Synthesis of coastal resilience information for human and ecological planning for climate change

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The North Atlantic Landscape Conservation Cooperative (LCC)

Atlantic and Gulf Coast Resiliency Project

Compilation and synthesis effort on sea level rise and storm impacts to priority coastal resources and management alternatives

North Atlantic LCC
North Atlantic Landscape Conservation Cooperative

Landscape Conservation Cooperatives

NE CSC
Northeast Climate Science Center

Peninsular Florida Landscape Conservation Cooperative

South Atlantic

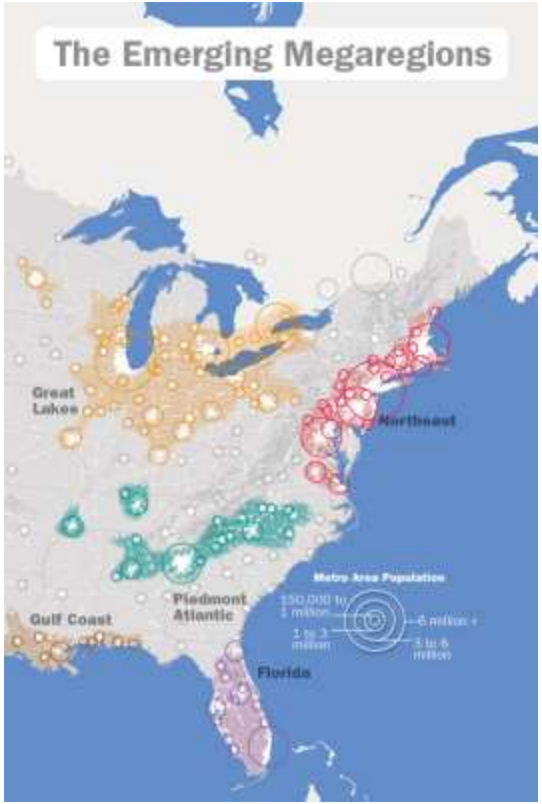
Gulf Coast Prairie
Landscape Conservation Cooperative

CLCC

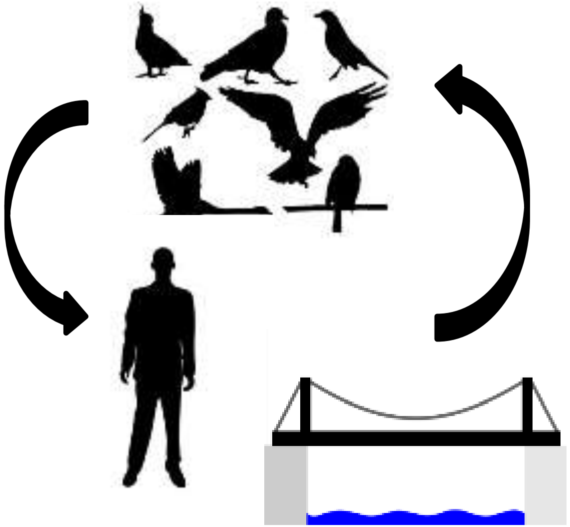
GCPO
Gulf Coastal Plains & Ozarks
Landscape Conservation Cooperative

