# METHODS FOR DETECTING PATTERNS IN GROUNDWATER FLOW INTO BISCAYNE BAY, FL

Caroline Herman

# BISCAYNE BAY

- Connected to the Biscayne Aquifer and Everglades
- National Monument 1968/National Park in 1980
- Significant anthropogenic changes

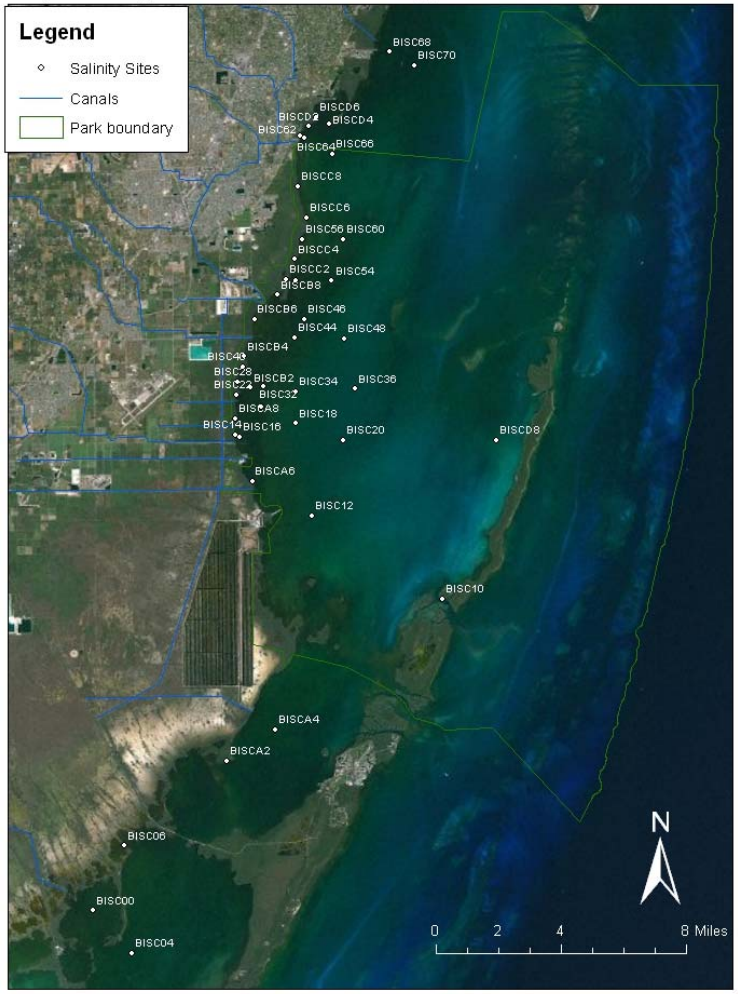
# IMPORTANCE OF SALINITY

- Animal osmoregulation
- Submerged Aquatic Vegetation (SAV)

# CURRENT MONITORING

- Integrated Biscayne Bay Ecological Assessment and Monitoring program (IBBEAM)
- Salinity Monitoring Project

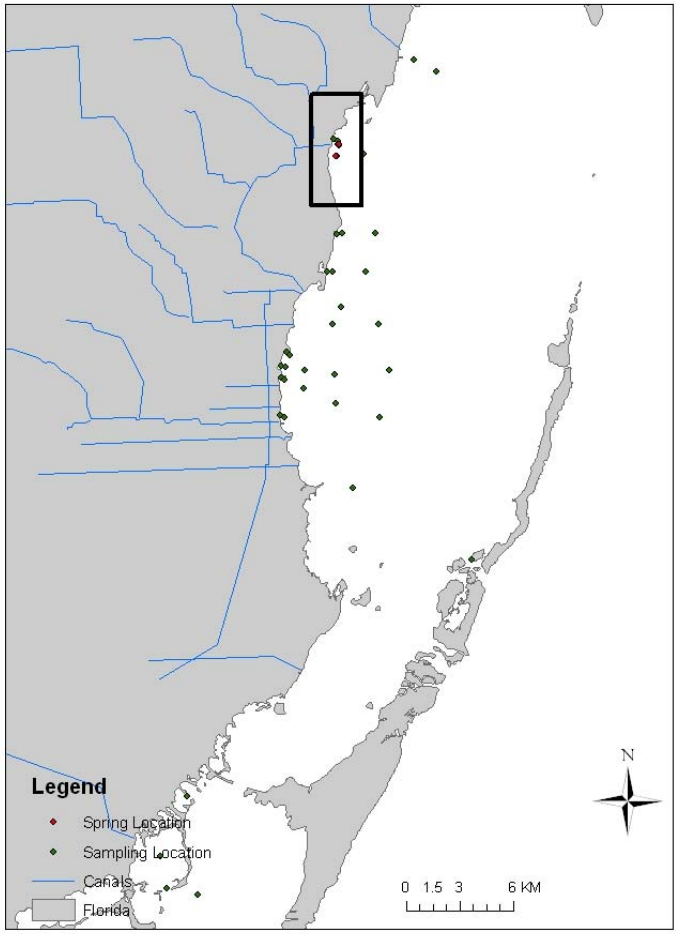
**Biscayne Bay Salinity Monitoring Network Site Locations**



# GOALS

- Evaluate different methods for their effectiveness in detecting groundwater upwelling into Biscayne Bay
- Estimate patterns of groundwater flow in Biscayne National Park
- Contribute to the understanding of the regional hydrology

