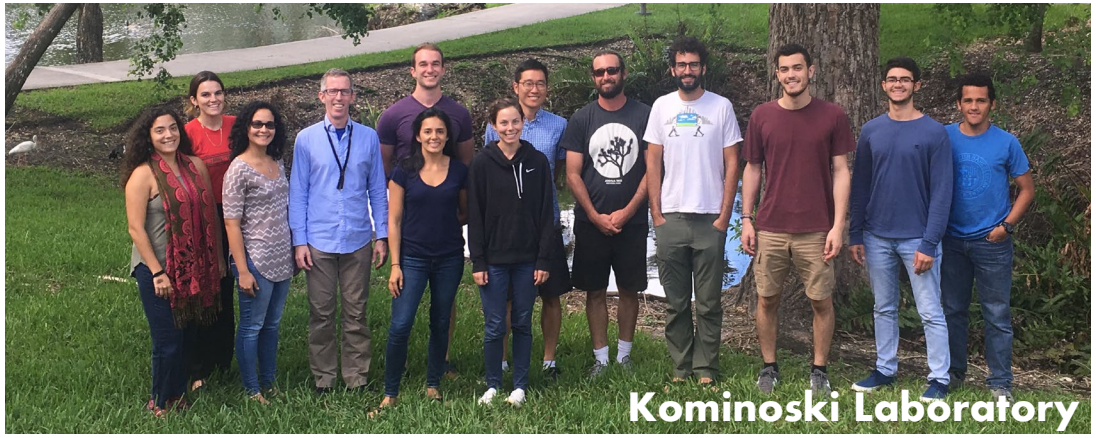
# Saltwater intrusion causes peat collapse.

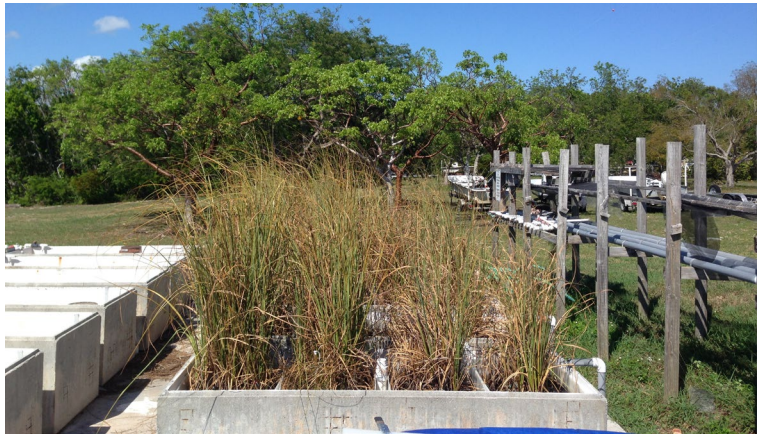



Principal researchers:

S. Charles, S. Servais, B. Wilson, J. Kominoski, S. Davis, T. Troxler, E. Gaiser

Technical researchers:

M. Kline, M. Robinson, L. Bauman



Added salt (10 PPT) and phosphorus (P, ×2 ambient load)

- … Freshwater (FW)
- … Freshwater with P (FWP)
- … Saltwater (SW)
- … Saltwater with P (SWP)

# Saltwater intrusion causes peat collapse.

| | *Rate* | | | *Biomass* | | *Soil* | |
|---|---|---|---|---|---|---|---|
| | Litter breakdown | Root growth | Root breakdown | Aboveground biomass | Belowground biomass | Soil elevation | Bulk Density |
| FWP | | | | | | | |
| SW | | | | | | | |
| SWP | | | | | | | |

Tukey's HSD post-hoc test compared to the control (FW)

… n.c. when no change

… ⇧ or ⇩ when $P < 0.05$

… ⇡ or ⇣ when insignificant

Geoderma Servais *et al*. (2019), Est. and Coa. Wilson *et al*. (2018), Charles *et al*. (in review)

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| | Rate | | | Biomass | | Soil | |
|---|---|---|---|---|---|---|---|
| | Litter breakdown | Root growth | Root breakdown | Aboveground biomass | Belowground biomass | Soil elevation | Bulk Density |
| FWP | ⇧ | ⇡ | ⇡ | ⇧ | | | |
| SW | ⇣ | ⇣ | ⇣ | ⇣ | | | |
| SWP | ⇧ | ⇡ | ⇧ | ⇧ | | | |

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| FWP | ⇧ | ⇡ | ⇡ | ⇧ | ⇡ | ⇡ | |
| SW | ⇣ | ⇣ | ⇣ | ⇣ | ⇣ | ⇣ | |
| SWP | ⇧ | ⇡ | ⇧ | ⇧ | ⇣ | ⇣ | |

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|---|---|---|---|---|---|---|---|
| | Litter breakdown | Root growth | Root breakdown | Aboveground biomass | Belowground biomass | Soil elevation | Bulk Density |
| FWP | ⇧ | ⇡ | ⇡ | ⇧ | ⇡ | ⇡ | ⇩ |
| SW | ⇣ | ⇣ | ⇣ | ⇣ | ⇣ | ⇣ | n.c. |
| SWP | ⇧ | ⇡ | ⇧ | ⇧ | ⇣ | ⇣ | ⇩ |

Tukey's HSD post-hoc test compared to the control (FW)

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# Can restored freshwater recover soil elevation?

