3.2 North Shore, Long Island Sound and Peconic Estuary

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Species and habitats along Long Island Sound are potentially at risk because of sea level rise. This brief literature review considers this risk for the New York portion of Long Island Sound (hereafter the Sound), including the shorelines of Westchester, Bronx, Nassau, and Suffolk counties as well as the Peconic Estuary at the far eastern end of Long Island. These Long Island shorelines contain important habitats for a variety of fish, shellfish, and birds, and a great deal is known about their ecology and habitat needs (see Map 3.1). Based on existing literature and the knowledge of local scientists, this review discusses the coastal species in areas that could be at risk because of further habitat loss resulting from sea level rise and shoreline protection. There are locations in the study area with naturally steep shorelines that will interfere to varying degrees with marine transgression of tidal wetlands in response to rising seas. Although it is possible to make qualitative statements about the possible impacts if sea level rise causes a total loss of habitat, our ability to discern what the impact might be if only a portion of the habitat is lost is more limited.[168]

TIDAL MARSH

In 2003, the Long Island Sound Habitat Restoration Initiative reported that there were 8,425.6 ha (20,820 acres) of tidal wetlands in the Sound, including all tidal wetland types, with 85 percent of the total in Connecticut.[169] Most of the remaining 15 percent of tidal wetlands found in the New York State portion of the Sound are along the shores of Westchester and Bronx counties.[170] In Westchester County, ecologically important tidal wetlands occur in the county-owned Marshlands Conservancy property.[171] The Marshlands Conservancy site is the only mainland breeding area for yellow-crowned night herons in the region.[172]

Tidal wetlands are also uncommon along the north shore of Long Island because of the steep uplands and sea cliffs created by the terminal moraine of glaciers, and therefore wetlands are

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[168]EPA's ambitious goal for these reviews would have had us address the four possible outcomes resulting from different rates of sea level rise (or wetland accretion) and whether shores are protected. In a typical case where area of wetlands is 5 times the area of land that might become new wetlands as sea level rises, the four possible outcomes are:
a. Existing wetlands are lost, shore protection prevents new wetlands forming inland (100% loss).
b. Existing wetlands keep pace, shore protection prevents new wetlands forming inland (no change, in total acreage, but possible loss of plants that inhabit the upper portion of the tide range).
c. Existing wetlands lost, no shore protection allows wetlands to form inland (80% loss).
d. Existing wetlands keep pace, no shore protection allows wetlands to form inland (20% gain).
We focus on the implication of case a, because the implication of a total loss of habitat is understood at least qualitatively. The literature is often insufficient for us to distinguish whether case c is more similar to "no impact" or to the total loss implied by case a, and hence, depending on context, the prose that follows may imply either that such large scale loss is similar to total loss, or that because some wetlands will continue to survive, that the impact is similar to "no impact." In the case of beaches and possibly mudflats, the absence of shore protection generally allows the system to survive. We did not examine cases b or d at all.

[169]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, p. 1-7, Available at: http://www.longislandsoundstudy.net/habitat/index.htm; and Rosza, R., 1995, "Human impacts on tidal wetlands: History and regulations, Chapter 2 in G.D. Dyer and W.A. Neiring, eds., *Tidal Marshes of Long Island Sound, Ecology History and Restoration*, The Connecticut College Arboretum, Bulletin No. 34, December. Available at: http://arboretum.conncoll.edu/publications/34/FRAME.HTM.

[170]Holst et al., 2003, p. 1-1 (see note 169).

[171]New York State (NYS) Department of State, Division of Coastal Resources, 2004, *Significant Coastal Fish and Wildlife Habitats*. Long Island Sound and Long Island, Marshlands Conservancy. Coastal Resources Online. Available at http://nyswaterfronts.com/waterfront_natural_narratives.asp.

