

# Biscayne National Park

## *South Florida Natural Resources Center*

National Park Service  
U.S. Department of the Interior



### AN IMPROVED BISCAYNE BAY HYDRODYNAMIC MODEL FOR EVALUATION OF RESTORATION EFFORTS AND GROUNDWATER FLOW ON SALINITY

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National Park Service  
Homestead, FL

Tuesday, April 20<sup>th</sup> @ 4:45 pm, session 14  
Contact: [Erik\\_Stabenau@nps.gov](mailto:Erik_Stabenau@nps.gov) or 305-224-4209



## Overview

- Physical setting and hydrodynamic modeling updates
- Evaluation of BBSM v.4
- Uses and next steps



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# The Model

- Model developed by John Wang and others at the University of Miami
- Used in various forms since late 70's.
- General name = CAFE3D
  - Current implementation is single layer
  - Fortran
- Model has been used in Biscayne Bay to:
  - determine residence times for various locations in the bay
  - evaluate the effect of restoration alternatives with respect to salinity
  - investigate connectivity between basins

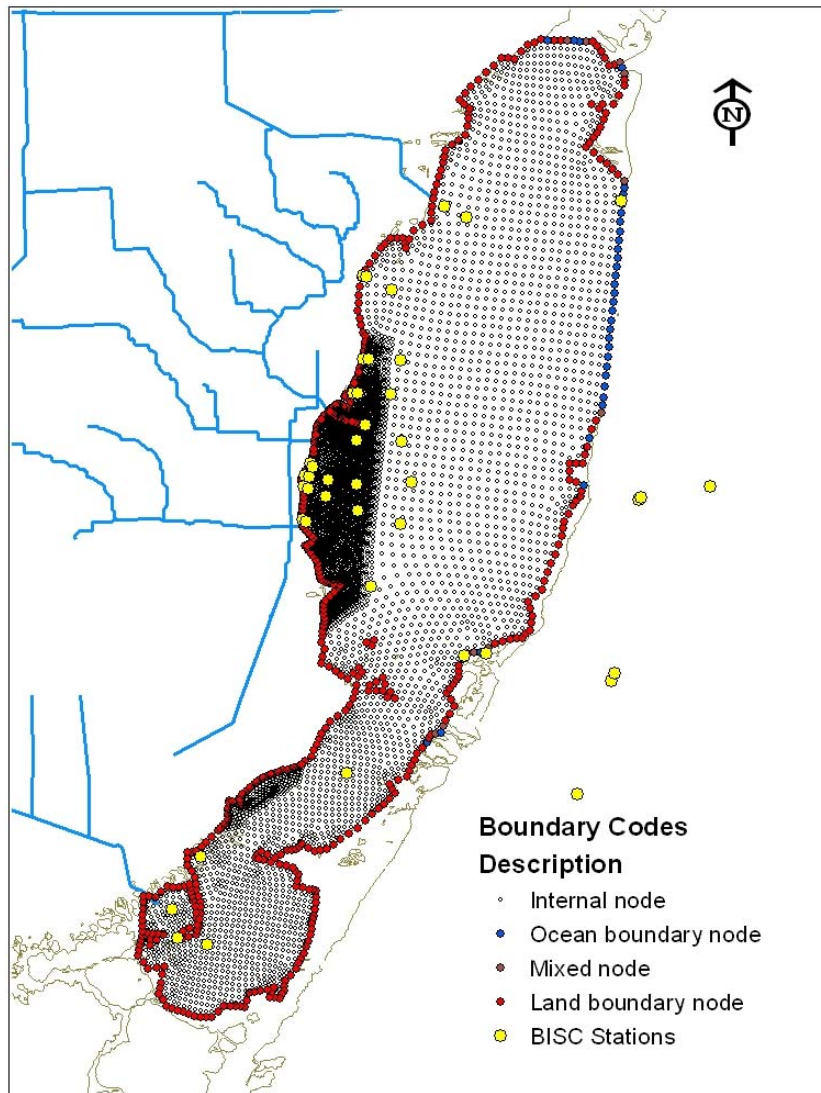


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# Biscayne Bay Simulation Model v.3



Predicting salinity regime under alternate discharge scenarios

BBSM model with:

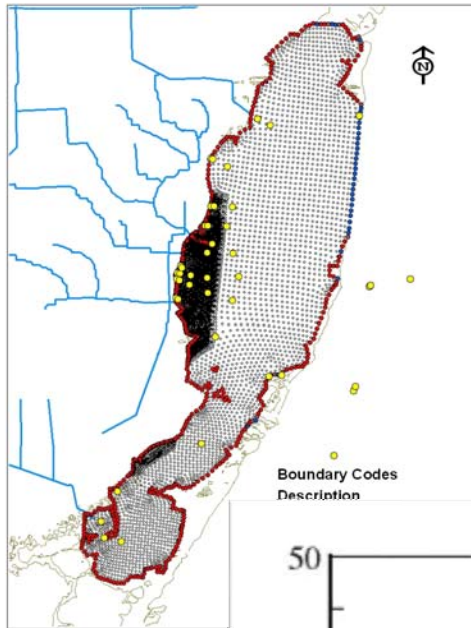
- Advection and diffusion
- Rain and evaporation
- Wind stress
- Bottom friction
- Tidal mixing
- Surface water inflows
- Control on boundary conditions
- 11 years (1996 – 2006) at 20 minute resolution
- Model processing time = 37 hours



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# Biscayne Bay Simulation Model v.3