**Dong Yoon Lee** [1,2], **John Kominoski** [2]

[1] South Florida Water Management District

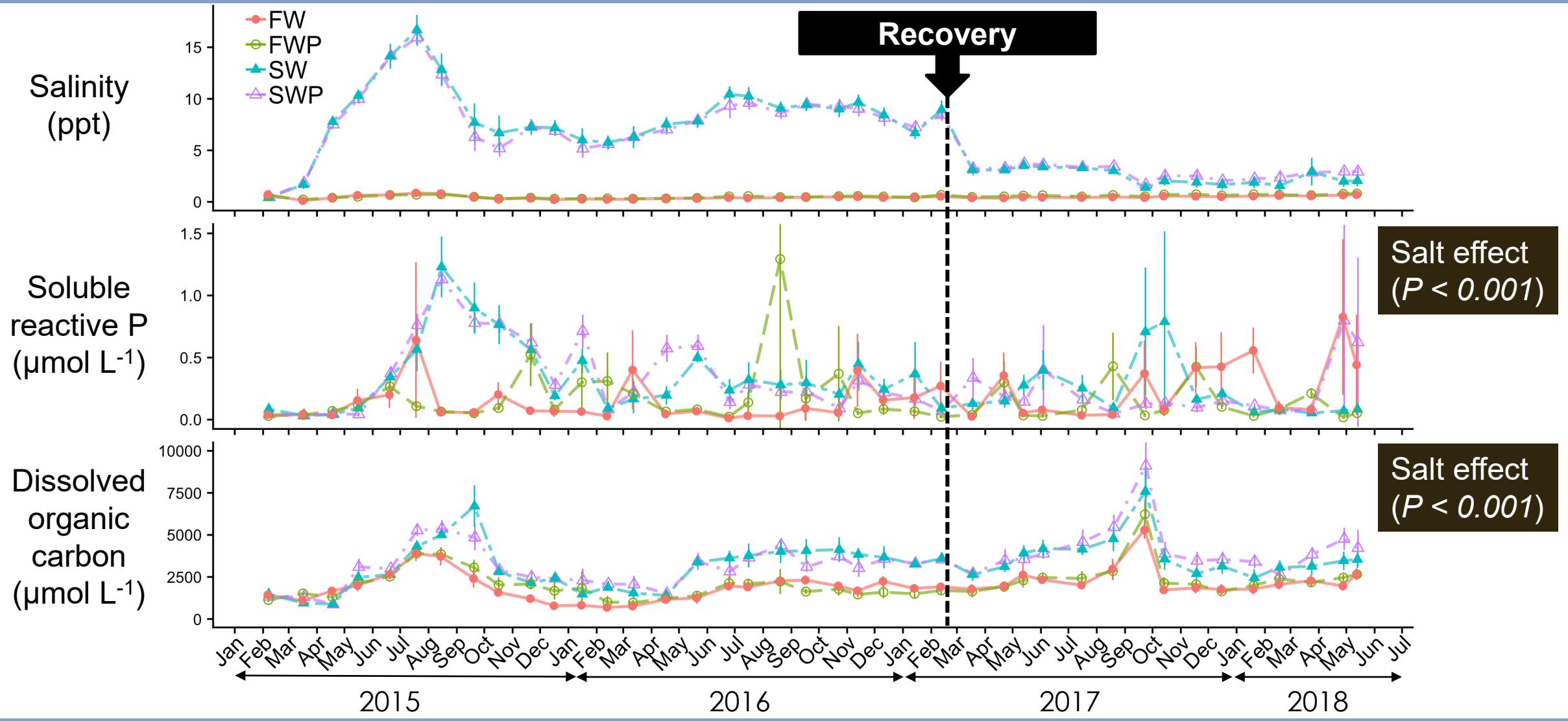
[2] Florida International University

# Freshwater recovery experiment

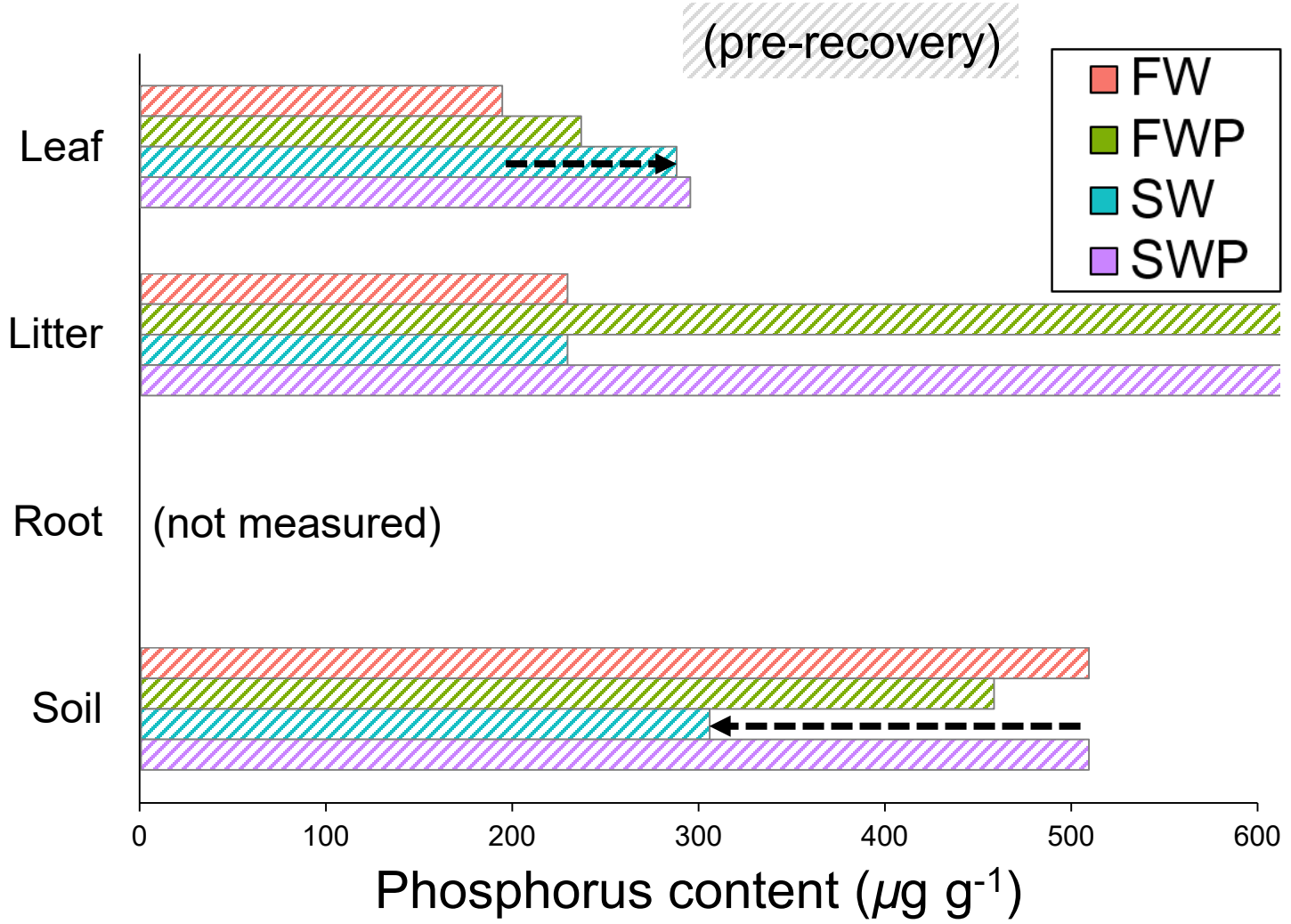
- **Hypothesis**: The legacy of saltwater intrusion would continue; P legacy would last longer than salt legacy
- **Methods**:
  - Add only **FRESHWATER**
  - $CO_2$ flux was measured monthly

$CO_2$ flux measured under different light and temperature

# Porewater


Salinity (ppt)
FW
FWP
SW
SWP
Recovery
Soluble reactive P (µmol L-1)
Salt effect (P < 0.001)
Dissolved organic carbon (µmol L-1)
Salt effect (P < 0.001)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
2015
2016
2017
2018

