Marsh-derived DOC and its fate in the coastal ocean of the northern Gulf of Mexico

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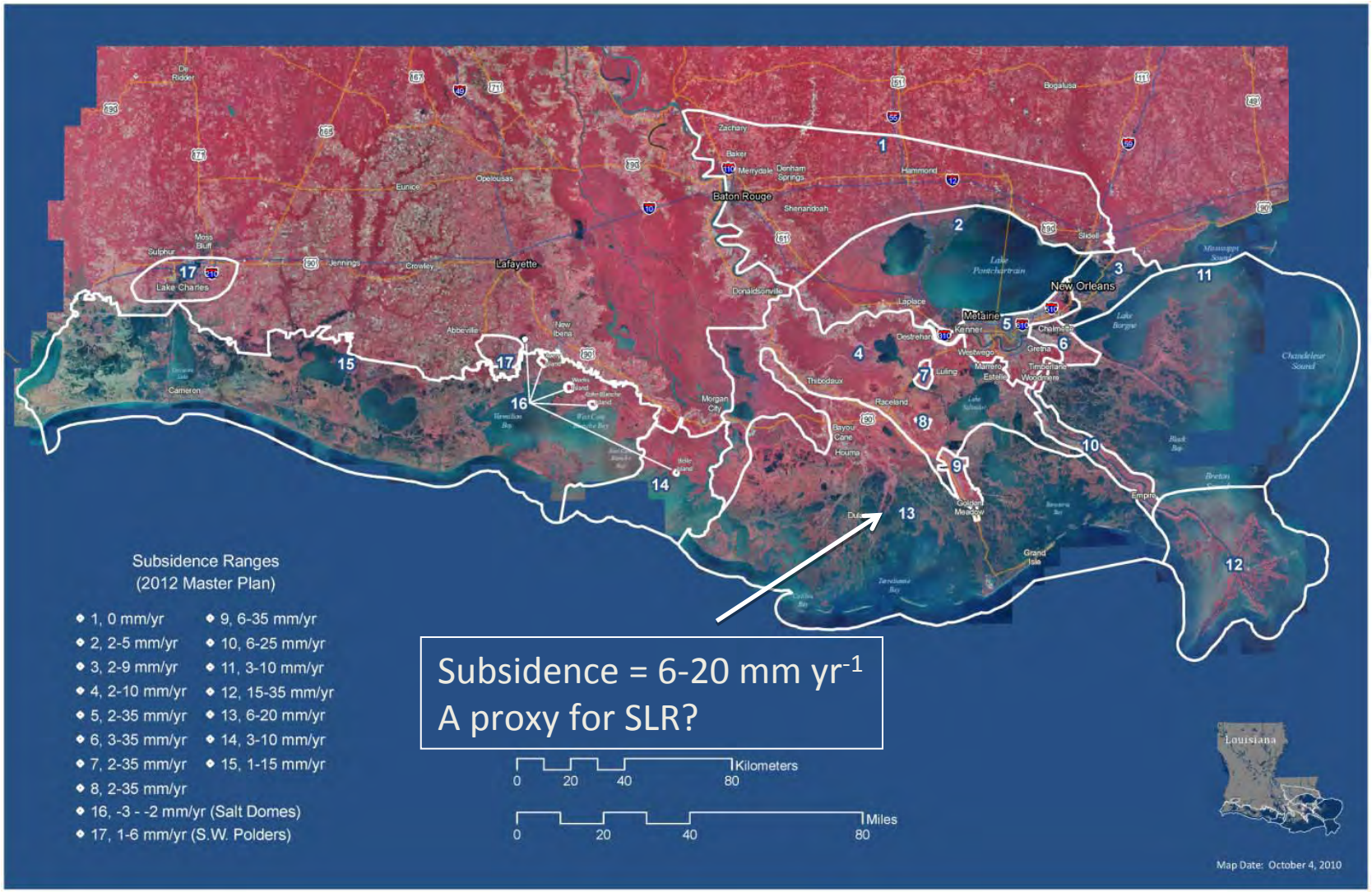
Some Background

Salt marshes, along with mangroves and sea grass beds, are 'blue carbon' environments that store large amounts of organic carbon and are significant to the global carbon budget.

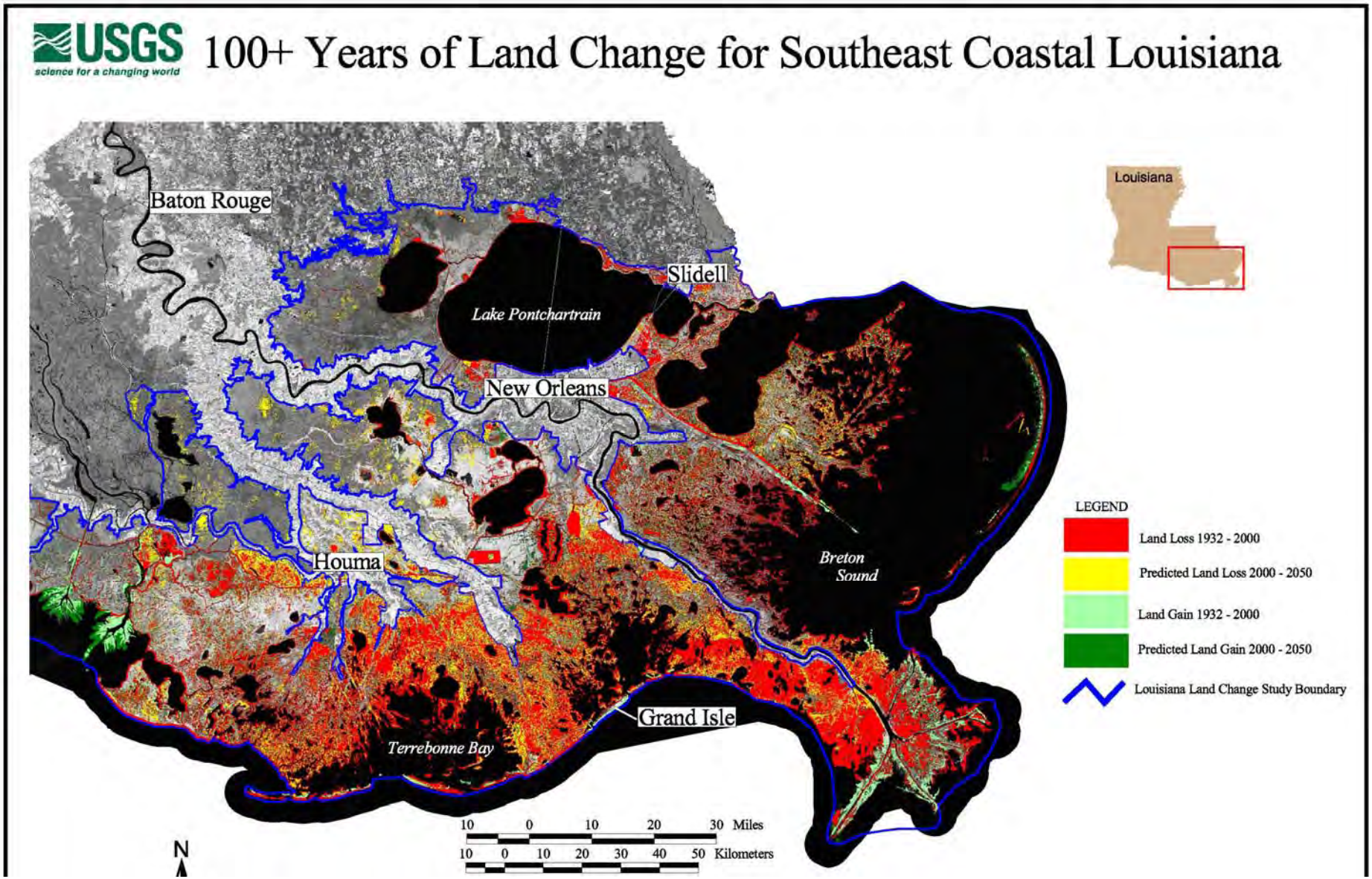
Coastal LA has 37 % of the estuarine marshes in the US (excludes Alaska).

