Habitat Suitability Modeling: Linking Fish and Invertebrate Data to Estuarine and Marine Habitats In Florida

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Habitat Suitability Modeling

Habitat Suitability Index (HSI) models were developed by the U.S. Fish and Wildlife Service in the early 1980's as part of the Habitat Evaluation Program.

Scientists at the Florida Fish & Wildlife Research Institute have developed spatial habitat suitability models (HSM) using geographic information systems (GIS).

HSM allows scientists to predict spatial distributions and relative abundance of species at various life stages using abundance indices associated with mapped habitat layers.

Critical Ecosystem Resources

Fish Habitat Modeling in Florida Estuaries

Fish Catch Data

Substrate.vat

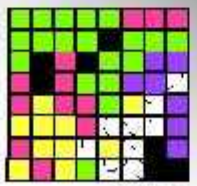
Value	Type
0	No Data
1	Hardbottom
2	Silt/Mud
3	sand
4	seagrass

Reclass.dat

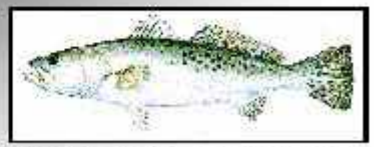
Value	SI
0	0
1	10
2	5.8
3	2.4
4	8

Suitability Index

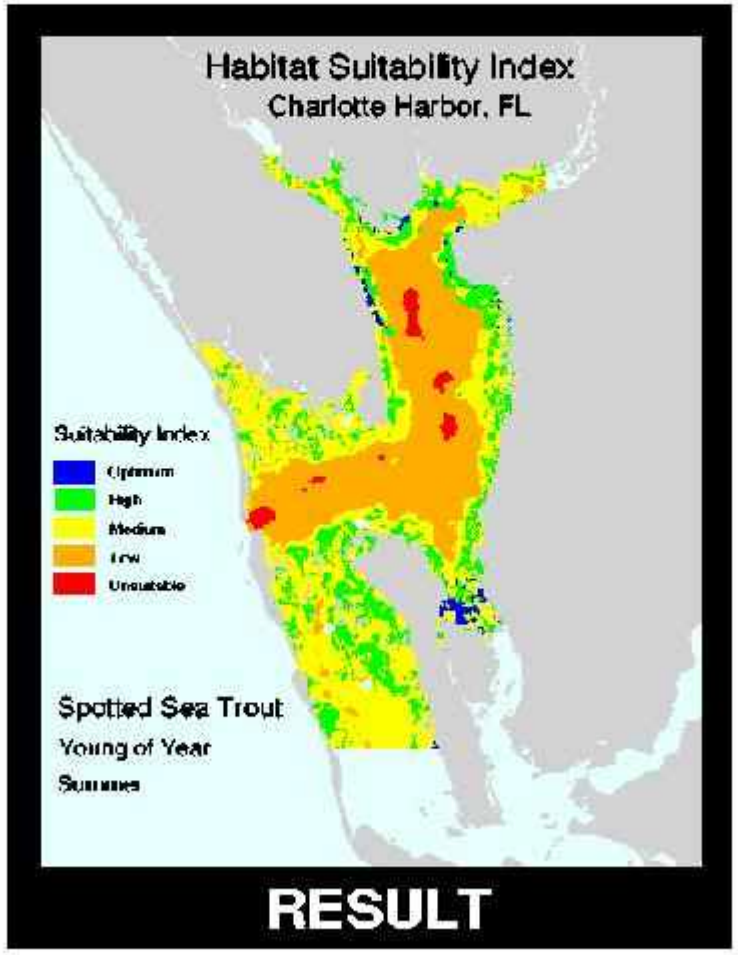
GIS Model



Environmental Variables



Species Life History Data



RESULT

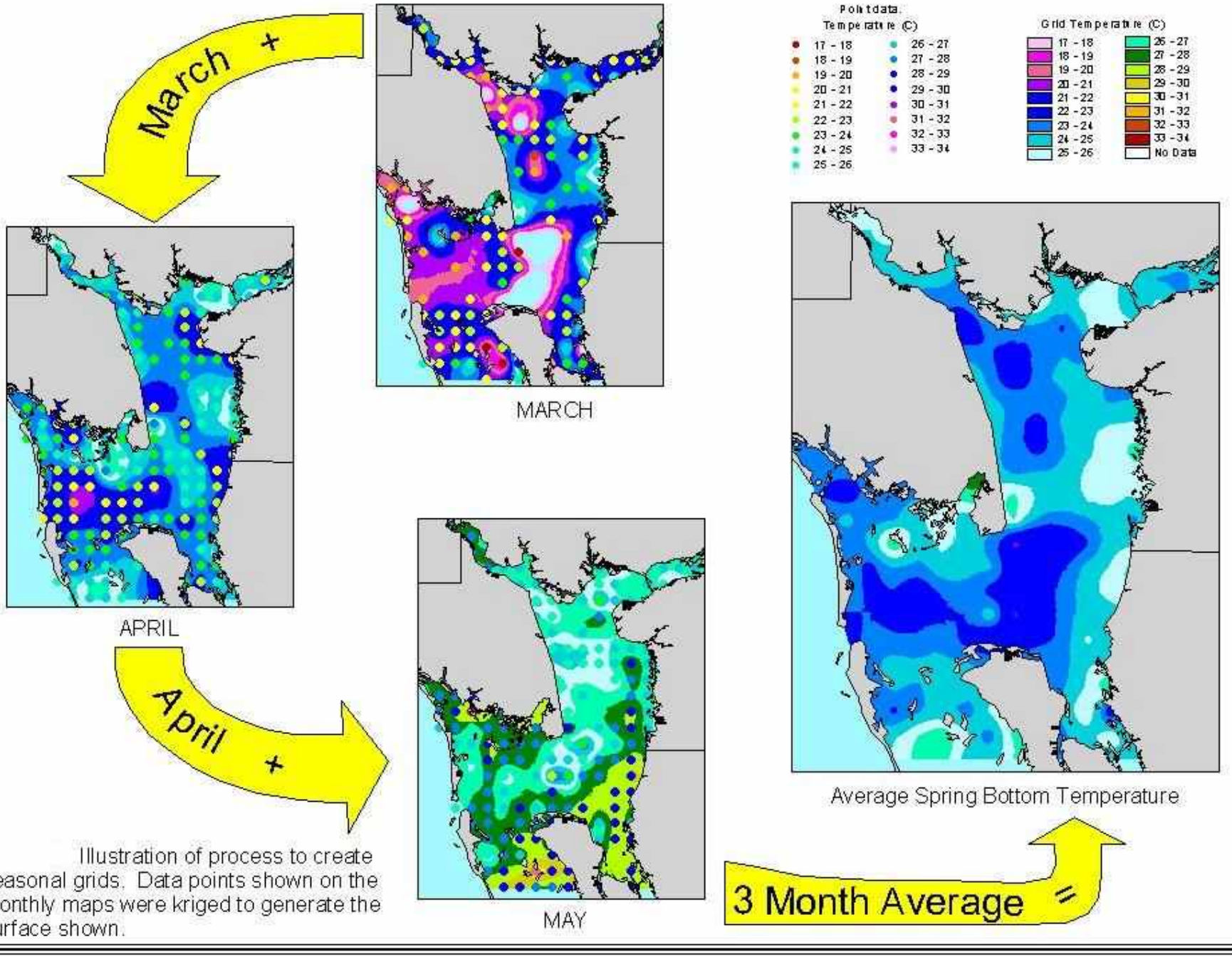
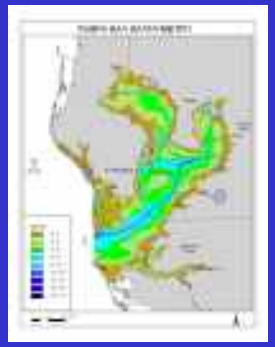


Illustration of process to create seasonal grids. Data points shown on the monthly maps were kriged to generate the surface shown.

Habitat Layers

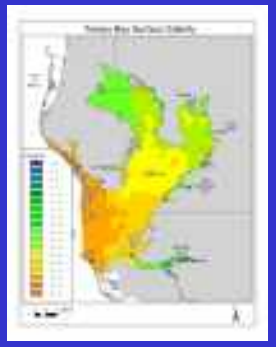
Bottom Type



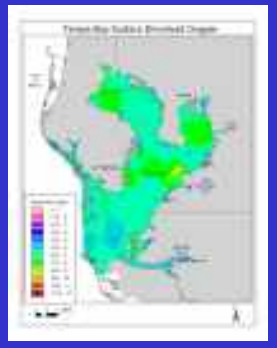
Depth

Environmental data used to create habitat maps of each of these physical factors...

