Habitat Quality Model

(Raster Data Format Example)

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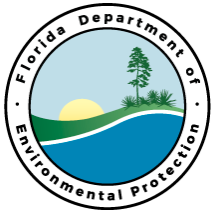


Habitat Quality Model

- Supporting Ecosystem Services
  - Habitat Quality
- Final Ecosystem Services

Habitat Quality Model

Organization

- Introduction
  - Services
  - Area of interest (AOI)
  - Purpose
- Model
  - "Coarse Filter", Habitat-Based Approach
- Data
  - Empirical Data on Land Use (LU)
  - Threats Data
- Data Statistics
  - Threat table
  - Table of sensitivity of LU types to each threat
- Results, Interpretation and Preliminary Conclusion

Habitat Quality Model

Introduction

The services provided by habitat quality

- Biodiversity is strongly associated or linked to the ecosystem services production.

- Biodiversity can be estimated by analyzing maps of land use and land cover (LULC) in conjunction with threats.

Habitat Quality Model

Introduction

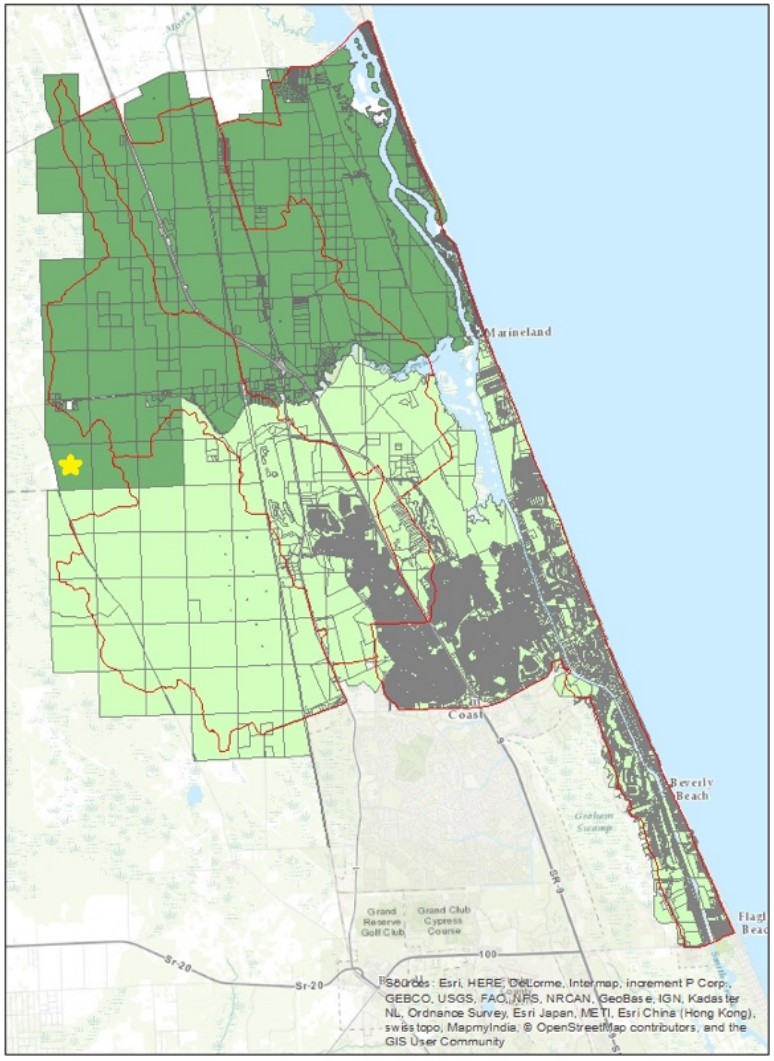
Area of interest (AOI): Florida Department of Revenue (DOR) LU parcels in Pellicer watershed and its tributaries

Purpose: To estimate the extent of habitat and vegetation types across a landscape, and their state of degradation and to identify win-win areas (i.e. conservation can benefit both natural systems and human economies).

