IDENTIFYING OPTIMAL SITES TO IMPLEMENT OYSTER REEF RESTORATION IN THE CHARLOTTE HARBOR ESTUARY USING A COUPLED BIOLOGICAL-PHYSICAL TRANSPORT MODEL

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Acknowledgment

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Gregory Tolley
Lesli Haynes
Mike Savarese
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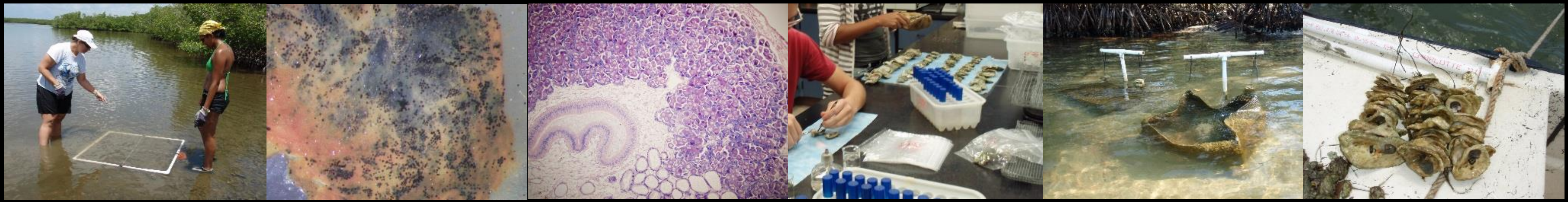
Dozens of FGCU students

Oyster monitoring

monthly survey from 2000 to 2016

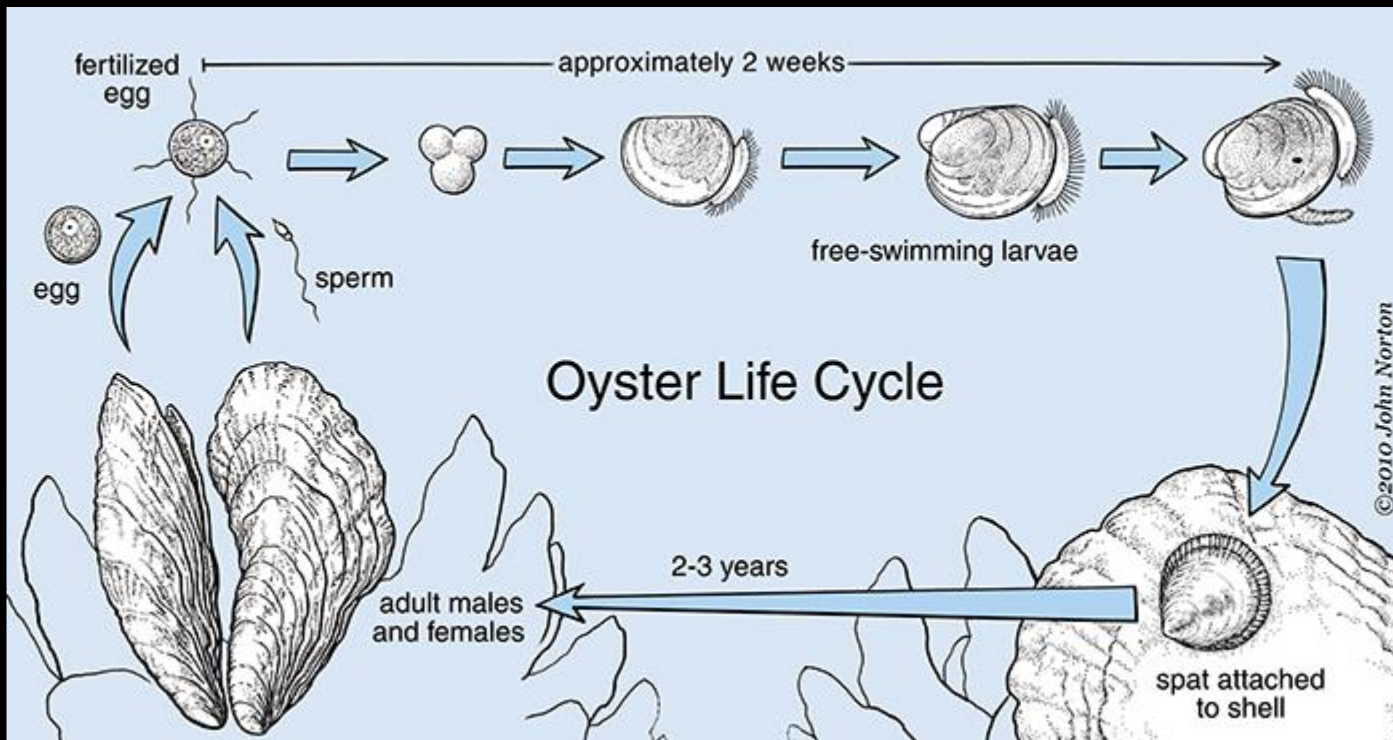
Peppertree point: up to 2011
Cattle Dock: up to 2010
Tarpon Bay: up to 2011

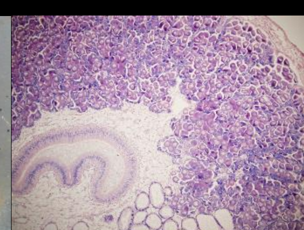
	Parameters	*Frequency*
Water surface	O_2, pH, Salinity, Temperature	Monthly
Oysters – adult 2006 - 2016	Density per m^2	Dry and wet season
Oysters - adult	*Perkinsus* prevalence and intensity	Monthly
Oysters	Gonad index	Monthly
Oysters	Condition index	Monthly
Oysters - spat	Recruitment	Monthly
Oysters – juvenile 2008 - 2016	Growth and survival	Monthly



Oyster monitoring

Oyster life cycle





Oyster monitoring

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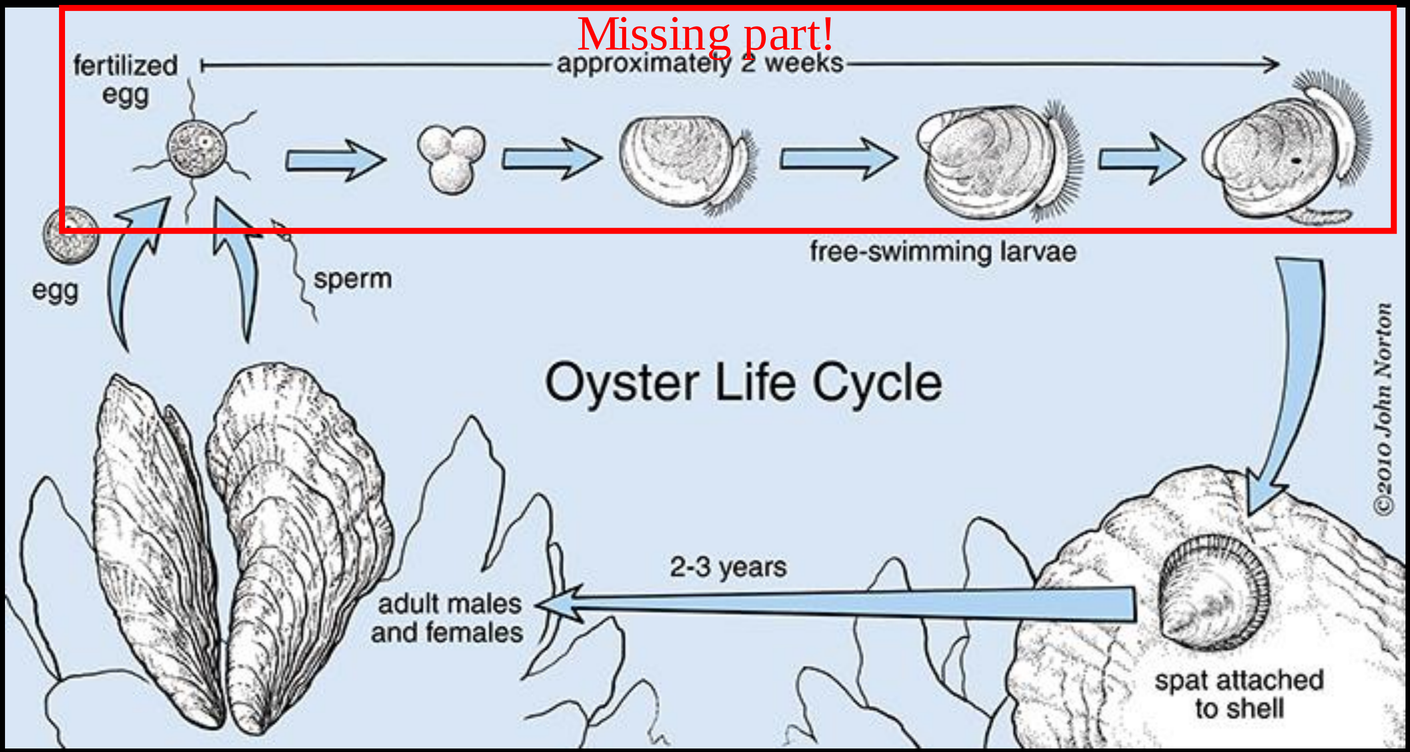

