STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

FACING OUR FUTURE:

Natural Coastal Shoreline Environment

Adapting to Connecticut's Changing Climate

"The biggest problem is that climate change and sea-level rise will come on top of the existing effects of habitat loss along the shore. Consequently, species that are already in a precarious state will have to deal with an additional set of problems. Ultimately, large-scale land use planning and better long-term monitoring of the state's biological diversity are the best ways to address all of these issues."

Sound Health 2008 'Wildlife & Habitats' Chris Elphick, PhD, Conservation Biologist, Department of Ecology & Evolutionary Biology, University of Connecticut

Coastal Implications

The region's largest estuary with an area of 1,320 square miles, Long Island Sound is home to more than 120 species of finfish and countless varieties of birds and other animals. Between New York and Connecticut, the Sound's coastline stretches more than 600 miles. Over the last three decades, Connecticut has made a significant commitment to protecting and restoring the Sound. Hundreds of millions of dollars have been invested to address pollution concerns and protect the tidal wetlands along its shore.

As climate change brings warming temperatures and intensified sea level rise to Connecticut's coastline we must begin to take action to protect the ecosystem. Along with other stressors the changing climate is impacting Connecticut's natural coastal environment in ways that may not support the continuation of current coastal habitats.

Sea Level Rise – Sea level rise projections vary but moderate estimates from a 2001 report by the Intergovernmental Panel on Climate Change state that global warming of 2.5° to 10.4° F (1.4°-5.8° C) could lead to a sea level rise of four inches to 2.9 feet by 2100. This does not take into consideration estimates incorporating the more dramatic melting of ice sheets that may already be occurring.

Shoreline Erosion - Accelerating sea level rise will mean that the average shoreline erosion rate, which in certain areas of Connecticut reaches one to three feet per year, will increase. Shoreline erosion could increase even more with the increased frequency and intensity of hurricanes and nor'easters that are anticipated. As a consequence, the terrestrial footprint of Connecticut decreases every year in response to sea level rise, a phenomenon that has been occurring for thousands of years but is now accelerating.

Barrier Beaches - Beaches with dunes, such as Long Beach in Stratford and Bushy Point Beach at Bluff Point in Groton, form barriers across water bodies creating sheltered lagoons and tidal wetlands. As sea level rises, storms wash the dunes into the lagoon, and the dunes rebuild and migrate landward. Under accelerated sea level rise, it is not known if these beaches will endure. These natural beaches contain rare plant communities and host endangered bird species like piping plovers. Endangered plovers nest on sandy beaches on open ground, a habitat that is being eliminated by these subtle and not so subtle changes in the coastline.

Further upland, existing coastal forests are experiencing the impacts of sea level rise. In Stonington at the edge of the Barn Island wetlands, a forest of black gum trees is being inundated more frequently by high tide events. Since these trees are not adapted to a high level of salt around their roots, their habitat is threatened. (Other forestry stressors are identified in the Forestry fact sheet).

Hypoxia – The severity of low dissolved oxygen (hypoxia) in the bottom waters of Long Island Sound is dependent on several factors not the least of which are seasonal temperature extremes. Changing weather patterns, including both warmer temperatures and shifting winds brought on by climate change, are important drivers. In Long Island Sound, nutrient loading, primarily in the form of nitrogen, stimulates algal growth. Climate change can exacerbate nutrient loading (see Water Resources Fact Sheet) and, combined with warmer water temperatures and wind changes, Connecticut has begun to see some effects. Excessive nutrient loading stimulates algal blooms and, when the algae and zooplankton settle into the darker, cooler bottom waters, their decomposition uses up the dissolved oxygen in the bottom waters, causing hypoxia.

During the summer, the strong temperature difference between surface and bottom waters causes stratification that prevents oxygenated surface water from circulating downward so that bottom-dwelling, oxygen-dependent organisms die or swim away to other waters where there is oxygen. Monitoring data suggests that warmer surface waters and shifts in wind patterns associated with climate change are strengthening stratification. While increased wind and rain events can remix the water to dissipate hypoxia, increased fresh water in the surface waters also exacerbates stratification by creating salinity density differences much as temperature does. These climate change effects may be altering the location and duration of hypoxia in Long Island Sound. If these trends continue, the benefits of nitrogen management efforts may be offset by the physical changes brought on by climate change, and water quality goals for hypoxia will not be met. (For the implications of a changing climate on fisheries see the Fisheries fact sheet).