**Habitat quality and rarity are proxies for biodiversity.*

Habitat Quality Model

Introduction



Habitat Quality Model

Model: "Coarse Filter", Habitat-Based Approaches

- Assumption: the legal protection of land is effective and all threats to a landscape are additive.

- Habitat quality: identify areas where biodiversity is likely to be most intact or imperiled

- Habitat quality: "the ability of the ecosystem to provide conditions appropriate for individual and population persistence." It is represented by a continuous variable in the model, ranging from low to medium to high, based on resources available for survival, reproduction, and population persistence, respectively (Hall et al 1997). Habitat quality depends on a habitat's proximity to human LUs and the intensity of these LUs.

Habitat Quality Model

Model: "Coarse Filter", Habitat-Based Approaches

Habitat: "the resources and conditions present in an area that produce occupancy – including survival and reproduction – by a given organism (Hall et al. 1997:175)."

- The user defines which LU types can provide habitat for the conservation objective. Which LU types should be considered habitat? – A binary approach: {0, 1}, or the habitat suitability score: [0, 1].

- H_j: the habitat suitability of LU type j

Habitat Quality Model

Model: "Coarse Filter", Habitat-Based Approaches

Threat sources: human modified LULC types that cause habitat fragmentation, edge, and degradation in neighboring habitat threats.

o_{ry}: threats r's score in raster cell y, $o_{ry} \in \{0, 1\}$

All mapped threats should be measured in the same scale and metric.

Habitat Quality Model

Model: "Coarse Filter", Habitat-Based Approaches

The impact of threats is mediated by four factors:

1. The weight relative impact of each threat: w_r
2. The distance between habitat cell and the threat source d_{xy} and the impact of the threat across space i_{rxy}

$$i_{rxy} = 1 - \left(\frac{d_{xy}}{d_{r\,max}}\right) \qquad if\ linear$$

$$i_{rxy} = e^{-\left(\frac{2.99}{d_{r\,max}}\right)d_{xy}} \qquad if\ exponential$$

   - i_{rxy}: the impact of threat r originates in cell y on cell x
   - d_{xy}: the linear distance between cell y and cell x
   - $d_{r\,max}$: the maximum effective distance of threat r, for threats outside of the AOI
3. The level of legal/institutional/social/physical protection from disturbance in each cell (access)
   - $\beta_x \in [0, 1]$: zero to complete accessibility to cell x
4. The total degradation in a cell with habitat

Habitat Quality Model

Model: "Coarse Filter", Habitat-Based Approaches

$$D_{xj} = \sum_{r=1}^{R} \sum_{y=1}^{Y_r} \left(\frac{w_r}{\sum_{r=1}^{R} w_r} \right) r_y i_{rxy} \beta_x S_{jr}$$

$S_{jr} \in [0, 1]$: the sensitivity of LU type j to threat r
Y_r: the set of grid cells on r's raster map

