Appendix A. Long Island

Authors: Dan Hudgens, Industrial Economics Inc.; A. Schellenbarger-Jones, Industrial Economics Inc.

Contributing Authors: E. M. Strange, Stratus Consulting Inc.; J. Tanski, New York Sea Grant; G. Sinha, Industrial Economics Inc.

Long Island has almost 1,350 miles of coastline along Long Island Sound, the Peconic bays, the south shore bays, and the Atlantic Ocean. Its northern coast is characterized by high bluffs, while the south coast includes low-lying inner bays and a long stretch of barrier islands that provide recreational beach access for many New Yorkers (such as Jones Beach State Park). Long Island consists of Nassau County, Suffolk County, and the New York City boroughs of Brooklyn and Queens (discussed in Appendix B). Nassau County is primarily suburban and very densely developed, with less than 2% of the land area vacant. Suffolk County to the east is comparatively less developed. Although not part of Long Island, this chapter includes some discussion of the areas of Westchester County, NY, and the Bronx, which have shorelines on the Long Island Sound.

A.1 LANDS VULNERABLE TO INUNDATION

The north shore of Long Island is generally characterized by high bluffs of glacial origin, making this area less susceptible to problems associated with increased sea level. This can be observed in Figure A.1. The south shore has comparatively much more land under 3 meters. Almost all areas in the barrier islands along the south shore of Long Island and

the tidal wetlands south of Nassau County in Great South Bay are low-lying. Between 81 and 193 square kilometers of lands are within 1 meter above the tides (see Table A.1); as the map shows, almost all of this land lies along the south shore of Long Island. As a result, there are already enormous planning efforts under way in the region to preserve the dry lands under threat of inundation. A brief discussion of these efforts, especially on the south shore, is provided in the policy discussion at the end of this chapter.

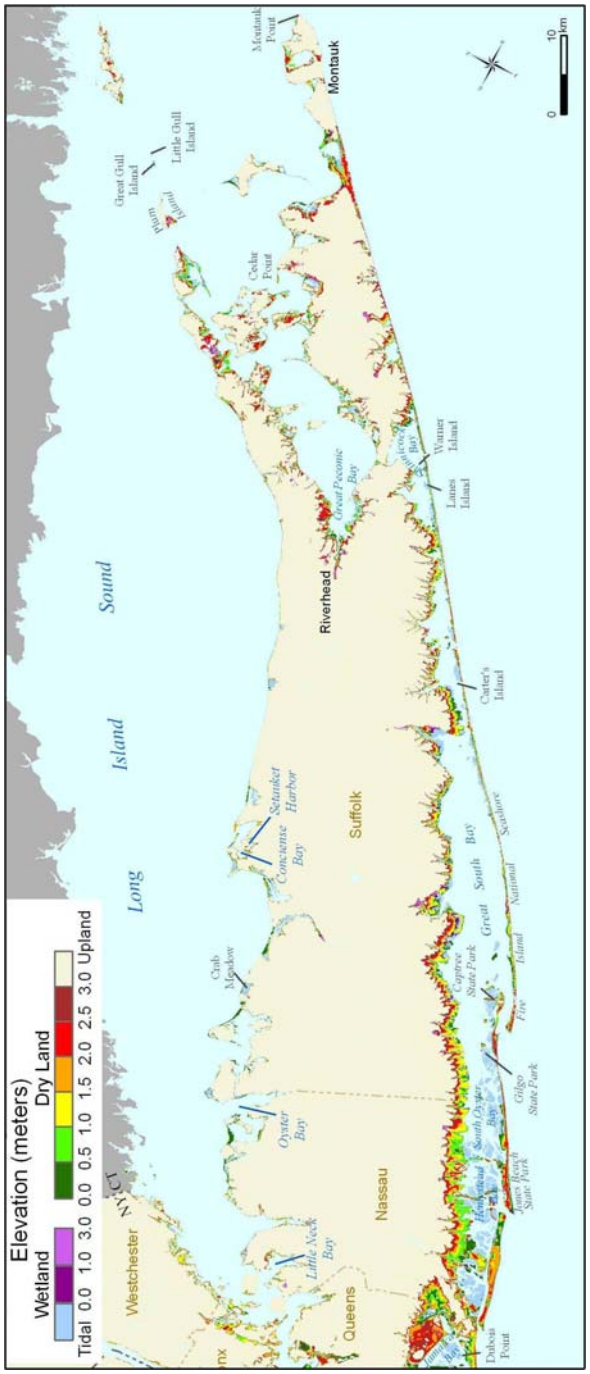

Figure A.1 Long Island: Elevations relative to spring high water (Source: Titus and Wang, 2008).

