



2023 COASTAL MASTER PLAN
COMMITTED TO OUR COAST

ICM-HABITAT SUITABILITY INDICES

DAVID LINDQUIST

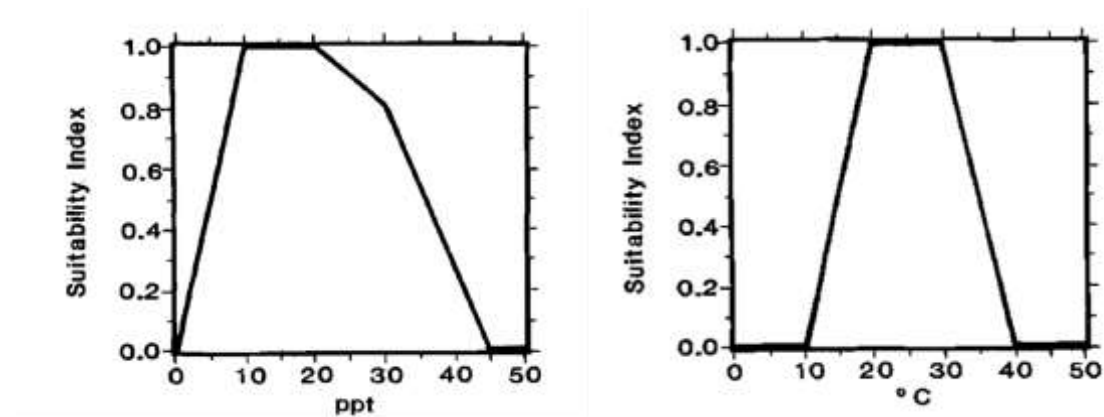


FEBRUARY 9, 2021

HABITAT SUITABILITY INDICES (HSIs)

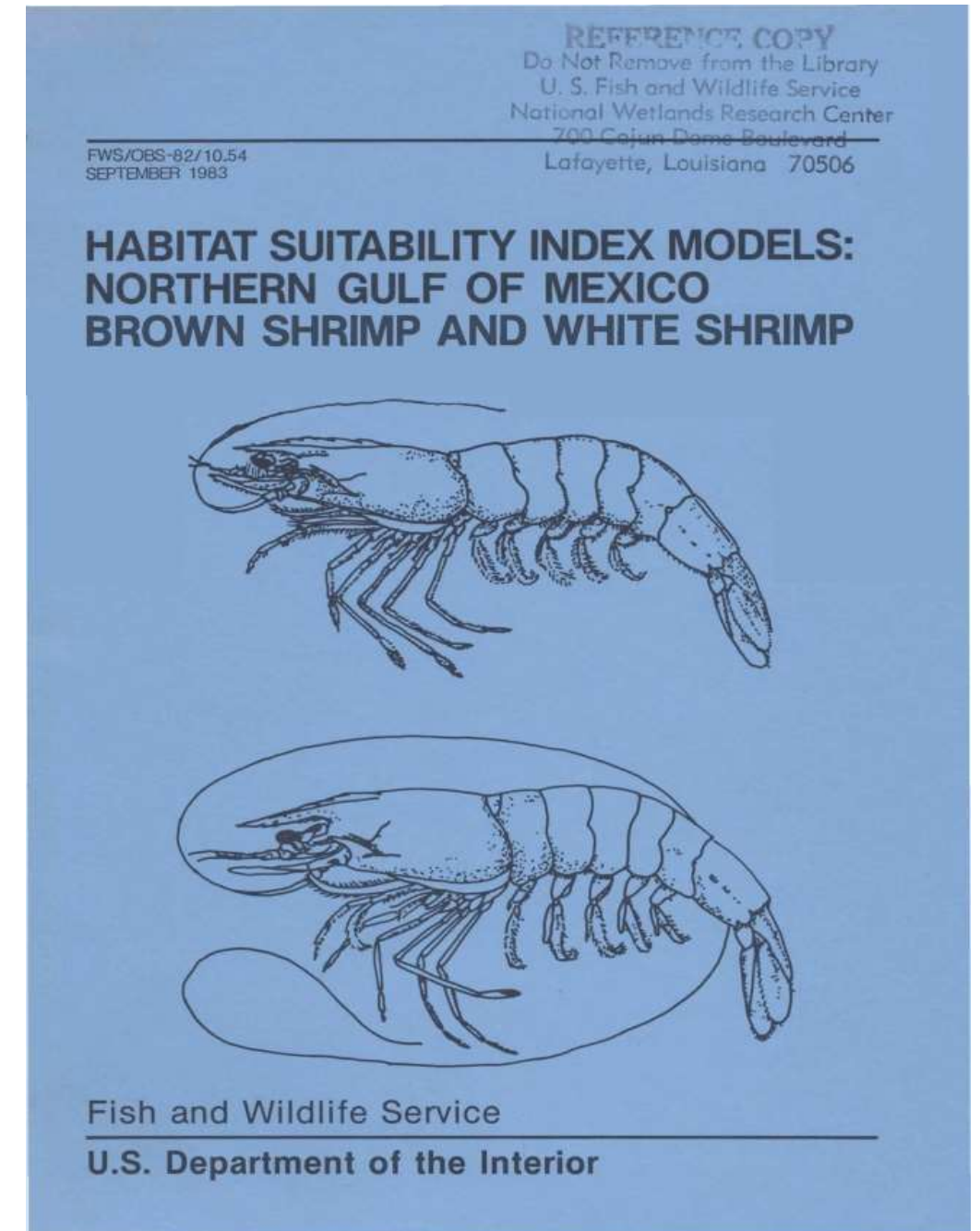
WHAT ARE THEY?

- Describe capacity of habitat to support species
- Consist of various suitability indices (SIs) that describe suitability of key environmental variables to a species



Salinity and temperature suitability relationships for brown shrimp (Turner and Brody 1983)

- Output is a numerical index (0 to 1)
 - 1 = optimal habitat; 0 = unsuitable habitat
- Not correlated with abundance, just habitat suitability



INTEGRATED COMPARTMENT MODEL (ICM)

- Evaluate effects of projects on habitat quality for key species
- Incorporated into ICM; use outputs from other subroutines
- HSIs also used in 2012 and 2017 Coastal Master Plans



2023 ICM-HSI MODEL IMPROVEMENT TEAM

- Dynamic Solutions
 - Shaye Sable
- CPRA
 - David Lindquist
 - Summer Langlois
- USGS
 - Ann Hijuelos
 - Laura D'Acunto
- UNO
 - Meg O'Connell
- LSU AgCenter
 - Elizabeth Robinson
 - Megan La Peyre
- Audubon Louisiana
 - Katie Percy
 - Erik Johnson
 - Nicole Michel
 - Lindsay Nakashima
- LDWF
 - Brady Carter



THE UNIVERSITY of
NEW ORLEANS



2023 COASTAL MASTER PLAN ICM-HSI MODELED SPECIES

- Species representative of range of habitats (swamps, marshes, barrier islands, etc.)
- Commercially- and recreationally-important species
- Species of conservation concern



Eastern Oyster



Crayfish



Brown Shrimp[^]



White Shrimp[^]



Gadwall



Mottled Duck



Blue Crab



Gulf Menhaden[^]



Brown Pelican



American Alligator



Spotted Seatrout[^]



Largemouth Bass



Seaside Sparrow⁺




Bald Eagle⁺

⁺*new for 2023*
[^]*HSI models developed for specific life stages*


2023 COASTAL MASTER PLAN ICM-HSI MODEL TYPES

- Literature-based: SI relationships derived from published research
- Statistical-based: SIs derived from analyses of LDWF datasets and literature


