Modeling to Assess Influence of Water Withdrawals On Spatial Distributions and Population Abundance of Estuarine Species in Charlotte Harbor, Florida

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Goal and Objectives

Goal: Assess the influence of water withdrawals on spatial distributions and population abundance of fish and shrimp species life-stages in the lower Peace River and Charlotte Harbor.

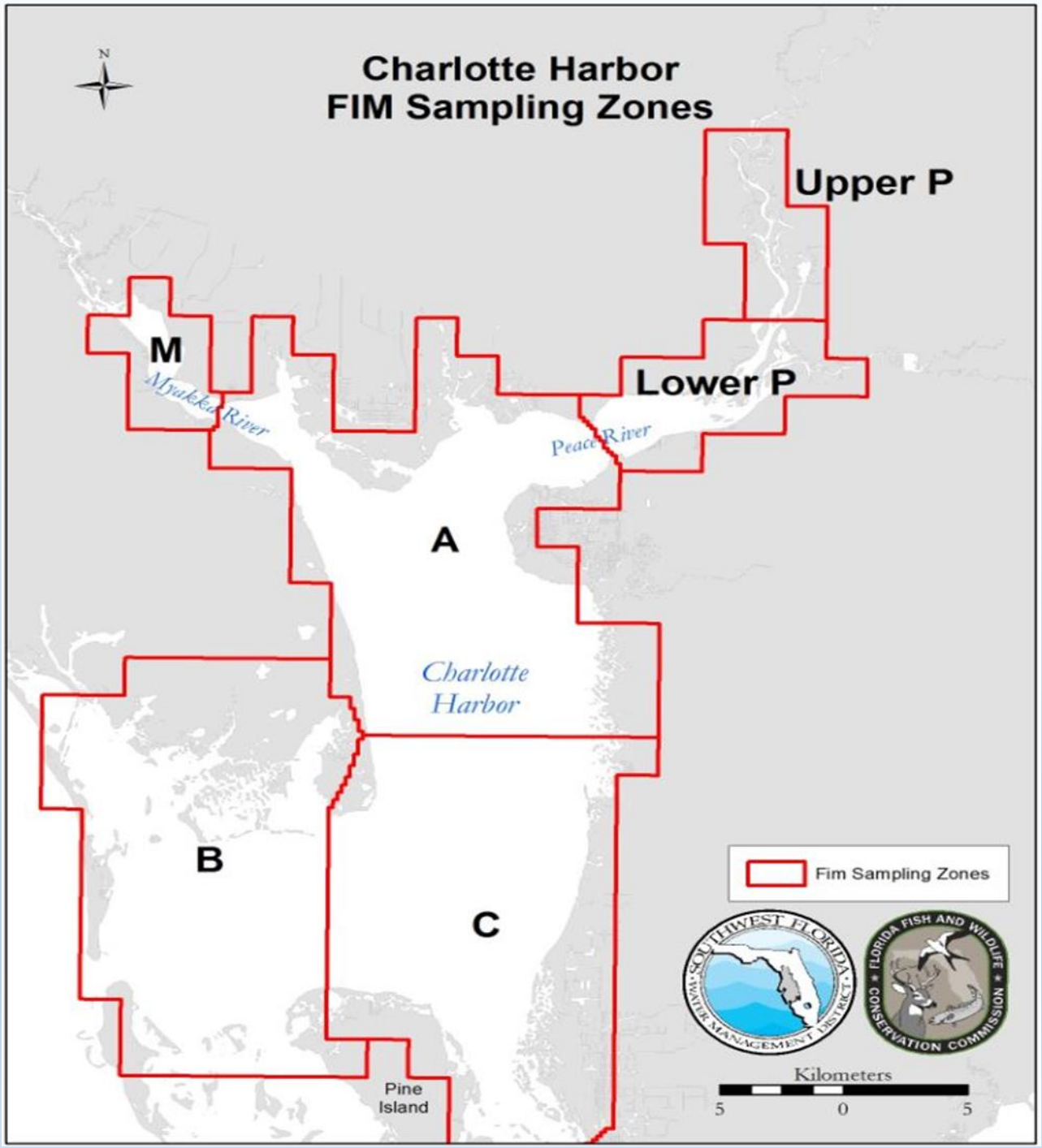
Objectives:

1. **Habitat suitability modeling (HSM) and habitat mapping were used to seasonally assess spatial distributions and relative abundances of species life-stages.**
    - **Phase I: Used water quality and Fisheries-Independent Monitoring (FIM) data to create habitat suitability models (HSMs) for 1996-2013.**
    - **Phase II (Baseline conditions): Used HSM data and habitat predictions from hydrodynamic modeling for 2007-2014.**
    - **Phase III (Water withdrawal conditions): Used HSM data and habitat predictions from hydrodynamic modeling for 2007-2014.**

3-D Hydrodynamic modeling used to predict temperature and salinity patterns. The years selected were associated with a range of freshwater inflow conditions.

Rainfall is generally low during the winter and spring and higher in the summer and fall. Used HSM and habitat mapping to establish baseline and then explored the influence of water withdrawals during each season.

