factors to the loss of habitat for birds that rely on inlets at critical times of their life and annual cycles.

Many shorebird populations, especially the many species that occur at inlets, are declining and are of conservation concern (Brown *et al.* 2001, Winn *et al.* 2013). Loss or degradation of habitat, including that associated with coastal engineering projects, is identified as a primary threat in all shorebird conservation and management planning documents, including those addressing Piping Plovers and Red Knots. The cumulative impacts of the loss and degradation of habitats that are essential to inlet-dependent wildlife jeopardizes the recovery of federally-listed species, threatens the existence of federally-listed species, and contributes to the decline of state-listed species, none of which are evaluated in the DEIS.

Impacts on Infauna: The DEIS overlooks impacts of the alternatives on the infaunal community (species that live within the sediment) at East End beach and consistently marginalizes and understates impacts to these organisms. The infaunal community is comprised of multiple different species that have variable recovery rates. The DEIS treats the infaunal community as a single species and states, "Reported rates of recovery have been rapid when highly compatible beach fill sediments were used and spring larval recruitment periods were avoided" (p. 5-29). The DEIS repeatedly uses the terms "short-term," "rapid recovery," and "rapid recolonization" (for examples, see pages 5-29, 5-30, 5-35, 5-44, 5-93) when addressing the impacts to the infaunal community, which is misleading because some organisms take up to four years to recover (Jaramillo *et al.* 1987, Peterson *et al.* 2014).

The majority of peer-reviewed literature demonstrates that infaunal species are negatively impacted by beach nourishment, and that the length of time for recovery varies by species (Hayden and Dolan 1974, Jaramillo *et al.* 1987, Rakocinski *et al.* 1996, Peterson *et al.* 2000a, Peterson *et al.* 2000b, Bishop *et al.* 2006, Dolan *et al*. 2006, Peterson *et al.* 2006, Bertasi *et al.* 2007, Colosio *et al.* 2007, Cahoon *et al.* 2012, Leewis *et al.* 2012, Schlachler *et al.* 2012, Viola *et al.* 2013, Manning *et al.* 2014, Petersen *et al.* 2014). In North Carolina, *Emerita talpoida* (mole crab) abundance recovered within months on nourished beaches compared to control beaches, but *Donax* spp. (coquina clam) and amphipods did not recover within the time frame of the study (Peterson *et al.* 2006). Peterson *et al.* (2014) monitored the recovery of a sandy beach community for 3-4 years following nourishment and documented that haustoriid amphipods (small crustaceans) and *Donax* spp. had reduced densities for 3-4 years following nourishment, *E. talpoida* had lower densities for 1-2 years following nourishment, and ghost crabs had lower abundances for four years.

For all alternatives except Alternative 2, beach nourishment is proposed. Historically, East End beach was nourished every two years. For the preferred Alternative 6 and all other alternatives that include a terminal groin, the DEIS states that nourishment will occur every four years. However, at inlets where terminal groins were constructed, the beach nourishment cycle is every 1-4 years (Riggs *et al.* 2009, Riggs and Ames 2011, Pietrafesa 2012). Pea Island was renourished every year from 1990-2004, and Fort Macon was renourished every 2-6 years from 1973-2007 (Pietrafesa 2012). If some species of the infaunal community recover in 3-4 years, the cumulative impact to the infaunal community due to nourishment at such sites is that the community cannot recover before the next nourishment cycle. In some cases, local extinction of benthic species has occurred (Colosio *et al.* 2007).

The compaction of sand by heavy machinery and changes in grain size and shape, permeability, and penetrability are other common results of beach nourishment that impact infaunal organisms (Greene 2002, McLachlan and Brown 2006). Further, though timing of activity is important to avoid periods of larval recruitment, all work is assumed to take place within existing environmental windows. The potential for additional impacts both from more frequent nourishments and out-of-season nourishments should be addressed by the DEIS.

Beach nourishment degrades beach habitats, thus decreasing densities of invertebrate prey for shorebirds. Each shorebird species has its own foraging microhabitat as well as its own feeding techniques. Shorebirds that collect food from specific depths beneath the sand can no longer rely on food from traditional habitats on nourished beaches (Peterson *et al.* 2006). This will negatively impact species that often forage in oceanfront intertidal and swash habitats, specifically Sanderlings (Macwhirter *et al.* 2002), Willets (Lowther *et al.* 2001), and the threatened Red Knot (Baker *et al.* 2013). Speybroeck *et al.* (2006) documented that the mortality of just one species of polychaete due to nourishment resulted in decreased abundances of foraging Sanderlings. Piping Plovers forage less on oceanfront beaches than other habitats during non-breeding months (Haig and Oring 1985, Cohen *et al.* 2008), but they have been documented foraging occasionally on oceanfront beaches. Therefore, renourishment activities also affect this Piping Plover foraging habitat.