Literature-based Models




Eastern Oyster




Crayfish




Gadwall




Mottled Duck



Brown Pelican




American Alligator




Seaside Sparrow


Statistical-based Models




Brown Shrimp




White Shrimp




Blue Crab




Gulf Menhaden



Spotted Seatrout



Largemouth Bass



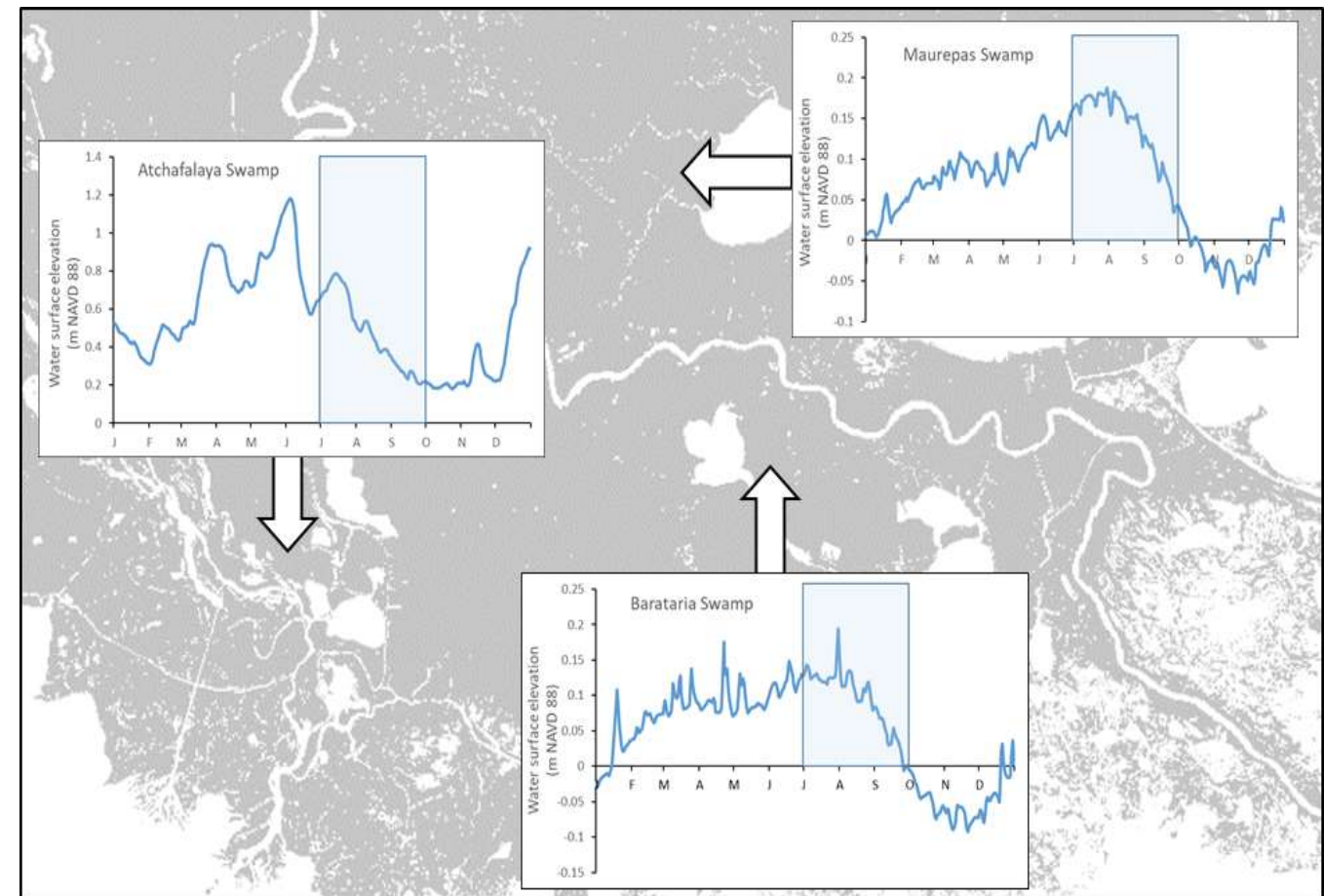
Bald Eagle



LITERATURE-BASED MODELS

LITERATURE-BASED ICM-HSI MODEL IMPROVEMENTS

- 2017 models improved by incorporating recent research; consulting experts
- Alligator, brown pelican, mottled duck, gadwall HSIs essentially unchanged from 2017
 - Gadwall: reduced suitability of forested wetlands
- Crayfish model adjustments:
 - Unchanged: Salinity, Habitat type SIs
 - Removed: % Sand in substrate SI
 - Modified: Seasonal water depths SIs
 - Low-water = Aug. through Nov.
 - High-water = Dec. through July

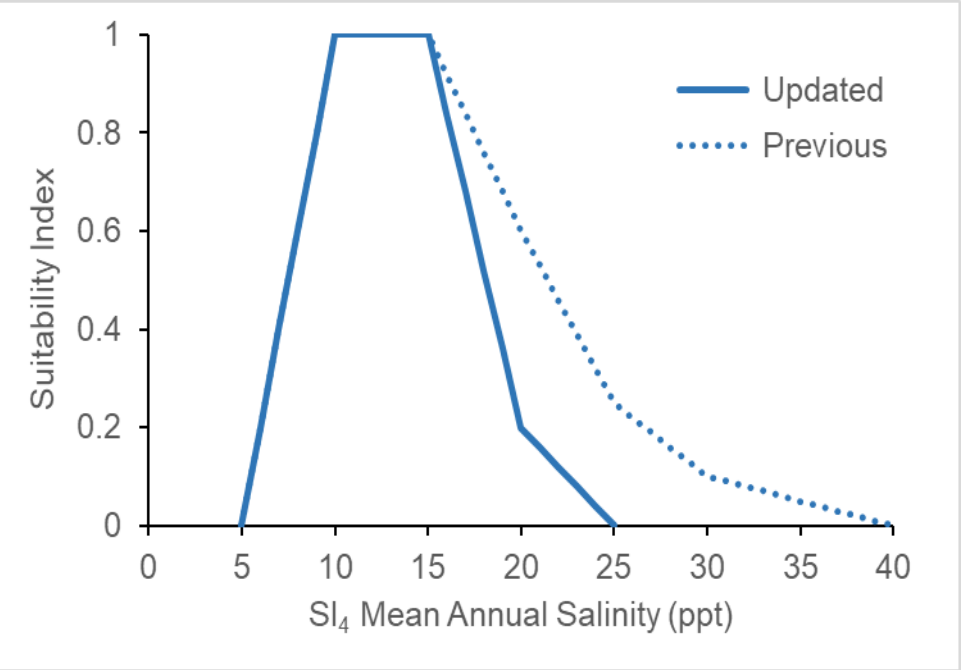
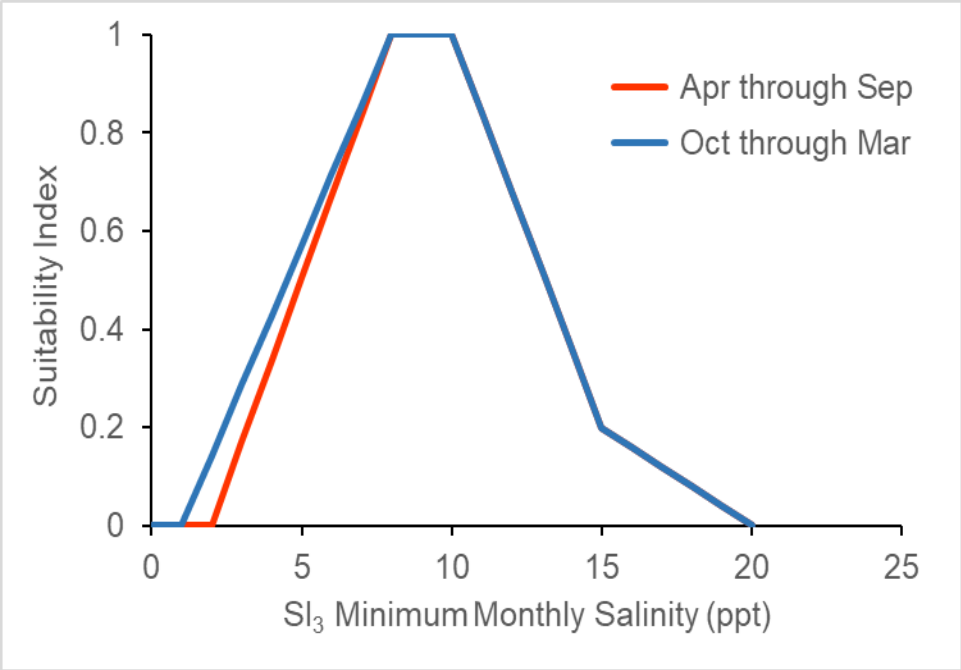
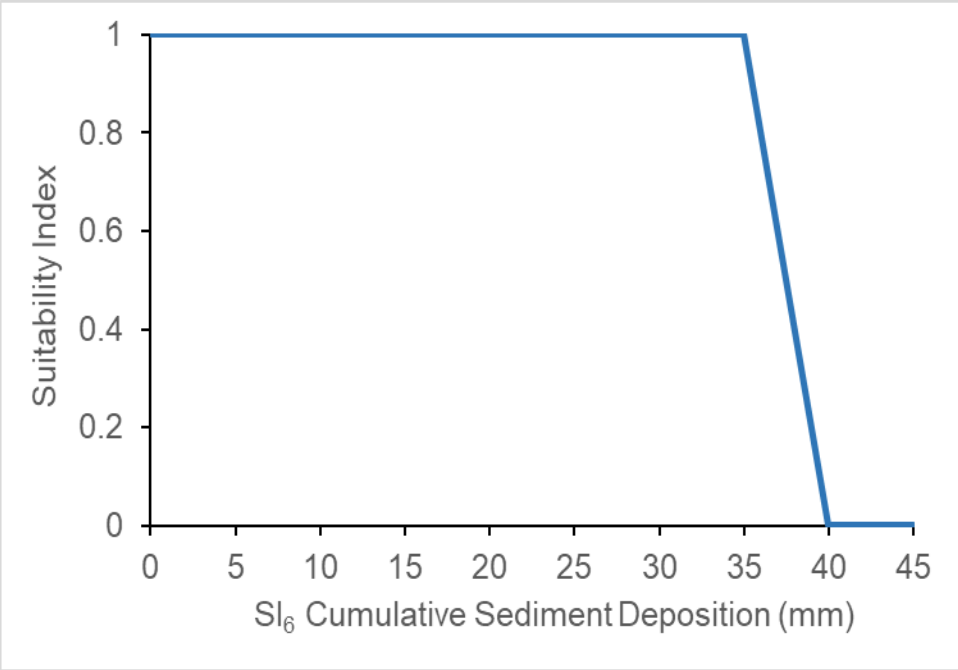