Temperature



Salinity



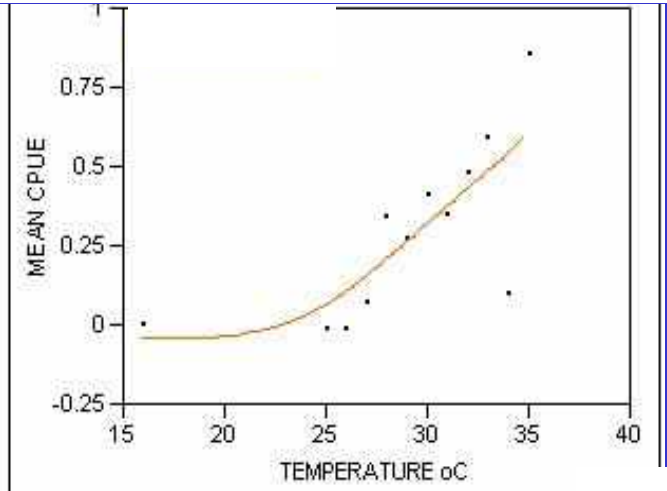
Dissolved Oxygen

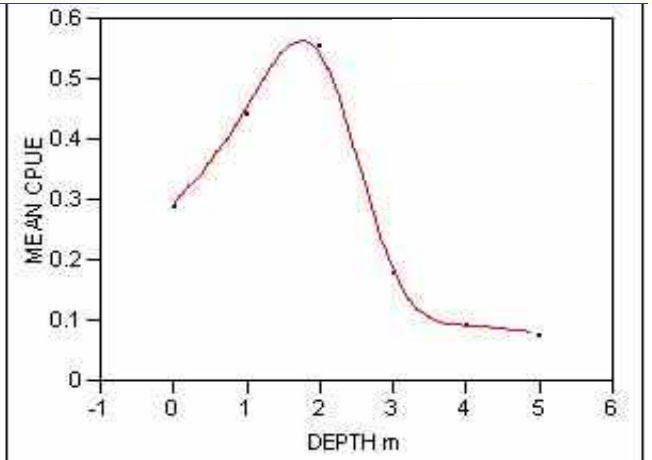
Suitability Curves

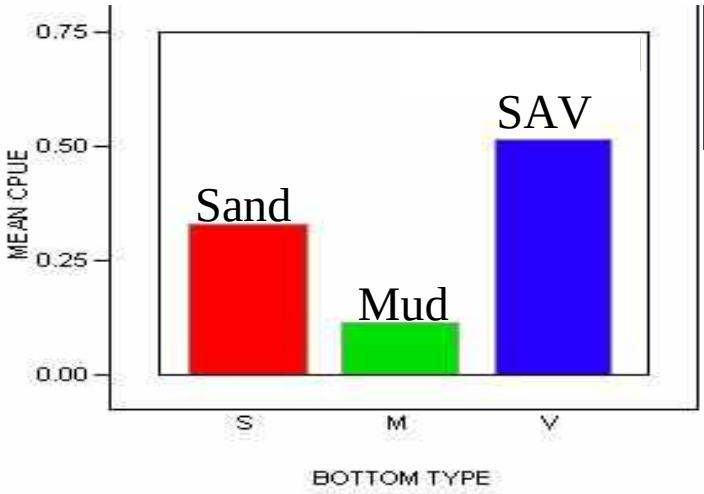
Juvenile Pinfish

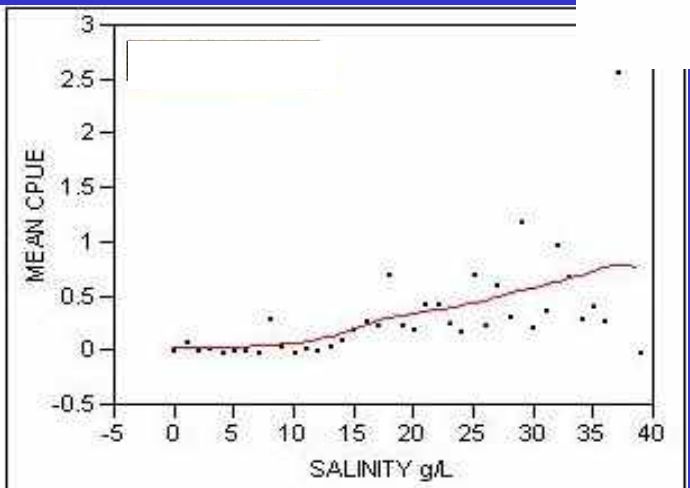
Summer

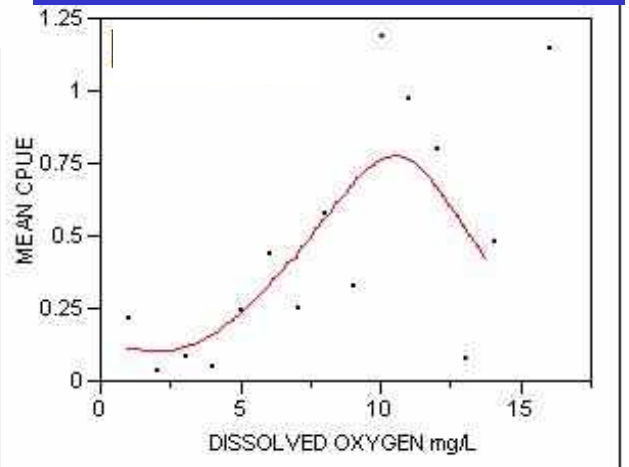
Charlotte Harbor





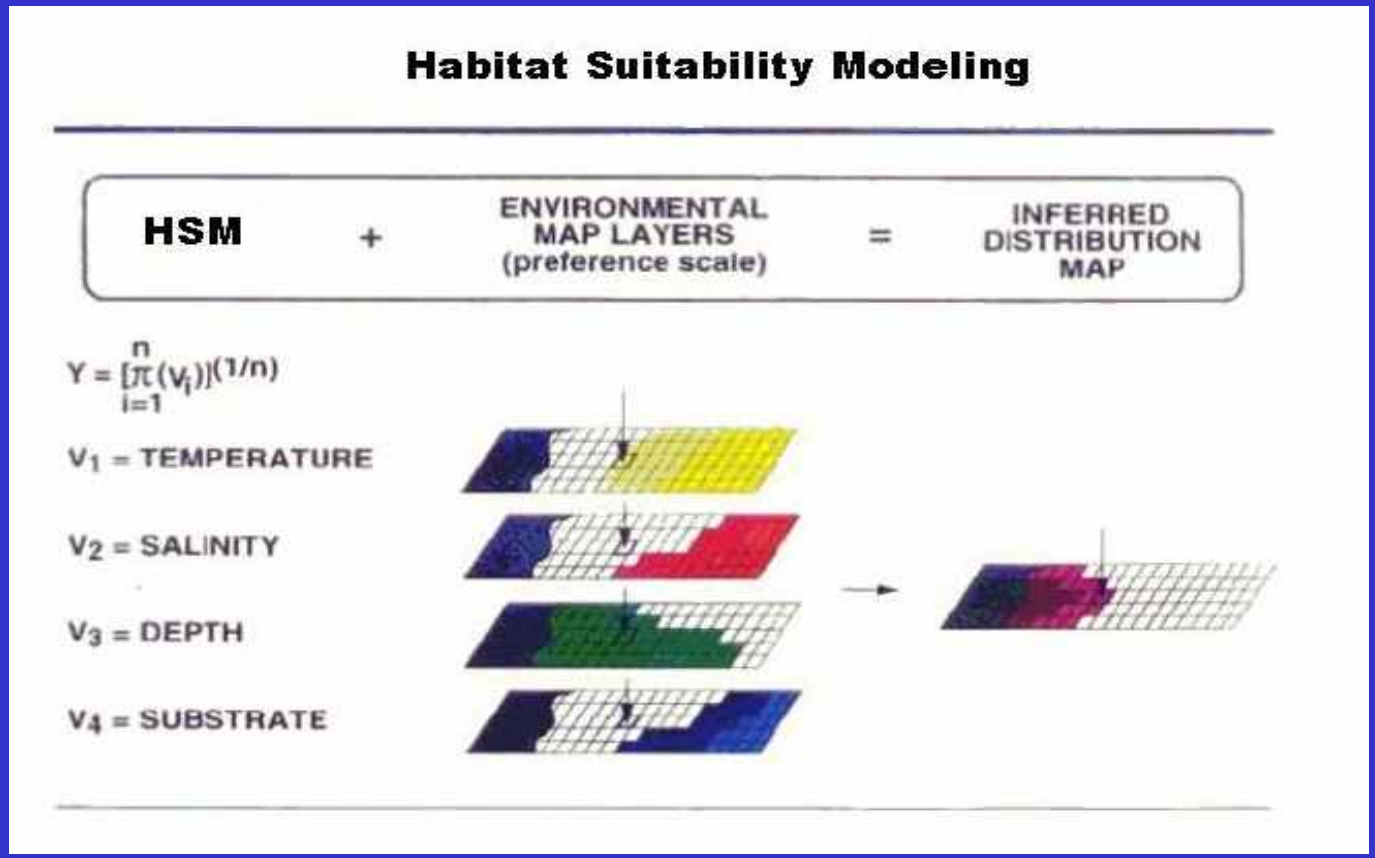




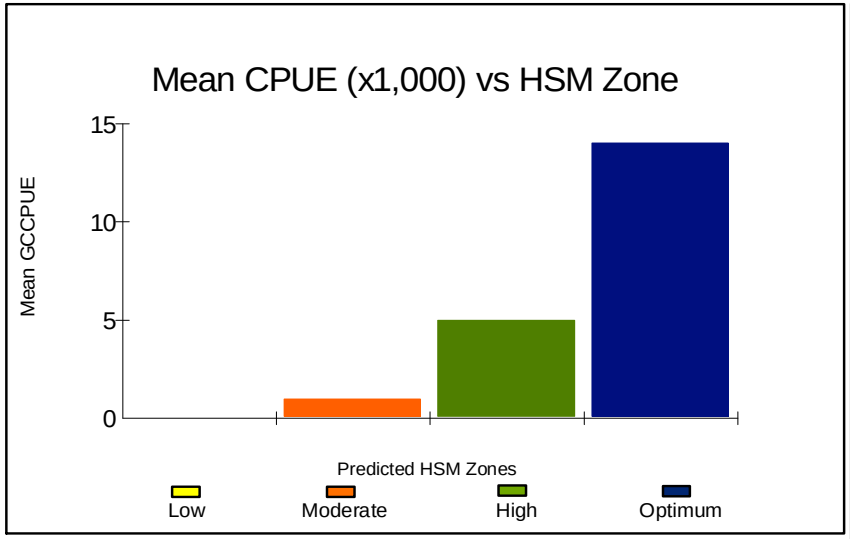


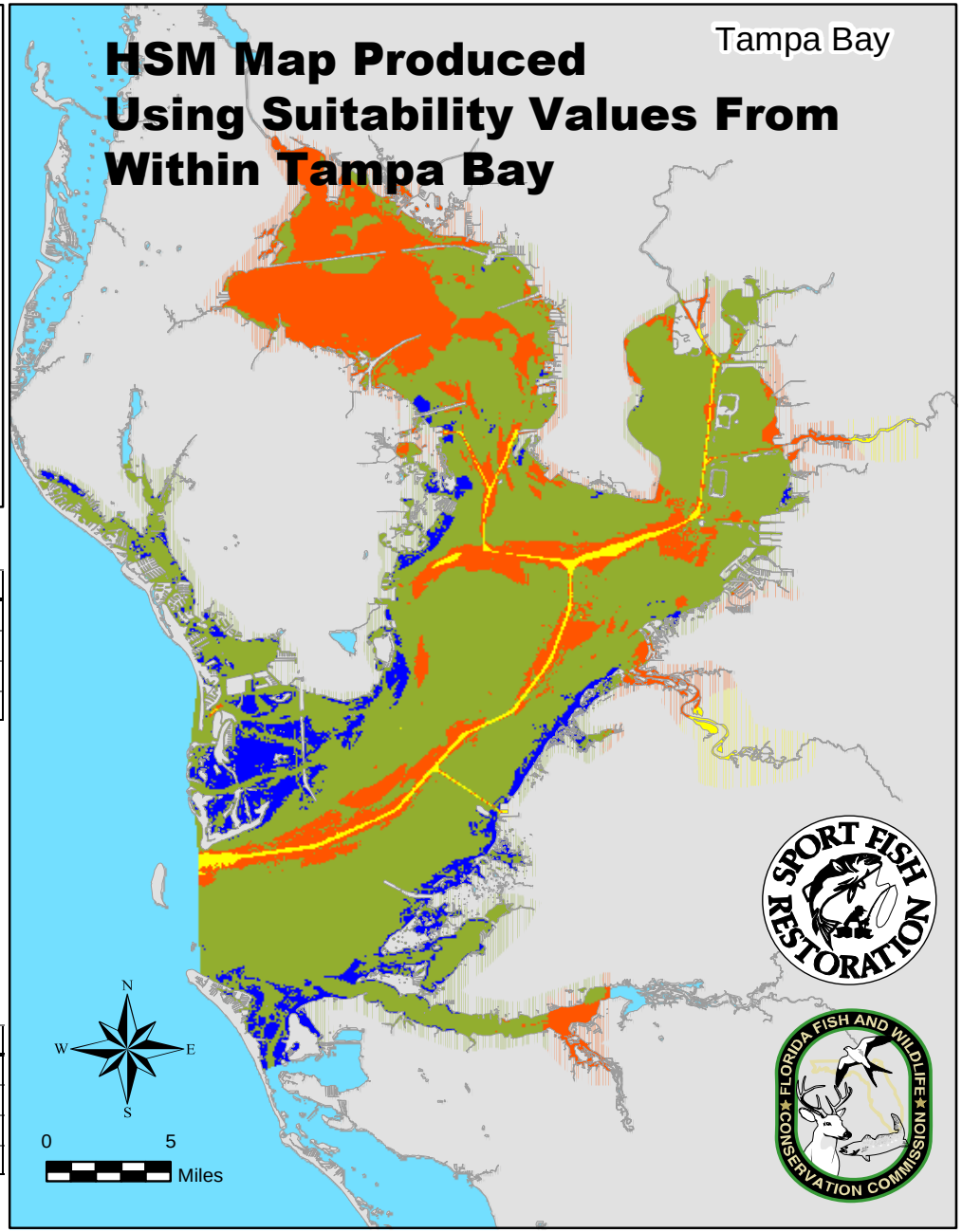
Spatial Analyses

Habitat suitability modeling (HSM) is conducted across all the cells to create maps for each species life stage. Predicted maps are created by computing the geometric mean of the suitability values within grid cells assigned to the habitat layers in the GIS



