Florida Coastal Everglades
Long Term Ecological Research

Carbon Storage and Soil Burial Rates in Riverine and Scrub Mangrove Forests of the Florida Coastal Everglades, USA

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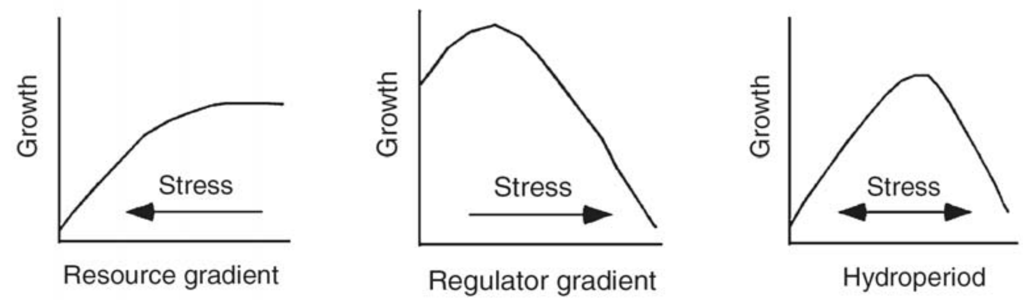
Riverine Mangrove Forests



Nutrients, Light

Salinity, Sulfide

Freq, duration, and depth

Environmental Gradients

Landscape Vegetation Patterns

Scrub Mangrove Forests

Hurricane Disturbances

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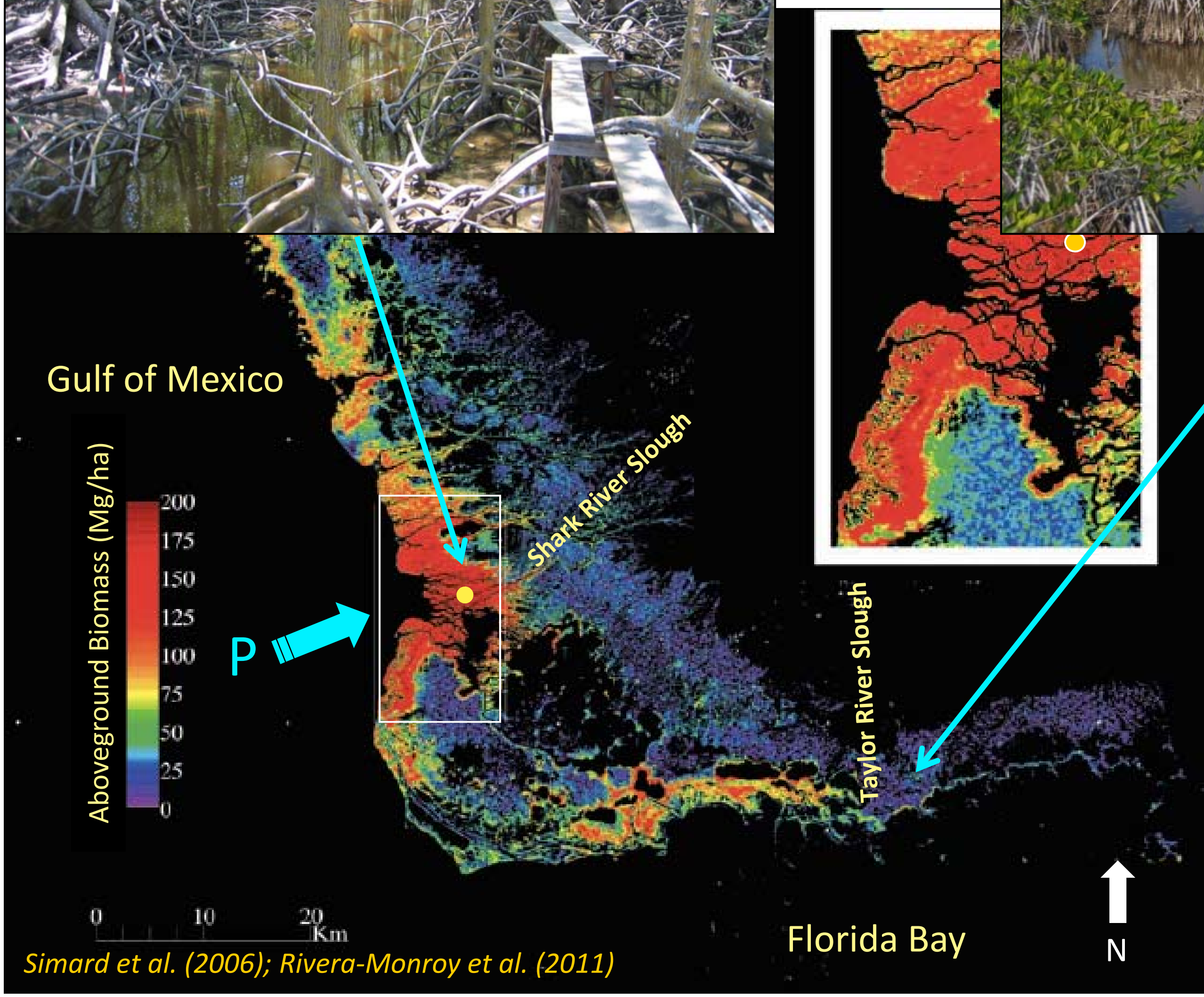
pical Moist