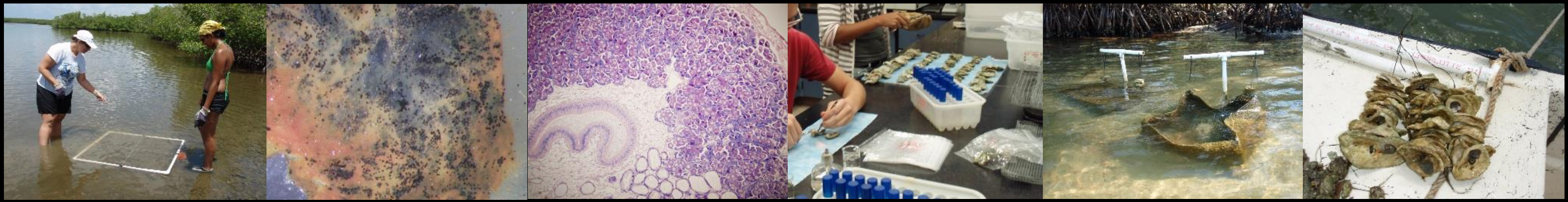

Oyster monitoring

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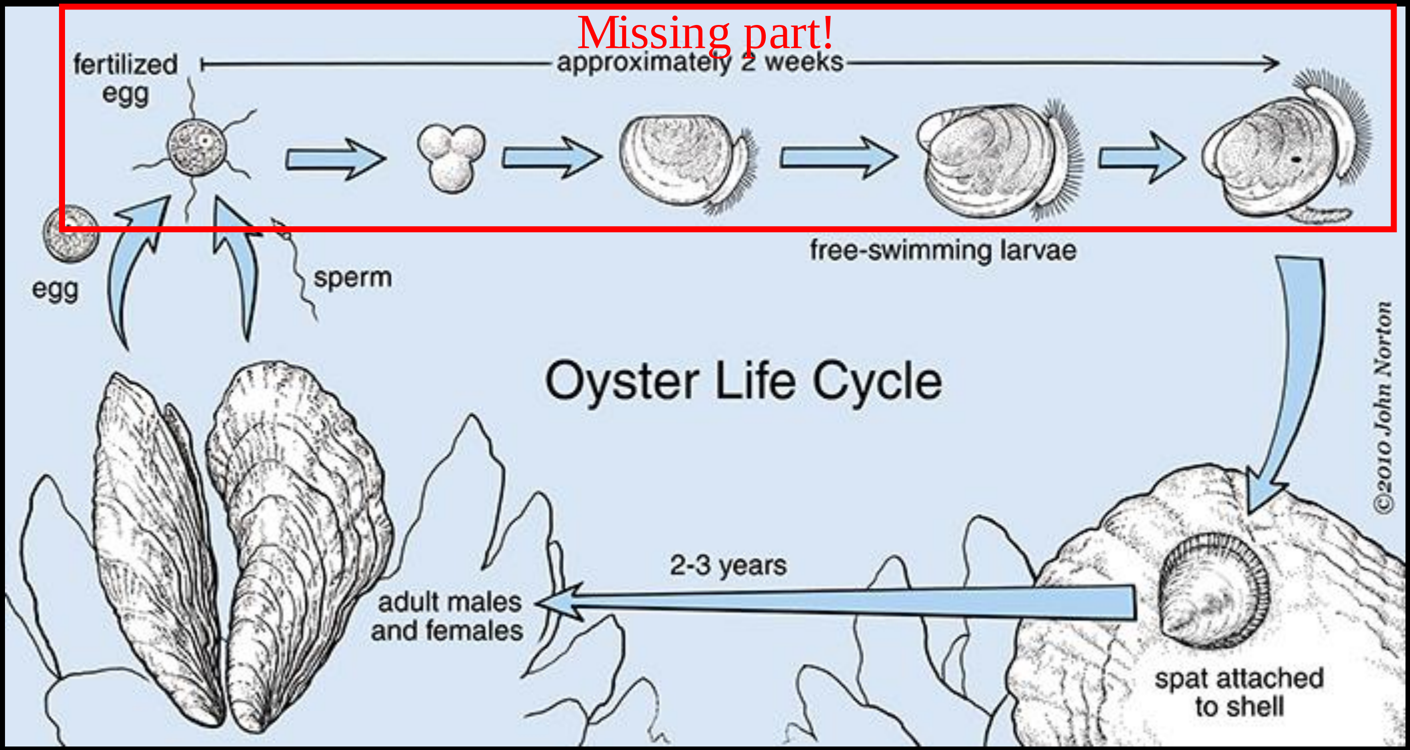


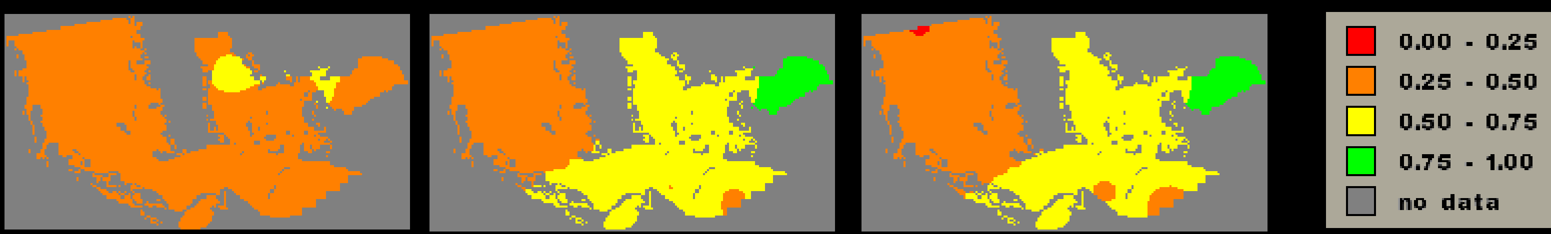
Moreover, water quality data is only once a month. We need to improve our spatio-temporal understanding of the system.