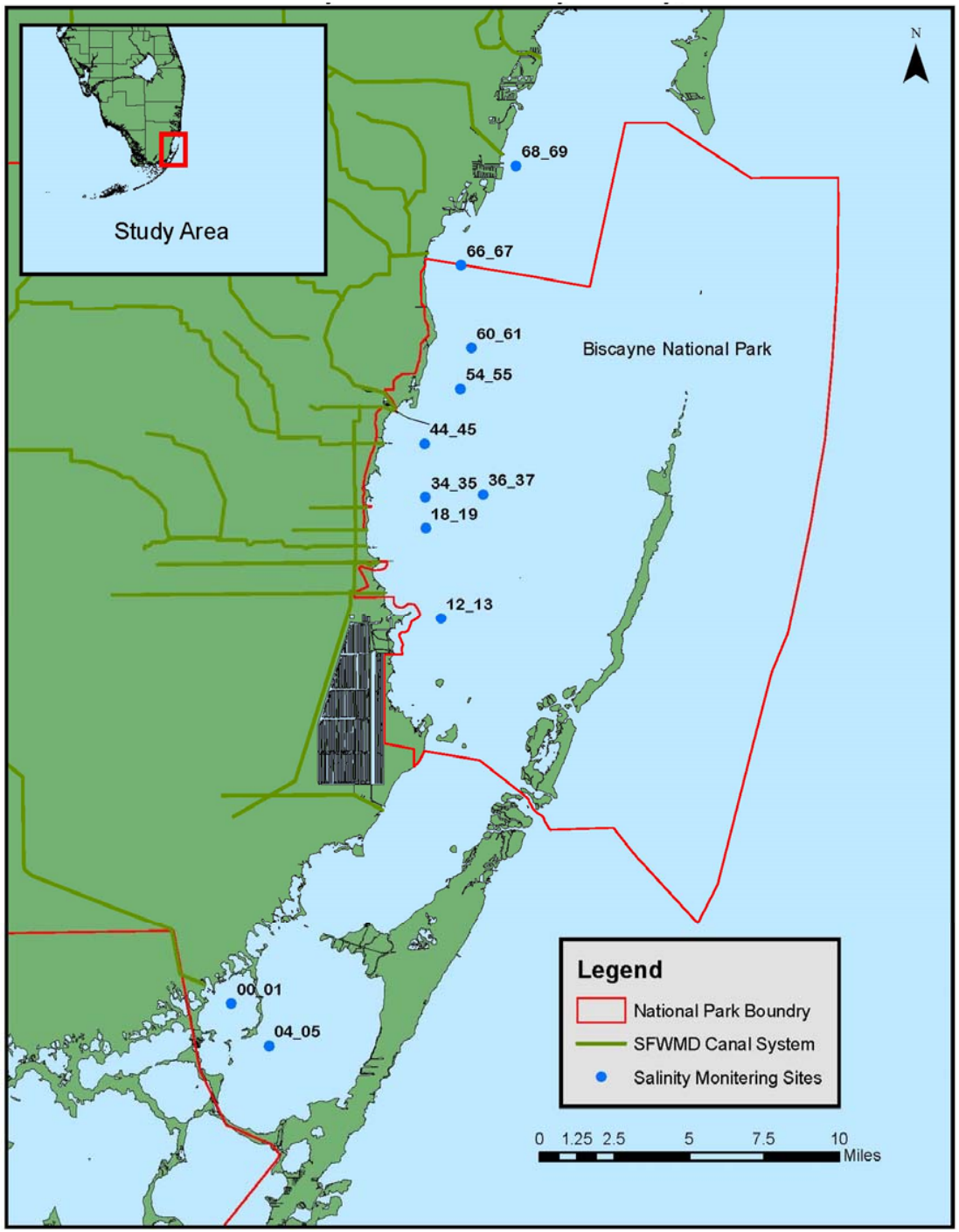
# FRESHWATER SPRINGS




# RESEARCH METHODS

Is there a difference in percentage, duration, and/or magnitude of groundwater upwelling between sites in Biscayne Bay both spatially and temporally?

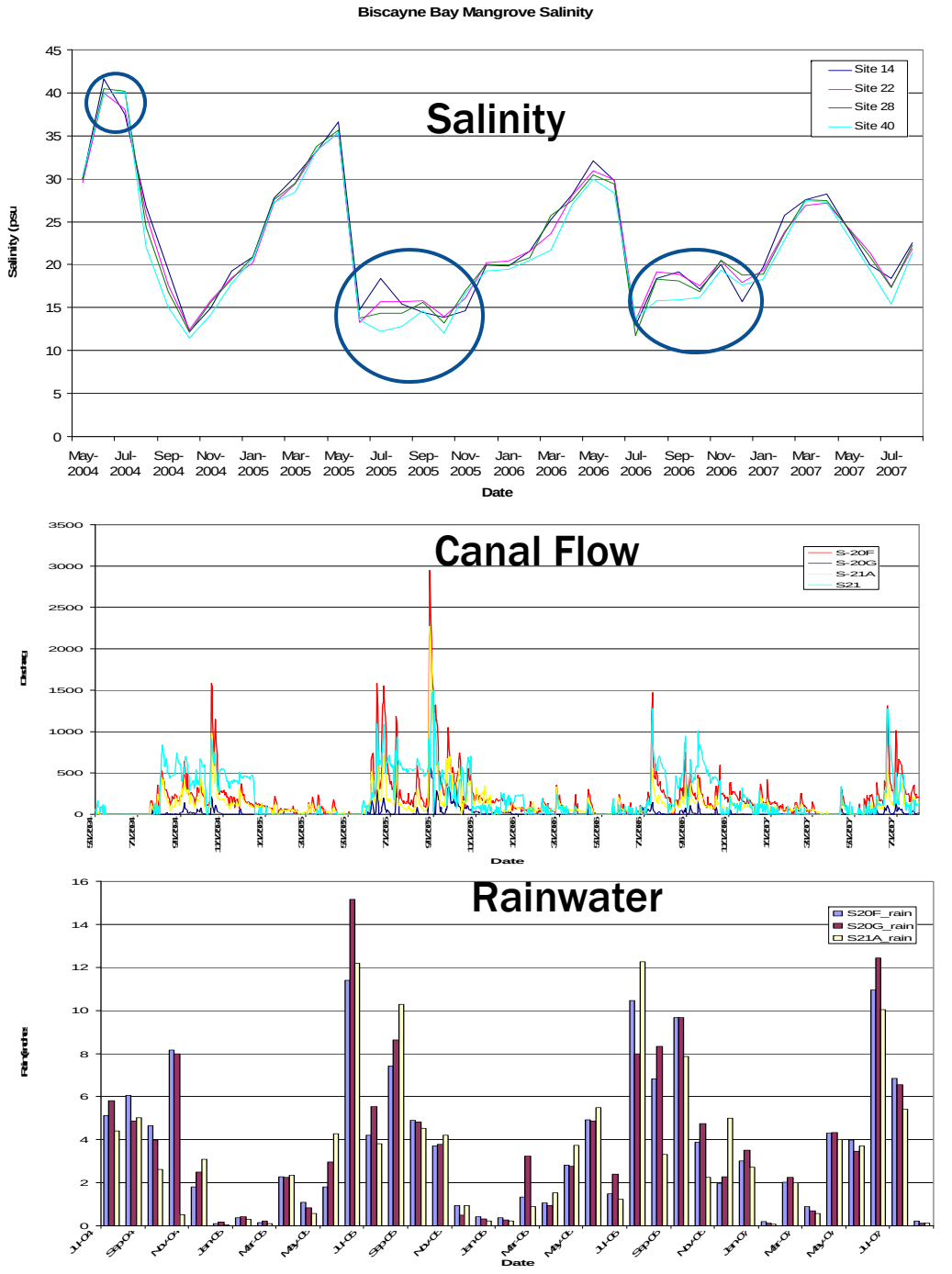
- 10 sites in Biscayne Bay
- Data from 2004-2010
- Three different methods used
  - Comparing Surface and Bottom Salinity Data
  - Submerged Aquatic Vegetation Surveys
  - Daily Salinity Variance at all Sites and Seasonal Variability Index