Table A.1 Low and high estimates for the area of dry and wet land close to sea level.

Long Island Sound, New York
(square kilometers)

		50 cm		1 meter		2 meters		3 meters		5 meters	
	Tidal	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Locality	**Cumulative (total) amount of dry land below a given elevation**										
Westchester		0.2	1.5	1.1	3.0	2.8	5.8	5.1	8.6	10.0	12.4
Bronx		0.4	2.6	1.8	5.1	4.8	9.8	8.7	14.6	16.9	19.6
Queens		6.2	17.0	14.6	28.1	31.7	48.6	50.7	66.6	76.5	80.8
Brooklyn		3.1	9.1	8.0	15.6	18.8	30.5	34.0	47.4	58.9	62.8
Nassau		2.2	19.2	12.9	44.5	50.9	85.4	85.4	104.1	119.3	132.1
Suffolk		13.7	51.5	43.1	96.8	114.9	181.3	188.6	251.3	318.8	371.4
Total		**25.8**	**100.9**	**81.4**	**193.1**	**223.9**	**361.4**	**372.4**	**492.6**	**600.4**	**679.1**
	Cumulative (total) amount of wetlands below a given elevation										
Westchester	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Bronx	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Queens	11.9	0.0	0.2	0.1	0.3	0.4	0.5	0.5	0.6	0.7	0.7
Brooklyn	10.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Nassau	43.7	0.1	0.4	0.3	0.7	0.8	1.5	1.4	2.1	2.6	3.2
Suffolk	72.1	1.5	5.7	4.9	9.8	10.8	15.2	15.1	18.3	20.8	23.8
Total	**140.0**	**1.7**	**6.4**	**5.4**	**11.0**	**12.1**	**17.4**	**17.2**	**21.3**	**24.3**	**28.1**
Dry and nontidal wetland		27	107	87	204	236	379	390	514	625	707
All land	140	167	247	227	344	376	519	530	654	765	847

Source: Titus J.G., and D. Cacela, 2008: Uncertainty Ranges Associated with EPA's Estimates of the Area of Land Close to Sea Level. Section 1.3 in: *Background Documents Supporting Climate Change Science Program Synthesis and Assessment Product 4.1: Coastal Elevations and Sensitivity to Sea Level Rise*, J.G. Titus and E.M. Strange (eds.). EPA 430R07004. U.S. EPA, Washington, DC. The low and high estimates are based on the contour interval and/or stated root mean square error (RMSE) of the data used to calculate elevations and an assumed standard error of 30 cm in the estimation of spring high water.

A.2 ENVIRONMENTAL IMPACTS

North Shore and Peconic Bay. Sea-level rise may threaten habitats along the Long Island Sound including the North Shore, Westchester, and the Bronx, as well as the Peconic Estuary at the far eastern end of Long Island. Habitats of interest include tidal marsh,

estuarine beaches, tidal flats, nearshore shallows, sea-level fens, and marsh and bay islands.

Of the 8,425.6 hectares (20,820 acres) of tidal wetlands in the Sound, about 15% are found in New York, primarily along the shores of Westchester and Bronx counties (Holst, 2003). There are some notable areas of marsh in and around Stony Brook Harbor and West Meadow, bordering the Nissequogue River and along the Peconic Estuary (NYS DOS, 2004), In general, tidal wetlands along the north shore are limited due to the steep uplands and bluffs[46]. Wetland loss may be expected if the shorelines of Long Island Sound are structurally protected (see Chapter 5)[47]. Indeed, there has already been a significant loss of the historical area of vegetated tidal wetlands in Long Island Sound (Holst, 2003; Hartig and Gornitz, 2004), which some scientists partially attribute to sea-level rise (Mushacke, 2003).

The loss of vegetated low marsh reduces habitat for several rare bird species that nest only or primarily in low marsh (*e.g.*, seaside sparrow)[48]. Low marsh also provides safe foraging areas for small resident and transient fishes (*e.g.*, weakfish, winter flounder). Diamondback terrapin live in the creeks of the low marsh, where they feed on plants, molluscs, and crustaceans (LISF, 2008).

46 Ron Rosza, coastal ecologist with the Connecticut Office of the Long Island Sound Program, written communication to EPA, 5/14/07.
47 Map 1, "Study Results for Coastal Region of New York State," in Tanski, J. In review. Assessment of Sea Level Rise Response Scenarios in New York. U.S. Environmental Protection Agency, Washington, DC.
48 See section on marshes, and references therein, in Chapter 4.