South Central
Climate Science Center

Department of the Interior
SE Climate Science Center

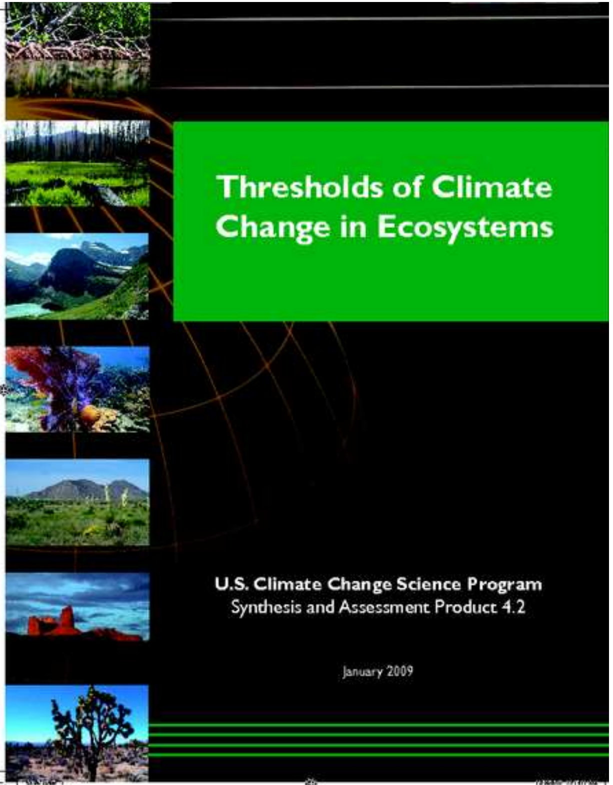

The Emerging Megaregions
Great Lakes
Northeast
Piedmont Atlantic
Gulf Coast
Florida
Metro Area Population
150,000 to 1 million
1 to 3 million
6 million +
3 to 6 million

$$$



Objectives:

1. Relate existing projections of SLR and storms to impacts on habitats and populations of priority fish and wildlife species of conservation concern.
2. Assess restoration and management alternatives for increasing persistence and resilience of these habitats and species as they relate to NBS for community resilience.
3. Identify remaining gaps, needs, best practices.



The capacity to predict, manage, and adapt to threshold crossings that could trigger large-scale, abrupt changes in ecosystems and/or the services they provide is an apparent information need for those responsible for making management decisions for rare species.

45 Focal Species











Coastal Habitats

- Tidal Marshes
- Beaches, Barrier Islands
- Shellfish Beds
- Mangroves




Common Name *(Scientific Name)*	**Habitat**		**Thresholds Related to Projections of Sea Level Rise and Storms**	**References**
	Tidal Marsh	Beaches/Barrier Islands		
Red knot *(Calidris canutus)*	X	X	• 0.6 m relative SLR could reduce foraging areas by 57% or more by 2100 in Delaware Bay. • 1-2 m SLR leads to a major loss of coastal wintering habitat for shorebirds in North America, particularly in areas with land subsidence like the Gulf Coast.	Titus et al. 2009; Galbraith et al. 2014
Snowy plover *(Charadrius nivosus)*		X	• 2 m SLR increased risk of extinction to 3.7% more than the baseline risk of about 7% for populations on west coast of Florida; the risk of a decline to 20 birds was 7.6% more; and the expected minimum abundance was 27.3 individuals less than without any SLR. The risk of extinction in the next 90 years increases from about 7% to 9% for 1 m of SLR and up to 11% for 2 m SLR.	Aiello-Lammens et al. 2011
Green sea turtle *(Chelonia mydas)*		X	• A 0.59 m SLR would inundate 28% of total nesting area, with the extent of inundation for individual beaches ranging from 11% to 36%. • 63% of nests about 45 miles from the eye of Hurricane Andrew were lost or destroyed.	Fuentes et al. 2010; Milton et al. 1994
Salt meadow Cordgrass *(Spartina patens)*	X		• Salinities between 30 and 40 ppt will cause stress, but not mortality; they can survive salinities upwards of 60-93 ppt, but the combination of elevated salinity and flooding frequency (more frequent high tides with longer inundation periods) may be the key abiotic stress in high marsh.	Smith et al. 2012

Tidal Marshes

Study Area	Projected Response to SLR	References
Mid-Atlantic	• Conversion to open water with 7-10 mm/yr of SLR above current rates, as could occur under a 1 m SLR scenario by 2100.	Reed et al. 2008
Delaware	• >95% inundated with a SLR of 0.5 m; 100% inundated with a SLR of 1 and 1.5 m, regardless of land conservation budget • 20% and >57% loss of intertidal shorebird feeding habitat with a 0.34 m global SLR by 2050 and 2100, respectively; 43% loss with a 0.8 m SLR by 2050, though habitat could increase by 2100 if coastline migrates inland and dry land converts to intertidal	Shriver and Wiest 2013; Galbraith et al. 2002
Southeast Coast	• *S. alterniflora* dominated marshes could survive SLR rates up to 12.5 mm/yr, if there is high sediment supply	Morris et al. 2002
Georgia Coast	• 0.8 m SLR by 2100 led to declines of 45% for salt marsh, 39% for tidal freshwater, and 1% for tidal brackish marsh areas (likely for entire SE coast). A 0.5 m SLR caused an overall 20% reduction in salt marsh.	Craft et al. 2009
Merritt Island NWR, Florida	• 1 m SLR showed an 82% reduction in irregularly-flooded marsh habitat by 2100 and a 2 m SLR in the same timeframe resulted in 92% loss of habitat.	USFWS 2011
Louisiana Coast	• Ranges below mean water level (MWL) of inundation depth for potential marsh collapse thresholds are: 30.7-35.8 cm for intermediate; 20-25.6 cm for brackish; and 16.9-23.5 cm for saline marsh.	Couvillion and Beck 2013