# STUDY SITES

## Biscayne National Park

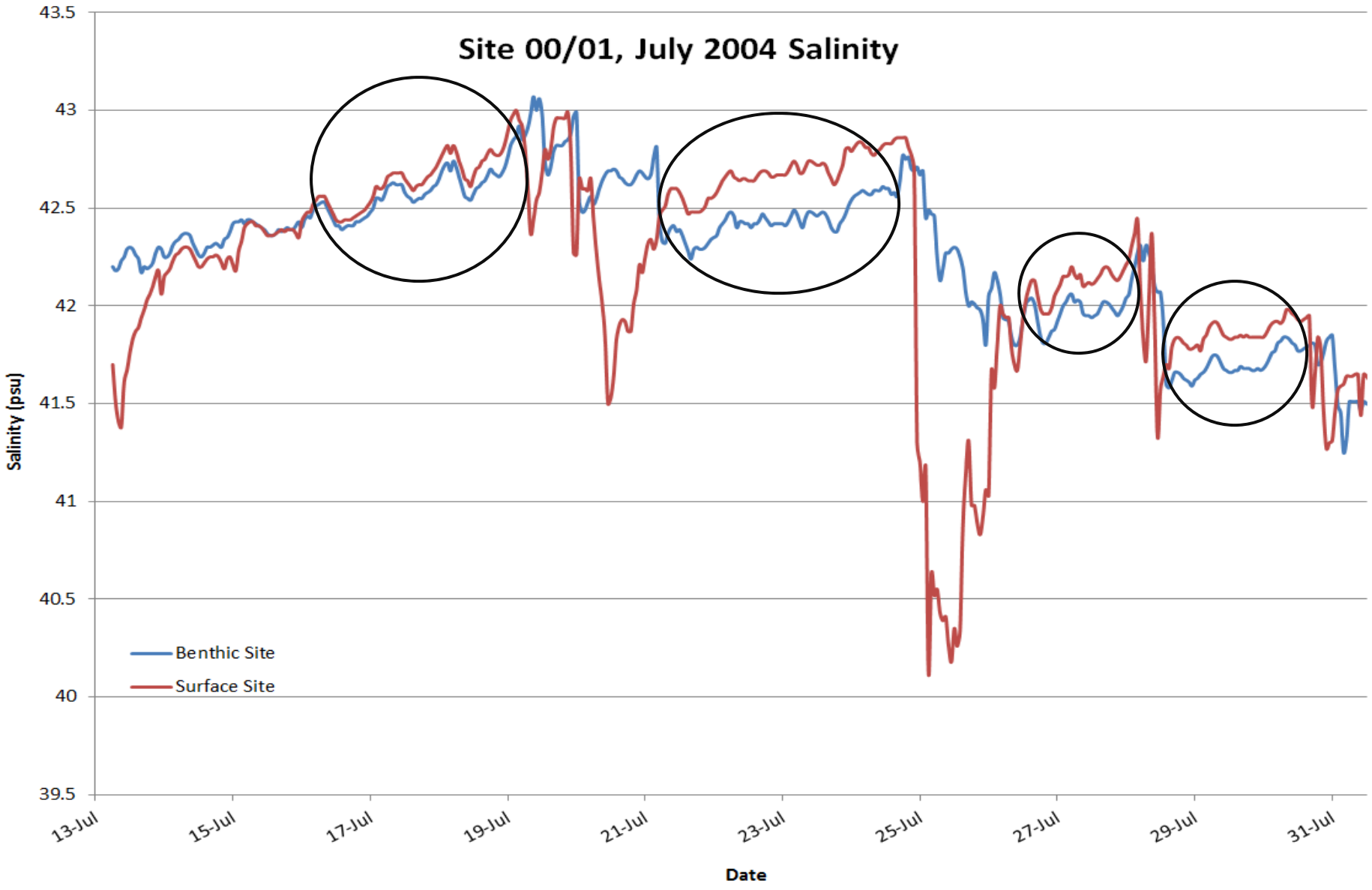
# YSI DATA SONDES


# OTHER SOURCES OF FRESHWATER

## Rainfall and canal flow

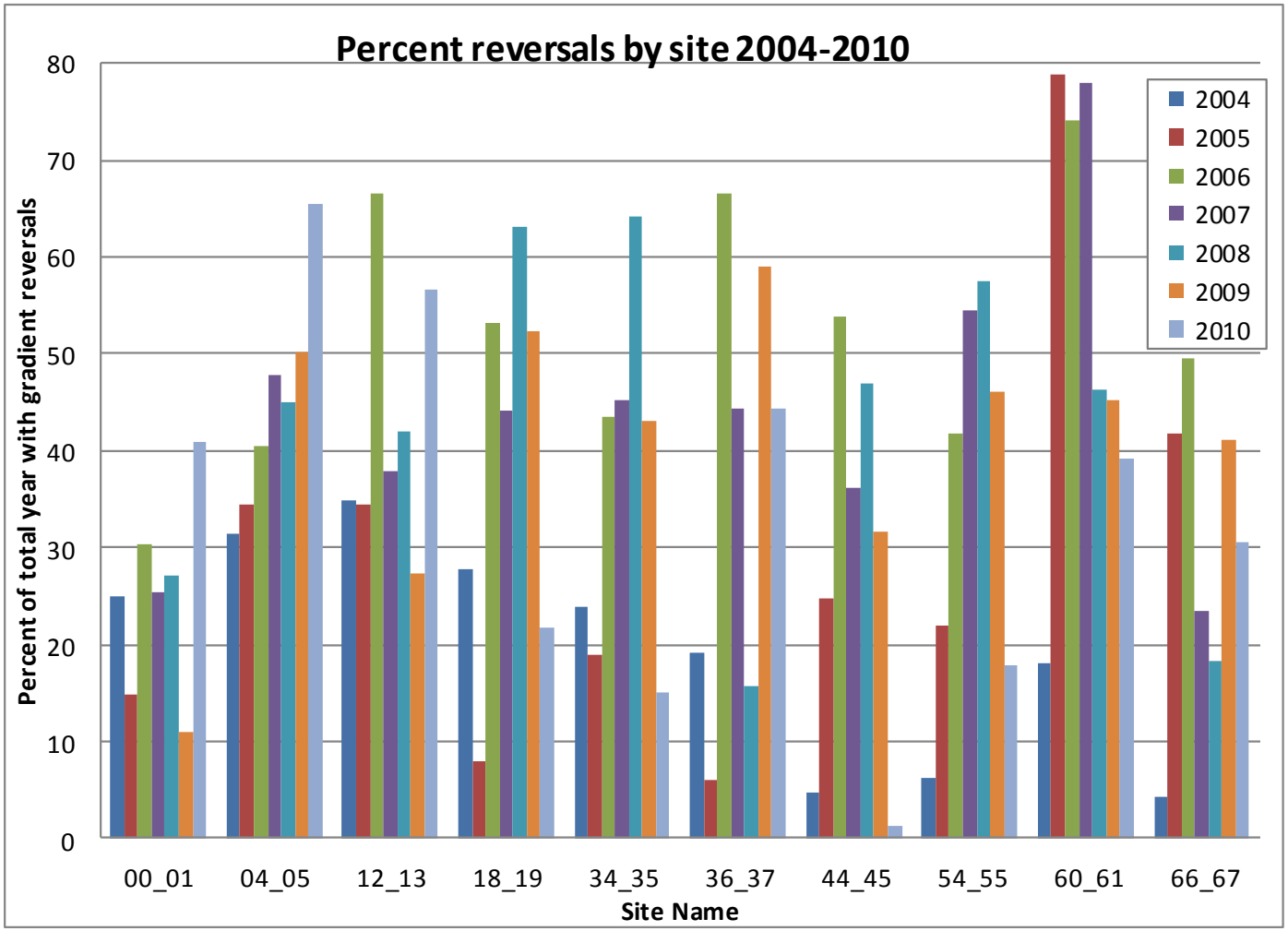