Fall, Adult Pinfish, >=100 mm SL, Tampa Bay CPUE





Observed Table

Zone	ObsMNGCCPUE	Min	Max	Std	Count
Low	0.00000395	0	0.00063234	0.00004999	160
Moderate	0.00124502	0	0.06753790	0.00579977	546
High	0.00474585	0	0.28758169	0.01569988	1156
Optimum	0.01352631	0	0.37305171	0.03247579	283

Predicted Table

Zone	PredMNCPUE	Min	Max	Std
Low	0.00012005	0	0.00098167	0.00027074
Moderate	0.00179888	0.00099114	0.00197895	0.00015639
High	0.00231815	0.00197904	0.00296398	0.00021408
Optimum	0.00336739	0.0029695	0.00395793	0.00017412

Ranges Table

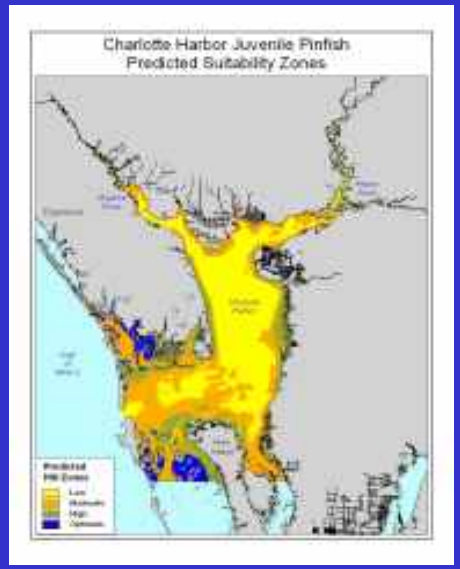
Zones	LowGCCPUE	HighGCCPUE	CellCount	Hectares	Percent
Low	0	2.499999	67240	2040.0616	2.10
Moderate	2.5	4.999999	682474	20706.2611	21.4
High	5	7.499999	2173216	65935.3734	68.1
Optimum	7.5	10	264546	8026.32564	8.29

HTAPW3WBTSDO0JL 10/24/2002

Transferability

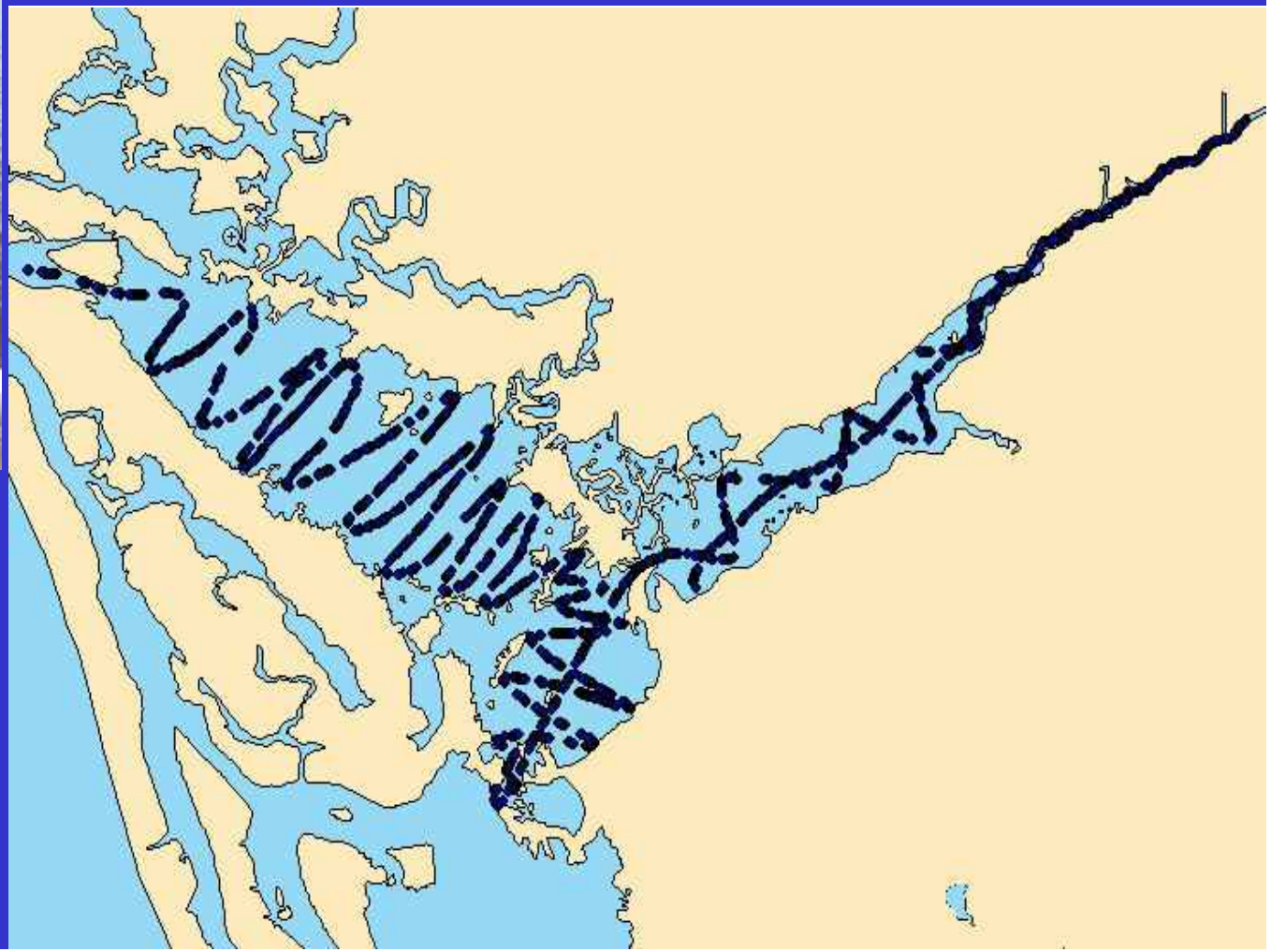
Suitability values from Tampa Bay were used with habitat layers from Charlotte Harbor to predict species distributions in Charlotte Harbor. Abundance data from Charlotte Harbor also were transferred to Tampa Bay. The approach can be used to predict conditions in other estuaries lacking long-term fisheries monitoring.

