GULF COAST VULNERABILITY ASSESSMENT

11/1/2015

Executive Summary

The Gulf Coast Vulnerability Assessment (GCVA) is a collaborative effort to evaluate the vulnerability of four key ecosystems and 11 associated species to the effects of climate change, sea level rise, and land use change across the U.S. portion of the Gulf of Mexico.

Gulf Coast Vulnerability Assessment

EXECUTIVE SUMMARY

The Gulf Coast Vulnerability Assessment (GCVA or "Assessment") is a collaborative effort to evaluate the vulnerability of four key ecosystems and eleven associated species to the effects of climate change, sea level rise, and land use change across the U.S. portion of the Gulf of Mexico. It is designed to inform land managers, researchers, and decision makers about the relative vulnerability across individual species and ecosystems and how that vulnerability varies spatially across the Gulf region for each.

The GCVA is a qualitative assessment that compiles the expert opinions of managers, scientists, administrators, and others. The results presented herein represent informed opinions of the experts engaged, and as such, they reflect individual experiences, values, and perspectives. With an understanding of these limitations, these results are extremely useful in helping identify the relative vulnerabilities of ecosystems and species in different areas of the Gulf Coast, as well as across taxa and habitat types. One anticipated application of this information is in project and proposal review, as a means to identify vulnerable resources that may require a greater level of scrutiny to ensure sustainability. Similarly, using this information to broadly evaluate where increased conservation effort should be directed to reduce vulnerabilities (i.e. adaptation) is another intended use of these results. From a research perspective, high variability in assessors' individual scores for specific aspects of the assessment help identify where uncertainties exist that should be the target of further investigation. The authors caution that these results should not be applied at scales below the subregion without careful consideration.

This was a team effort led to completion by a Core Planning Team coordinated by Amanda Watson. Ecosystem and Species Expert Teams were established for each of the four ecosystems evaluated: Mangrove work was led by Laura Geselbracht (The Nature Conservancy); Tidal Emergent Marsh by Mark Woodrey (Grand Bay NERR/Mississippi State University); Oyster Reef by Megan LaPeyre (U. S. Geological Survey/LSU Agricultural Center); and Barrier Islands by P. Soupy Dalyander (U. S. Geological Survey). Additional authors included Blair Tirpak (U. S. Geological Survey/Gulf Coast Prairie LCC), Joshua Reece (Valdosta State University), and Cynthia Kallio Edwards (Gulf Coast Prairie LCC).

The Core Planning Team, Ecosystem and Species Expert Teams, and the individual assessors are collectively referred to as the Assessment Team throughout the document.

SECTION 1: INTRODUCTION

SUMMARY:
This section describes the components of vulnerability assessments, the importance of the habitats of the Gulf Coast region to fish and wildlife species, the economy, and culture. It includes a description and map of the six subregions covered in this Assessment.

MAIN POINTS:
Throughout the GCVA, the term **vulnerability** refers to potential impact (estimated as the combined exposure to and sensitivity of ecosystems and species to potential threats) coupled with adaptive capacity (the ability to sustain or modify despite ecosystem changes).

- The main threats to the Gulf Coast region include hypoxia, urbanization, sea-level rise, wetland loss, altered freshwater inflows, and invasive species.

- The Gulf Coast provides valuable energy resources, abundant seafood, extraordinary beaches, and a rich cultural heritage. Coastal ecosystems are of central importance to communities that rely on them for their livelihood, food, and leisure.[i] As a result, a decline in ecosystem health can have a direct and significant impact on the economy and overall well-being of coastal citizens.

SECTION 2: ECOSYSTEMS & SPECIES ASSESSED

SUMMARY:
This section includes an overview of each of the four main ecosystems assessed; and the species associated with each of them. The four coastal ecosystems were chosen primarily on the availability of data and models. The species chosen are widely distributed across the Gulf, are recognized as conservation targets by at least one LCC, and/or are representative of how other species may be impacted by projected changes.

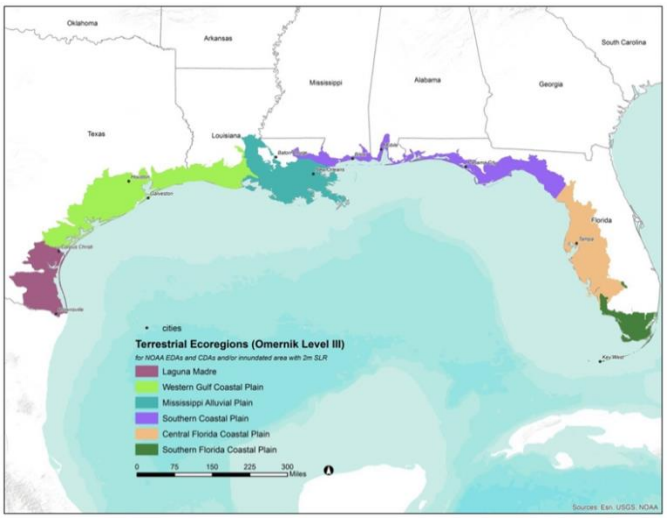


Fig. 1 GCVA subregions modified from the full extent of EPA Level III Terrestrial Ecoregions

MAIN POINTS:

1) MANGROVES are tidally-influenced tropical or subtropical forests found on intertidal mud flats along estuary shores that may extend into river courses.

- The **roseate spoonbill** nests in the Gulf of Mexico along the coasts of Texas, Louisiana, and south Florida and is found throughout the Gulf Coast region outside of breeding season.

2) TIDAL EMERGENT MARSH is dominated by emergent vegetation found along low-wave-energy intertidal areas of estuaries across a range of salinities from fresh to saline.

- **Blue crab** is a valuable commercial species across its range and also has an important role in the structure and function of the estuary.
- **Clapper rail** distribution depends on the presence of tidal salt marsh and fiddler crabs.
- **Mottled duck** is a resident waterfowl species that occurs along the Gulf Coast in two distinct populations – one in the western Gulf and the other in south Florida.
- **Spotted seatrout** depend on estuaries for feeding, spawning, and nursery grounds.

3) OYSTER REEFS are created from the shells of oysters both living and dead, which then provide a hard substrate for oyster larvae to settle, continuing the reef building cycle.

- **Eastern oyster** is a commercially important species scattered throughout the bays and estuaries of the Gulf of Mexico.
- **American oystercatcher** is a shorebird that breeds and winters across the Gulf and has a highly specialized bill for foraging on mollusks.
- **Red drum** is a highly mobile and popular game fish found along the entire Gulf Coast.

4) BARRIER ISLANDS formed during the deceleration of sea level rise over the past 5,000 years and persist from sand delivered from onshore sources and longshore transport. They are the first line of defense for protecting mainland coastal ecosystems from the direct effects of wind, waves, and storms.

