Potential Updates to Nutrient Load Estimates from Chesapeake Tidal Wetlands

Modeling Workgroup Meeting – April 2019

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Based on **Cornwell et al. 2018 - *An Investigation of the Composition and Reactivity of Material Eroded from Chesapeake Bay Marshes***. Report to United States Army Corps of Engineers (ERDC-EL)

Proposed changes to shoreline erosion load coefficients based on Cornwell et al. 2018

	Current values	Proposed values
Sediment bulk density (g/cm^3)	1.38 banks 0.62 marshes	1.38 banks 0.3 marshes
[N] (%)	0.029 banks 0.029 marshes	0.029 banks 1.20 marshes
[P] (mg/g)	0.205 banks 0.205 marshes	0.205 banks 0.70 marshes
% IP	14	14
OM decay rate (d^{-1})	20% G2 ($180 * 10^{-5}$) 80% G3 ($6.5 * 10^{-5}$)	100% G3 (based on observed decay rate ~ $7 * 10^{-5}$)

Numbers will be subject to verification and potential adjustments during model calibration

How are loads from shoreline erosion currently estimated?

Sources: Hennesee et al. 2006; Halka & Hopkins, 2006

1. **Calculate volume of sediment lost from erosion:**

$$V = L * W * H$$

V = annual volume of sediment lost from bank erosion (m^3/year)
L = shoreline length (m)
W = rate of shoreline recession (m/year)
H = bank height or marsh elevation (m)

2. **Convert sediment volume to mass:**

$$M = d * V$$

M = annual mass of sediment lost from bank erosion (kg/year)
d = dry sediment bulk density (kg/m^3)

How are loads from shoreline erosion currently estimated?

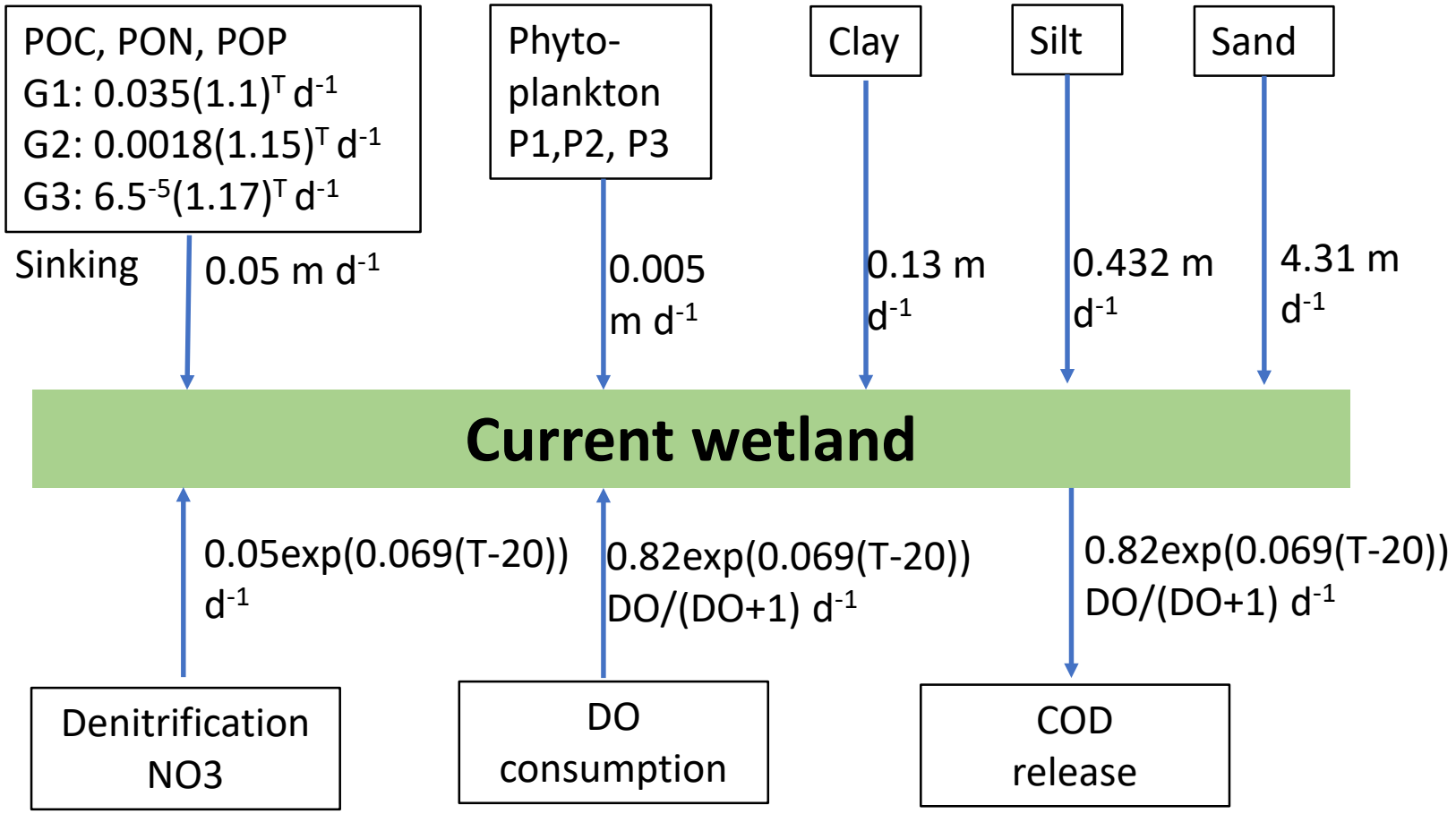
3. Multiply sediment mass by assumed nutrient content:

$$\textbf{N Load} = \textbf{M} * [\textbf{N}]$$
$$\textbf{P Load} = \textbf{M} * [\textbf{P}]$$

Current assumptions:

- **d = 1.38 g/cm^3** for banks and **0.62 g/ cm^3** for marshes
- **[N] = 0.29 mg N/g solids** and **[P] = 0.205 mg P/g solids**
- **[N] = 20% G2, 80% G3**
- **[P] = 14% PIP, 17% G2, 69% G3**
- Bank erosion = 56% silts and clays, 44% sand (no organic)
- Marsh erosion: 44% silts and clay, 34% organic matter, 12% sand

Current wetland model

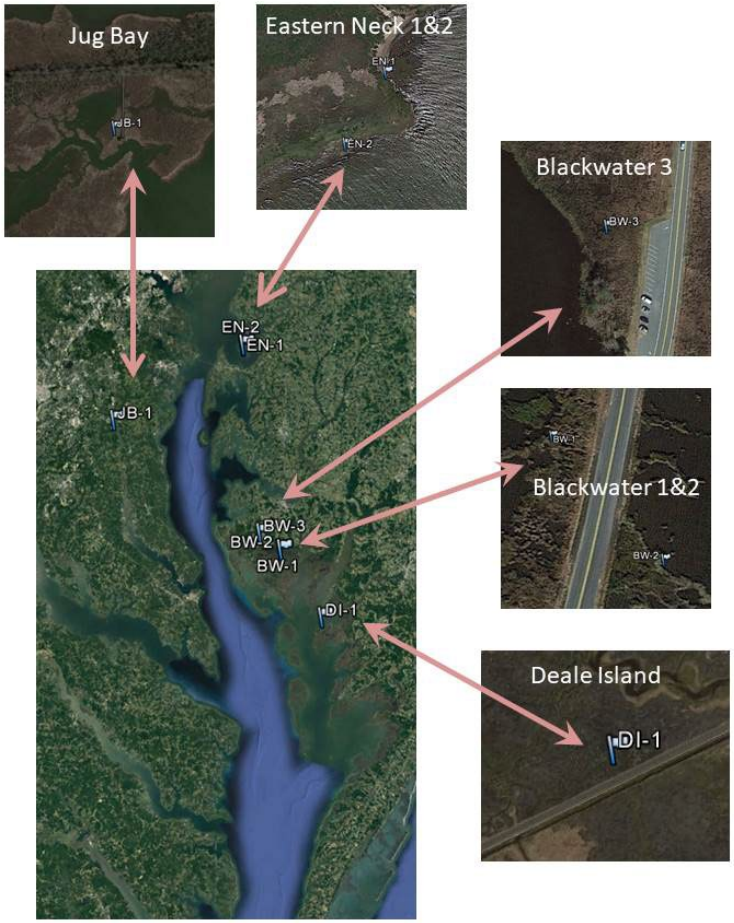


Results from recent study

An Investigation of the Composition and Reactivity of Material Eroded from Chesapeake Bay Marshes

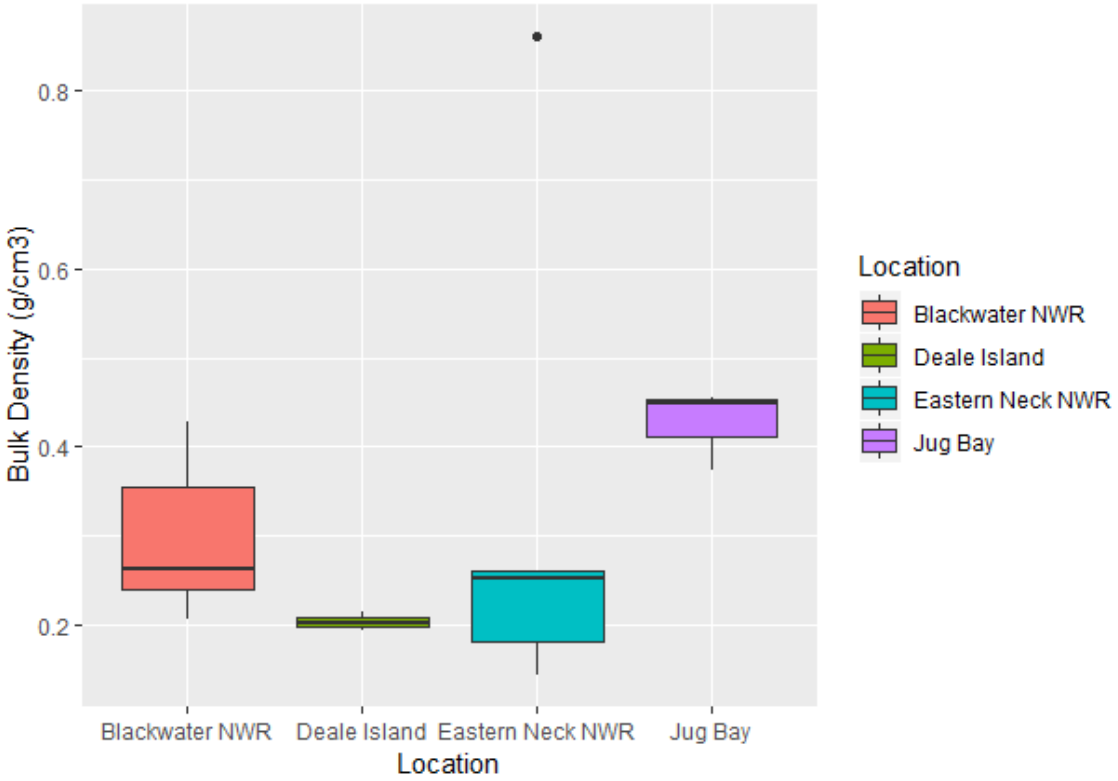
Final Report to United States Army Corps of Engineers (ERDC-EL)