# POSSIBLE GROUNDWATER EVENTS



# COMPARING SURFACE AND BOTTOM SALINITY DATA

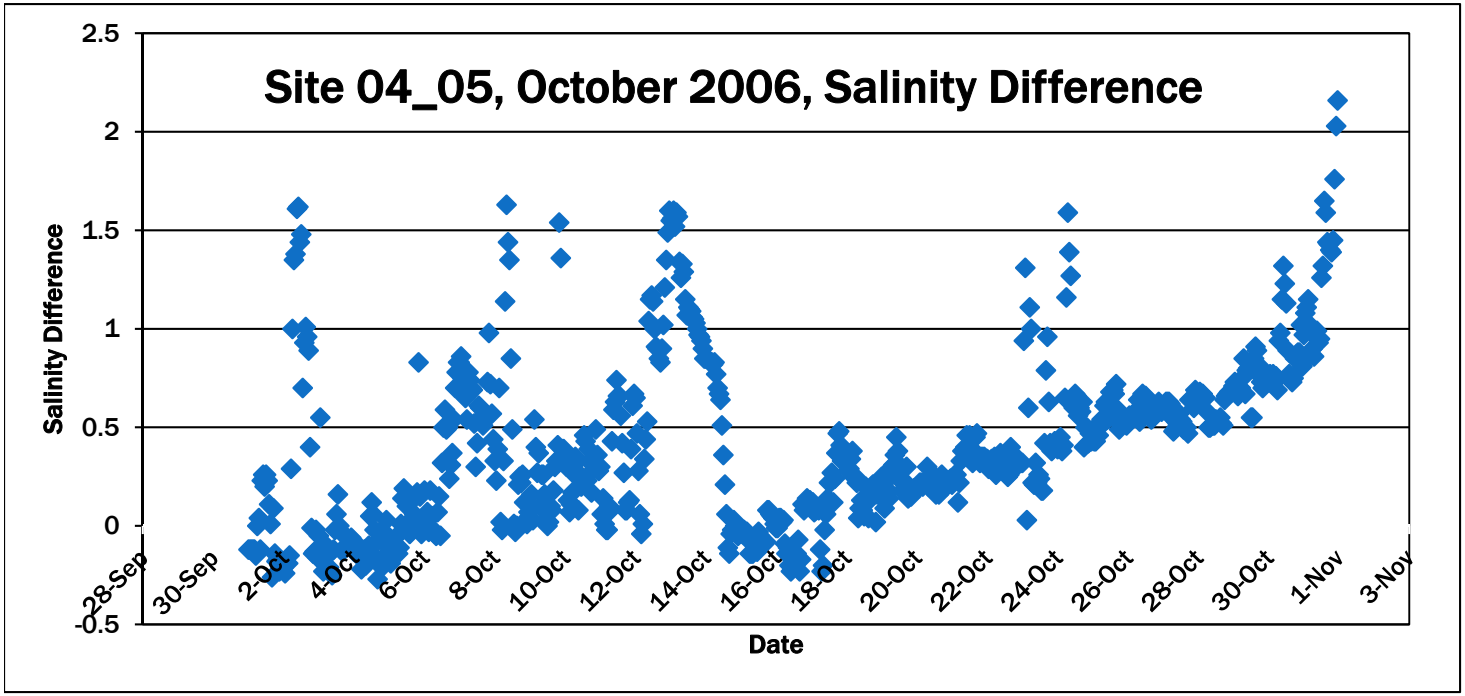
# COMPARING SURFACE AND BOTTOM SALINITY DATA