- Different mangrove types at the same latitudinal gradient.
- Karstic Oligotrophic P-limited system.
- P is supplied by the Gulf of Mexico during storm events.

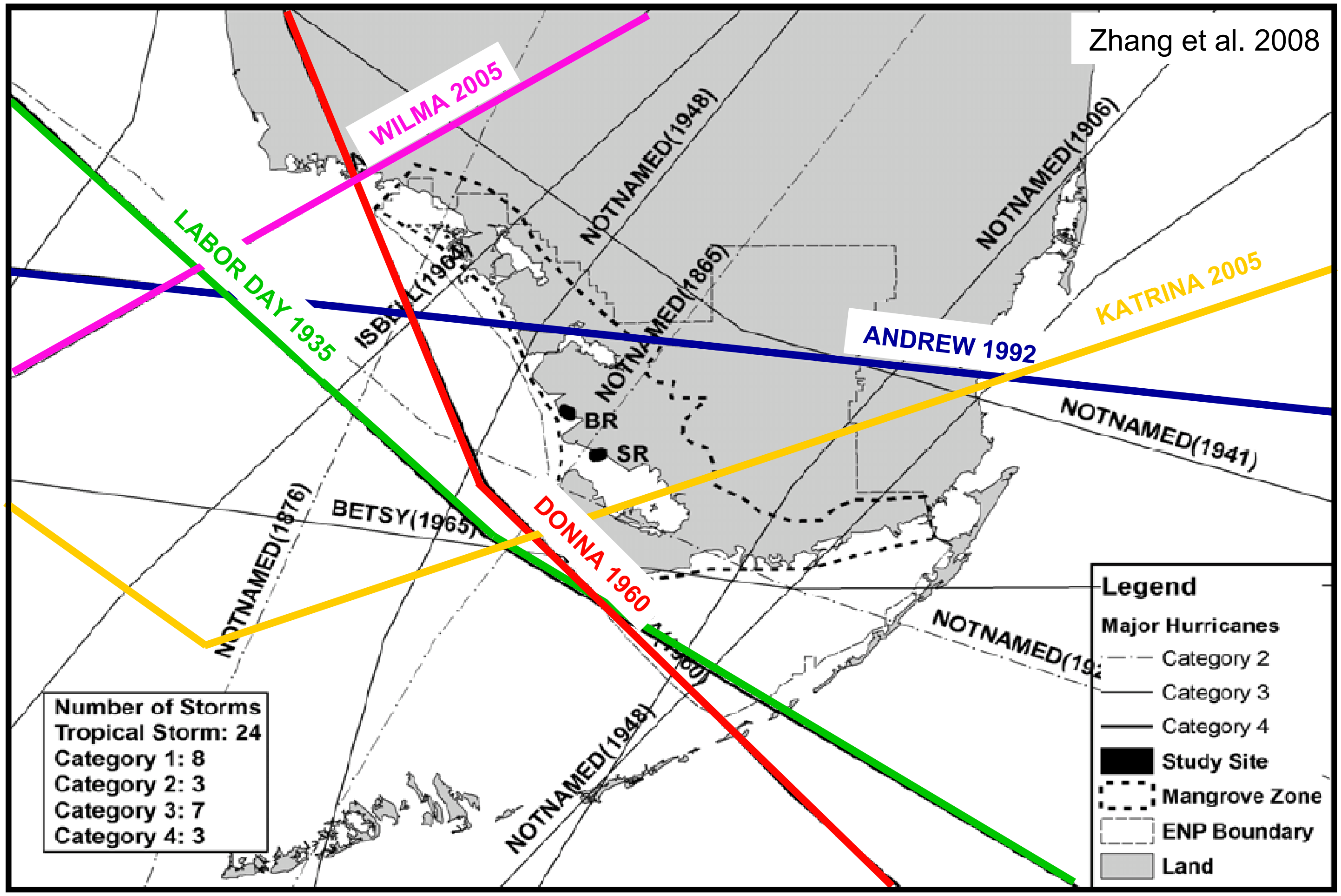
Landscape Gradients in Resources (nutrients), Regulators (sulfide), and Hydroperiod