Globally Significant Habitat - Barn Island is a unique location with five tidal marshes. Tidal wetlands are one of the most productive habitats on the globe, second only to rain forests. They developed several thousand years ago when sea level rise rates slowed to 1 mm/yr. Under the two millimeter rise of the past century, most persisted except for areas in western Long Island Sound where the lower elevation grasses have been converting to mudflat over several decades. Marshes can keep pace with sea level by accumulating sediment and building soil with roots but scientists do not know at what sea level rise rate marshes will drown. The highest forecasts of 15 mm/yr (0.6 in/yr) are very likely to cause marsh grass drowning making future tidal wetlands only narrow fringes. It is expected that there will also be a loss of plant diversity and regional genetic stock.

Example of wetland loss from submergence of the Quinnipiac River marsh in LIS. Wetland loss should increase with accelerated sea level rise.

Nowhere To Go - Tidal marshes grow vertically and move horizontally landward with rising sea level. However, in places where there are cliffs or developed lands (e.g., bulkheads and seawalls) the otherwise natural progression of the marsh toward the upland side becomes an impossible task. The marsh is essentially squeezed out of existence as the higher salt water drowns the seaward grasses and the land wall blocks the grasses on the landward side from moving inland. Losses of coastal wetlands reduce an important buffer against the impacts of storm surges, flooding and releases of pollutants from the land. (See the Infrastructure and Water Resources fact sheets for more details).

The freshwater and brackish tidal marshes of the Connecticut River were designated as Wetlands of International Importance in 1994. If the snowpack decreases in New England, and subsequently the spring freshet is reduced, and other precipitation patterns do not adjust to

subsidize this deficiency, salt water will move further upriver. Under this scenario, new brackish marshes will begin to replace freshwater tidal marshes.

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Vulnerable Species - Timing is critical for the saltmarsh sharp-tail sparrow that only nests in high parts of the high marsh in short grass. Its cycle of laying eggs, hatching and independence of hatchlings only takes 27 days. However, as hydrology shifts in the marsh it can disrupt this cycle causing eggs or hatchlings to be washed out of their nests. This bird species may be one of the more vulnerable to sea level rise in North America because a few inches of sea level rise results in a loss of their narrow band of breeding habitat.

Seaside sparrow, which only occurs in a few large marshes in Connecticut, is another coastal species dependent upon salt marsh habitats. The loss of these habitats due to sea-level rise is also expected to reduce the area of habitat available for feeding and cover. This change of reduced overall habitat area will particularly affect the seaside sparrow. (For more about habitats see the Biodiversity and Wildlife fact sheets).

Why Action is Needed Now

With accelerated sea level rise, in combination with other varied stressors, important natural links will be broken and others will form with unforeseen results. It is uncertain how quickly, if at all, species will be able to adapt to sea level rise in conjunction with all of the other variables such as direct human interference and encroaching invasive species. Because of these uncertainties it is incumbent upon Connecticut to protect existing habitats and make plans to minimize and hopefully reverse these projected changes to Connecticut's coastal environment.

Continued and new monitoring is needed to better quantify the impacts of climate change and evaluate the success of adaptation strategies. The Connecticut Department of Environmental Protection (CTDEP) and educational affiliates will need to conduct environmental monitoring to determine the success of preservation and restoration efforts relative to a baseline and whether or not the strategies need to be adjusted. Critical areas that warrant closer monitoring include sites like the Housatonic River, Nells Island and Barn Island, so predictions concerning the resilience of the natural coastal environment can be made in ways that inform us about necessary investments for long term ecological health.