Habitat Quality Model

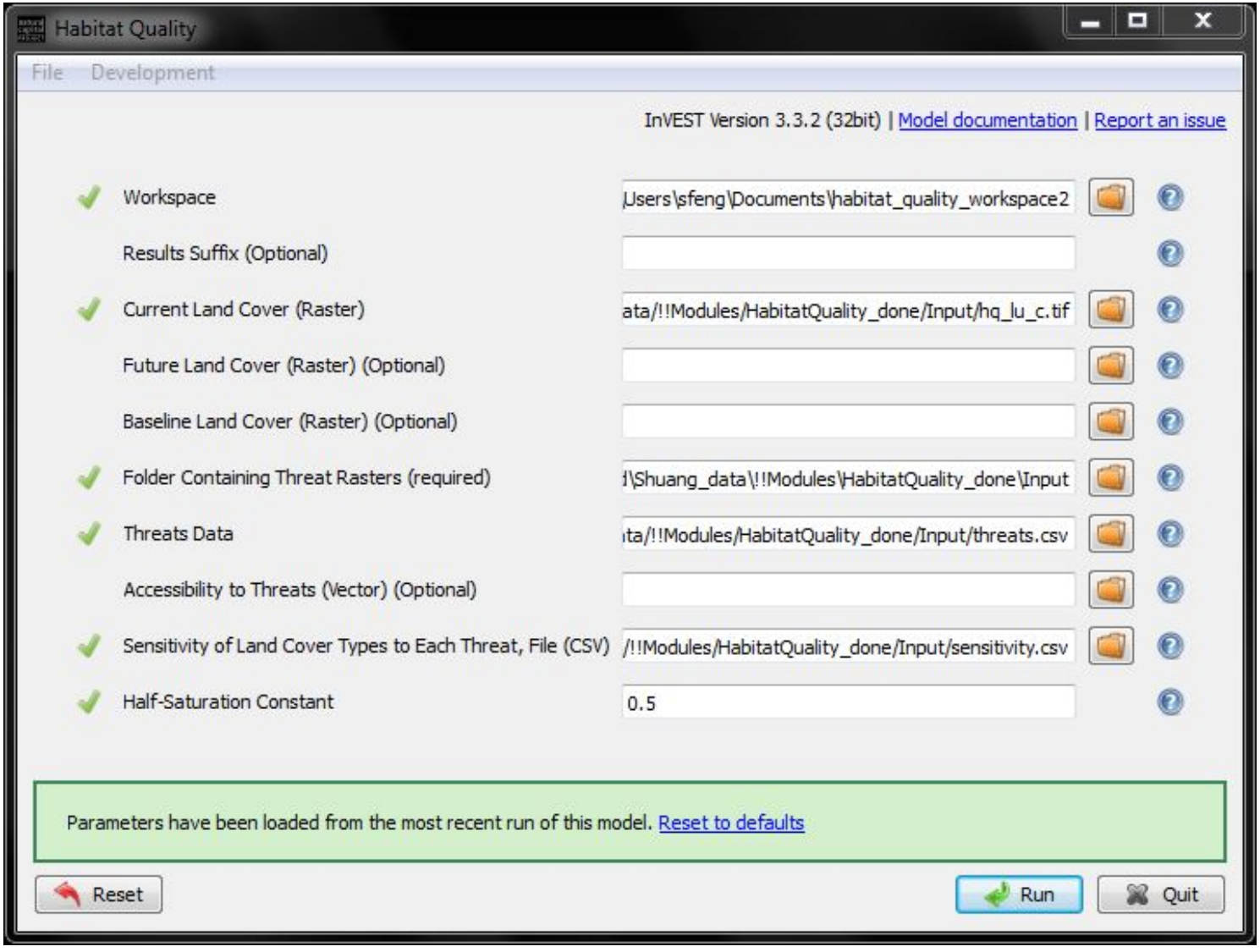
Model: "Coarse Filter", Habitat-Based Approaches

Habitat quality value: the value translated from a grid cell's degradation score by using a half-saturation function

$$Q_{xj} = H_j(1 - \frac{D_{xj}^z}{D_{xj}^z + k^z})$$

$z = 2.5$: the default scaling parameter
k: the half-saturation constant

Habitat Quality Model



Habitat Quality Model

Data

- Empirical data on LU: The Florida Department of Revenue County Property Appraiser (2016)
  Data source:
  http://floridarevenue.com/dor/property/appraisers.html