Jeffrey C. Cornwell, Alison Sanford, Michael Owens, Zoe Vulgaropulos



Cornwell et al. 2018

Results from recent study – Dry sediment bulk density



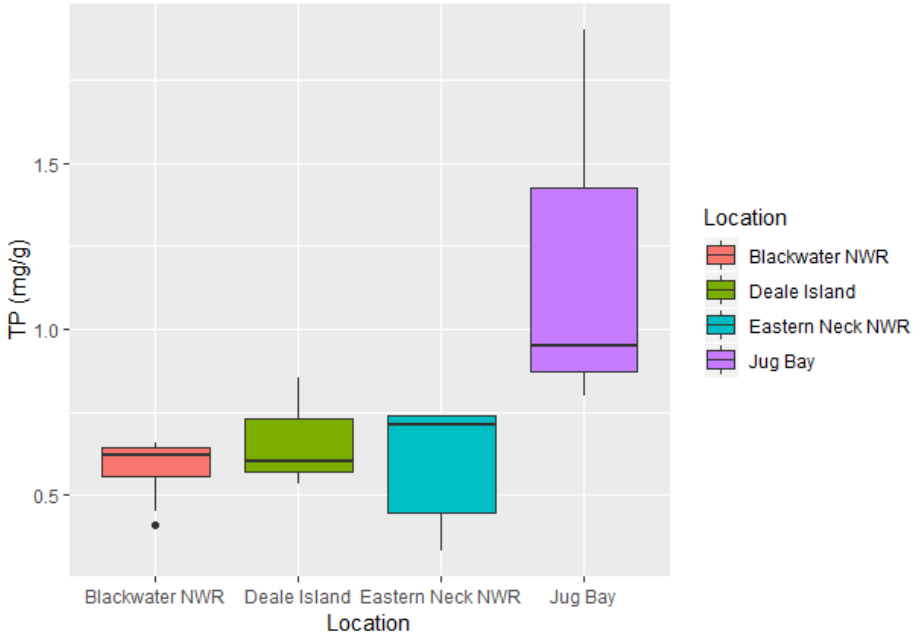
Location	Avg Density (sd) g/cm^3
Blackwater	0.3 (0.08)
Deale Island	0.2 (0.01)
Eastern Neck	0.3 (0.3)
Jug Bay	0.4 (0.05)

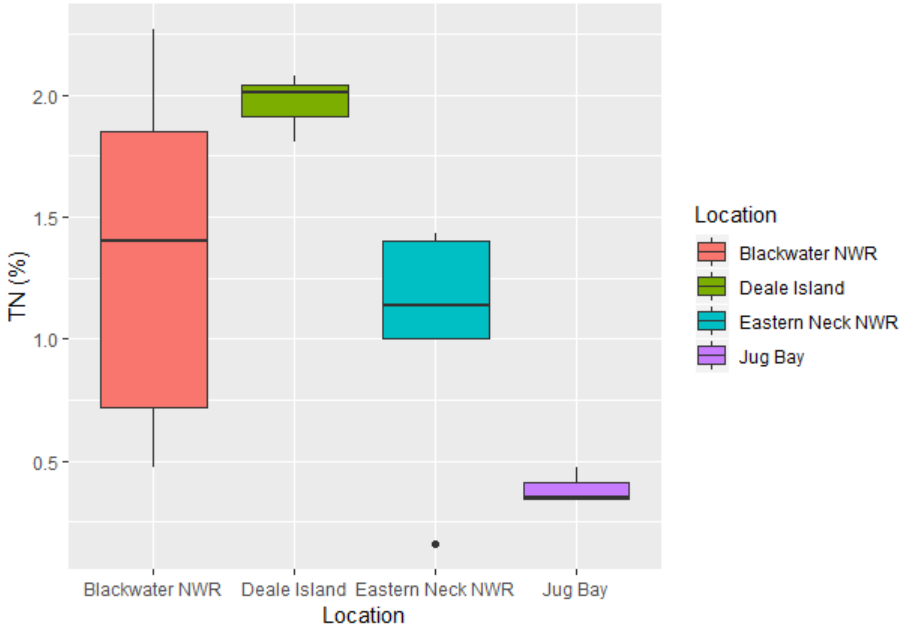
Current numbers:

d = 1.38 g/cm^3 for banks
d = 0.62 g/cm^3 for marshes

Cornwell et al. 2018

Results from recent study – Sediment nutrient content





Location	Avg TP (sd) (mg/g)
Blackwater	0.58 (0.10)
Deale Island	0.67 (0.17)
Eastern Neck	0.59 (0.19)
Jug Bay	1.22 (0.60)