Louisiana marshes are rapidly disappearing due to subsidence (mostly) and erosion.

- Main reason for the high subsidence rates is the lack of replenishment of river sediments associated with the MR levee system.
- Also, sediment load in river has decreased because of upriver dams.



- From 1985-2010, LA has had a wetland loss rate of 42.9 km^2 yr^{-1}



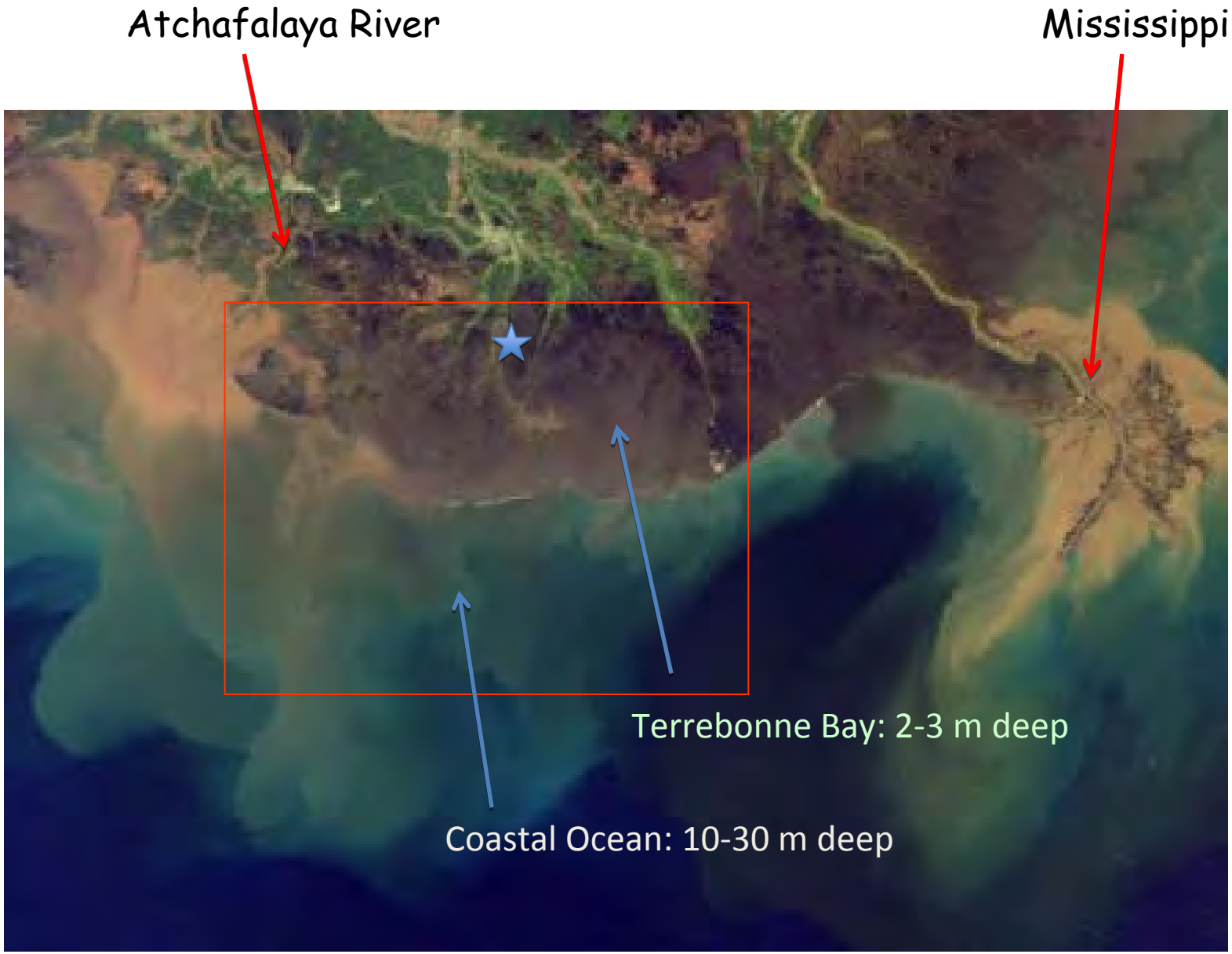
The goals of today's talk

Provide some details about the marsh contributions to the coastal ocean

Specifically:

1) Does marsh derived DOM reach the coastal ocean?
2) If so, does this DOM contribute to sedimentation and sequestration of POC.

Study area - detail




LUMCON Monitoring station

80 % of the days had some marsh flooding

Water height (m)

2.4
2.0
1.6
1.2
0.8
0.4
0.0
-0.4

9/1/07 11/1/07 1/1/08 3/1/08 5/1/08 7/1/08 9/1/08

Date

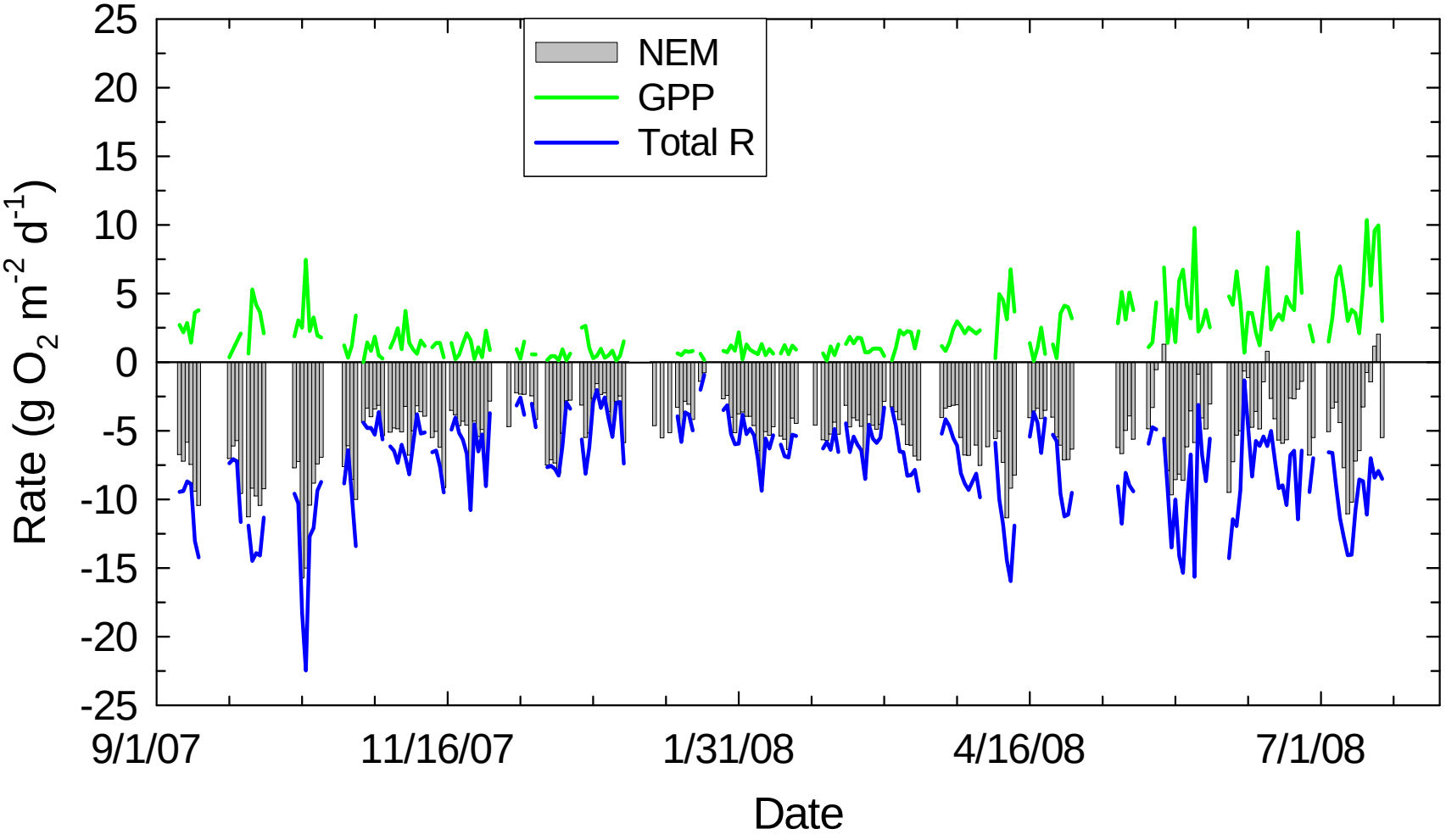
During these flooding and relaxation cycles, water draining off the marsh had a higher DOC concentration than water flooding the marsh.