To make our shoreline and its communities and habitats more resilient, existing conceptions of property rights and regulatory authorities must be reevaluated. New approaches must be considered in light of the need for tailored and thoughtful variation in response to rising sea levels and more frequent and intense storms. New or revised policies for establishing clear standards and encouraging sustainable and economically viable outcomes regarding shoreline armoring versus retreat, proactively protecting habitats and ensuring responsible growth are all part of what Connecticut needs to be doing as part of an adaptation strategy in the face of a changing climate. The CTDEP can lead by example through fully evaluating proactive measures, including the potential for retreat as an option to protect natural coastal habitats in state managed lands.

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What Connecticut is Doing

Information management - In 2008, the CTDEP partnered with the University of Connecticut Marine Sciences Program to begin the development of a monitoring strategy to assess how climate change will affect the coastal ecoregion and coastal waters of Connecticut. Ocean observing systems and sentinel monitoring sites are essential to accurate tracking of change and the development of effective adaptation plans. The EPA Long Island Sound Study supports climate change monitoring and provided Connecticut and New York with startup funds to further the development of a strategy and fund new monitoring. In partnership with the CTDEP, the United States Geological Survey and the University of Connecticut Marine Sciences Program, funding was received from the Long Island Sound Fund to install, maintain and operate real-time recording salinity gauges on the Connecticut River to evaluate the upstream migration of the salt water wedge and the consequences for the river's wetlands, designated as Wetlands of International Importance. This continues the CTDEP's collaborative administrative stewardship of long term monitoring projects to ensure, into the future, continuity over the continuum of researchers from various educational and environmental organizations.

The CTDEP has recently acquired high resolution elevation data for the coastal hazard zone of the coast that could assist with the production of inundation scenarios based on sea level rise projections. These data could also be helpful in identifying low-lying lands along the coast that could sustain tidal wetlands in the future.

The CTDEP has created historic shoreline information in GIS that can be used with modern shoreline maps being generated by the National Oceanic and Atmospheric Administration (NOAA) to calculate rates of shoreline erosion.

Education – As published in the *Sound Outlook* (June 2008), Connecticut Sea Grant, with the support of the CTDEP, recently received a grant to raise public awareness of the significance of the Connecticut River estuary and tidal wetlands complex as it relates to the 1994 designation of Ramsar Wetlands of International Importance and to World Wetlands Day. Connecticut recognizes the need to identify the most vulnerable habitat types, and living resources, and closely monitor and examine climate change scenarios to devise adaptation responses.

In Conclusion - Future climate change impacts to Connecticut's treasured coastline could be substantial. To help mitigate these impacts the CTDEP will: continue to protect state managed coastal lands, monitor changes in ecological indicators, and seek proactive options to protect coastal habitats in a way that fosters adaptation to changing climatic conditions.

This is one of eight documents in the series *Facing our Future* concerning Connecticut's changing climate, www.ct.gov/dep/climatechange

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IMPROVEMENTS AND CHALLENGES FOR TODAY

Individual, Corporate, Municipal and State Stewardship

- Review rights and opportunities in shoreline development, see the CTDEP's web site at www.ct.gov/dep/cwp/view.asp?a=2705&q=323542&depNav_GID=1622&depNav=|
- Eliminate the use of fertilizers, pesticides and herbicides in coastal communities to help mitigate the effects of hypoxia.
- Assess estuary vulnerability, see EPA's Climate Ready Estuaries program.
- Review Rhode Island Sea Grant website, including a national summary of responses to sea level rise by state, seagrant.gso.uri.edu/ccd/haz.html
- Utilize updated USGS saltwater intrusion mapping for Connecticut, once available.
- Monitor sea level rise relative to elevation to better understand the impacts on wetlands.
- Identify areas adjacent to Connecticut's major tidal marshes capable of accommodating the inland migration of marshes as sea-levels rise and, where appropriate, acquire these areas for conservation purposes.
- Consider possible adaptation strategies including utilizing seed banks.
- Employ beneficial use of dredged material for artificial high marsh.
- Continue to work with the Coastal Hazards Standing Committee of the Northeast Regional Ocean Council to acquire the data and tools that are needed for hazards planning and sea level rise adaptation.