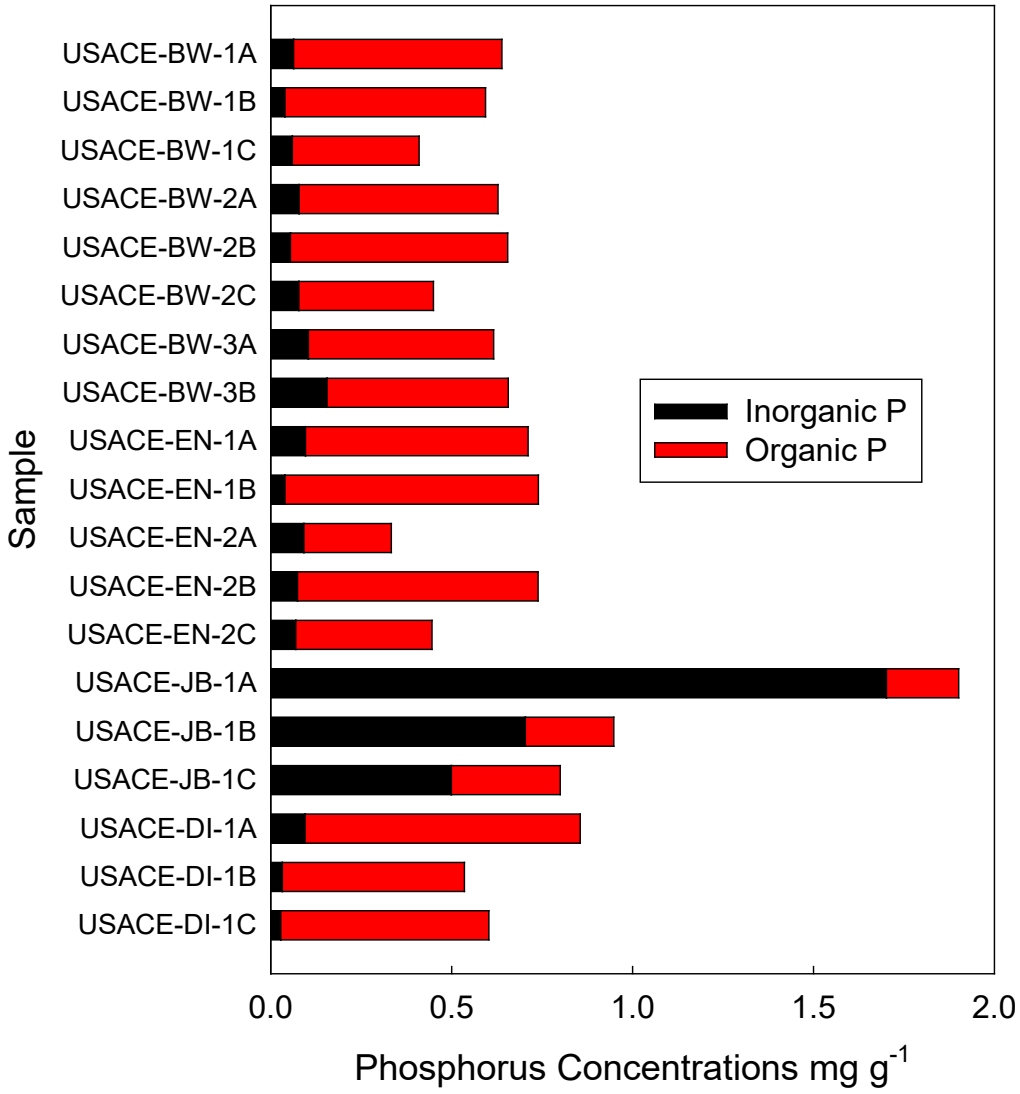
Location	Avg TN (sd) (%)
Blackwater	1.35 (0.70)
Deale Island	1.97 (0.14)
Eastern Neck	1.03 (0.52)
Jug Bay	0.39 (0.07)

[P] = 0.205 mg P/g solids

[N] = 0.29 mg N/g solids = 0.029 % N

Cornwell et al. 2018

Results from recent study – Sediment nutrient content



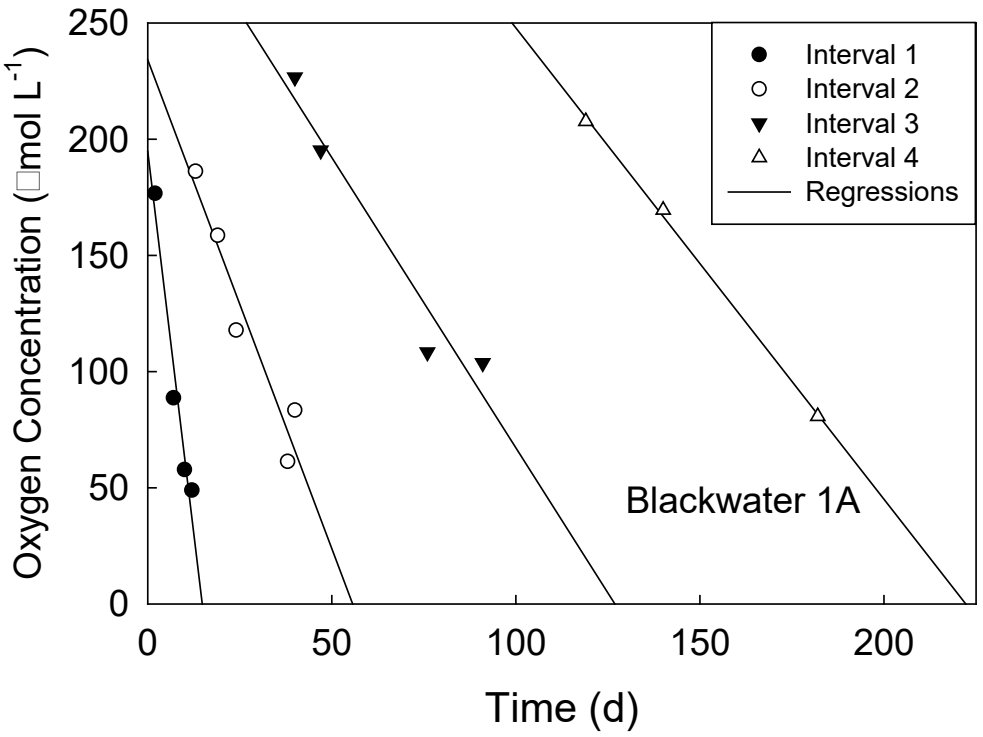
Current number:

[P] = 14% INORGANIC

Cornwell et al. 2018

Results from recent study – Decomposition experiments

Each incubation, with the exception of Deale Island, consisted of 4 time periods. One regression of O_2 vs time was estimated for each time period

