Evaluating the effects of varying spatial scales on habitat suitability model input parameters and outcomes

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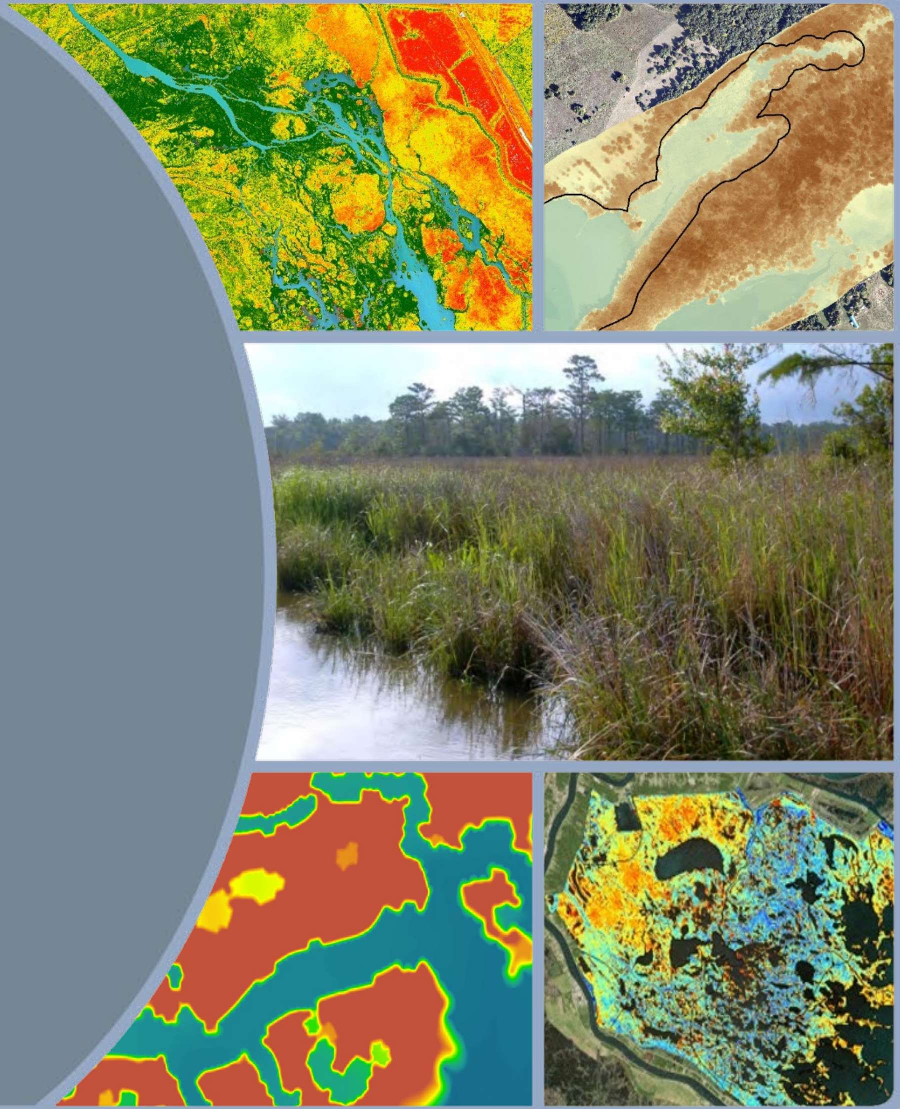
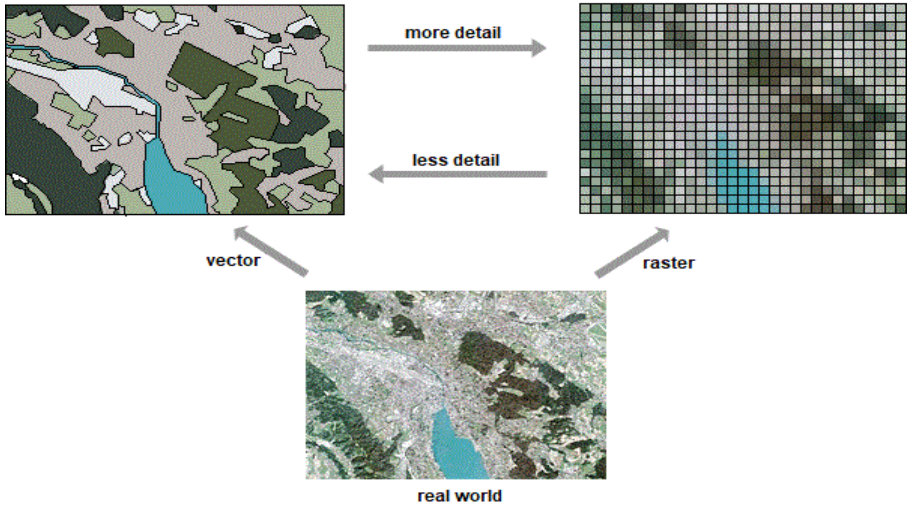


Next Generation Ecological Modeling Seminar Series
21 June 2023

INTRODUCTION

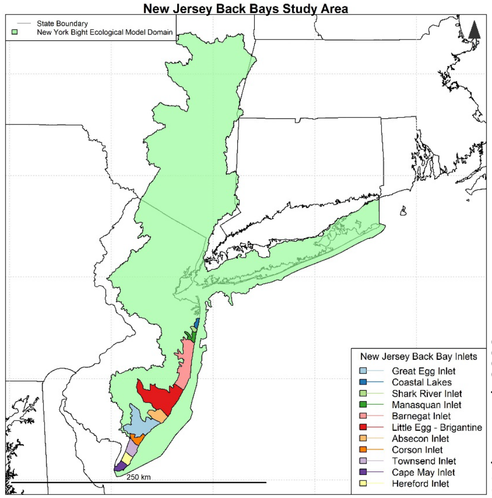
Background

Current ecological models used by the USACE often do not incorporate spatial data or processes at the level of detail that leverages current advancements of these data. While spatially implicit models may be useful for some applications, they encounter challenges when implemented in complex ecosystems. The inability to capture ecosystem drivers can result in less accurate future predictions for project scenarios, and ultimately, in underperforming projects or project benefits.



Objectives

- Develop ecological habitat suitability model iterations at a spectrum of spatial scales, from spatially limited to spatially explicit, for a District case study
- Generate comparative analyses between spatially implicit and explicit ecological models for the case study (i.e. pros and cons)
- Quantify and summarize the differences between model approaches with regard to the calculation of habitat units
- Communicate research findings regarding spatial data integration in next generation ecological modeling and their benefits to USACE



Mahan et al. 2023

INTRODUCTION

New Jersey Back Bay (NJBB) Case Study

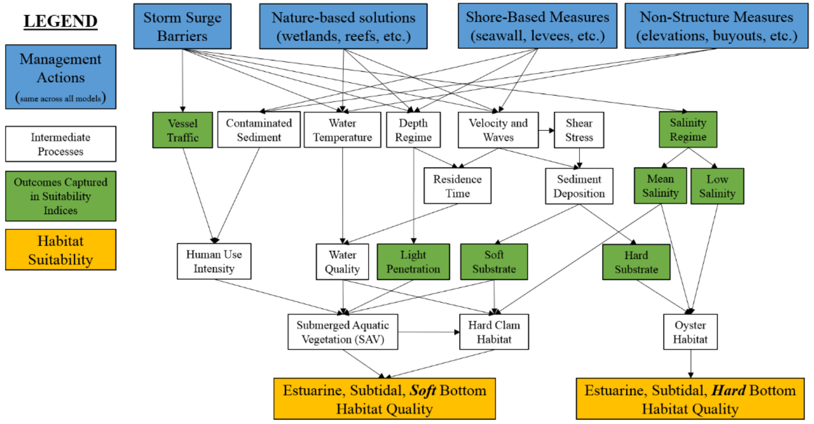
Model Purpose

Evaluate relative environmental effects of proposed large-scale alternatives which can inform the feasibility process and NEPA assessments