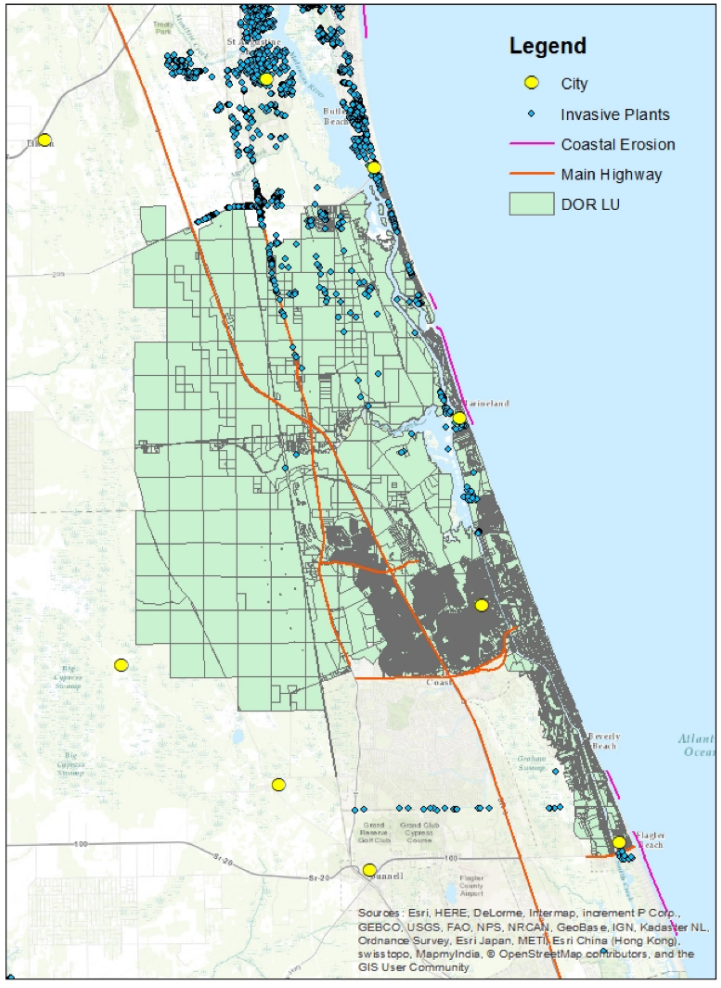
- Threats Data:
  - Threats relating to human activities: cities and roads
  - Other possible degradation sources: invasive species and coastal erosion

  InVEST online document
  http://data.naturalcapitalproject.org/nightly-build/invest-users-guide/html/habitat_quality.html#id3)
  The causes of endangerment for American species classified as threatened or endangered by the US Fish and Wildlife Service

Habitat Quality Model

Data

Land Use Parcels and Threats



Habitat Quality Model

Data Statistics

Threats Table

	A	B	C	D
1	MAX_DIST	WEIGHT	THREAT	DECAY
2	11.6	1	hq_city	exponential
3	5.1	0.3	hq_hwy	linear
4	20	1	hq_invp	linear
5	18	0.7	hq_eros	linear
6				

Threats table is used to calculate the impact of the threat i_{rxy} across space.

Habitat Quality Model

Data Statistics

Threats	Est. # of species endangered, derived by extrapolation of 5% sample from Federal Register	Weight of relative impact w_r	Buffer distance (km) $d_{r\,max}$
Cities	340	1	11.6
Roads	100	0.3	5.1
Invasive Plants	340	1	20
Florida Coastal Erosion	240	0.7	18

Data of maximum distance (buffer distance) is cited from USGS "Conservation Buffer Distance Estimates for Greater Sage-Grouse—A Review (2014)"
Local data on buffer distance should be approached via researchers in Engineering, Biology, and/or Environmental Science.