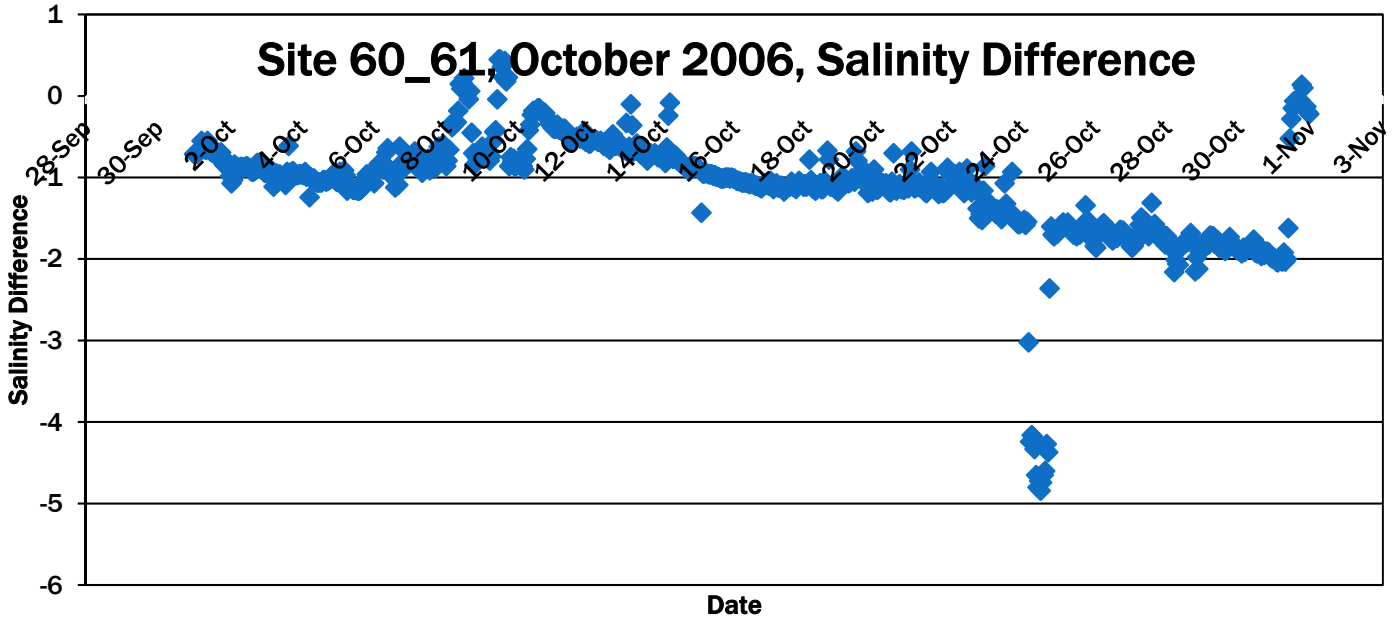
- What is the difference between the bottom and surface salinities?
- Hourly data
- Percentage of time with a gradient reversal recorded




# SALINITY GRADIENT REVERSALS

By site and year



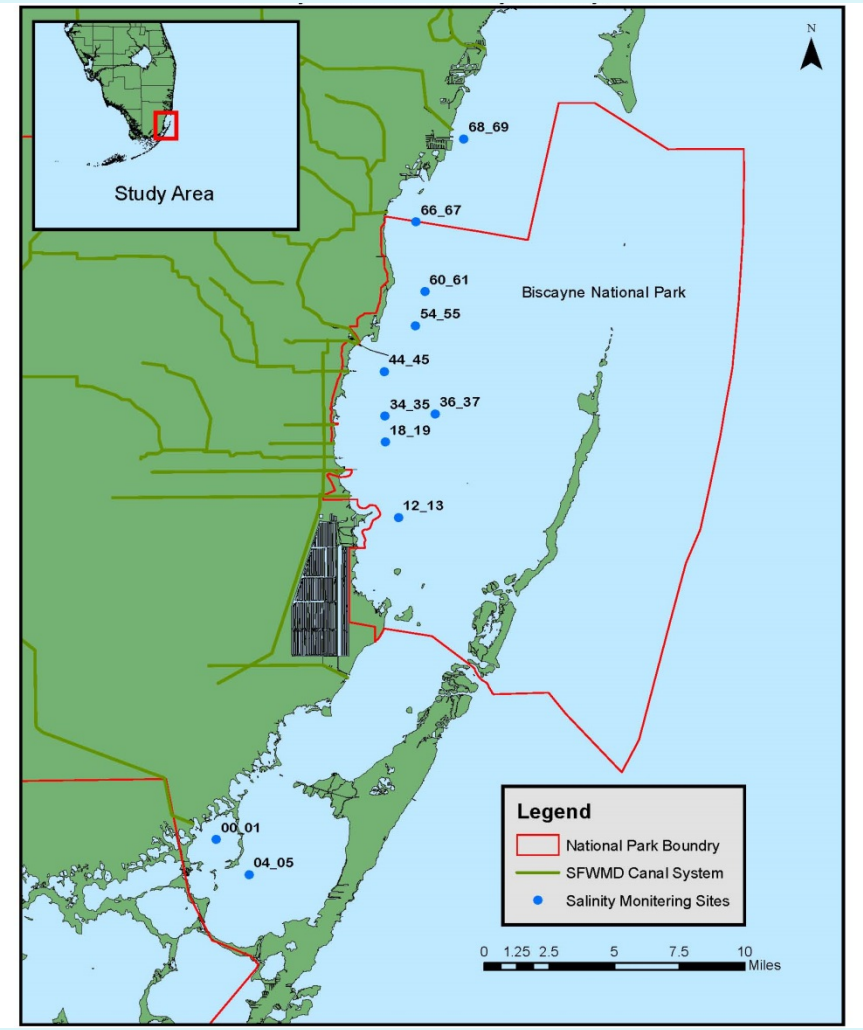




# MONTHLY REVERSAL PLOTS

Site 04_05 and Site 60_61

# COMPARING SURFACE AND BOTTOM SALINITY DATA

- Temporal differences
- Spatial differences
- Instrument malfunction



# SUBMERGED AQUATIC VEGETATION SURVEYS

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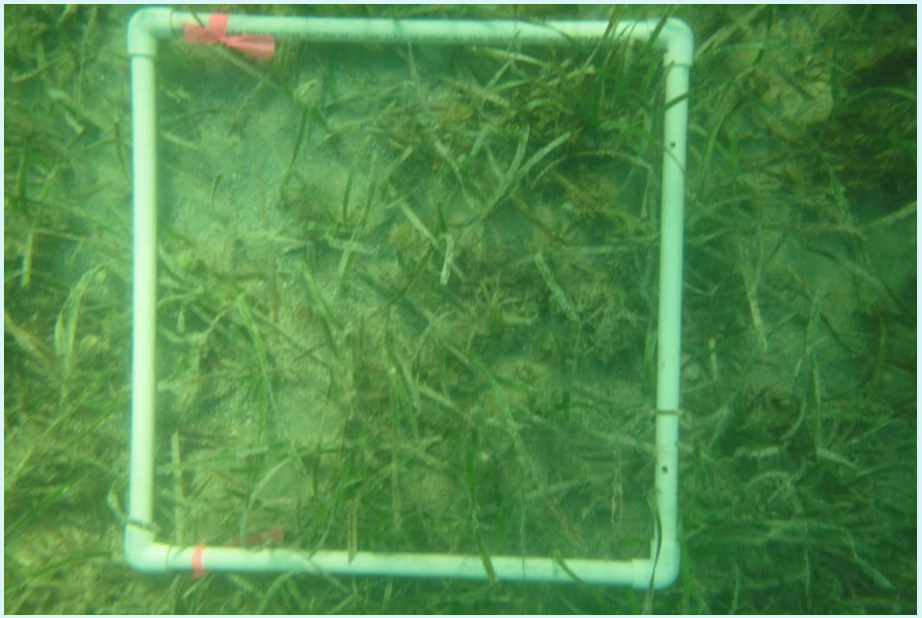
- Known salinity tolerances
  - *Thalassia testudinum*
  - *Halodule wrightii*
- .25m$^2$ quadrant
- Parameters measured