- Hydroperiod: Tide-dominated
- P gradient: downstream to upstream limitation upstream (N:P = 105)
- PW Sulfide: Negligible (<0.06 mM)
- PW Salinity: 5-27 ppt

- Permanently or seasonally flooded
- No P gradient: P limitation in all sites (N:P ranges from 70-109)
- High (1.0-2.3 mM)
- 17-20 ppt

Castañeda-Moya et al. (2013)

High Recurrence of Tropical Storms and Hurricanes in South Florida



- South Florida has been struck by 40 named storms since 1926.
- Three category 4 hurricanes have impacted the FCE mangrove zone.
- The frequency of direct hits by category 3-5 hurricanes is ~once every 20-30 years.

Hurricane Wilma caused Defoliation, Tree Snapping, and Uprooting

Wilma (category 3) landed at FCE on October 24, 2005

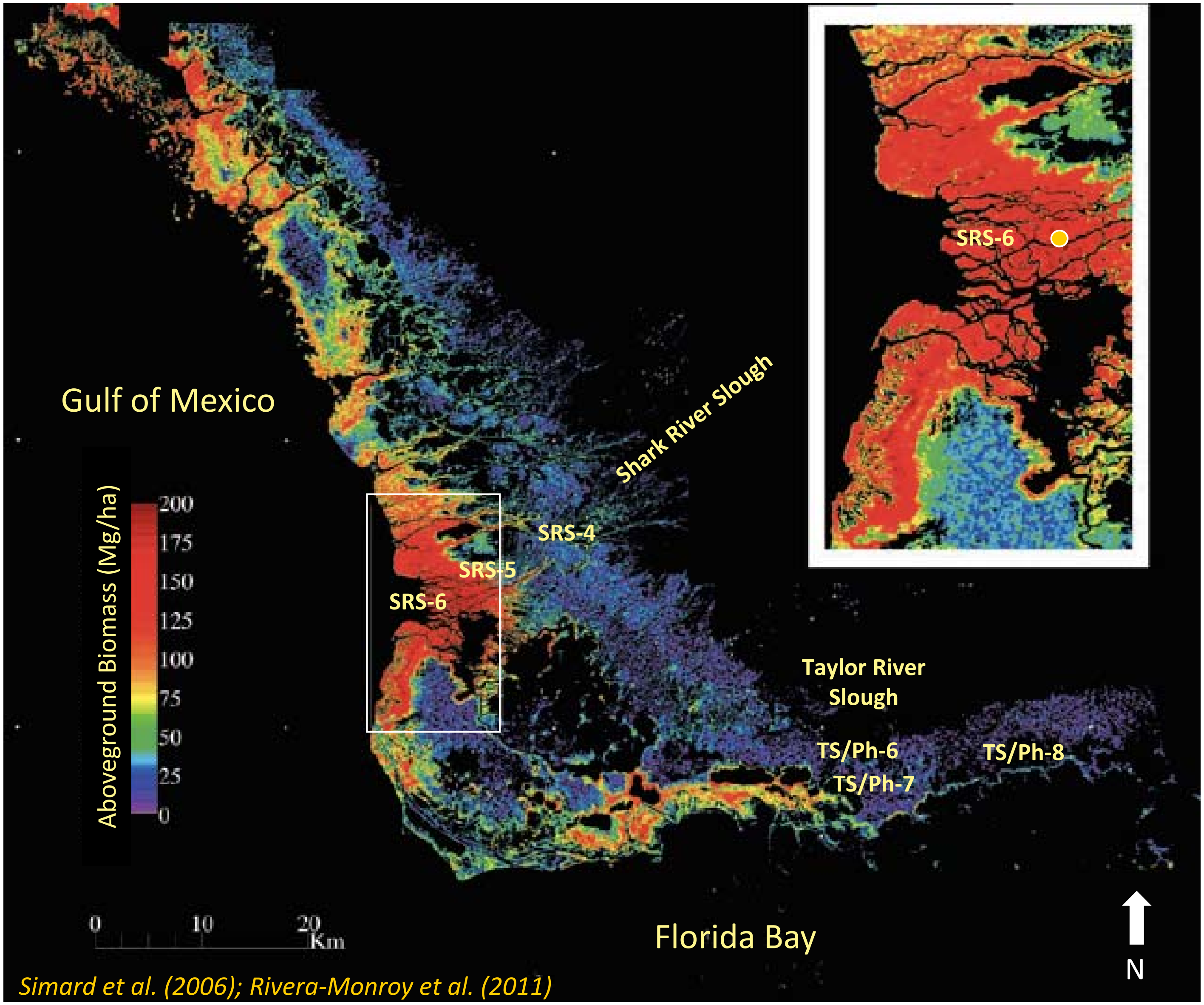
Research Questions

- What are the carbon allocation patterns between above- and belowground components of mangrove vegetation across the P-limited conditions of FCE?

- What is the total (vegetation and soil) ecosystem carbon storage in riverine and scrub mangrove forests of the Florida Everglades?

- What are the long-term soil accretion and carbon burial rates, and how do they vary between mangrove ecotypes?

FCE-LTER Mangrove Sites



Mangrove Sites

- Shark River:
- SRS-4 (upstream)
- SRS-5 (upstream)
- SRS-6 (downstream)

- Taylor River:
- TS/Ph-6 (upstream)
- TS/Ph-7 (upstream)
- TS/Ph-8 (downstream)

Aboveground Biomass

- Shark River sites and TS/Ph-8 (two 20 x 20 m plots).
- Trees (DBH > 2.5 cm) were tagged and measured (May 2001 to May 2004 - sampling is ongoing).
- Species-specific allometric equations for FCE mangroves.
- TS/Ph-6 & 7: Coronado-Molina 2004.

Belowground Biomass

- Dec 2000 and Dec 2002.
- Root cores (10 x 90 cm) collected from each site:

- Shallow (0-45 cm) and Deeper (45-90 cm) zones.

- Live roots: Fine (<2 mm), Small (2-5 mm), and Coarse (5-20 mm).