Model Zones

NJBB Ecological Sub-Models

- Freshwater Tidal
- Estuarine Intertidal
- Estuarine Subtidal
- Marine Intertidal
- Marine Subtidal
- Marine Deepwater



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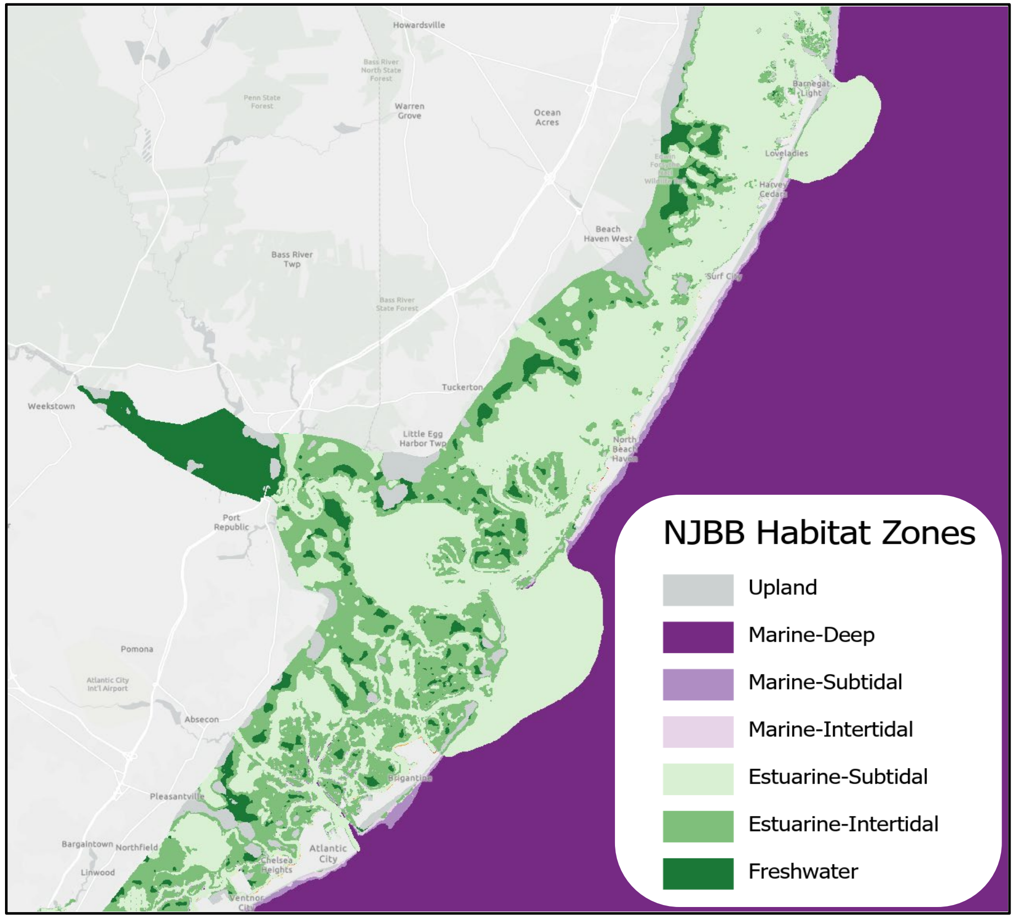
Model Parameters

- 30 Parameters across all habitat zones
- 9 parameters in the Estuarine Subtidal Model



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METHODS

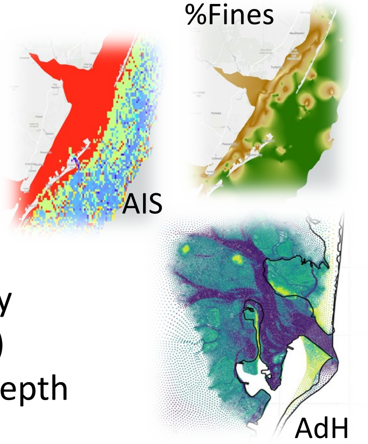
NJBB Case Study

NJBB Ecological Sub-Models

- Freshwater Tidal
- Estuarine Intertidal
- ***Estuarine Subtidal***
- Marine Intertidal
- Marine Subtidal
- Marine Deepwater

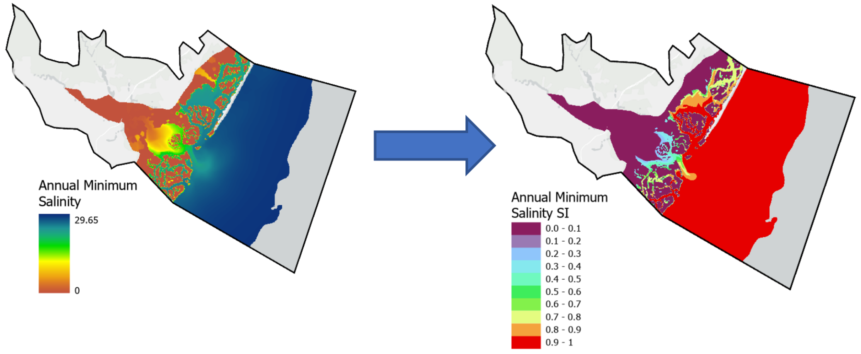
Data Sources

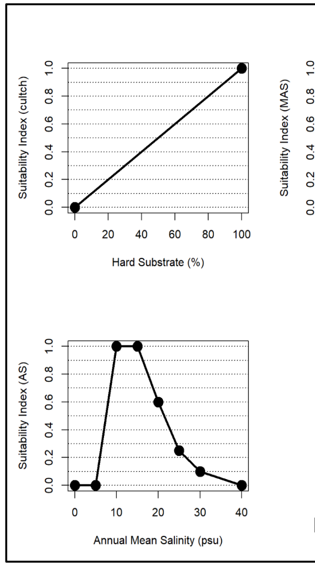
- ERDC Adaptive hydraulics model (AdH)
  - Annual Minimum Salinity
  - Annual Mean Salinity
- Automatic Identification System (AIS) vessel track density
- US SEABED and Stockton University (%gravel and %fines)
- Light availability (AdH water depth and regional Secchi depth standard)