| Date | Site | Quad | Epi | %SAV | Tt | Hw | Sf | Algae | Sed Depth | Canopy Height |
|---|---|---|---|---|---|---|---|---|---|---|
| 10/17/2014 | 00_01 | **1** | | 80 | | 5 | | 75 | 5 | 15 |
| 10/17/2014 | 00_01 | **2** | | 100 | | | | 100 | 5 | 15 |
| 10/17/2014 | 00_01 | **3** | | 45 | | 40 | | 5 | 15 | 15 |
| 10/17/2014 | 00_01 | **4** | **BH** | 70 | 5 | 65 | | | 5 | 20 |
| 10/17/2014 | 00_01 | **5** | **BH** | 75 | 60 | 5 | | 5 | 10 | 30 |
| 10/17/2014 | 00_01 | **6** | **BH** | 60 | 50 | | | 10 | 10 | 20 |
| 10/17/2014 | 00_01 | **7** | **BH** | 60 | 55 | | | 5 | 5 | 25 |
| 10/17/2014 | 00_01 | **8** | **BH** | 50 | 30 | | | 10 | 5 | 25 |
| 10/17/2014 | 00_01 | **9** | **BH** | 80 | 50 | 10 | | 5 | 5 | 25 |
| 10/17/2014 | 00_01 | **10** | **BH** | 75 | 20 | 10 | | 5 | 10 | 30 |

# SUBMERGED AQUATIC VEGETATION SURVEYS

- Hard bottom sites
- Consistency of flow
- *Halodule* at two sites
- Groundwater or canal water?



# DAILY VARIANCE AND SEASONAL VARIABILITY INDEX

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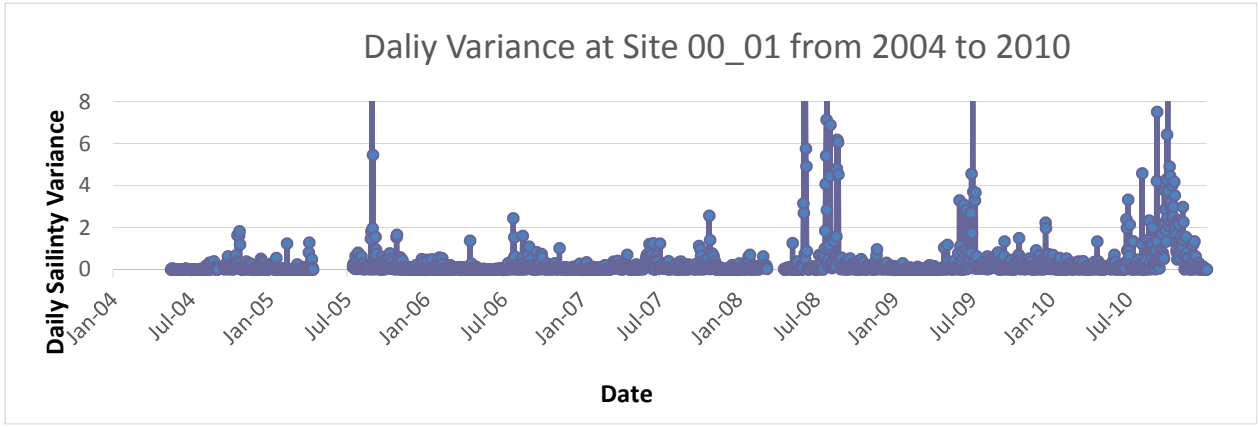
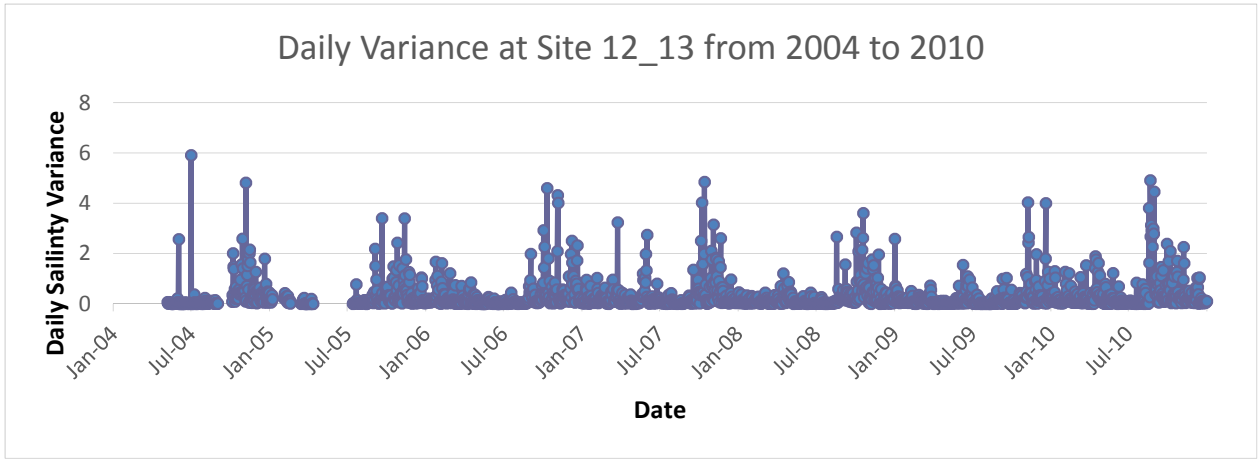
- 15 minute salinity data
- Daily site variance
- Drastic changes over the course of a day
- Seasonal variability indices
  - 5psu change per day