Conclusion:

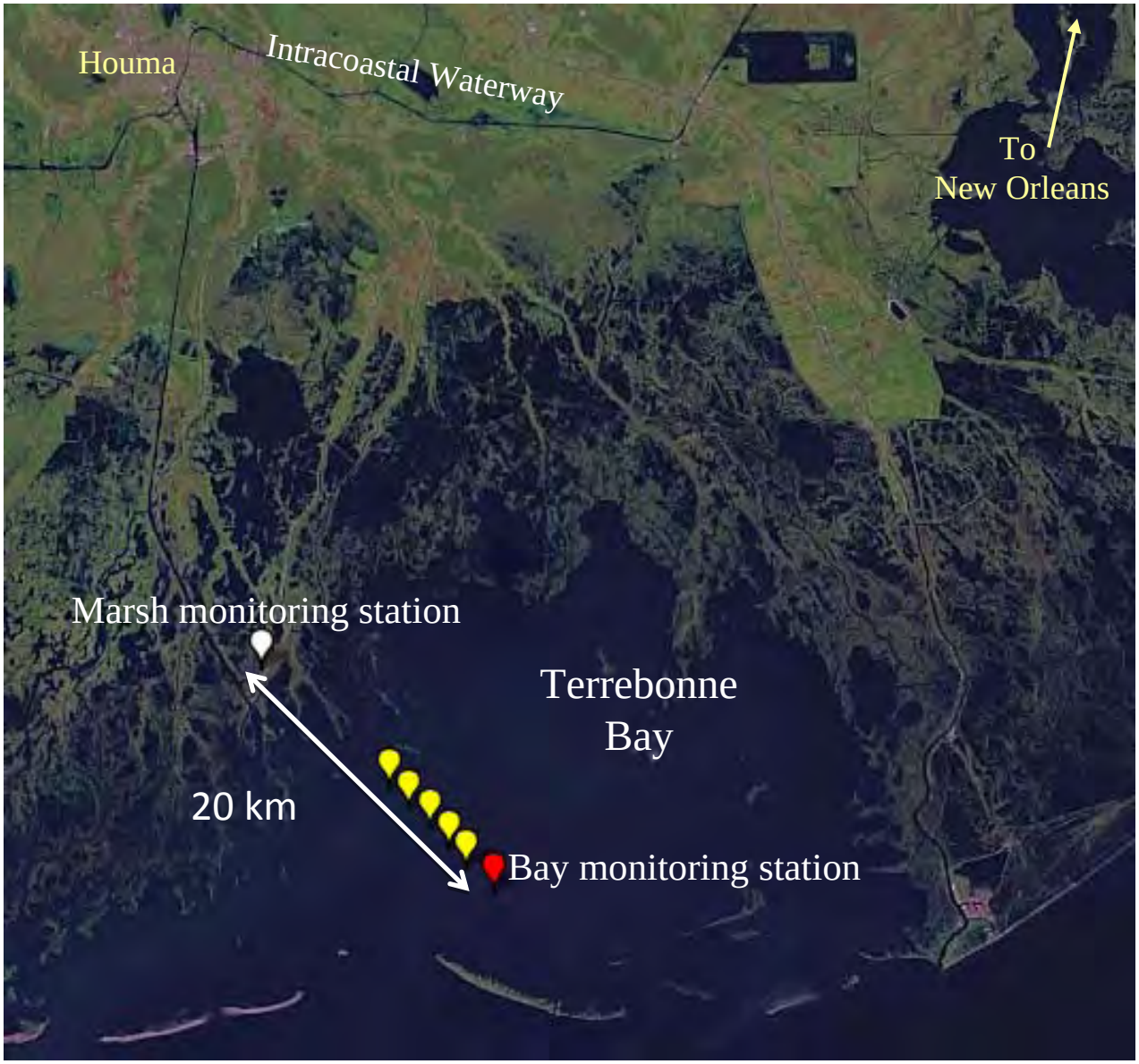
- when water floods onto the marsh it gains DOM from the marsh.
- when water drains off the marsh, it carries this DOM with it.

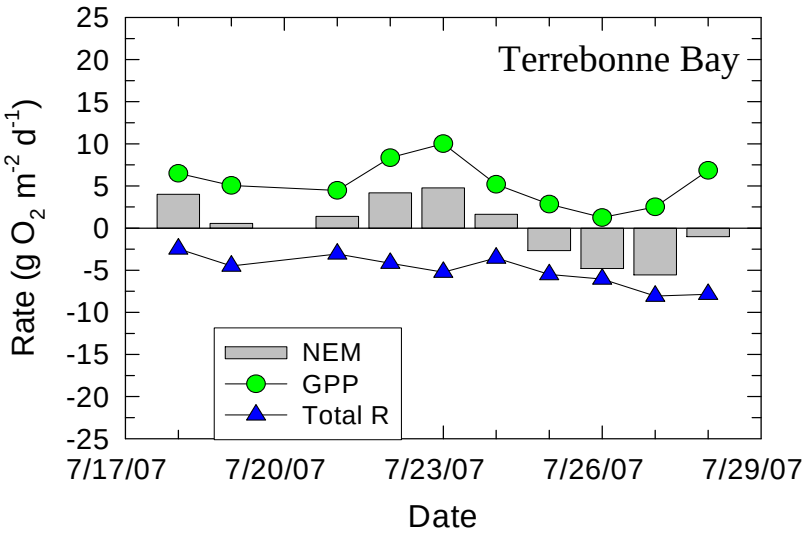
O_2 concentration in the water at the marsh edge was monitored (15 min intervals) for 1 year

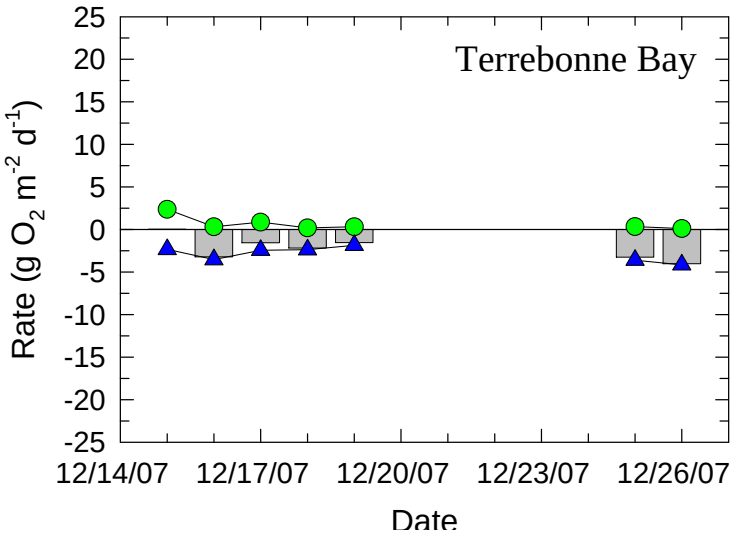
Ecosystem metabolism at marsh edge was net heterotrophic on 97 % of the days – external source of OM

