Ecosystem History of Florida Bay and the Southern Estuaries – Five Year Update

G. Lynn Wingard (USGS)
Progress since 2003
Florida Bay Science Conference

- Expansion of Ecosystem History Research into surrounding estuaries
- Synthesis and standardization of existing data
- Focus on Question 1 of Florida Bay Strategic Science Plan – salinity, freshwater flows, sea level rise
- Development of new methods and applications for paleoecologic data
Expansion of Ecosystem History
Research into Surrounding Estuaries

2003 sources of information:
- 11 cores
- 10 coral samples
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2008 new sources of info:
- 11 new USGS cores in SW (6 with preliminary results)
- 8 Biscayne Bay Cores (all analyzed – 3 by USGS & FIU)
- 4 new FIU FL Bay Cores

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Synthesis And Standardization Of Existing Data

- Develop preliminary view of changes over time in estuaries
- Age model – all of Biscayne Bay & Florida Bay cores – collected over different time periods and run through different labs
- Compilation of all modern data into database
Changes Over Time In Estuaries: Preliminary Synthesis of Core Data
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Prior to 1900 system was undergoing gradual change toward increasing salinity.
Changes Over Time In Estuaries: Preliminary Synthesis of Core Data

~ 2000 yrBP
Freshwater reached past the current terrestrial margin

~ 1900 AD
Increasing estuarine salinities consistent with rising sea level

Current
Loss of typical estuarine zonations occurred in 20th century
Standardization of Age Models for Cores:

- Details available age data on all cores
- Allows direct comparison of data from all cores
- Sets standard for analyses on new cores

Ideally age models are developed on three lines of evidence:

- **Carbon-14**
- **Lead-210**
- **First occurrence of exotic *Casuarina***

Concurrence of Lead-210 going to background levels and the first appearance of *Casuarina* is an indicator of approximately 1900-1920.
Modern Analogue Data Compiled

USGS Molluscan Data

- 145 locations – BB, FB, SW coast
- 718 site visits from 1995 to present

http://sofia.usgs.gov/exchange/flaecohist/
Modern Analogue Data Compiled

- Sediment Cores (USGS)
- Near shore sites – Modern
- Open bay sites - Modern

FIU Diatom Data
- 58 sites
- Biscayne
- 38 mangrove & freshwater sites – FL Bay
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To set attainable and sustainable performance measures and targets need to consider spatial and temporal variations.

Spatial variations occur throughout the region.

Temporal changes occur on many scales – daily, seasonal, annual and longer term cycles - can be very significant.

Addressing management challenges:

- Modeling?
Linear Regression Model based on Paleoecology Data: 3 Phases

**Phase I:** Paleoecology

**Phase II:** Linear Regression Models developed based on observed instrumental data from stations in the wetlands and the estuaries

**Phase III:**
Couples the simulated paleosalinity regime with the LRM to produce estimates of flow, stage, and hydro-period.

For details
See Frank Marshall’s Talk Sess. III Tues 2:00 pm
Developing Paleo-based Simulated Time Series Using Observed Climate Data for 1965 to 2000

Linear Regression Model: Phase I
Develop Paleo-based Salinity Regime

NSM salinity
Developing Paleo-based Simulated Time Series Using Observed Climate Data for 1965 to 2000

Linear Regression Model: Phase I
Develop Paleo-based Salinity Regime

NSM salinity

NSM adjusted to Paleo-based (-8.5 ppt)
Develop LRM\texttext{s that predict:}

1) salinity at WB based on stage at CP & P33
2) flow at SRS and TSB based on stage at CP & P33
3) stage at other locations
4) salinity at other locations
Linear Regression Model based on Paleoecology Data: Phase III & Output

Phase I: Paleoecology

Phase II: Linear Regression Models based on observed instrumental data records

Phase III: Couples the simulated paleosalinity regime from Phase I with the LRMs from Phase II to produce estimates of flow, stage, and hydro-period.

Output: Paleo-based historical estimates
- Daily stage at CP & P33
- Historical flows
- Hydroperiod & hydro-patter at ENP locations
- Salinity estimates at locations in FL Bay

For Results See Frank Marshall’s Talk Sess. III Tues 2:00 pm
Use of Modern Analogue Data

Multi-taxon Prediction Models

- Uses weighted-average partial least squares regression
- Determines relationship between salinity and each diatom taxon

ALSO
- Using discriminant function techniques to reconstruct benthic substrates

For Details
See A. Wachnicka’s Talk
Sess. III Tues 2:20 pm
Use of Modern Analogue Data

Modification of transfer function techniques
Developed to address problems of assemblage analysis – statistical based, associated error and confidence levels for each measurement
Not subjective so works even with euryhaline assemblages

Cumulative Weighted Percent Method

For Details
See Wingard Talk
Sess. III Tues 1:40 pm
CWP Method Tested Against Known Salinity

<table>
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<th>Statistical Measure</th>
<th>Calibration Data Set</th>
<th>Preservation Categories</th>
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<th>3 Months</th>
<th>6 Months</th>
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</table>

Correlation Coefficients of 0.8 and 0.9 for 24 and 36 month Salinity averages

For Details See Wingard Talk Sess. III Tues 1:40 pm
What’s Next?

- Use the methods discussed here to analyze (or re-examine) existing cores
  - CWP Molluscan data
  - Diatom data
  - Coupled with Linear Regression Models
- Develop coupled Linear Regression Models for multiple cores throughout south Florida’s estuaries
What’s Next?

- From the regional overview of change to south Florida’s estuaries over the last 100-1000 years
  - Attempt to determine what component is anthropogenic and . . .
  - What is due to larger scale factors such as sea level and climate change
- Calculate recent rates of sea level rise and project into the future based on IPCC scenarios for 21st century
Setting Attainable Restoration Performance Measures: Accounting for Sea-Level Rise

- Blue line highlights the trend in increasing salinity due to rising sea level
- Gray area represents the offset from the natural trend – can assume this is probably an anthropogenic effect
Performance measures that set targets at pre-1900 salinities may not be attainable because sea level rise and other factors would make it difficult to return to this salinity range.
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As sea level rises, zones within the estuaries will shift.

Can use core data from current zones, shifted landward under different SLR scenarios to determine realistic PMs and targets.
Paleoecologic data have an essential role in restoration efforts by providing:

- data on the past environment
- rates of change
- causes of change
- projections of future change
- input to models to understand past and future conditions