Some wetlands along Long Island Sound may be allowed to respond naturally to sea-level rise, including some in the Peconic Estuary. Where migration is possible, preservation of local biodiversity as well as some regionally rare species is possible. Several rare bird species are found in the Flanders Bay wetlands, including least tern, common tern, piping plover, black skimmer, osprey, and common loon (NYS DOS, 2004) (see text box on piping plover). Waterfowl also feed in and around the wetlands.

Beaches are far more common than tidal wetlands in the Long Island Sound study area. Several notable barrier beaches exist. For example, the sandy barrier-beach system fronting Hempstead Harbor supports a typical community progression from the foreshore to the bay side, or backshore (LISHRI, 2003). The abundant invertebrate fauna provide forage for sanderling, semipalmated plovers, and other migrating shorebirds (LISHRI, 2003). The maritime beach community between the mean high tide and the primary dune provides nesting sites for several rare bird species, including piping plover, American oystercatcher, black skimmer, least tern, common tern, roseate tern, the Northeastern beach tiger beetle, and horseshoe crab (LISHRI, 2003). Diamondback terrapin use dunes and the upper limit of the backshore beach for nesting (LISHRI, 2003).

Since nearly all of the Long Island shoreline of the Sound is densely populated and highly developed, the land may be armored in response to sea-level rise, raising the potential for beach loss. The Long Island Sound Habitat Restoration Initiative cautions, “Attempts to alter the natural cycle of deposition and erosion of sand by

construction of bulkheads, sea walls, groins, and jetties interrupt the formation of new beaches" (LISHRI, 2003).

Shallow water habitats are a major ecological feature in and around the Peconic Estuary. Here eelgrass beds provide food, shelter, and nursery habitats to diverse species, including worms, shrimp, scallops and other bivalves, crabs, and fish (PEP, 2001). Horseshoe crabs reportedly forage in the eelgrass beds of Cedar Point/Hedges Bank, where they are prey for loggerhead turtles (federally listed as threatened), crabs, whelks, and sharks (NYS DOS, 2004). Atlantic silverside spawn here; silverside eggs provide an important food source for seabirds, waterfowl, and blue crab, while adults are prey for bluefish, summer flounder, rainbow smelt, white perch, Atlantic bonito, and striped bass (NYS DOS, 2004). The Cedar Point/Hedges Bank Shallows eelgrass beds are known for supporting a bay scallop fishery of statewide importance (NYS DOS, 2004). The consequences of sea-level rise for submerged aquatic vegetation (SAV) are unknown, although studies suggest that deepening water, which may limit sunlight penetration, could reduce eelgrass growth and undermine the productivity and services the beds provide (Short, 1999). Increased salinity from sea-level rise may also negatively impact SAV. Furthermore, shoreward movement of eelgrass beds could be impeded by steep shores or water turbidity in front of shoreline protection structures.

Other noteworthy habitats that could be affected by sea-level rise include the following:

- A sea-level fen vegetation community grows along Flanders Bay (NYS DOS, 2004). Because sea-level fen vegetation needs nutrient-poor waters, the Flanders Bay fen may not survive inundation by sea-level rise.
- On Long Island's north shore, longshore drift carries material that erodes from bluffs and later deposits it to form tidal flats and barrier spits or shoals (LISHRI, 2003). For instance, one of the largest areas of tidal mudflats on the north shore is near Conscience Bay, Little Bay, and Setaucket Harbor west of Port Jefferson (NYS DOS, 2004). Large beds of hard clams, soft clams, American oysters, and ribbed mussels are found in this area (NYS DOS, 2004). As seas continue to rise and the flats become inundated, the invertebrates of tidal flats could become less accessible for feeding by the many wading birds, dabbling ducks, and shorebirds whose growth and survival depend on such invertebrate food supplies (Erwin, 2006).

South Shore. Species and habitats along the south shore of Long Island are also potentially at risk because of sea-level rise. Key habitats include back-barrier salt marshes, back-barrier beaches, tidal flats, marsh and bay islands, and shallow nearshore environments.