2017 ICM simulated water surface elevations for select swamp compartments. Blue box indicates low-water period used for 2017 crayfish HSI model.

OYSTER ICM-HSI MODEL IMPROVEMENTS

OYSTER HSI MODEL

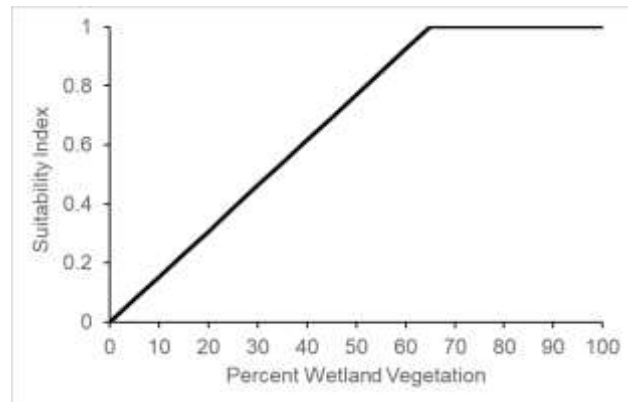
- 2023 ICM-HSI model consists of six SIs:
 - Unchanged: Percent cultch & Percent land SIs
 - Added: Sediment deposition SI
 - Modified: Three salinity SIs:
 - Time period for salinity during spawning SI now Apr. through Nov.
 - 2 relationships for minimum salinity SI
 - Adjusted annual salinity SI relationship



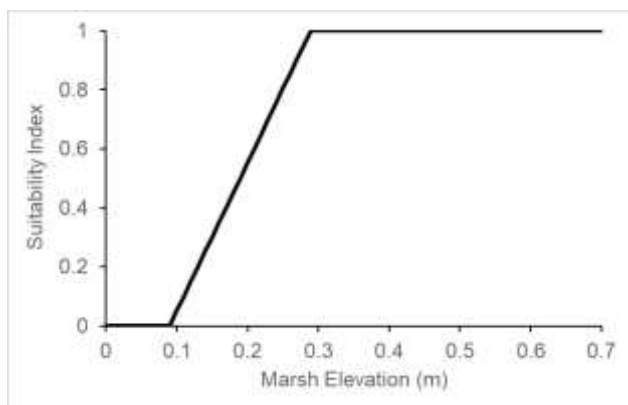
Based on Denapolis (2018)

NEW SEASIDE SPARROW ICM-HSI MODEL

- Prime sparrow habitat =
 - Densely-vegetated *Spartina* sp. dominated marshes
 - Higher elevations for nesting
- Vegetated Habitat Type SI:
 - Saline marsh = 1.0 ; Brackish = 0.7; Intermediate = 0.3
- Percent Vegetation Cover SI:



- Marsh Elevation SI:



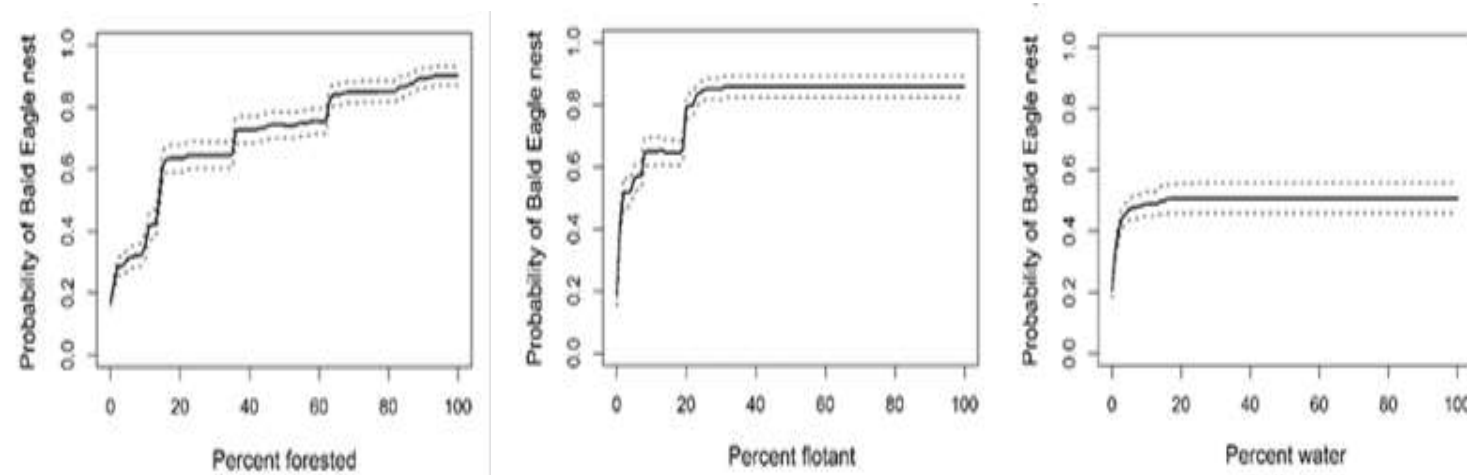
Seaside sparrow salt marsh habitat



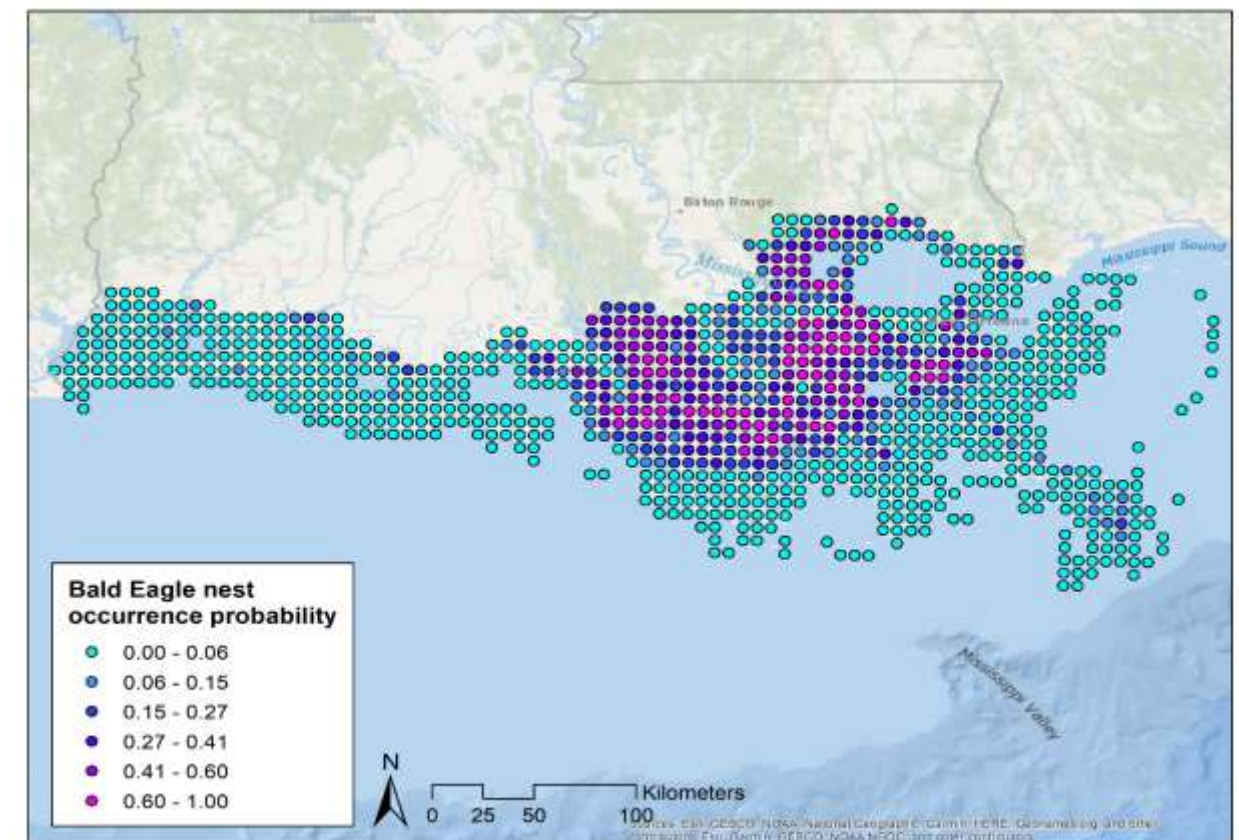
STATISTICAL-BASED MODELS

NEW NESTING BALD EAGLE ICM-HSI MODEL

- Nest in large trees near water (forested wetlands)
- Statistical model relating nests with land-cover type
 - 2014-15 land-cover and LDWF nest survey data
 - Used 6 km x 6 km grid (= home range)
- Nest probability of occurrence model
 - Six land-cover types had most influence: forested wetland, floatant marsh, open water, fresh marsh, intermediate marsh, upland
 - Land-cover type relationships converted into SIs;



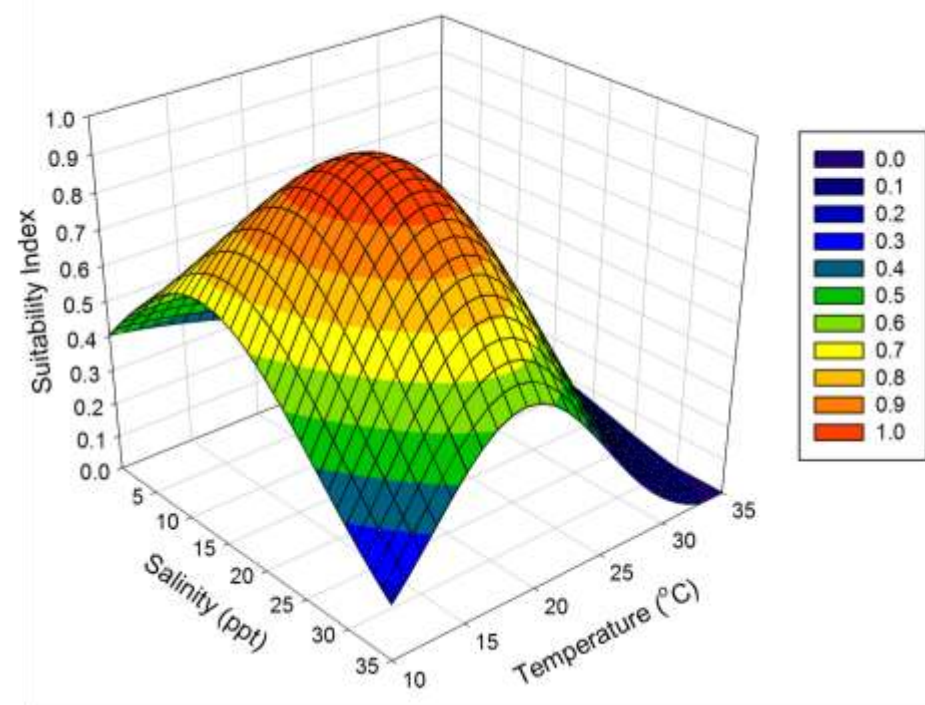
Probability relationships for the three land cover types with greatest effect on nest occurrence



Results of the nest probability of occurrence model using a 6 x 6 km grid. The ICM-HSI calculations will also use a 6 x 6 km grid.

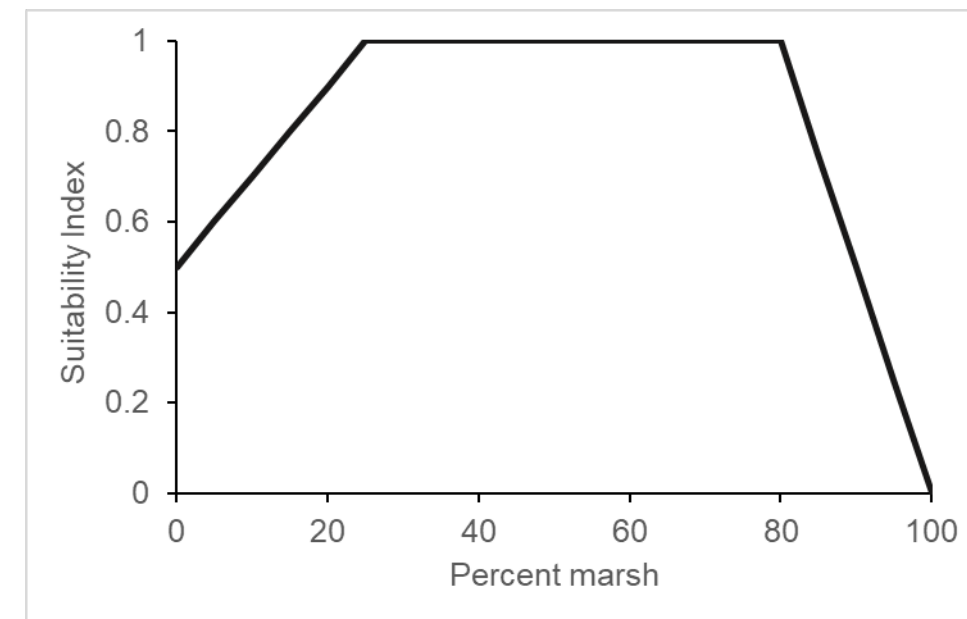
FISH, SHRIMP, AND BLUE CRAB ICM-HSI MODELS

- 2017 fish, shrimp, and blue crab HSI models consist of:
 - Water Quality SI (salinity and water temperature)
 - Structural Habitat SI
 - ~~Chlorophyll SI~~ (ICM modeling difficulties)
- For 2023 these SIs redeveloped using more refined analyses



SI1: Water quality suitability index for 2017 small juvenile white shrimp HSI.

X



SI2: structural habitat suitability index used in the 2017 juvenile fish, shrimp, and blue crab HSI models.