Results of compilation

- Half (24) of species have quantitative threshold data available
- Birds, reptiles, and plants most well studied groups
- 13 species (29%) are projected to lose at least 50% of their population or habitat (e.g. foraging, nesting, spawning, or resting habitat) in certain areas with a 0.5 m or greater SLR by 2100
- Half of these species lack numeric information, indicating a major information gap
- For many species, data limited by: small # of studies, # and variety of SLR scenarios or storm levels considered, and by spatial scale

Green or Grey: tradeoffs in coastal decision making

Credit: Virginia Institute of Marine Science

Example: Sachuest Point NWR, RI

- RSLR rates are nearly double average accretion rates
- SLR is projected to be up to 2 m above 1990 levels by 2100
- Half or more of existing salt marsh at risk
- The USFWS and TNC are using thin-layer deposition to ensure the marsh surface remains at elevations that can support *S. patens* (<10 cm thickness).
- Target elevation = 2.2-2.3 NAVD88
- Long-term restoration emphasizes the maintenance of tidal marsh bird populations

Example: Delaware Bay

The red knot's sensitivity to a SLR of 0.6 m by 2100 (Galbraith et al. 2002) has prompted management efforts to expand and increase the resilience of coastal impoundments to SLR and storms as roosting habitat during spring migrations.

Photo: Atlantic Coast Joint Venture

Alternative Management & Adaptation Actions

- Tidal flow restoration/salt marsh restoration
- Habitat migration through site assessment, acquisition, and management of adjacent areas
- Expanded network of connected conservation areas
- Beach, dune, barrier island (non)management to restore and/or enable dynamic responses
- Sediment augmentation
- Living shorelines focused on vegetation plantings and non-biogenic materials (e.g. coir logs, rock sills)
- Oyster reef restoration and construction
- Coral reef restoration
- Mangrove restoration and conservation
- Retreat from coasts
- Open space preservation
- Shoreline setbacks/rolling easements
- Incorporate future conditions to extend current land use planning horizons

Co-Benefits of Tidal Flow/Salt Marsh Restoration

Ecological

- Restores natural functioning
- Helps reduce marsh subsidence and collapse to keep pace with SLR
- Improves drainage to minimize flood impacts
- Supports native vegetation while lowering threat and spread of invasive species
- Improves habitat quality for a diversity of marsh-dependent species
- Moderates and restores salinity to natural levels

Human

Regulating

- Increases flood storage capacity
- Dissipates wave energy
- Improves water quality
- Enhances climate mitigation through carbon sequestration and storage (blue carbon)

Cultural

- Supports eco-tourism through fishing, hunting, and wildlife viewing

Supporting

- Provides habitat for recreational and commercial species

InVEST
integrated valuation of ecosystem services and tradeoffs

ESII tool

SolVES
Social Values for Ecosystem Services

e.g. 33 unique studies in U.S. on disturbance regulation by wetlands, beaches and barrier islands, coral reefs, oysters, dunes, and mangroves in GOM (GecoServ)

Examples of how ecological information is informing planning and decision making

- 5 case studies on how SLR projections are informing restoration and management

- 2 case studies on integrative planning for SLR to support the use of nature-based solutions

- 2 case studies on how ecosystem services are being valued and integrated into planning processes and decision making

1: Landscape connectivity to combat SLR
Guana Tolomato Matanzas NERR, Florida

SLR has risen 0.25 m; projected SLR is 0.5-1.5 m by 2100.