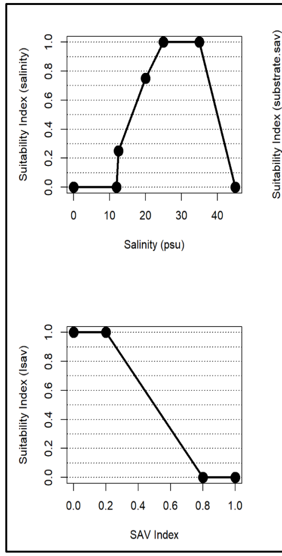
Parameter Value

Parameter SI

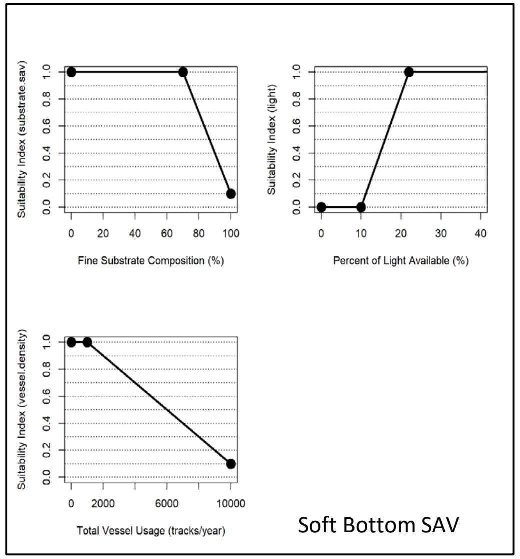




Hard Bottom Oysters



Soft Bottom Clams

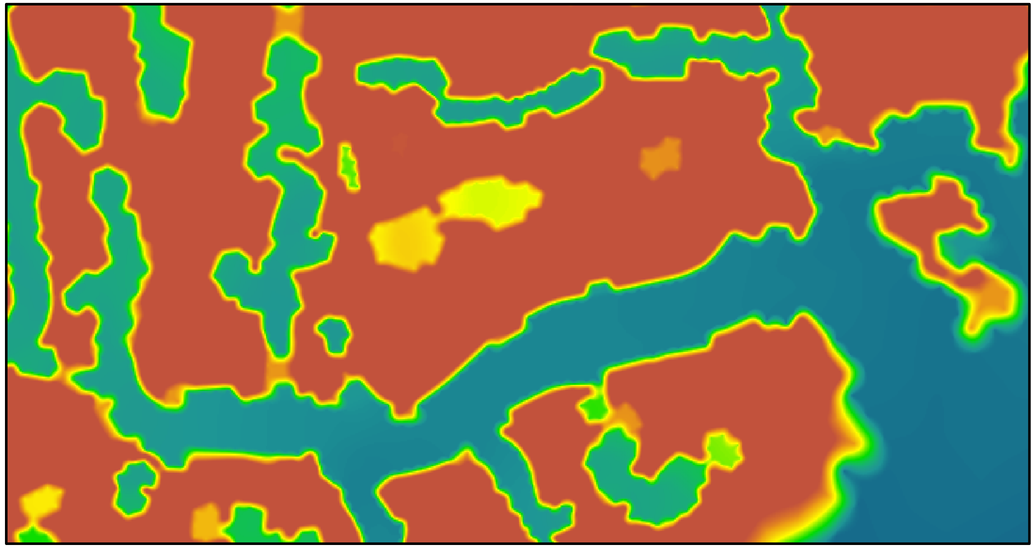


Soft Bottom SAV

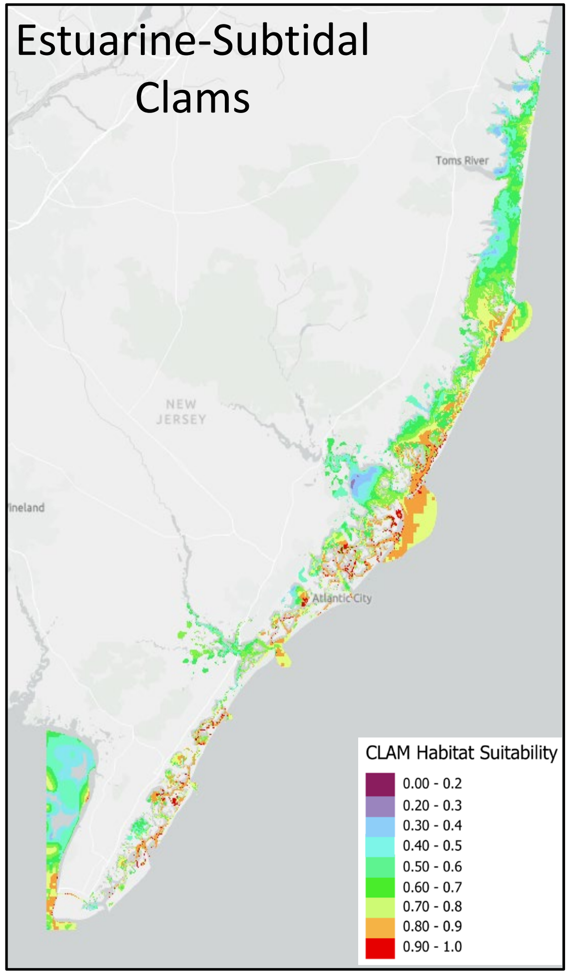
APPROACH

Spatially Implicit (limited data)

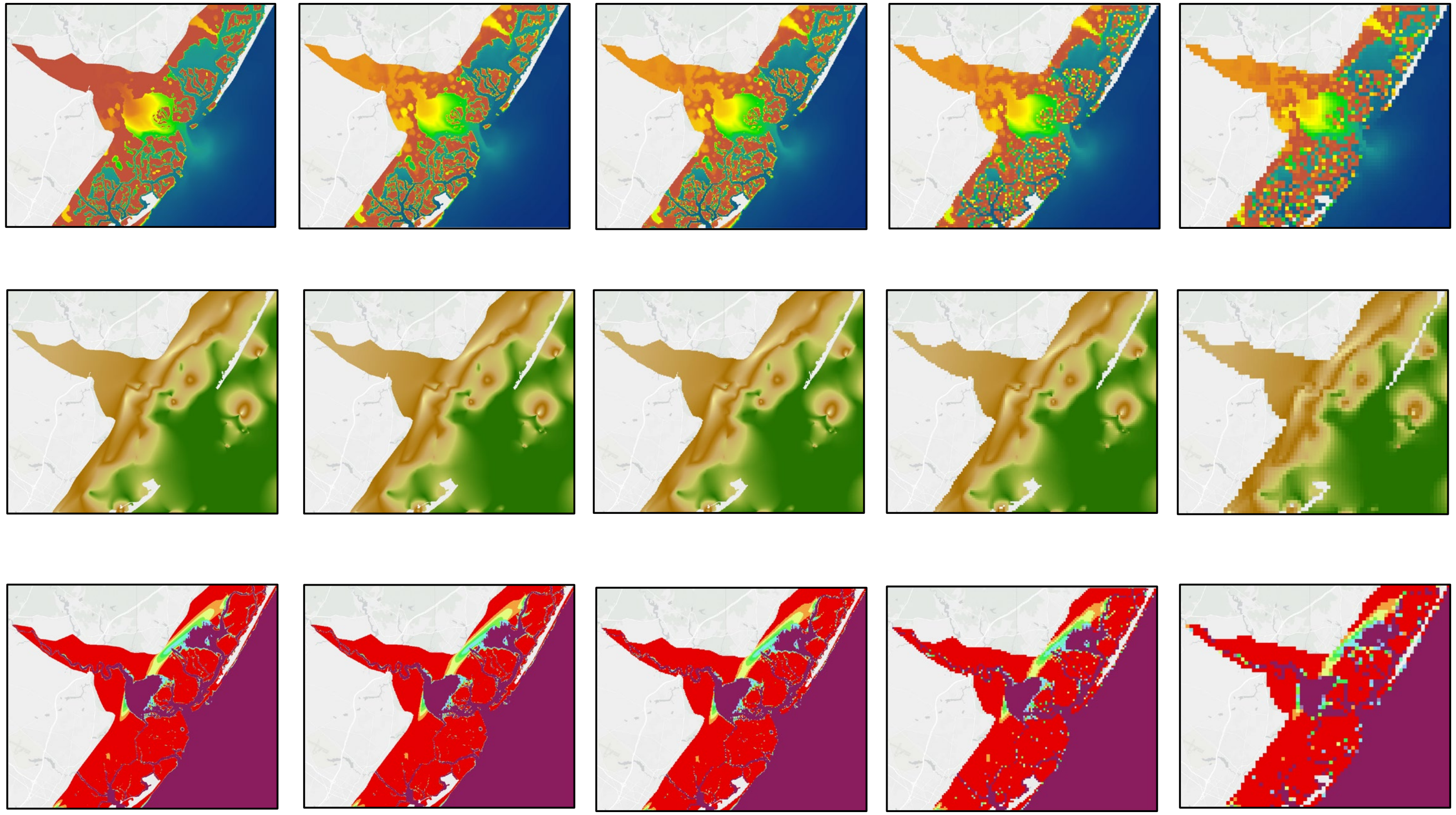
Spatially Explicit (lots of data)