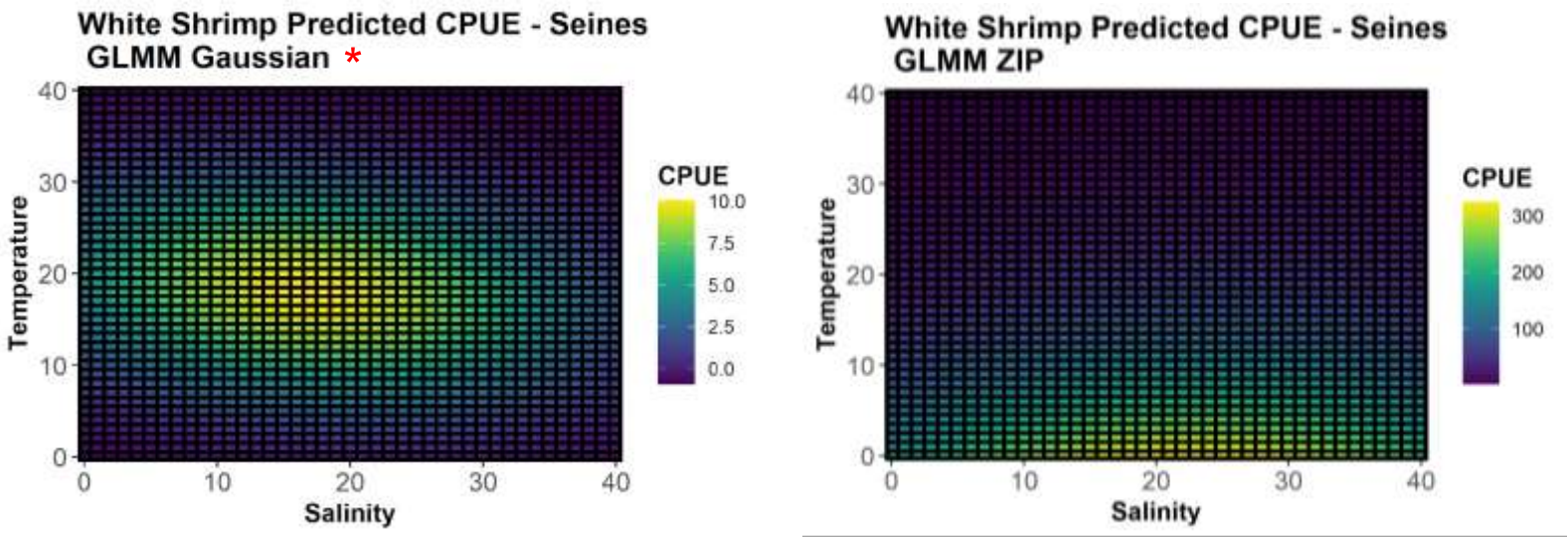
FISH, SHRIMP, AND BLUE CRAB ICM-HSI MODELS

WATER QUALITY SI



Small juvenile white shrimp

- LDWF data used to relate catch per unit effort (CPUE) with salinity & water temperature
- Different models developed
 - Generalized linear mixed model (GLMM)
 - Generalized additive mixed model (GAMM)
- Different error distributions
 - Gaussian, Poisson, Zero-inflated Poisson, Negative Binomial
- Selected model based on:
 - Model fit statistics
 - Ecologically reasonable



Predicted responses of small juvenile white shrimp CPUE (from seines) to average salinity and temperature from June through November. GLMM Gaussian was model selected.

Model Approach	Error Structure	Adjusted R ²	Deviance explained (GAMM only)	RMSE
GAMM	Gaussian	0.18	19.1%	218.54
	Poisson	0.09	28.1%	203.63
	Zero-Inflated Poisson	.	99.4%	204.20
	Negative Binomial	0.06	22.1%	207.29
GLMM	* Gaussian	0.16		218.73
	Poisson	0.99		206.41
	Zero-Inflated Poisson	0.62		207.90
	Negative Binomial	0.05		208.56

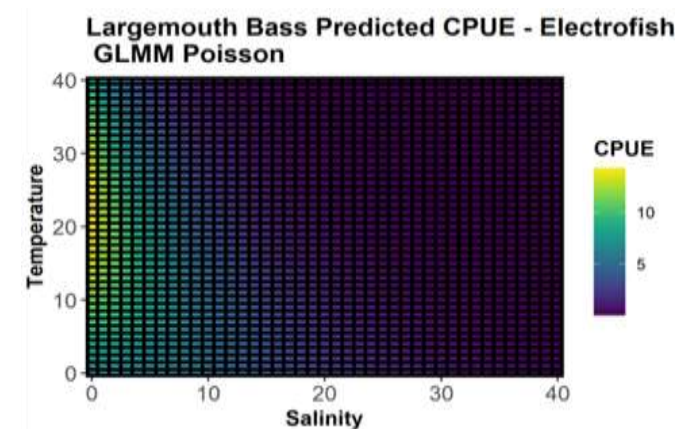
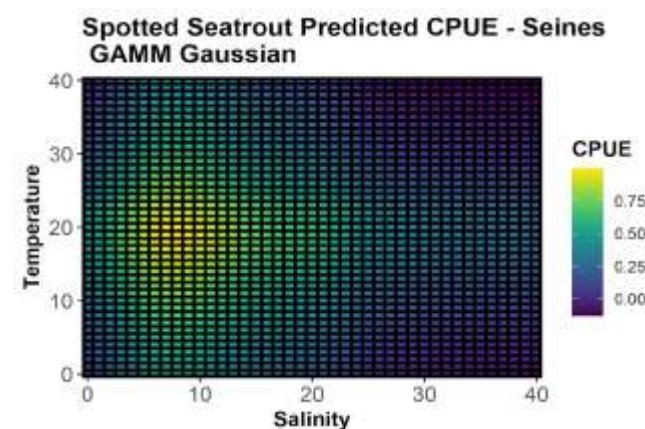
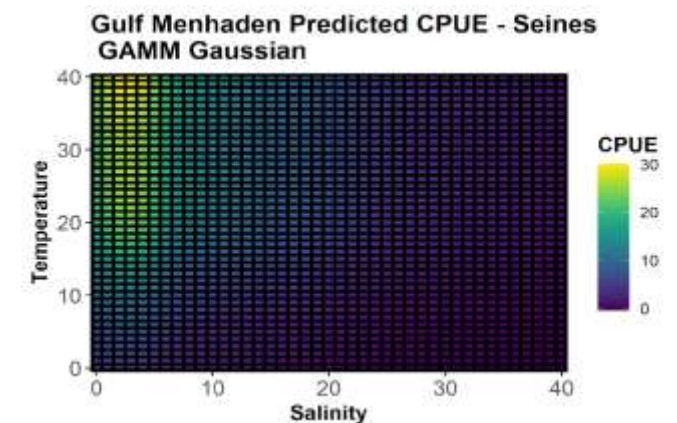
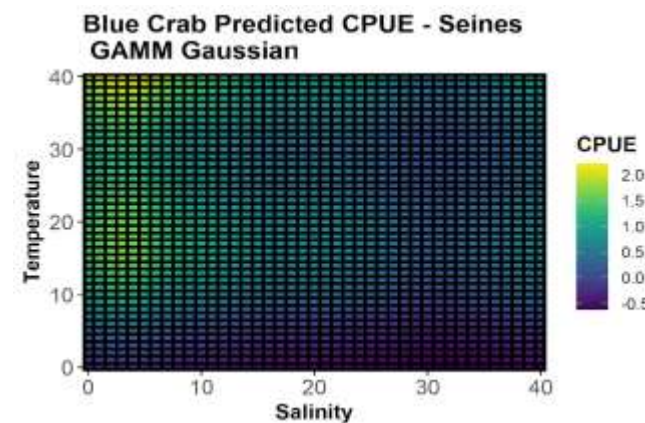
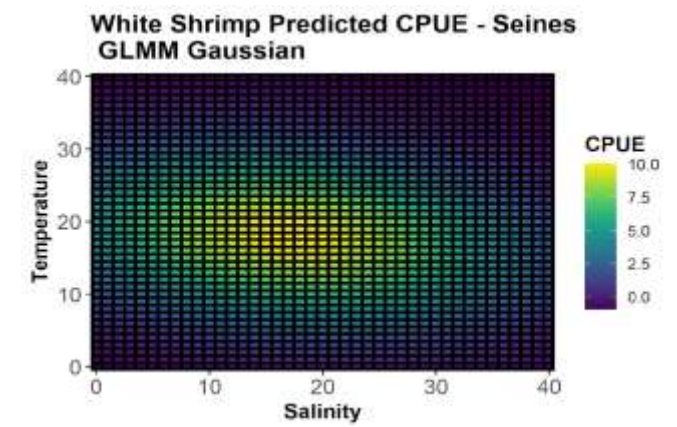
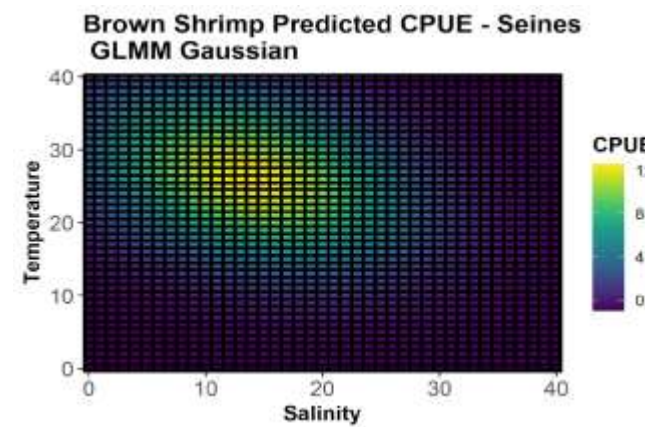
Summary of model fit statistics for the small juvenile white shrimp water quality model.
*Denotes selected model.