- **Black skimmer** is a beach-nesting species that nests in colonies on sparsely vegetated beaches and spoil islands.
- **Kemp's ridley sea turtle** is the world's most endangered sea turtle, with primary nesting regions in Mexico and Texas and scattered nests across the Gulf Coast.
- **Wilson's plover** is a medium-sized shorebird found primarily along dunes and beaches.

SECTION 3: METHODS

SUMMARY:

This section describes the expert engagement process that was used to complete the assessment and brief descriptions of the data sources that were used. Most importantly it explains the Standardized Index of Vulnerability and Value Assessment (SIVVA),[ii] the assessment and prioritization tool that incorporates threats from climate change, land use change, and sea level rise and which was used to conduct the GCVA.

MAIN POINTS:

- The year 2060 was chosen as an assessment timeframe because it coincides with other projects along the Gulf Coast, such as the Southeast Conservation Adaptation Strategy, Florida's Statewide Climate Scenarios, and the State of Louisiana's Coastal Master Plan.
- Assessors were provided with data and maps on climate projections, sea level rise, and projected urban growth for each subregion.
- Assessors were asked to evaluate species and ecosystem vulnerability under 3 different scenarios:
    - low CO_2 emissions (B1 and RCP 2.6) and low (0.41 m) sea level rise
    - low CO_2 emissions (B1 and RCP 2.6) and high (0.82 m) sea level rise
    - high CO_2 emissions (A2 and RCP 8.5) and high (0.82 m) sea level rise
- Assessor engagement was led by Ecosystem and Species Expert Team (ESET) leads, and 144 assessments (each consisting of the 3 scenarios) were completed by 59 individual assessors across the Gulf.

SECTION 4: RESULTS: ECOSYSTEM & SPECIES VULNERABILITY

SUMMARY:

This section describes the threats, adaptive capacity, and overall vulnerability for each ecosystem and species. Figures spatially depict the average vulnerability scores for ecosystems and species as well as vulnerability across climate scenarios and subregions. Given the qualitative nature of the SIVVA, there were minimal differences among the assessments across the three climate scenarios. As a result, vulnerability results display only the most conservative scenario (low CO_2 emissions and low sea level rise).

MAIN POINTS:

- The range in vulnerability scores for species was fairly wide with blue crab at the low end (average vulnerability of 0.30) and Kemp's ridley sea turtle demonstrating high vulnerability (average vulnerability score of 0.71).
- Ecosystem vulnerability across the four systems differed less than it did for species with mangroves being the least vulnerable (average score of 0.62) and tidal emergent marsh being the most vulnerable (average score of 0.70).
- The vulnerability of ecosystems was calculated by averaging the scores from the SIVVA Ecosystem Status and Potential Impact modules. The vulnerability of species was calculated by averaging the scores from the SIVVA Potential Impact (exposure + sensitivity) and Adaptive Capacity modules.

VULNERABILITY: Mangroves & Roseate Spoonbill

MANGROVES

Everglades Mangrove Island/D. Grimes/NPS

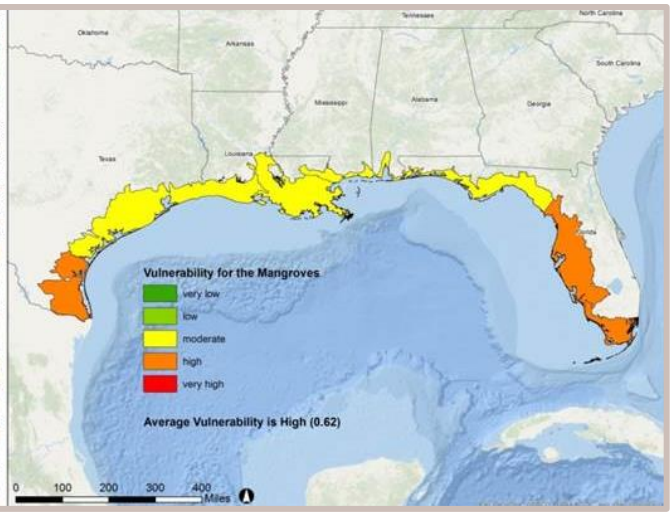


Fig. 2 Vulnerability of Mangroves

Mangroves were highly vulnerable in the Laguna Madre, Central Florida Coastal Plain, and Southern Florida Coastal Plain; and moderately vulnerable elsewhere (Figure 2). Mangrove expansion has been documented in Texas, Louisiana, and Florida; however, future expansion will be dependent on the ability of mangroves to keep pace with sea level rise. The high vulnerability scores reflect mangrove loss based on sea level rise estimates and constraints on range shifts.

ROSEATE SPOONBILL

Roseate Spoonbill/USFWS

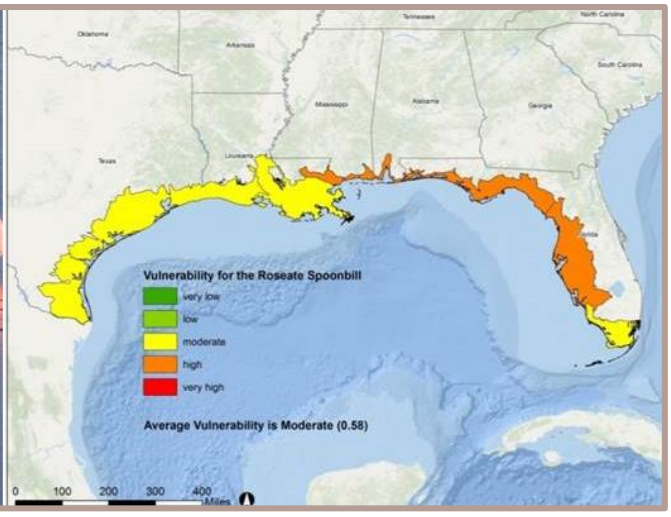
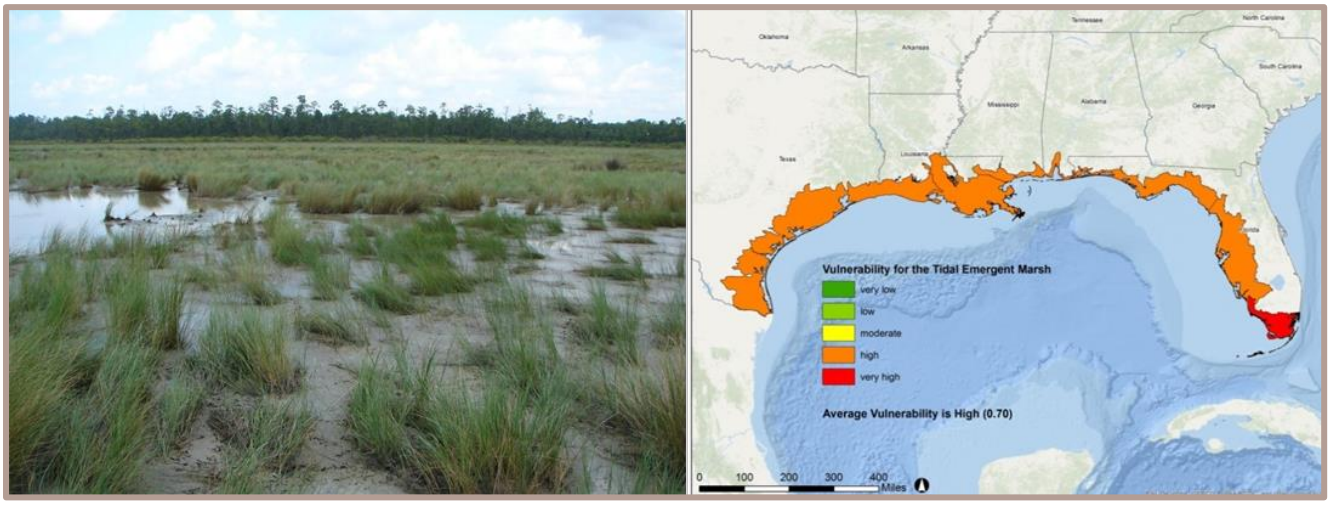