Fisheries Independent Monitoring using seines and trawls


Charlotte Harbor
FIM Sampling Zones
N
Upper P
M
Myakka River
Lower P
Peace River
A
Charlotte Harbor
B
C
Pine Island
Fim Sampling Zones
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION
Kilometers
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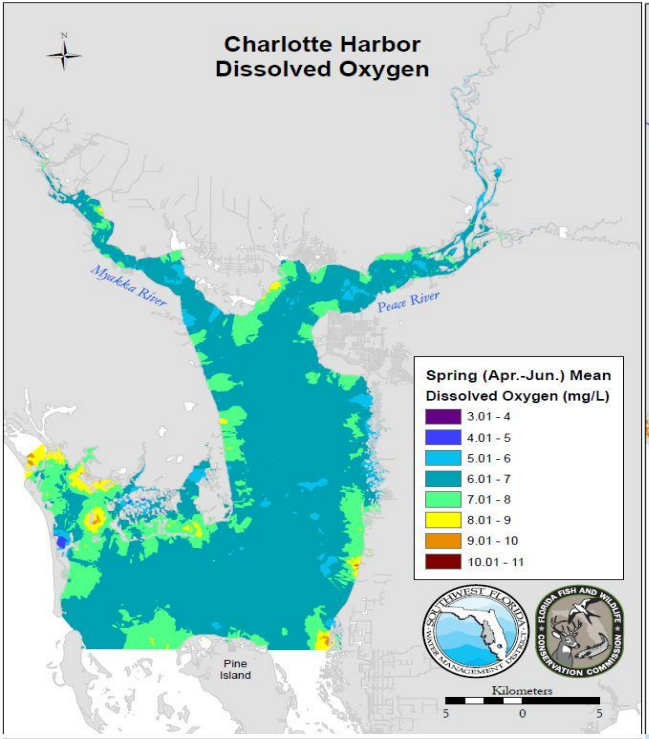
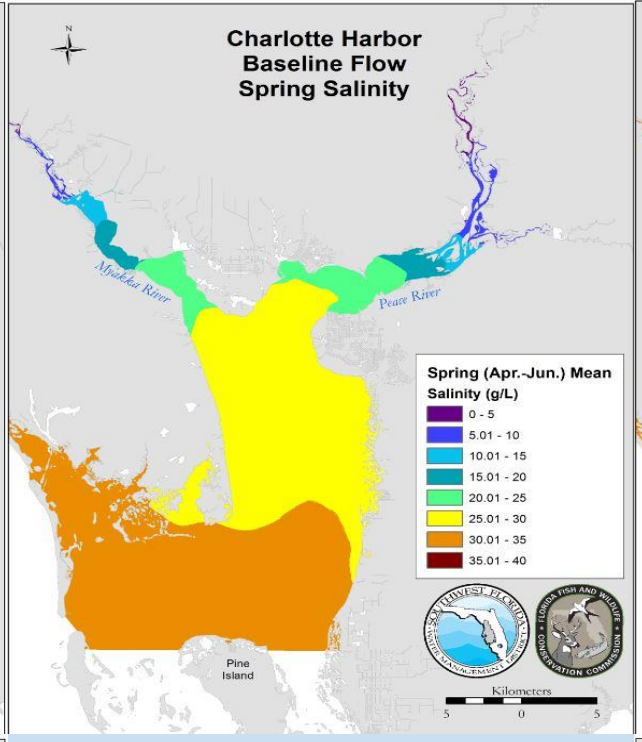
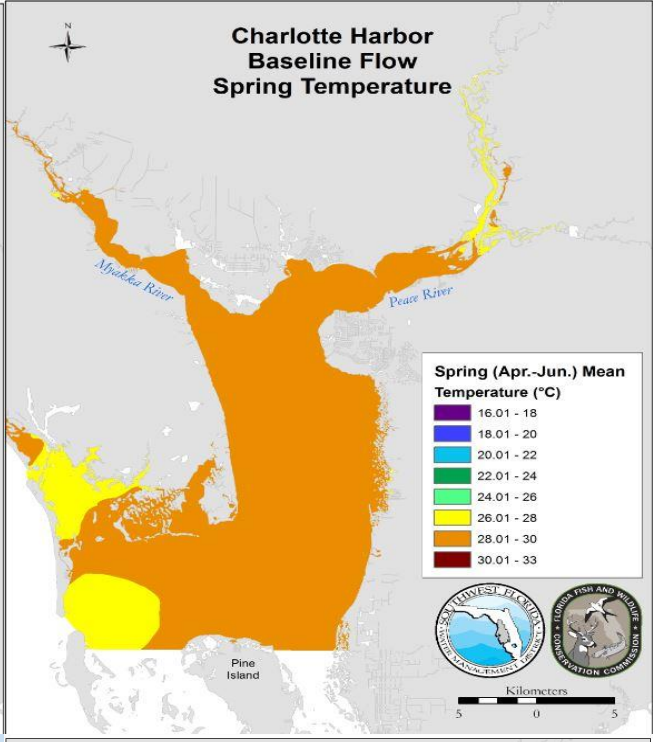
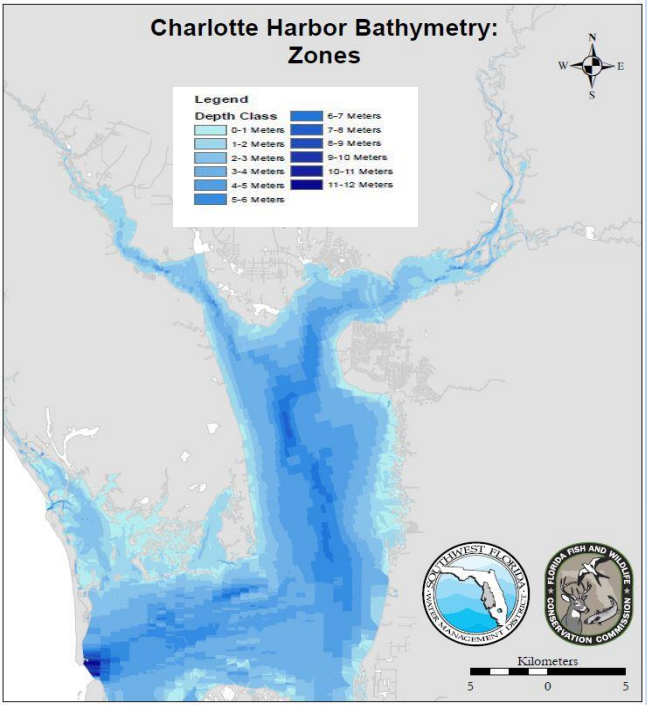


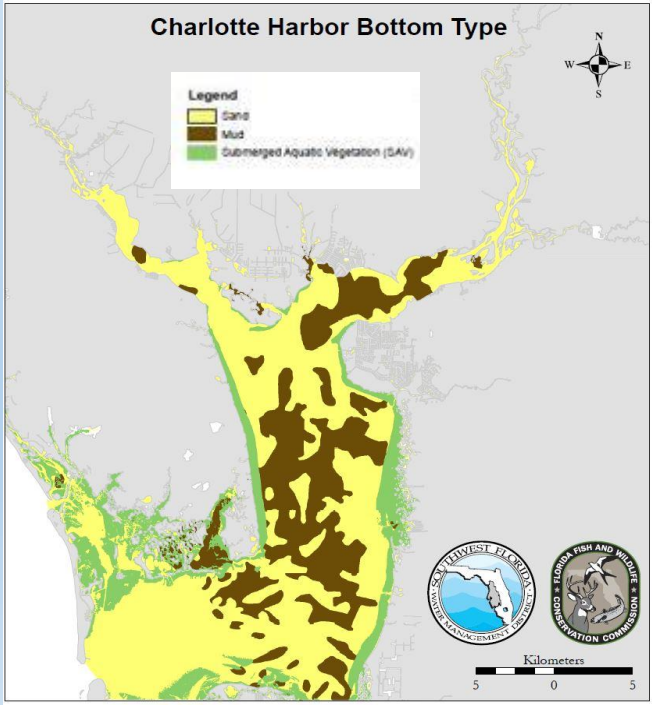






Creation of Habitat Grids

Point data interpolated to produce seasonal grids for dissolved oxygen, salinity, and temperature, plus bathymetry and bottom type



GAMLSS-Generalized Additive Models for Location, Scale, And Shape

Developed habitat suitability models (HSMs) from FIM data for +CPUEs and for +/-data. Varied factors used in the models from 1 to 5.