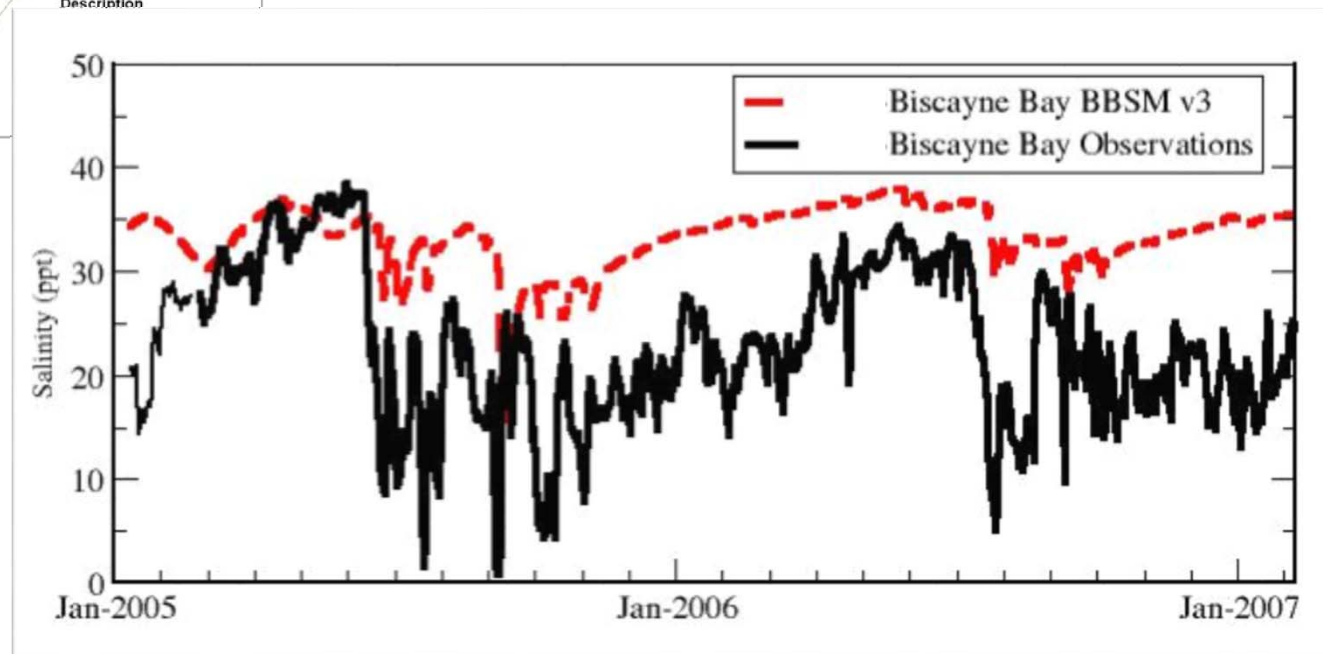


BBSM v3 strengths:

- Salinity mid-bay
- Seasonal aspects of salinity
- Currents are available

BBSM v3 weakness:

- Low variability in salinity nearshore
- Unrealistic representation of groundwater

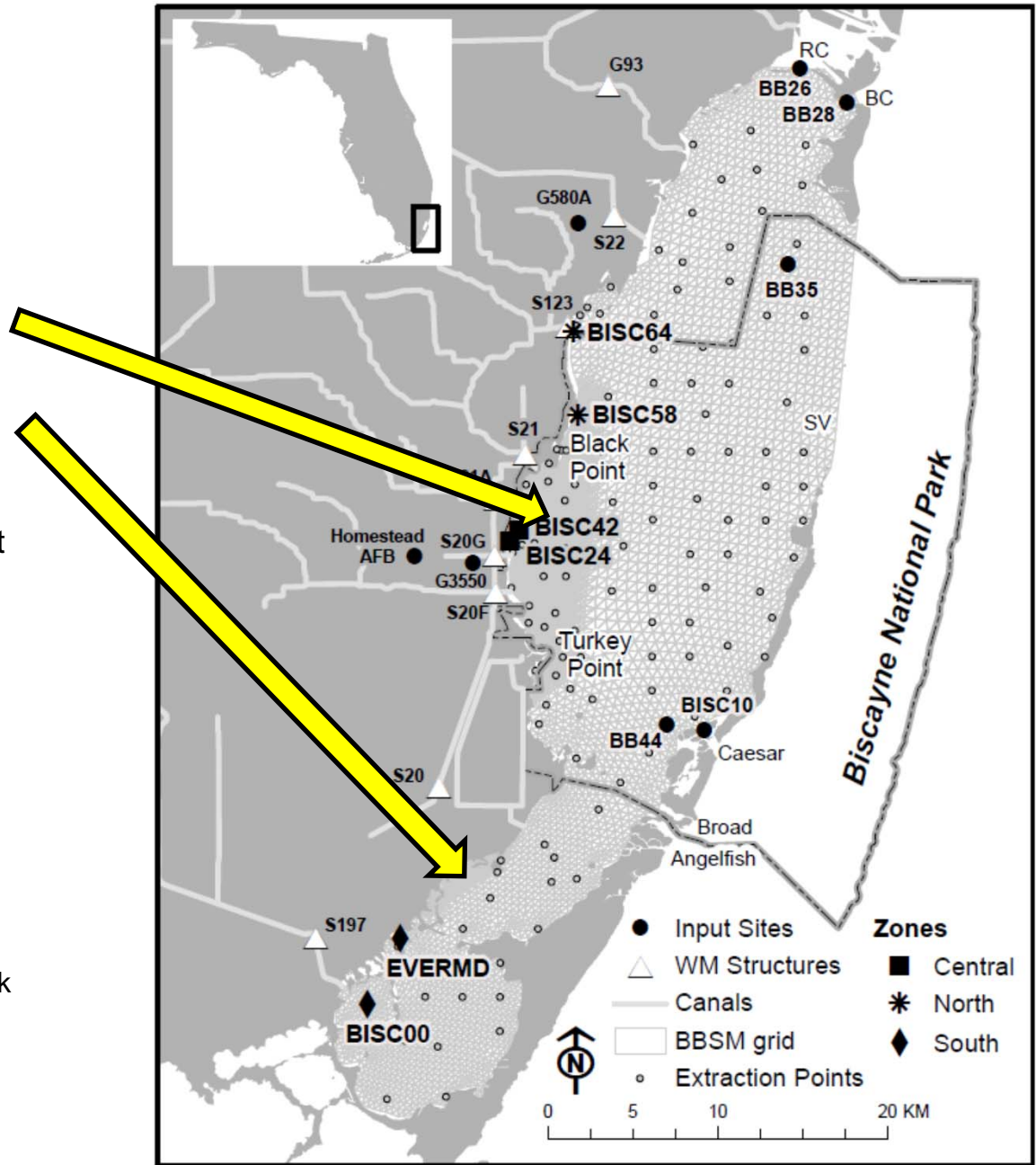


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# Biscayne Bay Simulation Model (BBSM) v.4