[172]USFWS, 1997, *Significant Habitat and Habitat Complexes of the New York Bight Watershed*. USFWS, South New England, New York Bight Coastal Ecosystems Program, Charlestown, RI; The Narrows, Complex #20, pp. 611–619.

largely confined to former drowned "kettle hole" embayments such as Mount Sinai.[173] There are some notable areas of marsh in and around Stony Brook Harbor and West Meadow, bordering the Nissequogue River,[174] and along the Peconic Estuary. Some marshes around the three large bays western Long Island Sound (Little Neck Bay, Manhasset Bay, and Hempstead Harbor) provide feeding and nesting areas for green-backed heron, clapper rail, and American black duck, as well as feeding areas for wading birds.[175]

Marshes will be lost where the shorelines are backed by steep slopes or where shorelines are hardened. There has already been a significant loss of the historical area of vegetated tidal wetlands in Long Island Sound.[176] In fact, local scientists have observed marsh submergence for decades.[177] The full extent and causes of marsh losses are unknown, but some local scientists believe that sea level rise may be an important factor.[178] Authors of the Long Island Sound Habitat Restoration Initiative reported that emergent marsh, especially low marsh, is converting to intertidal flat along the shores of many of the tidal rivers that drain into the Sound, and concluded that "the biophysical changes in these marshes bear a striking resemblance to other eastern seaboard wetlands that scientists attribute to accelerated relative sea level rise."[179]

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) (see Section 3.1). Low marsh also provides foraging areas sheltered from predators for dozens of fish species, including small resident fishes such as mummichog, striped killifish, and sheepshead minnow, and early life stages of estuarine and marine transients, which use the tidal creeks and low marsh for a nursery area (Section 3.1). Many of these transient fish species such as weakfish and winter flounder enter local commercial and recreational fisheries as adults.[180] Diamondback terrapin live in the creeks of the low marsh, where they feed on plants, mollusks, and crustaceans.[181] Marsh invertebrates of the Sound's low marsh zones include rough periwinkles, ribbed mussels, fiddler crabs, striped sea anemone, and the common clamworm.[182]

Some wetlands along Long Island Sound will be allowed to respond naturally to sea level rise, and where migration is possible, preservation of local biodiversity and some regionally rare species is possible. For example, local planners believe that Peconic Estuary shorelines around Shelter Island, Robins Island, the Conscience Point National Wildlife Reserve, the E.A. Morton National Wildlife Reserve, Novack, Sag Harbor, Orient Point and Orient Beach, and Napeague Bay will be allowed to respond naturally to sea level rise. Local planners also expect that coastal lands designated for preservation, conservation, or recreation in northern Suffolk County will remain unprotected.

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[173]Ron Rosza, coastal ecologist with the Connecticut Office of the Long Island Sound Program, email entitled Opportunity to comment on U.S. EPA-sponsored papers related to sea level rise and related impacts on habitat and species, to Karen Scott, EPA, 2/20/07 (discussing visual observations).

[174]NYS Department of State, Division of Coastal Resources, 2004 (see note 171). Wetland losses will also occur along shorelines with steep slopes, even though they are not hardened—a common characteristic of the north shore of Long Island.

[175]USFWS, 1997, The Narrows, Complex #20, p. 613 (see note 172).

[176]Holst et al., 2003, p. 1-8 (see note 169).

[177]Ron Rosza, written communication to EPA, 2/20/07 (discussing personal observations) (see note 173).

[178]Mushacke, F., 2003, "Wetland loss in the Peconic Estuary," abstract of presentation at the Long Island Sound Tidal Wetland Loss Workshop, June 24–25, Stony Brook, NY, *Workshop Proceedings and Recommendations to the Long Island Sound Study*, p. 18. Available at: http://www.longislandsoundstudy.net/habitatrestoration/more.htm. In this abstract, Fred Mushacke, a marine biologist with the New York State Department of Environmental Conservation, who has conducted GIS analyses to determine areas of marsh loss in the Peconic Estuary, stated that "the extent and causes of vegetative losses are currently unknown and can only be surmised. It is, however, a synergy of anthropogenic and natural causes, and may include, but is not limited to, sediment budget disruption, sea level rise, erosion, subsidence, and eutrophication."

[179]Holst et al., 2003, p. 1-8 (see note 169).

[180]See, for example, NYS Department of State, Division of Coastal Resources, 2004, p. 3 (see note 171).

[181]Long Island Sound Foundation, n.d., Plants & Animals of Hammonasset, available at: http://www.lisfoundation.org/coastal_access/hamm_wildlife.html The Long Island Sound Foundation has been collecting and disseminating information on the sound for the public since 1992.

[182]Warren, R.S. and P.E. Fell, 1996, "*Phragmites australis* on the lower Connecticut River: Patterns of invasion and spread. As cited on p. 1-2 of Holst et al., 2003 (see note 169).