Fig. 3 Vulnerability of Roseate Spoonbill

Roseate spoonbill was most vulnerable in the Southern Coastal Plain and Central Florida Coastal Plain (Figure 3). This is anticipated due to the increased coastal development and the accompanying water management impacts in these subregions. Gulf-wide threats include changes to biotic interactions (specifically prey), loss of habitat to sea level rise and erosion, and storm surge.

VULNERABILITY: Tidal Emergent Marsh, Blue Crab, Clapper Rail, Mottled Duck & Spotted Seat Trout

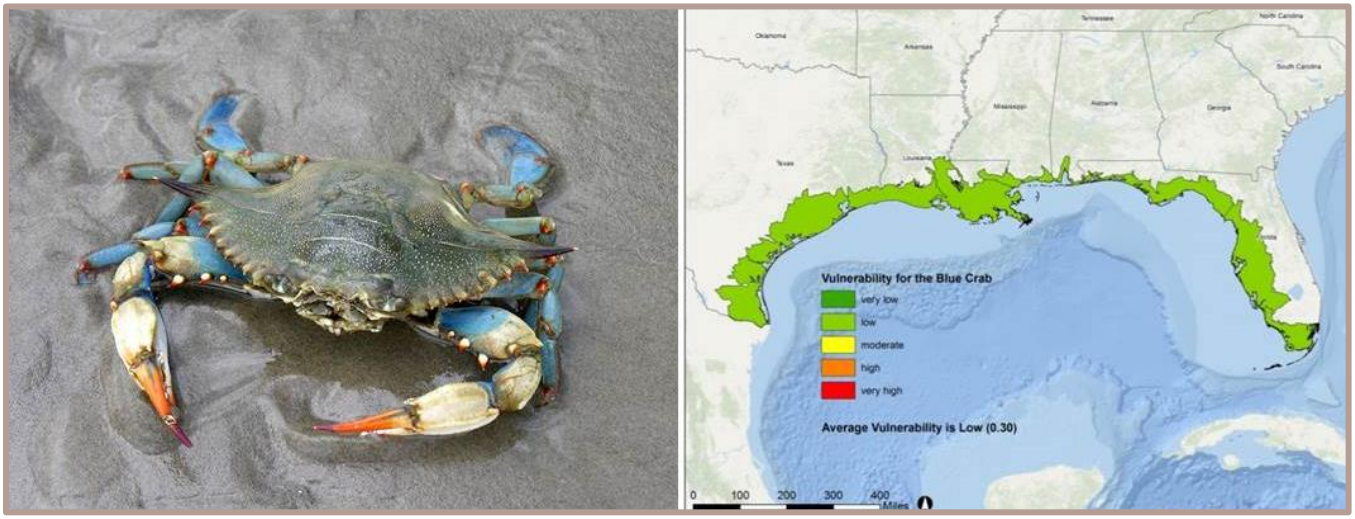
TIDAL EMERGENT MARSH



Goose Point/Platte Marsh/USFWS *Fig. 4 Vulnerability of Tidal Emergent Marsh*

The vulnerability of tidal emergent marsh is high across the entire Gulf coast, except in the Southern Florida coastal plain where it is very high (Figure 4). Sea level rise, fragmentation of the ecosystem, altered hydrology, and constraints on range shift were typically judged to be the most serious threats across all subregions. In the Southern Florida Coastal Plain, these threats were judged to have severe negative impacts on marsh as compared to the other subregions.

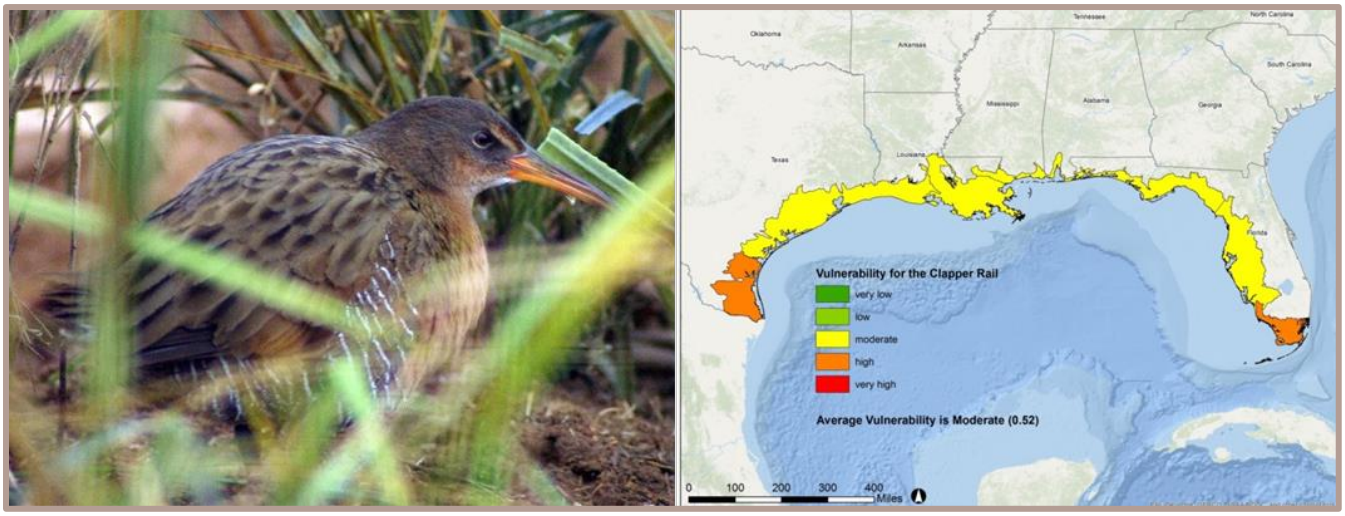
BLUE CRAB



*Blue Crab/Jeremy Thorpe/Flickr: EOL Images. CC BY-NC-SA/*http://bit.ly/1Mk0Y1K *Fig. 5 Vulnerability of Blue Crab*