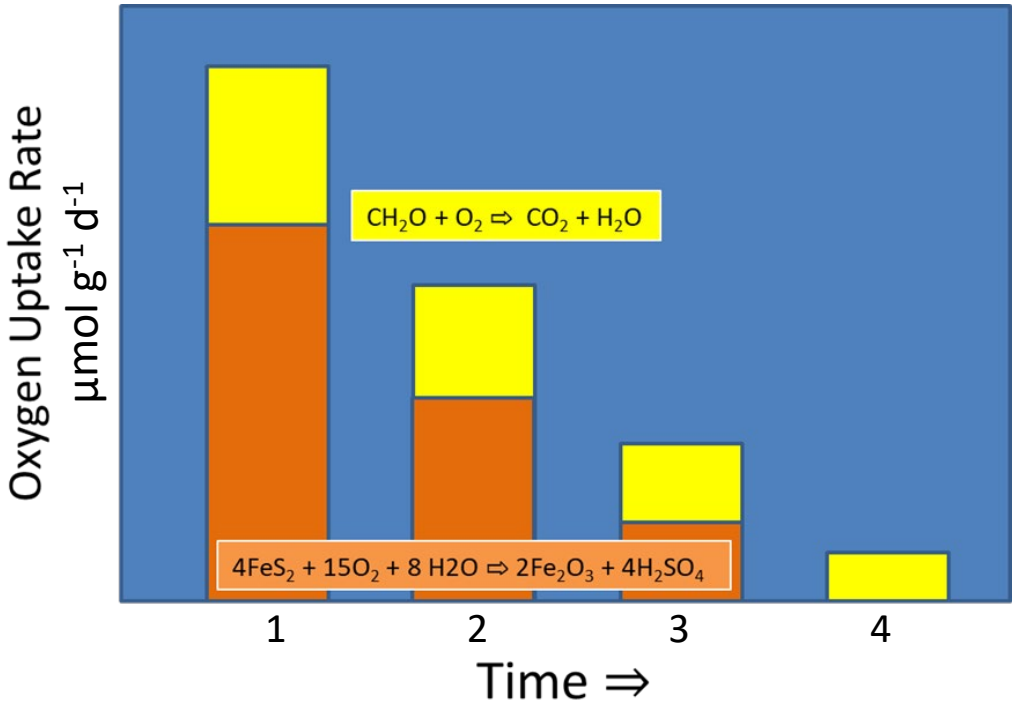


Cornwell et al. 2018

Results from recent study – Decomposition experiments

Two processes consume O_2 during incubation experiments:

- FeS_2 oxidation (occurs rapidly and dominates O_2 consumption at early stages of incubation)
- Decomposition of organic matter (dominates at later stages of incubation)

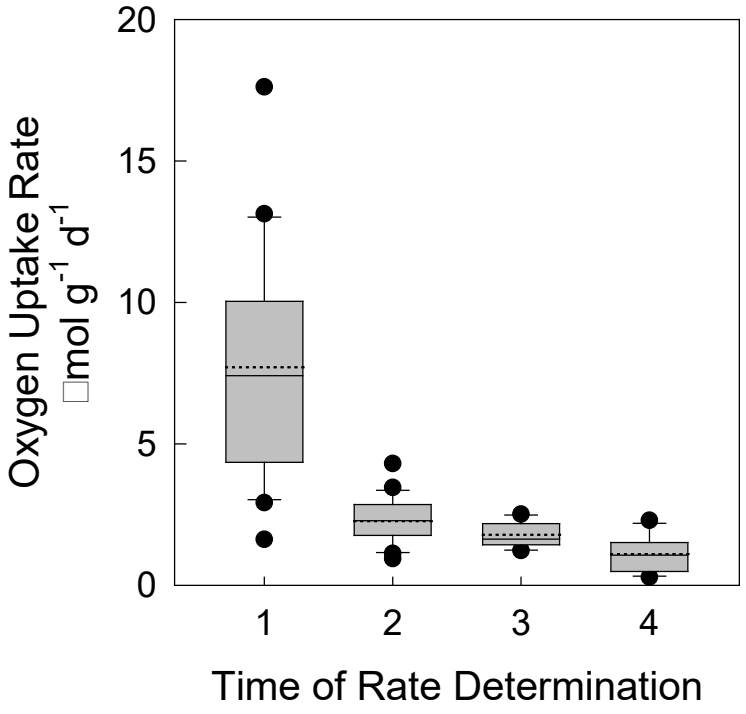


Cornwell et al. 2018

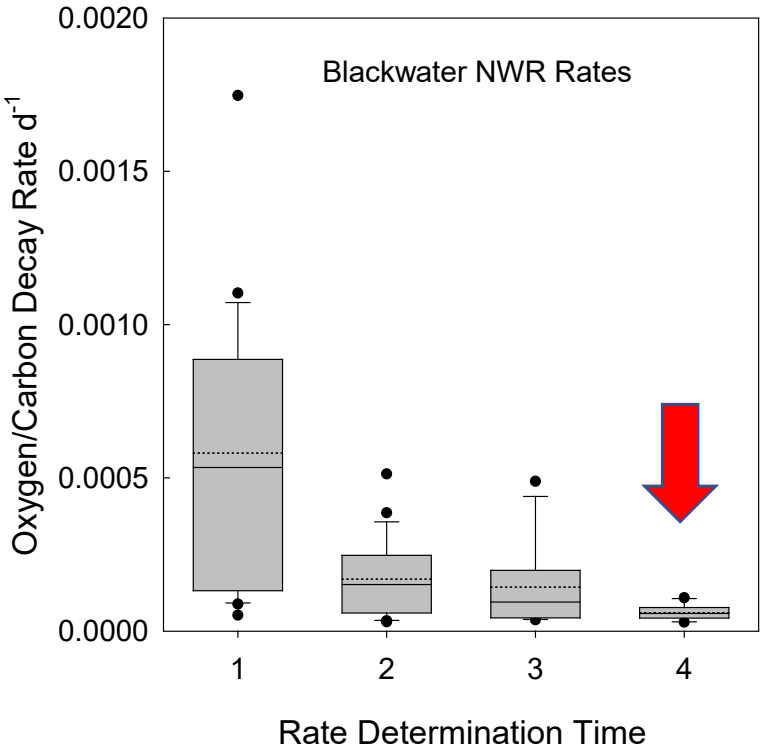
Results from recent study – Decomposition experiments

Example of decomposition rates during incubation
Blackwater National Wildlife Refuge

