Potential Environmental Problems from Building the Proposed North Carolina International Terminal:
Preliminary Report

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Background

The North Carolina State Ports Authority has indicated that it wishes to construct a new International Terminal (NCIT) for container vessels on a 600-plus acre site on the Cape Fear Estuary near Southport, next to the Brunswick Nuclear Power Plant and the intake canal that brings cooling water into that plant. This facility is expected to cost over $2.5 billion and is planned for commissioning in 2017. It is being designed to service vessels up to 1,260 ft. long and 185 beam (CH2M Hill 2008), with at least 250 such large vessels visiting the NCIT per year (CH2M Hill 2008). A feasibility study conducted for the N.C. Ports Authority estimated that the Port of Wilmington had shipping traffic of 150,000 TEU (twenty-foot equivalent units) throughput in 2008 (Moffatt & Nichol 2010). The NCIT is planned for 3,000,000 TEU (CH2M Hill 2008), thus, this would represent about a 20-fold increase in capacity for this river over 2008. The NCIT will require extensive road widening and potentially road building, as well as rail enhancement in Brunswick County to carry containers to and from the port. It has been estimated that over 4,400 truck trips per day will utilize about 20 miles of (yet-to-be-constructed) four-to-eight lane highway to service the NCIT (Moretto and Rohling 2008) and 10-15 trains a day will visit the NCIT (Ellert 2008)). The facility proper will require extensive use of impervious surfaces to cover the mixed farmland and forest that now covers most of the site, as well as destruction of the marshlands where the wharf structure will be built. Areas to service the ships, the turning basin, and a new channel will require dredging to 54.5 ft. deep and 500-600 ft. wide to accommodate the vessels (Gibson 2006; CH2M Hill 2008; Mozo 2008). The large amount of terrestrial and marine construction, the dredging, and the operation of the port will create extensive ecological and environmental damage, only some of which can be mitigated. This report provides an analysis of potential environmental problems that are likely to occur on land, in wetlands, and in the river and estuary should the NCIT be built. Mitigation, which is reduction of negative impacts on-site, and compensation, which is purchasing or providing similar habitat off site are feasible in some cases, while other problems generated by port construction or operation cannot be mitigated or compensated for. Opinions on the latter options will also be provided where appropriate.

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Impacts of Road Building and Expansion

In order to support the proposed NCIT a massive amount of infrastructure accessing the port will be required. It has been estimated that truck traffic to and from the facility would rise to approximately 4,407 truck trips per day (Moretto and Rohling 2008). Consultants have proposed four routes to the NCIT (Moretto and Rohling 2008), including following the present NC-87 to its intersection with US 17 (Route 1), another that basically follows NC-211 to US 17 (Route 2), another following the present NC-133 to its intersection with US 17 (Route 3), and another involving new road building and following secondary roads through forest and farmland near the Town of Half-Hell to US 17 (Route 4). A fifth potential route (called the Yellow Route) has also been suggested on a map prepared by Rummel, Klepper & Kahl, LLP (RK&K, FS-0803C) for the N.C. Department of Transportation. The Yellow Route represents a direct route south from planned 140 "skyway" to intersect with NC-133 near Boiling Springs Lake. This would be a constructed road passing though farms and wildlands including Town Creek. For any route, to accommodate this extensive large-vehicle traffic either the present road systems would have to be expanded (widened) or a new road would have to be built, or some combination of the above would have to occur. It has been recommended by consultants that at minimum the roadway would have to consist of four 12-foot lanes, with a potential of eight 12-foot lanes, including a 40 foot median strip (Moretto and Rohling 2008). At present, both NC-87 and NC-133 consist of two 12-foot lanes each, with no center median and about 18 feet of right-of-way along either side of the roads. Thus, expanding the present roads would involve increasing the amount of impervious surface by factors of at least two to potentially four times the present size. There would be additional road building to access the site itself from the main artery. Of course, construction of new roads would involve creating miles of impervious pavement where none existed before. Expansion of railways will also add to the disturbance.

Habitats and Wildlife

Unique and Specially-Designated Habitats Likely to be Impacted by Road Building

The North Carolina Natural Heritage Program lists several areas in the Cape Fear River basin as Significant Aquatic Habitat, which are bodies of water that contain significant aquatic resources such a high diversity of rare aquatic animal species (NCDENR 2005). Two such areas would be directly affected by the proposed port construction or operations. One is the Lower Cape Fear Aquatic Habitat, where manatees, shortnose sturgeon and the American alligator are found (this area will be dealt with subsequently in the report sections dealing with channel dredging and port operations). Inland there is the Town Creek Aquatic Habitat which contains several rare aquatic animals and plants (NCDENR 2005). This is a habitat that could likely be affected by road building or widening projects (Route 3 and the Yellow Route) to service the proposed port. Such impacts could force major disruptions to the native habitats.

By definition these are unique habitats, and thus one cannot truly mitigate or compensate for their loss or degradation that would occur during and after construction activities.

Threatened or Endangered Species Potentially Impacted by Road Building or Widening

Brunswick County is rich in terms of hosting listed species; i.e. Endangered Species, Threatened Species and Federal Species of Concern. The U.S. Fish and Wildlife Service lists three mammals, eight birds, eight reptiles, one amphibian, four fish, 10 invertebrate, and 30 plant species for this county alone (see Appendix A). While a few of the larger animal species are on the list because of past hunting or fishing pressure or chemical pollution, the majority of terrestrial-associated species are there because they have suffered from habitat destruction. Some species, especially certain plants, have narrow habitat requirements that are not found elsewhere. A massive road building or road widening project, along with the associated roadside development that will surely follow cannot help but impact or destroy some of these plant or animal habitats, and lead to local extirpation of listed species. For instance, as mentioned above, the North Carolina Natural Heritage Program lists Town Creek as a Significant Aquatic Habitat; this creek contains the only known population of the Federally-listed Greenfield ramshorn snail *Helisoma eucosmium* (NCDENR 2005). Two of the proposed road expansion sites (Route 3 and the Yellow Route) pass through this area and could impact the creek as detailed in the subsequent sections of this report.

Because the populations of listed species are so small, and often associated with unique habitats, one cannot mitigate or compensate for their loss or population decrease that would occur through construction activities

Impact of New Roadways on Wildlife and Natural Communities

Road Kill: As even the most casual of observers can see, numerous animals are killed on highways and secondary roads each year, with the majority of deaths occurring in migratory or reproductive seasons. Some studies of wildlife mortality on highways (road kill) have indicated that mortality was most related to increased vehicle speeds, while other studies found increased mortalities to be a function of increased traffic volume (Forman et al. 2003). A long-term study in Michigan showed that in the year after I75 was completed, deer mortalities increased 500% and remained at elevated numbers for years later (Reilly and Green 1974). Clearly, new or expanded four-to-eight lane highways are likely to lead to more collisions with deer and other wildlife in rural Brunswick County than the present smaller, lower-speed roads. Thus, ways must be found to mitigate road kill losses to native wildlife.

Connectivity and Diversity: Roadways, especially large roads, can divide wildlife areas and create habitat fragmentation which will lead to losses in wildlife diversity in the now-smaller wildland portions (Forman et al. 2003). This is not only true of wildlife, but plant communities and birds as well. Connectivity is important as it allows for continued reproductive success and genetic diversity of the various native species that populate an ecosystem. Thus, in addition to reducing road kill, ways must be found to increase wildland connectivity to reduce habitat fragmentation.