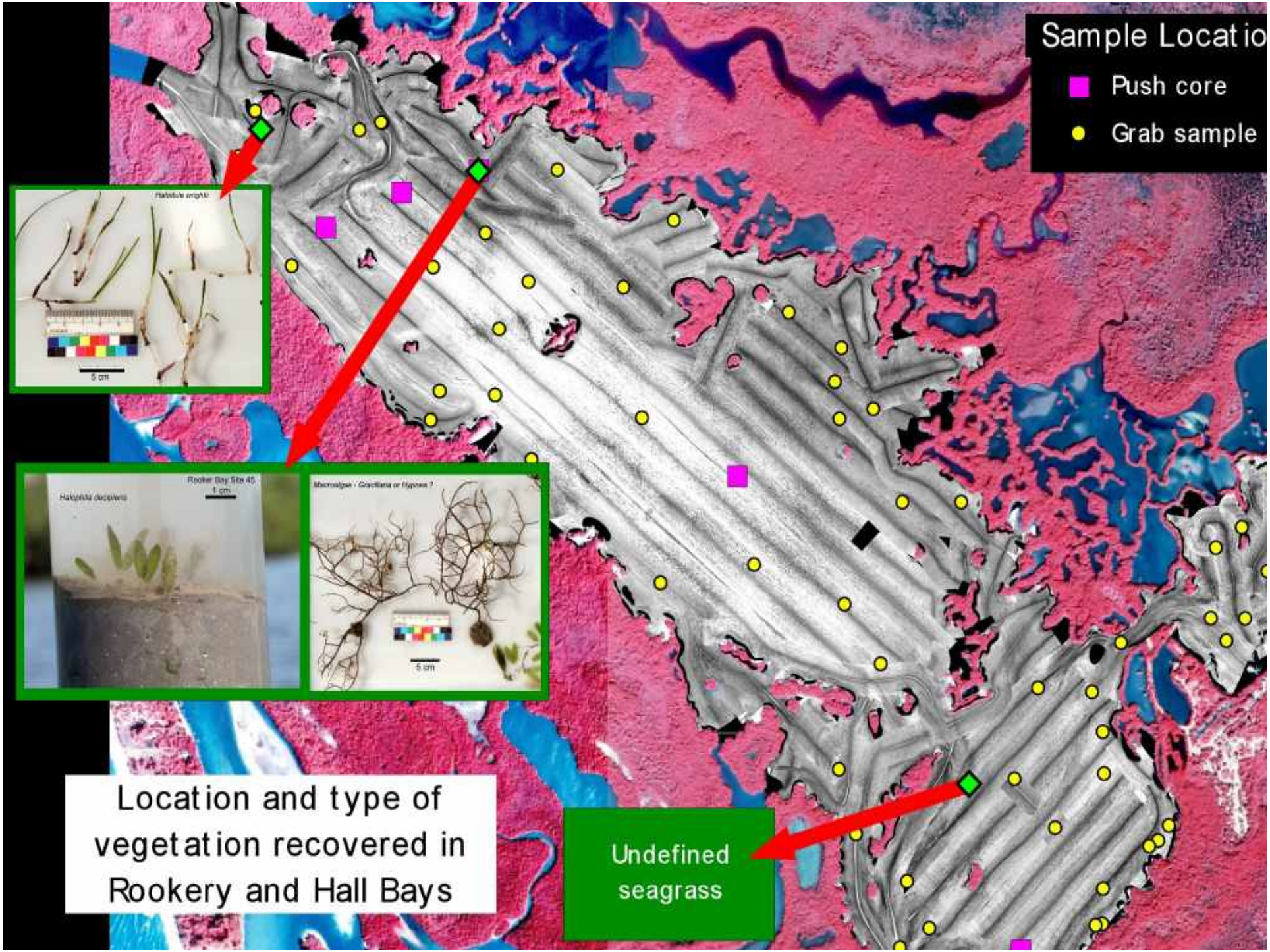
Data

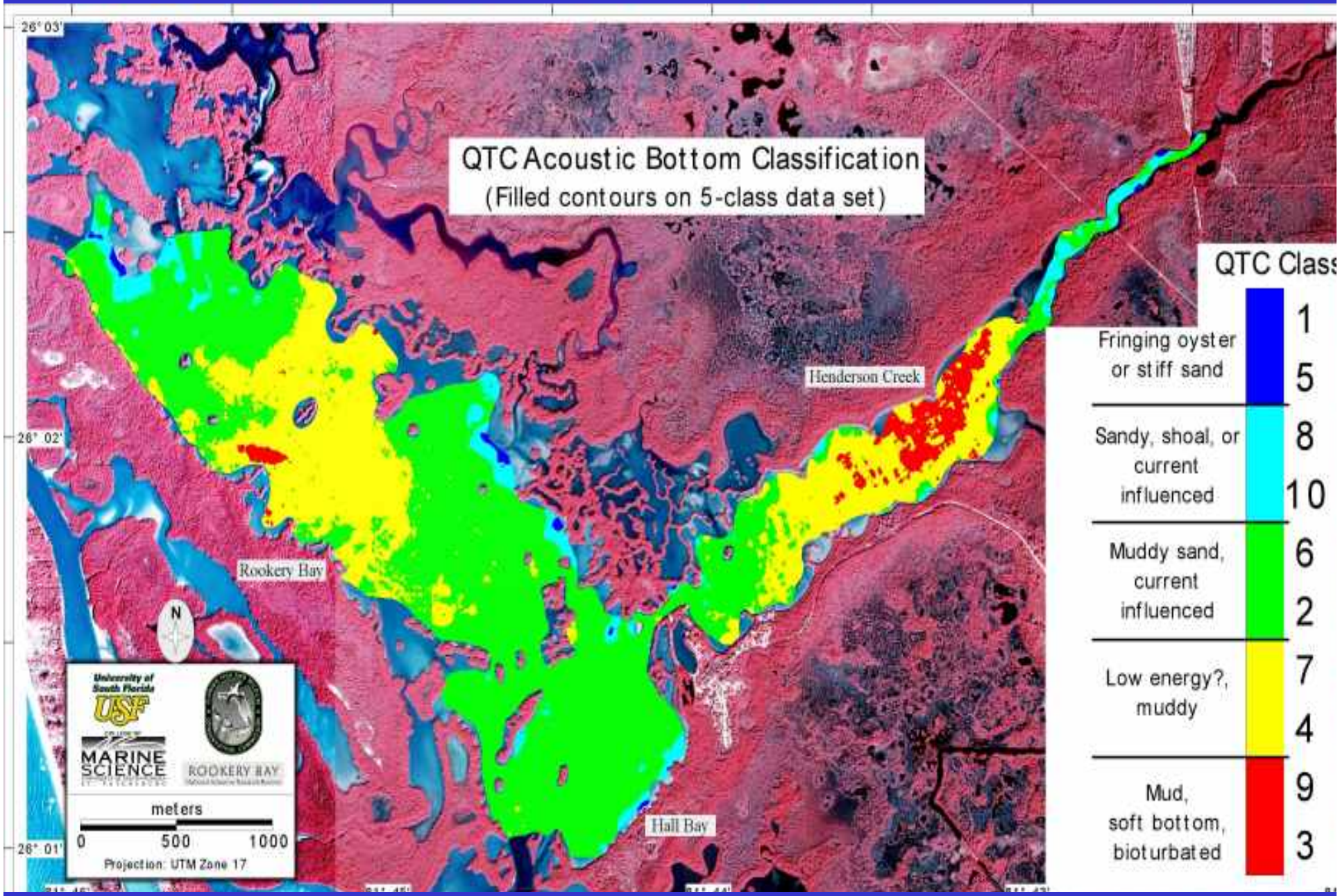


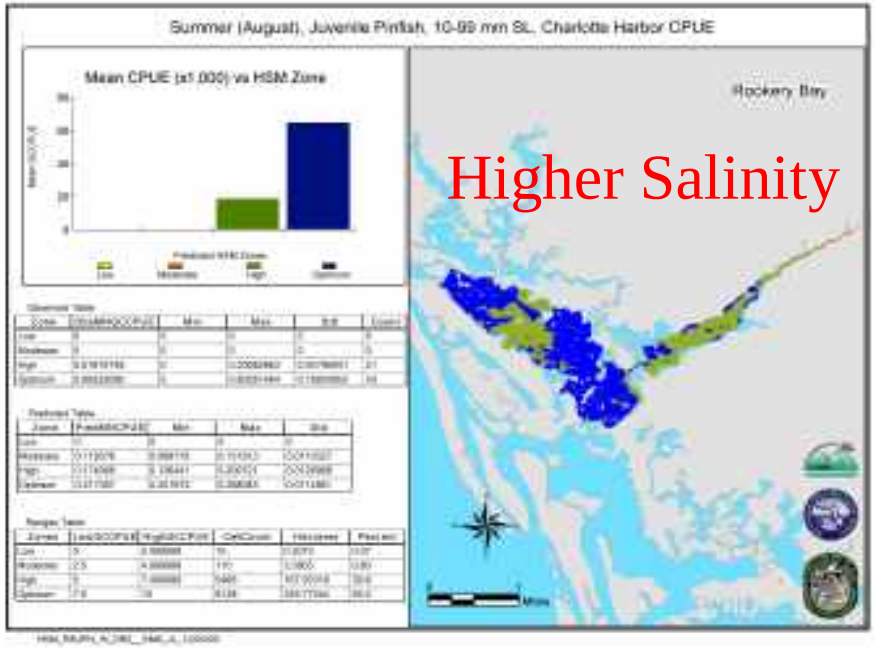
Data logger

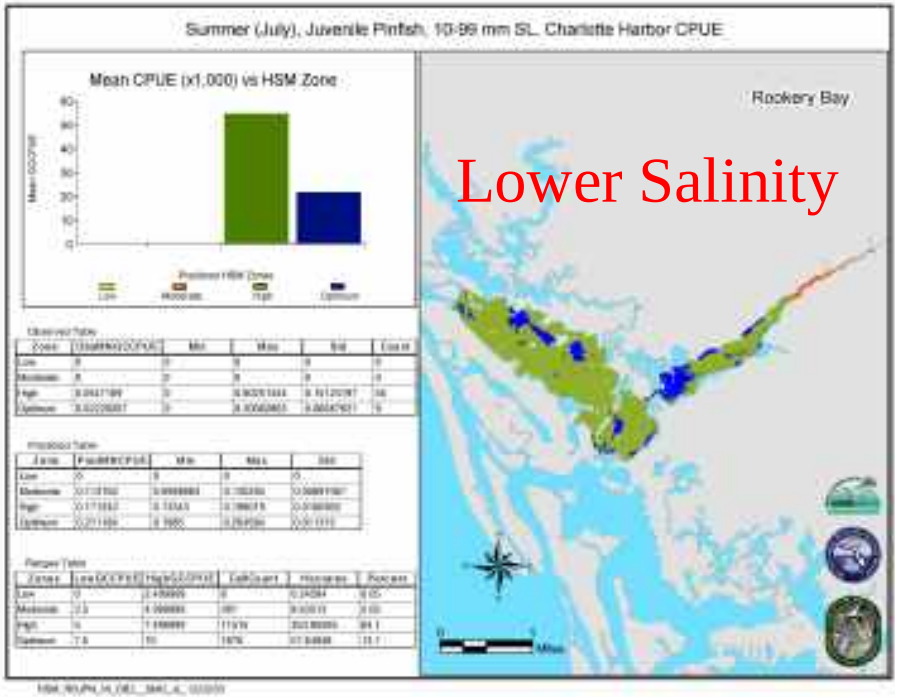
Scientists used a data logger to map the following environmental conditions: temperature, salinity, and dissolved oxygen. Data were then interpolated by GIS staff to create raster-based habitat grids to support habitat suitability modeling.

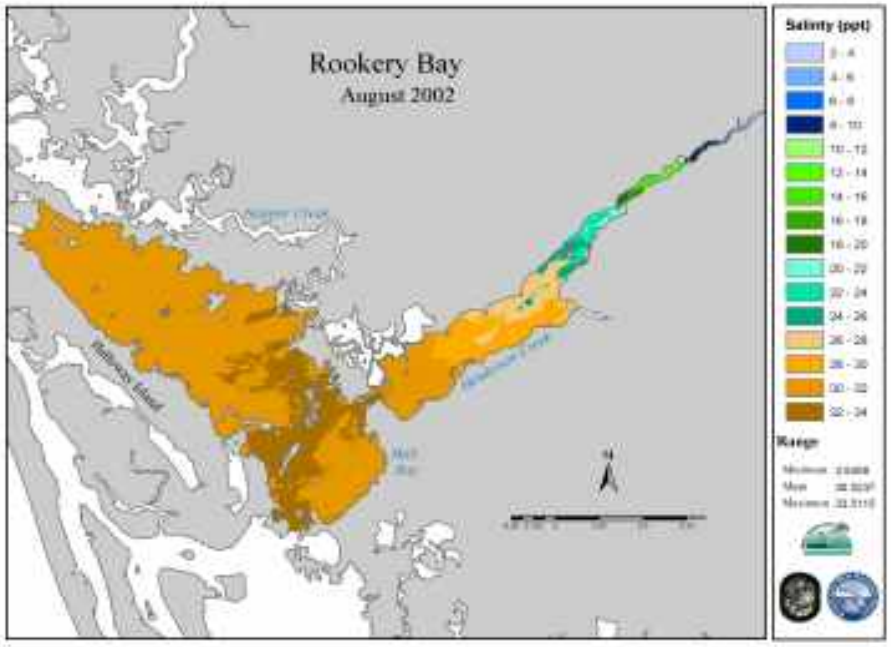


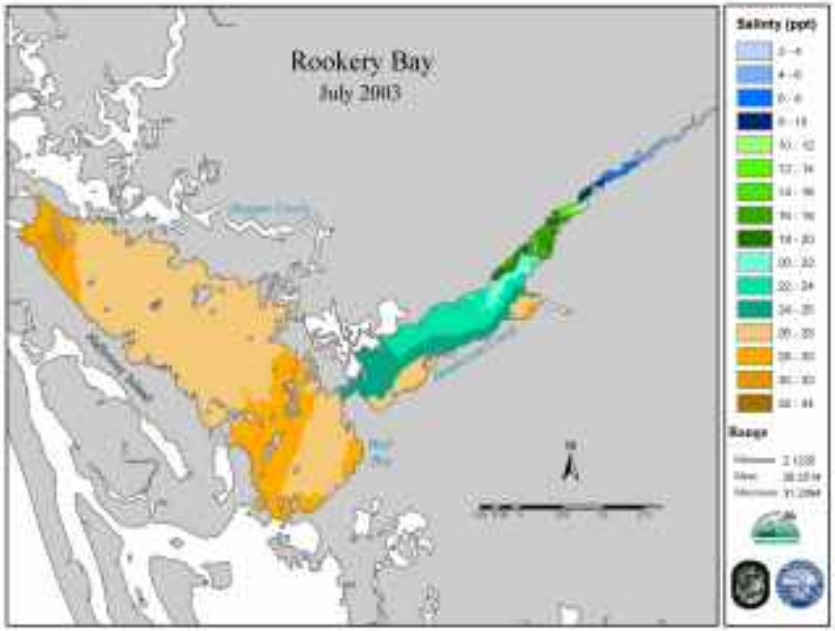

Sample Locatio
Push core
Grab sample
Rooker Bay Site 45
1 cm
5 cm
5 cm
Location and type of vegetation recovered in Rookery and Hall Bays
Undefined seagrass


QTC Acoustic Bottom Classification
(Filled contours on 5-class data set)
QTC Class
Fringing oyster or stiff sand
1
5
Sandy, shoal, or current influenced
8
10
Muddy sand, current influenced
6
2
Low energy?, muddy
7
4
Mud, soft bottom, bioturbated
9
3
Henderson Creek
Rookery Bay
Hall Bay
26° 03'
26° 02'
26° 01'
N
University of South Florida
USF
COLLEGE OF MARINE SCIENCE
ROOKERY BAY
meters
0
500
1000
Projection: UTM Zone 17