Habitat Quality Model

Data Statistics

Habitat Types and Sensitivity of Habitat Types to Each Threat Table

	A	B	C	D	E	F	G
1	LULC	NAME	HABITAT	L_hq_city	L_hq_hwy	L_hq_invp	L_hq_eros
2	1	Timberland	1	0.71	0.59	0.02	0
3	2	Vacant Com	0	0	0	0	0
4	3	Municipal, o	0	0	0	0	0
5	4	Churches	0	0	0	0	0
6	5	State, other	0	0	0	0	0
7	6	Federal, oth	0	0	0	0	0
8	7	Vacant Resi	0	0	0	0	0
9	8	Rivers and la	1	0.97	0.75	0.82	0.93
10	9	Residential (	0	0	0	0	0
11	10	Condominiu	0	0	0	0	0
12	11	Single Famil	0	0	0	0	0
13	12	Miscellaneo	0	0	0	0	0
14	13	Counties (ot	0	0	0	0	0
15	14	Acreage not	0	0	0	0	0
16	15	Public count	0	0	0	0	0
17	16	Heavy indus	0	0	0	0	0
18	17	Light manuf	0	0	0	0	0
19	18	Warehousin	0	0	0	0	0
20	19	Right-of-way	0	0	0	0	0
21	20	Utility, gas a	0	0	0	0	0
22	21	Timberland	1	0.71	0.59	0.02	0
23	22	Grazing lanc	1	0.71	0.59	0.02	0
24	23	Sewage disp	0	0	0	0	0
25	24	Golf courses	0	0	0	0	0
26	25	Tourist attra	0	0	0	0	0
27	26	Office buildi	0	0	0	0	0
28	27	Airports (pri	0	0	0	0	0
29	28	Office buildi	0	0	0	0	0
30	29	Colleges (no	0	0	0	0	0
31	30	Mixed use -	0	0	0	0	0
32	31	Parking lots	0	0	0	0	0
33	32	Clubs, lodge	0	0	0	0	0
34	33	Community	0	0	0	0	0
35	34	Bowling alle	0	0	0	0	0
36	35	Auto sales, a	0	0	0	0	0
37	36	Professional	0	0	0	0	0

	A	B	C	D	E	F	G
1	LULC	NAME	HABITAT	L_hq_city	L_hq_hwy	L_hq_invp	L_hq_eros
38	37	Stores, one	0	0	0	0	0
39	38	Financial ins	0	0	0	0	0
40	39	Restaurants	0	0	0	0	0
41	40	Multi-family	0	0	0	0	0
42	41	Homes for t	0	0	0	0	0
43	42	Drive-in Res	0	0	0	0	0
44	43	Private scho	0	0	0	0	0
45	44	Forest, park	1	0.85	0.78	0.7	0
46	45	Vacant Indu	0	0	0	0	0
47	46	Timberland	1	0.71	0.59	0.02	0
48	47	Repair servi	0	0	0	0	0
49	48	Multi-family	0	0	0	0	0
50	49	Nightclubs,	0	0	0	0	0
51	50	Hotels, mote	0	0	0	0	0
52	51	Improved ag	1	0.71	0.59	0.02	0
53	52	Centrally ass	0	0	0	0	0
54	53	Mobile Hom	0	0	0	0	0
55	54	Cooperative	0	0	0	0	0
56	55	Vacant Insti	0	0	0	0	0
57	56	Mortuaries,	0	0	0	0	0
58	57	Florists, gree	0	0	0	0	0
59	58	Orphanages	0	0	0	0	0
60	59	Ornamental	1	0.71	0.59	0.02	0
61	60	Packing plar	0	0	0	0	0
62	61	Outdoor rec	1	0.97	0.75	0.82	0.93
63	62	Grazing lanc	1	0.71	0.59	0.02	0
64	63	Service stati	0	0	0	0	0
65	64	Poultry, bee	0	0	0	0	0
66	65	Undefined	0	0	0	0	0
67	66	Regional Sh	0	0	0	0	0

Habitat Quality Model

Data Statistics

Habitat suitability H_j

- The continuum suitability across LU types
  The project team measured the habitat suitability using the Land Development Intensity (LDI) studied in Brown and Vivas (2005)
  LDI on a scale $1 - 10$ to different LU classifications
  FSU CEFA mapped this LDI score to a continuum suitability score on a scale $1 - 0$ (1 means perfect suitability and 0 means non $-$ suitability) by the following equation:

$$H_j = 1 - \frac{LDI_j - 1}{9}$$

- The binary approach (natural or unnatural) by considering biodiversity generally

Habitat Quality Model

Data Statistics

Habitat Suitability for LU Classifications and LDI in Brown and Vivas (2005)