Extensive back-barrier salt marshes exist to the west of Great South Bay in southern Nassau County (USFWS, 1997). These marshes are particularly notable given widespread marsh loss on the mainland shoreline of southern Nassau County (NYS DOS and USFWS, 1998; USFWS, 1997). Accretion experts indicate that most back-barrier marshes adjacent to Jones Inlet may survive modest sea-level rise rate increases, but that

they will be lost under higher sea-level rise scenarios (Reed, 2008). To the east of Jones Inlet, the extensive back-barrier and fringing salt marshes are keeping pace with current rates of sea-level rise, but experts predict that the marshes' ability to keep pace will be marginal if the rate of sea-level rise increases moderately, and that the marshes would be lost under higher sea-level rise scenarios (Reed, 2008). Furthermore, opportunities for marsh migration along Long Island's south shore will be limited. Much of the mainland shoreline in southern Nassau County is already bulkheaded. Outside of New York City, the state requires a minimum 75-foot buffer around tidal wetlands to allow marsh migration, but outside of this buffer, additional development and shoreline protection are permitted[49]. Numerous wildlife species could be affected by salt marsh loss:

- Under higher sea-level rise scenarios, many commercially and recreationally important fish species may move elsewhere in search of suitable nursery and foraging areas.
- The recovery of a number of at-risk bird species could be impeded if additional marsh loss occurs. For example, the Dune Road Marsh west of Shinnecock Inlet provides nesting sites for several species that are already showing significant declines, including clapper rail, sharp-tailed sparrow, seaside sparrow, willet, and marsh wren (USFWS, 1997). The salt marshes of Gilgo State Park provide nesting sites for northern harrier, a species listed by the state as threatened (NYS DOS, 2004).

49 The state has jurisdiction up to 300 feet beyond the tidal wetland boundary (150 feet in NYC). See NYDEC, Undated.

- The northern diamondback terrapin, a federal species of concern, feeds and grows along marsh edges and the nearshore bays of the south shore. A local terrapin expert believes that additional marsh loss could lead to a "very serious reduction" in the terrapin's already low abundance (Feinberg and Burke, 2003)[50].

Of the extensive tidal flats along Long Island's southern shoreline, most are found west of Great South Bay and east of Fire Island Inlet, along the bay side of the barrier islands, (USFWS, 1997) in the Hempstead Bay–South Oyster Bay complex, (USFWS, 1997) and around the Moriches and Shinnecock inlets (USFWS, 1997; NYS DOS and USFWS, 1998). These flats provide habitat for several edible shellfish species, including soft clam, northern quahog (hard clam), bay scallop, and blue mussel. Tidal flats and shallow water habitats are heavily used by shorebirds, raptors, and colonial waterbirds in spring and summer and by waterfowl during fall and winter (Erwin, 1996). The tidal flats around Moriches and Shinnecock inlets are particularly important foraging areas for migrating shorebirds. If shoreline waters become too deep for foraging on these flats, migrating shorebirds may lack forage for their long-distance migrations. Scientists writing on behalf of the South Shore Estuary Reserve program have asserted that "because shorebirds concentrate in just a few areas during migration, loss or degradation of key sites could devastate these populations" (NYS DOS and USFWS, 1998).

50 Written communication from Dr. Russell Burke, Department of Biology, Hofstra University, as cited in Section 3.4 of Background Documents Supporting Climate Change Science Program Synthesis and Assessment Product 4.1: Coastal Elevations and Sensitivity to Sea Level Rise, J.G. Titus and E.M Strange (eds.), EPA430R07004, Washington, DC: U.S. EPA. Russell Burke has operated an annual diamondback terrapin conservation project at the Jamaica Bay Wildlife Refuge in the Gateway National Recreational Area since 1998.

Several other habitat types merit consideration when characterizing sea-level rise impacts on Long Island's south shore:

- As sea levels rise, back-barrier beaches will erode in front of shoreline protection structures, and will be lost without continual beach nourishment. The back-barrier beaches of the south shore provide nesting sites for the northern diamondback terrapin, the endangered roseate tern, and horseshoe crabs (NYS DOS, 2004; USFWS, 1997; USFWS, 1998). Shorebirds (*e.g.*, red knot) feed preferentially on horseshoe crab eggs during their spring migrations.

Increased flooding and erosion of marsh and dredge spoil islands will reduce habitat for many bird species that forage and nest there, including breeding colonial waterbirds, migratory shorebirds, and wintering waterfowl. For example, erosion on Warner Island is reducing nesting habitat for the federally endangered roseate tern and increasing flooding risk during nesting (NYS DOS and USFWS, 1998). The Hempstead Bay–South Oyster Bay complex includes a network of salt marsh and dredge spoil islands that are important for nesting by herons, egrets, and ibises. Likewise, Lanes Island and Warner Island in Shinnecock Bay support colonies of the state-listed common tern and the roseate tern (USFWS, 1997).