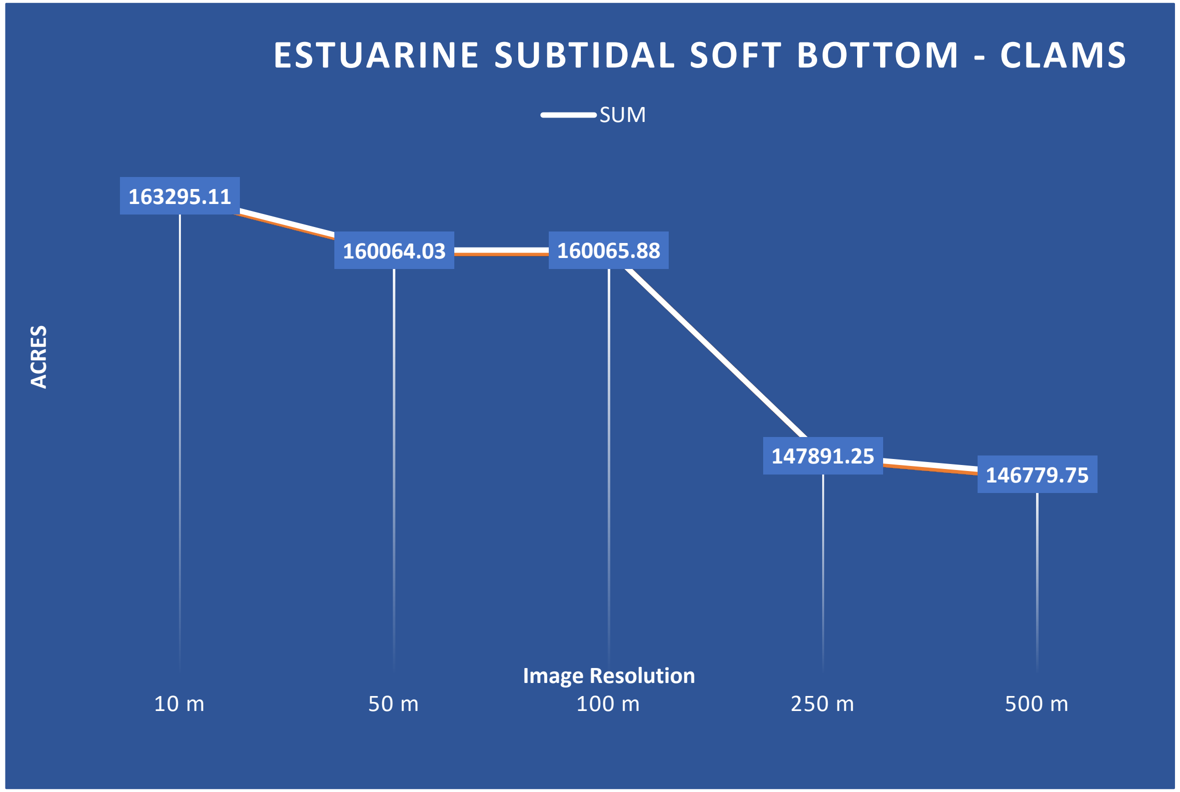
SPATIALLY EXPLICIT

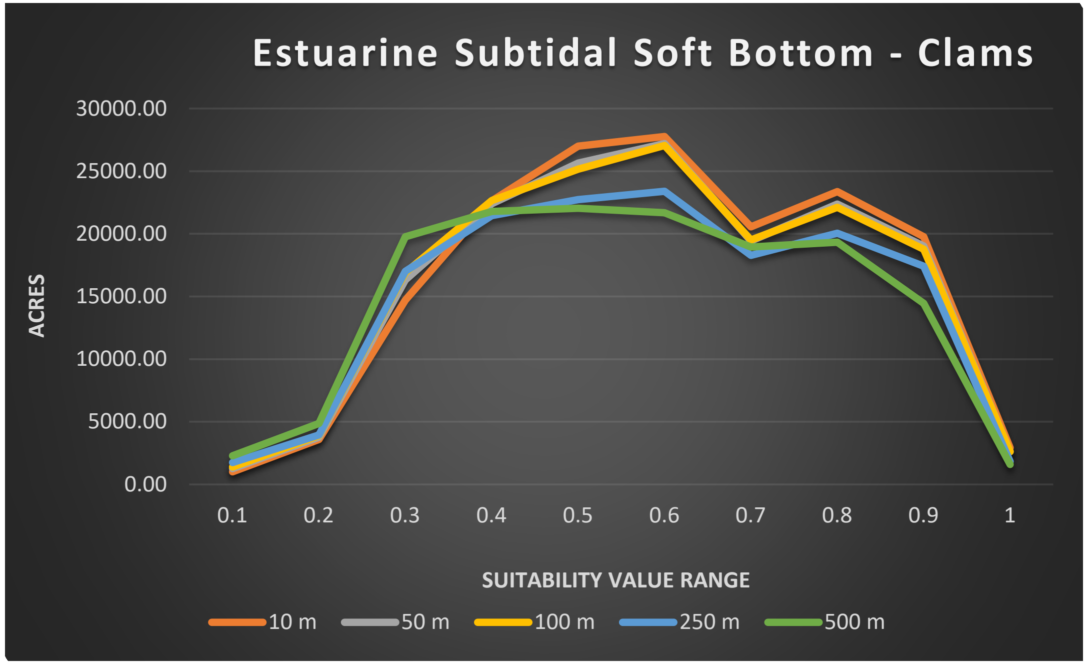


	10 m	50 m	100 m	250 m	500 m
Annual Minimum Salinity					
%Fines					
SAV Index					



RESULTS
SPATIALLY EXPLICIT





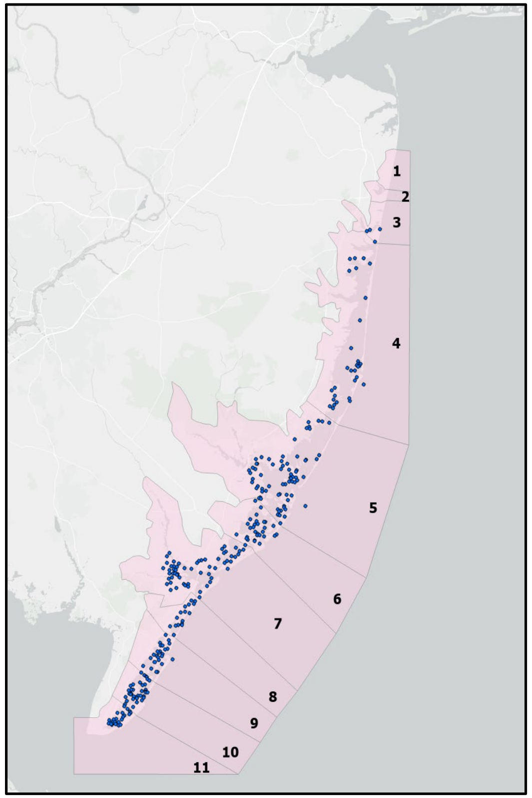
SI VALUE 0.6	*Acres*	*Difference*	*AAHUs*	*Difference*	*%Change*
10 m	27768.26		16660.96		
50 m	27208.90	-559.36	16325.34	-335.61	-2.01%
100 m	27061.32	-147.58	16236.79	-88.55	-0.54%
250 m	23403.25	-3658.07	14041.95	-2194.84	-13.52%
500 m	21674.25	-1729.00	13004.55	-1037.40	-7.39%
			10m-500m change		*-21.95%*

HSI VALUE	10 m	50 m	100 m	250 m	500 m
0.1	994.69	1255.38	1380.73	1759.88	2284.75
0.2	3575.89	3776.63	3887.78	3936.56	4878.25
0.3	14705.00	16326.70	16902.21	17012.13	19760.00
0.4	22641.06	22392.40	22662.25	21458.13	21797.75
0.5	26999.47	25654.04	25154.48	22739.44	22044.75
0.6	27768.26	27208.90	27061.32	23403.25	21674.25