Decreased abundances of shorebirds after nourishment may be due to decreased foraging area, decreased prey densities, and the occurrence of coarse sediments further reducing foraging habitat (Peterson *et al.* 2006). Coastal armoring caused beach widths to narrow significantly in southern California, which resulted in the loss of intertidal habitat available to macroinvertebrates, and, therefore, the abundance of macroinvertebrates decreased (Dugan and Hubbard 2006, Dugan *et al.* 2008). The diversity and abundance of shorebirds on beaches was positively correlated with the diversity and abundance of macroinvertebrate prey, and since a decline in prey was observed, a decrease in foraging shorebirds, gulls, and other seabirds was also observed (Dugan and Hubbard 2006, Dugan *et al.* 2008). **These authors concluded that**

increasing coastal armoring accelerates beach erosion and increases ecological impacts to sandy beach communities.

Any hard structure placed in a coastal environment modifies physical processes there, and these changes will impact the species composition, abundance, and structure of invertebrate communities, and therefore birds that consume these prey will also be impacted. Hard-engineered structures are thought to be responsible for the loss of more than 80% of sandy beach shorelines globally (Brown and McLachlan 2002). Additionally, the placement of a terminal groin as called for in Alternatives 5 and 6, will result in the loss of the spit on the east end of Holden Beach. Although it's been stated above, it bears repeating that the modeling reported for Alternatives 5 and 6 indicate that a significant amount of sediment would be lost from the system, resulting in the loss of habitat, primarily low-energy shoals and sandbars which provide habitat for a variety of benthic invertebrates that are consumed by shorebirds and fishes.

Despite this, the DEIS preferred Alternative (6) and most other alternatives assert few impacts on infauna, and impacts that are acknowledged are marginalized: "Simultaneous losses of intertidal benthic infauna along both reaches may have minor adverse effects on surf zone fishes and shorebirds; however, such effects would be confined to the benthic community recovery period and would not carry over to subsequent nourishment events. Therefore, any spatially-crowded cumulative impacts on surf zone fishes and shorebirds under Alternative 1 would be short term and localized" (p. 5-36-37).

Every recovery or management plan that pertains to species of shorebirds that use the coast recognizes the importance of infaunal organisms and their habitats. These species include the Piping Plover (USFWS 1996a, 2001, 2003, 2009), Red Knot (USFWS 2013), Sanderling (Payne 2010), and Dunlin (Fernández *et al.* 2010).

Audubon North Carolina conducted an extensive review of literature regarding the impacts of hardened structures and beach fill activities with a focus on scientific, peer-reviewed articles. We found 43 peer-reviewed articles and included three reports regarding the impacts of renourishment on benthic organisms. Of these 46 documents, 34 (74%) found an impact to one or more species of benthic organism, 4 (9%) found no impact, and 8 (17%) were ambiguous or found equivocal results.

Of the peer-reviewed, scientific articles that found an impact to infaunal organisms, only two (Rakocinski *et al.* 1996, Burlas *et al.* 2001) are cited in the DEIS. Burlas *et al.* 2001 is a monitoring report written by the USACE and is not peer-reviewed. The results of Rakocinski *et al.* 1996, were not accurately reported by the DEIS because relevant findings were omitted. The authors studied the impacts of a beach and profile nourishment project on the Gulf coast of Florida for approximately two years following the initial beach fill event. The DEIS states, "Rakocinski et al. (1996) also reported relatively rapid recovery (≤1 year) of nearshore benthic communities following a beach nourishment project in FL (p. 5-29)." However, the DEIS does not mention that the same study also found that the dominant species of amphipod and a dominant species of polychaete had not recovered within that same time frame and that the amphipod did not recover until two years after the beach renourishment. Like the mole crab, amphipods and polychaetes are common shorebird prey items.

In its treatment of impacts to the infauna, the DEIS relies nearly exclusively on outdated literature that is generally not peer-reviewed, and it omits the many recent, peer-reviewed scientific papers that are available on the subject. Peterson and Bishop (2005) suggested that weaknesses in nourishment studies are due to studies being conducted by project advocates with no peer review process and the duration of monitoring being inadequate to characterize the fauna before and after nourishment. Thus, uncertainty surrounding biological impacts of nourishment can be attributed to the poor quality of monitoring studies, not an absence of impacts.