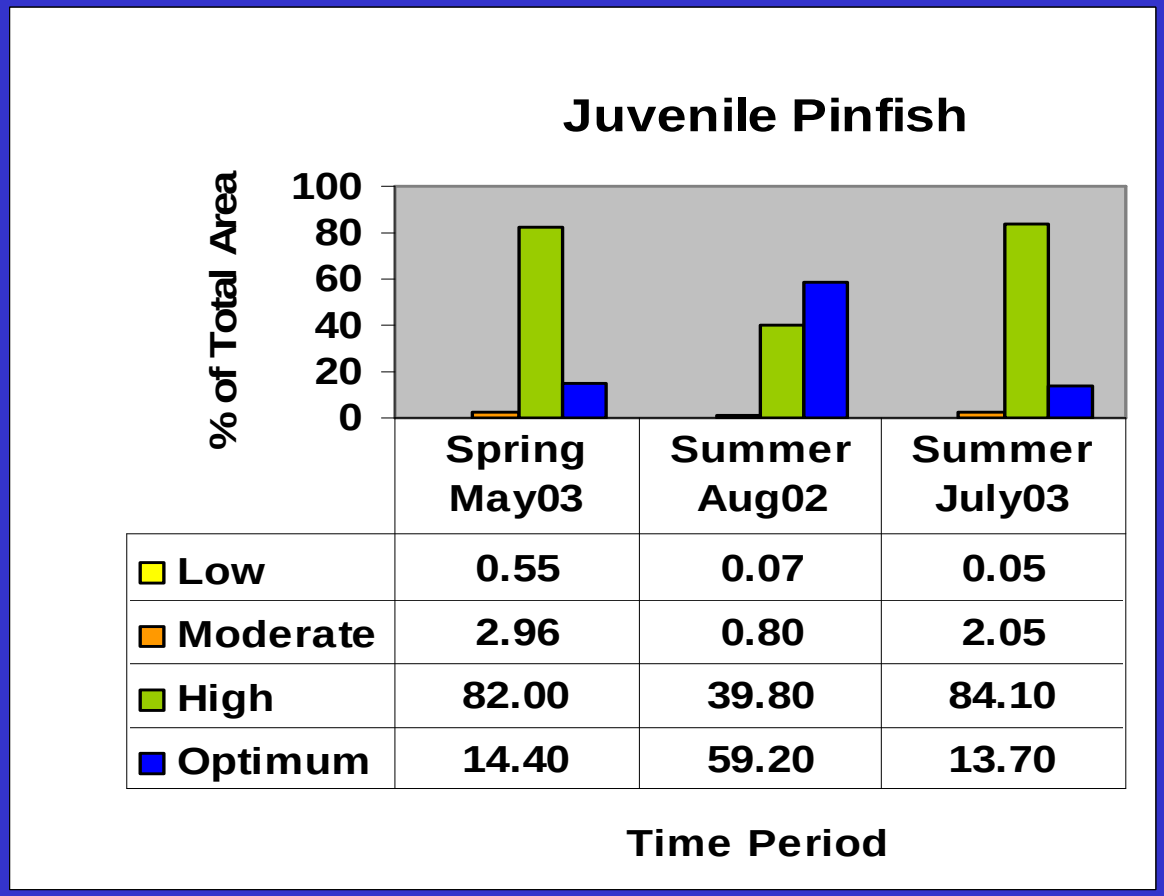

Summer (August), Juvenile Pinfish, 10-99 mm SL, Charlotte Harbor CPUE
Mean CPUE (x1,000) vs HSM Zone
Rookery Bay
Higher Salinity


Summer (July), Juvenile Pinfish, 10-99 mm SL, Charlotte Harbor CPUE
Mean CPUE (x1,000) vs HSM Zone
Rookery Bay
Lower Salinity


Rookery Bay
August 2002
Salinity (ppt)
Range

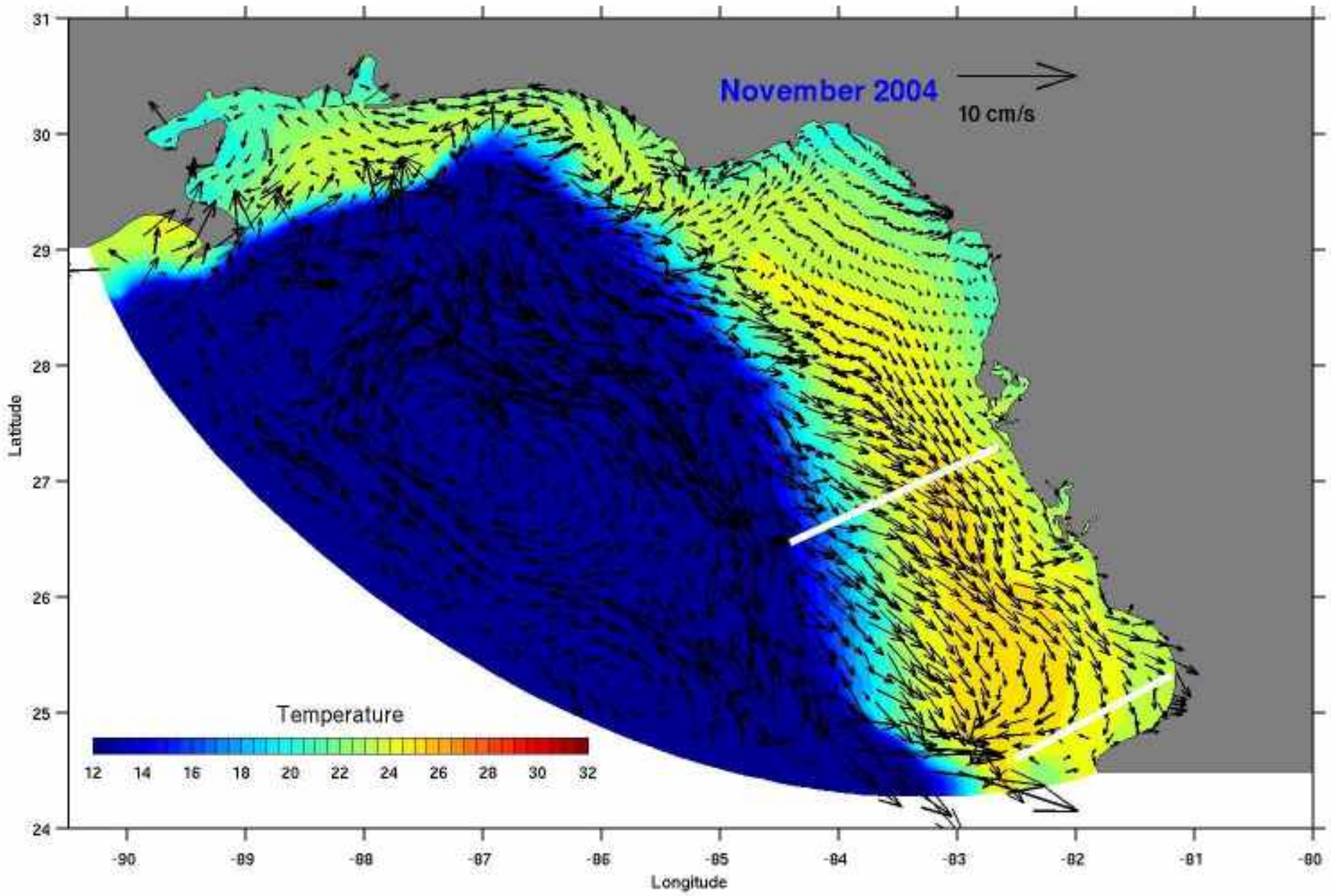

Rookery Bay
July 2003
Salinity (ppt)
Range

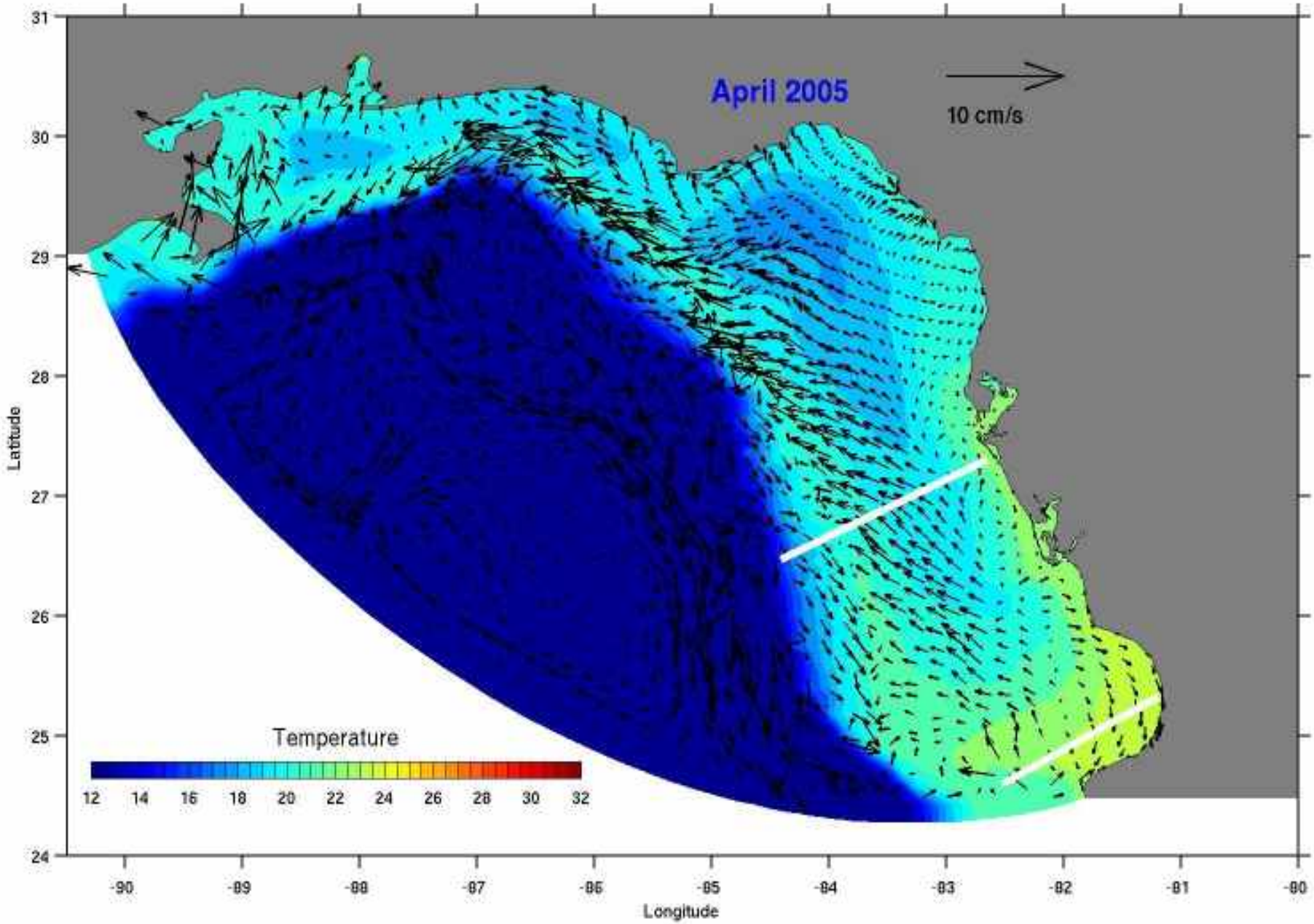
The graph shows how suitability for juvenile pinfish changed over three time periods. High salinities (30-34 ppt) dominated during August 2002. The percentage of the total optimum area in Rookery Bay declined during July 2003 associated with a reduction in salinity (26–29 ppt).

