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Modernizing Habitat Suitability Indices (HSI): A Northern Diamondback Terrapin Case Study

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Photo by: Hannah Dallas


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Introduction

Northern diamondback terrapins (*Malaclemys terrapin terrapin*) are threatened throughout their range due to anthropogenic factors, habitat loss, and global change [1]. Although multiple programs monitor nesting populations, a regional approach is required to standardize data collection on terrapin nesting habitat requirements, improve management, and restore nesting habitat. After reviewing the 1988 habitat suitability index (HSI) created for Atlantic coast terrapins [2], we began developing a modernized HSI that includes more variables and is targeted specifically to terrapins within the northeast. Our goal is to use this new HSI to standardize data collection, assess existing nesting habitat, standardize monitoring across sites, and guide habitat restorations.


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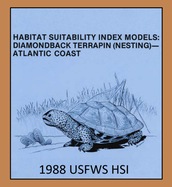


Methods

Site Selection – soil samples analyzed from 22 confirmed terrapin nesting sites across MA, RI, CT, NY, and NJ

Updated HSI Equation:

1988: $HSI = (SI_{\%\ shrub} \times SI_{\%\ grass} \times SI_{slope})^{1/3}$

2019: $HSI = (SI_{soil} \times SI_{landcover} \times SI_{slope} \times SI_{aspect} \times SI_{MHHW})^{1/5}$

Survey – 12 experts ranked 5 variables in order of importance to terrapin nesting habitat [3]

Soil Grain Size Analysis and % Soil Organic Matter – field collected bulk soil samples from 22 different sites

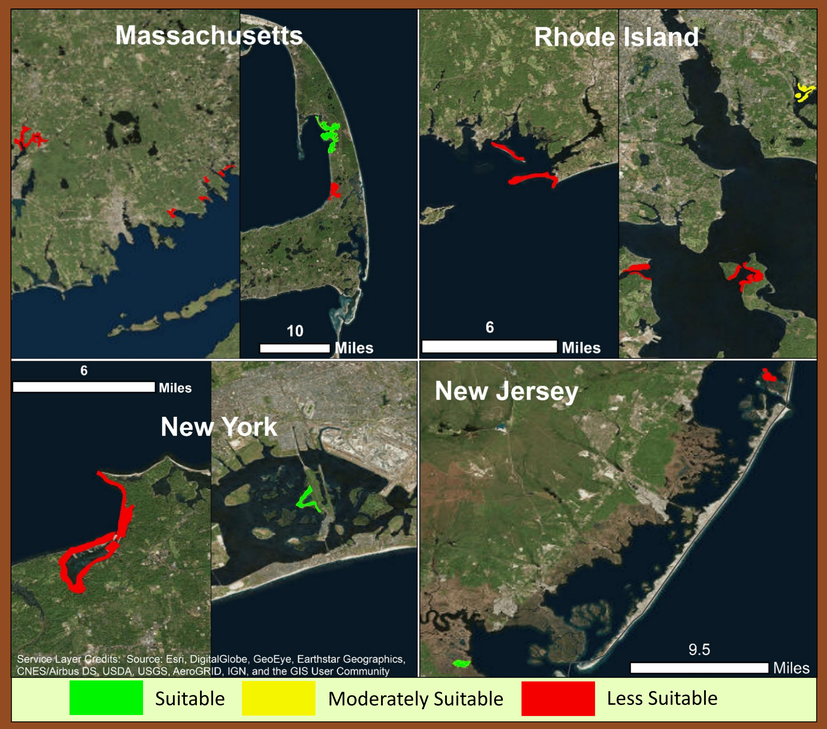
Google Earth Engine – analyzed Landsat8 data to differentiate between % water, % soil, and % vegetation cover

Other Data Collection and Analysis – NOAA (aspect & tidal datums), NRCS (slope), and US Census Bureau (population and distance to roads)

ArcGIS – mapped data and conducted spatial analysis to modernize and quantify HSI variables

Abundance – used relative abundance data of terrapins at each site to create HSI

Original Approach: Updated Habitat Suitability Index



***Description*:** Used 1980 USFWS habitat suitability indices guidelines [4].

***Assumptions*:** Sites with highest number of terrapins are the most suitable.

***Conclusions*:** Only three sites (green) are ranked as suitable: South Wellfleet, Jamaica Bay, and Leeds Point. Barrington (yellow) is ranked as moderately suitable, and the other 13 sites (red) are ranked as less suitable.

***Strengths*:**

- Accurately shows suitability for sites of known terrapin nesting.

***Weaknesses*:**

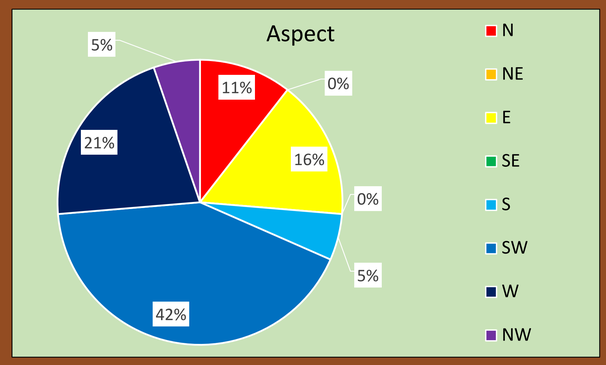
- Biased by data availability (abundance) at each site and requires higher-resolution data to more accurately assess suitability.