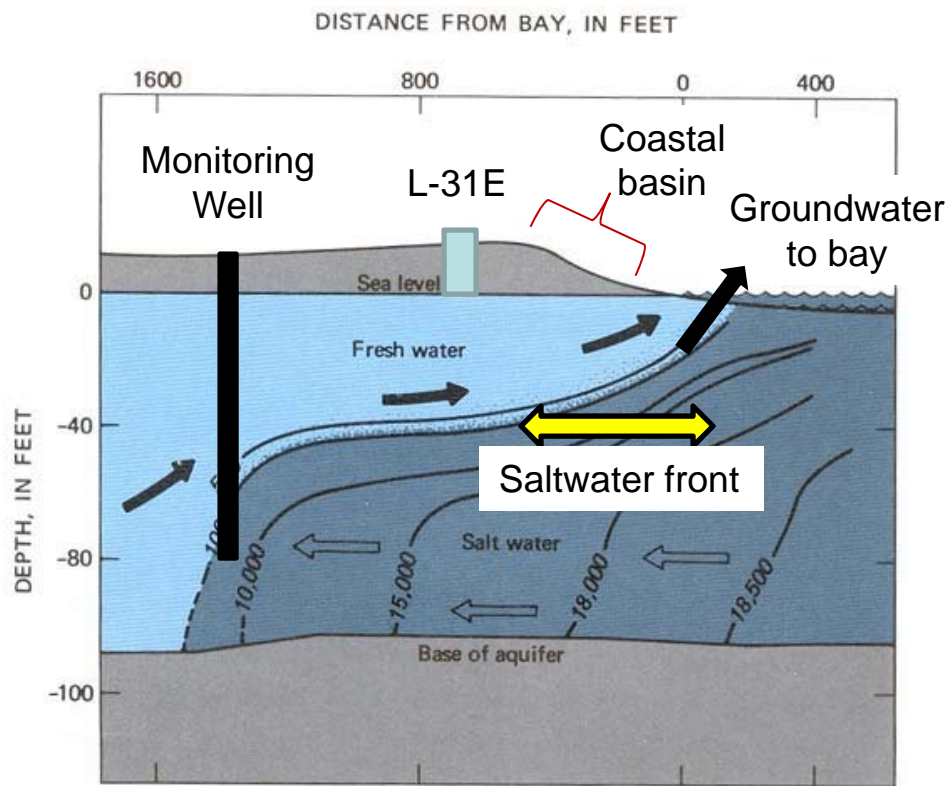
- Maintained grid from v.3
- Updated friction to improve retention of water in shallow areas
- Added surfacewater component for coastal basins
- Added groundwater component based on modeled and measured estimates
- Improved input parameters
  - Daily rain-evaporation
  - Daily salinity on boundary
  - Calculated tides on each creek
  - Updated structure discharge



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# Water management and groundwater connections



- Tidal and seasonal influences on groundwater motion
- Water levels in canals are variable
- Wells west of coastal zone reveal extent of saltwater intrusion
- Low density freshwater floats on top of denser saltwater component
- Precipitation on basin between L-31E and coast flows to bay