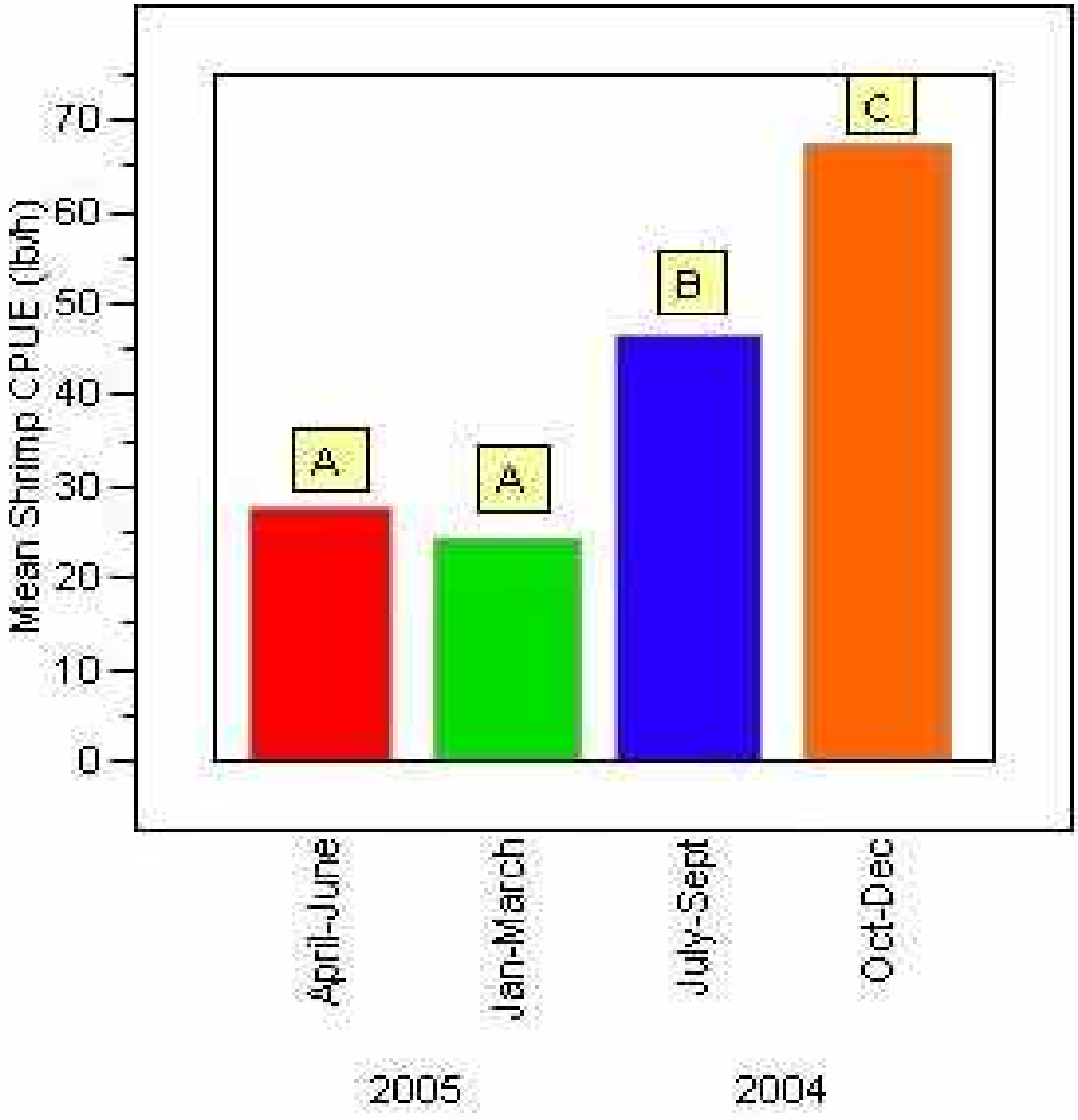


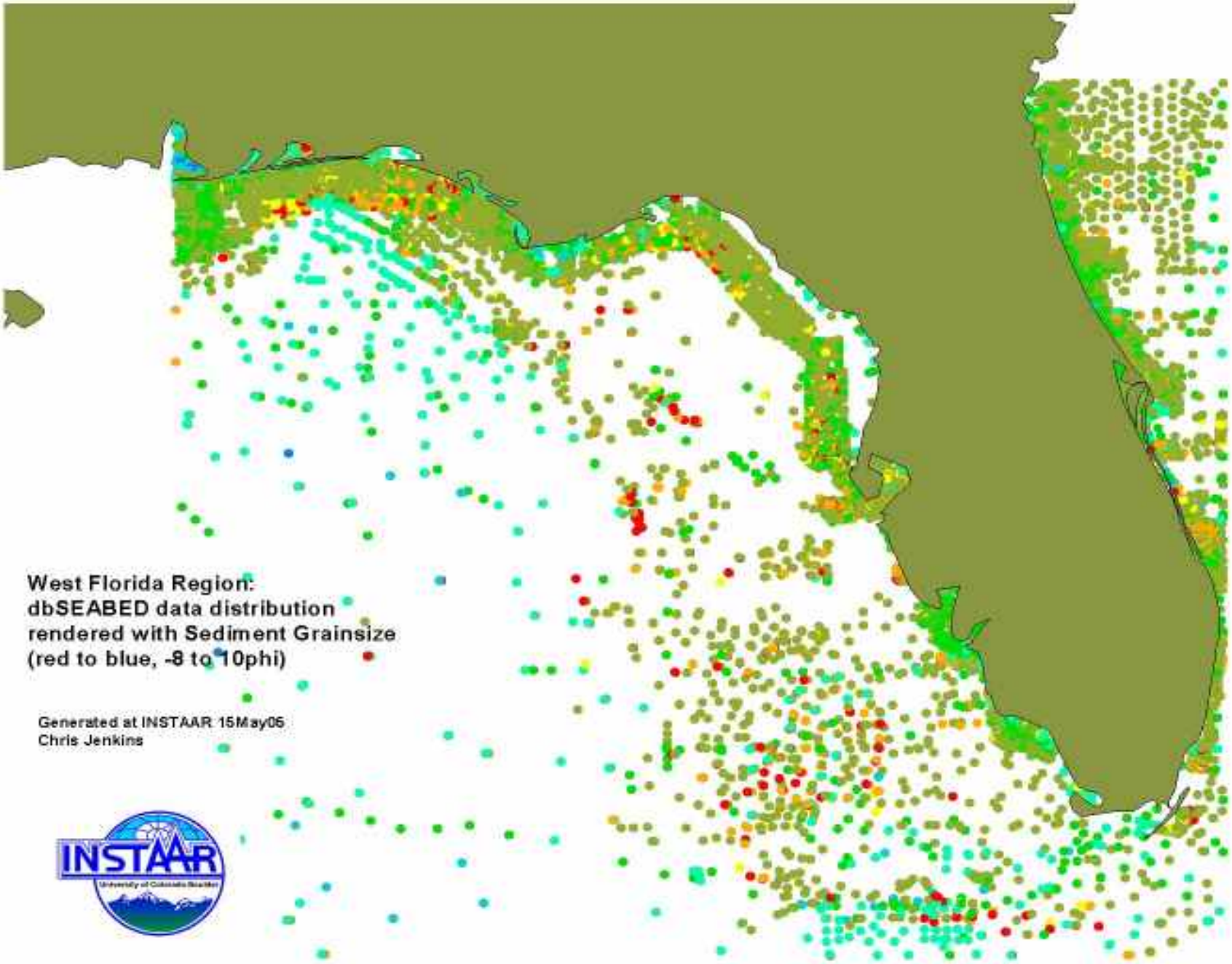
	Spring May03	Summer Aug02	Summer July03
Low	0.55	0.07	0.05
Moderate	2.96	0.80	2.05
High	82.00	39.80	84.10
Optimum	14.40	59.20	13.70

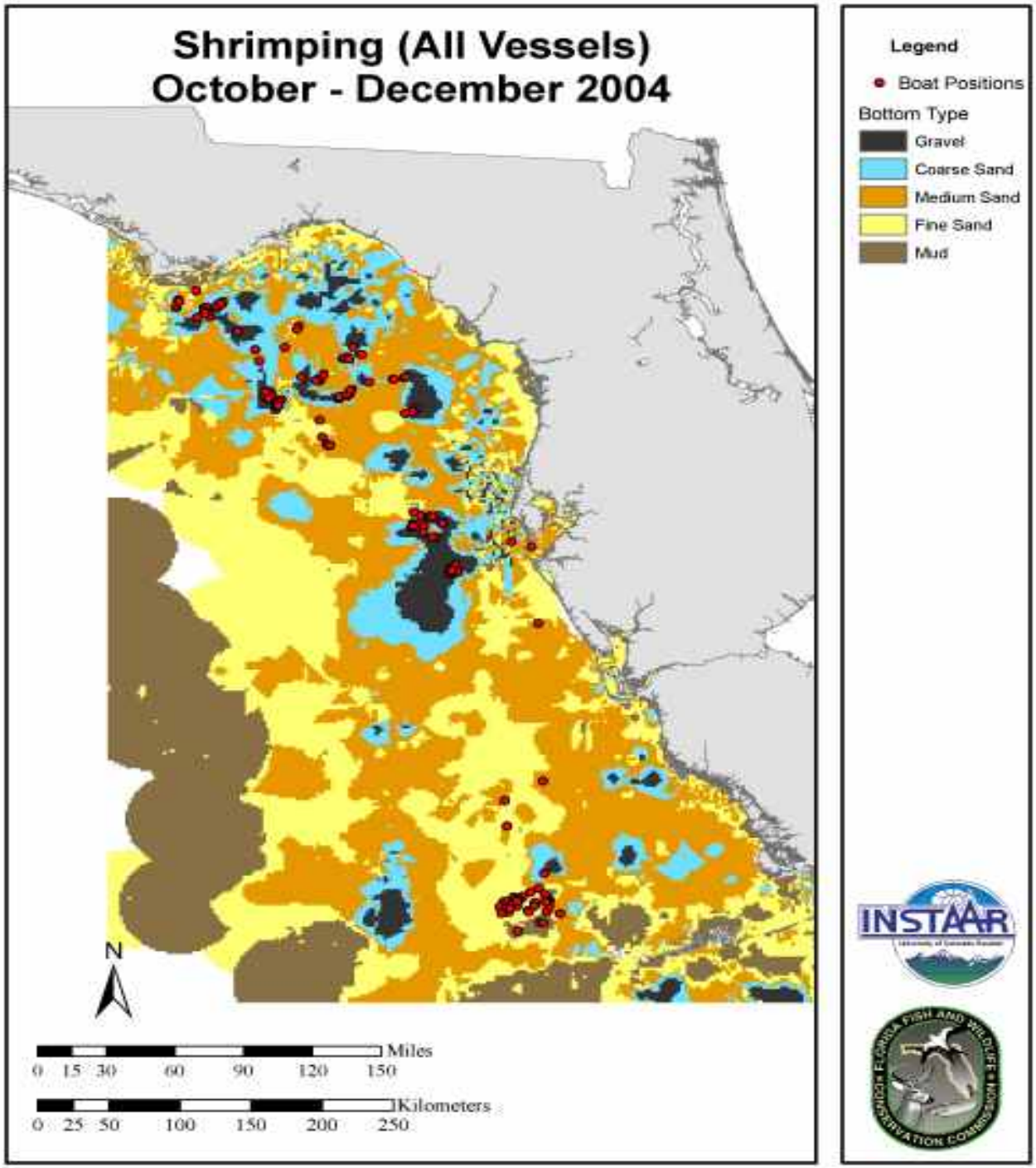

Electronic Log Book
New Voyage
End of Day
Exit
Trawl Down Info
7/27/01 14:54:35
N 27° 57.844
W 82° 24.728
Trawl Up Info
7/27/01 15:50:34
N 27° 47.847
W 82° 24.726
N 27° 57.845
W 82° 24.725
15:07:16
Pink Tails 16-20
121
LB
Pink Tails 36-40
133
LB
Pink H/On 31-35
244
LB
Pink Tails 31-35
100
LB
Pink H/On 36-40
11
LB
Sand _Shell
1
2
3
4
5
6
7
8
9
0
<
Clear


November 2004
10 cm/s
Temperature
12 14 16 18 20 22 24 26 28 30 32
Latitude
Longitude
31 30 29 28 27 26 25 24
-90 -89 -88 -87 -86 -85 -84 -83 -82 -81 -80


April 2005
10 cm/s
Temperature
12 14 16 18 20 22 24 26 28 30 32
Latitude
Longitude
31 30 29 28 27 26 25 24
-90 -89 -88 -87 -86 -85 -84 -83 -82 -81 -80