There are a number of ways to mitigate the loss of wildlife due to highway collisions, mainly in the form of designing crossing areas (summarized in Forman et al. 2003). These can often serve the function of permitting wildlife to cross in safety while in some cases providing habitat connectivity and diversity as well. In a few U.S. areas wildlife overpasses have been created, which provide safe crossings for large and small animals and enhance forest connectivity. For larger local fauna such as deer, enhanced underpasses, especially at stream and marsh bridges will help mitigate the problem. For small mammals and amphibians tunnels under the highway, along with fencing to guide the animals to the tunnels, has been successful. It should be noted that small wildlife frequently utilize other structures to cross highways (such as storm drains and utilities tunnels) and such features can be enhanced to provide wildlife usage as well (Forman et al. 2003). Pertinent to the above discussion, culvert design is important. Researchers have found that large openings with a wide bottom are best for wildlife, as opposed to circular or oval designs (Forman et al. 2003).

Other Issues: Creating new roadways provides a path for non-native terrestrial species to spread along and impact the native vegetation (Forman et al. 2003). One need only look at the spread of kudzu *Pueraria thumbergiana* along North Carolina roadways to see this in action. It has also been hypothesized that the rapid spread of coyotes across the U.S. from west to east was enhanced by the interstate highway system. Another problem will occur because the addition of over 4,400 truck trips per day through the rural Brunswick County countryside will greatly increase traffic noise along the corridor. A number of studies (cited in Forman et al. 2003) found that increased traffic noise was related to decreased bird densities and number of species for several hundred meters back from the road.
Mitigating for the above would be very difficult; to reduce non-native plant species proliferation herbicides would need to be used, creating other problems. Mitigating truck noise would require either solid sound barriers (which fragments habitats and reduces ecosystem connectivity) or making denser forests along roads.

<u>Road Building and Use Degrades Air Quality</u>
Road construction creates massive amounts of dust, as even the casual observer can see. In addition, general use of roads by traffic creates dust on a chronic basis. Dust itself is an irritant to the lungs of humans and other animals, and dust particles accumulate other pollutants that are then carried where the dust goes. Cars and trucks also emit pollutants via their exhaust systems. Such pollutants can adversely affect human health, especially individuals with pulmonary impairments, and may possibly affect wildlife as well. The large increase n truck traffic will have to lead to increased air quality degradation.
Reduction of dust during construction can be at least partially mitigated by wetting of surfaces to reduce dust formation, and through spreading of mulch on areas that adjoin the roadbed proper. Exhaust from vehicles is of course ultimately regulated by Federal EPA standards, which improve over time. However, their will be an immediate and inevitable increase in air pollution in this rural area simply by the increase in traffic.

Aquatic Impacts and Water Pollution

Brunswick County, especially near the Cape Fear River, is rich in aquatic habitats. There are abundant wetlands, including isolated freshwater wetlands, freshwater tidal marshes and salt marshes. There are both large and small creeks; for instance, along

NC-133 from the exit corridor from the proposed NCIT to US17 (proposed Route 3) there are at least six small creeks and five large creeks, the latter including Lilliput Creek, Sand Hill Creek, Town Creek, Mallory Creek and Jackey's Creek. Severe impacts to such aquatic resources are likely to occur as a result of such massive construction activity.

Road Construction Impacts to Aquatic Habitats

Fresh and brackish wetlands are well-known as natural filters for pollutants. This function is performed by a variety of means. When running water (stream, river or tidal-driven) enters a wetland area, the flow slows down. This slowing is caused by baffling of the current by emergent and submersed vegetation. As water movement slows, particles precipitate to the bottom (fall out of the water column) with heavier particles falling out first. As discussed in detail subsequently, suspended sediments have a direct negative impact on wildlife, plus they are often physically associated with pollutants, so this precipitation from the water is a good thing. The particles become part of the wetland sediments. Wetlands also clean the water of nutrients. Vascular plants and algae take up nitrogen and phosphorus directly and convert it into wetland plant material. Additionally, the natural bacteria residing in the wetland also utilize these nutrients. Wetland plants and soils also harbor bacteria that are denitrifiers, which mean they convert inorganic nitrogen into N2 gas (in the presence of carbon and areas of low dissolved oxygen), rendering it unavailable to algae and removing from the system. This is the principal means of wetland nitrogen removal (Weisner et al. 1994). Wetlands also remove fecal bacteria and other microbes from contaminated water (Vymazal 2005). This removal is through settling along with the associated suspended solids, consumption by protozoans and other microfauna in the wetland, and deactivation of fecal microbes by solar irradiance, which is UV destruction (Vymazal 2005). Wetland soils and some wetland plants also take up heavy metals and other pollutants that are in the overlying water, with organic-rich soils more effective than sandy, less organic sediments (Pond 1995). When a variety of plant species are present in the wetland, pollutant removal is more efficient because there are more surfaces to adsorb the pollutants and more sites for bacteria to process pollutants, and likewise more sites for predators of fecal bacteria to utilize (Gerba et al. 1999). Thus, pollutant removal is a key wetland function and some economists have actually quantified this function in dollar terms as "ecosystem services" (Costanza et al. 1998).

In contrast to wetlands, roadways are impervious surfaces, meaning rainfall cannot percolate through the road material (concrete or asphalt). The construction of new roads will convert natural groundscapes that support vegetation and infiltrate water to solid surfaces that will deflect rain and cause it to run off the surface as stormwater runoff (Figure 1). As mentioned above, if built to suggested specifications (Moretto and Rohling 2008), this would entail a minimum 48 feet wide surface for driving, a 40 foot median that may or may not be paved, as well as some amount of impervious surface as part of the right-of-way, with this roadway being somewhere between 13 and 22 miles in length.


Figure 1 (left) Stormwater inputs to Smith Creek, New Hanover County, N.C..
Figure 2 (right) Debris from clearcut along blackwater stream in Pender County, N.C.

Road construction can create major changes in an area's hydrology. First, cutting and removing of trees (Figure 2) will eliminated their water removal service of evapotranspiration, in essence producing more flood water and stormwater runoff. Roads that are then constructed intercept surface streamflow and subsurface (groundwater) flows and reroutes the water into roadside ditches. The ditches then carry the water into streams that did not originally receive the water. In Brunswick County in the area in question, those water bodies include tidal creeks, marshes, and ponds. This can physically fragment natural habitats, reduce groundwater recharge in a given area by channeling rainwater elsewhere as stormwater runoff, and alter existing surface water bodies hydrologically or ecologically through increased stormwater inputs. Stormwater inputs from roadside ditches often carry elevated concentrations of suspended sediments (Figure 1), organic debris (Figure 2), nitrogen and phosphorus, fecal bacteria, heavy metals and organic chemicals into receiving surface waters (Wu et al. 1998; Forman et al. 2003; Davidson et al. 2010).

Road construction has well-known impacts to nearby aquatic habitats (Waters 1995). As mentioned, the first process that would be carried out is clearcutting of extensive forested areas near streams and creeks, which has been shown to have major negative impacts to aquatic communities. When large amounts of organic material enter a stream en masse following a clearcut, low dissolved oxygen is likely to result from the sudden increase in biochemical oxygen demand (BOD) load (Figure 2). In a Coastal Plain stream in the Cape Fear River watershed, similar to the Brunswick County area in question, Ensign and Mallin (2001) found that a clearcut severely impacted a blackwater stream, even with a 30 ft. buffer left. The stormwater runoff from the clearcut led to significant increases in turbidity, fecal bacteria, nitrogen and phosphorus, and caused stimulation of blue-green algal blooms, with subsequent large periodic drops in dissolved oxygen over a two year period. Tree removal itself has severe consequences for aquatic habitats. Trees provide shade and cool stream waters in summer, during autumn leaf fall they provide small particulate organic material that serves as food to aquatic organisms, and periodically they provide stream habitat in the form of larger woody parts (branches that are called snags) as substrata for algae, microbes, benthic invertebrates and fish (Forman et al. 2003).