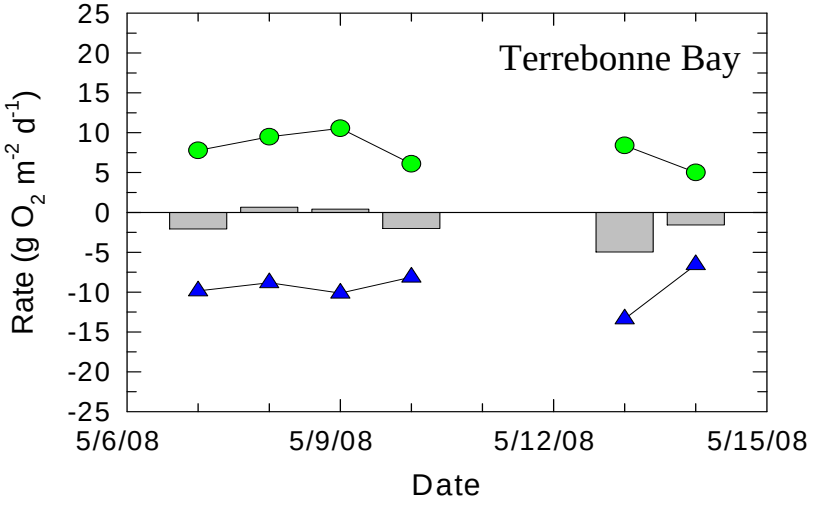


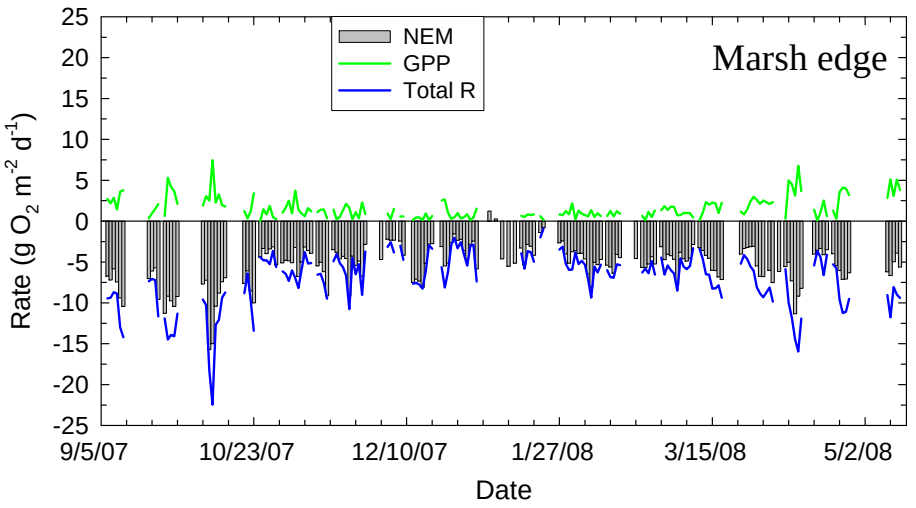
How far does this extend?


Houma
Intracoastal Waterway
To
New Orleans
Marsh monitoring station
Terrebonne
Bay
20 km
Bay monitoring station