<u>Impacts on Sea Turtles</u>: Threatened loggerhead sea turtles (*Caretta caretta*) nest along the length of North Carolina's coast, including on Holden Beach and Oak Island. Information on the impacts of hard structures to sea turtles is extremely limited, but the few studies that exist found negative impacts to sea turtles. Lamont and Houser (2014) documented that loggerhead turtle nest site selection is dependent on nearshore characteristics, therefore any activity that alters the nearshore environment, such as the construction of groins or jetties, may impact loggerhead nest distribution. Loggerhead nesting activity decreased significantly in the presence of exposed pilings, and a 41% reduction in nesting occurred where pilings were present (Bouchard *et al.* 1998). In a study of the impact of coastal armoring structures on sea turtle nesting behavior, Mosier (1998) demonstrated that fewer turtles emerged onto beaches in front of seawalls than onto adjacent, non-walled beaches, and of those that did emerge in front of seawalls, more turtles returned to the water without nesting. Loggerhead sea turtle nests on North Carolina beaches increased in number as distance from hard structures including piers and terminal groins increased (Randall and Halls 2014). Studies in Florida have also found avoidance behavior and decreased hatching success associated with a managed inlet (Herren 1999).

Beach renourishment also negatively impacts loggerhead sea turtle nesting. Renourishment can cause beach compaction, which can decrease loggerhead nesting success, alter nest chamber geometry, and alter nest concealment, and nourishment can create escarpments, which can prevent turtles from reaching nesting areas (Crain *et al.* 1995). Nourishment can decrease survivorship of eggs and hatchlings by altering characteristics such as sand compaction, moisture content, and temperature of the sand (Leonard Ozan 2011), all of which are variables that can affect the proper development of eggs. The success of incubating eggs may be reduced when the sand grain size, density, shear resistance, color, gas diffusion rates, organic composition, and moisture content of the nourished sand is different from the natural beach sand (Nelson 1991). Negative impacts from beach renourishment include decreases in nesting activity and decreases in hatching success due to the use of incompatible material, sand compaction, and suboptimal beach profile (NMFS and USFWS 1991).

Sea turtles may be impacted by construction on beaches or dredge equipment, especially when work takes place outside the environmental window for sea turtles. During the spring and summertime construction phase of the Bald Head Island terminal groin, an adult female was trapped inside the construction zone for one day and a nest was destroyed when it was dug up by construction equipment (Sarah Finn pers. com. 2015). Pipeline and other obstructions placed on the beach may obstruct hatchling emergences or impede their path to the ocean (NMFS and

USFWS 1991). Hopper and cutterhead dredges may also kill sea turtles during dredge work (NMFS and USFWS 1991). The loggerhead sea turtle recovery plan emphasizes that the only beneficial impacts of nourishment are in cases where beaches are so highly eroded, there is “a complete absence of dry beach” (NMFS and USFWS 1991).

The DEIS does not address the impacts to sea turtles should beach renourishment intervals turn out to be similar to those at other North Carolina inlets with hardened structures, rather than at the four-year intervals it forecasts. Nesting activity on nourished beaches decreased for one to three years following a nourishment event due to changes in the sand compaction, escarpment, and beach profile (NMFS and USFWS 1991, Steinitz *et al.* 1998, Trindell *et al.* 1998, Rumbold 2001, Brock *et al.* 2009). The DEIS also does not address the impacts to sea turtle nesting should the east end of Holden Beach experience downdrift erosion that would narrow the beach west of the groin where nesting occurs. The loggerhead recovery plan does include these negative impacts: “In preventing normal sand transport, these structures accrete updrift beaches while causing accelerated beach erosion downdrift of the structures [groins and jetties] (Komar 1983, Pilkey *et al.* 1984, National Research Council 1987), a process that results in degradation of sea turtle nesting habitat” (NMFS and USFWS 1991).

Impacts on Fishes: Fishes would be negatively impacted by the construction of a terminal groin and the subsequent beach nourishment projects at Lockwood Folly Inlet in the following ways: 1) the groin would interrupt larval transport through the inlet, therefore impacting recruitment; 2) the native fish community would be replaced with a completely different structure-associated fish community; and 3) surf zone fishes would suffer from direct mortality. Hard structures reduce the successful passage of fish larvae from the open ocean to the estuarine nurseries they inhabit until reaching maturity (Hettler and Barker 1993, Pilkey *et al.* 1998). Inlets are critical pathways for adult fishes to get to offshore spawning sites and larvae immigrate through inlets to get to estuarine nurseries (Able *et al.* 2010).