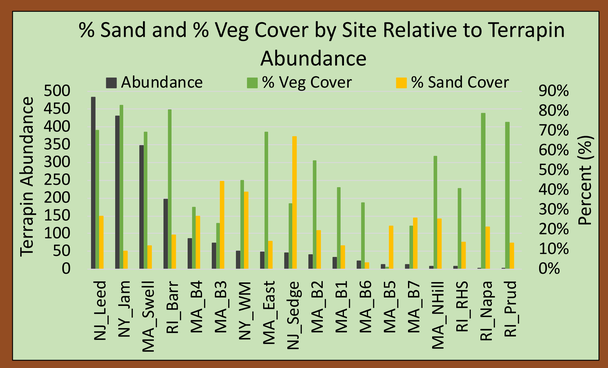
Developing a Modernized Habitat Suitability Index

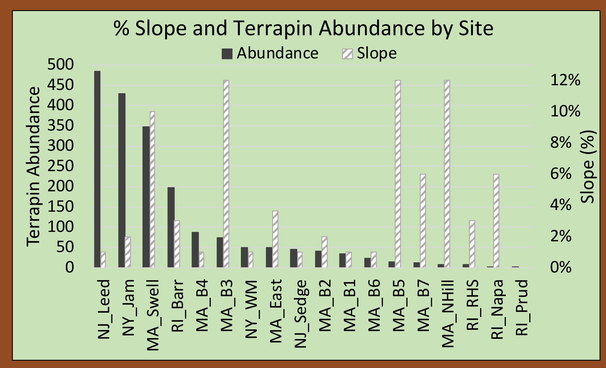
We are using GIS to modernize the 2019 HSI in order to assign a suitability score to possible nesting sites. This work in progress will determine the importance of each variable by assigning a weight and then calculating a suitability score for potential habitats.

Correlation Matrix

	Abun.	TS %	NS %	% OM	>2mm	Asp.	Slo.	DtR.	Pop.	Hou.	S %	V %	Area
Area	-0.13	-0.5	0.47	-0.24	0.37	0.21	0.03	-0.13	0.22	0.2	-0.21	-0.17	1
% Veg	0.49	-0.22	0.19	0.13	-0.4	0.28	-0.29	0.21	-0.28	-0.27	-0.36	1	-0.17
% Sand	-0.15	0.31	-0.25	0.26	0.09	-0.35	0.09	0.47	-0.1	-0.16	1	-0.36	-0.21
Housing	-0.07	-0.08	0.14	0.11	0.42	-0.05	-0.06	-0.68	0.99	1	-0.16	-0.27	0.2
Population	-0.11	-0.07	0.14	0.17	0.43	-0.11	-0.05	-0.68	1	0.99	-0.1	-0.28	0.22
Dist. To Rd	-0.04	0.21	-0.26	-0.19	-0.38	0.29	-0.17	1	-0.68	-0.68	0.47	0.21	-0.13
Slope	-0.09	0.16	-0.22	-0.14	0.22	-0.67	1	-0.17	-0.05	-0.06	0.09	-0.29	0.03
Aspect	0.03	-0.05	0.01	-0.21	-0.36	1	-0.67	0.29	-0.11	-0.05	-0.35	0.28	0.21
>2mm %	-0.02	-0.33	0.31	-0.19	1	-0.36	0.22	-0.38	0.43	0.42	0.09	-0.4	0.37
% OM	0.07	0.01	0.24	1	-0.19	-0.21	-0.14	-0.19	0.17	0.11	0.26	0.13	-0.24
Non-Sand %	0.34	-0.96	1	0.24	0.31	0.01	-0.22	-0.26	0.14	0.14	-0.25	0.19	0.47
Total Sand %	-0.37	1	-0.96	0.01	-0.33	-0.05	0.16	0.21	-0.07	-0.08	0.31	-0.22	-0.5
Abundance	1	-0.37	0.34	0.07	-0.02	0.03	-0.09	-0.04	-0.11	-0.07	-0.15	0.49	-0.13







Conclusions

***Survey*:** Soil type and land cover were considered the most important factors for terrapin nesting habitat.
Soil grain size analysis: Sandy soil is important, sand fraction size less so, supporting the literature [1, 5].
Land cover: Terrapins nest in sites with high vegetation cover and moderate sand cover but higher resolution data is needed to fully understand the ideal cover.
***Aspect and slope*:** The highest abundance of terrapins occurred at sites with S, SW, or W facing aspects and at sites with shallower slopes.
***MHHW*:** Surprisingly, data do not suggest terrapins nest in areas with lower MHHW. This variable is flawed because MHHW relates to site size and elevation. This variable requires additional work.
***Human influences*:** No consistent relationship between terrapin abundance and distance to roads or terrapin abundance and human population density.
***Data gaps*:** Significant data gaps exist for terrapin nesting habitat in the northeast and uneven data collection (e.g., terrapin abundance, landcover, site size) across sites make cross-site comparisons challenging. For example, while experts ranked land cover as the most important habitat characteristic, only two sites actually conducted vegetation surveys. Instead, we used Landsat8 imagery to quantify land cover across sites thereby using comparable data across sites but low resolution obscured relationships between land cover and terrapin nesting, particularly at smaller sites.

Future Research

Data collection: Standardized, site-specific, data collection is required to allow cross-site comparisons and regional analysis. Specifically, standardized vegetation surveys (e.g., % cover) and terrapin population surveys are needed.
Site restoration: Further research is needed to determine how to best protect and restore terrapin nesting sites.
Public engagement: Engaging the public is crucial to protecting and maintaining terrapin populations and their nesting habitats.
Other variables: Data from NOAA (aspect and MHHW), NRCS (slope), and US Census Bureau (human population density and distance to roads) was satisfactory.

Literature Cited

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Pictures: Top (left to right): Maria J., Dan Q., Amber H.; Middle (left to right): Garth T., Nikki H., Jenn S.; Bottom (left to right): Hannah D., Anthony C.