LU Classification and LDI in Brown, M.T. & Vivas, B. M. (2005)		
Land Use	LDI (on a scale 1 - 10)	Habitat Suitability (on a scale 1 - 0)
Natural system	1	1.00
Natural open water	1	1.00
Pine/tree plantation	1.58	0.94
Recreational/open space - low intensity	1.83	0.91
Woodland pasture (with livestock)	2.02	0.89
Improved pasture (without livestock)	2.77	0.80
Improved pasture - low intensity (with livestock)	3.41	0.73
Citrus	3.68	0.70
Improved pasture - high intensity (with livestock)	3.74	0.70
Row crops	4.54	0.61
Single family residential - low density	6.9	0.34
Recreational/open space - high intensity	6.92	0.34
Agricultural - high intensity	7	0.33
Single family residential - medium density	7.47	0.28
Single family residential - high density	7.55	0.27
Mobile home - medium density	7.7	0.26
Highway - 2 lanes	7.81	0.24
Low intensity commercial	8	0.22
Institutional	8.07	0.21
Highway - 4 lanes	8.28	0.19
Mobile home - high density	8.29	0.19
Industrial	8.32	0.19
Multi-family residential - low rise	8.66	0.15
High intensity commercial	9.18	0.09
Multi-family residential - high rise	9.19	0.09
CBD - average 2 stories	9.42	0.06
CBD - average 4 stories	10	0.00

Habitat Quality Model

Data Statistics

- Because discrepancies exist between the LU classifications in different studies, or for different study purposes, a relative habitat suitability score between 0 and 1 can be customized based on the demand of InVEST users.

- This study, we followed the example of the binary approach as outlined by the InVEST development group.

Habitat Quality Model

Data Statistics

Relative Sensitivity Table for Perfect Habitat Suitability LU

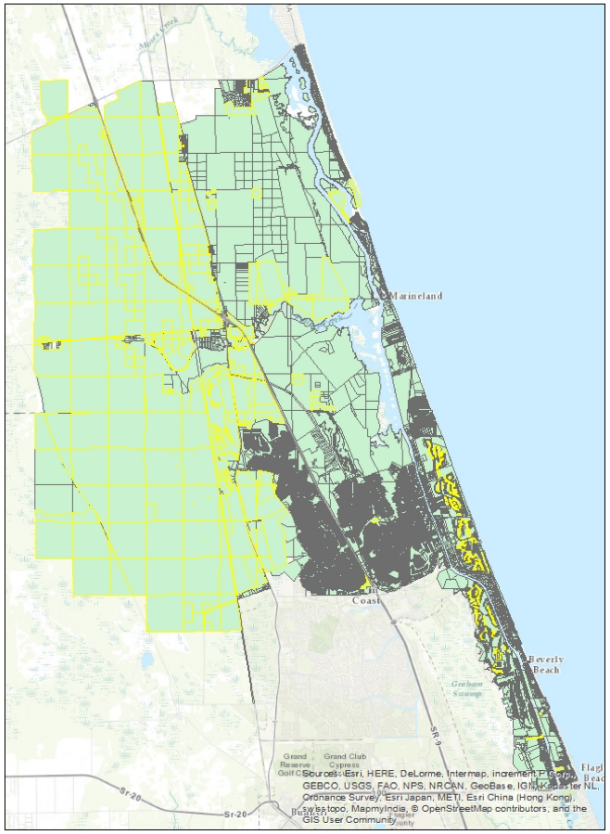
LU categories defined as perfect habitat suitability	Threats			
	Cities	Roads	Invasive Plants	Florida Coast Erosion
Agricultural, except 67 (poultry, bees, tropical fish, rabbits, etc.) and 68 (dairies, feed lots)	0.71	0.59	0.02	0
Governmental, 82 (forest, parks, recreational areas)	0.85	0.78	0.70	0
Miscellaneous, 95 (rivers and lakes, submerged lands) and 97 (outdoor recreational or parkland, or high-water recharge subject to classified use assessment)	0.97	0.75	0.82	0.93

Data Source: Table A3 from the study of Terrado, Sabater, and Acuna (2016) "Identifying regions vulnerable to habitat degradation under future irrigation scenarios"
Local data should be approached via researchers in Biology, and/or Environmental Science.