Stream crossings are areas where some of the most severe impacts of road construction are seen (Waters 1995). In Brunswick County this would include fresh and salt marshes. One of the most visible impacts to aquatic bodies from clearcutting and construction is displacement (during rainstorms) of terrestrial soils into the water. This is essentially dirt washed into the water bodies from any type of construction disturbance including tree removal, other vegetation removal, and earth moving. Inorganic and organic particles that comprise this dirt are termed *suspended sediments* when they enter water bodies. Suspended sediments are measured gravimetrically as total suspended solids (TSS) as mg/L using standard water analysis methods. There are no water quality standards for TSS in North Carolina for ambient waters. However, based on numerous samples in this region the UNCW Aquatic Ecology Laboratory considers levels of 25 mg/L and higher as elevated TSS. Organic and inorganic particles also create cloudiness in the water column that in called *turbidity*. Turbidity is measured by a process called nephelometry, which is based on the reflectance of a beam of light shot through a sample of water. The State of North Carolina has legal standards for turbidity of 50 Nephelometric turbidity units (NTUs) in freshwater and 25 (NTUs) in brackish water. The type of suspended sediment and turbidity impacts to streams (non-tidal, freshwater systems) and creeks (tidal, fresh-to-brackish-to saline systems) will vary by site depending upon the prevailing soils. Heavier particles will sink to the bottom rather quickly and coat the bottom, covering the native microscopic and macroscopic vegetation and sessile animals associated with it. Lighter particles will remain suspended for possibly long periods and create substantial turbidity levels.

Impacts of suspended sediments and turbidity to freshwater and marine systems are many and varied and include the following:

- Interference with shellfish filter feeding; shellfish are filter feeders and obtain their nutrition by filtering large amounts of water to obtain foods such as microscopic algae. Suspended materials, particularly inorganic “dirt” can clog gills, cause them to reject large amounts of particulates (called psuedofeces) and spend way too much energy in feeding to survive (Rothschild et al. 1994).
- Impedence to sight-feeding finfish; it has been demonstrated experimentally that increasing turbidity will lower the feeding rates for sight feeding fish such as bluegill (Gardner 1981) as well as with zooplankton (Kirk 1991) which are the prey items for most species of larval and juvenile fish.
- Reduction of rooted aquatic plant photosynthesis and loss of submersed aquatic vegetation (SAV) beds. Beds of SAV are well known to be excellent habitat for both freshwater and estuarine fishes (Dennison et al. 1993). Turbidity reduces available sunlight passing through the water column (called solar irradiance) and reduces photosynthesis. High turbidity, as well as anthropogenic nutrient loading can cause massive loss of SAV beds such as what occurred in Chesapeake Bay (Dennison et al. 1993).
- Changing of the natural bottom habitat by coating sediments with dirt and organic particles. In fresh water, brackish water and marine systems the bottom

declines along with increasing percentage of finer sediments as opposed to larger grain sizes (Cahoon et al. 1999) – implication – erosion of fine sediments into streams, rivers and estuaries may lead to lower benthic microalgal biomass, and less food for the invertebrates and fish that consume this food source.

- In estuarine waters including the Cape Fear River system some aquatic organisms, including highly economically valuable shellfish like oysters, require solid surfaces to settle and grow on. Large inputs of suspended sediments (such as from major construction projects) can smother the scant available oyster reef habitat. Oyster reefs not only provide habitat for oysters to grow on, but also provide habitat for many estuarine species to feed and hide within/on. In the New Hanover County tidal creek system UNCW researchers Dr. Martin Posey and Troy Alphin found relict oysters and clam shells in upper tidal creek areas, indicating that they once existed in those habitats but are now gone. Increased siltation of the bottom habitat caused by upstream development and subsequent erosion of terrestrial soils was posed as a likely explanation for this loss.
- Suspended sediment particles accumulate fecal coliform bacteria, phosphate, ammonium, and other pollutants and transport them downstream into shellfishing waters and recreational waters. Published papers from the lower Cape Fear area and other areas have shown strong correlations between pollutants such as fecal bacteria, phosphate, and BOD with turbidity and/or suspended sediments (Mallin et al. 2002; Mallin et al. 2009).

Mitigation of erosion caused by stormwater runoff is accomplished by use of mulch during and soon after construction; this will deflect the force of the rain's energy as well as absorb water. Vegetated buffer strips that are rapidly established post-construction can be effective at significantly reducing runoff of suspended sediments as well as other pollutants (Forman et al. 2003). Vegetation cover has numerous benefits, including dissipation of rainfall energy to reduce erosion, reducing runoff velocity by baffling, providing structural integrity to the soil through root systems, filtering pollution from runoff, increasing water infiltration into soil and increasing evapotranspiration of rainfall and runoff (Forman et al. 2003). There are many types of structural methods to mitigate runoff from roads and road building, some less effective than others. Check dams, diversion structures, straw bales, and silt fences are commonly seen. In Wilmington, this author has seen examples of the latter clearly failing (Figure 3).

Figure 3. Failing sediment fences in New Hanover County, N.C.

As mentioned, the amount of impervious surface area along the road sites would increase by a minimum of fourfold-to-eightfold. This will concentrate pollutants and lead to increased stormwater runoff pollution of nearby creeks, swamps, marshes and potentially the upper aquifer.

<u>Runoff of Pollutants from Impervious Surfaces into the Nearest Water Body</u>
Rainfall striking a roadway will wash accumulated materials, including pollutants, into roadside ditches as stormwater runoff. What are some of the most common pollutants that come from road use and what are they generated by? Chemicals on roads originate from roadway construction material, car and truck emissions, fluids, vehicle parts and tire wear and application of chemicals to roads and roadsides. Included are oil, grease, hydraulic fluids, metals plating and rust (Forman et al. 2003). Some breakdown products include monocyclic aromatic hydrocarbons and polycyclic aromatic hydrocarbons (PAHs); the latter are known to be toxic to aquatic life. High concentrations of suspended solids are also produced from highways (Wu et al. 1998) and can impact nearby aquatic communities as outlined above. The various pollutants leave a chronic legacy; for instance, strong gradients of heavy metals are found outward up to 100 meters from roadways in soil, air and plants (Forman et al. 2003). Additionally, chemical spills occur on highways. While such spills are rare for a given area, when they occur they can cause severe pollution damage to terrestrial and aquatic communities. In addition to PAHs, metals, pesticides, herbicides, and various other organic compounds can accumulate in receiving streams, lakes, marshes and ponds and become toxic to aquatic life (USEPA 2000; MacDonald et al. 2000).

Eutrophication is a set of processes that degrade water bodies, caused by loading of excessive amounts of nutrients (nitrogen and phosphorus) into lakes, rivers, streams, ponds and marshes. The nutrient loading stimulates algal blooms, which can be toxic or noxious, and excessive algal growths that create loads of organic material that die, decompose, and lead to decreases in dissolved oxygen. The organic material produced is referred to as biochemical oxygen demand (BOD) which also can be created by direct stimulation of bacterial growth by excessive nutrients. These various processes can lead to fish kills and invertebrate kills, aesthetic problems, and taste and odor problems in drinking water supplies.