Some preservation of species may occur where "soft" protection is the preferred protection alternative. For example, local planners believe that shore protection to hold back rising seas is "likely" or "almost certain" along the shorelines of Flanders Bay, where the Flanders Bay Wetlands occur. The New York State Department of State, Division of Coastal Resources has concluded that if protection is considered necessary, alternatives such as vegetation-based approaches should be explored. This agency has asserted that shoreline hardening "may result in loss of productive habitat areas which support the fish and wildlife resources of Flanders Bay Wetlands." Several rare bird species are found in the Flanders Bay Wetlands, including least tern, common tern, piping plover, black skimmer, osprey, and common loon. Waterfowl also feed in and around the wetlands. Midwinter aerial surveys averaged 125 birds per year in the wetlands and 700 birds per year in the adjacent bays over the period 1986–1996. Diamondback terrapin are also found in the marshes and beaches along Flanders Bay.[183]

Sea Level Fen

A sea level fen vegetation community grows along Flanders Bay.[184] This rare type of coastal wetland grows only under the unusual circumstances where there is a natural seep from a nearby slope providing nutrient-poor groundwater to support its unique vegetation, and where there is protection from nutrient-rich tidal flow (see Section 3.1). Because of the need of sea level fen vegetation for nutrient-poor waters, the Flanders Bay sea level fen may not survive inundation by sea level rise.

Estuarine Beaches

Barrier beaches are less common than tidal wetlands in the Long Island Sound study area, but beaches may be at greater risk because sea level rise will accelerate shoreline erosion. Headland erosion is the dominant type of beach development along the Sound's Long Island shoreline.[185]

Notable undeveloped barrier beaches along the north shore of Long Island include those fronting Hempstead Harbor,[186] the beach-wetland system on Eatons Neck Point,[187] the Port Jefferson Beaches near the Town of Brookhaven,[188] the Nissequogue Inlet Beaches at the mouth of the Nissequogue River in the Town of Smithtown,[189] and Cedar Point Peninsula in the Peconic Estuary.[190]

The sandy barrier-beach system fronting Hempstead Harbor is typical of these beach systems, and shows a characteristic community progression from the foreshore to the bay side, or backshore. The foreshore occurs between the highest and lowest tide zones. The abundant invertebrate fauna characteristic of this area provide forage for sanderling, semipalmated plovers, and other shorebirds that stop over during migrations.[191] Shorebirds feed on all trophic levels of beach invertebrate communities, including primary consumers (herbivorous insects, amphipods, and isopods, as well as suspension-feeding crabs and bivalves) and the secondary consumers that feed on them (crabs, isopods, polychaetes, and beetles).[192] The maritime beach community between the mean

[183]NYS Department of State, Division of Coastal Resources, 2004, Long Island Sound and Long Island, Flanders Bay Wetlands, pp. 1–4 (see note 171).
[184]NYS Department of State, Division of Coastal Resources, 2004, Flanders Bay Wetlands, p. 1 (see note 171).

[185]Long Island Sound Habitat Restoration Initiative, 2003, *Technical Support for Habitat Restoration, Section 5: Coastal Barriers, Beaches, and Dunes.* November 2003. EPA Long Island Sound Office, Stamford, CT, p. 5-1. Available at: http://www.longislandsoundstudy.net/habitat/index.htm.
[186]NYS Department of State, Division of Coastal Resources, 2004, Hempstead Harbor (see note 171).
[187]NYS Department of State, Division of Coastal Resources, 2004, Eatons Neck Point (see note 171).
[188]NYS Department of State, Division of Coastal Resources, 2004, Port Jefferson Beaches (see note 171).
[189]NYS Department of State, Division of Coastal Resources, 2004, Nissequogue Inlet Beaches (see note 171).
[190]NYS Department of State, Division of Coastal Resources, 2004, Cedar Point Peninsula (see note 171).
[191]Long Island Sound Habitat Restoration Initiative, 2003, p. 5-2 (see note 185).
[192]See, for example, Bertness, 1999 (see note 133).