Oyster reef restoration

Oyster reef restoration

based on habitat suitability index (HSI)

Wet year Normal year Dry year HSI values



Less suitable

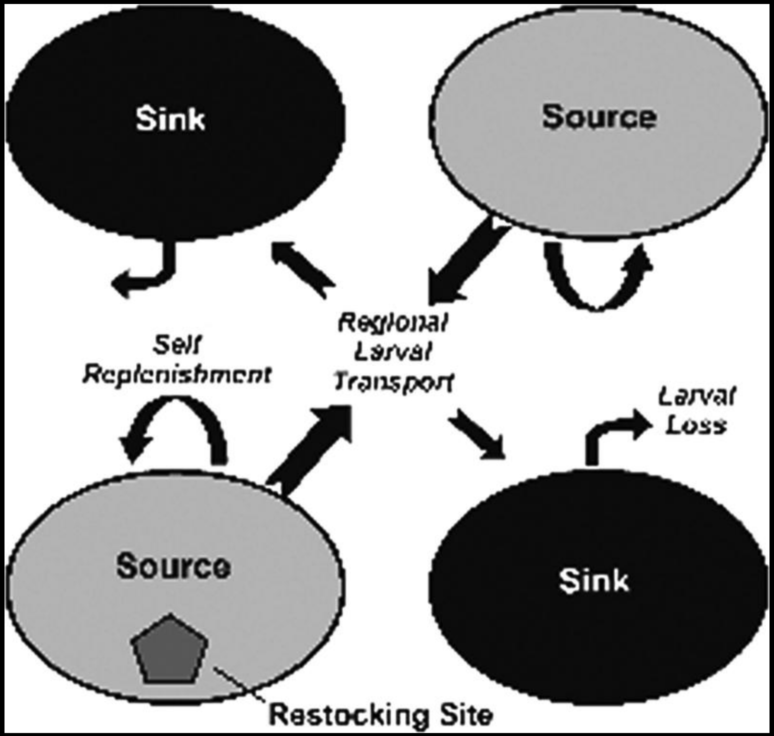
More suitable

Salinity, temperature, substrate and high flow frequency have been chosen as particular requirements for determining habitat suitability for the eastern oyster in the Caloosahatchee estuary.

Barnes *et al*., 2007

Oyster reef restoration

Importance of metapopulation connectivity



Lipcius *et al*., 2008

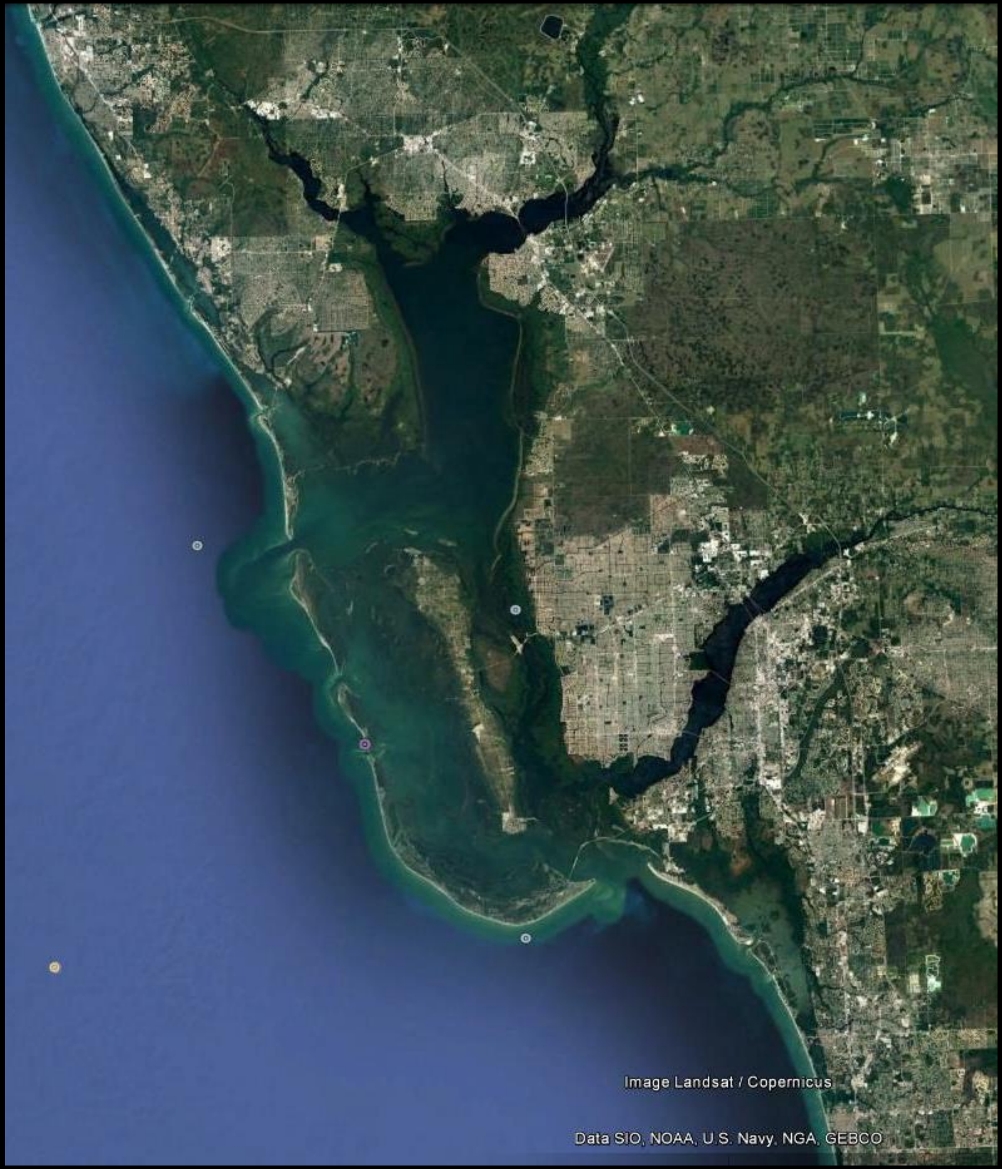
The lack of spatially explicit knowledge of larval dispersal and source-sink metapopulation relationships has been a fundamental obstacle to establishing restoration strategies for exploited marine population in many estuarine systems. Failure to investigate metapopulation dynamics can doom restocking programs for marine species.