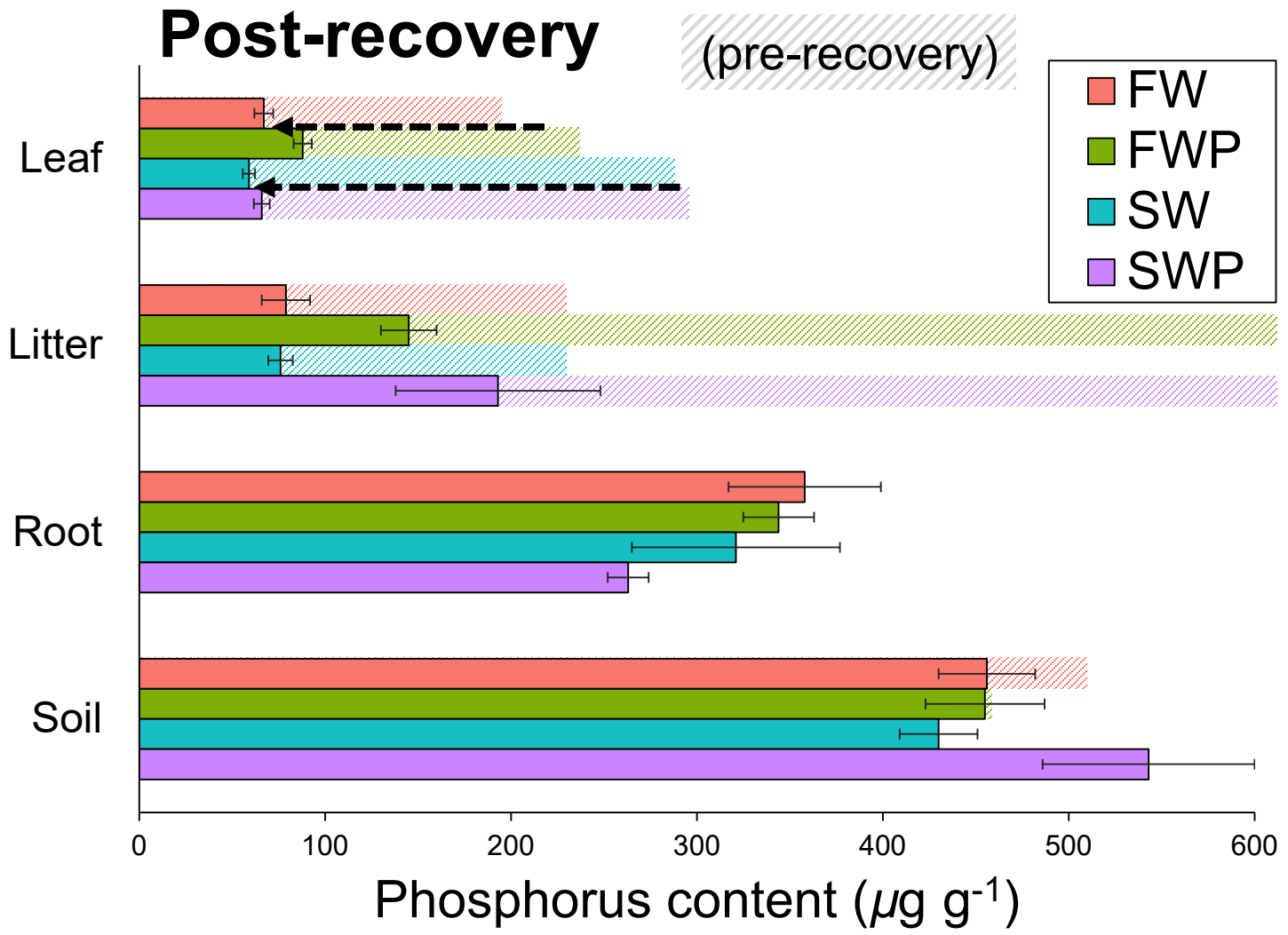
# Phosphorus


(pre-recovery)
FW
FWP
SW
SWP
Leaf
Litter
Root
(not measured)
Soil
0
100
200
300
400
500
600
Phosphorus content (μg g-1)

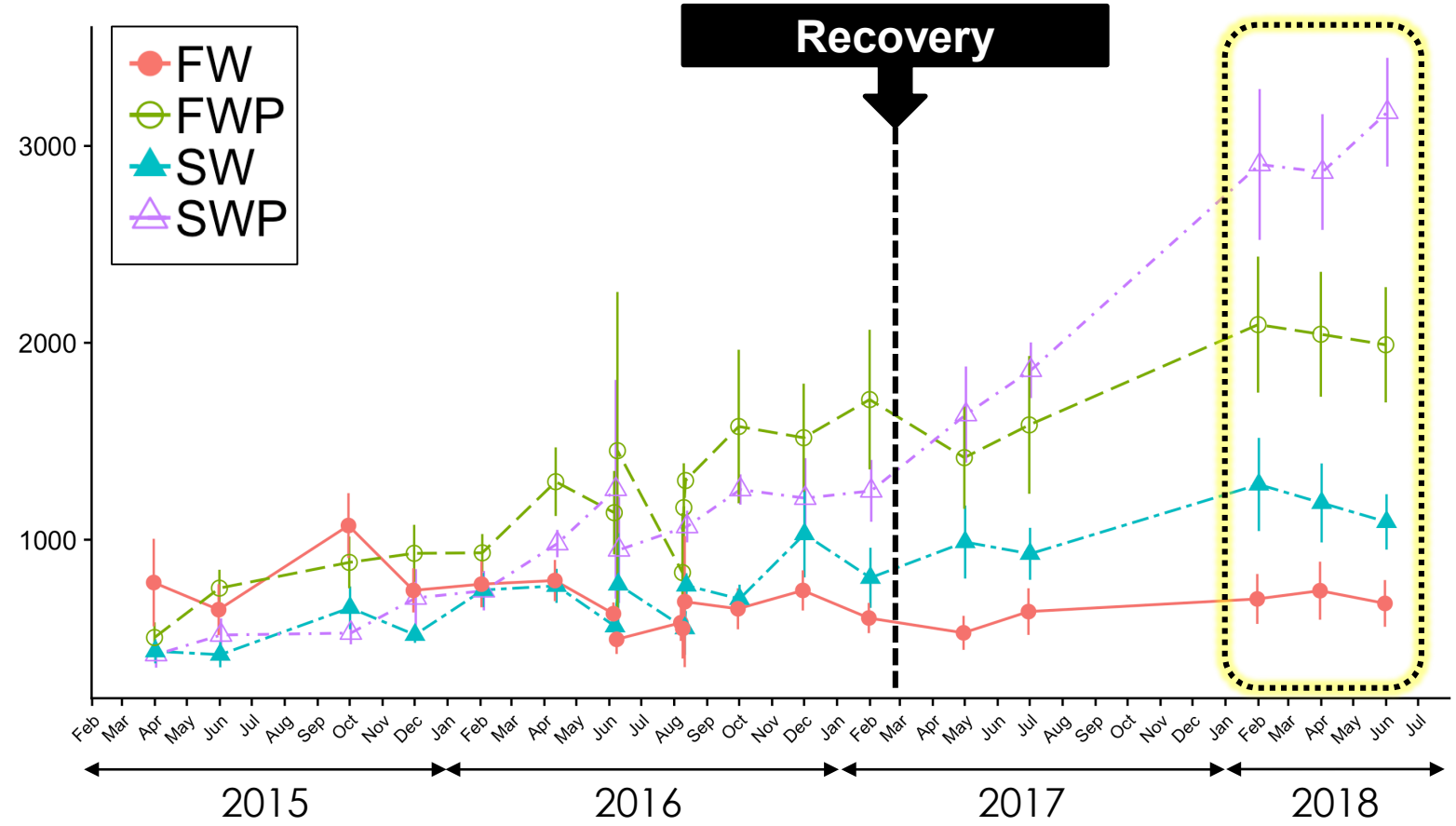
# Phosphorus

P legacy ($P < 0.01$)
Salt legacy ($P < 0.01$)