Pertinent to the eutrophication of nearby lakes, creeks and marshes is the high amount of nitrogen that comes from road runoff. Nitrogen (N) in vehicle exhaust is emitted as nitric oxide, nitrogen dioxide, nitrous acid and ammonium. A study of roads in Cape Cod estimated that that 10 kg of dissolved nitrogen were produced annually per hectare of roadway in stormwater runoff (Davidson et al. 2010). The authors of that study noted that this nitrogen impacts the sensitive coastal waters around Cape Cod. Mallin et al. (1999) found that in summer nitrogen stimulates the growth of algae in the lower Cape Fear Estuary. In the proposed NCIT area the large amounts of nitrogen, and other pollutants, will run off the new and expanded roads during rain events into highway ditches and then into the creeks and marshes that feed the Cape Fear to cause algal blooms and other problems. Along with these vehicle-produced pollutants are any airborne pollutants that happen to become deposited on the road. In a natural area nutrients and other pollutants are adsorbed or absorbed and processed by vegetation, soil and the resident bacteria within soils. However, they become concentrated on impervious surfaces, are then carried off the surfaces in a rainstorm, enter streamside ditches and are carried into creeks and streams. There these nutrients and other pollutants disrupt the natural stream communities as outlined above.

Mitigation of pollutant-containing runoff can be accomplished by the use of constructed wetlands. Natural wetlands are not normally permitted to be used as wastewater disposal areas, but constructed wetlands have proven to be very useful in the treatment of stormwater runoff (Weisner et al. 1994; Vymazal 2005; Mallin et al. 2010). However, the effectiveness of constructed wetlands will be proportionate to its design parameters, i.e. appropriate size is needed, as well as forebays for TSS settling, a diverse array of aquatic plant species, and sufficient retention time are all needed (Mallin et al. 2010). In order to mitigate for road runoff, one tactic would be to construct a series of treatment wetlands that would intercept ditch-borne runoff before it can enter creeks, ponds or marshes. When space is insufficient for a wetland, bioretention areas can be created. This is a mix of vegetation plus various substrate layers (mulch and sand) that can be effective in removing pollutants from runoff. These systems may not be effective in removing nitrogen through denitrification, but can be specifically engineered to do so (Lim et al. 2003). Some such systems are visible along highways in various areas of the U.S. Additionally, there various types of sand filtration systems (mostly proprietary) and installed filtration units that are effective, although may be expensive.

Note: Construction of new highways or expansion of old roadways will certainly lead to requests for developers to build new exits/accesses to the road and open up present wildlands to construction. The roads will have a “multiplier” effect on new development Such development along new road corridors (including new housing, shopping areas, and industrial parks) will destroy more habitat, displace biota, create pollution, and require septic systems in rural areas. This will greatly magnify the pollution from the roadways proper, as well as lead to loss of much more wildlife habitat.

Environmental Impacts of Site Clearing and Port Construction

Site construction, both terrestrial and marine, will involve numerous processes that have been known to cause environmental damage. The natural ground cover is removed, and replaced with asphalt or concrete. This has numerous hydrological and ecological repercussions, some of which are explained below. Construction work with heavy machinery causes massive amounts of dust pollution (see above), and air pollution from exhaust from the machinery and trucks. An additional major issue would be the loss of wetlands on site (i.e. the conversion of wetlands to other uses, such as parking areas and buildings). Along shore the natural brackish wetland marshes would be removed and replaced with dock structures which not only removes habitat but leads to erosion upstream and downstream. Of the 600 acres, about 400 will be covered by impervious surface of some kind (Benson and Bowles 2008), interfering with natural percolation and accumulating pollutants. Other impacts include increased water pollution, and increased local temperatures in summer due to the "heat island" effect that the concrete and asphalt will produce (in the absence of trees).

<u>Conversion of Natural Site Soils to Impervious Surface</u>
When rain hits the ground it has one of three fates. It can percolate into the ground, where it enters the upper aquifer (called groundwater recharge) and in some cases eventually enters a deeper aquifer. It is also taken up by vegetation, and eventually transpired back into the atmosphere. It can also be evaporated during periods of warm weather- the two latter processes are often considered under the blanket term evapotranspiration. If soils are water logged then whatever is not evapotranspired becomes surface runoff, usually termed stormwater runoff where pollutants are concerned. The NCIT will convert 400 acres of natural ground, including the trees, to impervious pavement. This conversion will remove the transpiration function of the vegetation and the infiltration function of the natural groundscape, converting all rain that lands there into surface runoff, reducing groundwater recharge (Klein 1979). Areas covered by impervious surfaces normally utilize storm drains to remove surface water from the site. With a storm drain system in place, water that would normally be infiltrated in place is conveyed elsewhere to surface water bodies, like wet detention ponds (or into streams or estuaries). On a large enough scale this can reduce the base flow of natural stream systems. For instance, on Long Island researchers found that the base flow of streams in an urbanized, sewered area was reduced 80% from normal, while base flow of streams in a control undeveloped area were not reduced (Simmons and Reynolds 1982).

The NCIT will thus be required to treat (on site) the first 1.5 inches of rainfall from the 400 acre impervious area. The consultants have estimated that their planned procedures would actually treat 4.5 inches of rainfall (Benson and Bowles 2008). The primary planned treatment mechanism appears to be a wet detention pond in the northeast corner of the lot to achieve 90% removal of TSS (CH2M Hill 2008). A separate document (Benson and Bowles 2008) indicates that the perimeter could be used for stormwater treatment as an infiltration trench, depending upon height of the

seasonal groundwater table. That document also makes note of potential use of underground exfiltration chambers to provide additional storage.
Wet detention ponds are one of the most common treatment devices and work very well for suspended solids. However, their efficacy for fecal bacterial removal and nutrient removal is equivocal at best. I would recommend the use of a constructed wetland to further treat the water as it exits the pond before it reaches natural waters. Such wetlands have high nutrient and fecal bacteria removal efficacy (see previous discussion in Road Construction Impacts to Aquatic Habitats for more on this). As the consultants correctly note, the perimeter infiltration trench may not be appropriate with an elevated groundwater table, as State law requires a two-foot unsaturated layer of soil below the trench and above the groundwater table. In some borings the seasonal groundwater table was encountered at seven feet (CH2M Hill 2008). Thus, further borings will be required to determine that the seasonal water table does not rise above seven feet below surface in order for the trenches to be effective. The use of underground exfiltration chambers can be an effective means to control stormwater in some curcumstances.

Loss of On-Site Wetlands

Wetland Removal Reduces Pollutant Filtration: As discussed earlier regarding road construction and wetland loss, natural wetlands play an important function in the removal of suspended sediments, nitrogen and phosphorus, and chemical pollutants from land-generated activities. On-site wetlands are also critical in regulating the hydrology of a given area – they serve as areas of groundwater recharge as opposed to impervious areas that generate stormwater runoff.
As mentioned above, constructed wetlands are presently not planned for the site. Rather, a wet detention pond and possibly infiltration trenches and/or exfiltration chambers are. I recommend that constructed wetlands be utilized if possible for the multiple benefits that can be gained.

Wetlands Removal Loses On-Site Wildlife Habitat: Wetlands are key habitats for a huge variety of organisms. Wetlands serve as roosting spots for birds, and nesting areas and foraging areas for many species including endangered species such as alligators, they provide water for drinking to numerous animals both resident and visiting, and serve as spawning or nursery areas for numerous species of fish and shellfish (see below). The inaccessibility of wetlands to casual human visitors enhances their function as areas where rare and protected species can thrive without interference. Snow's Marsh lies adjacent to the proposed NCIT site and is a well-studied wetland and wildlife habitat (Cammen et al. 1982).
There is little available on-site mitigation for this loss of animal habitat. Since the habitat is wetland, there would be compensation elsewhere at a rate of two acres for one lost; preferably the compensation would be in the same watershed. Constructed wetlands may mitigate in part, but they would be freshwater and thus not useful in the propagation of the salt water organisms in the estuary. Additionally, constructed wetlands would obviously concentrate pollutants generated on site which may adversely impact the animals themselves or their predators.