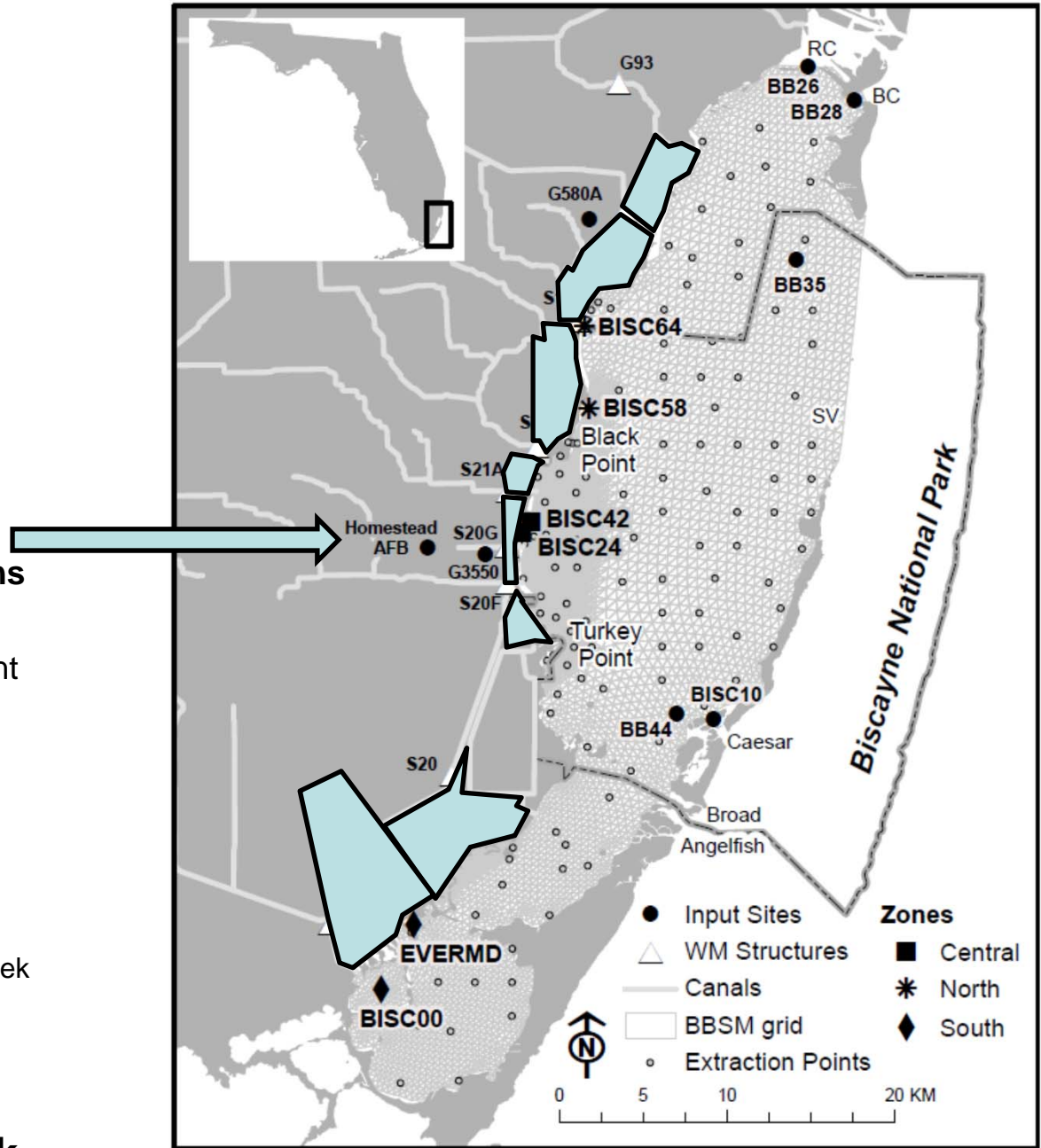


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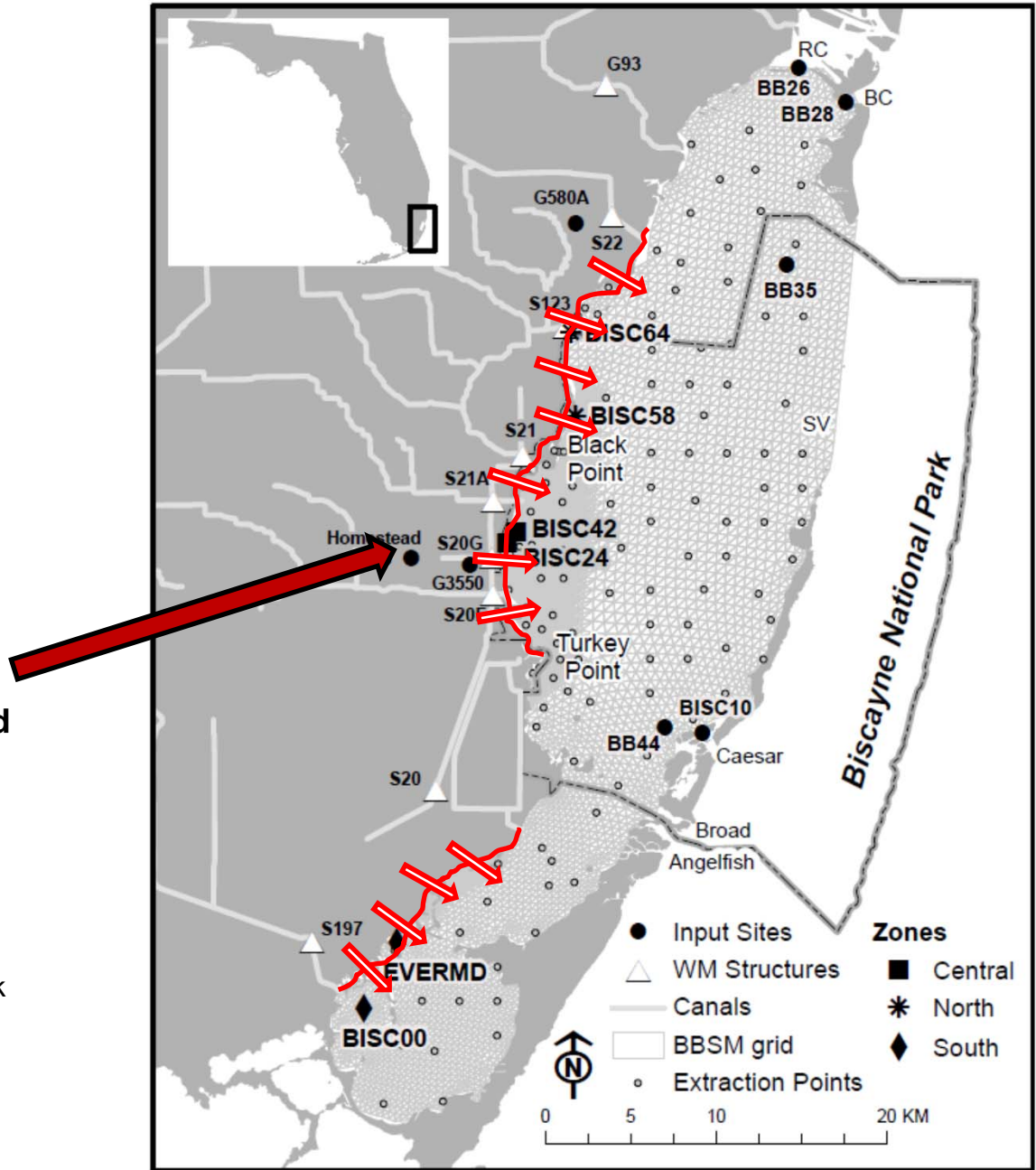
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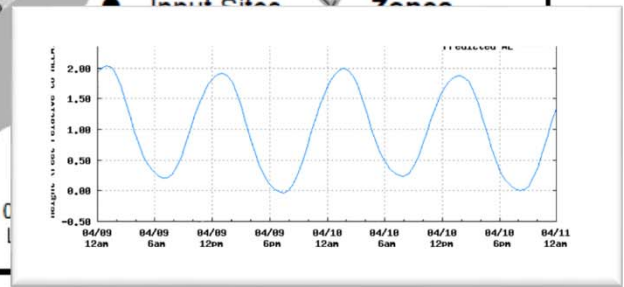
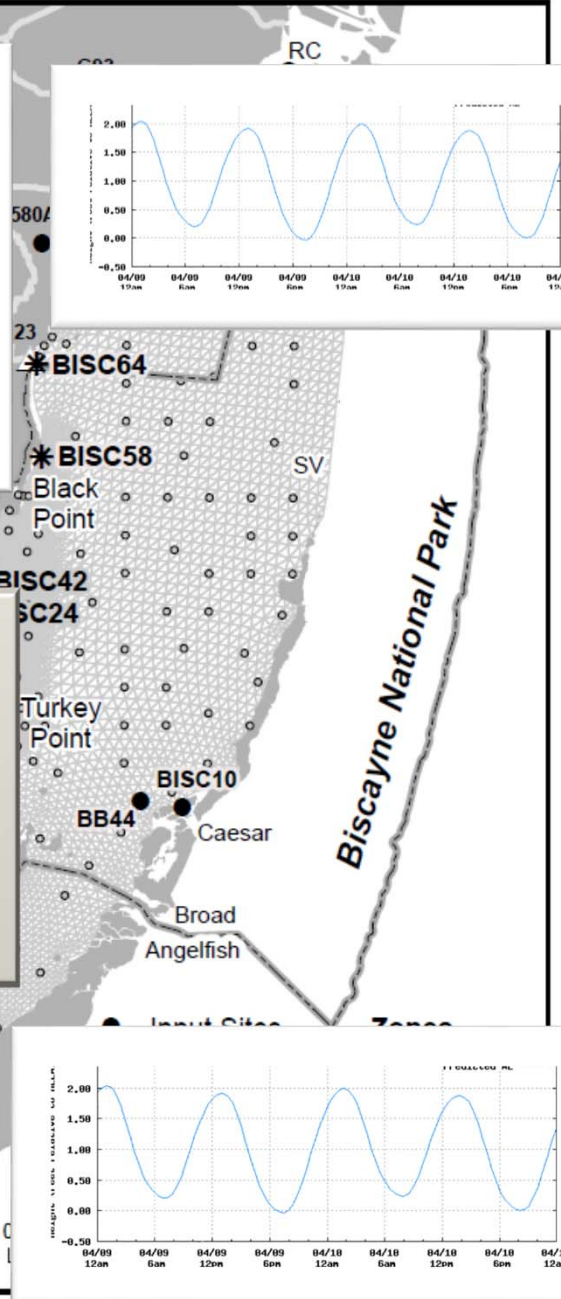
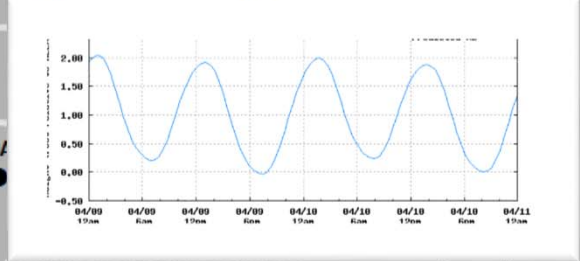