Estero Bay hydrodynamic model

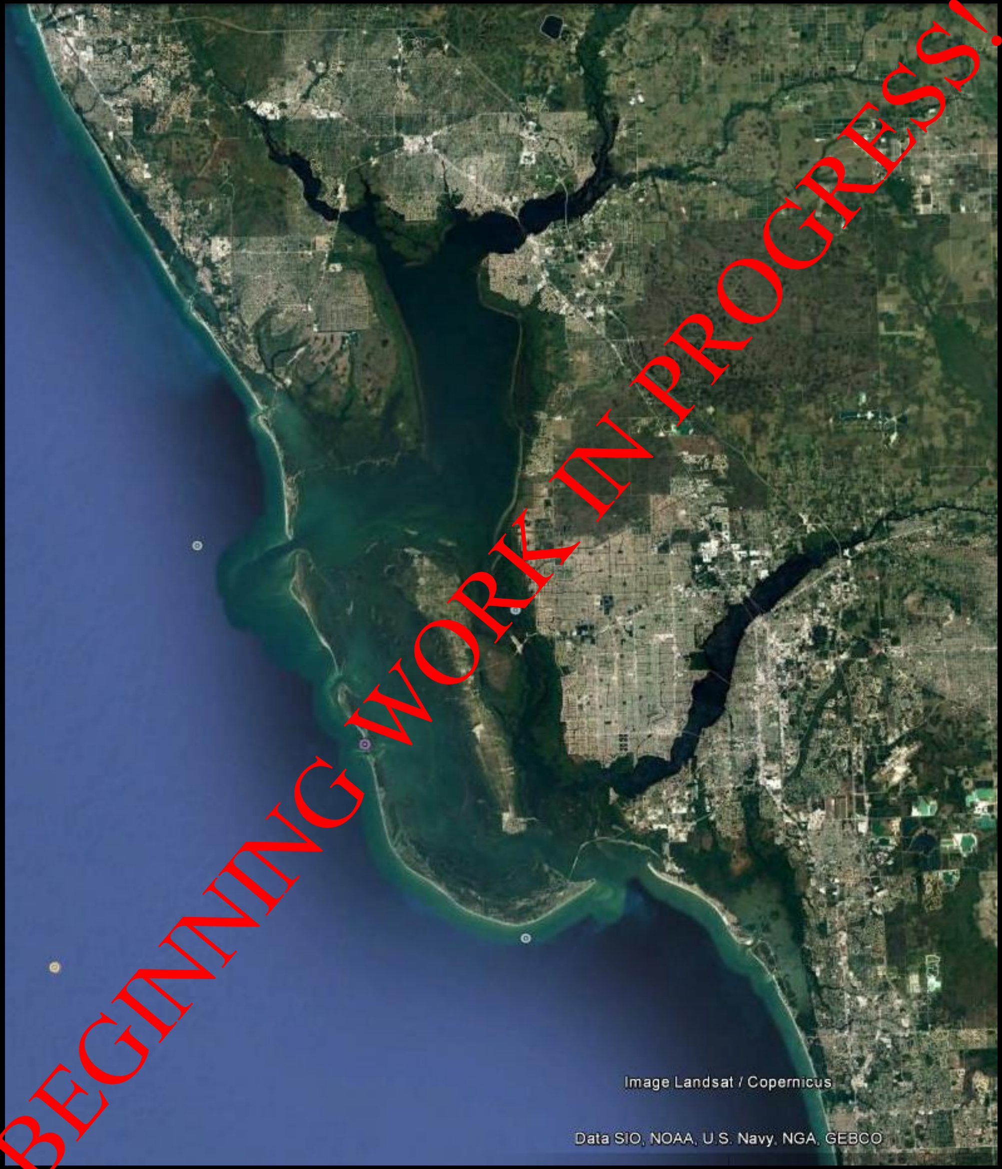
Felix Jose

If predictable pathways of larval dispersal can be established then this information can be used to ensure sustainable local populations by ensuring a supply of recruits. Recognizing the potential importance of both physical transport and biological movement, a coupled biological-physical model can be a useful tool to investigate larval dispersal and source-sink metapopulation relationships (Kim *et al.*, 2013)

Charlotte Harbor Estuary



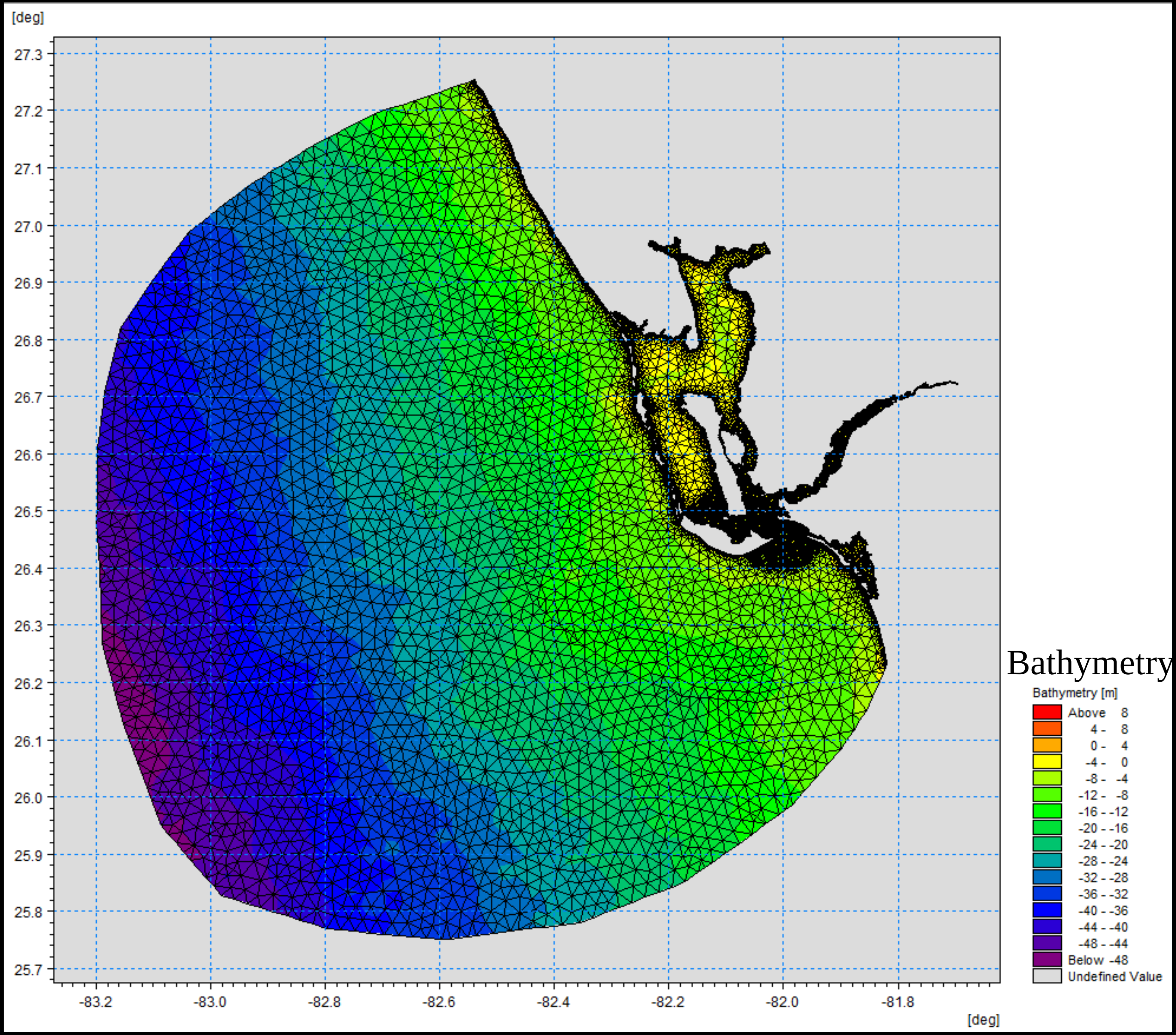
Charlotte Harbor Estuary



BEGINNING WORK IN PROGRESS!