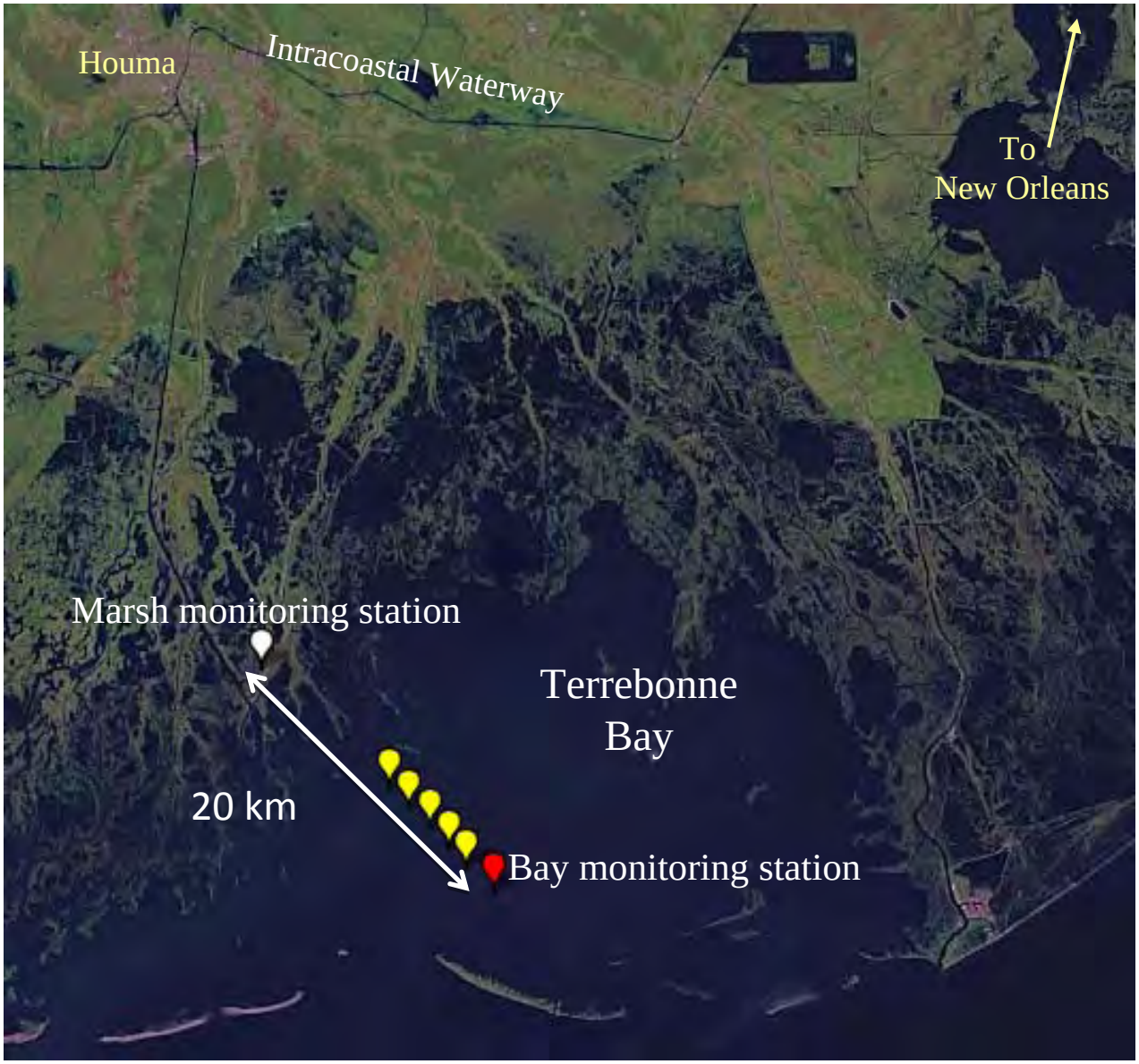








Water at the outer bay station is often net heterotrophic, but not as strongly as at the marsh edge.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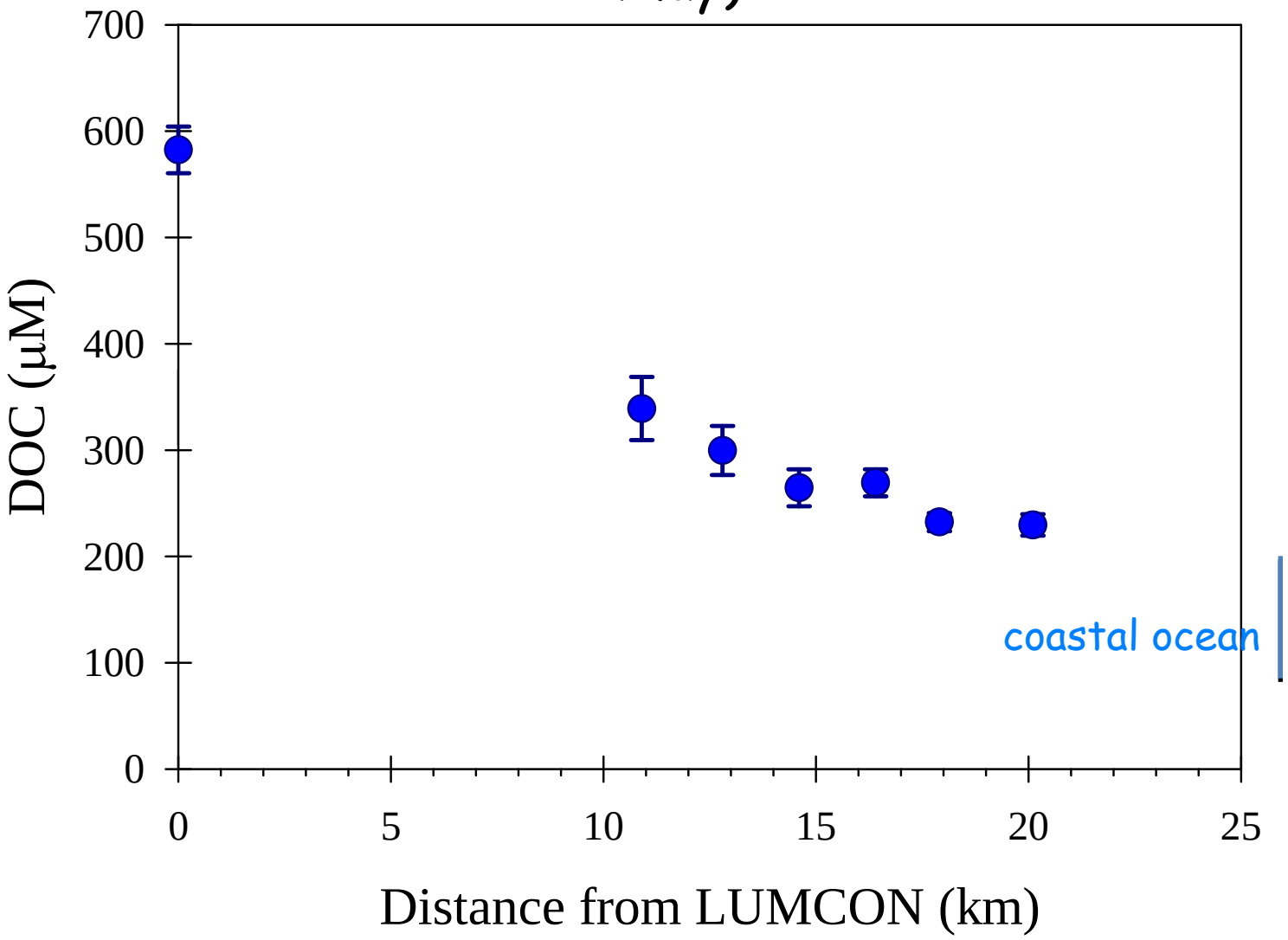
DOC gradient from marsh edge to outer bay – 7 surveys (August, September, October, December, January, April, May)



Summary so far

- DOC is added to water flooding the marsh
- Water near marsh edge is strongly net heterotrophic
- Outer bay is often net heterotrophic
- Strong gradient of decline in DOC from marsh edge to outer bay

Conclusion so far

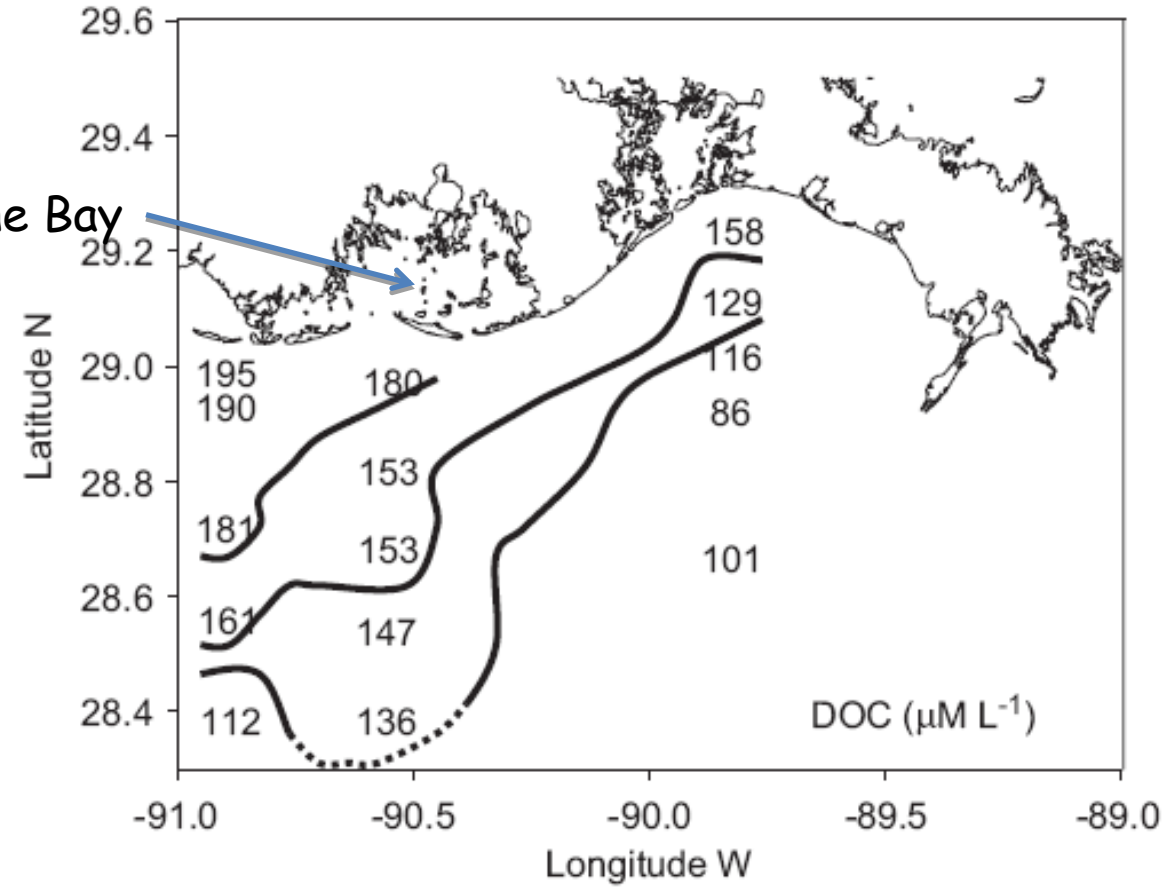
Some marsh - derived DOC is reaching the outer bay

Bay-Ocean exchanges

Based a hydrodynamic model – mean flushing time of Terrebonne Bay is 27 days (Inoue and Wiseman 2000)

Coastal ocean DOC – August 2004

Terrebonne Bay



DOC concentrations are higher in the inner coastal region
Contribution of marsh derived DOC vs river and in situ (?)