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- **Evaluation of BBSM v.4**
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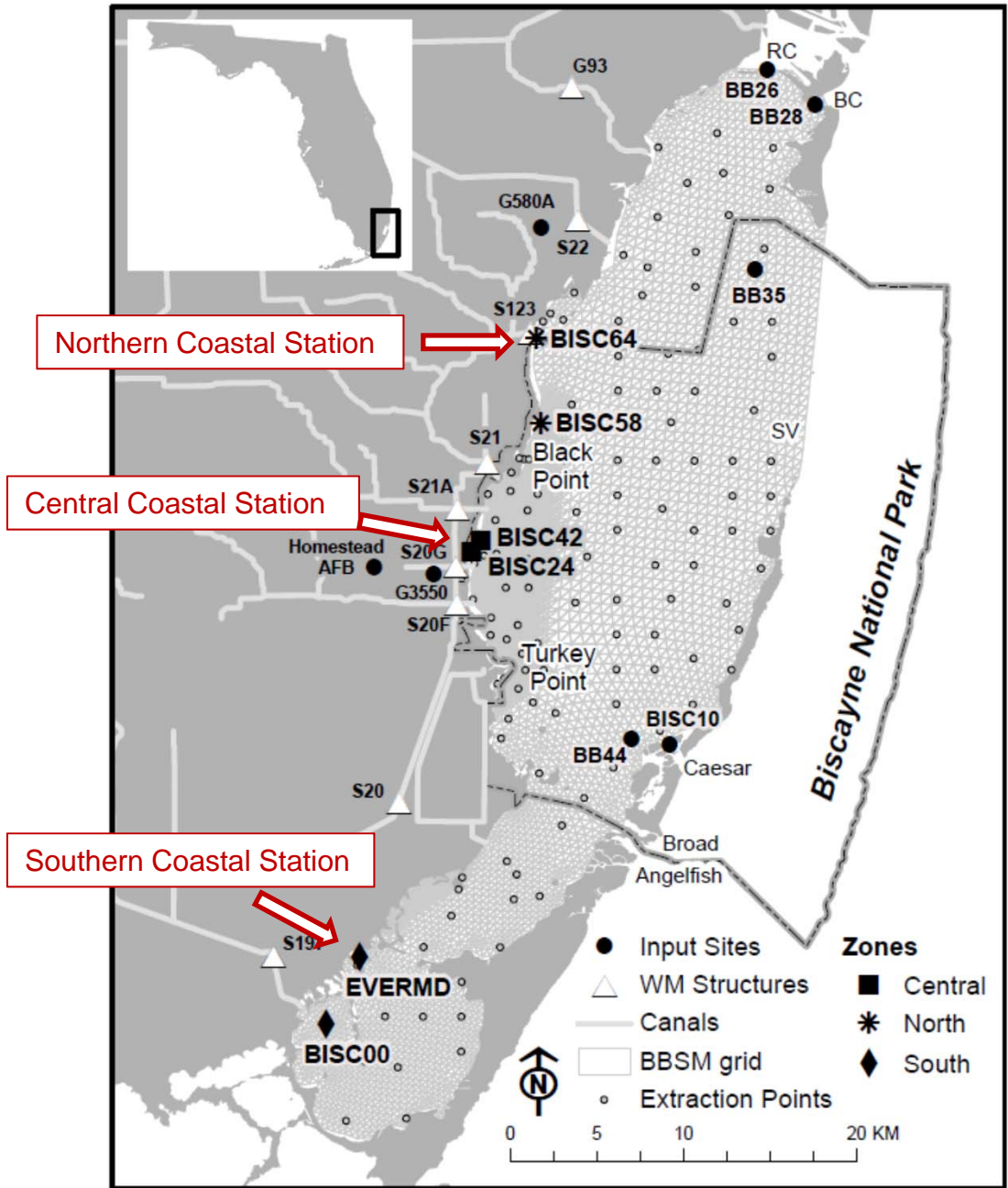
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# Biscayne Bay Simulation Model (BBSM) v.4

Salinity monitoring starts in 2004  
 BBSM v3: 1996 – 2006  
 BBSM v4: 1996 – 2011

## Improved input parameters

- Daily rain-evaporation
- Daily salinity on boundary
- Calculated tides on each creek
- Updated structure discharge

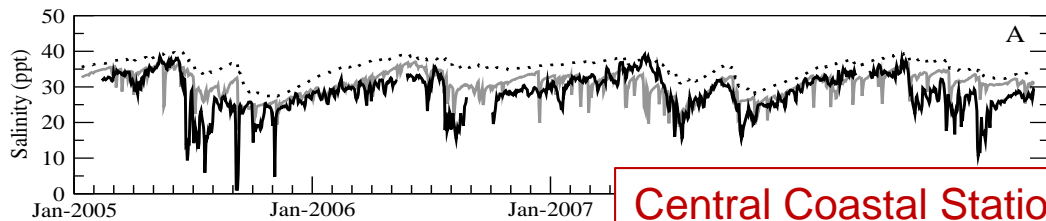


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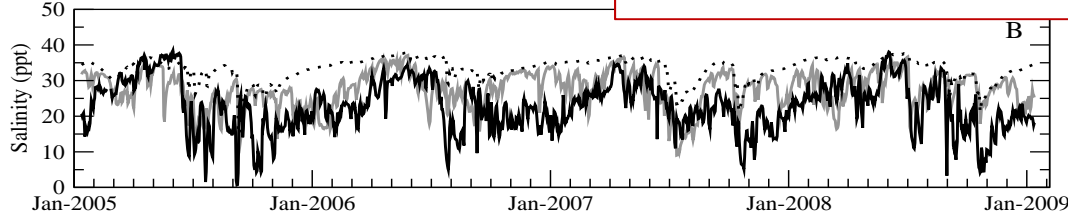
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# Comparison with available salinity data

