The Florida Bay Ecosystem

- Florida Bay is a unique shallow estuary
- Heavily influenced by water flow from the Everglades
- Water leaving Florida Bay affects coastal Florida Keys waters
- Supports multiple fisheries
- Nursery habitat for economically important species
- Total value of ecosystem services estimated at $15 billion annually
  - Recreational fishing $438 million
The Florida Bay Ecosystem

- A lagoonal system of complex network of shallow banks
- Banks isolate interior basins of the bay from oceanographic influences
- Surface and groundwater flows, rainfall, and evaporation greatly affect the Bay’s salinity

- Composed of four principal subregions
- Northeast – Most freshwater inflow; receives water from Taylor Slough; isolated from ocean
- Central – Less freshwater inflow; prone to hypersalinity
- West – Least isolated; robust tidal mixing
- South – Affected by perturbations in Central Bay; strong connection to outer Bay and the ocean
Freshwater flow from the Everglades has been reduced by 50-60% from historic levels. The majority of freshwater entering the Bay now is from rainfall and in dry years freshwater input is not enough to offset losses due to evaporation.
This slide represents average salinity measured over a 7 year period (1998-2004) in Florida Bay.

Nov-Jan are the freshest months (lowest salinity) when evaporation is low and river runoff (which lags rainfall 1-2 months) is highest. Lowest salinities occur in Northeast Florida Bay where several creeks fed by Taylor Slough empty directly into the bay. Note that this effect is relatively isolated due to poor water exchange among basins.

Maximum salinities tend to occur in early summer following the dry season when evaporation is highest and freshwater input is low. North Central Florida Bay typically becomes hypersaline during late winter, spring, and early summer due to poor water exchange and lack of fresh water.

Nutrient dynamics in Florida Bay are complex. The bay generally contains low levels of dissolved nutrients, but the vast seagrass beds act as a nutrient sink. These nutrients are released during die-offs. In general, flows from the Everglades are a very small fraction of the total nutrient load (<10%). Exchange with the Gulf of Mexico and atmospheric and groundwater inputs account for the majority of the total loads.

Note that some loading information is uncertain, especially relative to groundwater.

Source: Kruczynski, W.L. and P.J. Fletcher (eds.) 2012 Tropical Connections: South Florida’s marine environment. IAN Press, University of Maryland Center for Environmental Science, Cambridge, MD.
Mangroves form structurally-complex environments at the waters edge providing habitat for both terrestrial and marine wildlife. Mangrove proproots provide substrate on which algae, sponges, tunicates, bivalves, bryozoans, crustaceans and critical habitat for numerous fish species. There was significant mangrove mortality associated with Hurricane IRMA in 2017. Some locations in the lower keys and 10,000 islands area suffered 20-30% mortality. Although recovery has begun it will take several years for many sites to return to pre-storm mangrove cover levels.

Hardbottom habitats occur throughout Florida Bay and support sponges, macroalgae and soft and hard corals attached directly to low relief limestone rock covered with a thin veneer of sediment. Hardbottom habitat is made up of sessile organisms attached directly to limestone rock covered with a few centimeters of sediment. These areas provide important juvenile habitat for spiny lobster (pictured vase sponge in foreground, loggerhead sponge in background).

Florida Bay contains one of the largest continuous seagrass beds in the world. Seagrass help maintain water clarity, stabilize the bottom, and provide food and shelter from predators to the numerous species of fish and invertebrates.
At around 500,000 acres, these meadows are some of the largest and most continuous in the United States.... They are dominated mostly by turtle grass (*Thalassia testudinum*), but manatee grass (*Syringodium filiforme*) and shoal grass (*Halodule wrightii*) are always present to some degree.

In general, turtle grass prefers near oceanic salinity, manatee grass mid-range salinities, and shoal grass does well under a range of salinities. Shoal grass often is the first grass to come back following die-off events. Seagrass beds with a mix of these species are generally more resilient.
There have been multiple seagrass die offs in Florida Bay in recent times. The largest and most extensive die off occurred in the late 1980s and early 1990s, in which more than 60,000 acres of seagrass were lost.

Extremely high salinities during a drought period in 2015 preceded another seagrass die off that affected a large portion of North Central Florida Bay. At least 20,000 acres of seagrass were lost. This die off was curtailed by heavy rains during the fall of 2015 which brought salinities back to a normal range.

Massive rafts of dead seagrass were documented associated with Hurricane Irma in 2017. Subsequent sampling has shown these effects to be relatively short lived with little total seagrass lost.