Blue crab vulnerability is low across all subregions (Figure 5). Their mobility and ability to tolerate a range of conditions are two characteristics that may be especially helpful in adapting to future conditions. Blue crab may also benefit from an increase in marsh edge.[iii]

CLAPPER RAIL



Clapper Rail/Rinus Baak/USFWS

Fig. 6 Vulnerability of Clapper Rail

Clapper rail vulnerability varies from moderate to high (Figure 6). In the Laguna Madre, there are few clapper rails because tidal emergent marsh is limited in this subregion. Thus, these relatively small populations may be more susceptible to projected threats and population fragmentation. Gulf-wide threats to clapper rail include loss of habitat to erosion and increased storm surge and hurricane frequency.

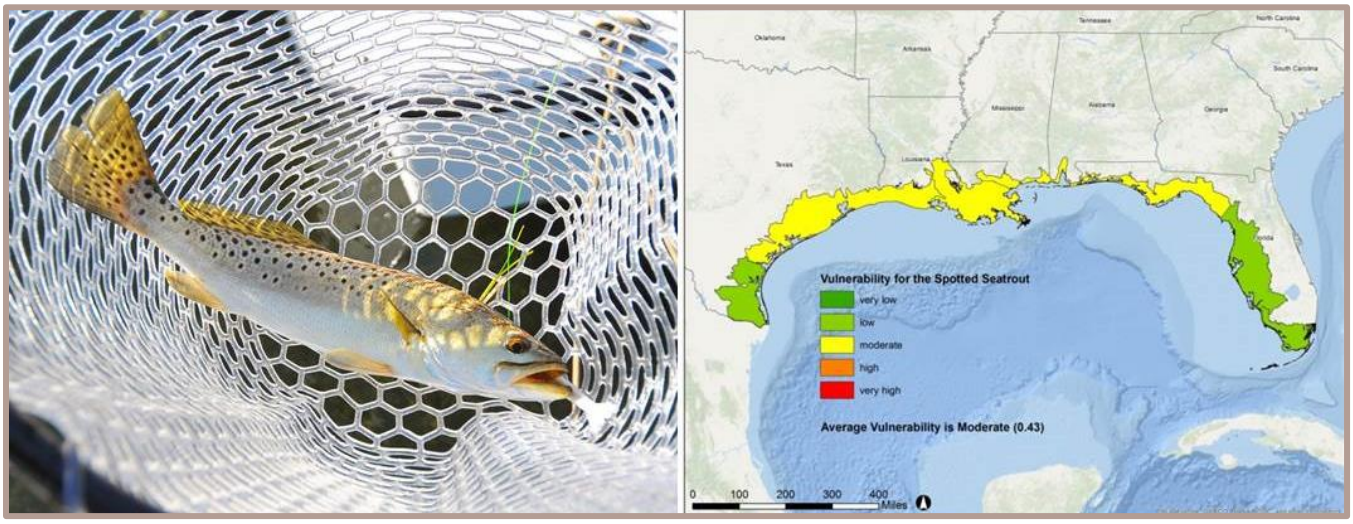
MOTTLED DUCK

Mottled Duck/USFWS

Fig. 7 Vulnerability of Mottled Duck

Mottled duck is moderately vulnerable across the Gulf (Figure 7). In general, assessors thought that although the species may experience some negative impacts associated with climate and land use change, the population will probably not be strongly affected. The mottled duck's demonstrated ability to adapt to a variety of habitats will likely contribute to the species' ability to adjust to change.

SPOTTED SEATROUT

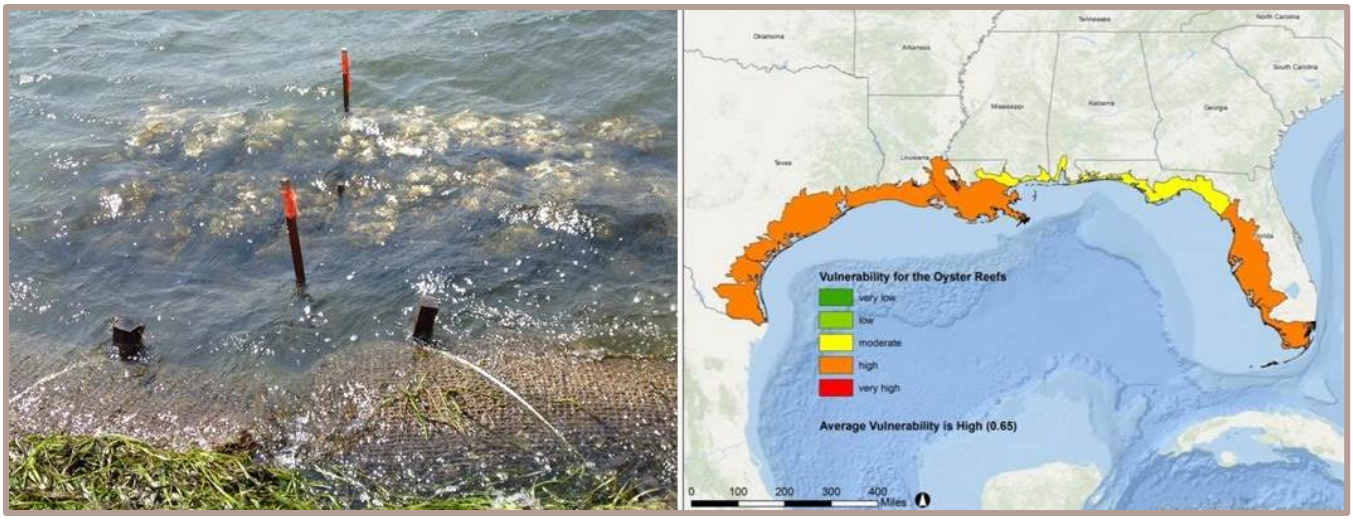


Spotted Seatrout/Tim Donovan/Florida Fish & Wildlife Conservation Commission *Fig. 8 Vulnerability of Spotted Seatrout*

Vulnerability of spotted seatrout to future conditions ranged from low in the Laguna Madre, Central Florida Coastal Plain, and Southern Florida Coastal Plain to moderate in other subregions (Figure 8). In subregions with moderate vulnerability, loss of habitat to sea level rise and erosion were judged to be more severe. Consequently, the limited ability of spotted seatrout to migrate away from threats in those subregions also increased vulnerability.