Displacement of Natural Animal Communities:

The construction of such a massive port complex will displace large number of animals, including birds, mammals, reptiles and amphibians. Bird habitat on the site will be converted from supporting a natural community of seed eaters, wading birds, aerial searching birds and probing shorebirds to a community of scavenging birds, primarily gulls. Mammals that currently live on-site are able to utilize several habitats; i.e. they have access to the river, wooded areas, farmed fields and old fields. This allows for high diversity and ready access to food resources as well as cover. The conversion of the site to the NCIT removes all such habitat and river access, although there are likely to be rats and other scavengers utilizing the site for human leavings. Reptile and amphibian communities will be reduced to whatever species find refuge in the wet detention pond scheduled to be built to capture stormwater runoff from the site (note that such ponds will contain large concentrations of pollutants including PAHs – bad for wildlife).

There is no on-site mitigation for this loss of animal habitat. Unless the habitat is wetland, there would also be no compensation elsewhere.

Impacts of Conversion of Riparian Habitat to Bulkheading:

The natural shoreline is also called a riparian zone, and is a transition between terrestrial upland habitats and the water itself. It generally consists of a sloping surface which may or may not contain rooted aquatic or terrestrial plants, variably inundated either according to local tides if present, or stream height changes according to upstream rainfall. The plant community of the shoreline area includes benthic microalgae, periphyton on living and non-living surfaces, and macroalgae in addition to vascular plants. All of these primary producers are food organisms for grazers including zooplankton, snails, aquatic worms, insect larvae, crabs and other crustaceans and fish. Rocks, tree roots, as well as tree debris (snags) in the shallows provide substrata for attached organisms and places of concealment for fish and other organisms. Birds utilize shoreline areas for hunting and scavenging, and mammals do likewise. When a shoreline area is bulkheaded for a structure such as a port facility, most of the natural functions of the shoreline are lost for good. A complex habitat becomes a one-dimensional surface that may support some fouling organisms but little else in the way of a community. Research has demonstrated that the nearshore waters of bulkheaded areas contain significantly lower abundance and species richness of fishes compared with natural shoreline areas or rip-rap shorelines (Waters and Thomas 2001, Street et al. 2004). Approximately 4,600 ft. of shoreline will be bulkheaded, according to consultant's plans for the proposed NCIT (Sanford and Holland 2008), thus losing the riparian capacity as outlined above. Additionally, the wharf structure will extend out approximately 125 ft. over the water (Mozo 2008), shading out any SAV or benthic microalgae in the area and losing that food and habitat resource.

The proposed bulkheading represents a permanent loss of shoreline habitat and one cannot mitigate on-site for this loss. To compensate elsewhere one can perhaps create artificial reefs in the estuary or offshore as shellfish habitat, fish attractant or fisheries enhancement devices. The use of riprap to stabilize shorelines is a better alternative but obviously cannot be used in this situation.

Potential for Increases in Downstream and Upstream Erosion:

Armoring a shoreline, which is converting the natural shoreline to a solid surface such as concrete (or in the case of the proposed NCIT – steel), deflects the energy of waves, tidal and downstream currents. However, it diverts that energy to unarmored shoreline areas down-current from the structure, causing erosion (Pilkey 2003). This is why North Carolina coastal regulations were designed to prevent the permanent armoring of coastal shores (i.e. beaches). Extreme cases of this down-current erosion are seen especially in Maryland along Assateague Island (Pilkey 2003). This type of erosion is also highly visible nearby along Snow's Cut, where areas on either side of the bridge abutment are severely eroded by tidal currents (Figure 4). Plans call for 4,600 ft. of shoreline to be armored with steel (Mozo 2008); thus natural areas upstream of it (Snow's Marsh) as well as the intake canal for the Brunswick Nuclear Power Plant, as well as the downstream ADM property are likely to be impacted by increased erosion. There is no on-site means of stopping erosion caused by armoring a shoreline. This has been clearly seen in numerous beach areas. If adjacent property owners do not armor their own neighboring waterfront areas, their property becomes eroded.

Figure 4. Severe upstream and downstream erosion and bank undercutting of riparian shoreline caused by rerouting of tidal energy away from bridge abutment armored by concrete, Snow's Cut in the Cape Fear River system, N.C.

Impacts of Channel Dredging on the Estuarine Environment

Extensive dredging will be required for 1) port facilities, 2) turning basin, and 3) the ship channel. Consultants for the Port Authority have estimated that 59,710,000 cubic yards of material will need to be dredged (Gibson 2006). The U.S. Army Corps of Engineers (2010) has estimated that dredging will lead to a loss of 13 acres of tidal marsh and 202 acres of shallow (< 10 feet deep) water habitat, and another 442 acres of deep water (> 10 feet deep) habitat will be impacted. Since there is a rock layer varying by location from 36 to 46 ft. deep MLLW (Gibson 2006), there will undoubtedly be blasting utilized as it has been previously in channel deepening on the Cape Fear Estuary (USACOE 2000). Dredging involves creation of large quantities of suspended sediments (TSS) which cause turbidity, measured as NTUs (see above discussion in Road Construction Impacts to Aquatic Habitats). Dredging also destroys aquatic animal and plant habitat in shallow water and marshes. Furthermore, dredging may increase erosion along nearby shores (such as Bald Head Island) and blasting could impact the aquifer in the area by leading to salt water intrusion (USACE 2010).

Impacts of Turbidity and Suspended Sediments on the Aquatic Environment

Impacts on the Ecosystem and Flora and Fauna: Turbidity is known to have a number of deleterious impacts to the environment. As mentioned, these include reduced feeding success for visual feeding fish and zooplankton (Gardner 1981; Kirk 1991) and reduced SAV growth (Dennison et al. 1993) and benthic microalgal growth (Mallin et al. 2005) by blocking light for photosynthesis. Additionally, pollutants become physically and chemically associated with particles causing turbidity and can be carried downstream (Mallin et al. 2009). Increased suspended sediments in the water column can impact oysters in several ways, including 1) reducing gill function and metabolic efficiency, 2) reproducing growth and reproductive efficiency, 3) increasing mortality and disease susceptibility, and 4) reducing the usable habitat for spat settlement (from Rothschild et al. 1994 and sources cited within). In the Cape Fear Estuary turbidity concentrations have been documented to increase near dredging operations, indicating that even the upper water column becomes impacted by bottom dredging (Mallin et al. 1999). Massive scale dredging such as what will be required for the port, turning basin and ship channel will greatly increase water column turbidity in the estuary. As such, negative impacts to benthic organisms and fish will occur.

The large amounts of TSS and turbidity will undoubtedly be carried by incoming tidal currents into Walden Creek, which enters Snow's Marsh just upstream of the NCIT site. Walden Creek has been designated a Primary Nursery Area (PNA) by the State of North Carolina (see 15A NCAC 03R.0103, PRIMARY NURSERY AREAS). Primary Nursery Areas are generally found in upper creek habitats with abundant marsh vegetation, and provide excellent habitat for young fish of numerous species as areas in which to feed and grow. Because these are sensitive habitats, some fishing gears and certain development activities are restricted in such designated waters. Incoming tides during construction dredging (or maintenance dredging) will very likely bring large amounts of suspended sediments into the PNA, impacting fish and shellfish health and feeding, and reducing the growth of periphyton.