- Seagrass beds occur along much of the southern shoreline of Long Island[51].

51 See SAV mapping information available at: http://www.csc.noaa.gov/benthic/data/northeast/longisl.htm. Accessed 1/11/08.
SW: NOAA Coastal Services Center, Northeast Region. Long Island South Shore SAV Data Set 2002

- The consequences of sea-level rise for SAV are unknown, although studies suggest that deepening water could reduce eelgrass growth and undermine the productivity and services the beds provide (Short, 1999).

BOX A.1: Effects on the Piping Plover

Piping Plover *Charadrius melodus*

Adult and juvenile piping plover foraging on a sandy beach near the water's edge.

Habitat: The piping plover, federally listed as threatened, is a small migratory shorebird that primarily inhabits open sandy barrier island beaches on Atlantic coasts (USFWS, 1996). Major contributing factors to the plover's status as threatened are beach recreation by pedestrians and vehicles that disturb or destroy plover nests and habitat, as well as shoreline development that inhibits the natural renewal of barrier beach and overwash habitats (USFWS, 1996). In some locations, dune maintenance for protection of access roads associated with development appears to be correlated with absence of piping plover nests from former nesting sites (USFWS, 1996).

Locations: Piping plovers winter on beaches from the Yucatan Peninsula to North Carolina. In the summer, they migrate north, and breed on beaches from North Carolina to Newfoundland.[52] In the mid-Atlantic region, breeding pairs of plovers have been observed at numerous coastal beaches and barrier islands, although suitable habitat is limited in some areas. For example, Virginia and Delaware have one site each where piping plovers breed.[53] (USFWS, 2000) In contrast, piping plovers breed more frequently on Long Island's sandy beaches, from Queens to the Hamptons, in the eastern bays and in the harbors of northern Suffolk County. New York's Breezy Point barrier beach, at the mouth of Jamaica Bay, consistently supports one of the largest piping plover nesting sites in the entire New York Bight coastal region (USFWS, 1997). New York has seen an increase in piping plover breeding pairs in the last decade from less than 200 in 1989 to near 375 in recent years (2003-2005), representing nearly a quarter of the Atlantic coast's total breeding population (USFWS, 2004). Despite this improvement, piping plovers are still state listed as endangered in New York (TNC, No Date).

Piping plover nest

Impact of Sea-Level Rise: Where beaches are prevented from migrating inland by shoreline armoring, sea-level rise will negatively impact Atlantic coast piping plover populations. As described, continuous linear dunes, hardened shorelines, and established vegetation are all avoided by plovers for breeding, indicating that any armoring or stabilizing structures such as jetties and groins already in place, or built in response to sea-level rise, will have a negative impact on their reproduction and populations.

To the degree that developed shorelines result in erosion of ocean beaches, and to the degree that stabilization is undertaken as a response to sea-level rise, piping plover habitat will be lost. In contrast, where beaches are able to migrate landward, plovers may find newly available habitat. For example, on Assateague Island, piping plover populations increased after a storm event that created an overwash area on

52 Cornell Lab of Ornithology Piping Plover bird guide available online here: http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/Piping_Plover.html. Access September 28, 2007.
53 Audubon IBA Barrier Island/Lagoon System IBA Northampton and Accomack Counties.

the north of the island.[54] This suggests that if barrier beaches are allowed to migrate in response to sea-level rise, piping plovers might adapt to occupy new inlets and beaches created by overwash events.

Beach nourishment, the anticipated protection response for much of New York's barrier beaches such as Breezy Point, can benefit piping plovers and other shorebirds by increasing available nesting habitat in the short-term, offsetting losses at eroded beaches, but may also be detrimental depending on timing and implementation (USFWS, 1996). For instance, a study in Massachusetts found that plovers foraged on sandflats created by beach nourishment.[55] However, once a beach is built and people spread out to enjoy it, many areas become restricted during nesting season. Overall, throughout the Mid-Atlantic, coastal development and shoreline stabilization projects constitute the most serious threats to the continuing viability of storm-maintained beach habitats and their dependent species, including the piping plover (USFWS, 1996).

Photograph credit: USFWS, New Jersey Field Office /Gene Nieminen 2006. Accessed at http://www.fws.gov/northeast/njfieldoffice/Endangered/Plover_public_domain/P_P_index.html on March 1, 2007.