Charlotte Harbor Estuary

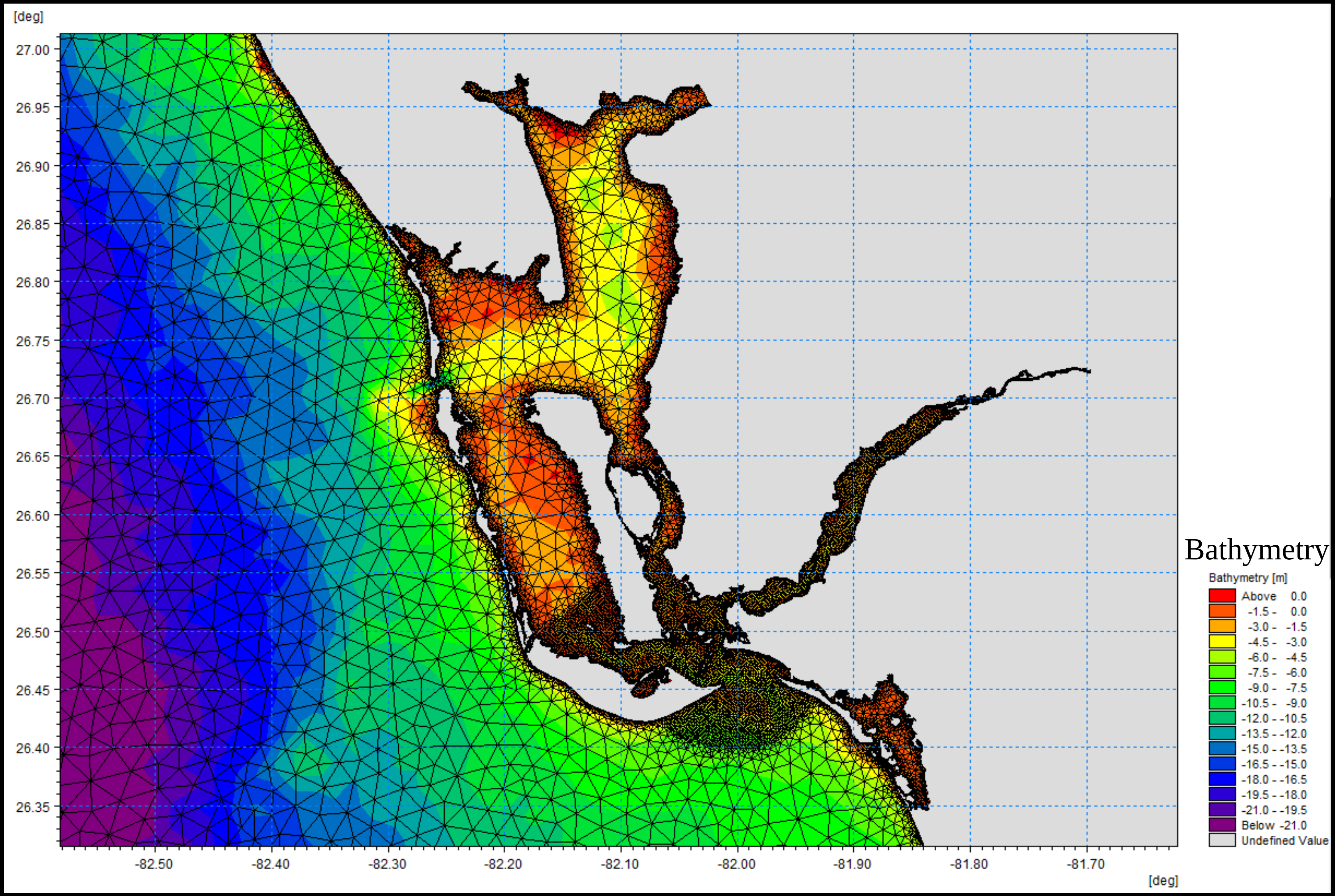
3D Hydrodynamic model



Model forces: Wind, tide and freshwater discharge (in the near future: temperature and salinity)