Impacts on a Nearby Nuclear Power Plant: The intake canal to the Brunswick Steam Electric Plant, a nuclear-powered facility, brings cooling water from the river to the reactors in the plant. Progress Energy operates this plant, which was built in the 1970s when the company was the Carolina Power & Light Company. In the 1970s and 1980s much fisheries research and mitigation work was performed by CP&L biologists and contract scientists from many universities on the wildlife of Snow's Marsh and the Cape Fear estuary. The company has a set of travelling screens and other devices to remove fish and invertebrates back to the marsh, and screens to keep debris out of the cooling water. The large amounts of suspended sediments produced by nearby dredging will likely increase cooling water treatment costs and may cause infilling of the intake canal.

Impact of Dredging on Fecal Bacteria Concentrations: Fecal bacteria from stormwater runoff, leaking septic systems and wastewater discharges that enter water bodies are often carried to the bottom sediments along with sedimenting suspended solids. Channel dredging has long been known to increase the abundance of fecal bacteria in the water column by displacing them from the bottom and bringing them to the surface, and separating them from the inorganic particles that they have been adhering to (Grimes 1975). Upstream of the NCIT site shellfishing waters are closed. Downstream of the proposed NCIT site are significant areas of open shellfishing waters, listed by N.C. Shellfish Sanitation as Areas B2 and B4 (see NCDEHNR website: http://www.deh.enr.state.nc.us/shellfish/maps.htm). During the extended construction period, the increases in fecal bacteria counts from dredging will very likely lead to additional closures of shellfishing beds to harvest, creating an economic burden on the commercial fishermen who utilize the lower Cape Fear for harvest.
Creation of large amounts of TSS and turbidity by dredging is impossible to mitigate on a large scale in a tidal system. Dredging in a small area can be mitigated by the use of screens for short periods. Dredging on the outgoing tide will reduce inputs of TSS into Snow's Marsh, but will spread fecal bacteria downstream into shellfishing waters. Channel maintenance dredging currently is done with some seasonal restrictions to avoid disrupting marine migrations or reproductive cycles, but it is doubtful that such care will be observed during such a vast construction project.

Blasting Impacts on Fish Including Endangered Sturgeon

Blasting has been used to deepen the ship channel previously when it was dredged to 42 feet. The Cape Fear River and estuary is host to the Federally-Endangered shortnose sturgeon, as well as the Atlantic sturgeon, currently being considered for listing (Figure 5). In 1998 and 1999 there were a number of studies performed to examine the impact of blasting on native species, including striped bass, mullet and the shortnose sturgeon (Moser 1999). Caged fish were located 35, 70, 140 and 280 feet from the test blast areas to study the impact on the fish. In some tests an experimental air bubble curtain was used to mitigate in the hope of lessening blast effects outside of the area (USACOE 2000). The test results (Moser 1999) showed that mortality of the caged fish was highest in the 35 foot location (26% with no curtain and 28% with the air curtain), next highest at the 70 foot location (24% with no curtain and 7% with air curtain) and less at 140 feet (2% with no curtain and 6 % with the air curtain). Thus, the

air curtain did not successfully reduce fish death from blasting. Mortalities were highest among striped bass, second among mullet, and least among sturgeon, probably due to the larger size of the sturgeon. The types of injuries commonly seen on the fish were loss of equilibrium, distended swim bladder and hemorrhaging (Moser 1999). The air bubble curtains were deemed not effective in those previous analyses, and physical barriers were deemed impractical (USACOE 2000).
Fish near the blasting will suffer mortalities in accordance with proximity to blast. As mentioned, air curtains are not effective in mitigating blast effects. Removing nearby fish by utilizing channel nets near the blast site just prior to blasting and removing the fish to other areas may have some mitigative success, as well as use of scare charges and limiting blast pressure of the actual charges (Moser 1999; USACOE 2000).

Figure 5. Top - Shortnose sturgeon (*Acipenser brevirostrum*), a Federally-Endangered Species native to the Cape Fear River system. Bottom - Atlantic sturgeon (*Acipenser oxyrinchus*) is currently being considered for endangered species listing by NOAA, and is also native to the Cape Fear system.

Impacts of Dredging on Shoreline Communities and Stability

In order to accommodate the newer, larger container vessels the channel, currently at 42 feet, will require dredging to >52.5 feet and widening to 500 or 600 ft (Gibson 2006; Ringwater Associates 2010). This will have major physical and biological impacts to upstream areas of the CFR estuary as well the lower river. An analysis by Hackney and Yelverton (1990) showed that dredging the estuary to allow larger vessels upstream over time has had led to a high tide elevation increase of >26 cm, which allowed higher salinity water to penetrate farther upstream. This has caused former rice paddies (which require fresh water) to be abandoned and a change from swamp forest to oligohaline/brackish marsh to occur in a number of locations. This is clearly visible as dead cypress trees especially around Motts and Barnards Creeks. Additionally, the increased salinity causes increases in sulfate reduction, which consumes organic carbon and leads to streamside land subsidence. Thus, impacts of sea level rise will be amplified by more land subsidence if the channel is dredged deeper and wider as proposed.

Other Potential Impacts from Dredging

The dredging will entail making a new channel, which the consultants have referred to as the "cut-thru" (Gibson 2006). This will pass through shallow water habitat behind

Battery Island, and also through the John H. Chafee Coastal Barrier Resources System. This system is obviously considered important by the U.S. Fish and Wildlife Service as Federal expenditures that encourage development on these barrier islands are restricted (these areas can be developed but Federal taxpayers can not underwrite the investments). Additionally, Battery Island is an important bird rookery, and dredging (and vastly increased ship traffic) may impede that function. Furthermore, as noted earlier the North Carolina Natural Heritage Program recognizes this area as Significant Aquatic Habitat, which supports Federally-listed species such as alligator, manatees and sturgeon. Large-scale dredging and ship traffic may impact use of these important habitats by these rare species. Downstream is Bald Head Island, the shoreline of which has been impacted by dredging previously, and may suffer from increased erosion with extensive deep channel dredging.

Impacts of dredging on salinity changes and shoreline and marine biotic community changes cannot realistically be mitigated. Additionally, should the deeper channel increase erosion this likewise cannot be mitigated except by armoring the shoreline of Bald Head Island, which is illegal. As Endangered Species are by definition rare, mitigation of impacts to them is highly unlikely.

Environmental Impacts of Port Operations

Introduction of Non-Native Species via Ballast Water:
One of the most important and damaging of environmental impacts of shipping is introduction of non-native species including algae, bivalves, zooplankton and bacteria through in-port ballast water exchanges (Pimentel et al. 2000; Holck et al. 2004; Burkholder et al. 2007). As of now, it is states with major ports and abundant water resources that are most frequently and severely impacted by invasive species transferred by ballast water. A large increase in shipping in the estuary will certainly increase the chances of non-natives taking hold in local waters. The U.S. spends $100,000,000/year on control of non-native aquatic plants that impact waters, and much more on control of invasive bivalves that impact water treatment and power plant cooling water intakes and other habitats (Pimentel et al. 2000).
Mitigation of invasive species transferred by ballast water exchanges is a current major issue of concern in shipping. Off shore ballast water exchanges, decontamination of ballast water by heat, ozone, or other chemicals are all solutions currently under investigation, but the U.S. presently has not overall definitive policy or regulations on this critical issue.