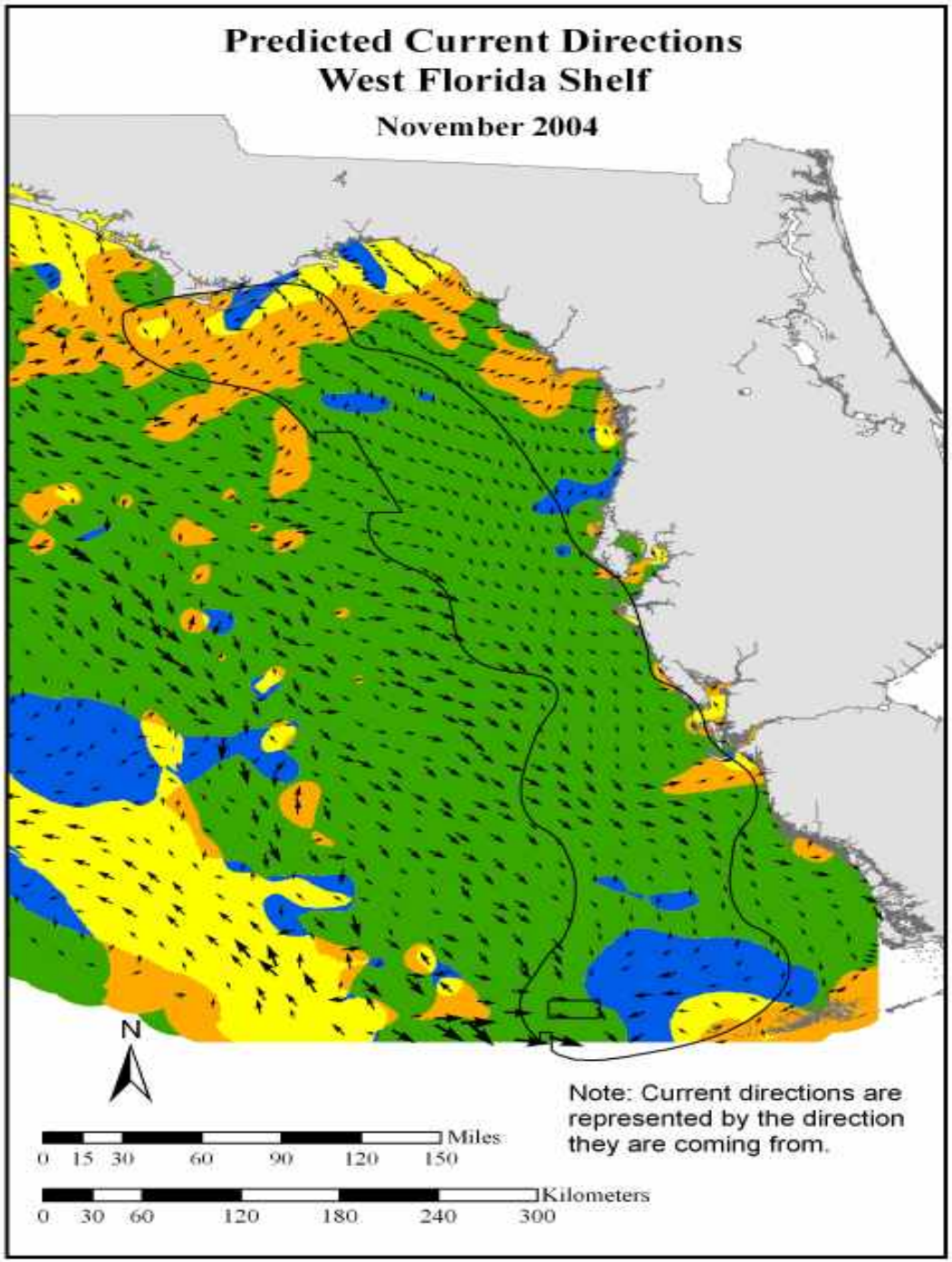

Mean Shrimp CPUE (lb/h)
0
10
20
30
40
50
60
70
A
A
B
C
April-June
Jan-March
July-Sept
Oct-Dec
2005
2004


West Florida Region:
dbSEABED data distribution
rendered with Sediment Grainsize
(red to blue, -8 to 10phi)
Generated at INSTAAR 15May06
Chris Jenkins
INSTAAR


Shrimping (All Vessels)
October - December 2004
Legend
Boat Positions
Bottom Type
Gravel
Coarse Sand
Medium Sand
Fine Sand
Mud
N
Miles
0 15 30 60 90 120 150
Kilometers
0 25 50 100 150 200 250
INSTAAR

Predicted Current Directions
West Florida Shelf

November 2004



Legend

Speed (CMS)

- 0.03 - 2.5
- 2.5 - 5.0
- 5.0 - 7.5
- 7.5 - 10.59

- Northeast
- Southeast
- Southwest
- Northwest

Bottom Current

Fishing Boundary

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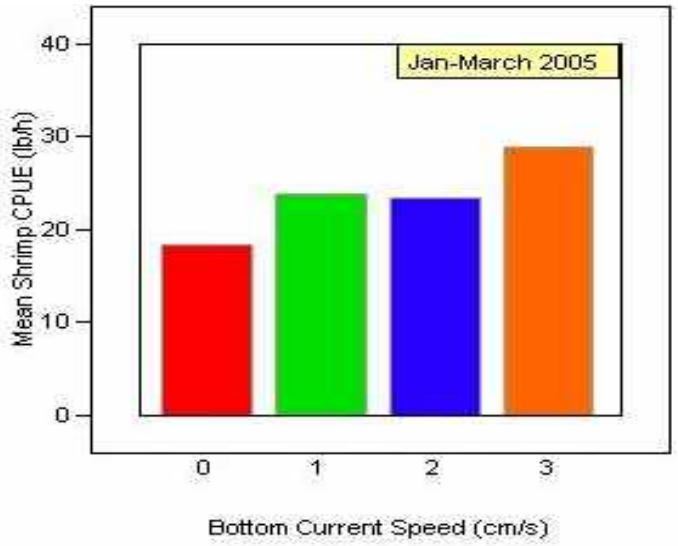
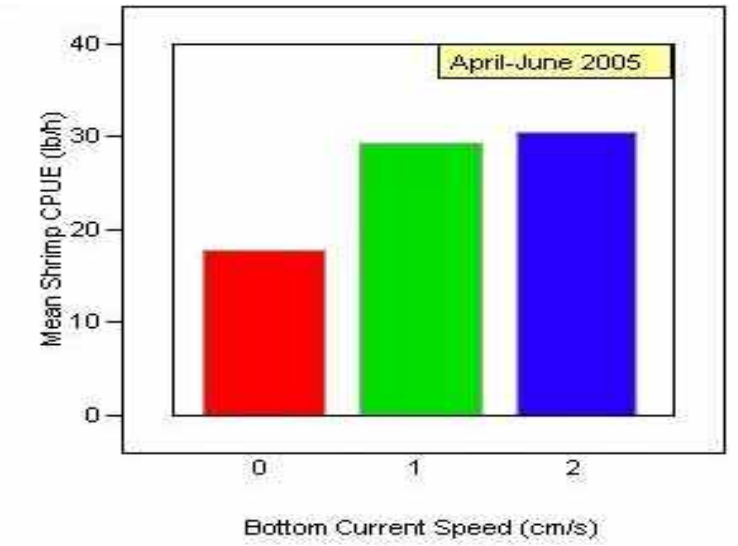
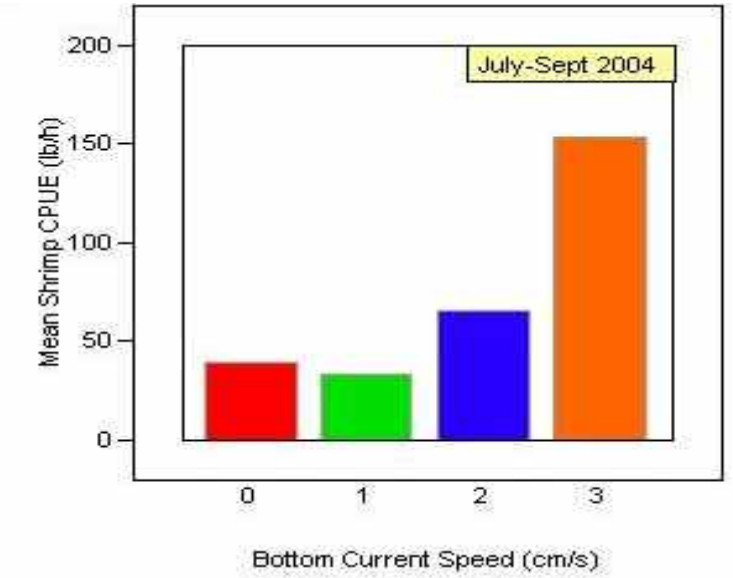
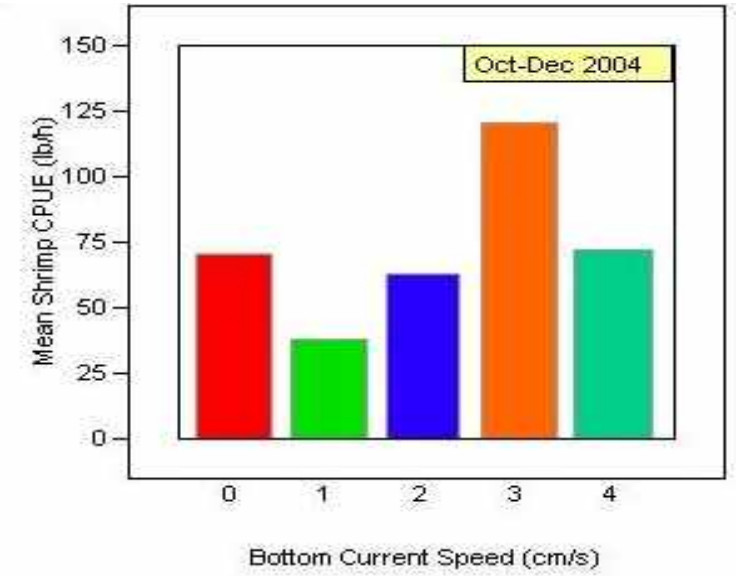
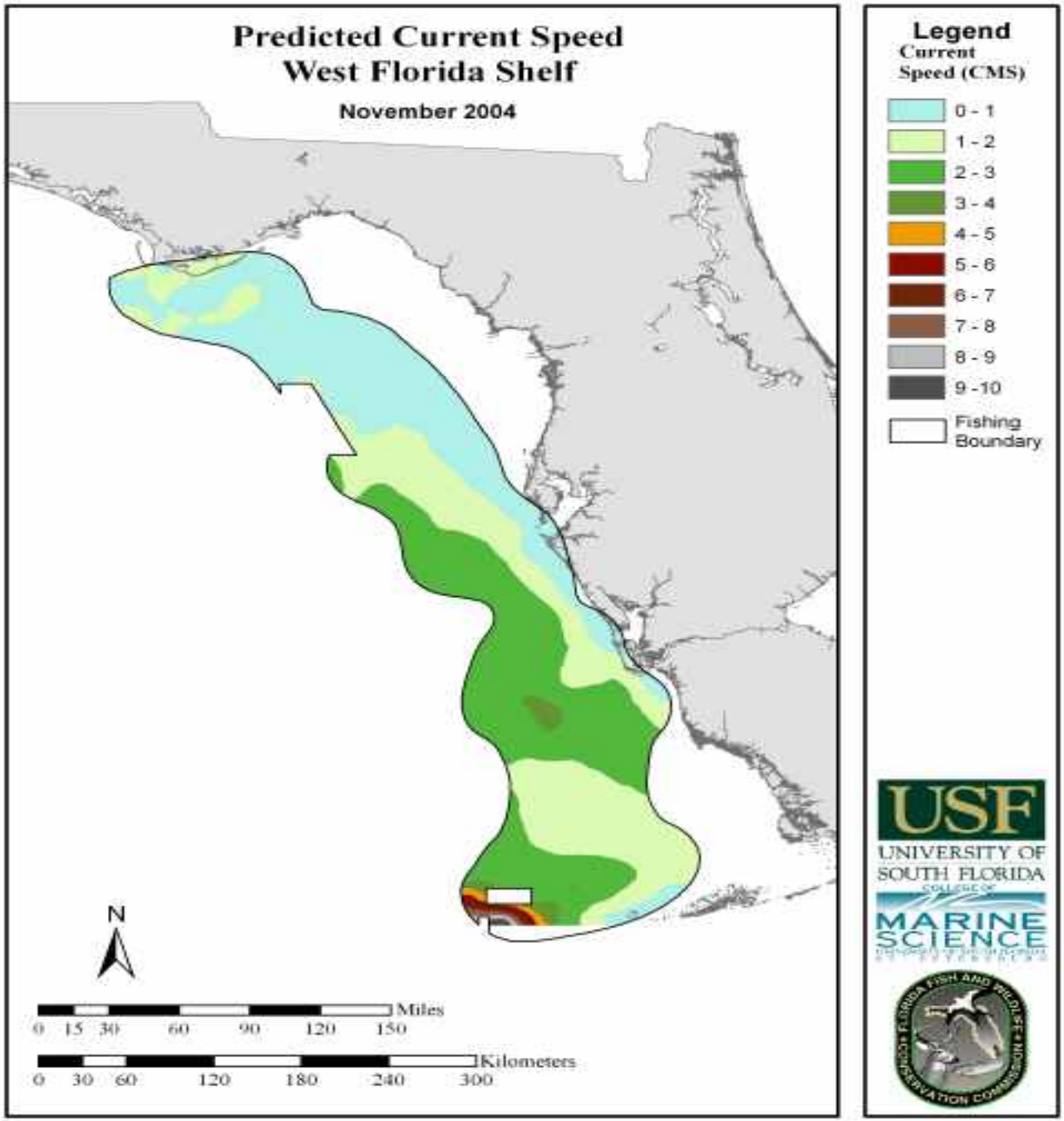