Used Akaike Information Criterion (lowest AIC) to choose the best delta-type generalized additive model (seasonal delta-GAMs).

The HSMs fitted splines across environmental gradients for: positive catch rates (+CPUE) and frequency of occurrence (+/-) data.

Fitted splines were combined and linked to interpolated habitat grids to create gear-corrected GC-CPUEs across the estuary.

The GC-CPUE grids were divided into 4 zones using natural breaks to create seasonal HSM maps.

Species Modeled

Juvenile+Adult Hogchoker (*Trinectes maculatus*) (10-100 mm SL)

Juvenile+Adult Blue Crab (*Callinectes sapidus*) (10-150 mm CW)

Juvenile Sand Seatrout (*Cynoscion arenarius*) (10-149 mm SL)

Early-Juvenile Southern Kingfish (*Menticirrhus americanus*) (10-119 mm SL)

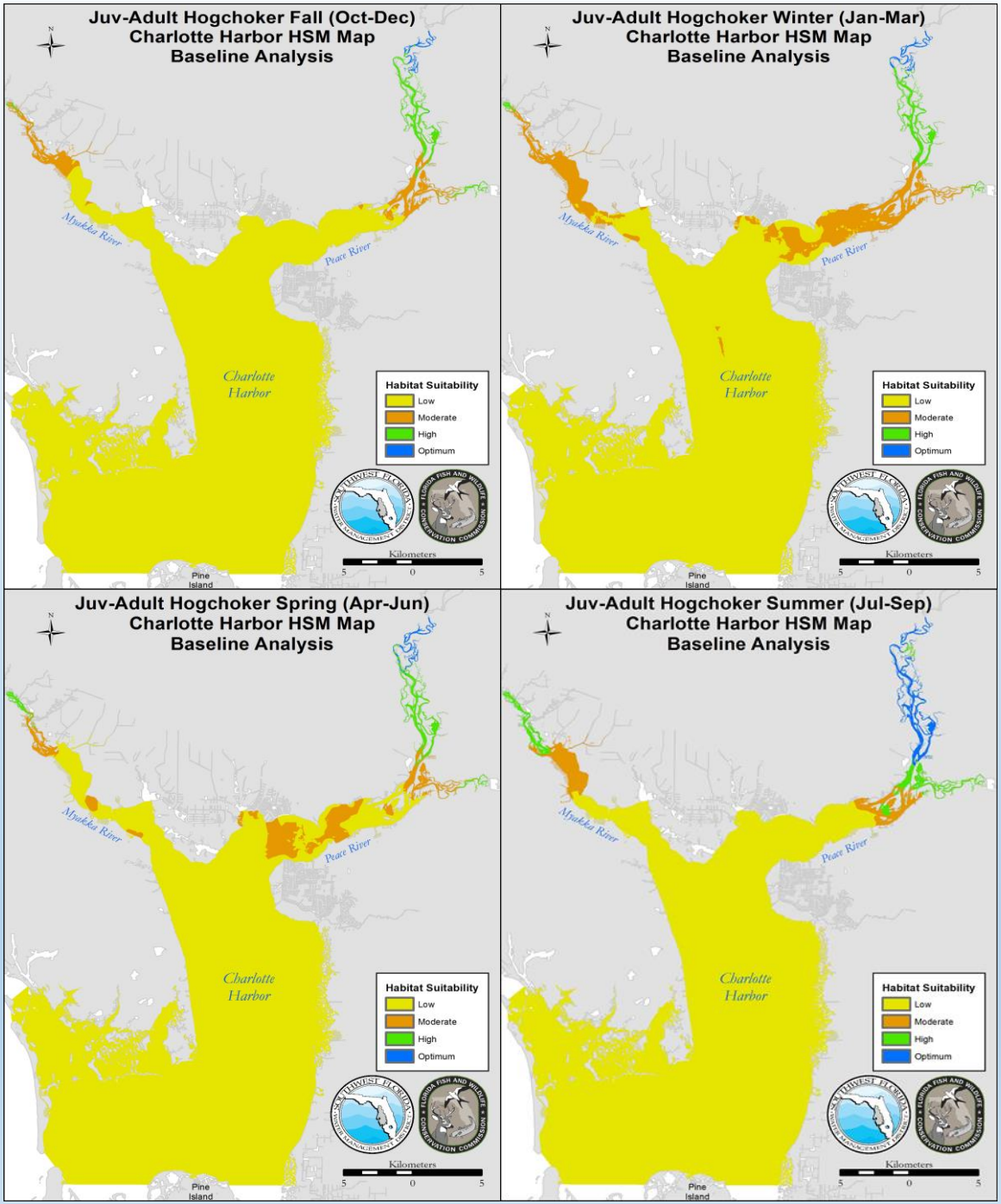
Juvenile Bay Anchovy (*Anchoa mitchilli*) (15-29 mm SL)

Adult Bay Anchovy (*Anchoa mitchilli*) (30-60 mm SL)

Early-Juvenile Red Drum (*Sciaenops ocellatus*) (10-299 mm SL)

Early-Juvenile Spot (*Leiostomus xanthurus*) (10-149 mm SL)

