Salinity (psu)

Community: Examining Alternate Ecosystem States

Thalassia testudinum

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Introduction

The seagrass community that carpets much of Florida Bay is dominated by turtle grass (Thalassia testudinum) and shoal grass (Halodule wrightii). In fresher areas of the mangrove Slough, there is a mixed species SAV bed that includes the saline tolerant halophytes Bugula nodosa and Actinocyclus fernandezii. Seagrass beds began to die in the 1980s and die-off continues sporadically to this day. This is considered to be partially the result of diversions of freshwater from Florida Bay, leading to often-chronic hypersaline conditions harmful to the ecosystem. Management plans within CERP and Minimum Flows and Levels (MFLs) initiatives are focused on restoring freshwater flow to the bay to establish conditions for a healthy seagrass ecosystem.

An ecological simulation model was developed for SFWMU USGS and FCELTHER. The model is used in support of restoration, management and research in Florida Bay.

- Calculate the optimum conditions for seagrasses
- Evaluate effectiveness of restoration strategies
- Calculate nutrient uptake capacity of SAV
- Predict pelagic-benthic interactions and dominance

Figure 1: Conceptual model underlying the numerical simulation model.

Model Description

The model (Figs. 1, 2) is developed for six basins in the bay (Fig. 3), and describes seagrass and microalgal dynamics. It is programmed in MATLAB with a timestep of 3 hours. Competition between seagrass species is implemented through density limitation and sharing of nutrient pools and PAR. Calibration of the model was achieved through least-squares minimization of the summed squared error of the biomass of both species.

Figure 2: Detailed conceptualization of core biogeochemy in the model and the generic equation governing the growth of SAV. Equations for each plant are parameterized with species-specific coefficients. Data input examples shown at left.

Results: Hindcasts using FATHOM model salinities

Thirty year hindcasts of SAV for 1970-2000 at three sites were performed using the FATHOM water balance model’s (Cosby and Nuttle 2004) hindcast salinities as input to the SAV model. In Little Madeira Bay and Eagle Key Basin, adjacent to Taylor River (Fig. 4 top right) the model shows that:
- Mixed beds of Thalassia and Halodule were favored during fresher periods when salinities were sustained below 40 psu
- Halodule dominated when monthly average salinities remained below 30 psu
- Sustained salinities above 40 psu occurred during three historic droughts (red rectangles) and Thalassia dominated at those times

In Whiptail Basin in the central bay farther from fresh inputs, mixed-species beds persisted throughout the period despite less variable and high (marine) salinities, indicating salinity effect on SAV is complex and location-specific.

Results: State change (Fig. 5), from benthic (6c) production due to P injection (6a) to pelagic (6d) production due to PAR reduction (6b).

Summary

Our model demonstrates that the effect of hypersalinity in situ is a function of SAV tolerance, resource conditions and interspecific competition affected by salinity stress. Halodule tolerance in presence of Thalassia differs from its response in a monoculture. Halodule near freshwater inflows is favored by < 30 psu and poorly tolerate salinities > 40 psu. Thalassia dominates under hypersaline conditions. Phytoplankton blooms strongly affect SAV via light attenuation. Efficient nutrient recycling maintains the effects of nutrient increases and bloom conditions on temporal scales of months to years.