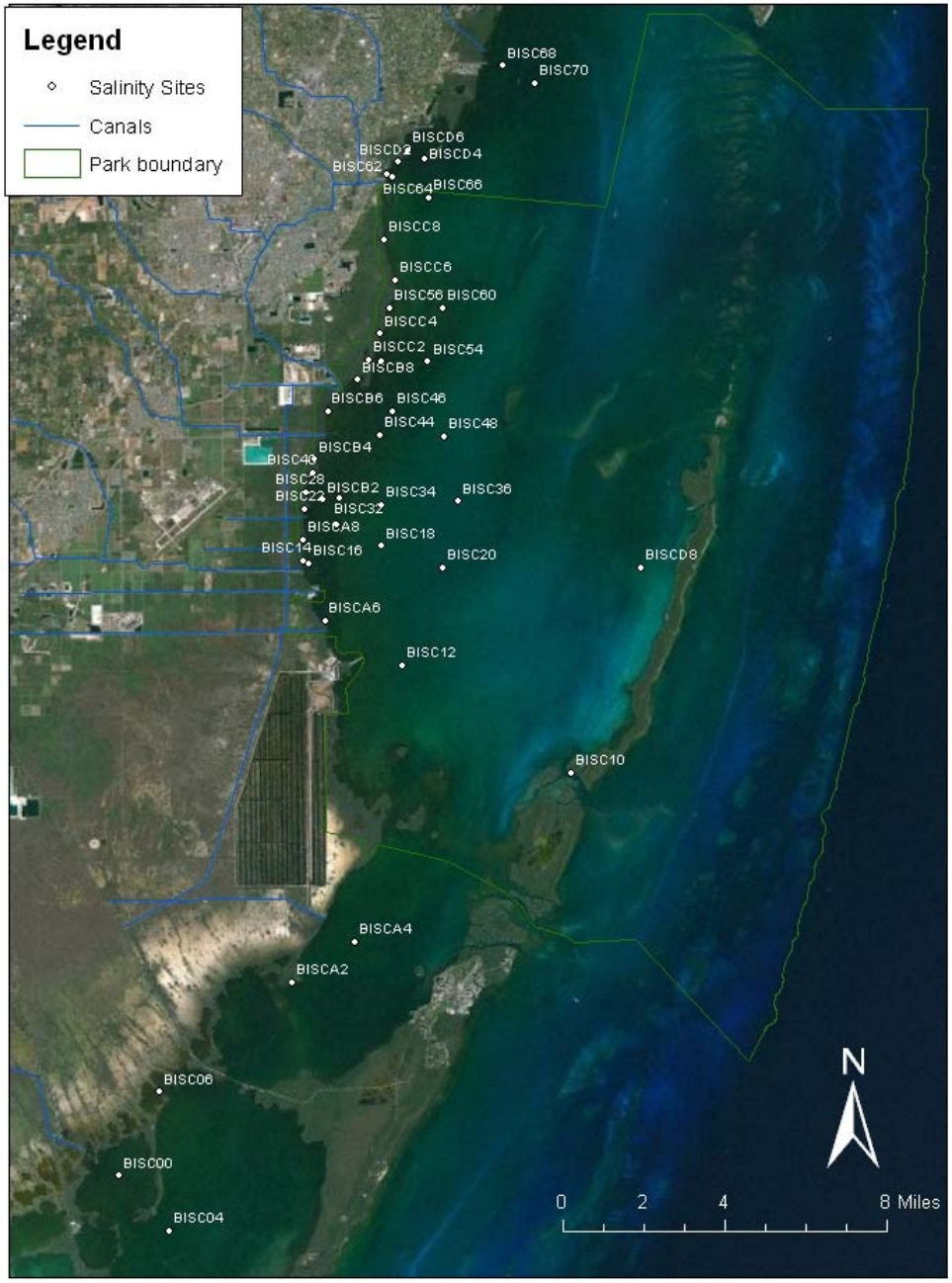

# SAMPLE DAILY VARIANCE PLOTS

## Site 00_01 on and Site 12_13

# DAILY VARIANCE AND SEASONAL VARIABILITY INDEX

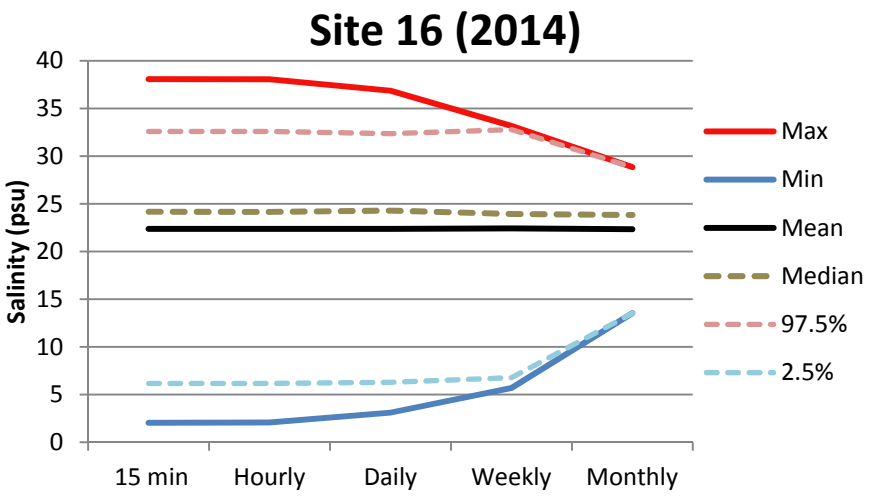
- Visual trend, not statistically significant
- Instrument malfunction
- More data during wet season needed

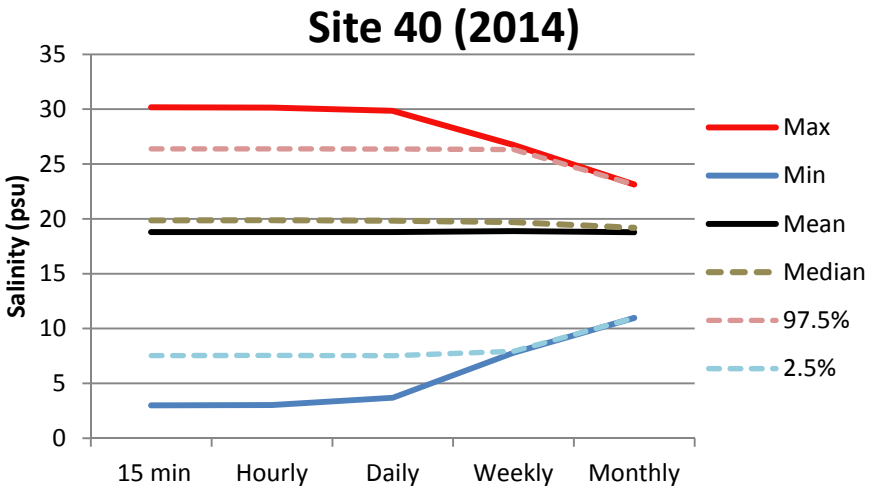
## Biscayne Bay Salinity Monitoring Network Site Locations