P legacy ($P < 0.001$)



# Aboveground biomass




… salt legacy
(*P* < *0.01*)

Pre-recovery …

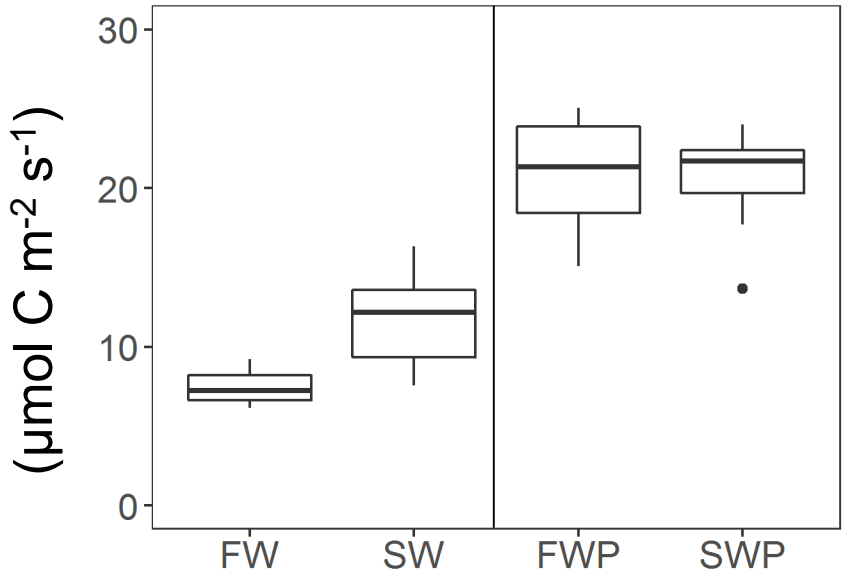
… P effect (*P* < *0.001*)

Recovery …

… P legacy (*P* < *0.001*)

# Metabolism during freshwater recovery

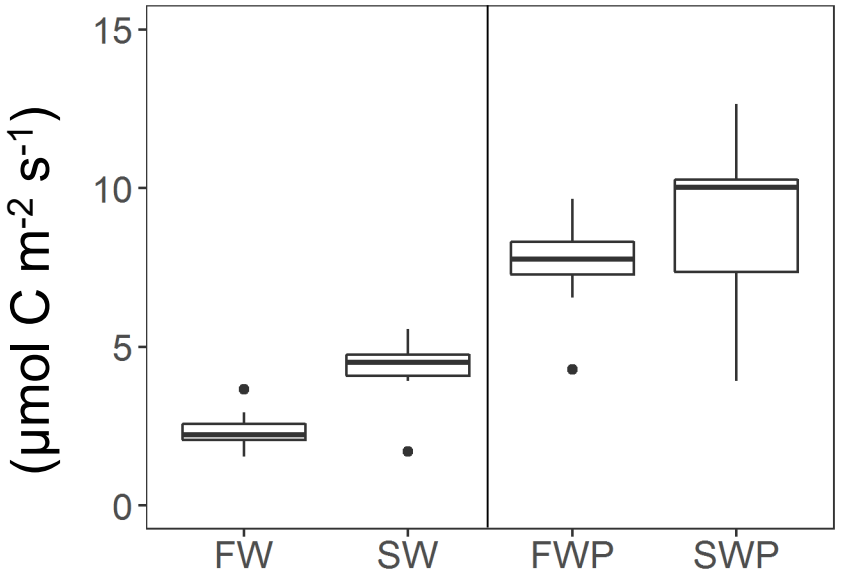
Gross primary production at maximum light




… no salt legacy

… P legacy (*P* < *0.001*)

