Three Dimensional Model Evaluation of Physical Alterations of the Caloosahatchee Estuary, Impact on Salt Transport

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Background

- Impacts of physical alterations noted worldwide
- South Florida estuaries have experienced significant changes
- Impacts possibly irreversible
Background

Why the study?

- Part of Caloosahatchee River Estuary Minimum Flow and Level update study
- What the salinity would look like if no alterations
- Potential implication for developing environmental flow targets
Historical Changes

1. 1887 Caloosahatchee River (4x35)
2. 1881 H. Disston Drainage Canal
3. 1882 Caloosahatchee (7x100)
4. 1891 Charlotte Harbor (12x200)
5. 1902 Orange River (4x50)
6. 1912 Boca Grande (24x300)
7. 1915 Caloosahatchee (5x40)
8. 1930 E.W. Crayton (3x40)
9. 1945 Realigned
10. 1960-64 Gulf Intracoastal Waterway
11. 1955 Big Hickory-Wiggins Pass (4x50)
12. 1960-68 Matanzas Pass
13. 1963 Two man-made islands built for construction of Sanibel Causeway
14. Historical oyster bars removed
15. 1930s Moor Haven Lock and Ortona Lock
16. 1960s Franklin Lock
Objectives

- Quantitatively evaluate the impact of physical alterations on salt transport in the Caloosahatchee River Estuary
- Identify which alteration is primarily responsible for the salinity changes
Modeling Methodology

- Modeling the existing condition (calibration/validation)
- Alteration made relative to existing condition by modifying grid and/or depth
- Keep forcing boundary conditions the same
- Compare salinities
- Five alteration cases modeled
Model Validation

- 5300 horizontal cells
- 5 vertical layers
- Covers CRE, San Carlos Bay, Pine Island Sound, part of Charlotte Harbor and offshore areas of Gulf of Mexico
- Validated with more than 10 years of tide, salinity data and 3 years of tidal discharge data
Model Validation

Monitoring stations
Model Validation (stage)

Shell Point

I75
Model Validation (flow)
Model Validation (salinity)
Modeling of Physical Alterations

Five model runs

- Removal of S-79
- Removal of Sanibel Causeway
- Oyster Bar
- Refill of the navigation channel
- Pre-development condition
Depth, Capt. Black, 1887

Depth, existing condition
Modeling of Physical Alterations

Surface salinity at Ft. Myers

- Oyster bar
- Without cswy
- Existing
- S79 removed
- Channel refill
- Pre-development

Salinity

Date

1/1/01   1/1/03   12/31/04   12/31/06   12/30/08   12/30/10
Modeling of Physical Alterations

Salinity difference relative to existing condition

Ft. Myers

-20 -15 -10 -5 0 5

S79 removal Causeway removal Oyster bar Channel refill Pre-development

2001 2007 2008 2011
Theoretical Analysis

\[ A = A_0 \exp \left( -\frac{x}{L_a} \right) \]

\[ L_{max} = \frac{D_0 A_0}{K Q_r} \]

\[ D_0 \sim 1400 \bar{u}_0 h_0 \]
Conclusions

- Physical alterations likely have had significant impact on salt intrusion
- Dredging and deepening are the primary cause of salinity increase
- Theoretical analysis supports numerical model simulation
- Implications: The impact of physical alterations should be carefully considered in the development of environmental flow target and associated rule making
Questions?

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