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 federally listed threatened northeastern beach tiger beetle, and horseshoe crab. Dunes and the upper limit of the backshore beach is used for nesting by diamondback terrapin.[193] They also nest on dredged sands and have been observed nesting on artificial dikes in the town of Fairfield, Connecticut.[194]

One study involving interviews with local planners found that nearly all of the Long Island shoreline of the Sound is "almost certain" to be protected in response to sea level rise. The study assumed that property owners fund their own shore protection. Moreover, 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." [195]

Tidal Flats

Longshore drift, which usually occurs from east to west along the Sound's Long Island shoreline, carries some of the material that erodes from bluffs and later deposits it to form tidal flats and barrier spits or shoals.[196] Shoals along the Long Island shoreline, particularly around Duck Point, Baiting Hollow, and the Port Jefferson area, provide forage for numerous bird species as well as habitat for shellfish.[197] There is hard clam habitat around the northern bays.[198] One of the largest areas of tidal mudflats on the north shore is near Conscience Bay, Little Bay, and Setauket Harbor west of Port Jefferson. Large beds of hard clams, soft clams, American oysters, and ribbed mussels are found in this area.[199] In western Long Island Sound, low marsh is converting to tidal flats as seas rise.[200] 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.[201] It is known, for example, that shorebird abundance is directly correlated with the abundance of invertebrate forage.[202]

NEARSHORE SHALLOW WATERS AND SUBMERGED AQUATIC VEGETATION (SAV)

Eelgrass distribution along the Sound is limited to the Peconic Estuary.[203] The Marine Program of Cornell Cooperative Extension of Suffolk County is monitoring sites in Bullhead Bay, Gardiners Bay, Northwest Harbor, Orient Harbor, Southold Bay, and Three Mile Harbor (see Map 3.1).[204] The U.S. Fish and Wildlife Service reports that eelgrass beds of statewide significance are in Orient Bay[205] and Cedar

[193]Long Island Sound Habitat Restoration Initiative, 2003, pp. 5-3, 5-4 (see note 185).
[194]Ron Rosza, email to EPA 2/20/07 (discussing visual observations) (see note 173).
[195]Long Island Sound Habitat Restoration Initiative, 2003, p. 5-7 (see note 185).
[196]Long Island Sound Habitat Restoration Initiative, 2003, pp. 5-1, 5-2 (see note 185).
[197]Important Ecological Areas in and Around Long Island Sound, Map Panel 9 of 10 – Riverhead Area and Map Panel 8 of 10 – Port Jefferson Area, n.d., produced by the USFWS Service, Coastal Ecosystems Program, Charlestown, RI, for Long Island Stewardship Initiative. Available at: www.rpa.org/maps/lismaps.html.
[198]USFWS, 1997 (see note 172)
[199]NYS Department of State, Division of Coastal Resources, 2004, Conscience Bay, Little Bay and Setauket Harbor, p. 1 (see note 171).
[200]Ron Rosza, email to EPA, 2/20/07 (discussing visual observations) (see note 173).
[201]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, p. 103.
[202]See, for example, Evans, P.R., and P.J. Dugan, 1984, "Coastal birds: Numbers in relation to food resources," in P.R. Evans, J.D. Goss-Custard, and W.G. Hale (eds.), *Coastal Waders and Wildfowl in Winter*, Cambridge University Press, Cambridge, U.K.
[203]Eelgrass does not occur along northern Long Island Sound because of nutrient enrichment.
[204]Schott, S. 2003. Eelgrass Monitoring: Historic Distribution and Current Trends. Presentation at the 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; Tiner, R., H. Bergquist, T. Halavik, and A. MacLachlan. 2003. Eelgrass Survey for Eastern Long Island Sound, Connecticut and New York. U.S. Fish and Wildlife Service, National Wetlands Inventory Program, Northeast Region, Hadley, MA. National Wetlands Inventory report.
[205]NYS Department of State, Division of Coastal Resources, 2004, Orient Bay, p. 1 (see note 171).

Point/Hedges Bank Shallows.[206] A recent survey found 15.7 acres of eelgrass on the north shore at Mulford Point, and 194 acres on Fisher's Island.[207]

The estuary's eelgrass beds provide food, shelter, and nursery habitats to a diversity of species, including worms, shrimp, scallops and other bivalves, crabs, and fish.[208] 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. Atlantic silverside is an important prey species that spawns here; silverside eggs provide an important food source for seabirds, waterfowl, and blue crab, and adults are prey for bluefish, summer flounder, rainbow smelt, white perch Atlantic bonito, and striped bass. The Cedar Point/Hedges Bank Shallows eelgrass beds are known for supporting a bay scallop fishery of statewide importance.[209]

The consequences of sea level rise for SAV are unknown. However, Short and Neckles (1999) predicted that a 50 cm (19.7 in.) increase in water depth as a result of sea level rise, which could occur in this century, could reduce the light available for seagrass photosynthesis by 50 percent, which would reduce eelgrass growth by 30–40 percent.[210] In turn, this would result in reductions in the productivity and functional values of seagrass beds. This implies that reductions in the growth and survival of eelgrass beds around the Peconic Estuary could harm local populations of scallops, which support a valuable fishery, as well as horseshoe crabs and other species that are prey for many species of commercial, recreational, and ecological value.