-- END TEXT BOX --

A.3 POPULATION OF LANDS CLOSE TO SEA LEVEL

Based upon a spatial analysis of elevation data and U.S. Census data on the number of residents, Table A.4 shows that more than 300,000 Long Island residents live within 2 meters of spring high water. Nassau County has the larger population within the low lands, up to 223,000 people.

Table A.2 Long Island block level population of the lands close to sea level by various scenarios of sea-level rise — low and high estimates.

	Population (count)					
	50 centimeters		1 meter		2 meters	
County	Low	High	Low	High	Low	High
Nassau County	2,863	146,134	2,863	174,237	97,208	223,039
Suffolk County	25	41,210	25	52,618	37,587	95,577

A.4 EXISTING SHORE PROTECTION AND POLICY CONTEXT

For information on New York's statewide policies relevant to coastal management and sea-level rise, readers should refer to Appendix B. Similar to the New York metropolitan area, the relevant policies for Long Island reflect the fact that the region is intensely developed in the west and developing fast in the east. Much of south shore, particularly within Nassau County, is already developed and has already been protected, primarily by bulkheads. For example, the Nassau County GIS database shows 528 miles of bulkheads[56].

Some of the south shore's densely developed communities facing flooding problems, such as Freeport and Hempstead, have already implemented programs calling for elevating buildings and infrastructure in place and installing bulkheads for flood protection. The Town of Hempstead has adopted the provisions of the state's Coastal

56Based upon an analysis by Jay Tanski of GIS data provided by Nassau County (Nassau County, 2002).

Erosion Hazards Area Act, described in Appendix B, because erosion and flooding along Nassau County's ocean coast have been a major concern. The Town of Hempstead has also been actively working with the U.S. Army Corps of Engineers to develop a long-term storm damage reduction plan for the heavily developed Long Beach barrier island (USACE, 2003).

Suffolk County has an aggressive open space preservation and land acquisition effort. Several programs focus on acquiring or preserving the open space remaining in the county, and hundreds of millions of dollars are spent to acquire lands that are open but still developable. In general, Suffolk County is interested in acquiring lands that are in floodplains, near streams, or near creeks because they do not want development in these areas. In the Shirley/Mastic area, Suffolk County initiated a land exchange program in which owners can exchange property in the floodplain for county-owned land outside of the floodplain, and 30 to 40 owners are participating in the program(Gaffney, 1996). Similar efforts by state, county, and local governments to buy development rights to agricultural lands would prevent them from being developed in the future.

Beach nourishment and the construction of flood and erosion protection structures are also common on the island. For example, in the early 1990s the U.S. Army Corps of Engineers constructed a substantial revetment around the Montauk Lighthouse at the eastern tip of Long Island and after a new feasibility study has proposed construction of a larger revetment (Bleyer, 2007). The Corps is also reformulating a plan for the development of long-term storm damage prevention projects along the 83 mile portion of

the south shore of Suffolk County. As part of this effort, the Corps is assessing at-risk properties within the 71 square mile floodplain, present and future sea-level rise, restoration and preservation of important coastal landforms and processes, and important public uses of the area (USACE, undated).

Existing regulations do not prevent shoreline property owners from attempting to protect their land against flooding or erosion as long as they apply for the permits at the right time (i.e., before the land becomes wetlands). However, state policy requires individual property owners first evaluate non-structural approaches and only if such methods can be shown to be ineffective can they graduate to armoring strategies (New York State, 2002). Because emergency permits may be issued in extreme cases, in some cases, individuals will wait until their house is in imminent danger before applying for a permit, which will almost always be granted in emergency cases. In extreme cases, individuals may even wait for damage to occur, at which time the federal government may step in to relieve the burden of reconstruction in severely damaged areas. After major disasters, emergency permits may be issued, allowing applicants to receive approvals without going through a long and often costly permit process.

According to state policy, non-structural methods of shore protection are preferred whenever possible. Local governments try to discourage using bulkheads and other shore-hardening structures. Shoreline structure, which by definition includes beach nourishment in New York State, are permitted only when it can be shown that the structure can prevent erosion for at least thirty years and will not cause an increase in

erosion or flooding at the local site or nearby locations (New York State, 2002). Setbacks, relocation, and elevated walkways are also encouraged before hardening.