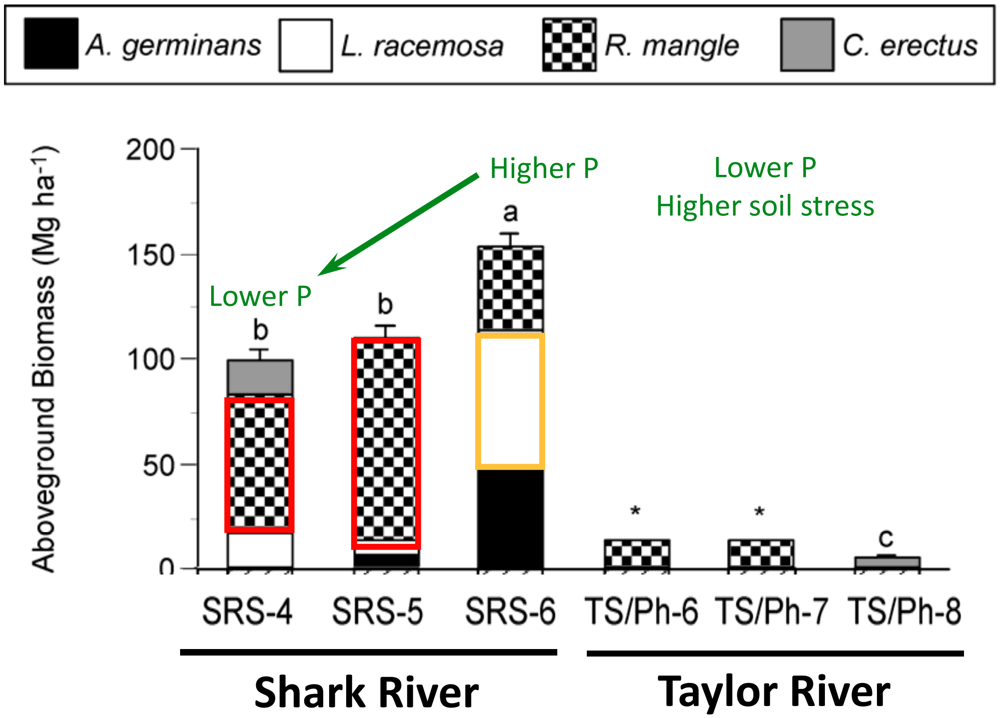
Soil C and Nutrient Pools

- May 2001 and Jan 2002.
- Soil cores (15 x 45 cm) collected from each site.
- Cores were divided into 2 cm intervals.
- Bulk density (BD), OM content, CNP, and burial rates using ^{137}Cs.

Ecosystem C Storage

- Vegetation (AG + BG): Biomass * [C]
- Soil: [C] * BD * depth interval
- Ecosystem C storage: Vegetation + Soil (0-45 cm)

Above- and Belowground Biomass (2001-2004)



- **Mean AG biomass**:
- Shark River = 122 $\pm$ 20 Mg ha^{-1}
- Taylor River = 9.4 $\pm$ 2.7 Mg ha^{-1}

- ***R. mangle***: 70-80% of total biomass in upstream sites of Shark River.

- ***L. racemosa***: 43% of total biomass in SRS-6.

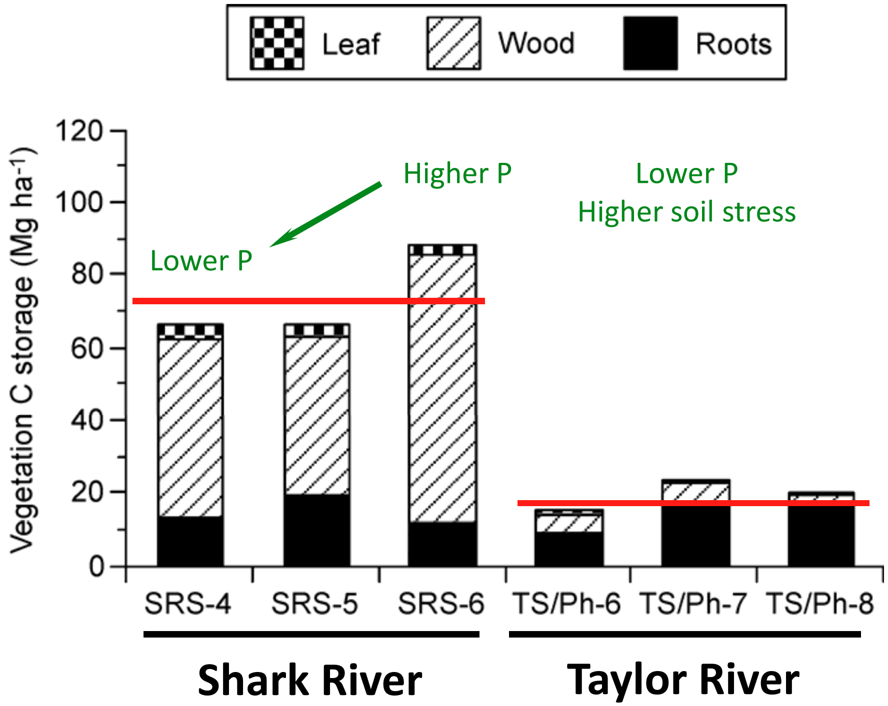
- **Average BG biomass** = 35 $\pm$ 4 Mg ha^{-1}

