Reviewed: 7/27/2021

Development of a Habitat Suitability Index for the Texas Diamondback Terrapin, *Malaclemys terrapin littoralis*

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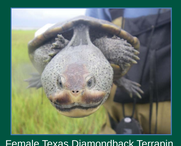
Background

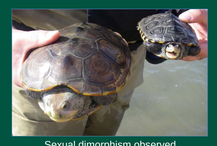
The Diamondback Terrapin (*Malaclemys terrapin)* is the only turtle species to occur exclusively in brackish water marshes along the Atlantic and Gulf Coasts of the United States. They are currently listed as endangered in Rhode Island, threatened in Massachusetts, and a species of concern in Georgia, Delaware, Louisiana, and North Carolina. Like many marsh-dependent species, Texas diamondback terrapin (*M. terrapin littoralis*) populations are believed to be in decline. Adequate nesting habitats associated with estuarine marsh are critical to the Texas diamondback terrapin life cycle and population sustainability. The potential impact of rising sea level, due to global climate change, combined with increased urbanization will likely severely impact essential terrapin habitat. The Habitat Suitability Index (HSI), was designed for a wide variety of applications including conservation planning and evaluation of alternative impact scenarios. A HSI model for Atlantic coast terrapin subspecies was published in 1988, but currently there is no HSI model for the Gulf Coast terrapin subspecies. Therefore in order to assess potential impacts on terrapin habitat along the Gulf coast we have developed a HSI model for the Texas Diamondback Terrapin and other Gulf subspecies.


Female Texas Diamondback Terrapin


Male Texas Diamondback Terrapin


Terrapin found buried in the sediment


Terrapin captured in an abandoned crab trap


Sexual dimorphism observed (left = female, right = male)

Study Area and Methods

South Deer Island is a 0.3 km^2 island located 1.6 km north of Galveston Island in Galveston Bay. South Deer Island contains multiple waterways, and is dominated by cordgrass (*Spartina* spp.). The University of Houston-Clear Lake has been studying the terrapin population on South Deer Island since 2007. To date over 320 terrapin have been captured, tagged, and released in the coastal marshes in West Bay, Texas. This mark recapture study is on-going and when complete will provide the most comprehensive, long term population data on the Texas Diamondback Terrapin. Capture location and associated habitat type (vegetation community) were tabulated and used to estimate preferred terrapin habitat. Remote sensing color infra-red imagery was then used to extrapolate "potential" terrapin habitat beyond South Deer Island but within the Galveston Bay system. The current HSI that was developed for terrapin along the East Coast of the U.S. was then modified and adjusted for Gulf coast physical and topographic differences.

Habitat Suitability Index

Diamondback terrapins occur in basically three cover types: estuarine open waters (EOW) where they feed, bask, and mate; Intertidal estuarine marshes (IEM) where they feed, bask, and brumate; and coastal uplands (U) where they nest.

<u>Nesting Habitat Variables</u>:

- **V1: percent canopy cover of vegetation (Optimum cover between 25% and 40%)** (Figure 1)
- **V2: percent soil type = sand (Optimum particle size classification between 20% and 100% sand)** (Figure 2)
- **V3: percent soil type = clay (Optimum particle size classification ≤20% clay)** (Figure 3)
- **V4: height above normal high tide (m) (Optimum height above normal high tide ≥0.5m)** (Figure 4)
- **V5: mean substrate slope (°) (Optimum mean substrate slope ≤7°)** (Figure 5)
- **V6: proximity to IEM (km) (Optimum proximity to nearest IEM ≤2km)** (Figure 6)

$$HSI = (SI_{V1} \times SI_{V2} \times SI_{V3} \times SI_{V4} \times SI_{V5} \times SI_{V6})^{1/6}$$

Interpreting Model Outputs

HSI values obtained by applying the terrapin model may not reflect actual population levels. Terrapin population levels may be influenced by non-habitat factors such as competition, seasonal storms, commercial crabbing mortality, the operation of outboard motors, and motorized vehicles in the animal's habitat. Outputs for this model can be used to compare the potential of two areas to support terrapin at a single point in time, or at future points in time.