Jan-March 2005
Mean Shrimp CPUE (lb/h)
40
30
20
10
0
0
1
2
3
Bottom Current Speed (cm/s)


April-June 2005
Mean Shrimp CPUE (lb/h)
40
30
20
10
0
0
1
2
Bottom Current Speed (cm/s)


July-Sept 2004
Mean Shrimp CPUE (lb/h)
200
150
100
50
0
0
1
2
3
Bottom Current Speed (cm/s)


Oct-Dec 2004
Mean Shrimp CPUE (lb/h)
150
125
100
75
50
25
0
0
1
2
3
4
Bottom Current Speed (cm/s)


Predicted Current Speed
West Florida Shelf
November 2004
N
Miles
0 15 30 60 90 120 150
Kilometers
0 30 60 120 180 240 300
Legend
Current Speed (CMS)
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8
8 - 9
9 -10
Fishing Boundary
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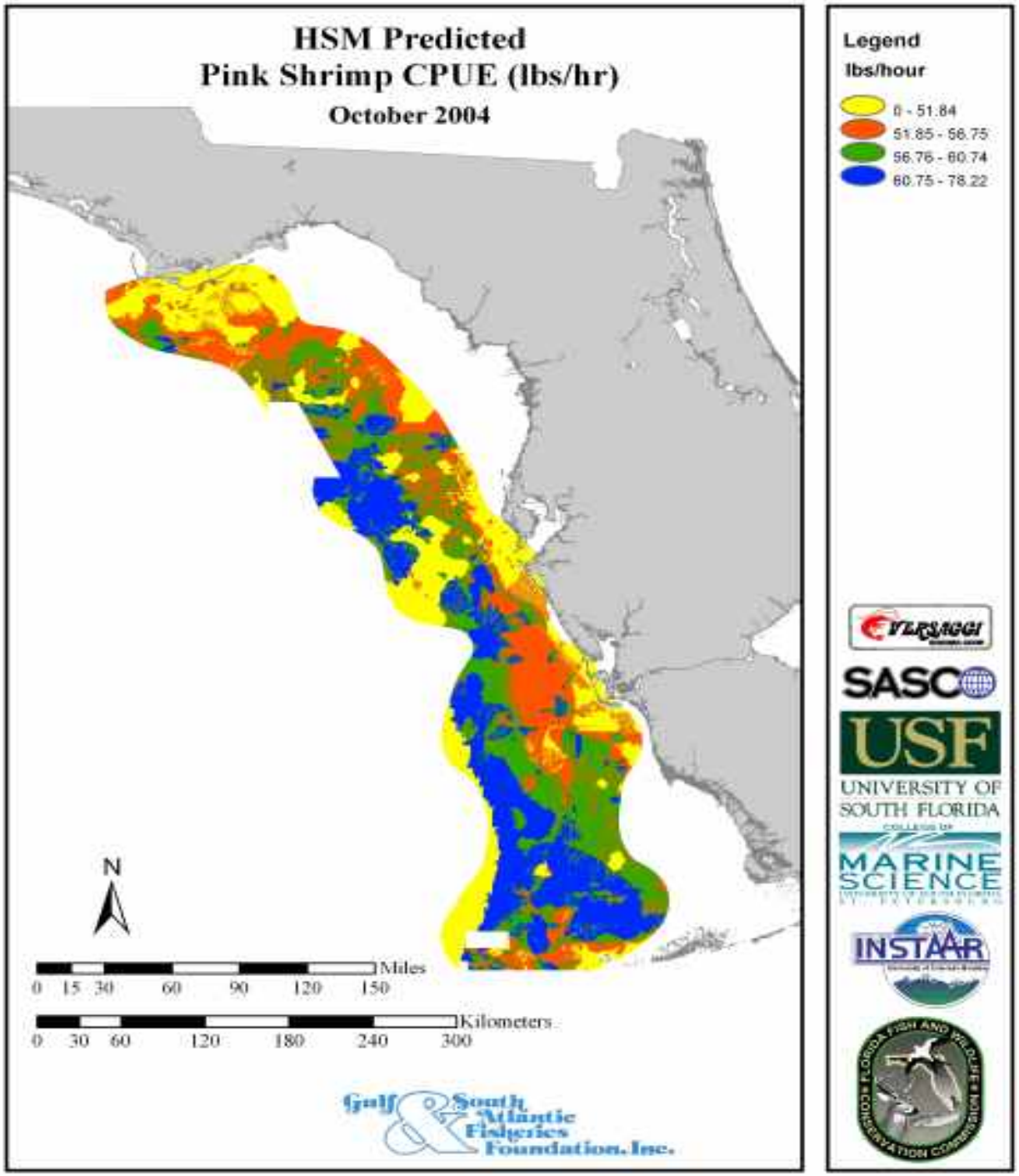
HSM Predicted
Pink Shrimp CPUE (lbs/hr)
October 2004
Legend
lbs/hour
0 - 51.84
51.85 - 56.75
56.76 - 60.74
60.75 - 78.22
N
Miles
0 15 30 60 90 120 150
Kilometers
0 30 60 120 180 240 300
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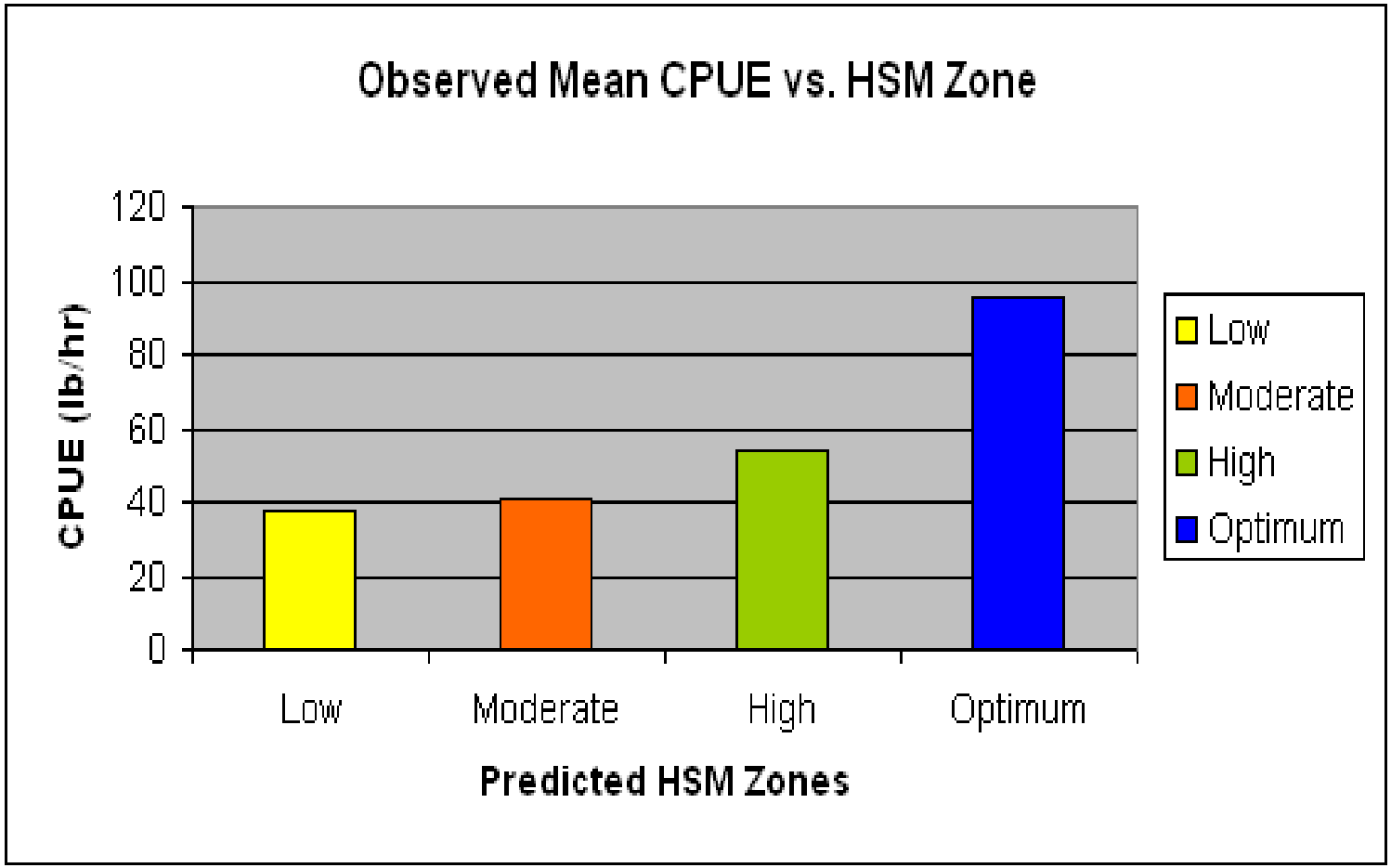
Verification of Observed Mean CPUEs From HSM Analysis September 2004



Summary

Spatial methods using GIS have been developed to map habitats and conduct habitat suitability modeling (HSM)

Environmental data points were interpolated to produce maps of water-column and benthic habitats

Catch rate data from fisheries-independent monitoring and the shrimp fishery were used to fit suitability index functions across environmental gradients

The abundance-based indices were linked to grid-based habitat layers in the GIS. The geometric-mean algorithm was used to spatially average the indices to produce predicted HSM maps.

The research has been used to spatially predict the spatial distributions and relative abundance of fish and invertebrate species in estuaries and pink shrimp on the west Florida Shelf.