O_2 uptake rate



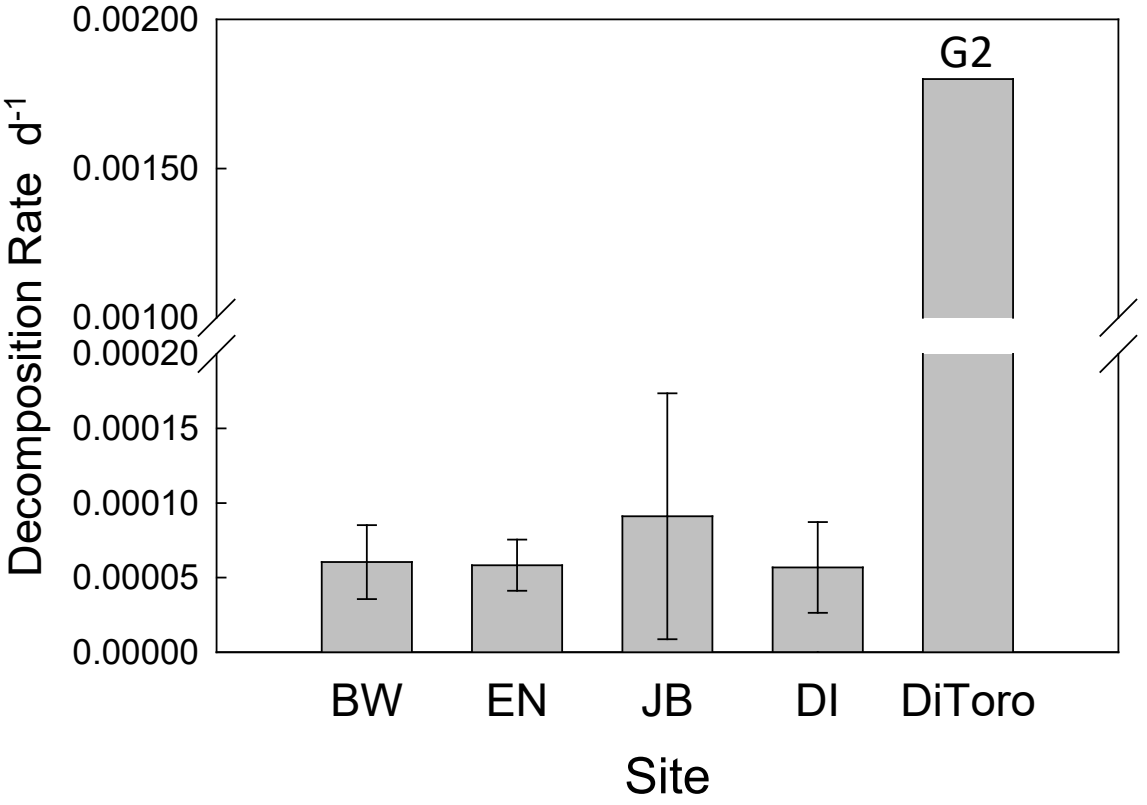
Aerobic decay rate of organic matter (assuming oxygen fluxes = carbon mineralization)



Cornwell et al. 2018

Results from recent study – Decomposition experiments

Decay rate of wetland organic matter at 4 sites compared to the algal G2 rate from DiToro (2001)



Current assumption:

20% G2
80% G3

Cornwell et al. 2018

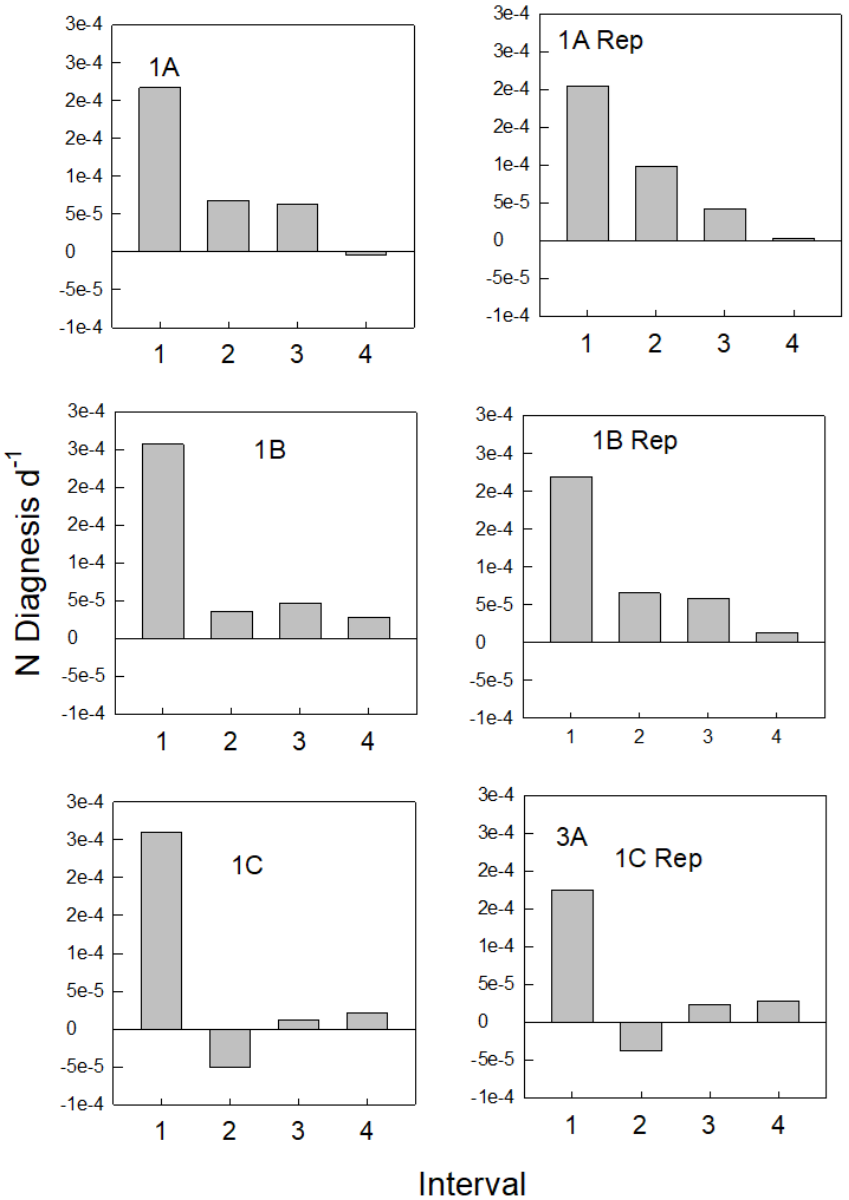
Results from recent study – Decomposition experiments

DIN (NH_4^+ + NOx^-) decay rates over time intervals of 1-8 days (1), 8-28 days (2), 28-50 days (3) and 50-97 days (4).

