

Maritime Forest Health Analysis

May 2, 2023 Town Council Meeting **M. Lee Bundrick, MS, MPA,** *Sr. Ecological Health and Conservation Coordinator*

Funding from the Town of Kiawah Island (FY22-23)







• Sound Finances • Ethical Conduct • Responsible Governance • Lasting Stewardship

Project Details / Objectives

Investigate the vegetative health of the maritime forest

- Productivity/health
- Forest density
- Saltwater Vulnerability

Develop tools and protocols for future analyses



Vegetative Productivity



Vegetative Health

Defined watershed units for assessment

Normalized Difference Vegetation Index

- Vegetative Productivity and Health
- Aerial imagery (USDA NAIP)
- Satellite Imagery (ESA Sentinel-2)

Time-series linear regression

• Python and R code integration



2.5-acre watershed assessment units

Defined uplands (green) and tidally influenced lowlands (blue) Highest Astronomical Tide (4.11' NAVD88) used

Upland Vegetation Trends USDA NAIP Imagery (2015-2021)



Annual Composite - Max value per pixel

NDVI₂₀₁₉NDVI₂₀₂₀NDVI₂₀₂₁NDVI₂₀₂₂



ArcPy for NDVI and Zonal Statistics

R Studio for Linear Regression

26 satellite images processed

Increase / Neutral / Decrease Based on slope and R-squared value Upland Vegetation Trends Sentinel-2 Satellite Imagery (2019-2022)



Salt Shrub Thicket Vegetation Trends USDA NAIP Imagery (2017-2021)



Adjusted dataset from Joel Gramling (2012)

0.22-acre assessment areas

Maritime Shrub Thicket Vegetation Trends USDA NAIP Imagery (2017-2021)



Adjusted dataset from Joel Gramling (2012)

Forest Density



Kiawah Island LiDAR 2022

LiDAR procured in 2022

- Equal cost share: TOKI, KICA, and Conservancy
- Flown January 30, 2022
- 24 pts / sq meter
- Maximum 5 returns

Classification and Processing

- LAS Ground
- LAS Building
- LAS Vegetation height





West of Parkway – Entrance to Kiawah Island

Kiawah Island LiDAR (2022): LAS tile #226789 (classified)



Digital Elevation Model (buildings ignored)

Canopy Height Model (nDSM)

DSM – DEM (buildings ignored)

Canopy Density (20-120') point count / pulse count

Seabrook Island

High

Low

i. the

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Ø.7°



Shrub Density (1-6') point count / pulse count

Seabrook



Low

Saltwater Vulnerability



Saltwater Vulnerability

Incorporate components of intrusion and inundation

Saltwater influences and freshwater recharge

Parameters

- Distance from coast (Highest astronomical tide)
- Upland slope
- Freshwater (-) and saltwater (+) inland waterbody inputs
- Inundation extents (NOAA flood levels)
- Plant productivity
- Impervious cover / land use land cover

Extreme Tide Input

Influence	Distance (ft, Ksat based)	Vulnerability Rating (+)
1 day	0-26	5 (high)
2 days	26-52	4
3 days	52-78	3
4 - 5 days	78 – 130	2
6 - 8 days	130 – 208	1
9 + days	208 +	0 (lowest)

Hydraulic conductivity derived distance from upland boundaries (Kennedy, 2012; Klassen & Allen, 2017).

Influence	Coverage	Vulnerability Rating (+)
High	50-100%	5 (high)
Moderate High	30-40%	4
Moderate	20-30%	3
Moderate Low	10-20%	2
Low to none	0-10%	1 (low)
	nfluence High Moderate High Moderate Moderate Low Low to none	InfluenceCoverageHigh50-100%Moderate High30-40%Moderate20-30%Moderate Low10-20%Low to none0-10%

Impervious surface coverage limits freshwater recharge into the shallow aquifer

Influence	Distance (ft, ksat based)	Vulnerability Rating (-)
1 day	0-26	4 (high)
2 days	26-52	3
3 days	52-78	2
4 - 5 days	78 – 130	1
6+ days	130 +	0