SL=standard length,
CW=carapace width


Juv-Adult Hogchoker Fall (Oct-Dec)
Charlotte Harbor HSM Map
Baseline Analysis
Juv-Adult Hogchoker Winter (Jan-Mar)
Charlotte Harbor HSM Map
Baseline Analysis
Juv-Adult Hogchoker Spring (Apr-Jun)
Charlotte Harbor HSM Map
Baseline Analysis
Juv-Adult Hogchoker Summer (Jul-Sep)
Charlotte Harbor HSM Map
Baseline Analysis
Myakka River
Peace River
Charlotte Harbor
Pine Island
Habitat Suitability
Low
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Optimum
Kilometers
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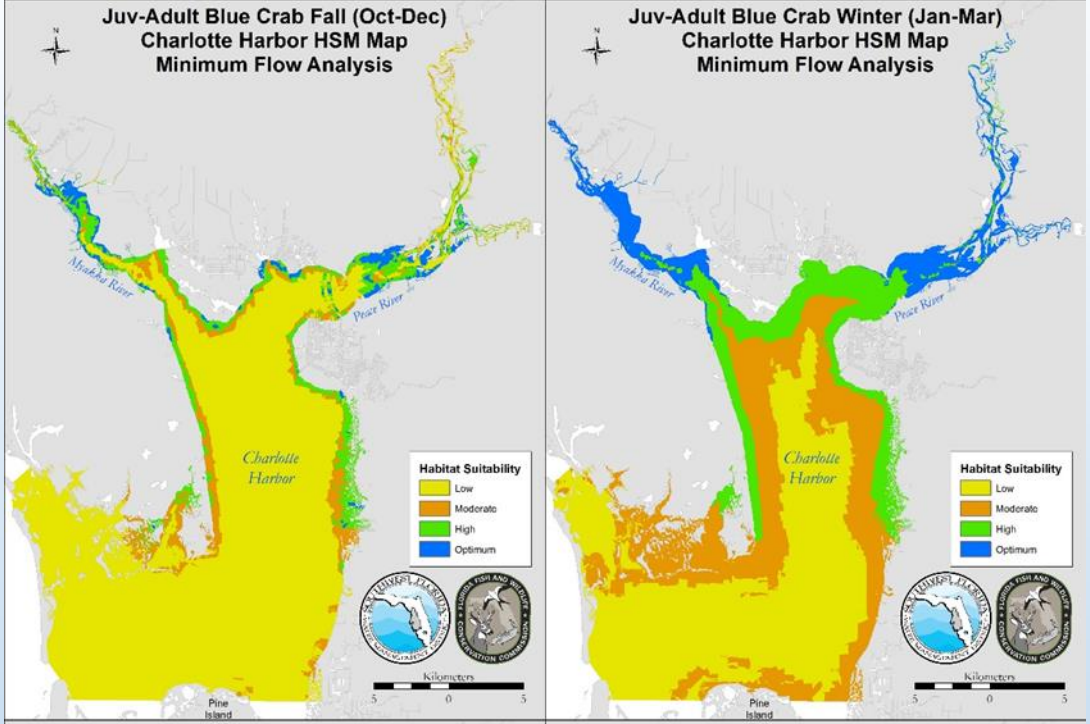
Juv-Adult Blue Crab Fall (Oct-Dec)
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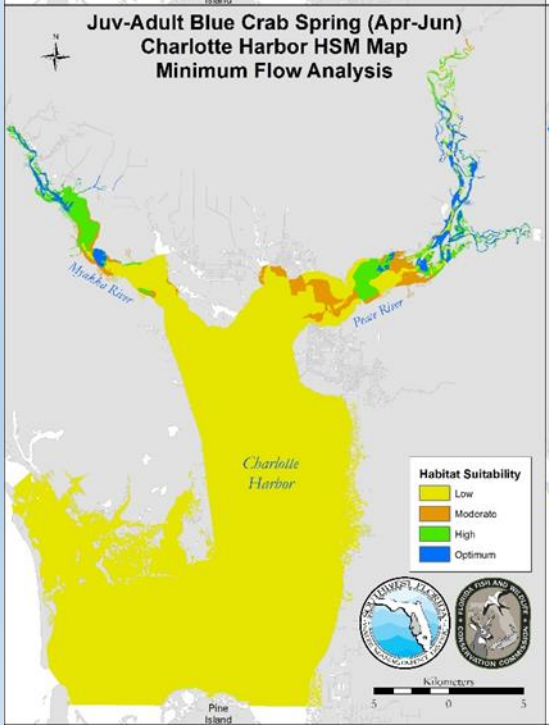
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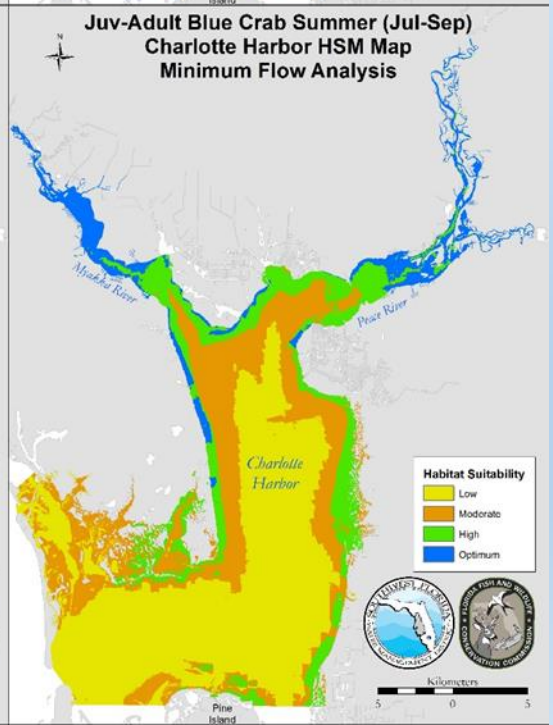
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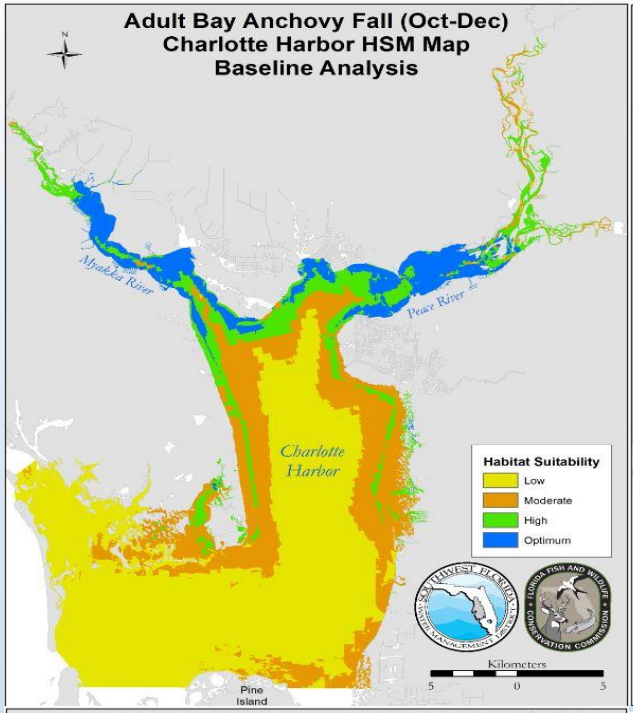
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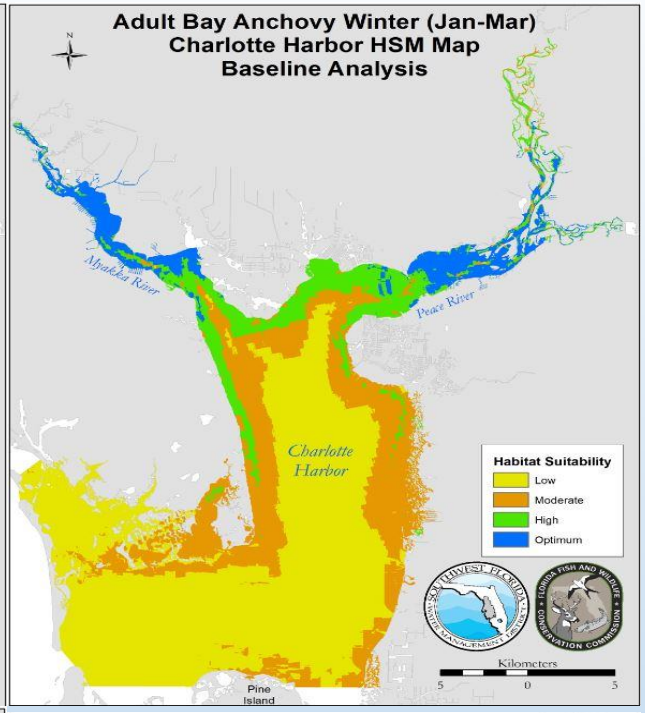