(from Dagg et al. 2008. CSR 28: 1127-1137)

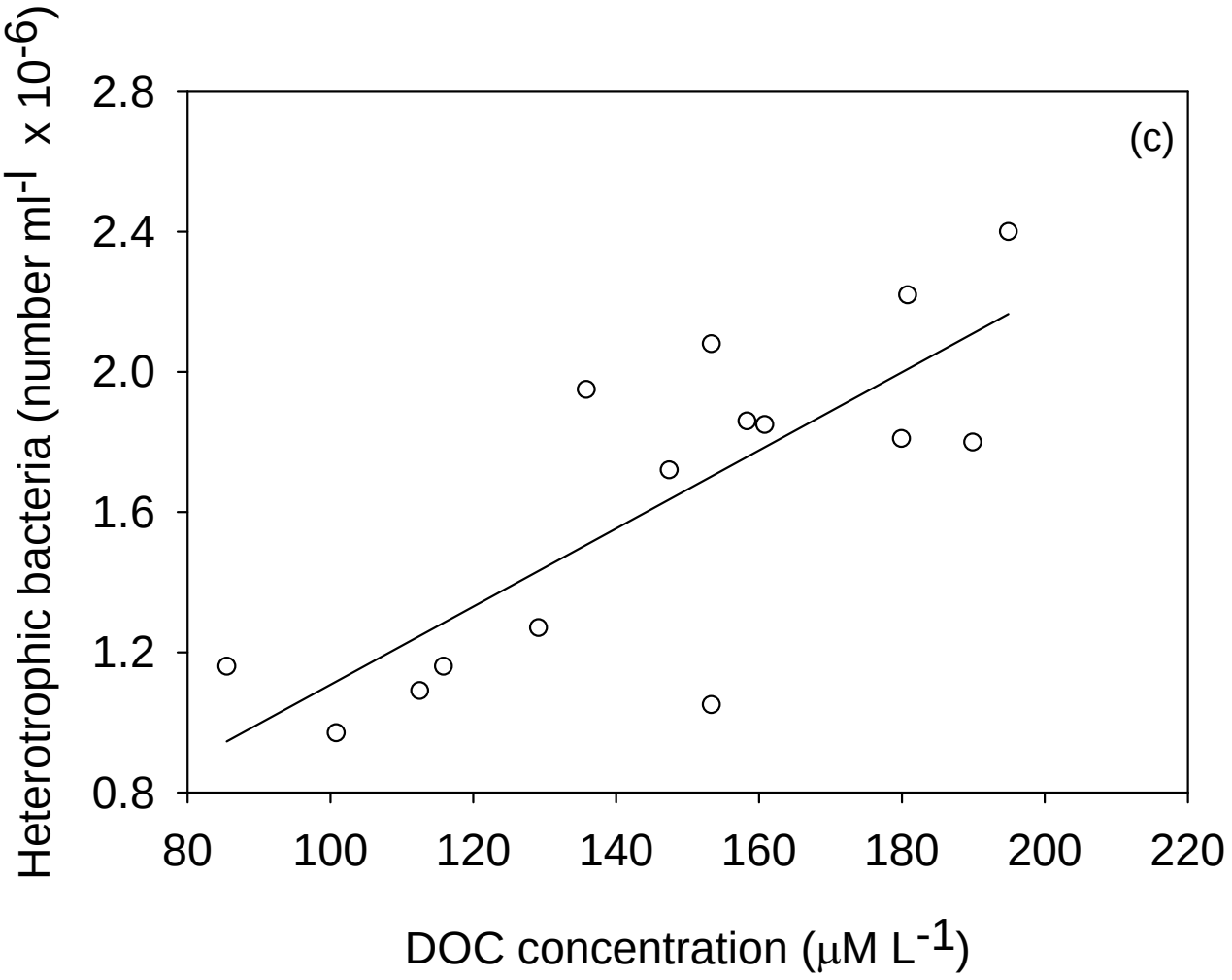
What are the fates of this marsh derived DOC in the coastal ocean?

1) Inert / refractory – advection (weeks to months)

2) Labile and available to bacteria

3) Photo-oxidation to inorganic forms available to phytoplankton or organic forms available to bacteria

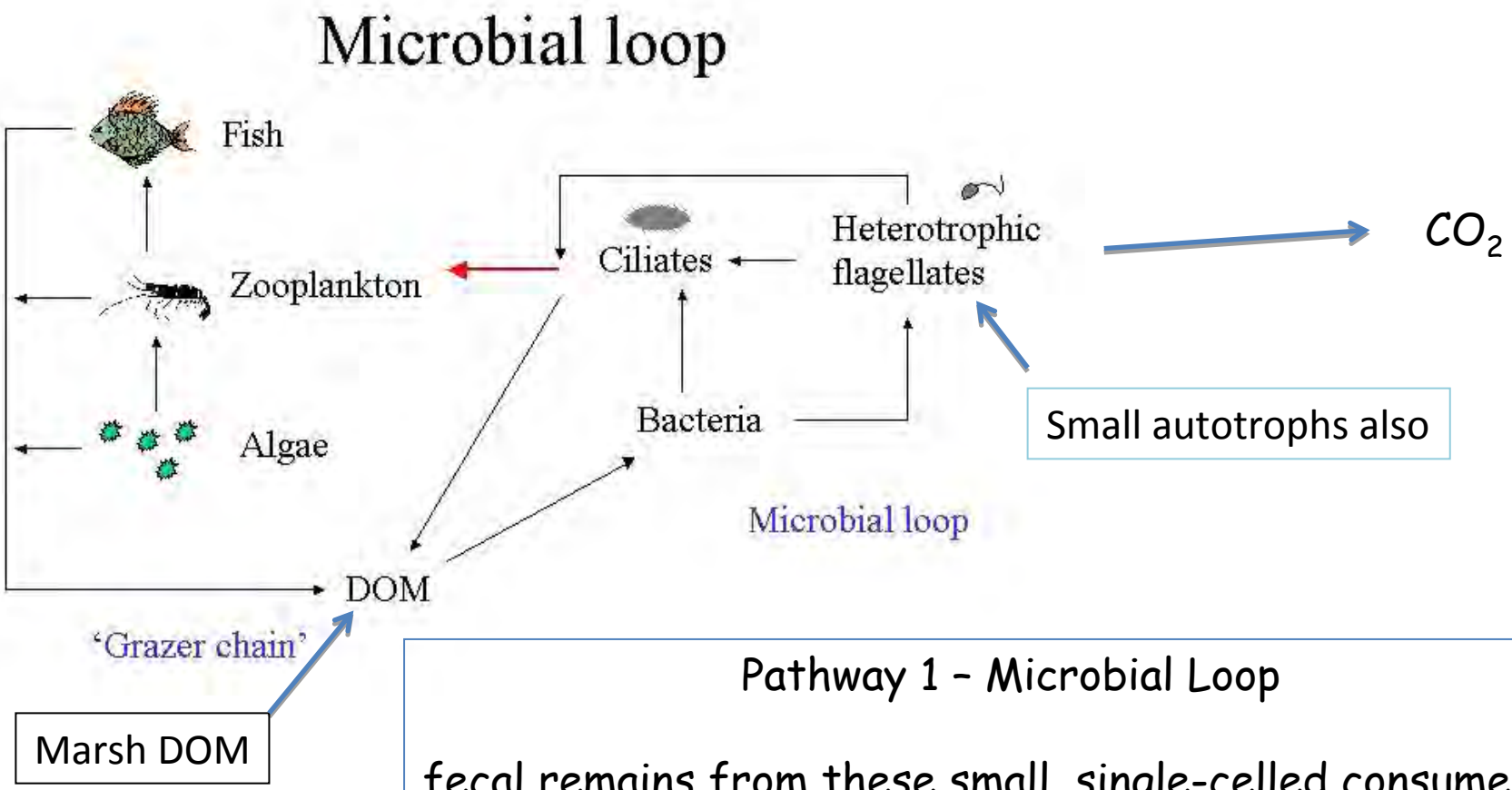
August 2004 – Coastal ocean bacterial uptake of to DOM