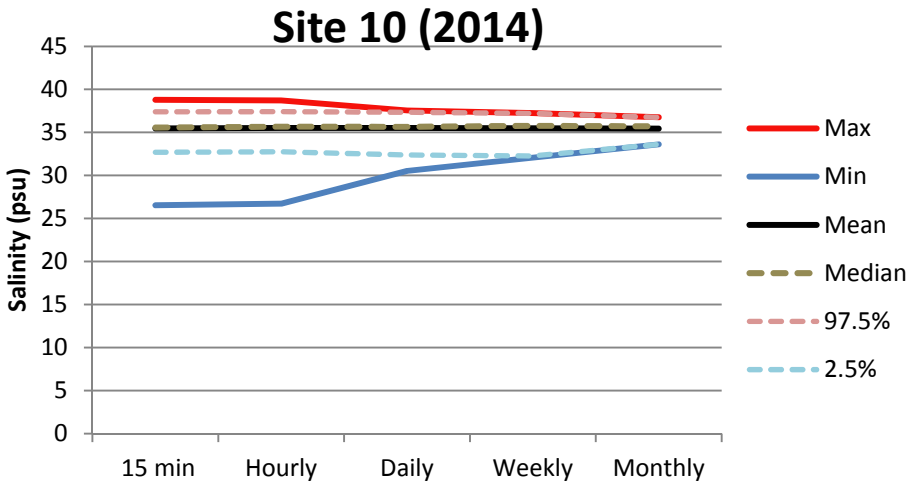


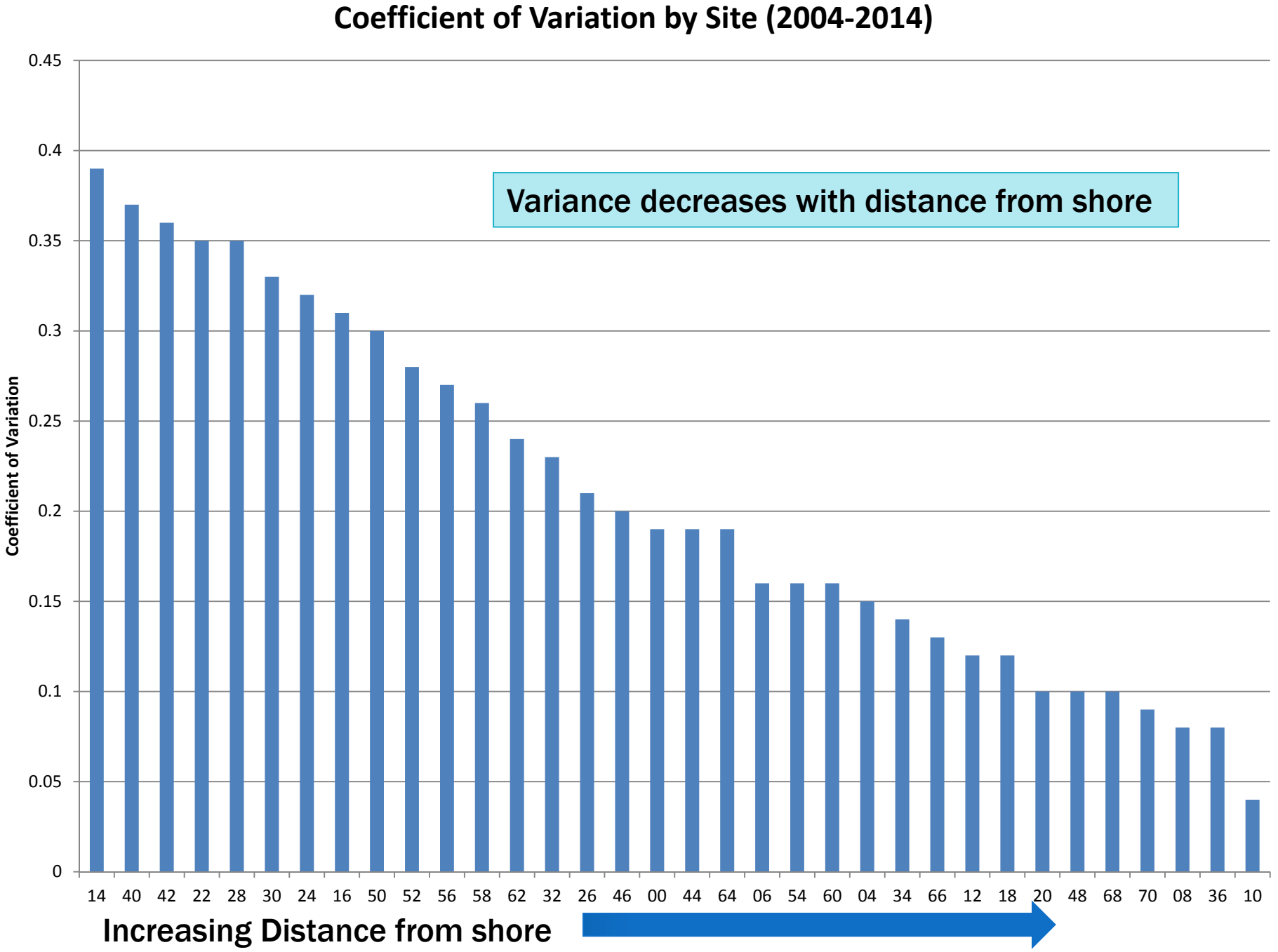

## ALL SITES IN THE SALINITY MONITORING NETWORK

# COMPARISON OF SAMPLING FREQUENCY




Coefficient of Variation by Site (2004-2014)
Variance decreases with distance from shore
Coefficient of Variation
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
14 40 42 22 28 30 24 16 50 52 56 58 62 32 26 46 00 44 64 06 54 60 04 34 66 12 18 20 48 68 70 08 36 10
Increasing Distance from shore

# CONCLUSIONS

- Seasonal patterns
- Spatial patterns
- Expanded analysis with more sites
- Combination of methods necessary

# RECOMMENDATIONS

- Seepage meter
- Isotope analysis
- Combine new equipment with statistical methods
- Necessary for hydrology understanding

# THANK YOU

- Sarah Bellmund
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- Herve Jobert
- Biscayne National Park


# QUESTIONS?