FISH, SHRIMP, AND BLUE CRAB ICM-HSI MODELS

WATER QUALITY SI

- GLMMs selected for:
 - White shrimp (both life stages)
 - Brown shrimp (both life stages)
 - Largemouth bass
- GAMMs selected for:
 - Blue crab
 - Gulf menhaden (both life stages)
 - Spotted seatrout (both life stages)
- Converted into water quality SI
 - GLMM = polynomial equation

$$SI_1 = \frac{e^{1.63+0.61(S_{SI})+1.69(T_{SI})-0.54(S_{SI}^2)-2.02(T_{SI}^2)-0.08(S_{SI}*T_{SI})} - 1}{10.05}$$
 - GAMM = look-up table

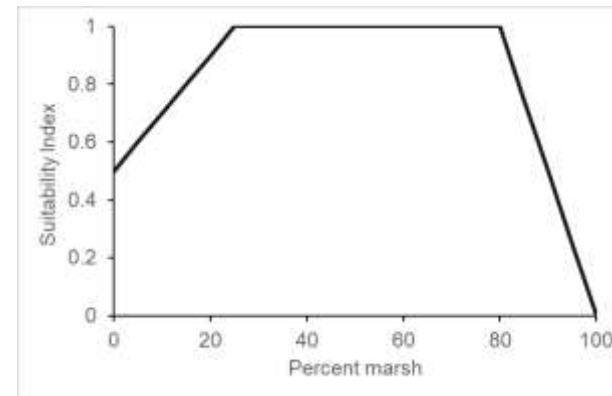


Selected water quality models for juvenile brown shrimp, juvenile white shrimp, juvenile blue crab, juvenile gulf menhaden, juvenile spotted seatrout, and largemouth bass. Note: models are limited to the extent of environmental conditions in the LDWF dataset (0-36 ppt and 3-36 °C).

FISH, SHRIMP, AND BLUE CRAB ICM-HSI MODELS

STRUCTURAL HABITAT SI

- 2017 structural habitat SI reflects the nursery habitat value of marsh edge
- Did not account for other notable nursery habitats
 - Submerged aquatic vegetation (SAV)
 - Oyster reefs
- For 2023, meta-analysis conducted to assess relative value of estuarine habitats
 - 36 studies, mostly from LA and TX
 - Compared catches among habitats



Structural habitat suitability relationship used in the 2017 juvenile fish, shrimp, and blue crab HSIs.



Fragmented marsh with high amount of marsh edge.



Submerged aquatic vegetation (SAV) and oyster reefs.

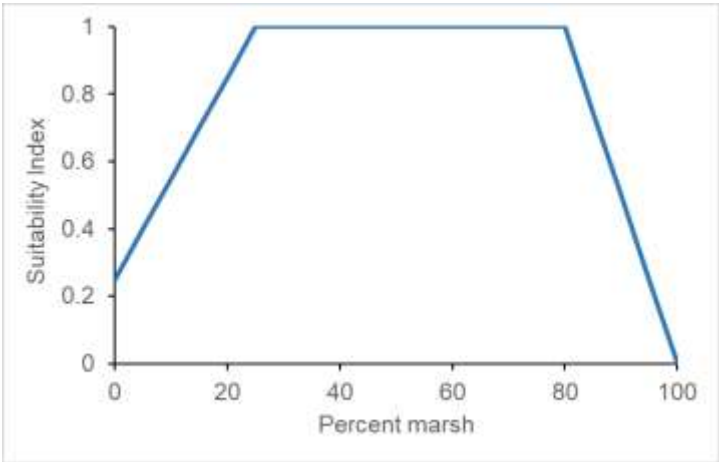
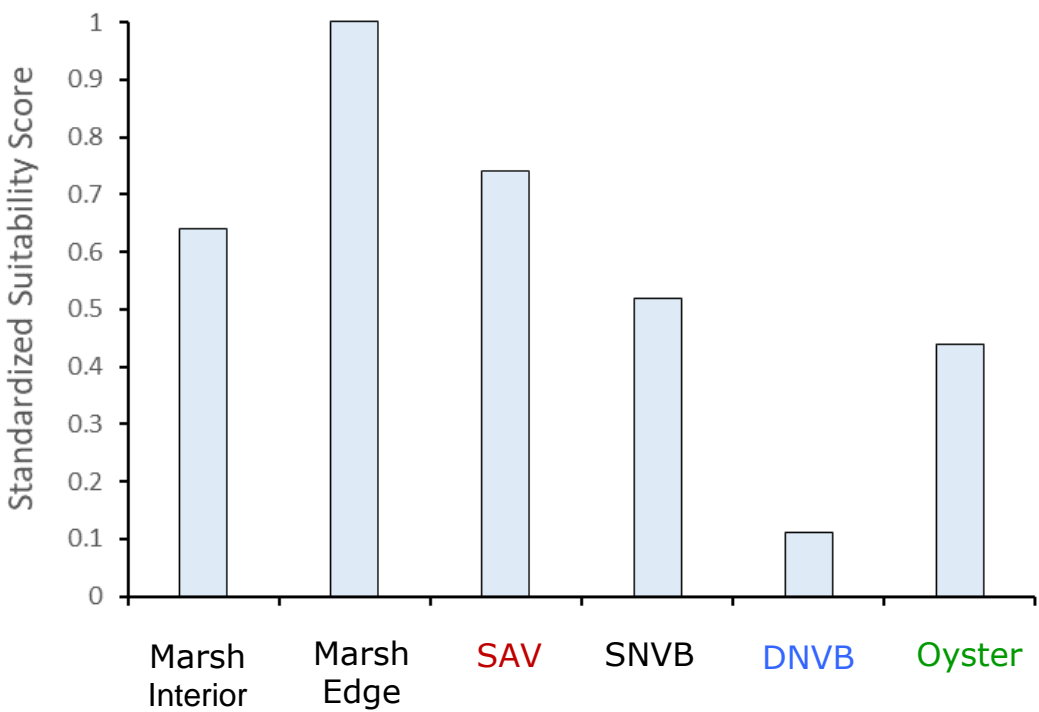
FISH, SHRIMP, AND BLUE CRAB ICM-HSI MODELS