The movement of eelgrass beds shoreward as seas rise could be impeded by steep shores or erosion and water turbidity in front of shoreline protection structures. Local planners believe that shorelines around Shelter Island, Robins Island, the Conscience Point National Wildlife Reserve, the E.A. Morton National Wildlife Reserve, Novack, Sag Harbor, Orient Point and Orient Beach, and Napeague Bay will be allowed to respond naturally to sea level rise. Other shorelines of the Peconic Estuary are considered "likely" or "almost certain" to be protected, and if these shorelines are hardened, SAV will be unable to migrate in response to sea level rise.

MARSH AND BAY ISLANDS

Several offshore islands in western Long Island Sound are significant for their colonial wading bird rookeries. The most important are Huckleberry Island, Great Captain Island, North Brother Island, South Brother Island, and Pelican Island. These islands are rocky and mostly covered by deciduous forest; their rocky shorelines provide habitat for species such as shellfish, sea stars, and barnacles. North and South Brother islands have the largest black crowned night heron colony in New York State, along with snowy egret, great egret, cattle egret, and glossy ibis.[211] The islands' bird colonies are of regional significance, and loss of island area with sea level rise could have far-reaching consequences.

[206]NYS Department of State, Division of Coastal Resources, 2004, Cedar Point/Hedges Bank Shallows, p. 1 (see note 171).
[207]Tiner et al., 2003 (see note 204); see also http://counties.cce.cornell.edu/suffolk/habitat_restoration/projectpage/StT/eeprojectsStT.htm.
[208]Peconic Estuary Program, 2001, Peconic Estuary Comprehensive Conservation and Management Plan, sponsored by the USEPA under Sec. 320 of the Clean Water Act, Suffolk County Department of Health Services, Program Office, p. 4-4.
[209]NYS Department of State, Division of Coastal Resources, 2004, Cedar Point/Hedges Bank Shallows, p. 2 (see note 171).
[210]Short, and Neckles, 1999, p. 175 (see note 91).
[211]USFWS, 1997, pp. 612–614 (see note 172).

The Long Island Sound Study considers Plum Island, Little Gull Island, and Great Gull Island off Orient Point "exemplary" colonial waterbird habitat, with sites "of national—if not international—significance."[212] The islands are relatively small and covered with grassy and herbaceous vegetation. According to the North Fork Audubon Society, Great Gull Island hosted 1,500 pairs of the endangered roseate tern in

1996 and 7,750 pairs of common tern.[213] The Long Island Sound Study reports that this population is the second largest breeding population of the roseate tern in North America.[214]

Gardiners Island,[215] Robins Island,[216] and Cow Neck[217] in Little Peconic Bay are in private ownership, and therefore staff of the Suffolk County Department of Planning believe that the shorelines of these properties will be left in a natural state. These islands provide habitats for many rare species such as roseate tern, common tern, least tern, northern harrier, red-tailed hawk, eastern mud turtle, and diamondback terrapin. Even if some protection of the islands' shorelines does occur, it seems likely that it will involve vegetation-based approaches rather than shoreline hardening to help preserve these valuable habitats.[218]

[212]Long Island Sound Study, LIS Stewardship Initiative**,** a cooperative effort involving researchers, regulators, user groups and other concerned organizations and individuals. Accessed December 4, 2007 at: http://www.longislandsoundstudy.net/stewardship/stewardship_sites.htm.

[213]Fact sheet by North Fork Audubon Society entitled *Great Gull Island IBA.* Accessed December 4, 2007 at: http://www.northforkaudubon.org/Gui/Content.aspx?Page=IBAGreatGull.

[214]Long Island Sound Study (see note 212).

[215]NYS Department of State, Division of Coastal Resources, 2004, Gardiners Island (see note 171).

[216]NYS Department of State, Division of Coastal Resources, 2004, Robins Island (see note 171).

[217]NYS Department of State, Division of Coastal Resources, 2004, Cow Neck (see note 171).

[218]For example, see NYS Department of State, Division of Coastal Resources, 2004, Robins Island, p. 5 (see note 171).

Map 3.1. Locations and Types of Habitat Discussed in this Report: Long Island