VULNERABILITY: Oyster Reef, Eastern Oyster, American Oystercatcher & Red Drum

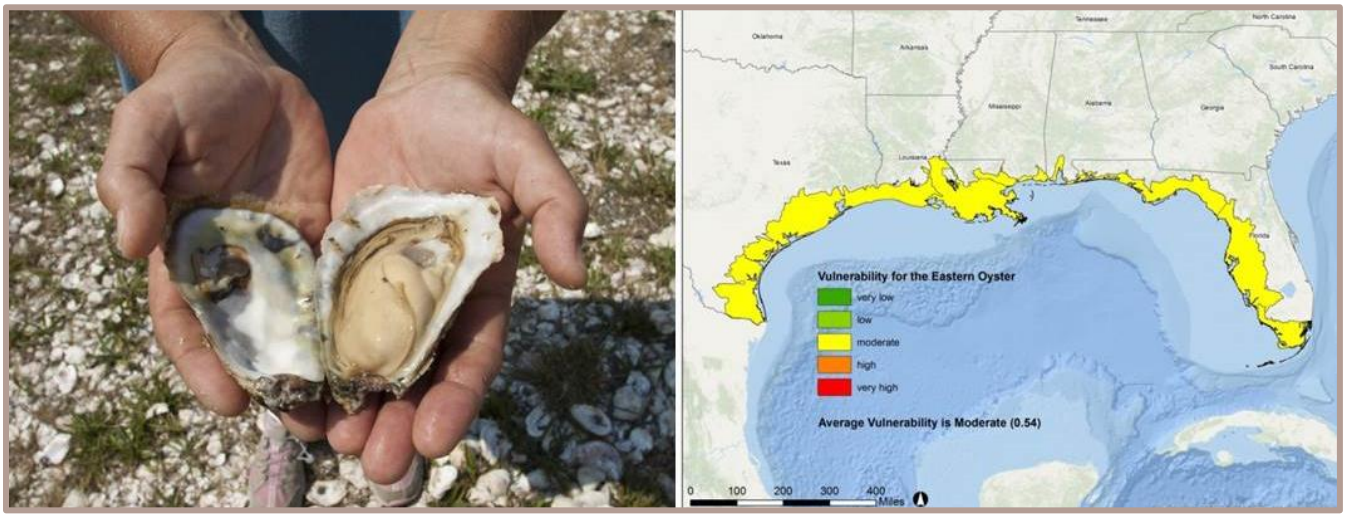
OYSTER REEFS



Oyster Reef/Lia McLaughlin/USFWS *Fig. 9 Vulnerability of Oyster Reefs*

Oyster reefs were judged to be highly vulnerable in all subregions except the Southern Coastal Plain, where they are moderately vulnerable (Figure 9). In the Southern Coastal Plain, assessors noted there was not enough information to score several of the Potential Impacts criteria that affected the average vulnerability score. Altered hydrology was judged to be the biggest threat to oyster reefs. The inability of the physical structures to migrate away from threats also increases their vulnerability.

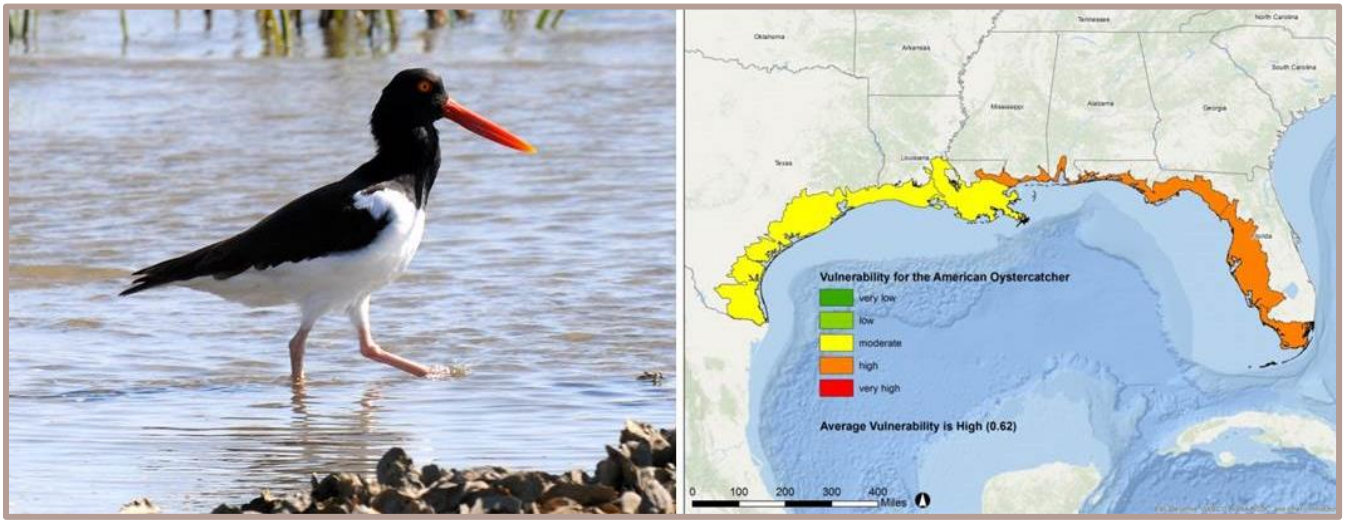
EASTERN OYSTERS



Eastern Oyster Lynda Richardson/USDA-NRCS *Fig. 10 Vulnerability of Eastern Oysters*

Eastern oysters were judged to be moderately vulnerable across all subregions (Figure 10). The species assessment of eastern oysters indicates lower vulnerability than the ecosystem assessment because it takes into consideration the ability of mobile oyster larvae to colonize new areas if conditions are suitable. However, because the eastern oyster is also a commercially valuable species, this vulnerability ranking can be drastically altered if oysters are harvested unsustainably.[iv] Gulf-wide threats to eastern oyster include changes to the natural hydrologic regime and increased predation from oyster drills, which may benefit from high salinities.