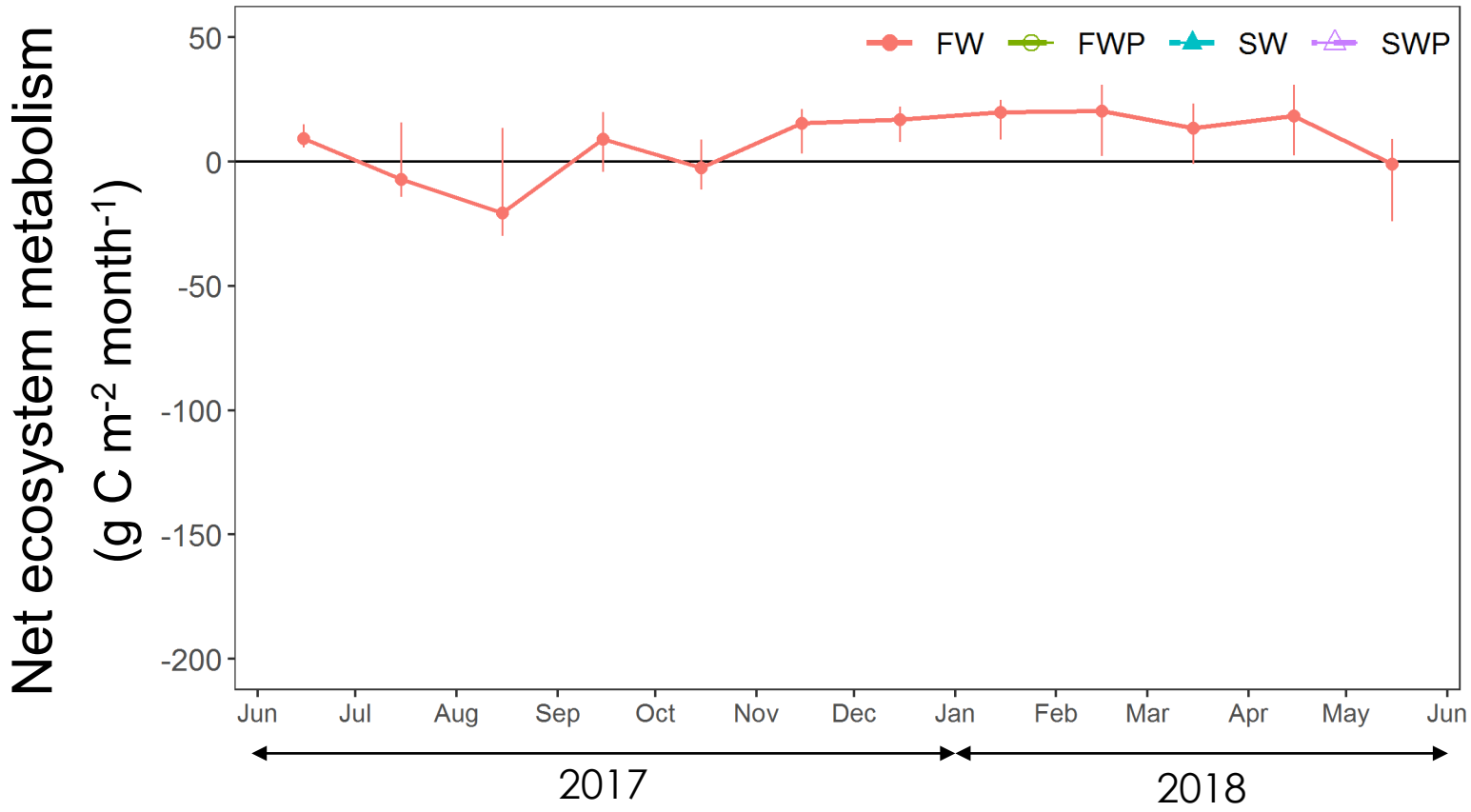
Ecosystem respiration




**… salt legacy (*P* < *0.05*)**

… P legacy (*P* < *0.001*)

# Ecosystem carbon balance




(Error bars are 25th and 75th percentiles of 1000 model outputs)