0.7	20553.59	19433.96	19515.47	18278.00	18957.25
0.8	23368.77	22376.97	22113.91	20053.31	19327.75
0.9	19762.59	19031.97	18764.59	17413.50	14449.50
1	2925.79	2607.09	2623.14	1837.06	1605.50
SUM ACRES	***163295.11***	***160064.03***	***160065.88***	***147891.25***	***146779.75***

SPATIALLY IMPLICIT

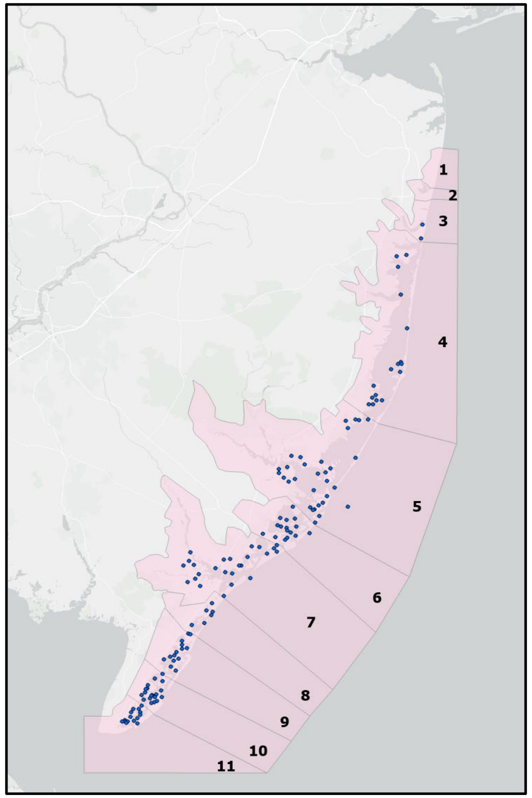
More Detail — Tidal Inlet Zones — Less Detail

Level 1



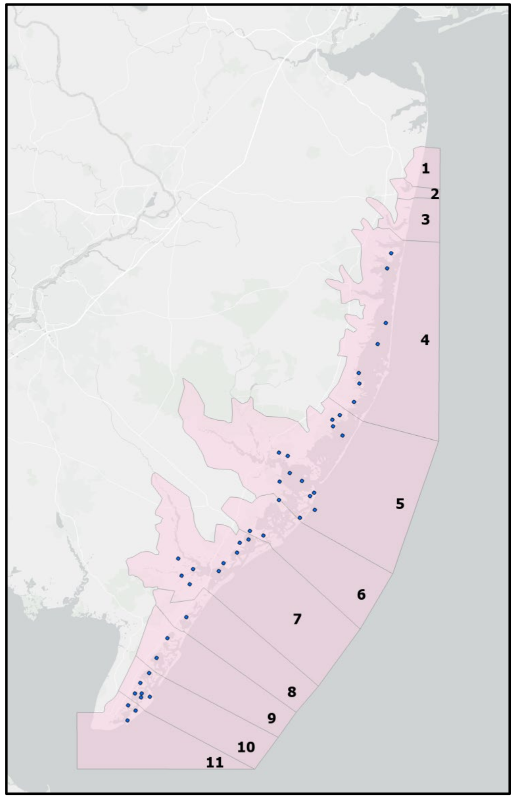
Sample size: 295
Zone 3 = 4
Zone 4 = 31
Zone 5 = 71
Zone 6 = 29
Zone 7 = 59
Zone 8 = 16
Zone 9 = 26
Zone 10 = 36
Zone 11 = 23

Level 2



Sample size: 145
Zone 3 = 2
Zone 4 = 17
Zone 5 = 31
Zone 6 = 16
Zone 7 = 25
Zone 8 = 6
Zone 9 = 14
Zone 10 = 19
Zone 11 = 15

Level 3

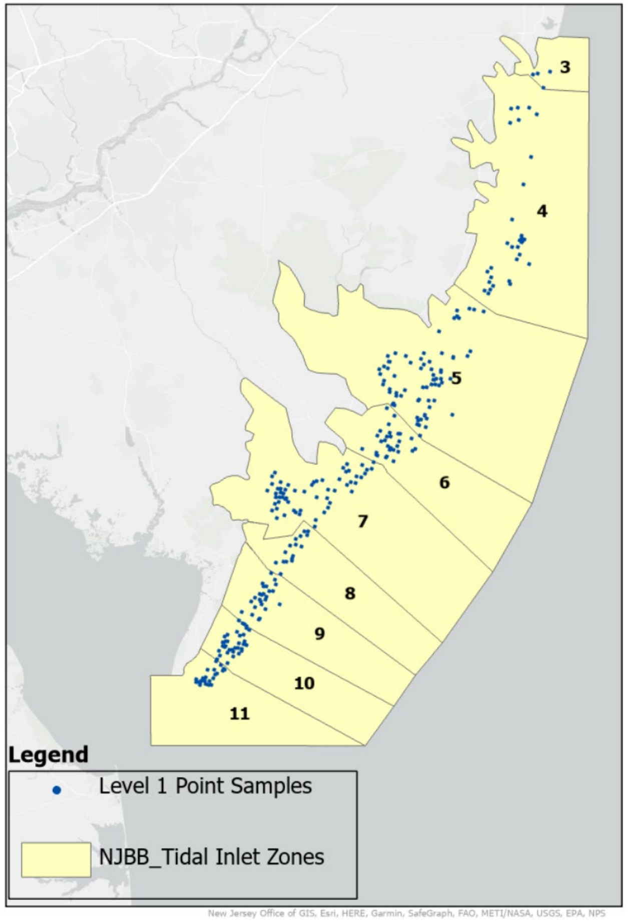


Sample size: 44
Zone 3 = 0
Zone 4 = 7
Zone 5 = 13
Zone 6 = 3
Zone 7 = 9
Zone 8 = 1
Zone 9 = 2
Zone 10 = 6
Zone 11 = 3