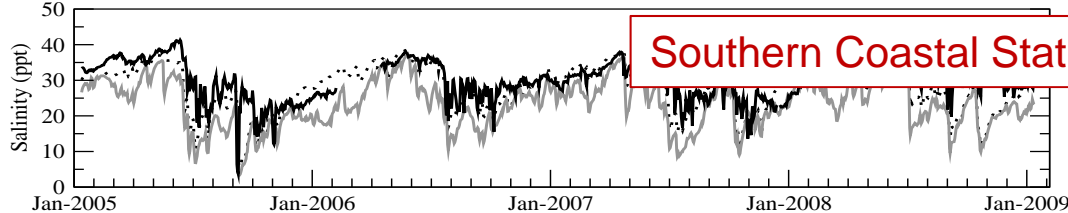
Northern Coastal Station



Central Coastal Station



Southern Coastal Station



- Improved mean and variability
- Maintained seasonality

Salinity monitoring starts in 2004

BBSM v3: 1996 – 2006

BBSM v4: 1996 – 2011

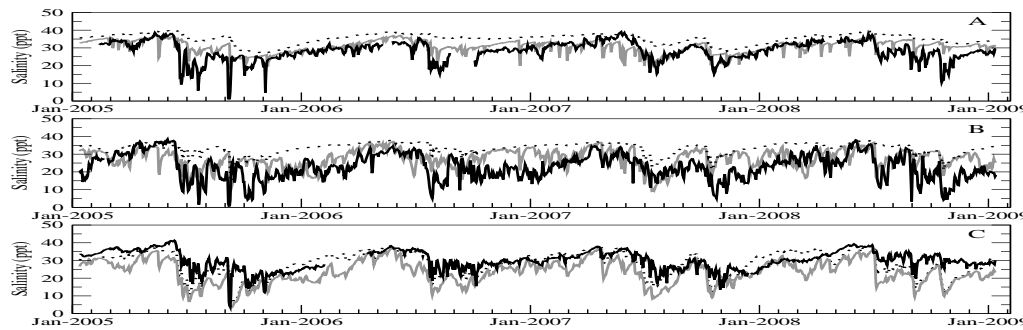


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# Comparison with available salinity data

Dotted – BBSM v3  
Grey – BBSM v4  
Black - Observed



- Improved mean and variability
- Maintained seasonality

Salinity monitoring starts in 2004

BBSM v3: 1996 – 2006

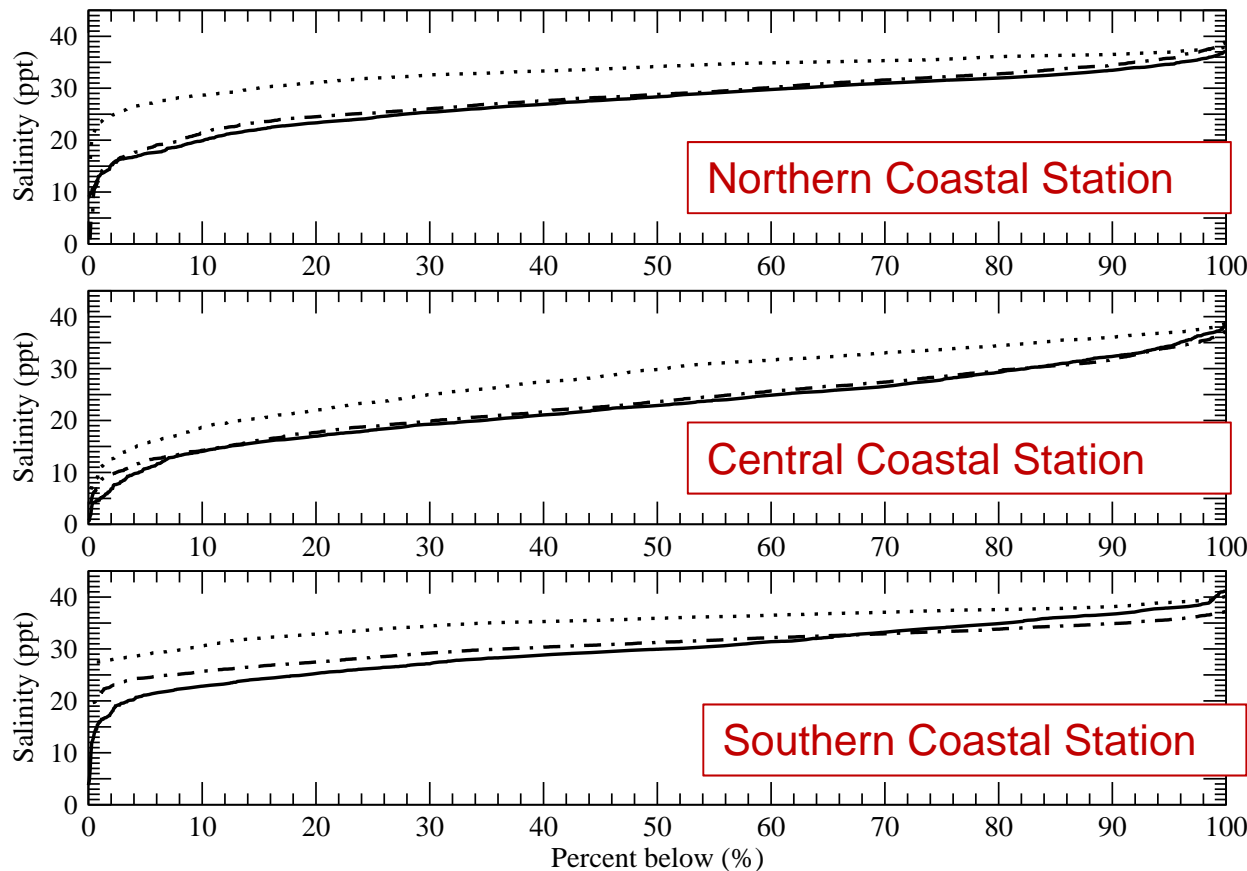
BBSM v4: 1996 – 2011



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# Comparison with available salinity data



- More natural salinity distribution
- Room for improvement in highest flow (lowest salinity) period