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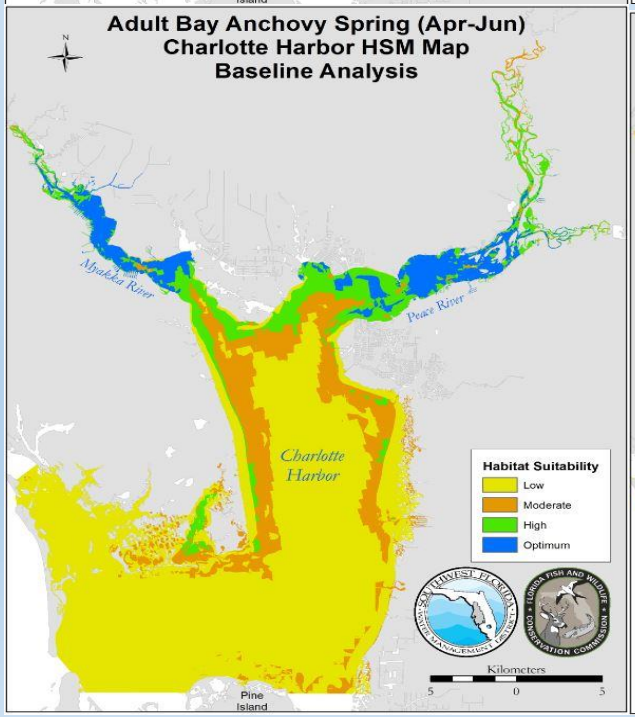
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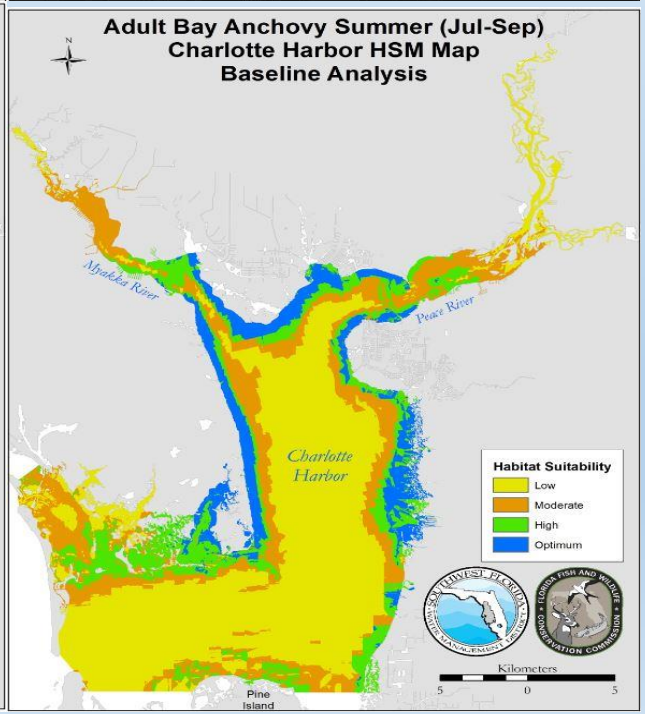
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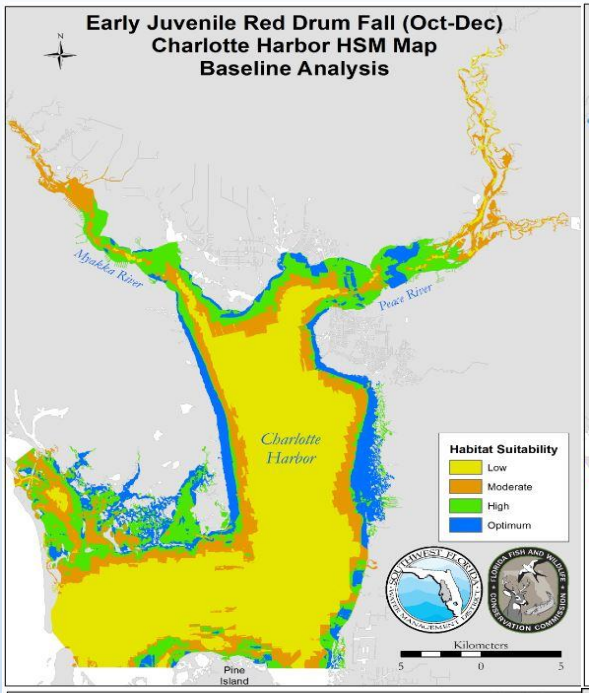
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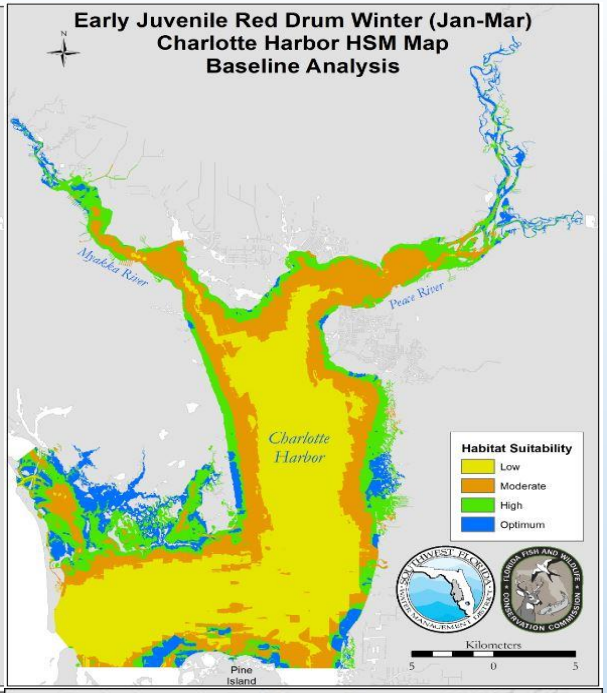
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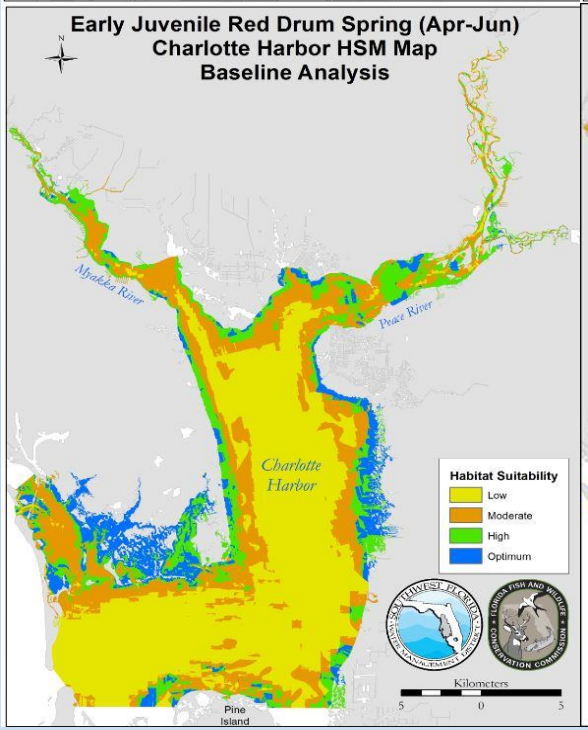
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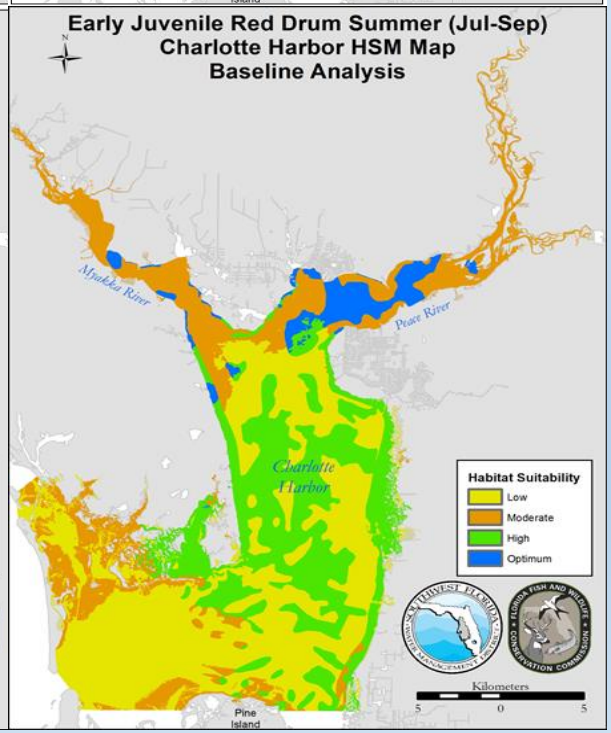