Spartina sp. with numerous *Littorina* spp. on South Deer Island, Galveston TX

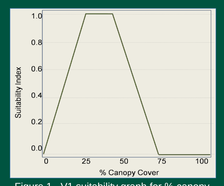


Figure 1. V1 suitability graph for % canopy cover

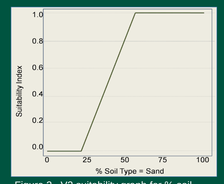


Figure 2. V2 suitability graph for % soil type = sand

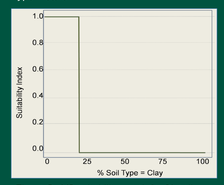


Figure 3. V3 suitability graph for % soil type = clay

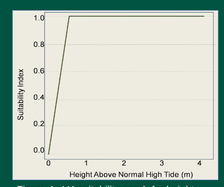


Figure 4. V4 suitability graph for height above normal high tide

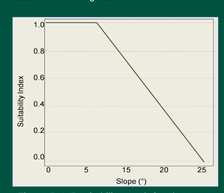


Figure 5. V5 suitability graph for slope

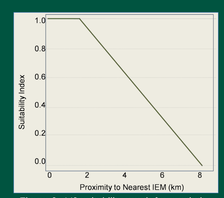


Figure 6. V6 suitability graph for proximity to nearest IEM

Habitat Classification

During our study we observed a geo-correlation between wetland habitats and terrapin distribution on South Deer Island. This relationship was used in conjunction with a remote sensing technique that utilizes three-band infrared imagery and a Maximum Likelihood Classification method, to classify terrapin habitat . A sub-set of the imagery from South Deer Island was then used to create signatures for three categories of coastal wetland plant assemblages including *Spartina* spp., mixed marsh and upland marsh as well as two other habitat categories, dune/bare soil and standing water (Figure 7). The process included the use of the isodata clustering algorithm, which is used to create natural groupings of spatial cells based on spectral characteristics in multidimensional attribute space. The determined signatures were used as inputs into the Maximum Likelihood Classification function in the Spatial Analyst extension in ArcGIS (Figure 8).

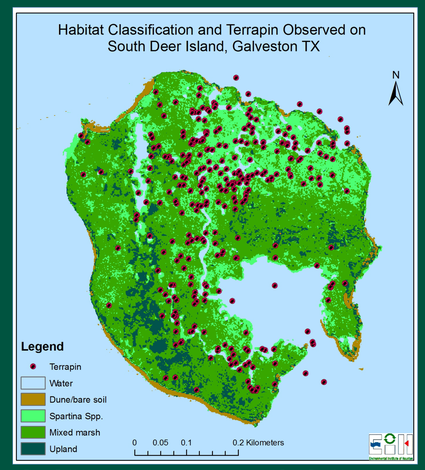


Figure 7. Habitat classification and terrapin captures on South Deer Island

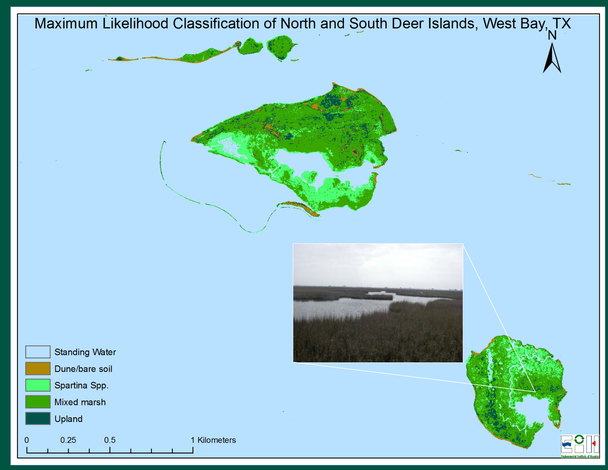


Figure 8. Maximum likelihood classification on North and South Deer Islands

Future Work

The Environmental Institute of Houston (EIH) will continue to monitor the population of Texas diamondback terrapin in Galveston Bay, and will soon expand this effort to the entire Texas Coast. The data generated from this research will help define the extent of terrapin populations in Texas and provide the information needed by managers to define the status of the population. Field validation tests using this HSI will be preformed to determine its effectiveness and to recalibrate it as necessary. Once the predictive power of the HSI is validated it will be ready for use in planning for future habitat restoration and protection along the Texas coast.

Future work for the GIS analysis of essential terrapin habitats includes the use of vegetation zoning, where different habitats can be found in different zones within the tidal frame – this requires high spatial topographical data (LIDAR data) and detailed tidal data and entails extensive ground-truthing. Future analysis may include the use of soft classification (fuzzy and/or linear mixture classifications) to reflect the mixed nature of these habitats.

Acknowledgments

We thank USFWS and the Houston Zoo for funding terrapin research in Galveston Bay. We also thank Emma Clarkson, Dianna Ramirez, and all of the countless graduate students and volunteers that have spent long hot days in the marsh capturing and releasing Texas Diamondback Terrapin.

For Further Information

Please contact *wrast@uhcl.edu*. More information on this and related projects can be obtained at EIH webpage: www.eih.uhcl.edu