SPATIALLY IMPLICIT

NAME	RESOLUTION	MIN	MAX	MEAN	MEDIAN	STD
Estuarine Subtidal Oysters HSI	Pts 295	0	0.827	0.371	0.389	0.139
	Pts 145	0	0.911	0.383	0.000	0.139
	Pts 44	0	0.646	0.399	0.000	0.161
Estuarine Subtidal Clams HSI	Pts 295	0	0.865	0.376	0.391	0.178
	Pts 145	0	1.000	0.389	0.409	0.195
	Pts 44	0	0.824	0.384	0.377	0.183
Estuarine Subtidal SAV HSI	Pts 295	0	1.000	0.887	0.991	0.220
	Pts 145	0	1.000	0.887	1.000	0.225
	Pts 44	0	1.000	0.850	0.870	0.288

Study Area Zones

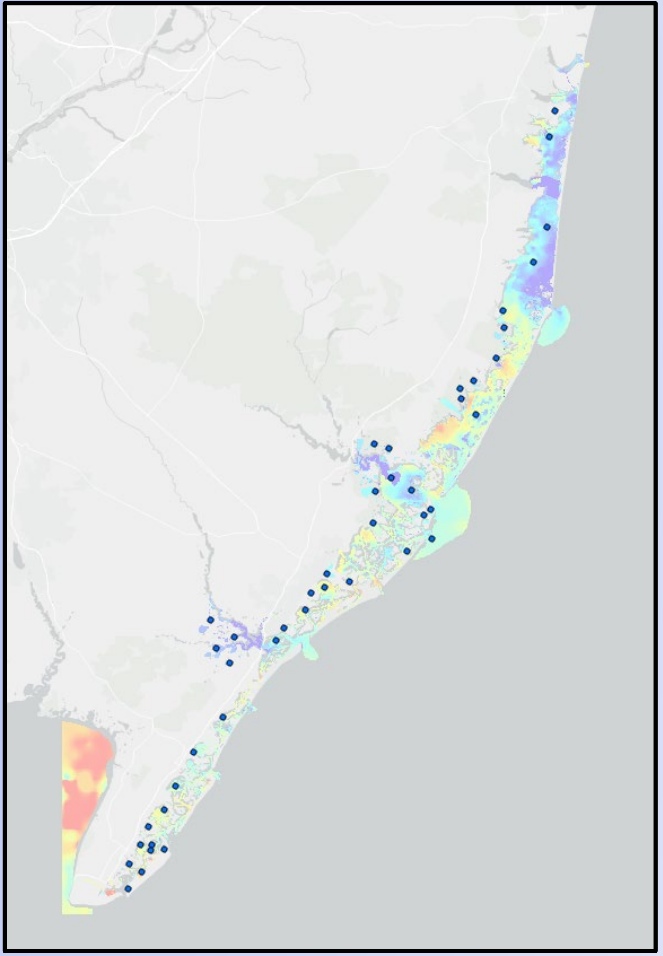


IMPLICT VS EXPLICIT

Implicit and Explicit Models Overall HSI Values

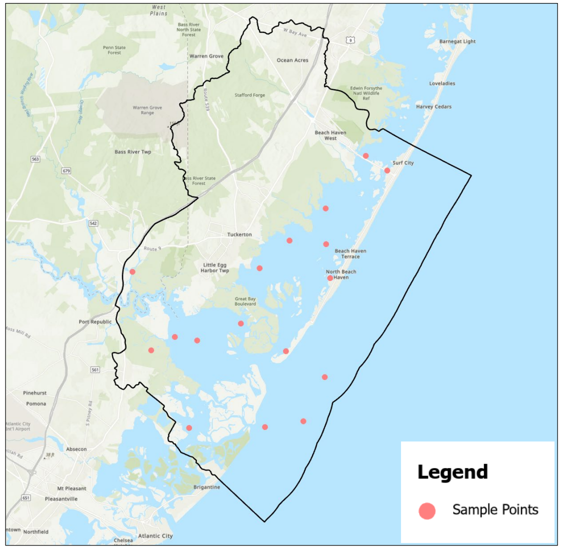
NAME	RESOLUTION	MIN	MAX	MEAN	MEDIAN	STD
Estuarine Subtidal Oysters HSI	Pts 295	0	0.827	0.371	0.389	0.139
	Pts 145	0	0.911	0.383	0.000	0.139
	Pts 44	0	0.646	0.399	0.000	0.161
Estuarine Subtidal Oysters HSI	Meters 10	0	1.000	0.029	0.000	0.146
Estuarine Subtidal Clams HSI	Pts 295	0	0.865	0.376	0.391	0.178
	Pts 145	0	1.000	0.389	0.409	0.195
	Pts 44	0	0.824	0.384	0.377	0.183
Estuarine Subtidal Clams HSI	Meters 10	0	0.998	0.433	0.424	0.229
Estuarine Subtidal SAV HSI	Pts 295	0	1.000	0.887	0.991	0.220
	Pts 145	0	1.000	0.887	1.000	0.225
	Pts 44	0	1.000	0.850	0.870	0.288
Estuarine Subtidal SAV HSI	Meters 10	0	1.000	0.695	0.667	0.227