Habitat Quality Model

Data Statistics

Parcels Defined with Perfect Habitat Suitability (Outlined by Bright Yellow)



Habitat Quality Model

Results, Interpretation and Preliminary Conclusion

Relative Level of Habitat Degradation D_{xj} on the Current Landscape

Habitat Quality Model

Results, Interpretation and Preliminary Conclusion

- The mapping of relative level of habitat degradation on the current landscape (a scale from 0 to 0.07).
- A high score in a grid cell means habitat degradation in the cell is high relative to other cells.
- St Johns County
  - Parcels belonging to LU of "Agricultural" in St Johns County, which are adjacent to main highways US-1 and I-95 and are closed to high invasive plants distributions, have high degradation scores.
  - Parcels belonging to LU of "Governmental" in St Johns County, which are at the boundary of St. Johns County and Flagler County, are with higher degradation scores and vulnerable to the effects of roads and invasive species.
  - Parcels of "Governmental", which are located near the coast, reflect higher degradation scores.

Habitat Quality Model

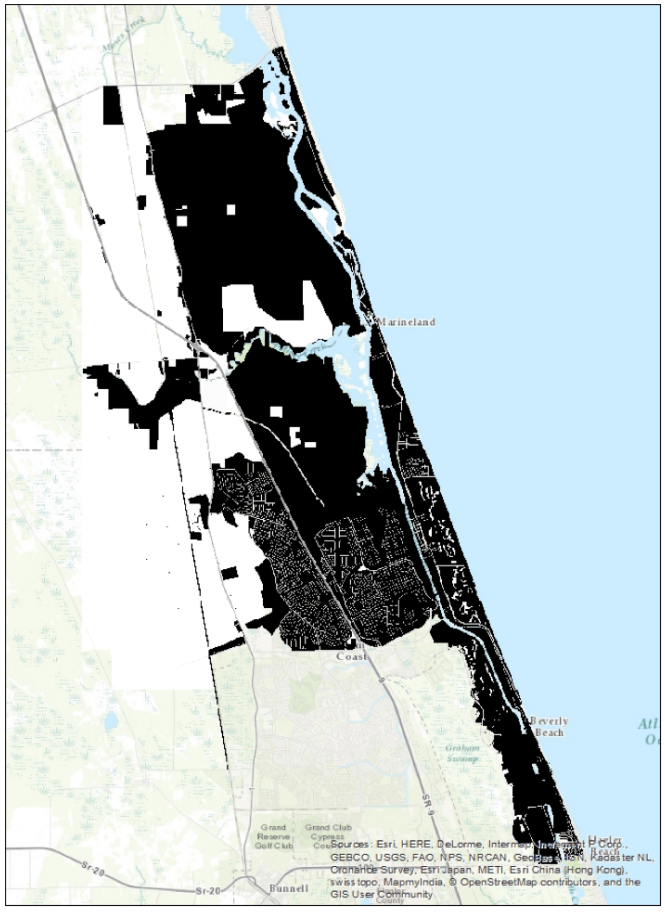
Results, Interpretation and Preliminary Conclusion

- Flagler County
  - Parcels with perfect habitat suitability: LU of "Agricultural" in Flagler County, which are adjacent to main highways US-1 and I-95, have high degradation scores.
  - Impacts of cities and costal erosion on habitat suitable parcels are shown to be insignificant.

Habitat Quality Model

Results, Interpretation and Preliminary Conclusion

Habitat Quality Value



Habitat Quality Model

Results, Interpretation and Preliminary Conclusion

- The habitat quality (a scale from 0 to 1) on the current landscape.
- Higher numbers (lighter color) indicate better habitat quality.
- Parcels on the current landscape that are not suitable habitat (with 0 habitat suitability) get a quality score 0 (shown in black).
- The more prevalent parcels defined with perfect habitat suitability, belong to LU's of "Agricultural", "Governmental" and "Miscellaneous".

Habitat Quality Model

Questions and Comments