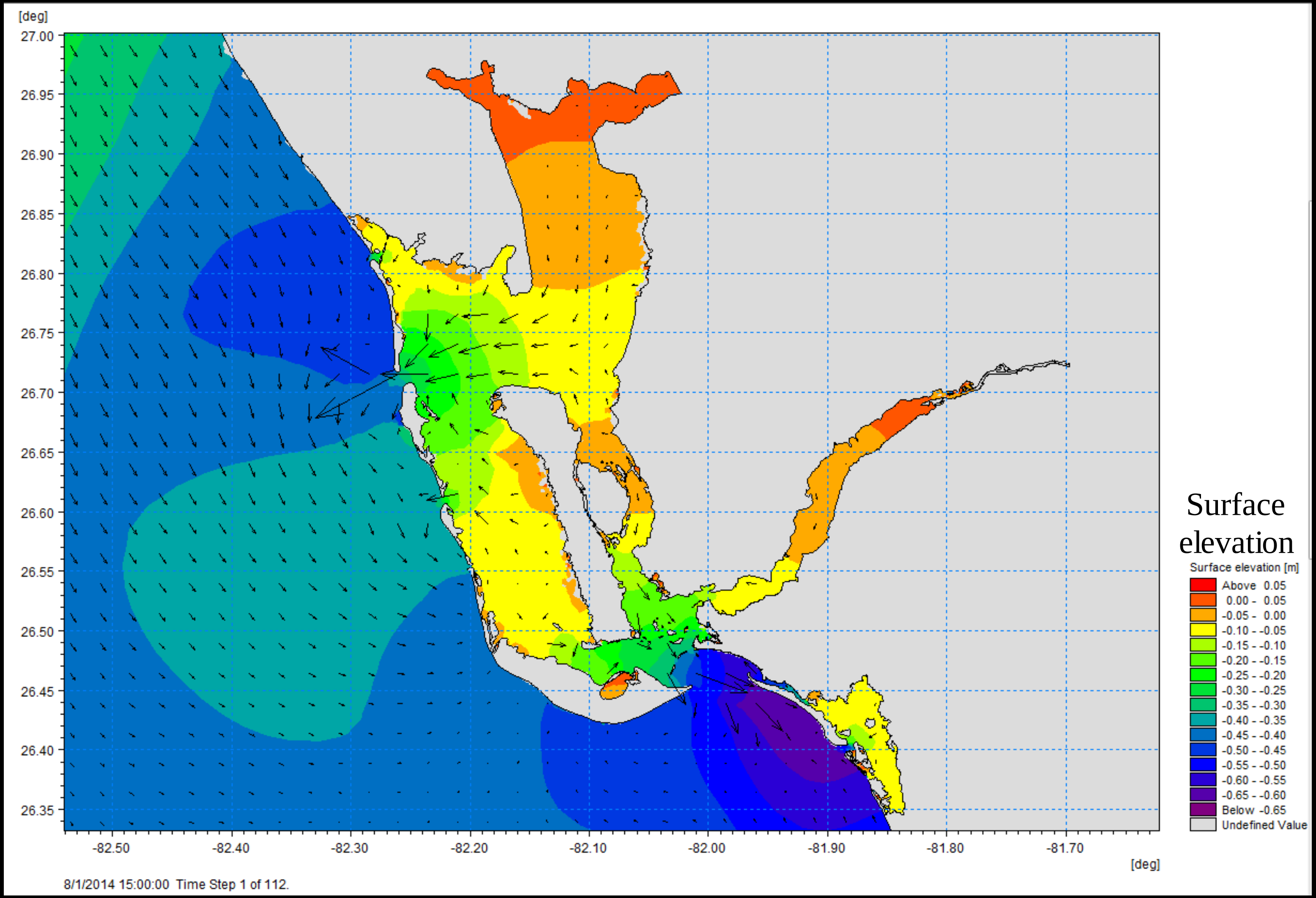
Charlotte Harbor Estuary

3D Hydrodynamic model



Charlotte Harbor Estuary

Tidal flow pattern during an ebbing phase



Charlotte Harbor Estuary

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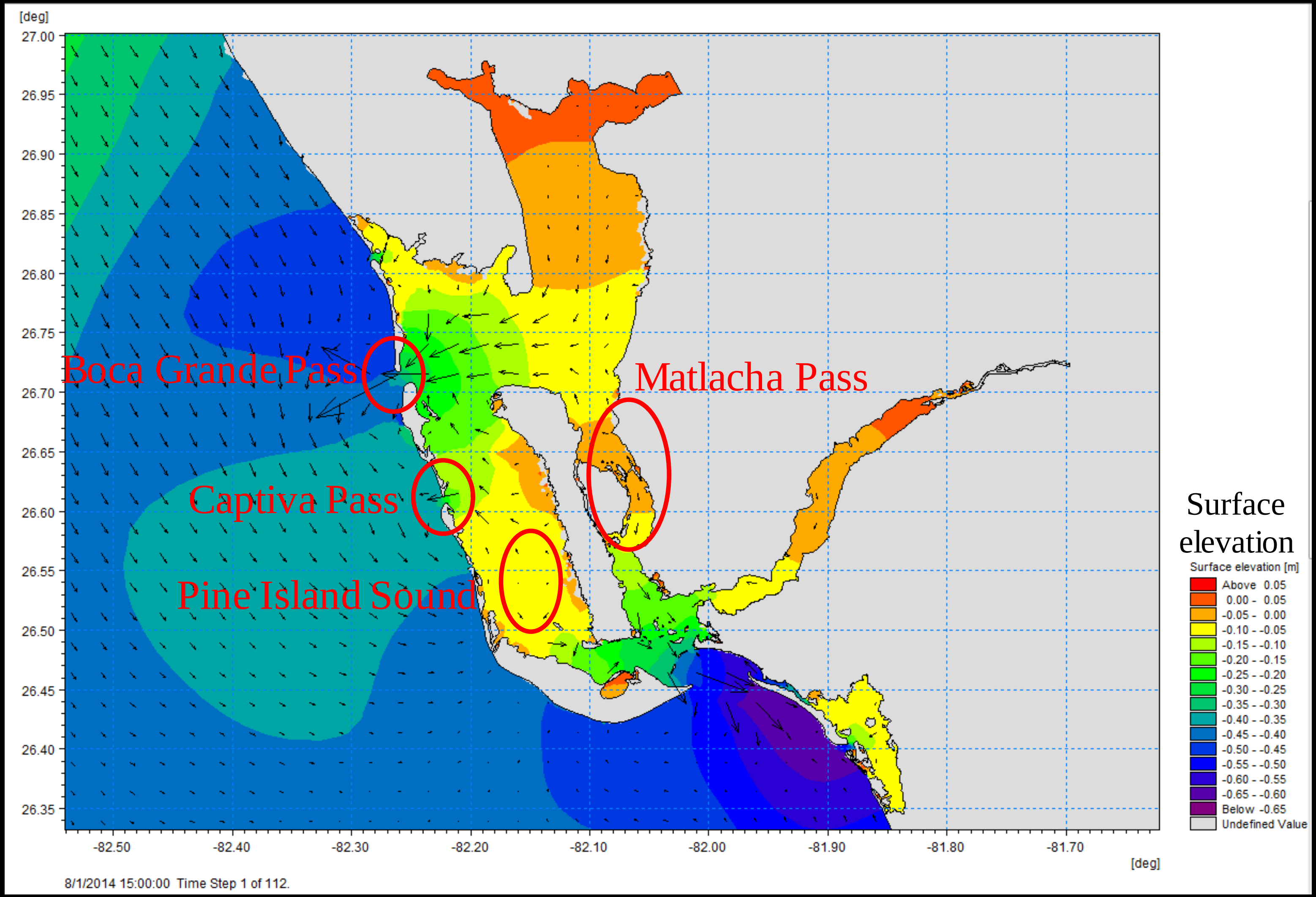
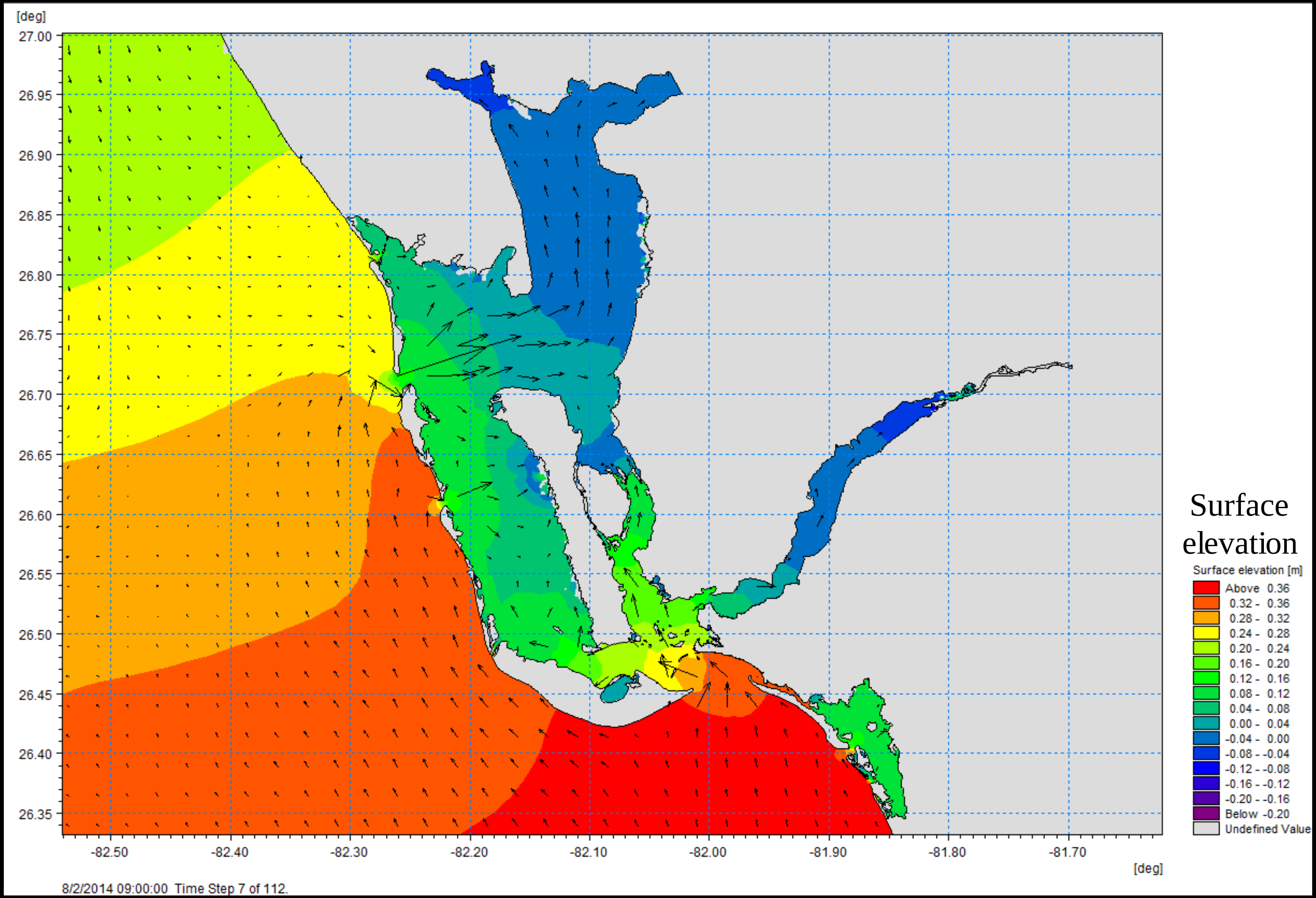