Net ecosystem metabolism

$= [CO_2]_{uptake} - [CO_2]_{release}$

$= GPP - ER$

For example,

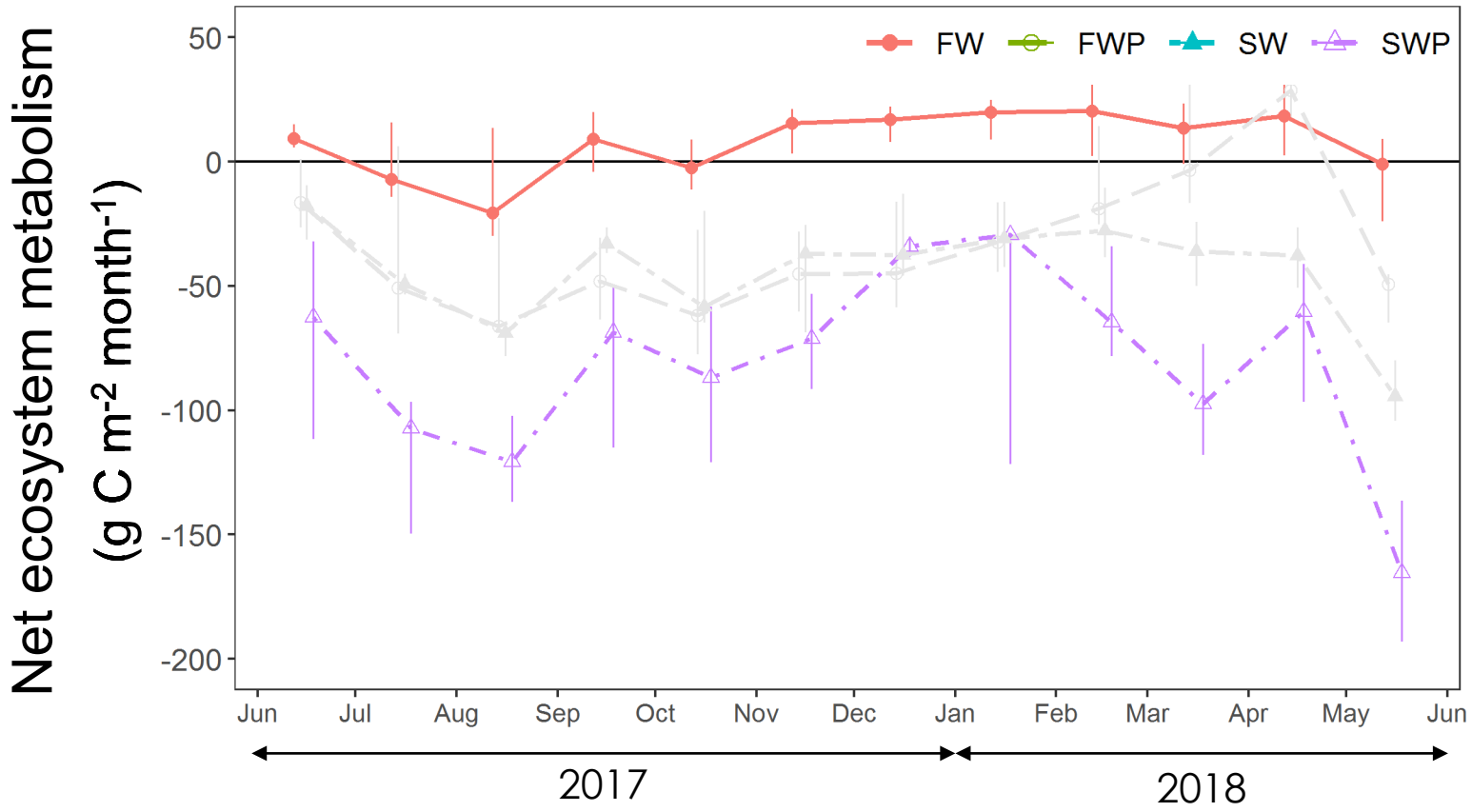
… when NEM > 0

: net carbon gain

… when NEM < 0

: net carbon loss

# Ecosystem carbon balance




(Error bars are 25th and 75th percentiles of 1000 model outputs)