Chemical Pollution:
Ships at anchor in ports do leak petroleum products into the water. In fact, small-scale oiling in total amounts to 8X that of the Exxon Valdez disaster (Ng and Song 2010). The author of this report has personally witnessed and photographed, while on sampling cruises, container ships at the Port of Wilmington leaking fuel and leaving miles-long plumes (reported by us to the Coast Guard). Presumably, an increase of 15-20X capacity of the NCIT over the Port of Wilmington will lead to increased petroleum spills and leaks. Routine shipping often releases other pollutants as well, including anti-fouling agents, garbage, grey water and floating trash (Ng and Song 2010). In addition, it is assumed that pesticides and herbicides will be used on-site to control vegetation, insect and possibly animal pests such as rats. There is the potential for off-site runoff of this material into nearby habitats, where it can impact natural communities.
Petroleum product leakage and other pollutant dumping will require increased surveillance by the Coast Guard, Cape Fear River Keeper, and University research personnel due to the considerable increase in maritime traffic on the estuary. Presumably some of the pesticides and herbicides will be captured and at least partially treated in the stormwater system on-site. Some material may escape this treatment depending upon treatment location and impact the environment.

Air Pollution and Ports
Large oceangoing vessels produce copious amounts of air pollution that can contribute to degrading human health. Some of the pollutants released include particulate matter, sulfur oxides, nitrogen oxides, hydrocarbons and carbon monoxide (Corbett et al. 2000; Corbett et al. 2007). It has been estimated that shipping related particulate matter emissions are responsible for approximately 66,000 cardiopulmonary and lung cancer deaths annually worldwide (Corbett et al. 2007). In addition, such emissions contribute to ocean acidification and global warming as well. A large influx of shipping to the

proposed NCIT site will undoubtedly degrade the air quality of residents of nearby communities and contribute toward illness.

Such forms of airborne pollution can only be mitigated at the source, which is the fuels burned by the ships, and how much they emit. For foreign vessels such matters are not controlled by the US EPA but by the International Maritime Organization, a United Nations Agency.

Impacts of Maintenance Dredging

Large amounts of suspended sediments come down the Cape Fear River and estuary from sources in the Piedmont and upper Coastal Plain (Benedetti et al. 2006) as well as from local sources. This is especially an issue when rainfall in the upper watershed is abundant and river discharge is elevated (Mallin et al. 1999). As this material will continue to come downstream and settle in the channel, maintenance dredging will need to be performed, as it currently is. In addition to the new, deeper channel, this will also involve the new turning basin and port area proper. Thus, there will be periodic problems including increased turbidity and suspended sediments and their effects of benthic animals, benthic microalgae, fish, shellfish, fecal bacteria, and pollution of a fisheries primary nursery area.

As mentioned, restricting maintenance dredging to the outgoing tide will reduce inputs of TSS into Snow's Marsh, but will spread fecal bacteria downstream into shellfishing waters. Channel maintenance dredging currently is done with some seasonal restrictions to avoid disrupting marine migrations or reproductive cycles which may lessen impacts at some times.

Impacts of Port Operations to Endangered Species

One of the most well-known Federally-listed Endangered Species utilizing the Cape Fear Estuary is the shortnose sturgeon *Acipenser brevirostrum* (Figure 5; Appendix A). This species has been sampled near the proposed NCIT site (Moser and Ross 1995), although few in general are caught. Upstream directed migrations observed by Moser and Ross (1995) indicated that this species does attempt to reproduce in this system. Since they migrate in this estuary, presumably they could be impacted by dredging operations or physical encounters with large vessels. As mentioned earlier, a related species, the Atlantic sturgeon *Acipenser oxyrhynchus* also utilizes the Cape Fear system (Moser and Ross 1990). In January 2010 NOAA announced that it is now considering placing this species on the Endangered or Threatened Species List (decision to be made by January 20100). This fish can grow to spectacular lengths (up to 15 ft.) and weigh up to 800 lbs., and adults can typically reach 6-8 ft in length and 300 lbs. A recent study in the Delaware Estuary by Brown and Murphy (2010) found that between 2005 and 2008 over 50% of the fatalities reported from that system were caused by large vessel strikes. The paper by Moser and Ross (1995) found a number of these fish caught in the Cape Fear had large dorsal wounds consistent with propeller strikes. Most tellingly, in 2001 UNCW biologists from my laboratory, while collecting water quality samples, found half a fresh carcass of a large Atlantic sturgeon in the lower Cape Fear Estuary (Figure 6). They brought the remains in and the fish was examined by fisheries expert Dr. Thomas Lankford of the UNCW Department of Biology and Marine Biology. Dr. Lankford concluded that the fish was a gravid female

approximately 26 years old and, had been about 7.5 feet long and weighed about 176 lbs, and its death was likely a result of a large vessel propeller strike. It is reasonable to assume that with a 20-fold increase in large vessel usage of the estuary such mortalities will likewise increase.
At present there is no recommended mitigation for loss of these large endangered fish by large vessel encounters. Use of ultrasound, lights and odors have been suggested but not tested on sturgeon. Reducing vessel speed is believed to be one strategy that may be effective, as it has worked in the case of marine mammals (Brown and Murphy 2010).

Figure 6. UNCW researchers examine Atlantic sturgeon cut in half by container vessel propeller in lower Cape Fear estuary, 2001. Estimated age 26 years, estimated weight >175 lbs, estimated length 7.5 feet.

Concluding Statement

The construction of the NCIT would have numerous environmental consequences, some of which are detailed within and others not yet fully explored. Road construction and use would lead to loss of animal habitat, including that of endangered species, fragmentation of plant and animal habitat, introduction of non-native species, disruption of hydrology, and pollution of streams, ponds and marshes. Replacing the present habitat on-site with 400 acres of impervious surface will impact groundwater recharge, produce stormwater runoff, remove animal habitat, and destroy wetlands and their pollution control and animal habitat functions. Armoring the natural shoreline with 4,600 ft. of steel will remove riparian habitat and lead to erosion of natural areas of shoreline on either side of the NCIT dock structure. Channel dredging will destroy shallow water estuarine habitat, create copious amounts of turbidity and suspended solids, impact the intake canal for the neighboring nuclear power plant, increase fecal bacterial pollution and lead to more shellfish bed closures, alter upstream salinities, and potentially increase erosion of Bald Head Island. The massive increase in large ship traffic will increase local air pollution and water pollution, increase local noise pollution, potentially introduce non-native species in ballast water, and lead to increased mortality of endangered sturgeon. While some of the impacts can be mitigated as outlined above, other impacts cannot be mitigated or compensated for elsewhere.

On a final note, regarding the Ports Authority-sponsored research by consultants in general, their documents show a startling lack of knowledge regarding the water quality and environmental issues of the Cape Fear River system. Copious quantities of such data are freely available on-line at http://www.uncw.edu/cmsr/aquaticecology/Laboratory/LCFRP/index.htm.

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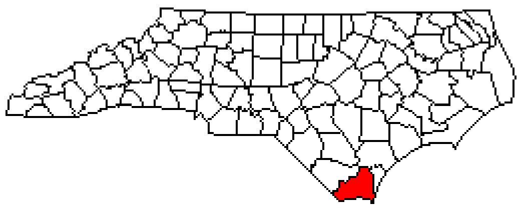
Appendix A. Endangered Species, Threatened Species, Federal Species of Concern, and Candidate Species,

Brunswick County, North Carolina

U.S. Fish and Wildlife Service



Updated: 01-31-2008

Piping plover - *Charadrius melodus* - See the Federal Register for a description of the primary constituent elements essential for the conservation of wintering piping plovers within the designated units. This document also contains a map and a description of each designated unit.
Federal Register Reference: July10, 2001, Federal Register, 66:36038?36136.