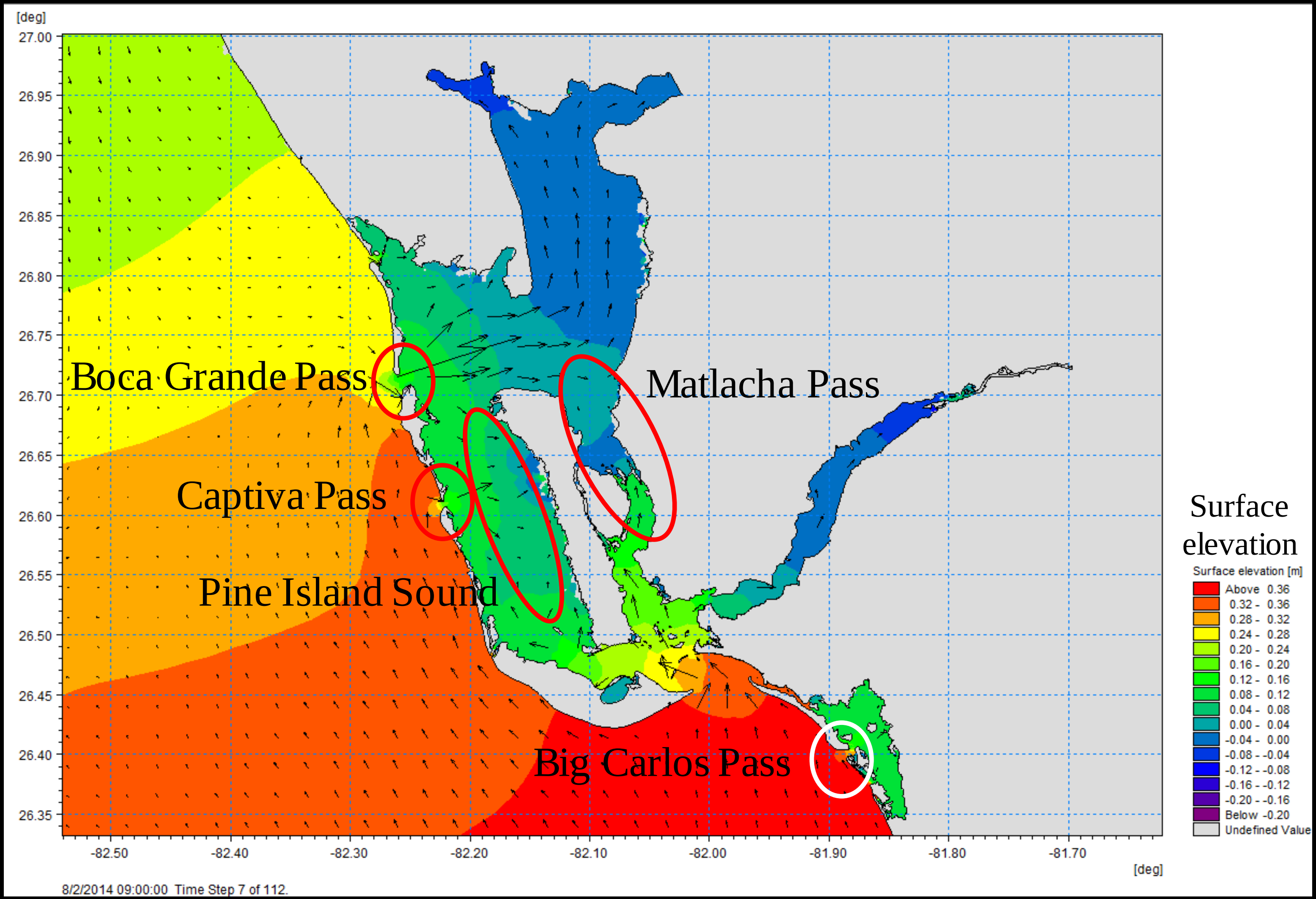
Charlotte Harbor Estuary

Tidal flow pattern during a flooding phase



Charlotte Harbor Estuary

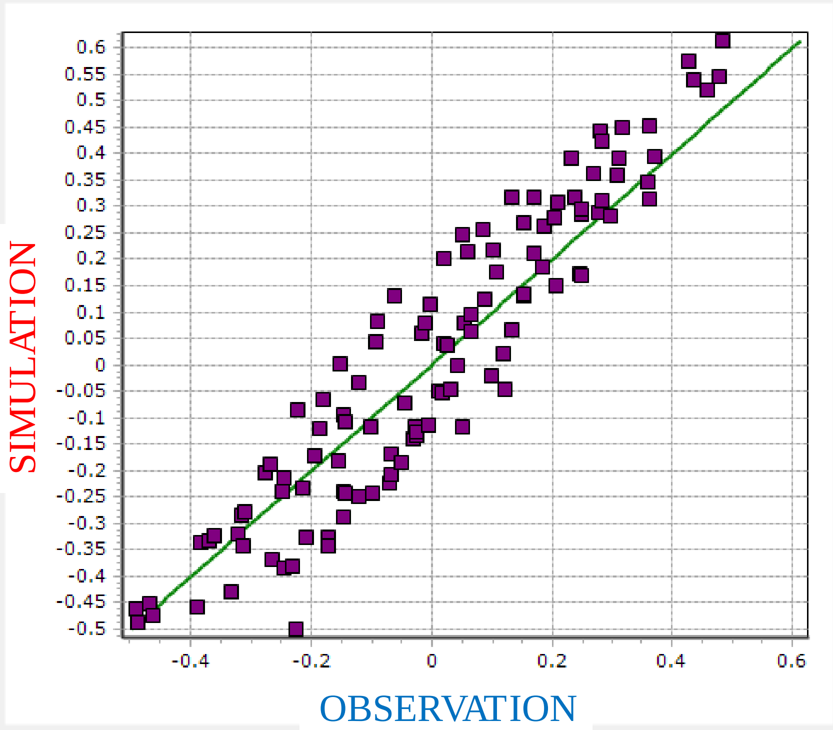
Tidal flow pattern during a flooding phase