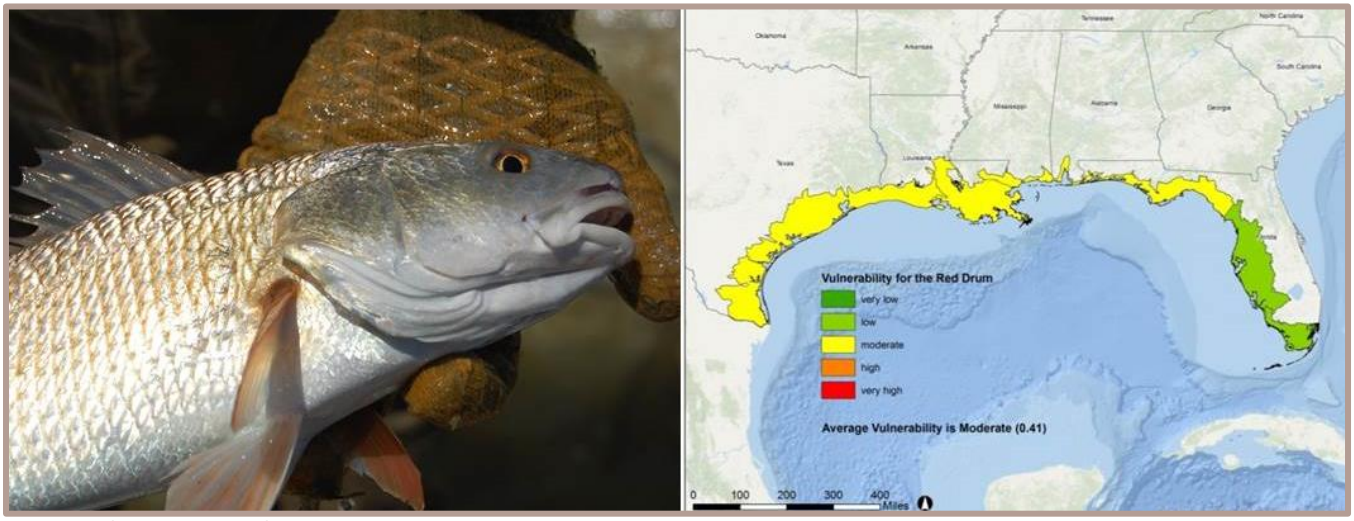
AMERICAN OYSTERCATCHER



American Oystercatcher/Garry Tucker/USFWS *Fig. 11 Vulnerability of American Oystercatcher*

American oystercatcher was highly vulnerable in the Southern Coastal Plain, Central Florida Coastal Plain, and Southern Florida Coastal Plain and moderately vulnerable in the other subregions (Figure 11). In the highly vulnerable subregions, increased vulnerability was due to barriers to dispersal, such as coastal development and shoreline armoring to prevent beach erosion. Gulf-wide threats include loss of nesting habitat to sea level rise and synergistic effects of climate change, sea level rise, and urbanization.

RED DRUM

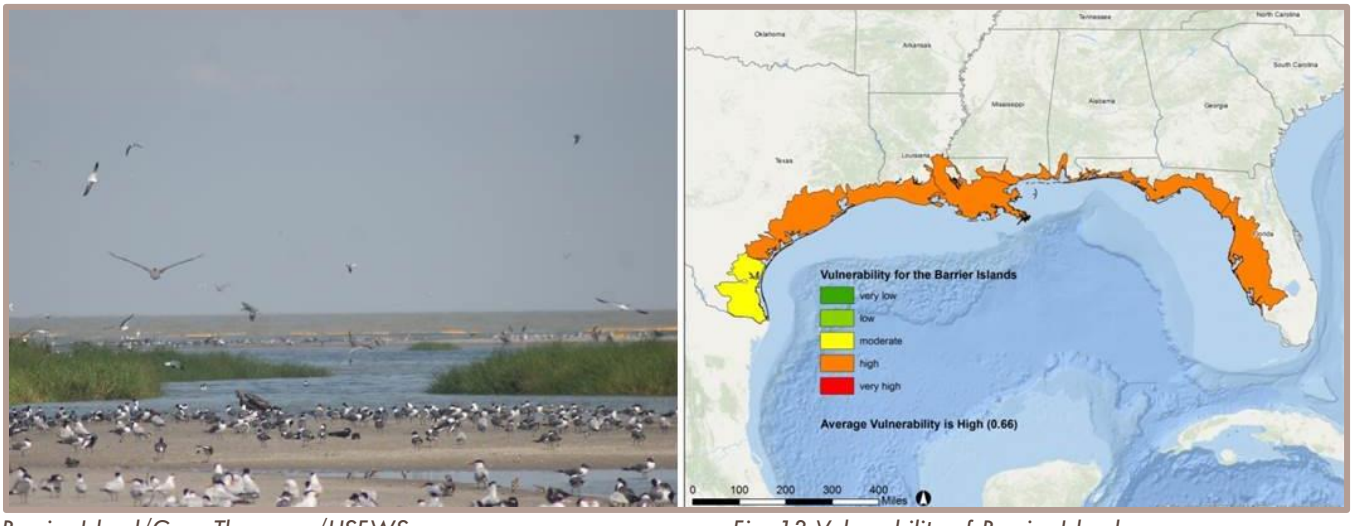


Red Drum/Katie Johnson/Florida Fish & Wildlife Conservation Commission *Fig. 12 Vulnerability of Red Drum*

Red drum vulnerability ranges from low to moderate across the Gulf Coast (Figure 12), driven in part by differences in expected loss of habitat to sea level rise. In the Western Gulf Coastal Plain and Mississippi Alluvial Plain, the loss of marsh habitat may decrease the dispersal of red drum, which increases vulnerability. In the Southern Coastal Plain, the overall vulnerability score was influenced by the relatively poor adaptive capacity scores. Assessors expect that red drum will have the ability to disperse from threats; however, there must be available nursery habitat. Adaptive capacity scores reflected a difference in assessor opinion regarding genetic diversity and the phenotypic plasticity of red drum.

VULNERABILITY: Barrier Islands, Black Skimmer, Kemp's Ridley Sea Turtle & Wilson's Plover