Common Name	Scientific name	Federal Status	Record Status
Vertebrate:			
American alligator	*Alligator mississippiensis*	T (S/A)	Current
American eel	*Anguilla rostrata*	FSC	Current
Bachman's sparrow	*Aimophila aestivalis*	FSC	Current
Bald eagle	*Haliaeetus leucocephalus*	BGPA	Current
Black-throated green warbler	*Dendroica virens waynei*	FSC	Current
Broadtail madtom	*Noturus* sp. cf. *leptacanthus*	FSC	Current
Carolina crawfish frog	*Rana capito capito*	FSC	Current
Carolina pygmy sunfish	*Elassoma boehlkei*	FSC	Current
Eastern Henslow's sparrow	*Ammodramus henslowii susurrans*	FSC	Current
Eastern painted bunting	*Passerina ciris ciris*	FSC	Current

Eastern puma (=cougar)	*Puma concolor couguar*	E	Historic
Green sea turtle	*Chelonia mydas*	T	Current
Kemp's (=Atlantic) ridley sea turtle	*Lepidochelys kempii*	E	Current
Leatherback sea turtle	*Dermochelys coriacea*	E	Current
Loggerhead sea turtle	*Caretta caretta*	T	Current
Mimic glass lizard	*Ophisaurus mimicus*	FSC	Current
Northern pine snake	*Pituophis melanoleucus melanoleucus*	FSC	Current
Piping plover	*Charadrius melodus*	T	Current
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	FSC	Current
Red-cockaded woodpecker	*Picoides borealis*	E	Current
Shortnose sturgeon	*Acipenser brevirostrum*	E	Current
Southern hognose snake	*Heterodon simus*	FSC	Current
West Indian manatee	*Trichechus manatus*	E	Current
Wood stork	*Mycteria americana*	E	Current
Invertebrate:			
Buchholz's dart moth	*Agrotis buchholzi*	FSC	Current
Cape Fear threetooth	*Triodopsis soelneri*	FSC	Current
Carter's noctuid moth	*Spartiniphaga carterae*	FSC	Current
Eastern beard grass skipper	*Atrytone arogos arogos*	FSC	Obscure
Greenfield rams-horn	*Helisoma eucosmium*	FSC	Current
Loammi skipper	*Atrytonopsis loammi*	FSC	Historic
Magnificent rams-horn	*Planorbella magnifica*	FSC	Current
Rare skipper	*Problema bulenta*	FSC	Historic
Venus flytrap cutworm	*Hemipachnobia subporphyrea*	FSC	Current
Waccamaw spike	*Elliptio waccamawensis*	FSC	Current
Vascular Plant:			
Awned meadowbeauty	*Rhexia aristosa*	FSC	Historic
Carolina atamasco lily	*Zephyranthes simpsonii*	FSC	Current
Carolina bishopweed	*Ptilimnium ahlesii*	FSC	Current
Carolina bogmint	*Macbridea caroliniana*	FSC	Current
Carolina grass-of-parnassus	*Parnassia caroliniana*	FSC	Current
Carolina lead-plant	*Amorpha georgiana* var. *confusa*	FSC	Current
Coastal beaksedge	*Rhynchospora pleiantha*	FSC	Current

Coastal goldenrod	*Solidago villosicarpa*	FSC	Current
Cooley's meadowrue	*Thalictrum cooleyi*	E	Current
Dune blue curls	*Trichostema* sp. *1*	FSC	Current
Grassleaf arrowhead	*Sagittaria weatherbiana*	FSC	Historic
Harper's fimbristylis	*Fimbristylis perpusilla*	FSC	Current
Large-leaved Grass-of-Parnassus	*Parnassia grandifolia*	FSC	Current
Loose watermilfoil	*Myriophyllum laxum*	FSC	Current
Pickering's dawnflower	*Stylisma pickeringii* var. *pickeringii*	FSC	Historic
Pineland plantain	*Plantago sparsiflora*	FSC	Current
Pondspice	*Litsea aestivalis*	FSC	Current
Purple balduina	*Balduina atropurpurea*	FSC	Historic
Raven's boxseed	*Ludwigia ravenii*	FSC	Historic
Rough-leaved loosestrife	*Lysimachia asperulaefolia*	E	Current
Savanna onion	*Allium* sp. *1*	FSC	Current
Seabeach amaranth	*Amaranthus pumilus*	T	Current
Spring-flowering goldenrod	*Solidago verna*	FSC	Current
Swamp forest beakrush	*Rhynchospora decurrens*	FSC	Current
Thorne's beakrush	*Rhynchospora thornei*	FSC	Current
Tough bumelia	*Sideroxylon tenax*	FSC	Current
Venus' fly-trap	*Dionaea muscipula*	FSC	Current
Wireleaf dropseed	*Sporobolus teretifolius sensu stricto*	FSC	Current
a quillwort	*Isoetes microvela*	FSC	Current
Nonvascular Plant:			
Savanna campylopus	*Campylopus carolinae*	FSC	Current
Lichen:			

Definitions of Federal Status Codes:
E = endangered. A taxon "in danger of extinction throughout all or a significant portion of its range."
T = threatened. A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."
C = candidate. A taxon under consideration for official listing for which there is sufficient information to support listing. (Formerly "C1" candidate species.)
BGPA =Bald and Golden Eagle Protection Act. See below.
FSC = federal species of concern. A species under consideration for listing, for which there is insufficient information to support listing at this time. These species may or may not be listed in the future, and many of these species were formerly recognized as "C2" candidate species.

T(S/A) = threatened due to similarity of appearance. A taxon that is threatened due to similarity of appearance with another listed species and is listed for its protection. Taxa listed as T(S/A) are not biologically endangered or threatened and are not subject to Section 7 consultation. See below.
EXP = experimental population. A taxon listed as experimental (either essential or nonessential). Experimental, nonessential populations of endangered species (e.g., red wolf) are treated as threatened species on public land, for consultation purposes, and as species proposed for listing on private land.
P = proposed. Taxa proposed for official listing as endangered or threatened will be noted as "PE" or "PT", respectively.

Bald and Golden Eagle Protection Act (BGPA):

In the July 9, 2007 Federal Register(72:37346-37372), the bald eagle was declared recovered, and removed (de-listed) from the Federal List of Threatened and Endangered wildlife. This delisting took effect August 8,2007. After delisting, the Bald and Golden Eagle Protection Act (Eagle Act) (16 U.S.C. 668-668d) becomes the primary law protecting bald eagles. The Eagle Act prohibits take of bald and golden eagles and provides a statutory definition of "take" that includes "disturb". The USFWS has developed National Bald Eagle Management Guidelines to provide guidance to land managers, landowners, and others as to how to avoid disturbing bald eagles. For mor information, visit http://www.fws.gov/migratorybirds/baldeagle.htm

Threatened due to similarity of appearance(T(S/A)):

In the November 4, 1997 Federal Register (55822-55825), the northern population of the bog turtle (from New York south to Maryland) was listed as T (threatened), and the southern population (from Virginia south to Georgia) was listed as T(S/A) (threatened due to similarity of appearance). The T(S/A) designation bans the collection and interstate and international commercial trade of bog turtles from the southern population. The T(S/A) designation has no effect on land management activities by private landowners in North Carolina, part of the southern population of the species. In addition to its official status as T(S/A), the U.S. Fish and Wildlife Service considers the southern population of the bog turtle as a Federal species of concern due to habitat loss.

Definitions of Record Status:
Current - the species has been observed in the county within the last 50 years.
Historic - the species was last observed in the county more than 50 years ago.
Obscure - the date and/or location of observation is uncertain.
Incidental/migrant - the species was observed outside of its normal range or habitat.
Probable/potential - the species is considered likely to occur in this county based on the proximity of known records (in adjacent counties), the presence of potentially suitable habitat, or both.