FW…

… +17 g d.w. $m^{-2}$ $mon^{-1}$

… +1.5 mm $yr^{-1}$

FWP…

… -6.3 mm $yr^{-1}$

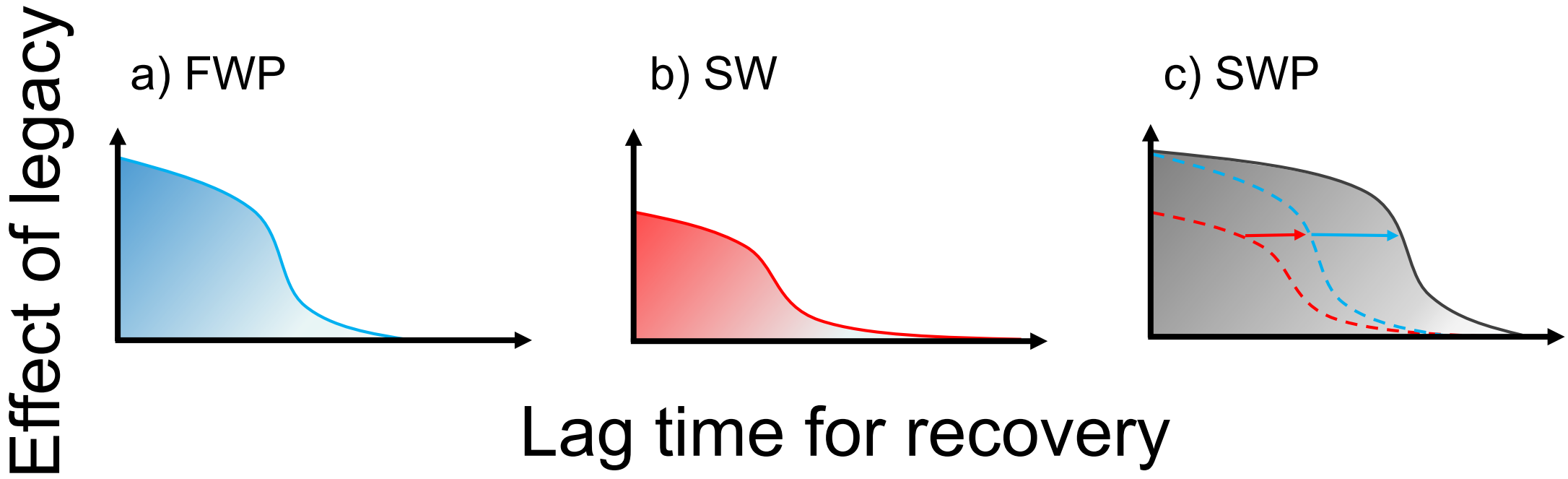
SW…

… -7.1 mm $yr^{-1}$

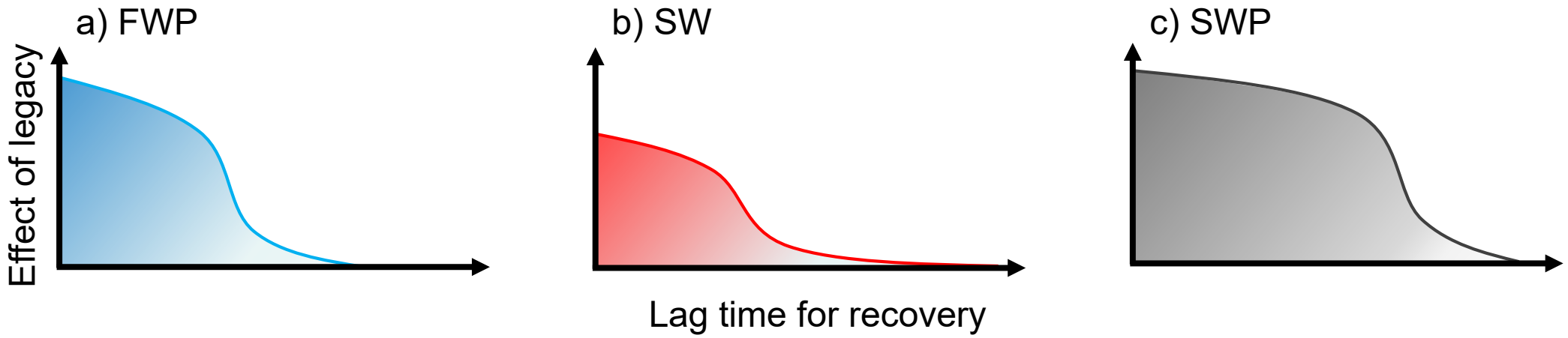
SWP…

… -12.5 mm $yr^{-1}$

# Summary



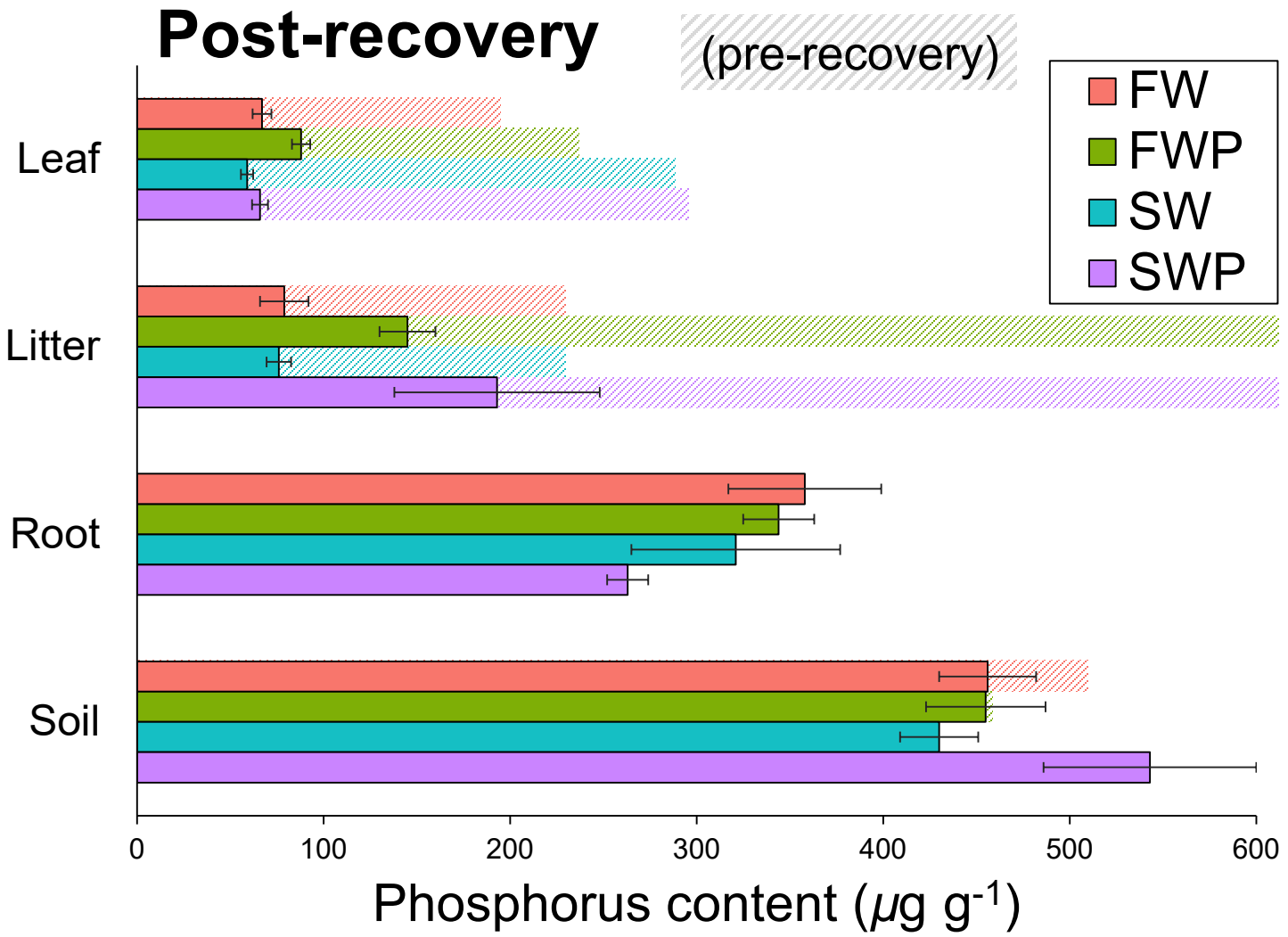
# Summary




- Although P legacy was effective, its effect can be short-term
- Salt legacy led to long-term changes in the rate and pathway of carbon and nutrient dynamics (likely due to geochemical and community changes)
- When salt and P legacies coexisted, organisms that adapted to high salinity and P enhanced net carbon loss ADDITIVELY
- **Short-term exposure to saltwater disproportionately enhanced carbon loss pathways and will delay ecosystem recovery**

# Phosphorus


Aboveground P concentration (mg P m-2)
400
350
300
250
200
150
100
50
0
FW
FWP
SW
SWP
Treatment


Post-recovery
(pre-recovery)
FW
FWP
SW
SWP
Leaf
Litter
Root
Soil
0
100
200
300
400
500
600
Phosphorus content (μg g-1)