BARRIER ISLANDS

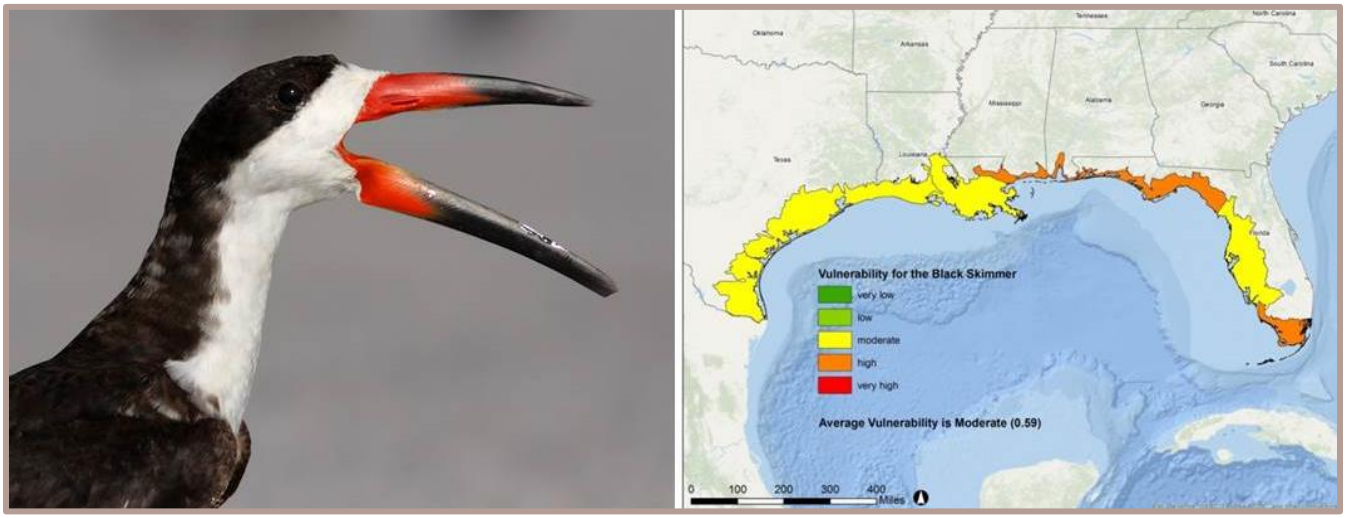


Barrier Island/Greg Thompson/USFWS *Fig. 13 Vulnerability of Barrier Islands*

Barrier island vulnerability is moderate in the Laguna Madre subregion and high in the remaining subregions (Figure 13). Barrier islands were not assessed in the Southern Florida Coastal Plain because the underlying

geology, including the offshore presence of coral reefs, is significantly different than islands throughout the rest of the Gulf. Vulnerability is lower in Laguna Madre because North Padre Island is protected, eliminating development as an issue. Although South Padre Island could potentially be developed, the extent of development will not exceed 30% of the total barrier island. While sea level rise is a threat across all subregions, in Laguna Madre the assessor thought there were no range constraints limiting the ability of the barriers to migrate.

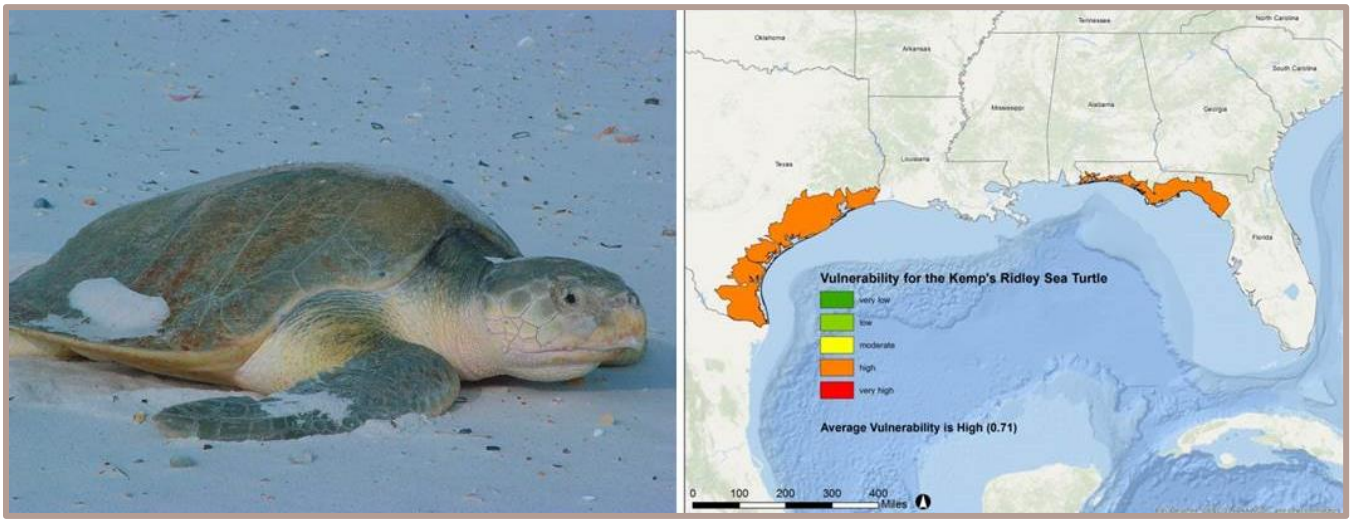
BLACK SKIMMER



Black Skimmer/Florida Fish & Wildlife Conservation Commission *Fig. 14 Vulnerability of Black Skimmer*

Black skimmer vulnerability was highest in the Southern Coastal Plain and Southern Florida Coastal Plain due to low adaptive capacity scores in these two subregions (Figure 14). Across all subregions, loss of habitat to sea level rise; impacts from storm surge and runoff; synergistic effects of climate change, sea level rise, and urbanization; and changes to the natural disturbance regime were scored as main threats.

KEMP'S RIDLEY SEA TURTLE

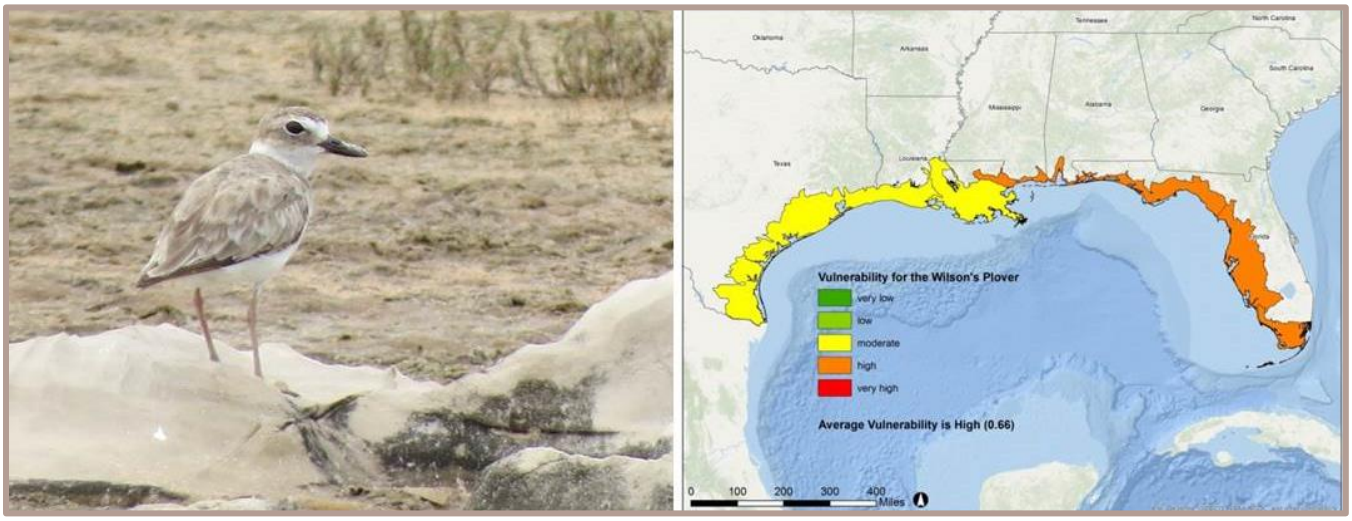


Kemp's Ridley Sea Turtle/Jereme Phillips/USFWS *Fig. 15 Vulnerability of Kemp's Ridley Sea Turtle*

Kemp's ridley were only assessed in the three subregions in which they most commonly nest, although nesting in

other areas of the U.S. portion of the Gulf Coast does occur. In the three subregions in which Kemp's ridley sea turtles were assessed, they were identified as the most vulnerable species (Figure 15). Kemp's ridley may be sensitive to habitat loss from urban development and sea level rise. Increasing temperatures could also cause shifts in sex ratios.