- Lowest lying section of vulnerable coastline
- Accelerated erosion
- More frequent, severe flooding
- Saltwater intrusion into aquifers
- Ecosystem changes
- Species migration

1: Landscape connectivity to combat SLR
Guana Tolomato Matanzas NERR, Florida

Impact assessment for 37 species

2 SLR Scenarios: 1 m and 2.5 m by 2100 (SLAMM)

Under a 1 m SLR scenario:

- Loss of habitat for species and habitats, incl. black rail (64%), seaside sparrow (43%), sea turtles (64%)
- Estuarine habitats (salt marshes, mangroves, tidal flats, etc.) likely to convert to open water

1: Landscape connectivity to combat SLR
Guana Tolomato Matanzas NERR, Florida

New adaptation strategies:

- Living shorelines
- Marsh restoration
- Habitat conservation through acquisitions and easements
- Conservation of lands outside reserve to mitigate habitat losses (possible new unprotected land within a 1-mile radius)

2: Valuing corporate coastal hazard mitigation

Dow Chemical Company, Freeport, TX

- A major coastal manufacturing facility
- Located in a low-lying area between 1 and 2.5 m above sea level
- +0.5 m SLR projected by 2050
- Fronted by several miles of undeveloped land and coastal marshes that provide flood protection and habitat for fish and wildlife

Credit: The Nature Conservancy

2: Valuing corporate coastal hazard mitigation

Dow Chemical Company, Freeport, TX

- 6-year, $10 million Dow-TNC collaboration, launched in 2011
- **Goal**: To develop tools and models that help to identify, value, and incorporate ecosystem services into their decision making and operations, with pilot project focusing on mitigating coastal hazards.

Credit: The Nature Conservancy

2: Valuing corporate coastal hazard mitigation

Dow Chemical Company, Freeport, TX

Compared 3 flood mitigation strategies:

1. Coastal habitats only
2. Constructing a levee along 6 miles of undeveloped land
3. Hybrid approach that uses coastal habitat and a levee

2: Valuing corporate coastal hazard mitigation
Dow Chemical Company, Freeport, TX

Levee provides the greatest flood protection BUT coastal wetlands offer additional benefits:

- Habitat for 12 fish species and 200+ other species
- Storm protection = $23 million to Freeport and surrounding communities
- Carbon sequestration net value = $30 million over 30 years
- Recreation value = $130 million

A hybrid approach combining marshes and hardened infrastructure makes the most economic sense at this location by offering the greatest flood protection benefits to communities combined with additional economic and ecological benefit

2: Valuing corporate coastal hazard mitigation
Dow Chemical Company, Freeport, TX

Lessons Learned:

- Created a “normative culture” around value of nature across Dow
- Importance of identifying incentives to build nature into business practices
- Quantifying value of nature can be sufficient to change business decisions when costs and benefits are internal; when they are external, additional market and policy incentives likely required

Challenges and Recommendations: *Ecosystem services*

- Ecological thresholds can offer the highest promise for rapid risk assessment based on benchmarks and rule-of-thumb approaches. For high-value investments, a more formal approach incorporating quantification of goods and services, sustainability, and maintenance costs is needed.
- Cost-benefit analyses should consider long-term cumulative benefits accrued by NBS that may outweigh benefits of hardened infrastructure.
- Risk of failure needs to be realistically quantified for NBS as they cannot be currently measured and communicated as easily as with engineered approaches.
- Increase understanding of the short- and long-term effects of climate change on ecosystem services (e.g. long-term carbon storage) to guide site selection and prioritization of restoration and conservation.

Remaining Challenges and Recommendations:
Increased coordination

- Use landscape conservation design approach to coordinate conservation goals with projected coastal development, land use, and other planning efforts (e.g. SWAPs invite representatives of municipal, county, and/or regional planning entities to serve on conservation plan committees).

- Utilize LCCs and CSCs to bring multiple partners together to identify shared priorities and prioritize landscape-level actions (e.g. Regional Conservation Opportunity Area process for the North Atlantic (Maine to Virginia) and the emerging Southeast Conservation Adaptation Strategy effort in the Southeast).

For more information:

http://northatlanticlcc.org/groups/coastal-resiliency/topics/atlantic-gulf-coast-resiliency

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