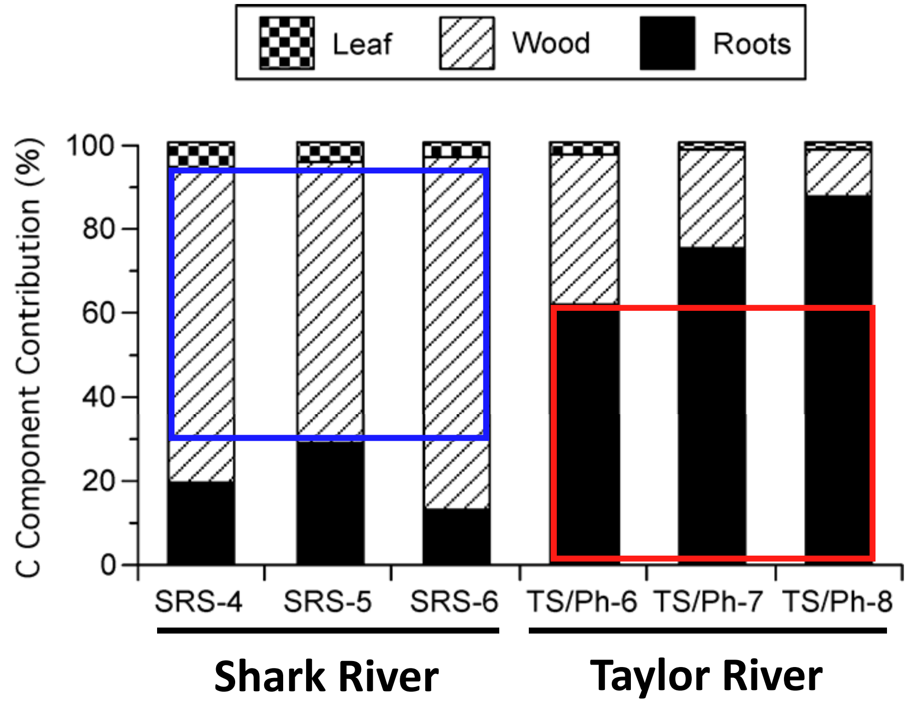
- Root biomass allocation was higher in mangrove sites with lower P fertility.

** TS/Ph-6 & 7: Coronado-Molina et al. (2004)*

Castañeda-Moya et al. (2013)