STRUCTURAL HABITAT SI

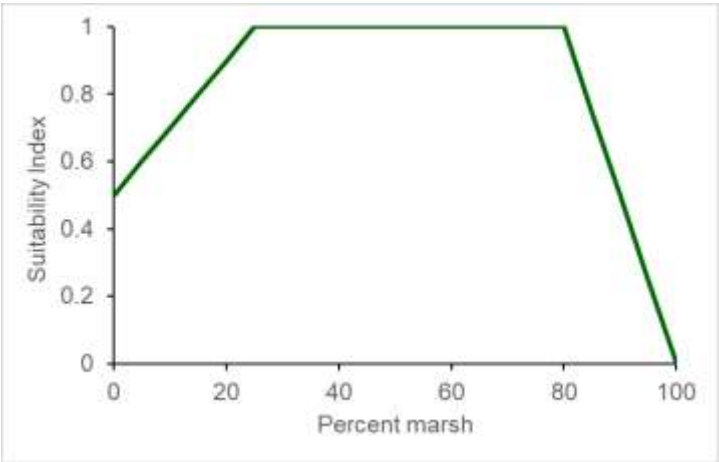


Small juvenile white shrimp

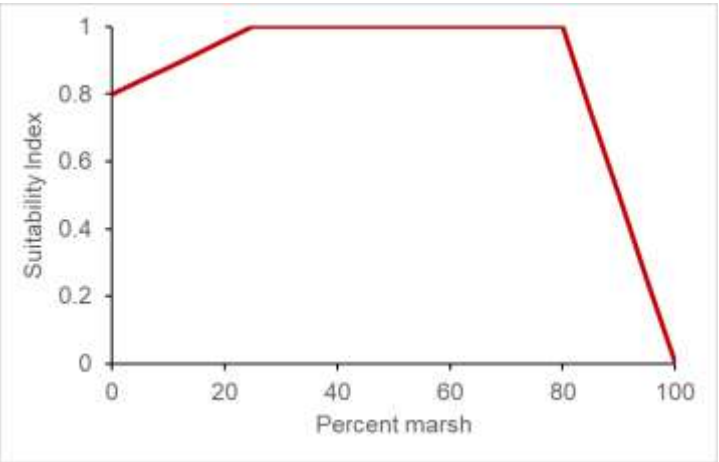
- For each species, catches among habitats averaged and standardized (max. = score of 1)
- Standardized suitability scores used to modify structural habitat SI relationship
- Additional SI relationships developed for model cells with oyster reef or SAV



Structural habitat SI for shrimp and blue crab - baseline



Structural habitat SI for shrimp and blue crab - oyster reef areas (based on oyster HSI scores)



Structural habitat SI for shrimp and blue crab - areas of high SAV coverage

HABITAT SUITABILITY INDICES

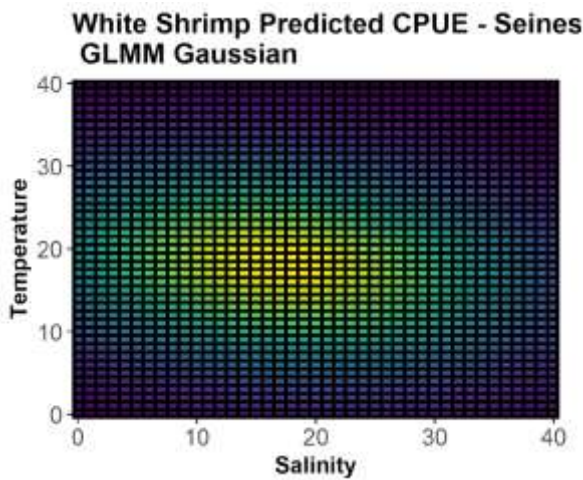
ICM INTEGRATION AND TESTING

- Uses outputs from other ICM subroutines
- ICM calculates annual HSI score per 480 x 480 m cell



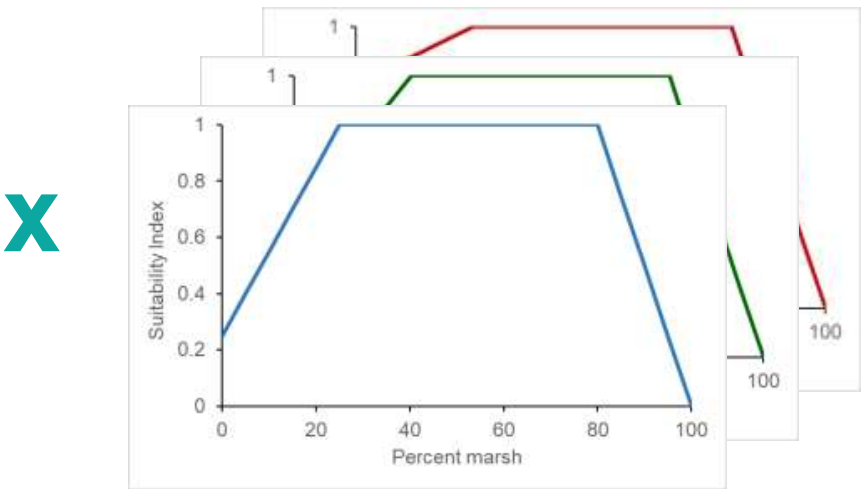
Small juvenile white shrimp

From: ICM-Hydro

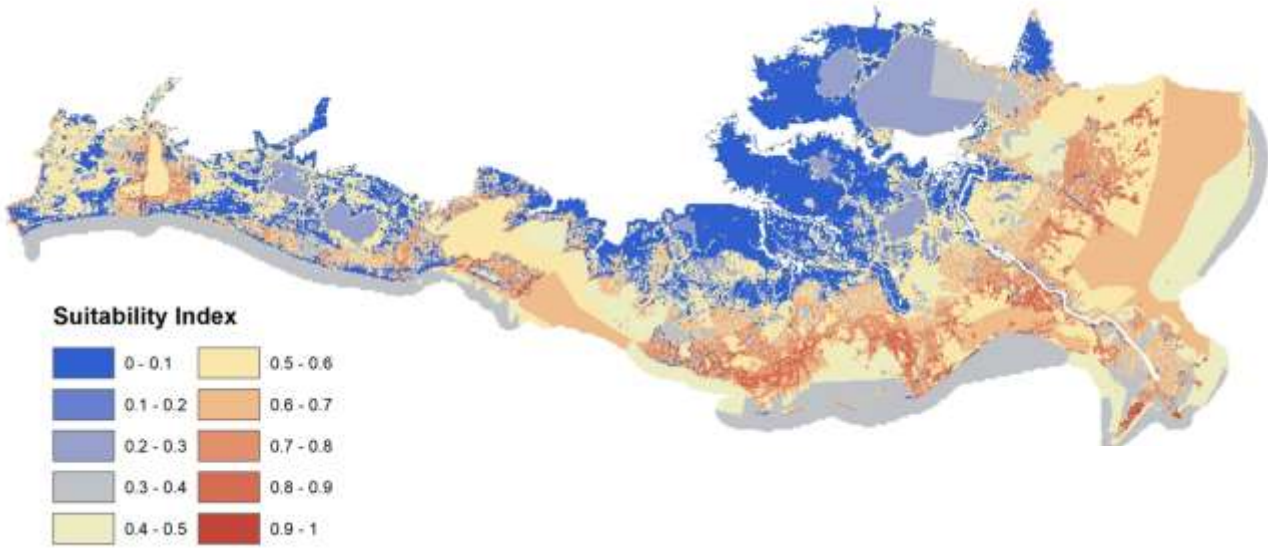


SI1: Water quality suitability index for 2023 small juvenile white shrimp HSI. Represents average conditions between July and November.

From: ICM-Morph, ICM-LAVegMod



SI2: Structural habitat suitability indices for 2023 small juvenile white shrimp HSI. Represents annual landscape configuration.



Test HSI output for small juvenile white shrimp using 2017 Future Without Action environmental output (Year 01 shown).