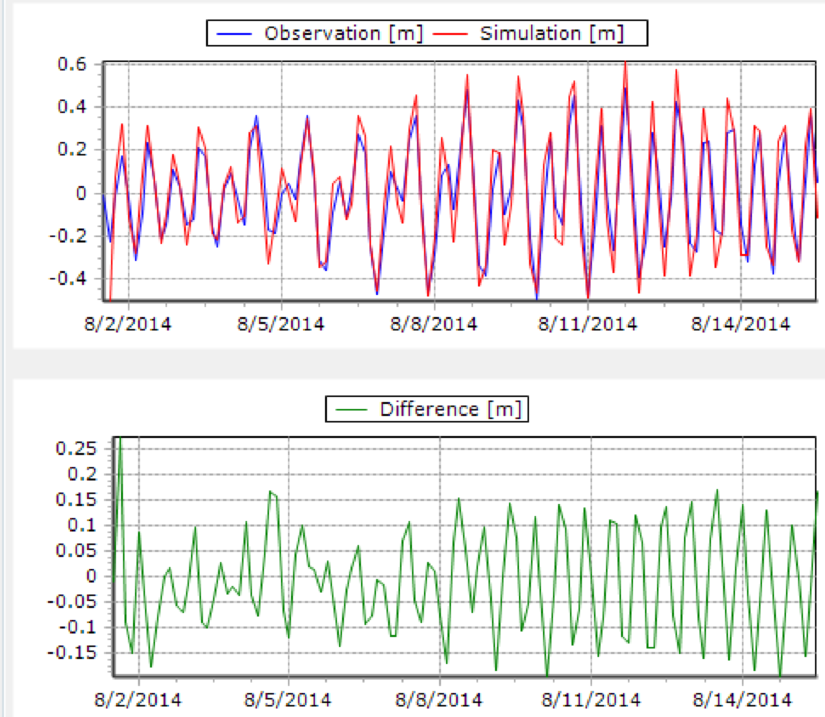
Charlotte Harbor Estuary

Model validation: Big Carlos Pass correlation

Scatter Plot



Time Series Plots



Performance Measures

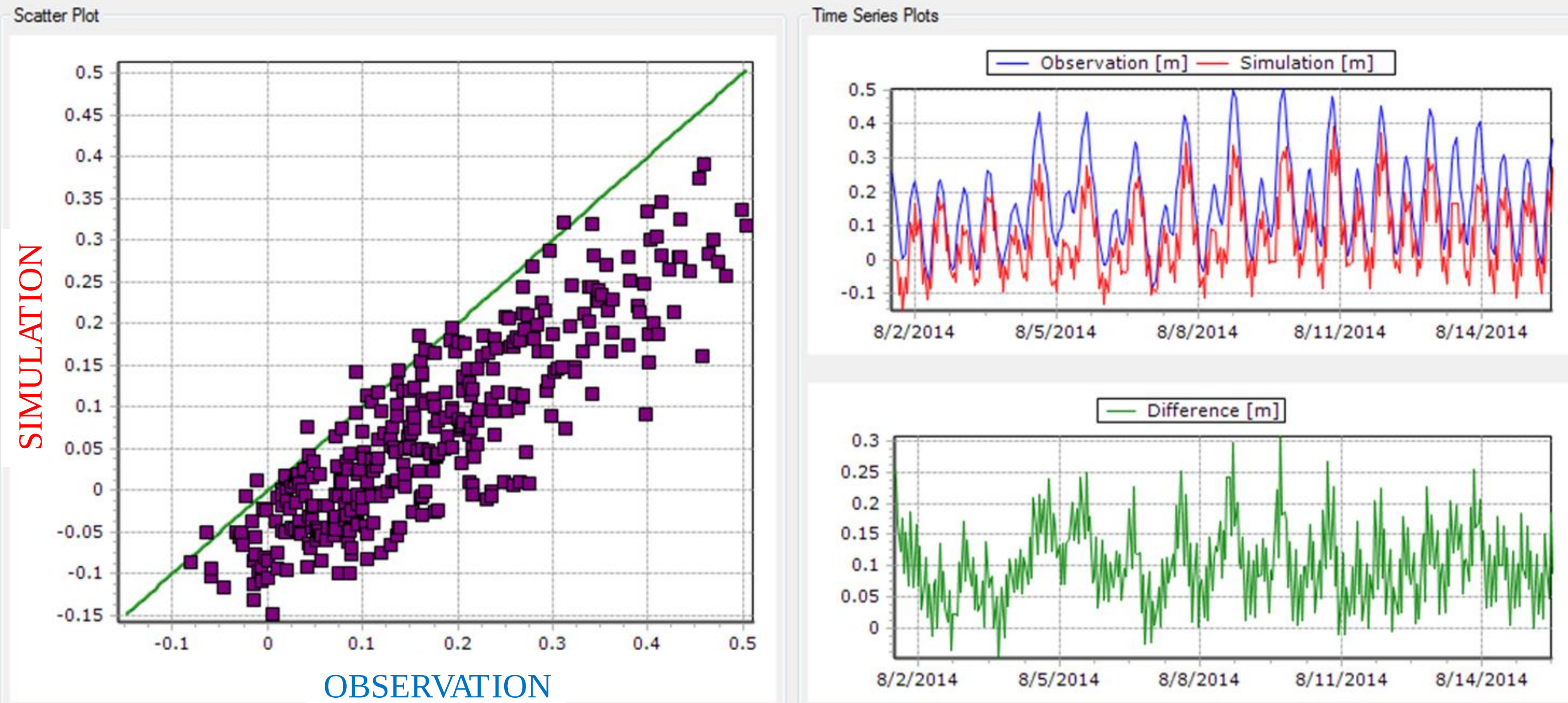
Indice	Value	Unit
Mean Error	-0.0094	[m]
Mean Absolute Error	0.0844	[m]
Root Mean Square Error	0.1013	[m]
Std. dev of Residuals	0.1008	[m]
Coefficient of Determination	0.8797	[-]
Coefficient of Efficiency	0.8687	[-]
Index of Agreement	0.9601	[-]

Statistics

	Observation	Simulation	Difference
Item Name	Water Level	Bif carlos: Surface ...	Difference
Item Unit	[m]	[m]	[m]
Minimum	-0.4910	-0.5001	-0.1955
Maximum	0.4840	0.6134	0.2731
Average	0.0031	0.0125	-0.0094
Std. deviation	0.2343	0.2794	0.1008

Charlotte Harbor Estuary

Model validation: Caloosahatchee River correlation



Performance Measures

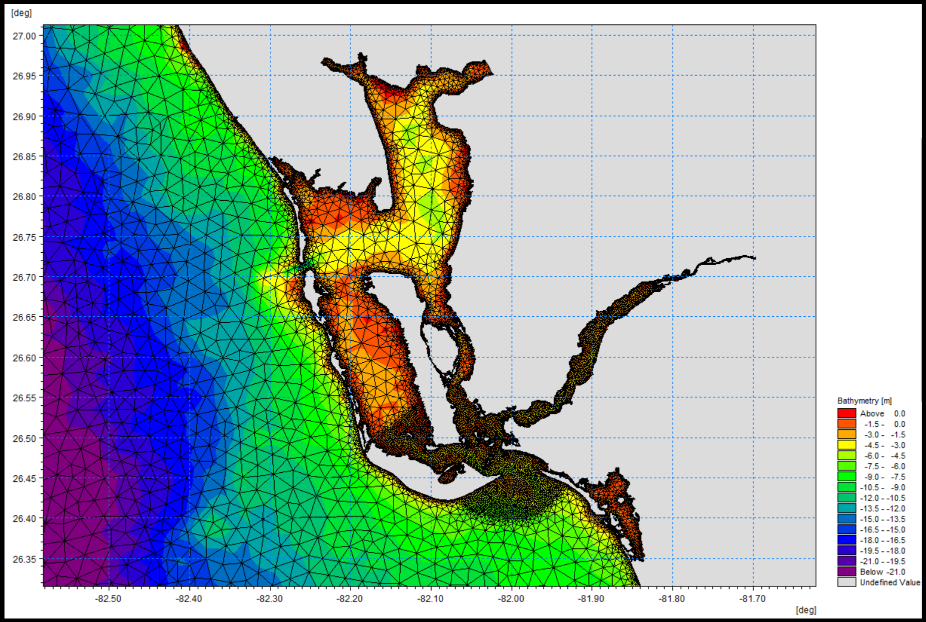
Indice	Value	Unit
Mean Error	0.1023	[m]
Mean Absolute Error	0.1034	[m]
Root Mean Square Error	0.1209	[m]
Std. dev of Residuals	0.0644	[m]
Coefficient of Determination	0.7500	[-]
Coefficient of Efficiency	-0.1613	[-]
Index of Agreement	0.7887	[-]

Statistics

	Observation	Simulation	Difference
Item Name	Water Level	River: Surface elev...	Difference
Item Unit	[m]	[m]	[m]
Minimum	-0.0800	-0.1487	-0.0483
Maximum	0.5040	0.3914	0.3072
Average	0.1723	0.0701	0.1023
Std. deviation	0.1289	0.1122	0.0644

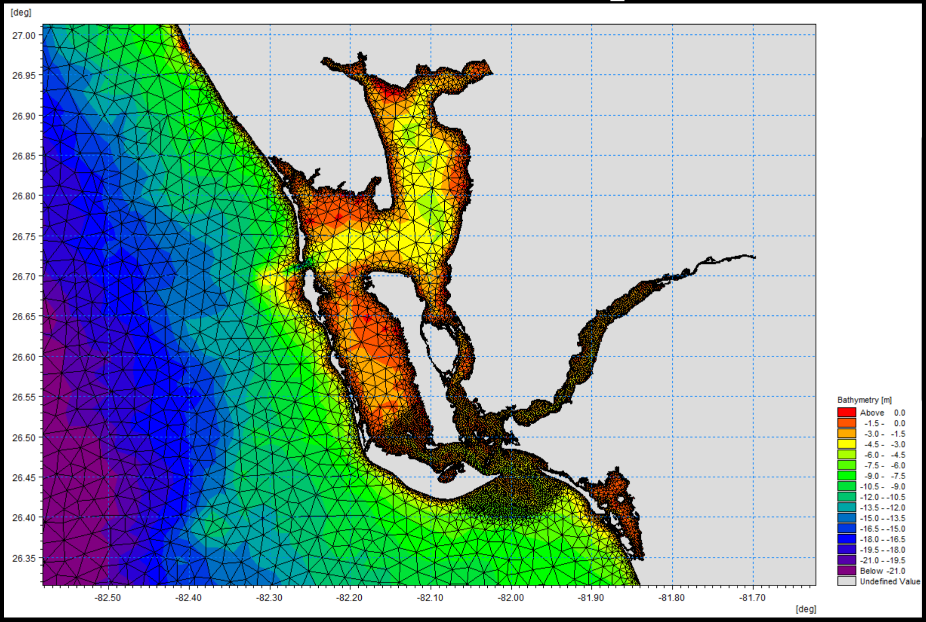
What next?

- Add the temperature, salinity and bottom friction as forces
- Add oxygen and chlorophyll
- Couple this model to a larval transport model
- Simulate different scenarios
- Validation of the larval transport model



What can we do with the model?

- It will improve our understanding of the spatio-temporal variations of the system and help us to understand those variations
- It can guide decision making for oyster reef restoration plans
- Results of the model will aid identifying optimal locations for building oyster reefs to achieve sustained recruitment success for the oysters
- It can be used to predict the impacts of environmental changes on oyster larval dispersal as well as on the health of the oyster reefs
- The model can be tweaked for other species



Thanks for your attention!

Any questions?

The art of seduction in the rain: the tactics of the oyster