(from Dagg et al. 2008. CSR 28: 1127-1137)

There are two biological pathways for marsh DOC (bacteria) to become incorporated into larger particulate forms:

- microzooplankton - microbial loop
- appendicularians

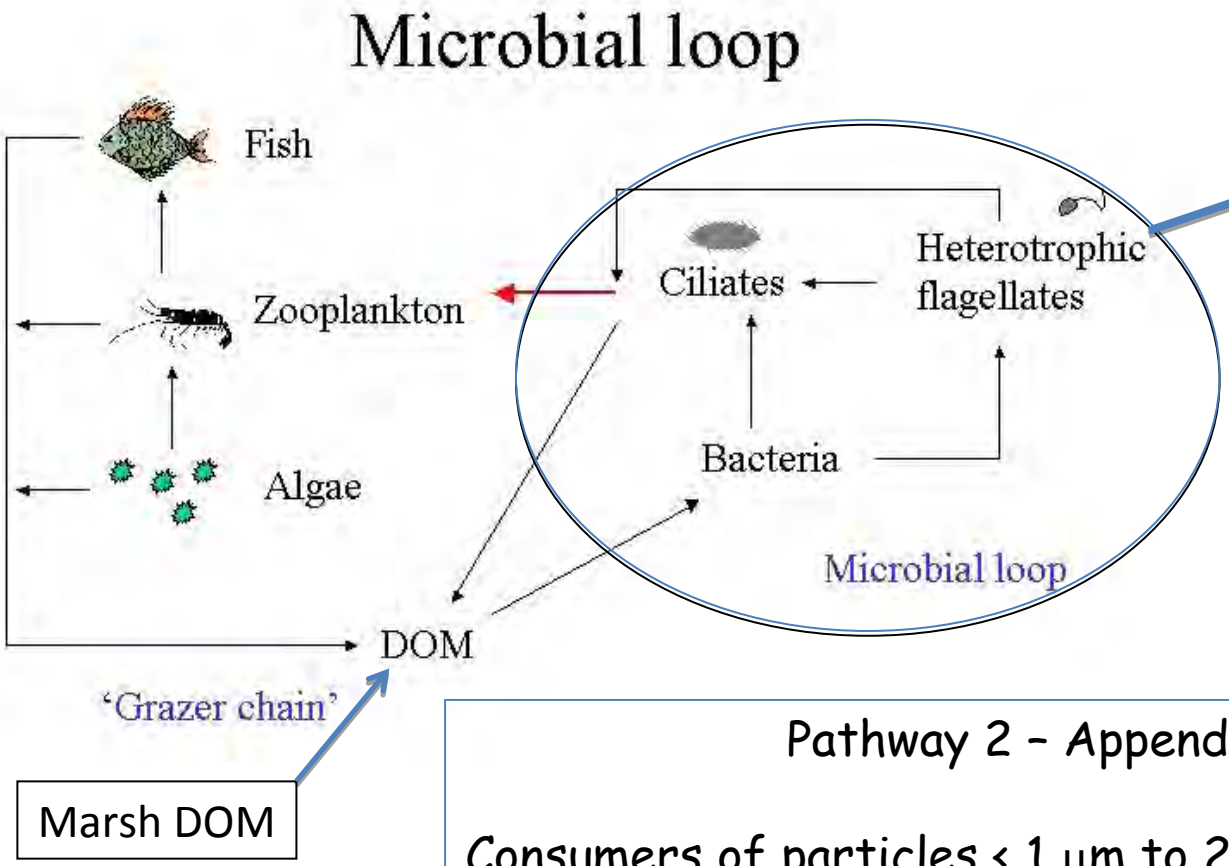


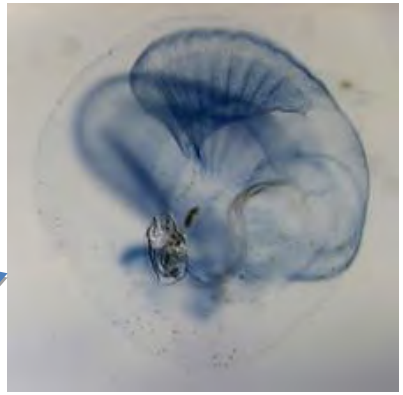
Pathway 1 – Microbial Loop

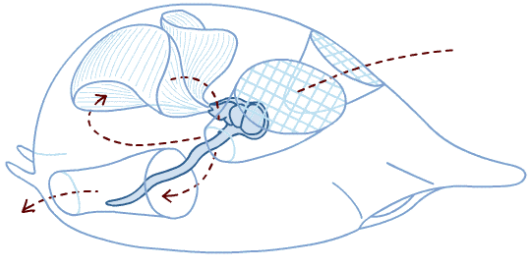
fecal remains from these small, single-celled consumers effectively do not sink.