The decay rate of N remineralization was similar to the rates estimated for organic matter remineralization (~$5x10^{-5}$ d^{-1})

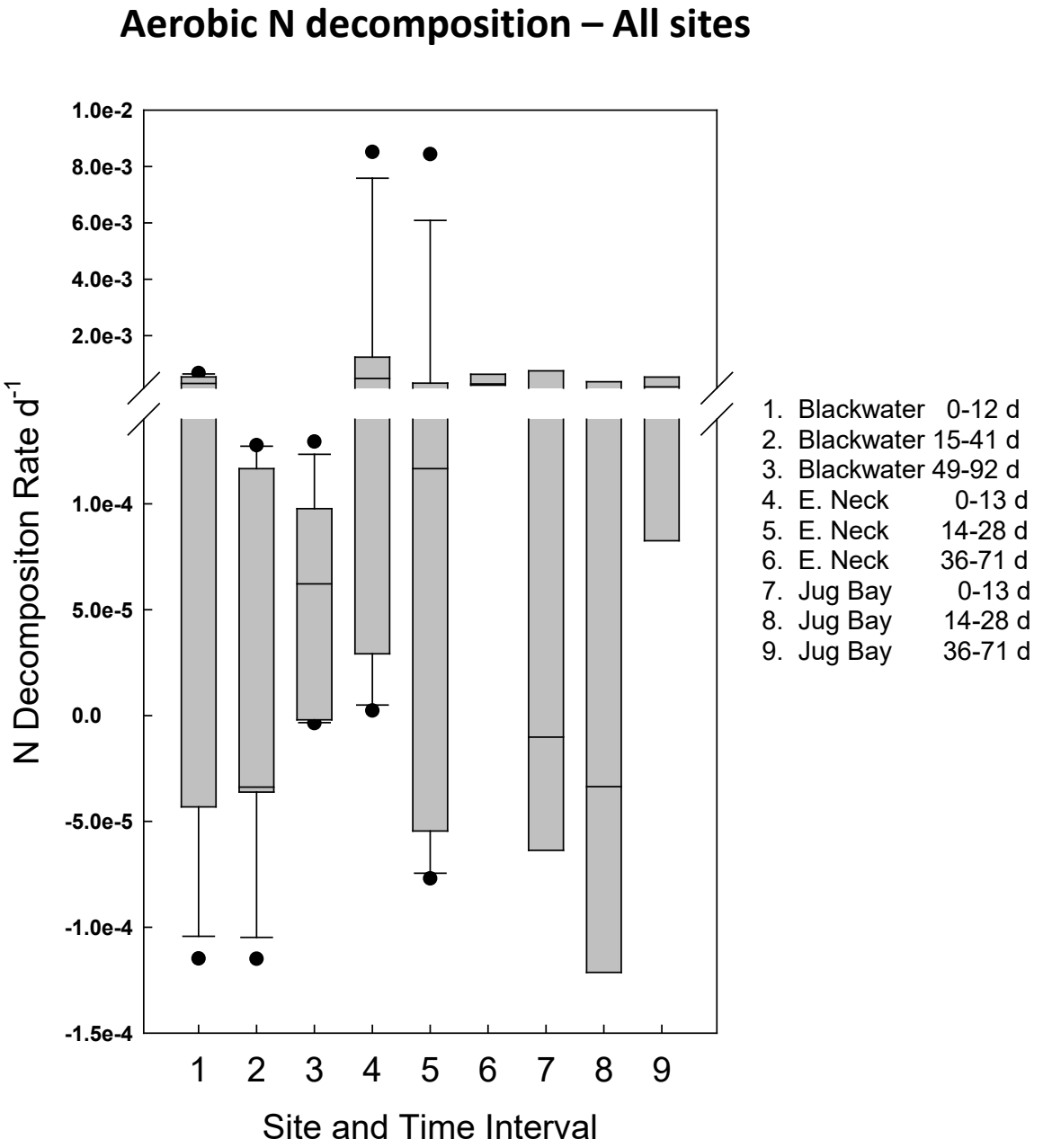
Cornwell et al. 2018

Aerobic N decomposition – Deale Island



Results from recent study – Decomposition experiments

DIN (NH_4^+ + NOx^-) decay rates at all sites.