The Comprehensive Coastal Management Plan (CCMP) of the Peconic Bay National Estuary Program Management Plan calls for "no net increase of hardened shoreline in the Peconic Estuary." The intent of this recommendation is to discourage individuals from armoring their coastline, but this document is only a management plan and does not have any legal authority. However, towns such as East Hampton are trying to incorporate the plan into their own programs. In 2006, the town of East Hampton has adopted and now enforcing a zoning overlay district that prevents shore armoring along much of the town's coastline (Town of East Hampton, 2006). Despite such regulations, authorities in East Hampton and elsewhere recognize that there are some areas where structures will have to be allowed to protect existing development.

The NY Department of State (DOS) is also examining options for managing erosion and flood risks through only land use measures, such as further land exchanges. For example, there is currently an attempt to revise the proposed Fire Island to Montauk Point Storm Damage Reduction project to in favor of combination of nourishment and land use measures. The intent is to then phase out the use of beach nourishment over the 50-year period. Over the 50-year project life, DOS staff would seek to promote measures to relocate out of hazardous locations[57]. Non-conforming development will eventually be

57 Comment from Fred Anders, New York State Department of State, Division of Coastal Resources and Waterfront Revitalization, in response to expert review draft of this appendix.

brought into conformance as it is reconstructed, moved, damaged by storms or flooding or other land use management plans are brought into effect[58].

APPENDIX A REFERENCES

Bleyer, B., 2007: Erosion protection for Montauk lighthouse creates waves. *Lighthouse Digest.* Available at http://www.lighthousedigest.com/Digest/StoryPage.cfm?StoryKey=2636. Accessed January 31, 2008.

Erwin, M.R., 1996: Dependence of waterbirds and shorebirds on shallow water habitats in the Mid-Atlantic coastal region: An ecological profile and management recommendations. *Estuaries*, **19**, 213–219.

Erwin, R.M., D.R. Cahoon, D.J. Prosser, G.M. Sanders, and P. Hensel, 2006: Surface elevation dynamics in vegetated *Spartina* marshes versus unvegetated tidal ponds along the mid-Atlantic coast, USA, with implications to waterbirds. *Estuaries and Coasts*, **29**, 96–106.

Feinberg, J.A. and R.L. Burke, 2003: Nesting ecology and predation of diamondback terrapins, *Malaclemys terrapin*, at Gateway National Recreation Area, New York. *Journal of Herpetology*, **37**, 517–526.

Gaffney, R., 1996: *Annual State of the County Address*. Available at http://co.suffolk.ny.us/legis/clerk/Proceedings/1996/02-28-96.htm. Accessed on January 31, 2008.

Hartig, E.K. and V. Gornitz, 2004: Salt marsh change, 1926-2003 at Marshlands Conservancy, New York. *7th Bienniel Long Island Sound Research Conference Proceedings*. Available online at:

58 Personal communication from Barry Pendergrass to James G. Titus. 9/19/2007.

http://lisfoundation.org/downloads/lisrc_proceedings2004.pdf. Last accessed January 30, 2008.

Holst, L, R. Rozsa, L. Benoit, S. Jacobsen, and C. Rilling, 2003: *Long Island Sound Habitat Restoration Initiative, Technical Support for Habitat Restoration, Section 1: Tidal Wetlands.* EPA Long Island Sound Office, Stamford, CT. Available online at: http://www.longislandsoundstudy.net/habitat/index.htm. Accessed 1/11/08.

LISF (Long Island Sound Foundation), 2008: *Plants & Animals of Hammonasset*. Long Island Sound Foundation, Groton, CT. Available online at: http://www.lisfoundation.org/coastal_access/hamm_wildlife.html. Accessed 1/11/08.

LISHRI (Long Island Sound Habitat Restoration Initiative), 2003: *Technical Support for Habitat Restoration, Section 5: Coastal Barriers, Beaches, and Dunes.* EPA Long Island Sound Office, Stamford, CT. Available online at: http://www.longislandsoundstudy.net/habitat/index.htm. Accessed 1/11/08.

Mushacke, F., 2003: Wetland loss in the Peconic estuary. *Long Island Sound Tidal Wetland Loss Workshop*, June 24-25, 2003, Stony Brook, New York. Workshop Proceedings and Recommendations to the Long Island Sound Study. Available at: http://www.longislandsoundstudy.net/habitatrestoration/more.htm. Accessed 1/11/08.

Nassau County, Nassau County GIS Department, 2002: Nassau County Bulkheads GIS data.

New York State, 2002: *State Coastal Policies* (Policy 13, 14, 17). Accessible at http://nyswaterfronts.com/downloads/pdfs/State_Coastal_Policies.pdf. Accessed on January 30, 2008.