HABITAT SUITABILITY INDICES

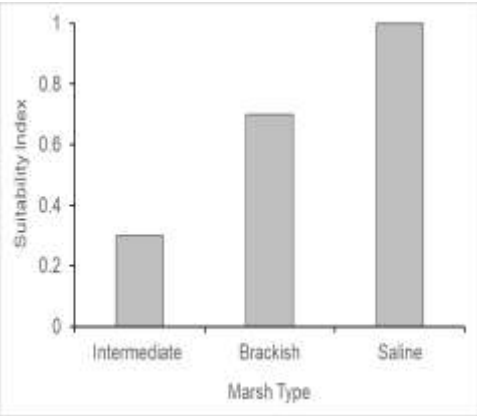
ICM INTEGRATION AND TESTING

- Uses outputs from other ICM subroutines
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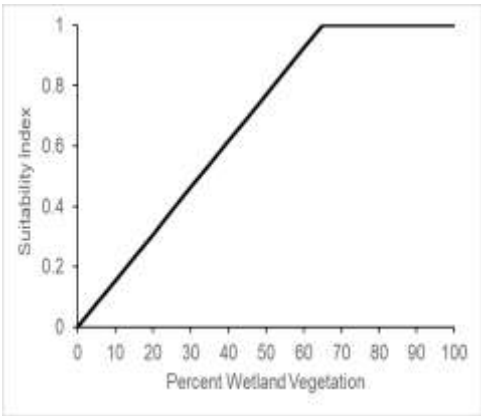
Seaside Sparrow

From: ICM-LAVegMod



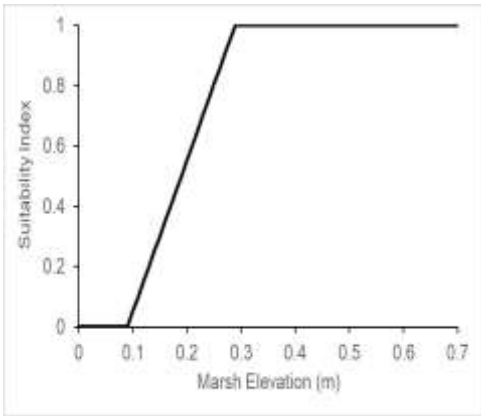
SI1: Vegetated habitat type

From: ICM-Morph,
ICM-LAVegMod



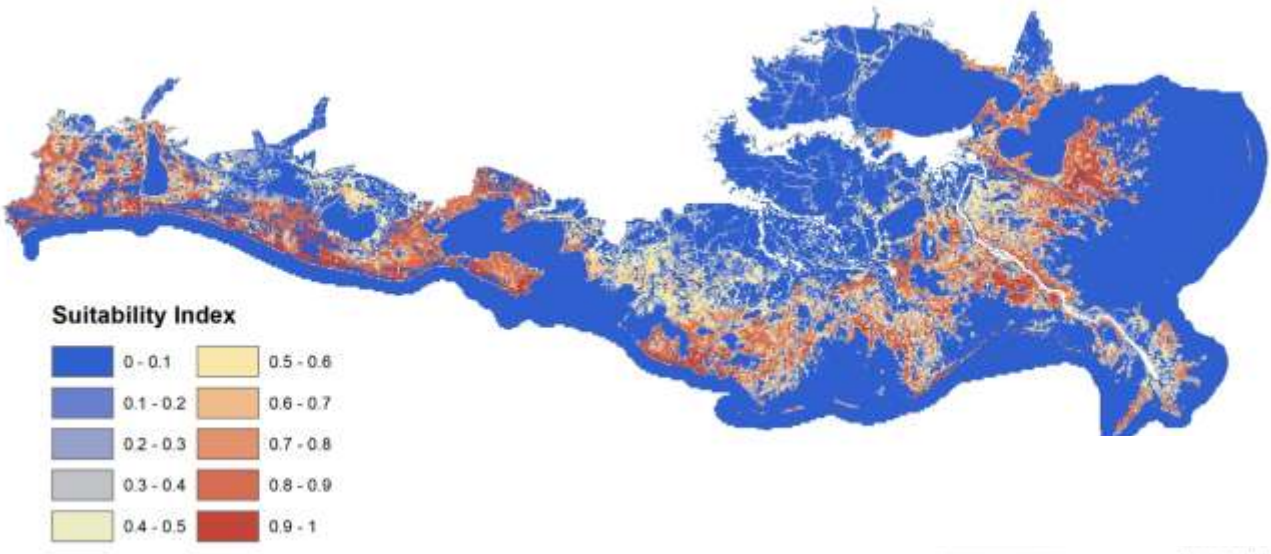
SI2: % Emergent Vegetation

From: ICM-Morph



SI3: Marsh Elevation

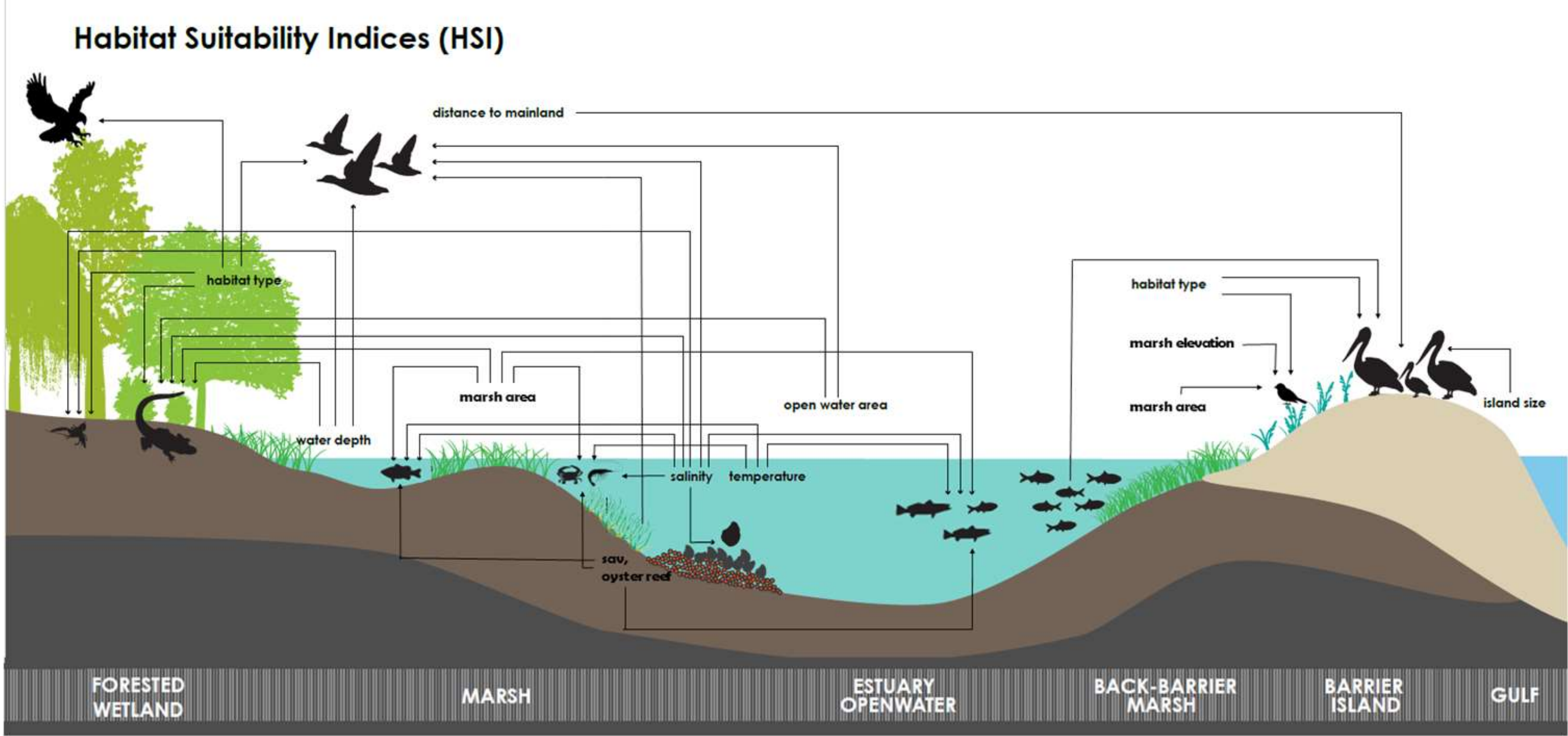
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Test HSI output for seaside sparrow using 2017 Future Without Action environmental output (Year 01 shown).

HABITAT SUITABILITY INDICES

ICM INTEGRATION



Conceptual diagram developed for the 2023 Coastal Master Plan showing ICM-HSI modeled species and ICM outputs used by the models.

A teal-tinted photograph of a coastal wetland. In the foreground, there is a body of water with gentle ripples. To the left, a large clump of tall, dry grasses stands in the water. In the middle ground, a small boat with a motor is moving from left to right, leaving a white wake. The background is filled with a dense line of trees and shrubs under a cloudy sky.

THANK YOU

More Information: coastal.la.gov/our-plan/2023-coastal-master-plan/