Estuarine –Subtidal
Soft Clams HSI



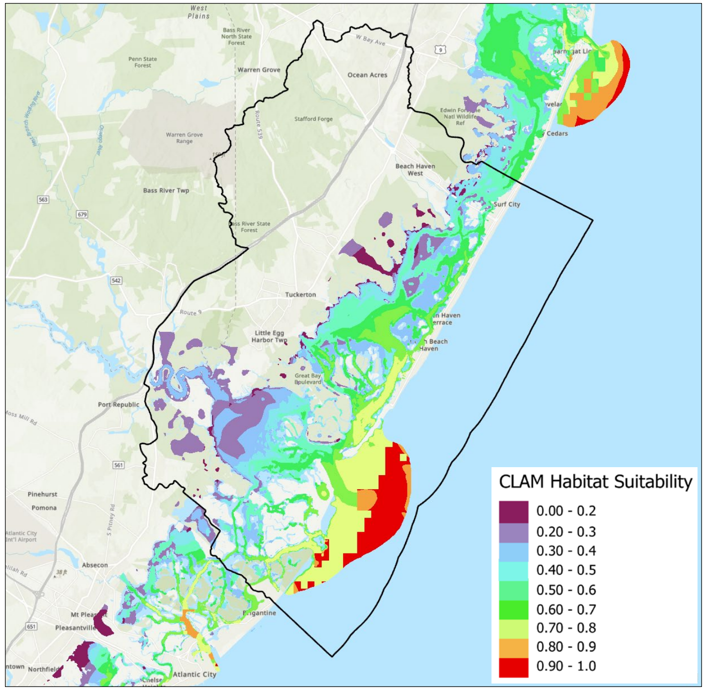
IMPLICT VS EXPLICIT

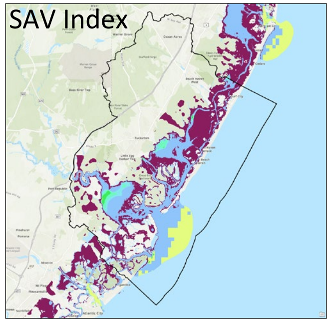
Implicit Model

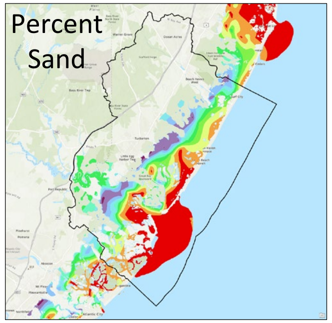


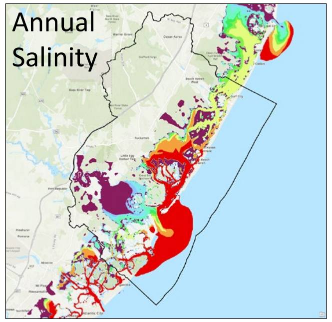
Sample	Annual Salinity	HSI	Sand Substrate	HSI	SAV Index	HSI	Overall HSI
1	23.03	0.80	58.99	0.61	0.84	0.00	***0.47***
2	25.68	1.00	97.87	0.98	0.67	0.22	***0.73***
3	26.21	1.00	98.96	0.99	0.33	0.77	***0.92***
4	3.95	0.00	47.85	0.47	1.00	0.00	***0.16***
5	4.13	0.00	11.26	0.09	0.46	0.57	***0.22***
6	25.99	1.00	94.20	0.95	0.67	0.22	***0.72***
7	16.02	0.36	82.55	0.86	0.90	0.00	***0.40***
8	6.83	0.00	38.40	0.35	0.67	0.22	***0.19***
9	26.75	1.00	85.56	0.88	0.33	0.77	***0.88***
10	0.40	0.00	55.14	0.56	1.00	0.00	***0.19***
11	23.42	0.84	18.46	0.15	0.67	0.22	***0.40***
12	24.41	0.94	41.28	0.39	0.78	0.02	***0.45***
13	24.51	0.95	86.46	0.89	0.67	0.22	***0.69***
14	23.80	0.88	63.95	0.67	0.68	0.20	***0.58***
15	23.46	0.85	27.29	0.23	0.66	0.24	***0.44***
16	22.82	0.78	59.26	0.61	1.00	0.00	***0.46***
17	11.35	0.00	26.31	0.22	0.96	0.00	***0.07***
MEAN	***18.40***	*0.44*	***58.46***	*0.60*	***0.72***	*0.13*	**0.39**

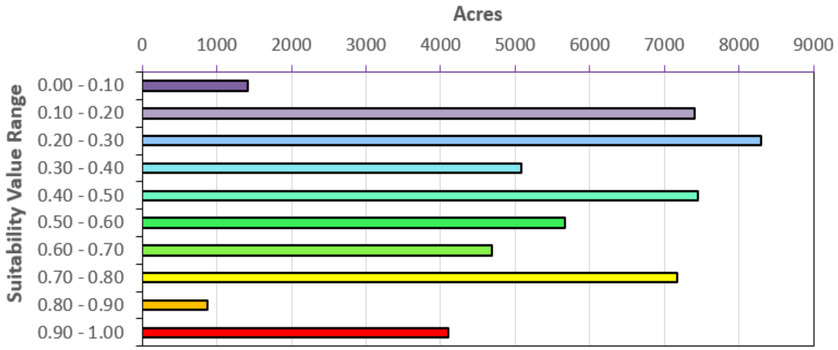
Explicit Model



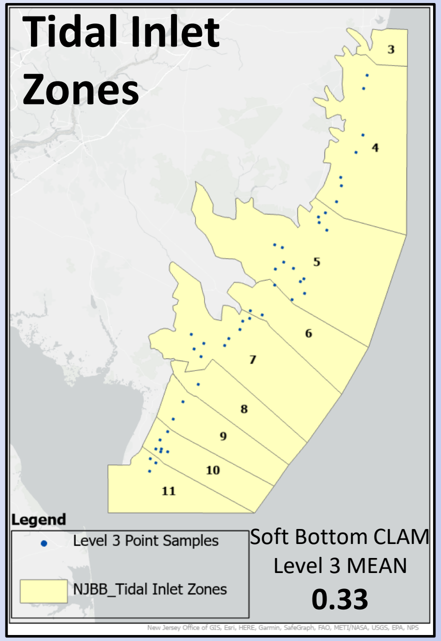








Mean 0.49

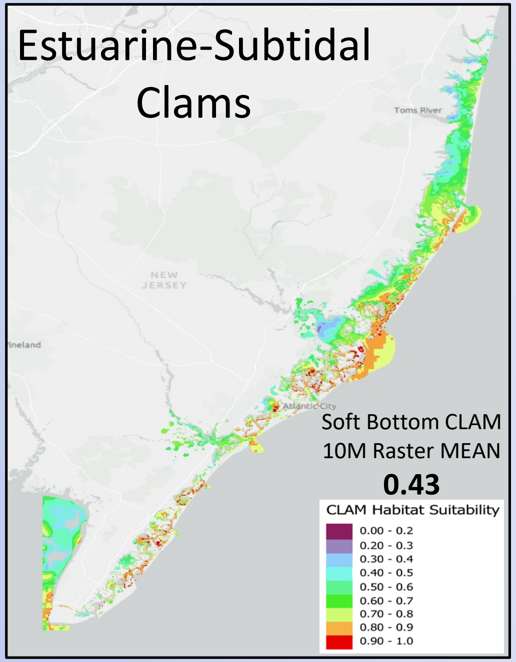


Implicit Model Mean HSIs by Zone

Zone	SAV Suitability HSI	Sand Substrate HSI	Min Annual Salinity HSI	Overall HSI
Zone 4	0.13	0.52	0.23	0.29
Zone 5	0.34	0.33	0.56	0.33
Zone 6	0.46	0.44	0.85	0.44
Zone 7	0.38	0.32	0.55	0.32
Zone 8	1.00	0.51	0.35	0.51
Zone 9	0.80	0.42	0.45	0.42
Zone 10	0.82	0.52	0.64	0.52
Zone 11	0.71	0.63	0.95	0.63
All Zone Mean	0.09	0.47	0.60	0.38

Explicit Model Mean HSIs by Zone

Zone	SAV Suitability HSI	Sand Substrate HSI	Min Annual Salinity HSI	Overall HSI
Zone 4	0.15	0.56	0.07087	0.29
Zone 5	0.16	0.42	0.317754	0.40
Zone 6	0.07	0.45	0.652356	0.48
Zone 7	0.11	0.53	0.82281	0.33
Zone 8	0.09	0.43	0.537469	0.45
Zone 9	0.07	0.40	0.85872	0.45
Zone 10	0.09	0.42	0.857213	0.50
Zone 11	0.22	0.59	0.818634	0.54
All Zone Mean	0.12	0.48	0.62	0.43