Hydraulic conductivity derived distance from freshwater ponds

Influence	Distance (ft, ksat based)	Vulnerability Rating (+)
1 day	0-26	5 (high)
2 days	26-52	4
3 days	52-78	3
4 - 5 days	78 – 130	2
6 - 8 days	130 – 208	1
9 + days	208 +	0 (lowest)

Hydraulic conductivity derived distance from brackish ponds

Percent Impervious Cover



Freshwater Input

Brackish Input



Inundation Extent



Influence	Level (NAVD88)	Vulnerability Rating (+)
Moderate to High Flood Stage	4.46'	4 (lowest)
King Tide with SLR 1.0'		based on episodic probability
Major Flood Stage	4.96'	3
King Tide with SLR 1.5'		
King Tide with SLR 2'	5.46'	2
King Tide with SIR 2 5'	5 96'	1 (lowest)
	5.50	based on episodic probability

Tidal extents from sustained high tide events (Balstrøm and Kirby, 2022)

Vegetation



Influence	NDVI Value	Vulnerability Rating (+)
Open water or bare soil	-1.0 - 0.0	5 (high)
Short grass or sparsely vegetated	0.0 - 0.1	4
Tall Grass	0.1 – 0.25	3
Shrubs and Tall Grasses	0.25 – 0.4	2
Tree Canopy	0.4 - 1.0	1 (low)
High Productivity		

Forest throughfall slowly introduces water to the soil surface. This promotes infiltration which flushes subsurface salts near the root zone.

Topographic Slope



Influence	Slope	Vulnerability Rating (+)
Gentle Slopes or Flat	< 1°	5 (high)
Somewhat gentle slopes	1 - 5°	4
Moderately Sloping	5 – 10°	3
Steeper slopes	10 - 20°	2
Steep slopes or escarpments	> 20°	1 (low)

Surrogate for hydraulic gradient (Kennedy, 2012; Klassen & Allen, 2017).

Inundation Vulnerability

SVI_{inundation} = Inundation_{rate} + NDVI_{rate} + Slope_{rate}

Rating between 0 (low) and 15 (high)



Intrusion Vulnerability

SVI_{intrusion} = HAT_{rate} + SWPond_{rate} + Impervious_{rate} - FWPond_{rate}

Rating between -5 (low) and 15 (high)



Combined Saltwater Vulnerability

 $SVI_{combined} = SVI_{intrusion} + SVI_{inundation}$

Rating between -3 (low) and 21 (high)







Exceptionally High Tide Events (2015 - 2022)



Inundation extent created using GIS toolset developed by Balstrøm and Kirby (2022)

 $\Delta S = P - PET + \Delta G$



Drought Coverage (%) Moderate Drought 50 -0 -12 16 20 24 28 32 36 44 48 52 56 40



Water budget (Current)

2020-2021	=	2" annual deficit
2021-2022	=	6" annual deficit

Data from 21 groundwater monitoring wells on Kiawah Island

NOAA NIDIS Charleston County Drought Conditions

- Yellow = Abnormally dry (D0)
- Orange = Moderate drought (D1)

Timbers Weather Station rainfall accumulation

• Throughfall compensated



Rain Garden Installations

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Nature-Based Solutions Manual for Kiawah Island

Emergency Coastal Resilience Fund 2019

Funding through NFWF's Emergency Coastal Resilience Fund with support from NOAA

Marsh Protection and Stormwater Mitigation

Detailed information on 13 practices

- Site Selection
- Preparation
- Materials
- Installation
- Maintenance
- Monitoring



Rain Gardens

"A depressed area in the landscape that collects rain-water from a roof, driveway or street and allows it to soak into the ground" (USEPA)



Groundwater recharge





Town Hall Rain Garden Conceptual Plan







Rhett's Bluff Rain Garden Conceptual Plan