Salinity monitoring starts in 2004

BBSM v3: 1996 – 2006

BBSM v4: 1996 – 2011

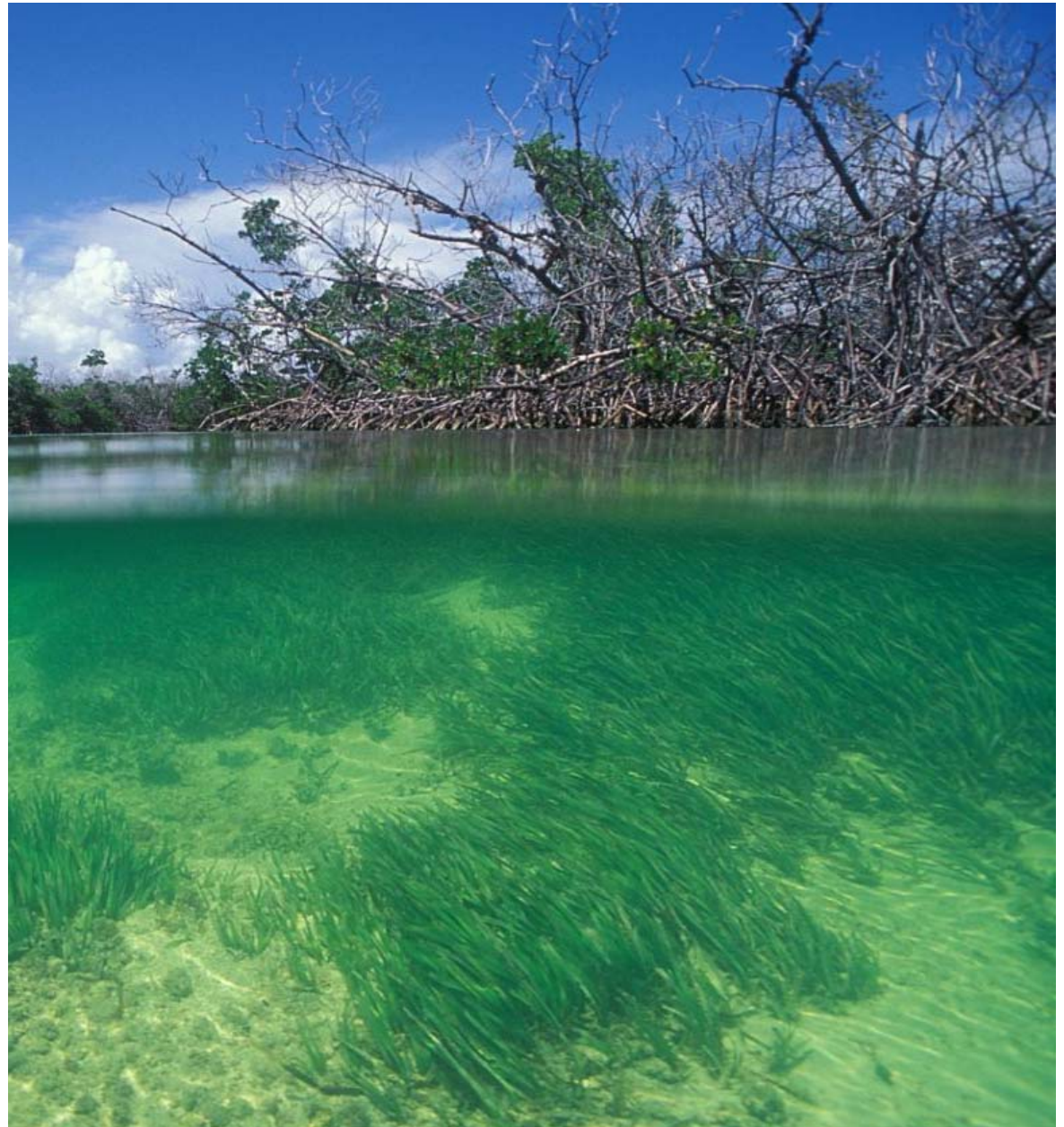


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## Ongoing uses of BBSM v.4

### L31E freshwater withdrawals

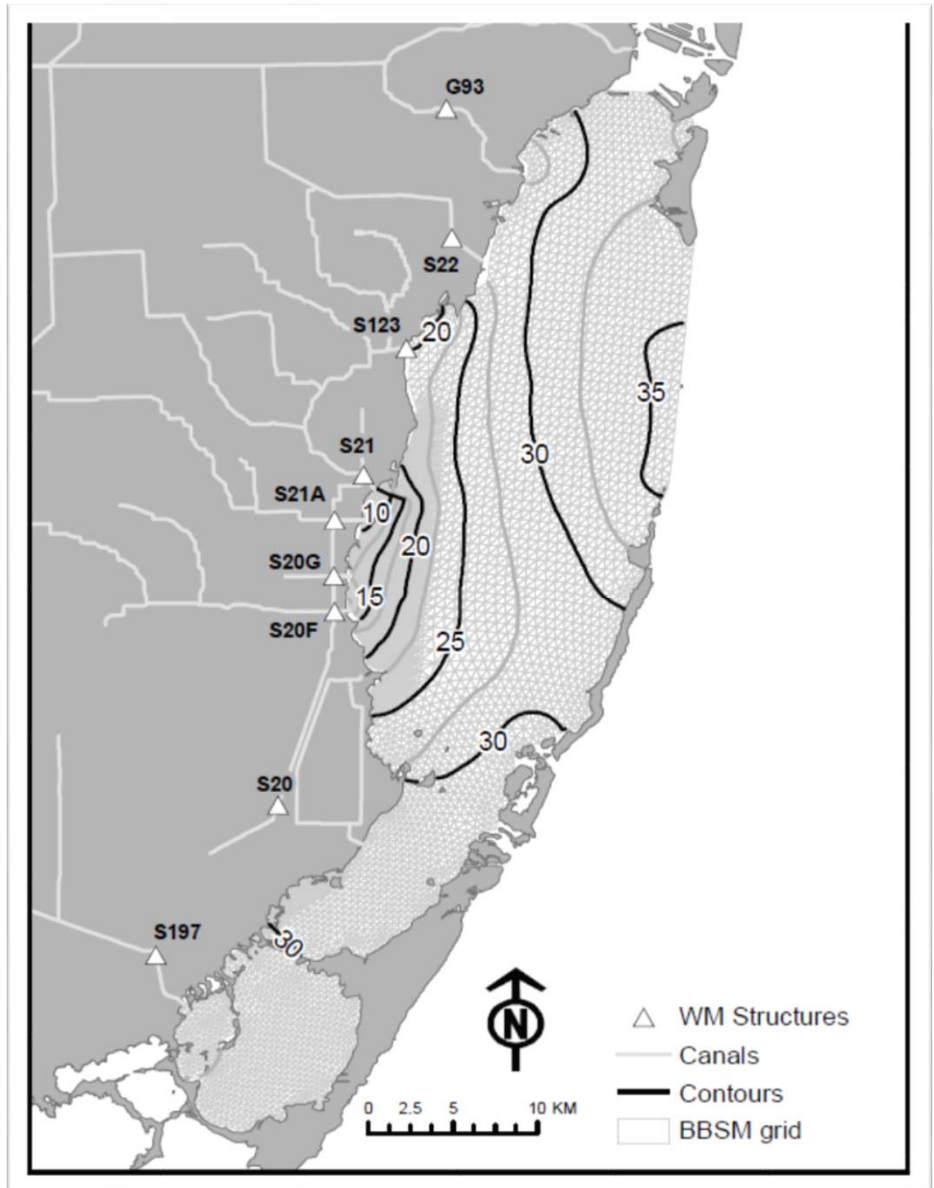
- FPL emergency operation to reduce salinity and temperature in IWF
- Freshwater being moved from coastal canal (L31E) to IWF
- Operations can be simulated and adjustments suggested to minimize impact