Above- and Belowground Carbon Storage

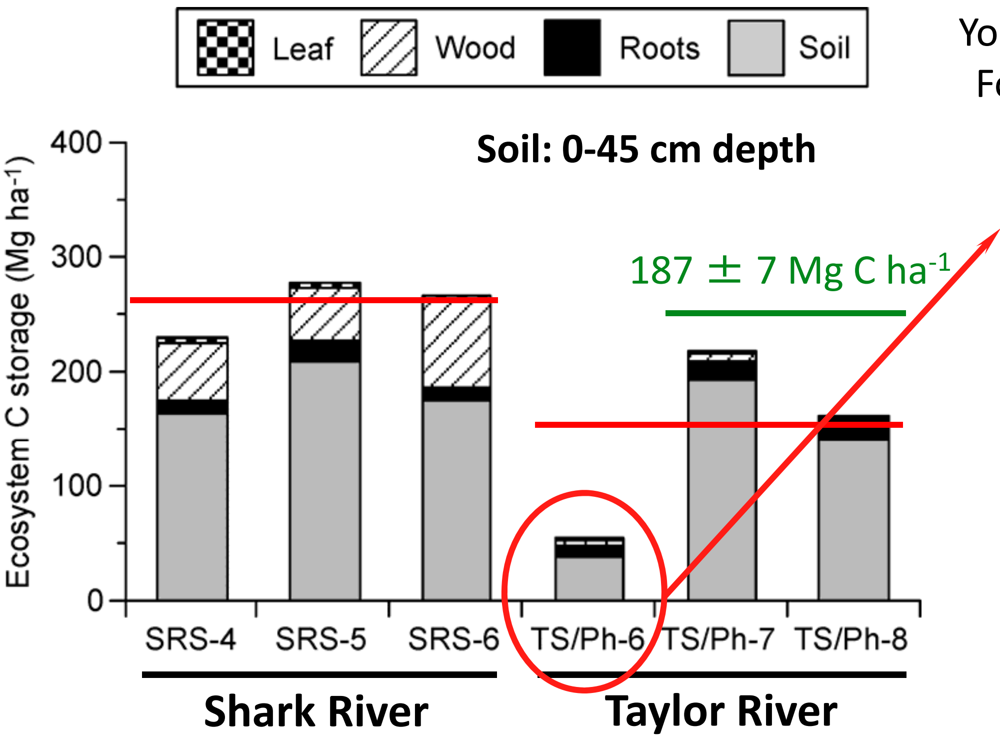




73 ± 7 Mg C ha^{-1} 19 ± 2 Mg C ha^{-1}

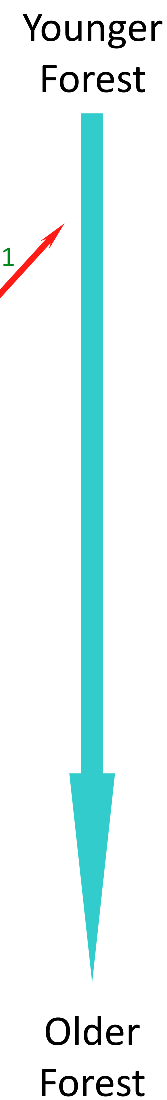
- Vegetation C storage is 4x higher in riverine mangroves compared to scrub forests.
- Shark River: Wood contributed 67-84% of the total C storage.
- Taylor River: Roots accounted for 61-88% of the total C storage.

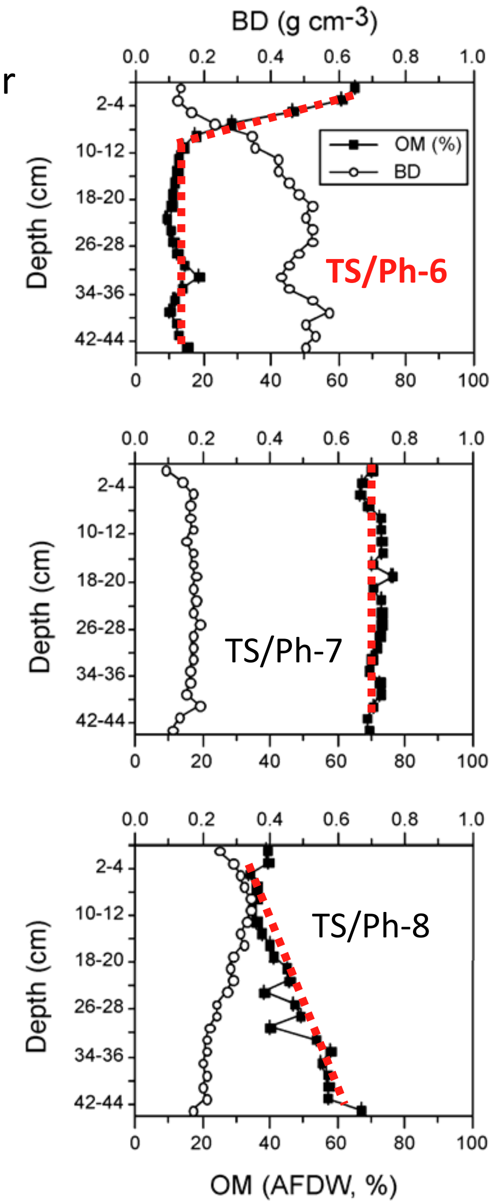
Ecosystem Carbon Storage (Vegetation & Soil)