Soft Bottom Clams – Zone 5 (*Little Egg - Brigantine*) Level 3

SampleID	Zone	V1	V2	V3	Habitat Suitability Index
		SAV SuitabilityHSI	Sand SubstrateHSI	Min Annual Salinity HSI	Overall HSI
3	5	0.000	0.280	0.840	0.280
4	5	0.000	0.307	0.922	0.307
5	5	0.000	0.436	0.965	0.436
6	5	0.000	0.267	0.800	0.267
7	5	0.000	0.283	0.848	0.283
8	5	0.000	0.483	0.929	0.483
9	5	0.347	0.140	0.073	0.140
10	5	0.000	0.312	0.936	0.312
11	5	0.980	0.327	0.000	0.327
12	5	0.925	0.323	0.045	0.323
14	5	0.902	0.395	0.285	0.395
26	5	0.317	0.374	0.584	0.374
28	5	1.000	0.407	0.000	0.407
	MEAN	*0.344*	*0.333*	*0.556*	*0.333*

Zone 5 (381047.5 Acres)

Level 3 Pts = 125,746 AAHUs
10M Raster = 152,419 AAHUs

Difference ***~17.5% decrease***

CONCLUSIONS

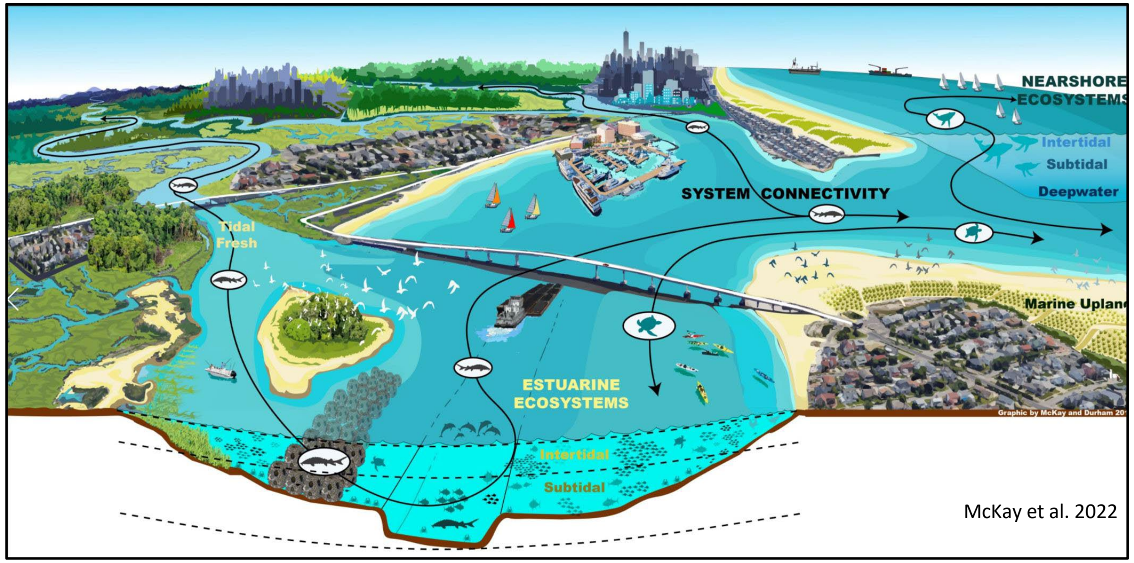
Implicit Approach vs Explicit Approach

- Explicit approach provides more detailed analysis, but can also introduce excess noise in the output
- Landscape processes that occur at fine scales could be missed at spatially limited sites.

- Implicit approach does not work as well for highly fragmented landscapes.

- A spectrum of spatially scaled model iterations demonstrates the increasing power of the spatial component in the analysis.

Evaluating the effects of varying spatial scales on habitat suitability index model input parameters and outcomes



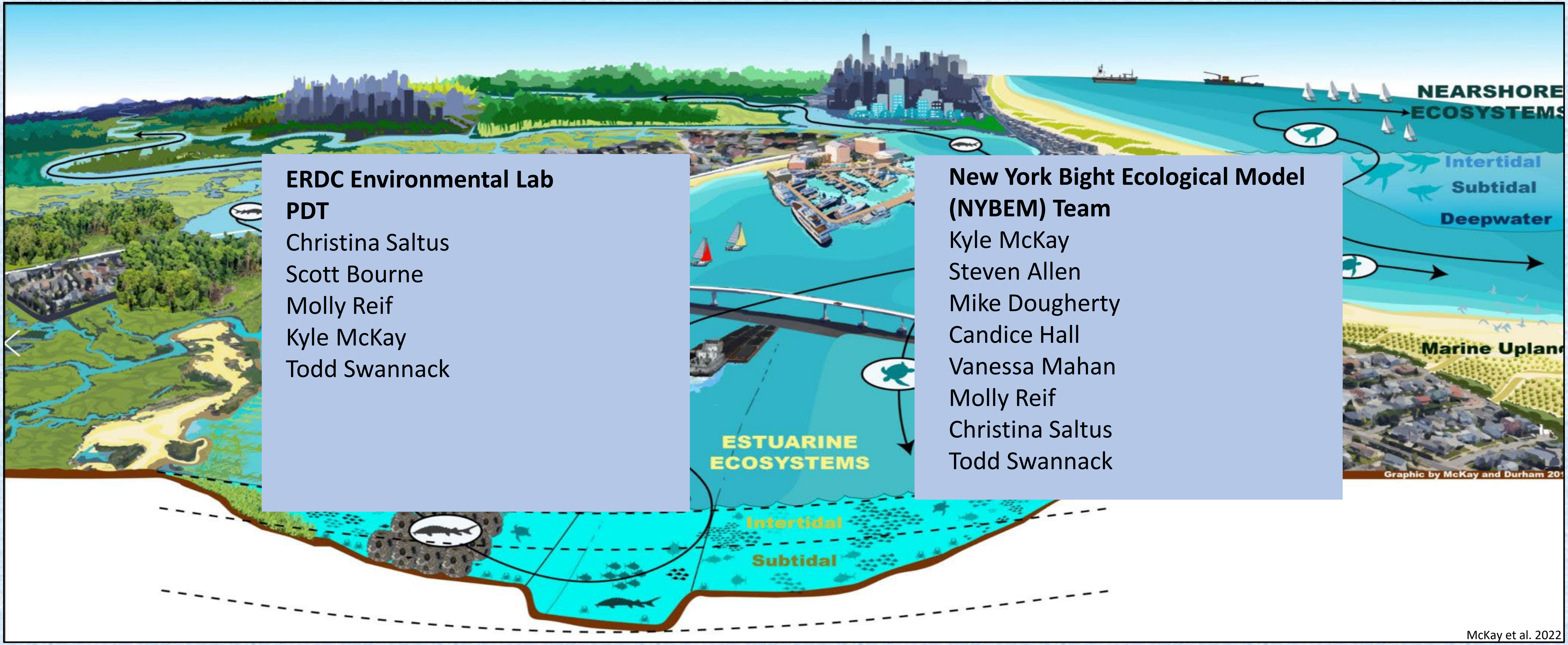
Value to the USACE

- Utilizing spatially explicit ecological models can improve ecological impact assessments of USACE managed projects (i.e. habitat connectivity, configuration)
- Demonstrates the efficacy of using spatial explicit versus limited spatial ecological models for decision making such as plan formulation, alternatives evaluation and analysis, and feasibility studies for ecosystem restoration
- Leverages the methodologies and findings funded through NavSYS, ANSRP, EMRRP, and section 219

Future

Assessing geospatial methods for ecological model evaluation

Acknowledgements



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