Several trophic links = most organic C is respired

This pathway contributes little to OM flux to the bottom





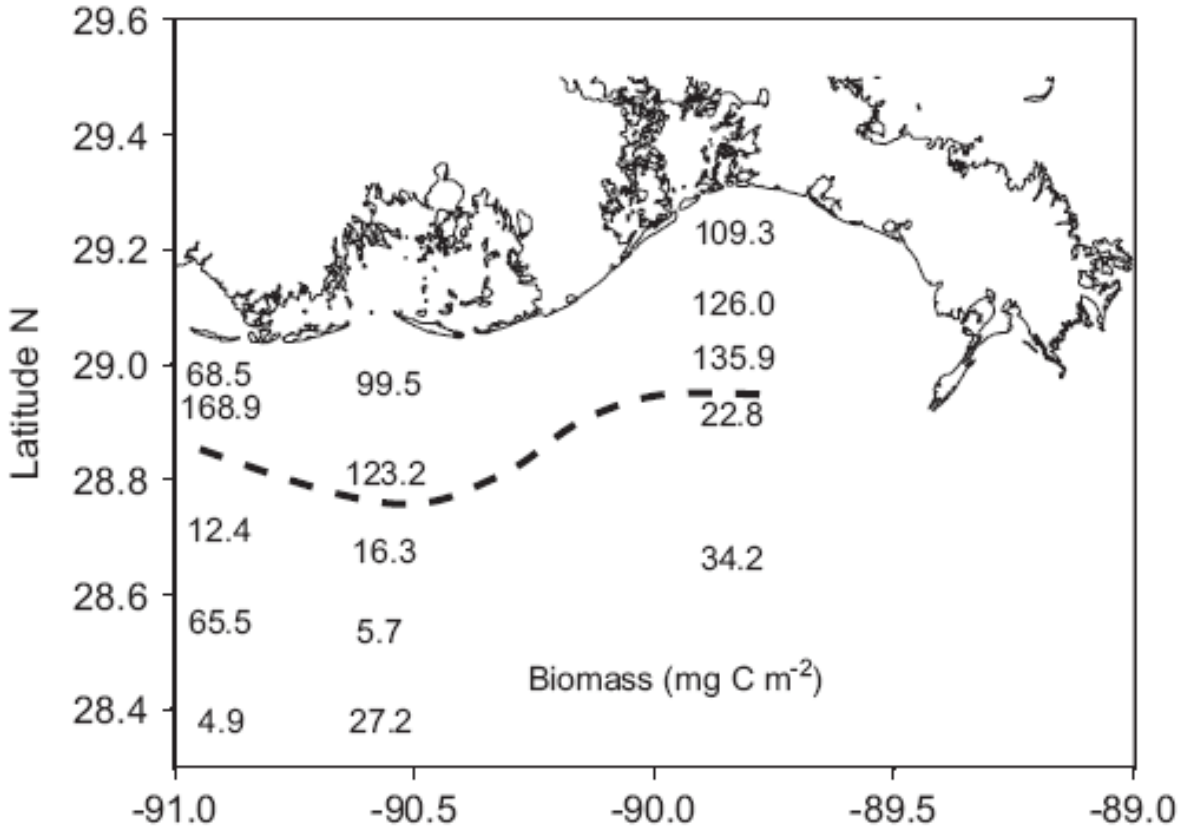


Pathway 2 – Appendicularians

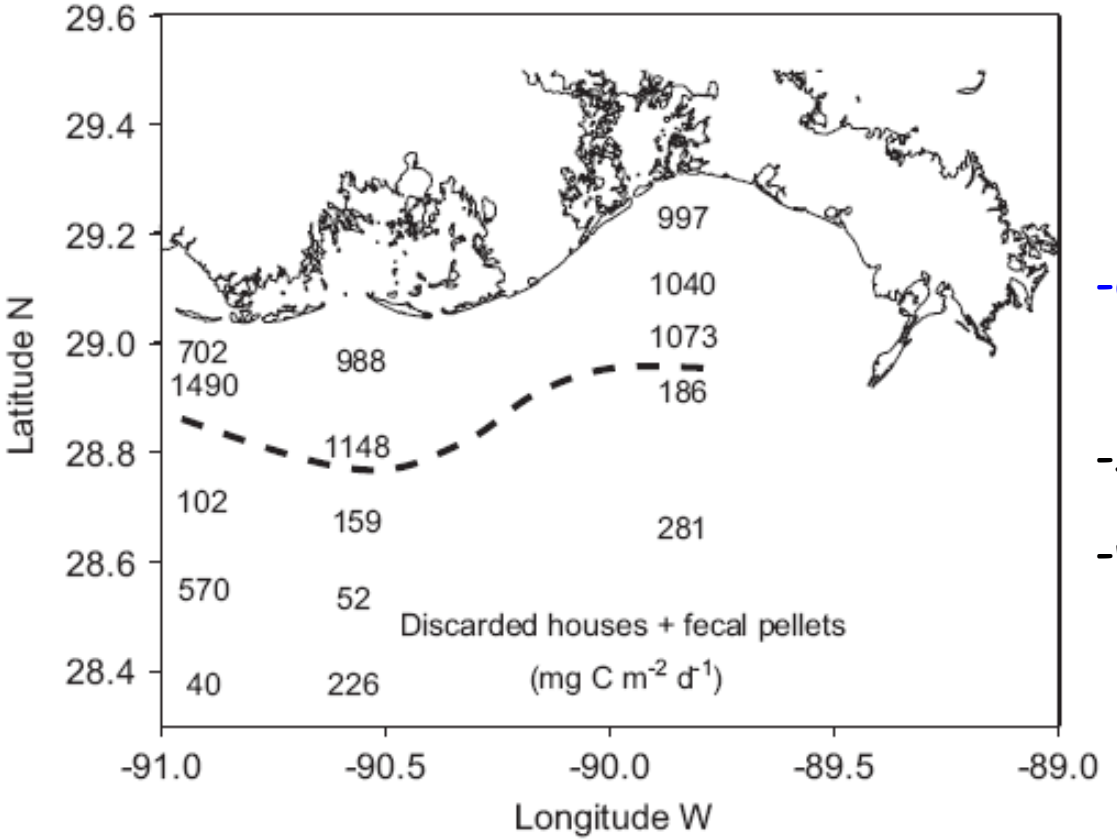
Consumers of particles < 1 μm to 20 μm (bacteria and small phytoplankton)

Oikopleura - *O. dioica* and *O. longicauda* are typically very abundant in the coastal ocean of the northern Gulf of Mexico

Oikopleura biomass – August 2004 – higher at inshore stations



Oikopleura pellet and house production - August 2004



-often > 1 g C m^{-2} d^{-1} at inner stations

-sinking rates of 10s m d^{-1}

-water depth 10-30 m

Potentially a large contribution to organic C flux to sub-pycnocline water and bottom

(from Dagg et al. 2008. CSR 28: 1127-1137)

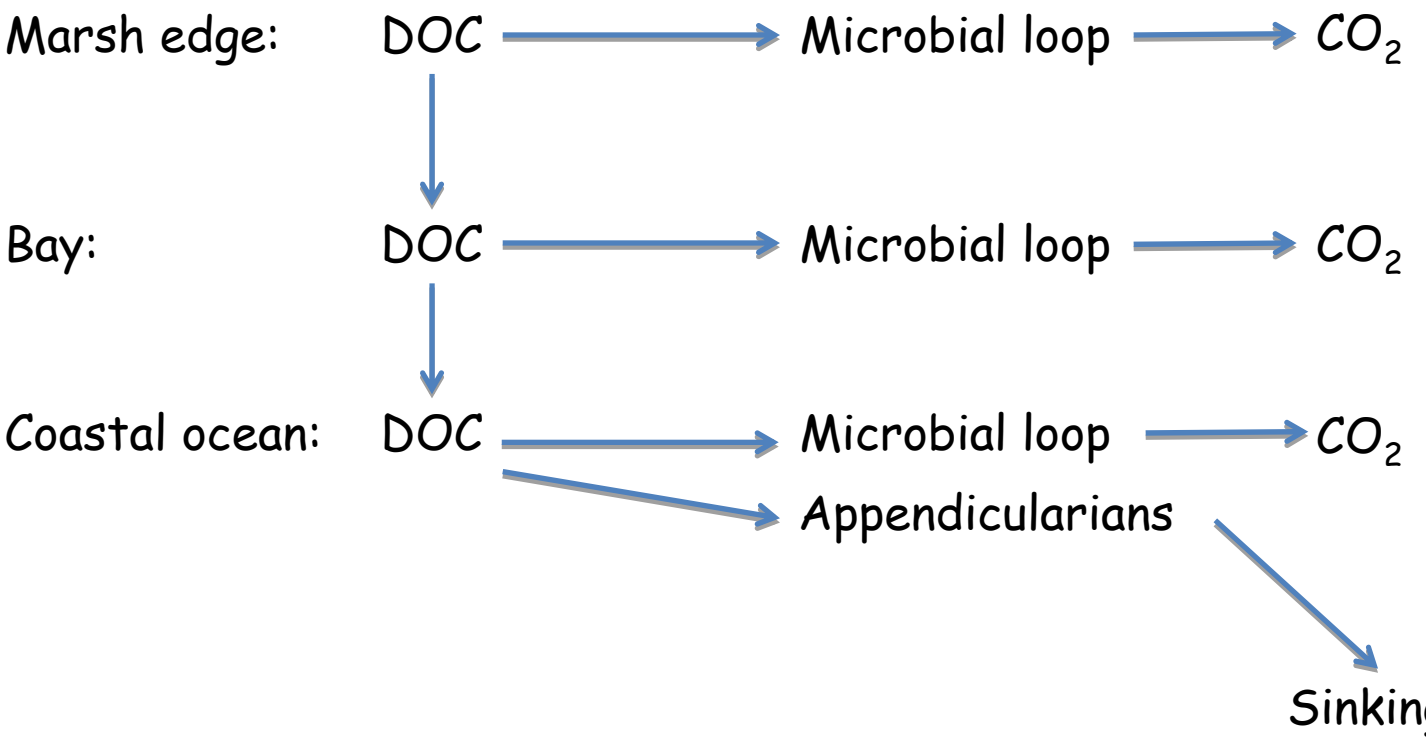
Sequestration ? Burial? - Unlikely

Shallow water and high temperatures – high remineralization rates

Wide-spread bottom water hypoxia in summer – high OM consumption rates

Fall mixing and overturn – nutrients return to surface

Summary: marsh DOC redistribution



Time period: days to months
POC recycled – CO_2

Conclusion

Deteriorating marsh primarily converts long-term stored POC from the marsh into CO_2

End