255 ± 14 Mg C ha^{-1} 142 ± 47 Mg C ha^{-1}

Regardless of mangrove ecotype, most (**67-90%**) of the total ecosystem C pool is stored in the soil.



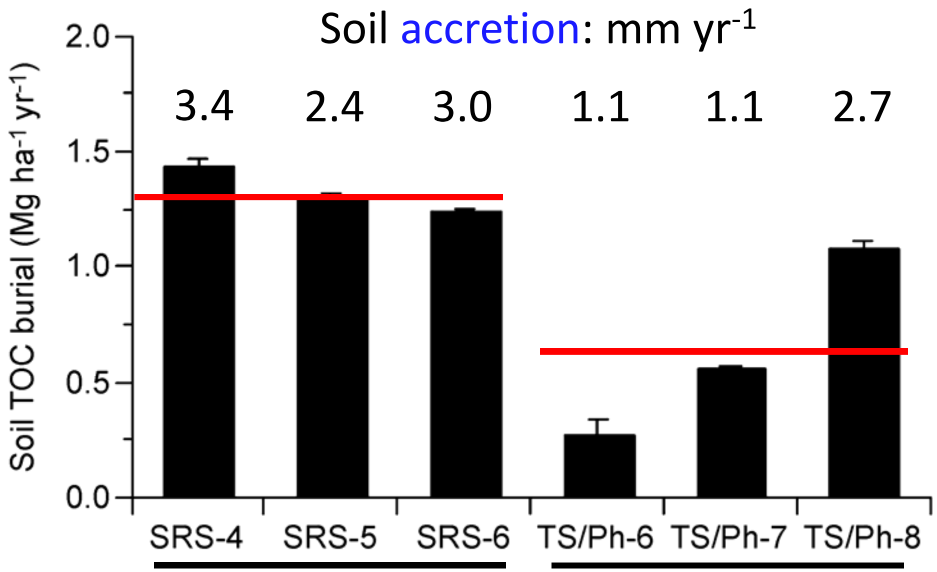


Taylor River

BD and OM with soil depth

Age of soil formation and mangrove establishment determine differences in C storage.

Long-term Soil Organic Carbon Burial Rates



Shark River **Taylor River**

1.31 ± 0.1 Mg ha^{-1} yr^{-1} 0.62 ± 0.2 Mg ha^{-1} yr^{-1}

- Deeper organic peat deposits in Shark River; peat depth ranges from 2 (SRS-4) to 4.5 m (SRS-6).
- Shallow (<1.5 m) soil peat in Taylor River basin.
- Unaccounted C in deeper (>45 cm) mangrove soils.

Deeper core section: 1.94 to 2.45 m

Courtesy: Qiang Yao, LSU

top 45 cm of soils

Summary

• Contrasting landscape patterns of vegetation (above- and belowground) C storage.

- P fertility and hydroperiod gradients control these patterns.

• Riverine mangroves allocated four times more C to vegetation relative to scrub mangrove forests.

- Wood: Highest contribution (67-84%) to the total C storage in vegetation (riverine).

• Higher allocation of carbon to roots (61-88%) in scrub mangroves of Taylor River.

- High root:shoot ratios.
- P limitation and high soil stress conditions.

• Soils represented the largest (67-90%) C pool of the total ecosystem storage in riverine and scrub mangroves.

- Deeper (>45 cm) soil peat deposits represent a significant pool of soil C storage (unaccounted in most studies).
- Significant role of belowground allocation to carbon sequestration in mangroves of south Florida.