WILSON'S PLOVER



Wilson's Plover/Karen Driver/Florida Fish & Wildlife Conservation Commission *Fig. 16 Vulnerability of Wilson's Plover*

Wilson's plover vulnerability was high in the Southern Coastal Plain, Central Florida Coastal Plain, and Southern Florida Coastal Plain (Figure 16). In the remaining subregions, vulnerability was moderate. Wilson's plover had the highest potential impacts score in the Southern Coastal Plain, which resulted in high vulnerability; whereas in the Central and Southern Florida Coastal Plains, high vulnerability is due to low adaptive capacity. The loss of habitat to sea level rise; impacts from storm surge and runoff; and the synergistic effects of climate change, sea level rise, urbanization, and changes to the natural disturbance regime were scored as the main threats across all subregions.

SECTION 5: LESSONS LEARNED

SUMMARY:

This section describes some considerations that could be made in future iterations, especially if those efforts cover a large area.

MAIN POINTS:

- Assessors were asked to assess vulnerability based on their interpretation of model outputs and their personal knowledge. While this qualitative approach suited this effort, a more quantitative approach that directly incorporates physical and ecological models would have reduced some of the uncertainty and variation in expert judgment.

- Assessors of the aquatic species commented that SIVVA is more suited for terrestrial species. Additional criteria that addressed issues like fishing pressure, water quality, currents, and ocean acidification would have been beneficial for determining aquatic species vulnerability.

- SIVVA does not have a predefined vulnerability ranking, so the user can dictate the qualitative descriptions (e.g. high vulnerability) and the range of values associated with each of those descriptions. Future assessments could aim to statistically justify rankings or better describe what the various vulnerability levels indicate.

- The ecosystem assessment did not explicitly account for adaptive capacity, which may explain why some moderately vulnerable species were associated with highly vulnerable ecosystems.

- The GCVA assessed how vulnerability varied across the Gulf, but logistical considerations related to the availability of data and reviewers limited the number of subregions. The spatial scale of these subregions did detect differences in vulnerability; however, future assessments could identify input data more appropriate for assessing vulnerability at finer spatial scales.

- Higher spatial resolution data would have improved the usefulness of the map layers that were provided to assessors.

- The decision to use a single set of species was made in the interest of consistency; however, some of the species chosen did not use all of the regions in the same way, or at all. For example, black skimmer in Texas use man-made islands in sheltered regions rather than barrier islands, and Kemp's ridley do not nest throughout the entire Gulf region. An alternate strategy could use widespread species where possible but substitute local species to capture regional differences in habitat usage.

SECTION 6: UNCERTAINTIES AND POTENTIAL FUTURE RESEARCH

SUMMARY:

The application of SIVVA allows the user to flag criteria where high uncertainty exists in conducting the assessment. This enables the identification of research priorities. This section notes some of the identified data gaps for the Gulf Coast region.

MAIN POINTS:

- A lack of information regarding impacts from projected changes in disturbance regimes, biotic interactions, and synergistic effects were commonly cited in both the species and ecosystem assessments.

- Many of the species assessments identified a lack of information on genetic diversity, phenotypic plasticity, life history, and species responses to past climate change and sea level rise.

- Most assessors indicated they were unaware of data regarding species responses to past sea level rise and climate change.

SECTION 7: SETTING THE STAGE FOR ADAPTATION

SUMMARY:

This section includes how the results of the GCVA can be used to inform adaptation strategies such as the Southeast Conservation Adaptation Strategy (SECAS) as well as coordinate conservation actions across the Gulf to maximize limited funding and the ecological impacts of those activities. SECAS was initiated by the

Directors of the Southeastern Association of Fish & Wildlife Agencies and members of the Southeast Natural Resource Leaders Group to provide a broader spatial and temporal context for conservation across the Southeast.

MAIN POINTS:

- The GCVA can be used to inform actions and link individual actions to support regional conservation and adaptation efforts by:
    - Identifying vulnerable species and ecosystems across the Gulf region;
    - Identifying the most common threats to species and ecosystems;
    - Identifying research gaps;
    - Re-evaluating vulnerability as new data become available.

- Assessors identified a number of management strategies that could be used as part of the following four general adaptation strategies identified by Stein et al. (2014)[v] as follows:
    - ***Reduce non-climate stresses***: Educating the public about the consequences of disturbing nesting and foraging birds, preventing overfishing/overharvesting of popular species, and reducing bycatch mortality can alleviate pressure on some species.
    - ***Protect key ecosystem features***: Areas that are currently on the threshold of suitability should be considered for restoration. For example, oyster reefs with marginal water quality could be targeted for habitat restoration to promote future population growth or recruitment in extreme years when isohalines have moved up or down estuary.
    - ***Restore structure and function***: Reducing the restrictions on freshwater flow can ensure that the needs of the downstream ecosystems and species are met.
    - ***Protect refugia***: Establishing marine reserves that provide refuge for populations of exploited species may be needed, including the establishment of protected reef areas that can provide source larvae.

The GCVA sets the stage for further development of adaptation strategies and tools to ensure conservation of the biological, cultural, economic, and recreational resources of the Gulf Coast. Although specific management actions should be based on local conditions, the GCVA can inform the decision-making process to ensure that conservation and restoration of areas and species focuses on those that are most vulnerable, most responsive to action, and most limiting. Advancing coordinated, Gulf-wide conservation efforts that supersede political and administrative boundaries is needed to ensure the long-term sustainability of the Gulf region, which will have far-reaching impacts for both wildlife and humans.

ACKNOWLEDGEMENTS

The GCVA was initiated by the four Landscape Conservation Cooperatives (LCCs) that cover the Gulf of Mexico: the Gulf Coast Prairie, Gulf Coastal Plains & Ozarks, South Atlantic, and Peninsular Florida LCCs. Each LCC is directed by a Steering Committee of partners that also provided support for this project. Additional support and guidance was provided through the National Oceanic and Atmospheric Administration (NOAA), the United States Fish & Wildlife Service (USFWS), the Northern Gulf Institute (NGI), the Gulf of Mexico Alliance (GOMA), the Louisiana Coastal Protection and Restoration Authority, and the United States Geological Survey (USGS). Individuals from these organizations formed the Core Planning Team. The Core Planning Team particularly recognizes Laurie Rounds who led the initial effort on this project, and without whose vision we would not have initiated this work.

SUGGESTED CITATION

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