NYDEC (New York Department of Environmental Conservation), Undated: *Tidal Wetlands Permit Program: Do I Need a Permit?* Available at http://www.dec.ny.gov/permits/6359.html. Accessed January 31, 2008.

NYSDS DOS & USFWS (New York State Department of State and U.S. Fish and Wildlife Service), 1998: *Shorebirds*. South Shore Estuary Reserve, Technical Report Series. Available online at: http://www.nyswaterfronts.com/Final_Draft_HTML/Tech_Report_HTM/PDFs/C8A_Index_pdf.htm. Accessed 1/11/08.

NYSDS DOS (New York State Department of State). *Significant Coastal Fish and Wildlife Habitats*. Available online at: http://nyswaterfronts.com/waterfront_natural_narratives.asp. Accessed 1/11/08. (Multiple location-specific pieces can be found on the site).

PEP (Peconic Estuary Program), 2001: *Peconic Estuary Comprehensive Conservation and Management Plan*. Sponsored by the United States Environmental Protection Agency under Sec. 320 of the Clean Water Act. Suffolk County Department of Health Services, Program Office, Riverhead NY, 866 pp.

Reed, D.J., D.A. Bishara, D.R. Cahoon, J. Donnelly, M. Kearney, A.S. Kolker, L.L. Leonard, R.A. Orson, and J.C. Stevenson, 2008: Site-specific scenarios for wetlands accretion in the Mid-Atlantic region. Section 2.1 In: *Background Documents Supporting Climate Change Science Program Synthesis and Assessment Product 4.1: Coastal Elevations and Sensitivity to Sea Level Rise* [Titus, J.G. and E.M. Strange (eds.)]. EPA 430R07004, Environmental Protection Agency, Washington, DC.

Short, F.T. and H.A. Neckles, 1999: The effects of global climate change on seagrasses. *Aquatic Botany*, **63**, 169-196.

Titus, J.G., and J. Wang, 2008: Maps of lands close to sea level along the middle Atlantic coast of the United States: an elevation data set to use while waiting for LIDAR. Section 1.1 in: *Background Documents Supporting Climate Change Science*

Program Synthesis and Assessment Product 4.1: Coastal Elevations and Sensitivity to Sea Level Rise [Titus, J.G. and E.M. Strange (eds.)]. EPA 430R07004, Environmental Protection Agency, Washington, DC.

Town of East Hampton, 2006: *Coastal Erosion Overlay District Legislation, Resolution 2006-899*. Available at: http://www.town.east-hampton.ny.us/coastal.pdf. Accessed January 30, 2008.

TNC (The Nature Conservancy), No Date:

USACE (U.S. Army Corps of Engineers), Undated: *Fire Island to Montauk Point Refomulation Study: Vision Statement*. Available at http://www.nan.usace.army.mil/fimp/pdf/vision2.pdf. Accessed on August 25, 2007.

USACE (U.S. Army Corps of Engineers), 2003: *Regional Sediment Management (RSM) Demonstration Program Project Brief, New York District: Town of Hempstead, Long Island, New York*. Available at www.wes.army.mil/rsm/pubs/pdfs/rsm-db9.pdf. Access January 31, 2008.

USFWS (U.S. Fish and Wildlife Service), 1996: Piping Plover (*Charadrius melodus*) Atlantic Coast Population Revised Recovery Plan. Prepared by the Atlantic Coast Piping Plover Recovery Team.

USFWS (U.S. Fish and Wildlife Service), 1997: *Significant Habitats and Habitat Complexes of the New York Bight Watershed*. U.S. Fish and Wildlife Service. http://training.fws.gov/library/pubs5/begin.htm. Accessed 1/11/08.

USFWS (U.S. Fish and Wildlife Service), 2000: *Piping Plover Atlantic Coast Population Delaware Status Report.* http://www.fws.gov/northeast/pipingplover/state/de.html. Accessed 1/11/08.

USFWS (U.S. Fish and Wildlife Service), 2004: *2002-2003 status update: U.S. Atlantic Coast piping plover population. Sudbury, Massachusetts*. 8 pp. Accessed at

http://www.fws.gov/northeast/pipingplover/status/index.html on March 2, 2006. Preliminary estimates of 2004 and 2005 populations also available at this site.

USFWS (U.S. Fish and Wildlife Service), 2005: Red knot, *Calidris canutus rufa*. Fact sheet available online at: http://www.fws.gov/northeast/redknot/facts.pdf. Accessed 1/11/08.