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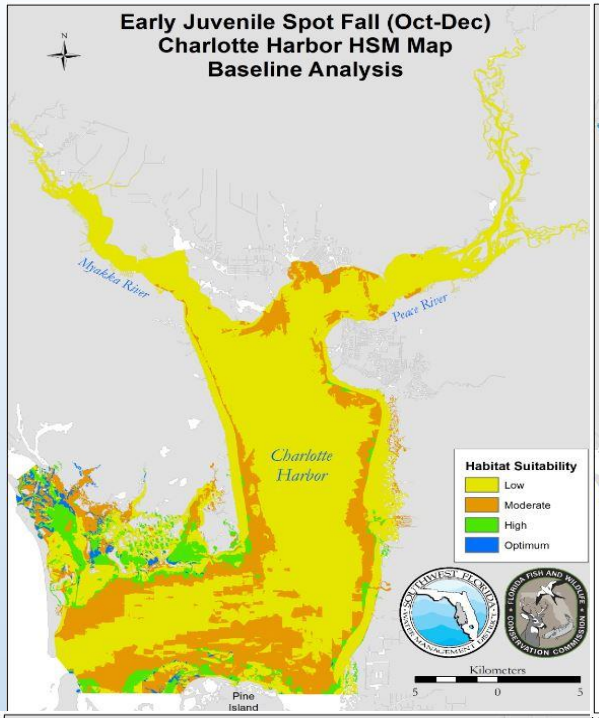
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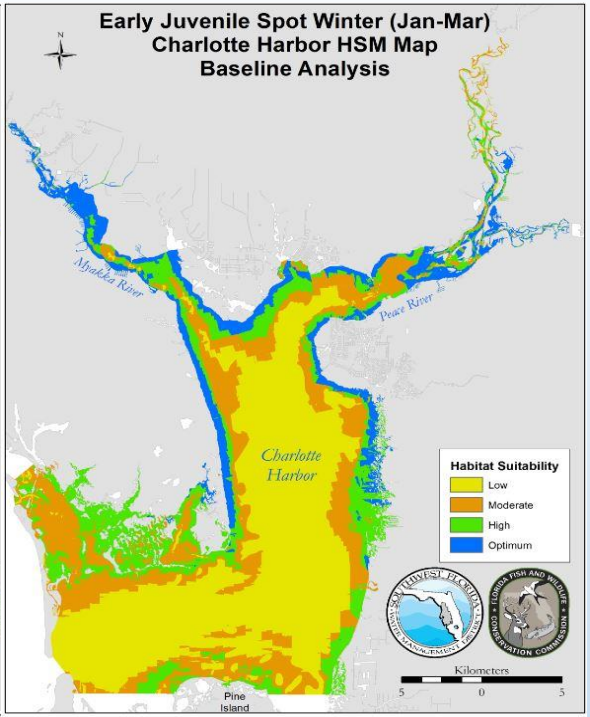
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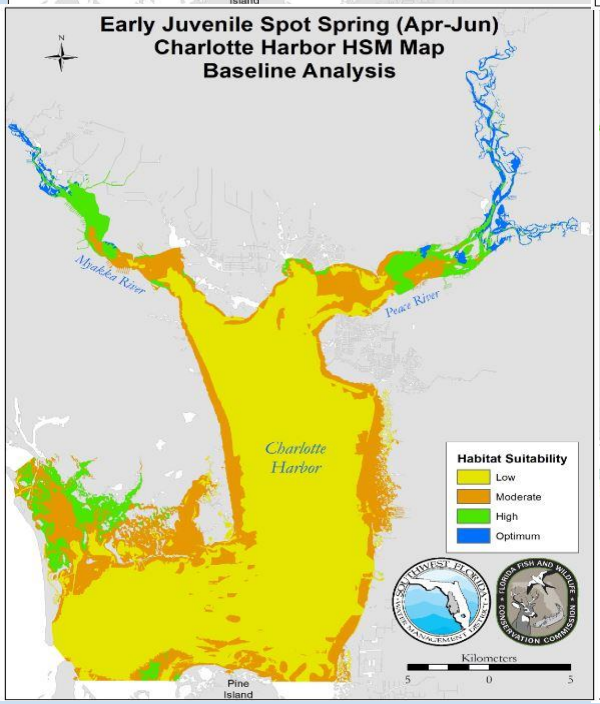
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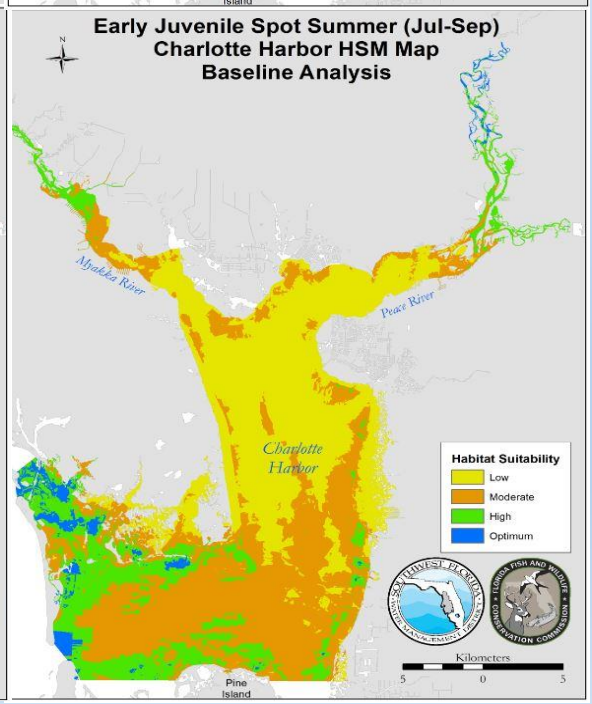
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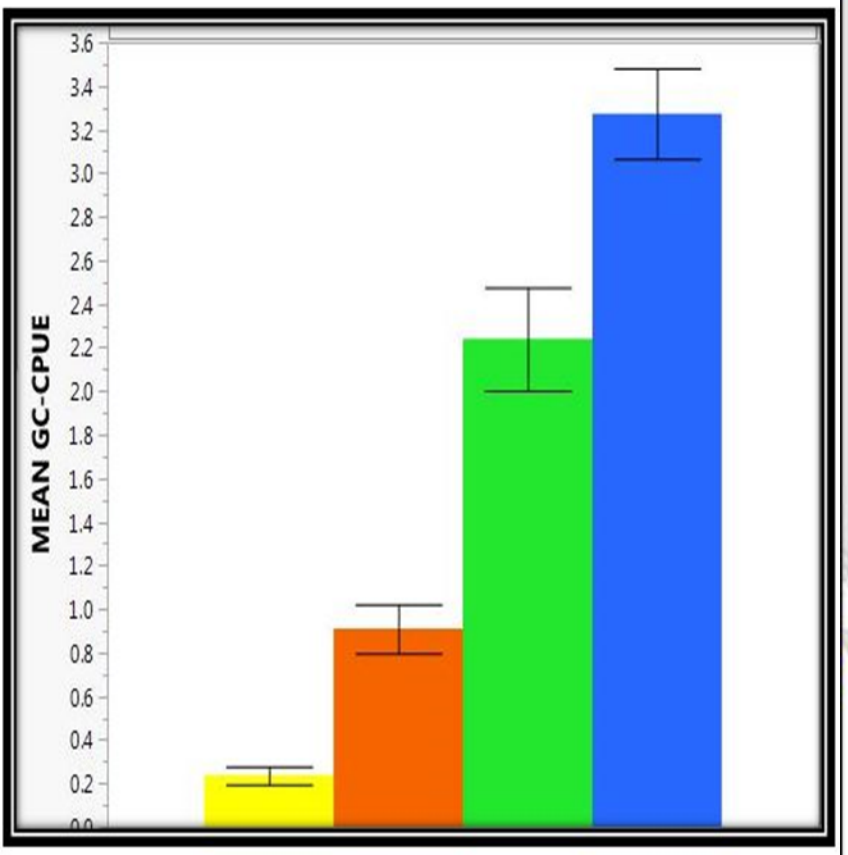
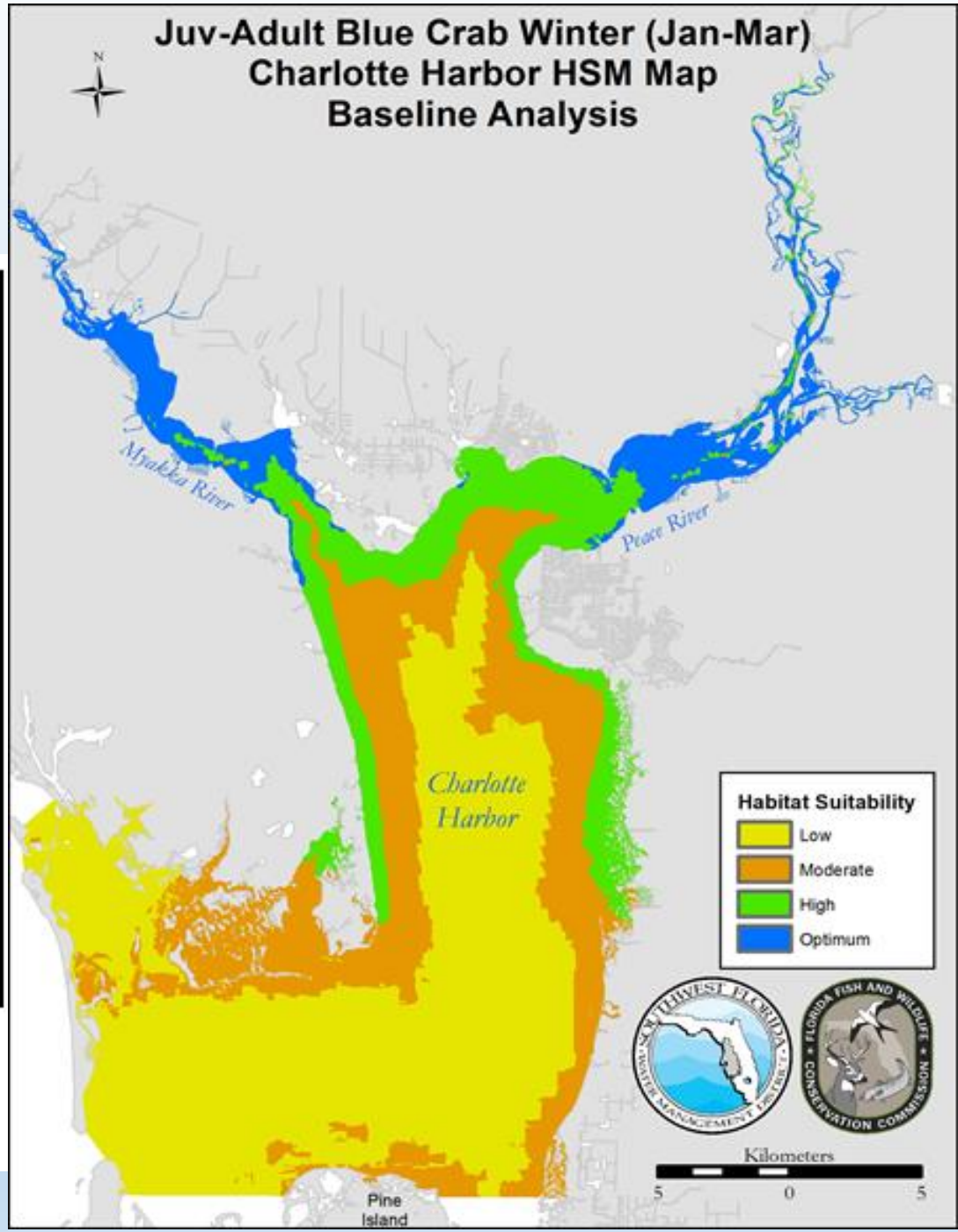


