Water circulation and renewal in Florida Bay

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We need a new figure here that shows the southern tip of Florida with labels for Everglades National Park, Shark River, Taylor Slough, ahd all five regions of Florida Bay.

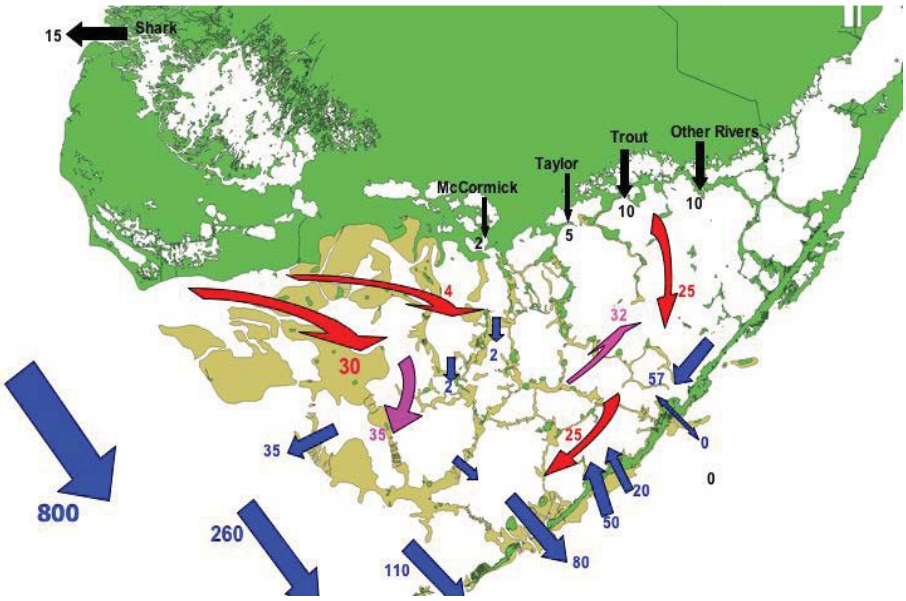
Florida Bay is located at the southern end of Everglades National Park (ENP), between the mainland and the Florida Keys. The Bay waters interact with adjacent coastal waters of the Southwest Florida Shelf to the west and Florida Keys to the east and southeast. Exchange of Bay interior waters with the Atlantic Coastal Zone of the Keys is restricted to a few narrow tidal channels in the Keys island chain between Key Largo and Islamorada. Whereas, water exchange with the southwest shelf region takes place across a 40-km (25-mile) wide open boundary. The combined tidal harmonics of the Gulf of Mexico and the Atlantic produce a mixed tide along this wide western boundary with a tidal range of 1 to 1.5 m (3 to 5 ft).

Surprisingly, the largest tide in the Gulf of Mexico or on the U. S. eastern seaboard south of Brunswick, Georgia, occurs at the mouth of Shark River. Here the tidal range can reach over 2 m (6.5 ft) during spring tides. Not surprising then, Flamingo Channel, which is the northwest entrance to the Bay and is only about 10 km (6 mi) from the mouth of Shark River, is the largest open channel to the Bay and has the greatest tidal exchange. The northern boundary of the Bay is fringed with mangroves and coastal lagoons. Fresh water discharge to the Bay is primarily confined to the northeastern region through Taylor Slough and Trout Creek.

The interior of the Bay is made up of a complex network of shallow basins with depths rangingfrom 1 to 3 m (3 to 10 ft) deep, separated by mud banks and mangrove islands. Connection between basins occurs through narrow channels and over the shallow banks. Water depths over the banks are typically less than 0.3 m (1ft) deep. During periods of low sea level (i.e., winter dry season or strong winds toward the west or southwest), the banks can become exposed, causing further isolation of the interior basins. The mud banks are also primarily responsible for the large landward fall-off in tidal range, which decreases from 1.5 m (5 ft) at the open western connection of the bay to a few centimeters (1 in) near the Bay's northeast boundary.

The typical climate of south Florida consists primarily of two seasons; a dry season during winter/spring and a wet season during summer/fall. The balance of freshwater flux, controlled by river discharge, precipitation, and evaporation, is negative during the dry season and positive over the wet season. This leads to increasing salinities in Florida Bay during the dry season and decreasing salinities in the wet season.

The configuration of mud banks and mangrove islands within Florida Bay, and differences in the magnitude of volume exchange with adjacent water bodies, together with the isolation of river discharge into the northeast tends to separate the bay into four subregions: northeast, north-central, southeast and western (see page xxx).



Annual mean volume transports (m^3/sec) in Florida Bay and through Keys (blue arrows) and estimated mean flow pathways (red arrows). River discharge is shown by **black arrows.** Estimated bank flow is shown by pink arrows.

The subregions of Florida Bay are characterized by prolonged hypersalinity in the north-central part and persistent lower salinity in the northeast with both subregions displaying large seasonal range of salinity. Salinity of the southeast and western subregions is more typical of the adjacent coastal areas, indicating enhanced water exchange with these regions.

Recent direct measurement of volume transports through channels connecting interior basins have been used together with time series of basin total volume transport derived from sea level measurements to estimate basin flushing rates and residence times and to identify the important physical processes regulating the water renewal. The measurement strategy was applied to the north-central, northeast and western subregions and clearly shows that local wind forcing is the primary flushing mechanism controlling basin residence times. South Florida winds are typically weak from the east and southeast during the summer, shifting to be more from the northeast during fall, with increased strength of wind events that can last several days. During winter and spring seasons cold fronts move through the region with a period of 3 - 7 days, causing increased winds that rotate clockwise from southwest through northwest to northeast. The cumulative effect from the passage of these wind events drives a mean flow through the basins with net inflows over the banks and net outflows through the channels. The resulting net basin through-flows are weak and require on the order of one year to replace an equivalent mean volume of the north-central and northeast basins.

Net basin through-flows were found to be significantly larger in the western basin, which resulted in enhanced water exchange with the adjacent coastal waters, moderation of seasonal changes in salinity and short residence times ranging from 0.5 to 2 months. Seasonal water balance estimates indicate that groundwater discharge to Florida Bay is negligible.

Florida Bay mean flow pathways were estimated from annual mean volume transport measurements, river discharges and derived bank flow estimates. The annual river discharge to the Bay of 25 m^3/second is essentially trapped in the eastern part with little diluting influence on hypersalinity of the north-central bay. To reduce hypersalinity in the Bay and corresponding degradation of water quality will require a diversion of a portion of the river discharge to the central region via McCormick Creek. There is a weak mean flow pathway from Flamingo Channel eastward across northern banks and then southward through the north-central basin of 4 m^3/second. There is also a much stronger clockwise mean flow pattern of about 30 m^3/second from the major arm of Flamingo Channel that feeds a mean outflow through Rabbit Key basin and through the channels of Nine-Mile Bank. However this recirculation through the western basins is small in comparison to the 800 m^3/seconds net southward coastal flow that provides the connection to transport riverine discharges from the west Florida shelf and Ten Thousand Islands area (including Shark River) to the western basins of Florida Bay.