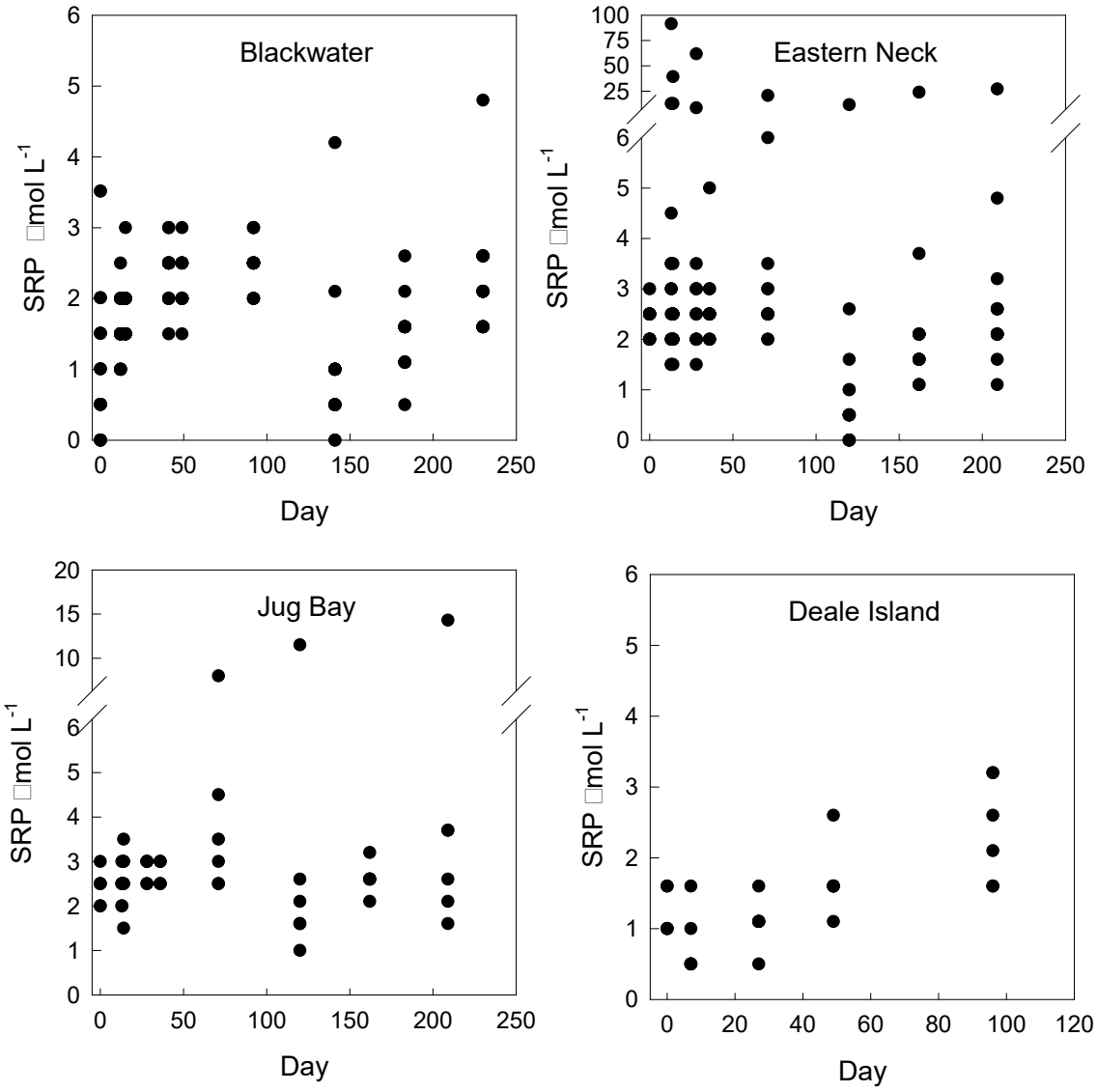


Cornwell et al. 2018

Results from recent study – Decomposition experiments

No clear increase in DRP over time, P decay rates could not be calculated.

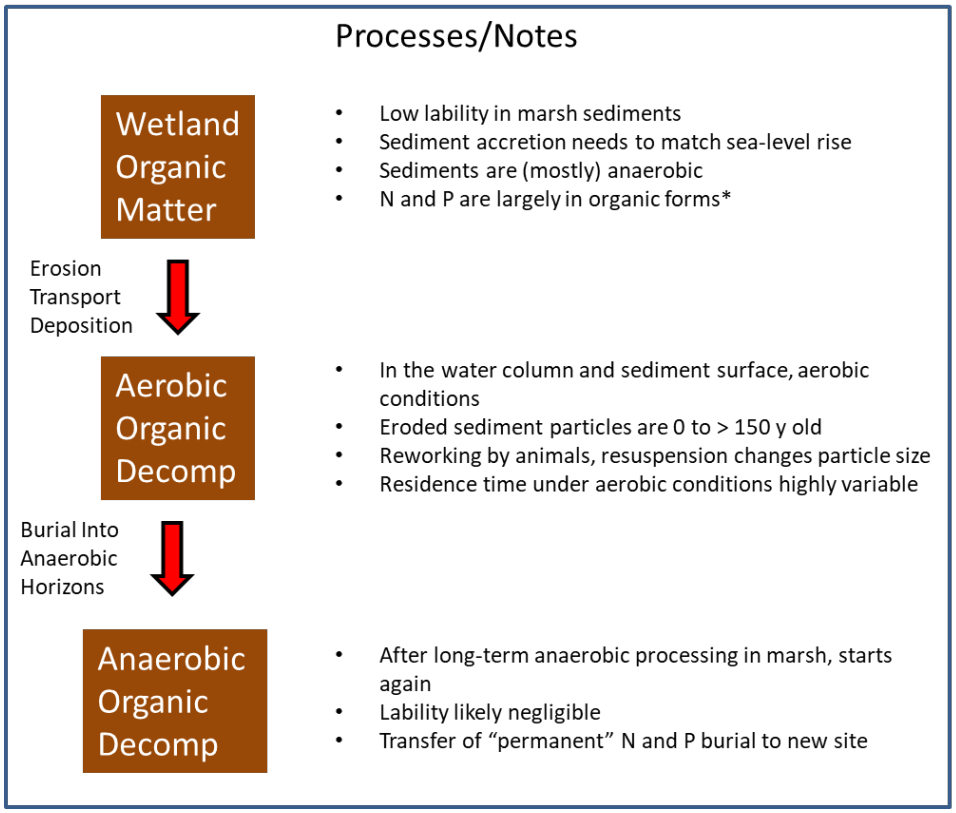
DRP concentrations during incubation – all sites



Cornwell et al. 2018

Results from recent study – Conclusions

- Wetland organic matter was recalcitrant and decomposed slowly
- Incubation experiments suggest that decay rates for N and C are ~ **7 x 10^{-5} d^{-1}** under aerobic conditions (comparable to **G3** material)
- The relatively low concentration of organic P in particulates resulted in no apparent P release
- Overall, the erosion of wetland sediments does not appear to release substantial amounts of N and organic P, even under the most favorable conditions



Cornwell et al. 2018

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