Many surf zone fishes are larval and juvenile individuals that benefit from the shallow water nursery habitat because it provides refuge from predators and foraging areas (Layman 2000). Due to their early weak swimming ontogenetic stage, fish larvae are not adapted for high mobility in response to habitat burial or increased turbidity levels. Studies have shown that beach nourishment degrades the important swash-zone feeding habitat for both probing shorebirds and demersal surf fishes (Quammen 1982, Manning *et al.* 2013, VanDusen *et al.* 2014). Surf habitats with hardened structures typically support a different community of fishes and benthic prey. Impacted species would include Atlantic menhaden, striped anchovy, bay anchovy, rough silverside, Atlantic silverside, Florida pompano, spot, Gulf kingfish, and striped mullet. Florida pompano and Gulf kingfish use the surf zone almost exclusively as a juvenile nursery area and as juveniles, they are rarely found outside the surf zone (Hackney *et al.* 1996). The dominant benthic prey for pompano and kingfish were coquina clams (*Donax*) and mole crabs (*Emerita*). Despite the fact that fishes in the surf zone are adapted to a high energy environment, rapid changes in their habitat can still cause mortality and other negative impacts. **There are documented negative impacts of renourishment on some of the invertebrates (especially mole crabs and coquinas) that are major foods of the fishes (Reilly 1978, Baca *et al.* 1991); therefore, negative impacts could be indirectly transferred to the surf zone fish community.**

Manning *et al.* (2013) states:

> *Beach nourishment can degrade the intertidal and shallow subtidal foraging habitats for demersal surf fishes by three major processes: (1) inducing mass mortality of macrobenthic infaunal prey through rapid burial by up to 1 m or more of dredged fill materials; (2) modifying the sedimentology of these beach zones through filling with excessive proportions of coarse, often shelly sediments that are incompatible with habitat requirements of some important benthic invertebrates, such as beach bivalves; and (3) incorporating into the beach fill excessive quantities of fine sediments in silt and clay sizes, which can induce higher near-shore turbidity during periods of erosion as onshore winds or distant storms generate wave action, thereby inhibiting detection of prey by visually orienting fishes. The opinion repeated in many environmental impact statements and environmental assessments that marine benthic invertebrates of ocean beach habitats are well adapted to surviving the sediment deposition of beach nourishment because of evolutionary experience with frequent erosion and deposition events associated with intense storms and high waves is unsupportable. A recent review of the literature on impacts of storms on ocean-beach macrofauna (Harris et al. 2011) reveals that about half the studies report massive reductions of beach infaunal populations after storms.*

Conclusion: A unique ecological community exists at Lockwood Folly Inlet that is connected to the base of the food chain. The base of the food chain (infaunal community) requires 1-4 years to recover from a nourishment event, and that has not been the case at the East End beach. If the base of the food chain is absent or largely absent due to nourishment activities every two years, then the organisms that consume them, like birds and fishes, will not be present either. The DEIS fails to make this connection.

Alternatives 1, 3, 4, 5, and 6 as presented in the DEIS would negatively impact birds, as well as infauna, fishes, and sea turtles.

The DEIS omits the vast majority of the ample body of scientific literature that is available to describe the well-known and accepted physical impacts of terminal groins and beach fill. It then fails to accurately describe the direct, indirect, and cumulative impacts that these activities would have on biological resources within Lockwood Folly Inlet, particularly the Piping Plover. Instead, adverse impacts to Piping Plovers, Red Knots, and other bird species are largely dismissed or ignored. The best, most recent data and peer-reviewed literature available to assess those impacts are omitted or misrepresented, and the recommendations of multiple management and recovery plans, including USFWS recovery plans, are largely disregarded.

Alternatives 1, 3, 4, 5, and 6 as presented in the DEIS would jeopardize the recovery and/or persistence of the Great Lakes breeding population of Piping Plover, the Atlantic coast breeding population of Piping Plover, Seabeach Amaranth, and Red Knot; and a terminal groin would permanently eliminate habitats for these species listed under the Endangered Species Act without any chance of restoration or reformation in other areas. The alternatives in the DEIS that involve hard structures or channelization (Alternatives 4, 5, and 6) at Lockwood Folly Inlet should be permanently removed from further consideration and other alternatives should be considered.

Alternative 2, as presented in the DEIS, is the only alternative in the DEIS that can and should be considered. We urge the Corps to reject all other alternatives presented in the DEIS and consider non-destructive, long-term and economically feasible solutions for the Town of Holden Beach.

Thank you for the opportunity to comment on this important project. Please do not hesitate to contact me if you have questions or concerns.

Sincerely,

Walker Golder

Walker Golder
Deputy Director