Loss of seagrass has initiated a cascading set of disturbances in Florida Bay. The massive seagrass die-off that began in 1987 resulted in the release of nutrients from decaying plant matter and widespread turbidity increases from sediment resuspension. These factors fueled algal blooms and contributed to a massive sponge die-off. Nearly every species of sponge was affected and in some areas more than 90% of the sponges died. Shading from the algal blooms may have fueled a secondary seagrass die-off a few years later. Loss of critical seagrass and sponge juvenile habitat impaired pink shrimp and lobster fisheries. Ultimately, Florida Bay experienced 10 years of recurrent algae blooms.
### Importance of Sponges in Florida Bay

- Filter large amount of water, removing particulates and transforming nitrogen into forms that are used by seagrass and phytoplankton
- Major structural component of the Florida Keys shallow-water ecosystem
- Essential habitat for fish and invertebrates that live around and under sponges
- Small scale commercial sponge fishery with no landings since 2015

Sponges are important habitat and filter large amounts of water which is fundamental to good water quality in Florida Bay. The commercial sponge fishery in Florida Bay has been historically very small scale. In 2014, 78,000 lbs of sponges (multiple species) were landed, in 2015 that number declined to less than 15,000 lbs and no commercial sponge landings were recorded in 2016-2018.
Sponge Die-offs in Florida Bay

- Periodic blue-green algae blooms in south-central Florida Bay have caused sponge die-offs in an area ~500 km²
- Reduced sponge biomass > 95% throughout much of this area
- Takes 10-15 years for sponge community to recover to pre-bloom conditions
Sponge Restoration in Florida Bay

- Many species of sponges can be easily propagated by cutting pieces of tissue from a healthy sponge
- FWC has five in-water sponge nurseries housing ~ 13,000 sponges
- FWC will outplant at least 15,000 sponges in late 2019
  - Test sponge restoration approaches designed to maximize sponge reproduction
  - A large-scale restoration to test broader ecosystem effects
Florida Bay has a history of cyanobacteria blooms since the 90’s; after these central FL Bay blooms, similar issues occurred in Barnes and Blackwater sounds in the mid 2000s.

These events are often associated with sponge and/or seagrass mortality, sometimes mortality occurs before the event, and sometimes during the event.

The cells that cause these blooms can reach 100’s of millions of cells per L, are tiny, and difficult to identify and enumerate using traditional technology

Figures and/or data from Berry et al. 2015, Glibert et al. 2008, and Phlips et al. 1999
Red Tide and Florida Bay

- Relatively uncommon in Florida Bay
  - 26 times in 66 years
  - Rare for red tide to reach central and northeastern basins
  - Red tide typically not considered a major factor in Florida Bay

Documented blooms (> 100,000 cells/liter)
Extensive bay-wide fisheries sampling was conducted in Florida Bay between 2006-2009. Results show a diverse fish community with distinct differences among basins tied to salinity variability and seagrass cover. The bar chart shows the most abundant species samples in two nearshore basins with highly variable salinity patterns, Long Sound and Little Madeira. Long Sound had relatively low seagrass coverage and had lower abundance of seagrass associated species such as spotted seatrout. Little Madeira basin, with high seagrass coverage, has a more diverse and abundant fish assemblage.

Because of the difficulty in efficiently sampling nearshore habitats in Florida Bay, we have deployed remote baited underwater video systems to monitor fish community structure. This plot shows the relative abundance of seven species in three nearshore basins of Florida Bay, Little Madeira, Joe Bay and Long Sound (west to east). Joe Bay recently reopened to catch and release fishing (2016) after a 36 year closure.
Florida Bay is a foraging area for thousands of sea turtles. We have captured about a thousand individual loggerheads at our study site in a relatively small area of southwestern Florida Bay. Many sea turtles are resident in Florida Bay for periods of at least a decade or two.
Conclusion

- Florida Bay is a unique estuarine system that is naturally highly variable and seasonally hypersaline in some areas.
- Water diversions and withdrawals have greatly reduced freshwater input into Florida Bay and amplified this natural variability.
- Florida Bay’s large, shallow basin makes it highly susceptible to meteorological events (rainfall, drought, hurricanes).
- Internal basins within Florida Bay may have limited water exchange and develop their own ecological conditions.
- North Central Florida Bay has been the epicenter for seagrass and sponge die-offs that have affected much of the bay – delivering freshwater to this portion of the bay remains a challenge.