VERIFICATION GRAPH ADULT BLUE CRAB CHARLOTTE HARBOR WINTER SEASON

MEAN GEAR-CORRECTED OBSERVED CPUE VERSUS PREDICTED HSM ZONE



Population Estimates For Juvenile+Adult Blue Crab During Winter Derived From CPUEs In HSM Grid For Charlotte Harbor

ZONAL AREA TABLE		CHABCWN		
HSM	MEAN GC-CPUE	CELL	ZONAL	POPULATION
ZONE	no/sq m	COUNT	AREA sq m	NUMBER
Low	0.00429045	947954	213289650	915110
Moderate	0.01250385	528522	118917450	1486926
High	0.02536456	261990	58947750	1495184
Optimum	0.04440596	168217	37848825	1680714
TOTAL		1906683		5577933

Life-stage Species	Season	Population Number Baseline	Population Number Minimum Flows	Percent Change Population No.
juvenile+adult	Fall	701377	620900	11.5
Hogchoker	Winter	553351	482250	12.8
	Spring	126269	102233	19.0
	Summer	124983	109281	12.6
juvenile+adult	Fall	337046	315665	6.3
Blue Crab	Winter	5577933	5338615	4.3
	Spring	204920	189248	7.6
	Summer	93881	89385	4.8
juvenile	Fall	983889	863283	12.3
Sand Seatrout	Winter	16827	14446	14.1
	Spring	4527044	4388843	3.1
	Summer	2999378	2369853	21.0
early-juvenile	Fall	480831	414399	13.8
Southern Kingfish	Winter	289190	267599	7.5
	Spring	289894	255701	11.8
	Summer	177108	146191	17.5
juvenile	Fall	411688848	386446156	6.1
Bay Anchovy	Winter	1278661747	1213423074	5.1
	Spring	2098586359	1996069439	4.9
	Summer	301026145	278322254	7.5
adult	Fall	409669579	386497346	5.7
Bay Anchovy	Winter	1114145755	1069235403	4.0
	Spring	2098463644	1995985434	4.9
	Summer	275313382	278372737	***1.1***
early-juvenile	Fall	12599998	12357379	1.9
Red Drum	Winter	2771344	2762907	0.3
	Spring	363119	363129	***0.0***
	Summer	265019	250736	5.4
early-juvenile	Fall	6153	6635	***7.8***
Spot	Winter	107931	106339	1.5
	Spring	783736	770237	1.7
	Summer	58781	61605	***4.8***

Summary

The study used a statistically rigorous approach combining fish survey data and habitat data integrated in a GIS.

Early-life stages of the species analyzed occupied low salinities in the tidally influenced lower Peace River.

As the fish grew they moved downstream in the river and with some species into Charlotte Harbor.

Predicted abundance grids were created which allowed the estimation of population numbers for species life-stages by season in the lower Peace River and Charlotte Harbor.

Small differences in population numbers between Baseline and Minimum Flows indicate that the changes were not detrimental to the species life-stages modeled.

Contact Information
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Tel. 727-327-9226

Rubec, P.J. 2019. Modeling and mapping to assess spatial distributions and population numbers of fish and Invertebrate species in the lower Peace River and Charlotte Harbor, Florida. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 11: 328-350.

Rubec, P.J., Santi, C., Chen, X. and Ghile, Y. 2021. Habitat suitability modelling and mapping to assess the influence of freshwater withdrawals on spatial distributions and population numbers of estuarine species in the lower Peace River and Charlotte Harbor, Florida. Marine and Coastal Fisheries, Dynamics, Management, and Ecosystem Science 13: 31-58.