### Restoration efforts

- Model and evaluate operations for phase 1 features
- Biscayne Bay coastal wetland phase 2 project

### Dry Season flow request (2011)

- Trial operations authorized and performed
- BBSM v4 to be used to evaluate results



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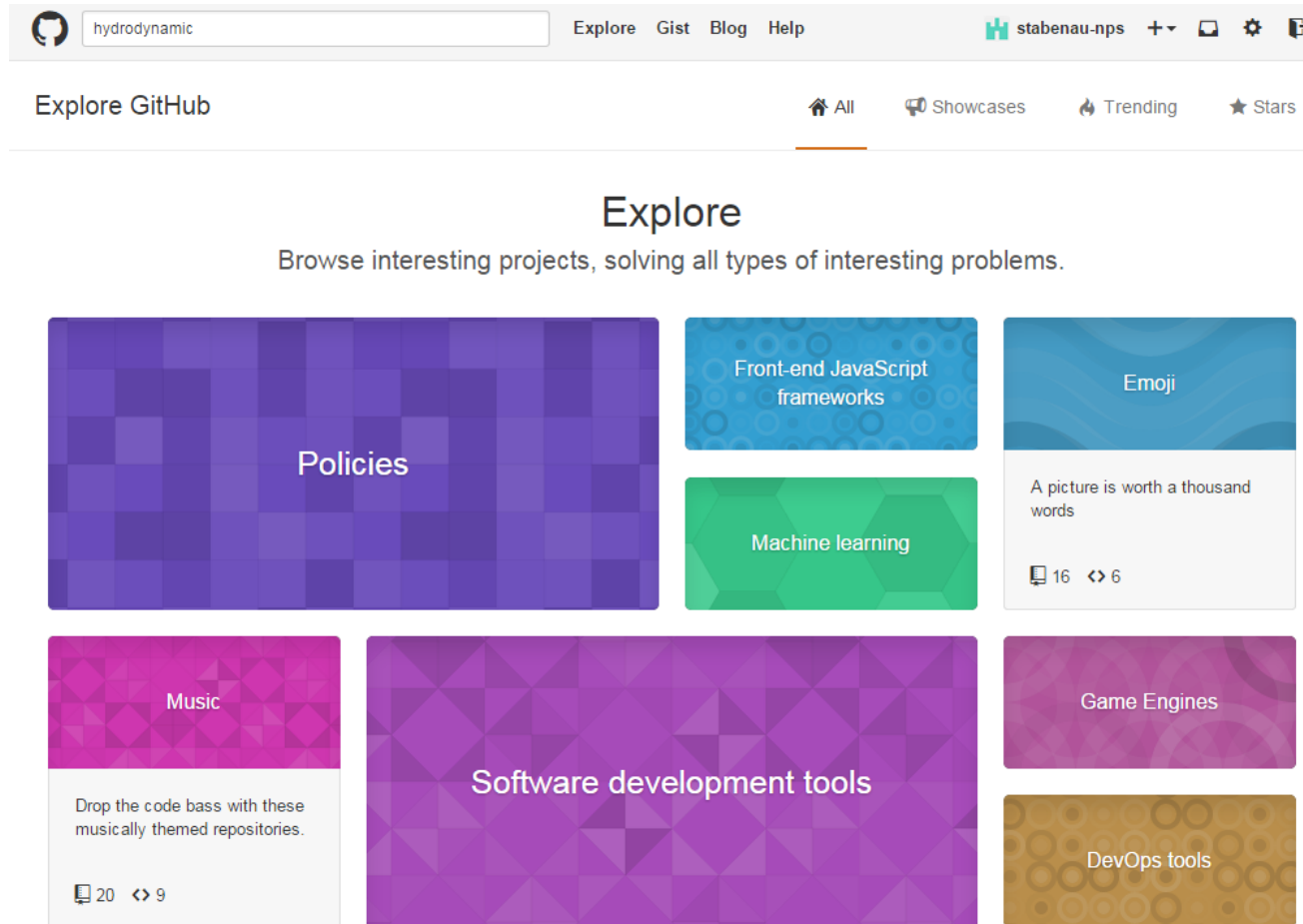
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# BBSM v.4 Available on GitHub

Open source

<https://github.com/stabenau-nps/BBSM.git>

Language: Fortran



The screenshot shows the GitHub Explore page. At the top, there is a search bar with the text "hydrodynamic" and navigation links for "Explore", "Gist", "Blog", and "Help". The user profile "stabenau-nps" is visible in the top right. Below the navigation bar, there are filters for "All", "Showcases", "Trending", and "Stars". The main heading is "Explore" with the subtext "Browse interesting projects, solving all types of interesting problems." Below this, several project categories are displayed as colored tiles: "Policies" (purple), "Front-end JavaScript frameworks" (blue), "Emoji" (light blue), "Machine learning" (green), "Music" (pink), "Software development tools" (purple), "Game Engines" (magenta), and "DevOps tools" (brown). The "Emoji" tile includes a preview of a repository with the text "A picture is worth a thousand words" and "16 <> 6". The "Music" tile includes the text "Drop the code bass with these musically themed repositories." and "20 <> 9".



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## Product of the South Florida Natural Resources Center

Contact: [Erik\\_Stabenau@nps.gov](mailto:Erik_Stabenau@nps.gov) or 305-224-4209

Data available at: [EVER\\_data\\_request@nps.gov](mailto:EVER_data_request@nps.gov)

BBSM v4 code available at: <https://github.com/stabenau-nps/BBSM.git>



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