

Biogeochemistry and food web roles of wood in aquatic ecosystems



Dana Warren
Oregon State University

Wood function

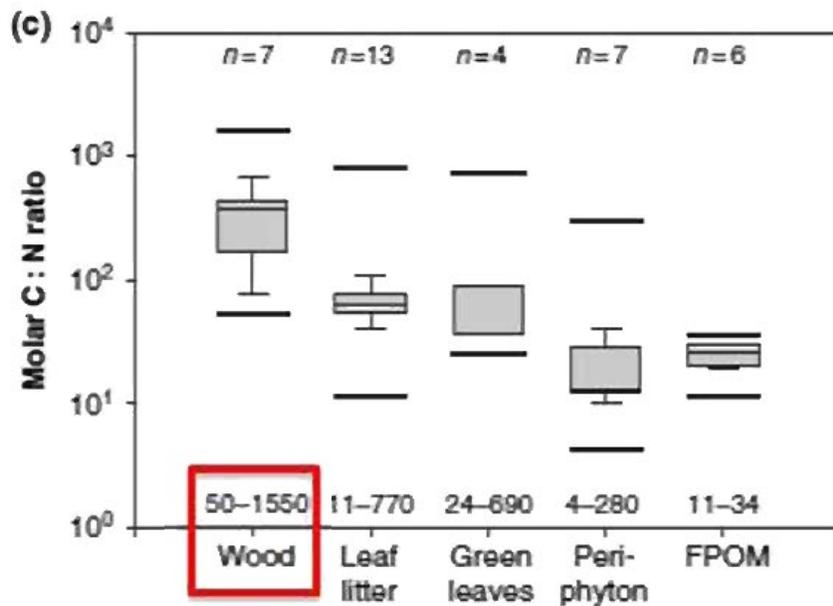
- Carbon source
- Structure

Wood as a carbon source

- Not very good . . .
 - Low “quality” carbon

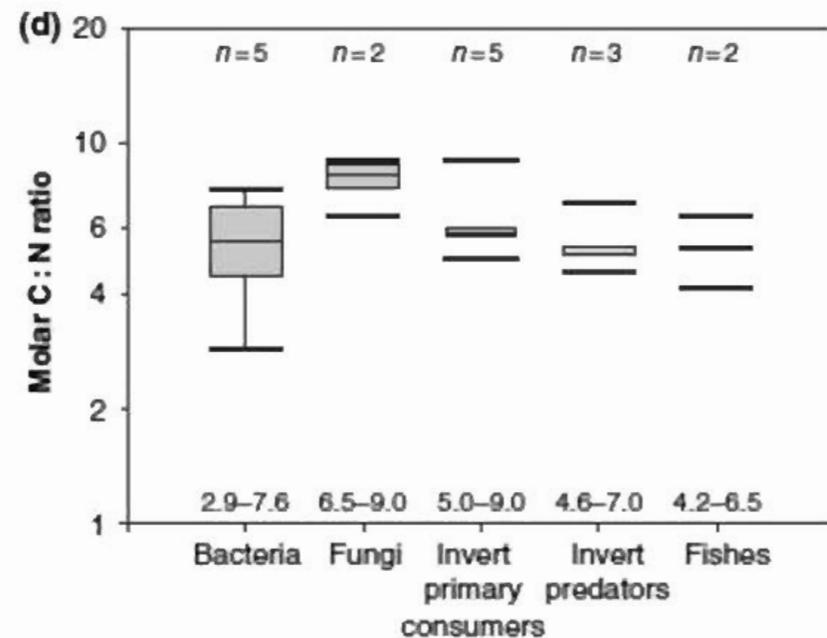
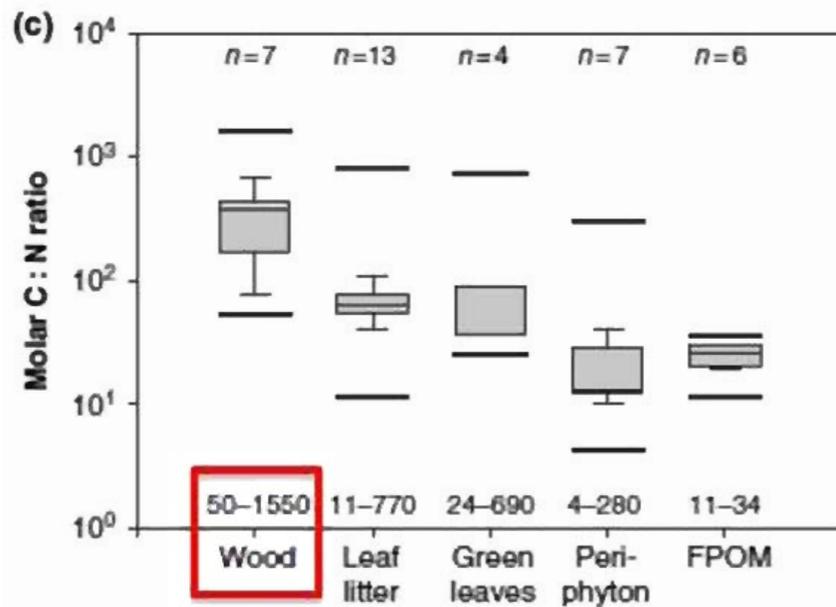
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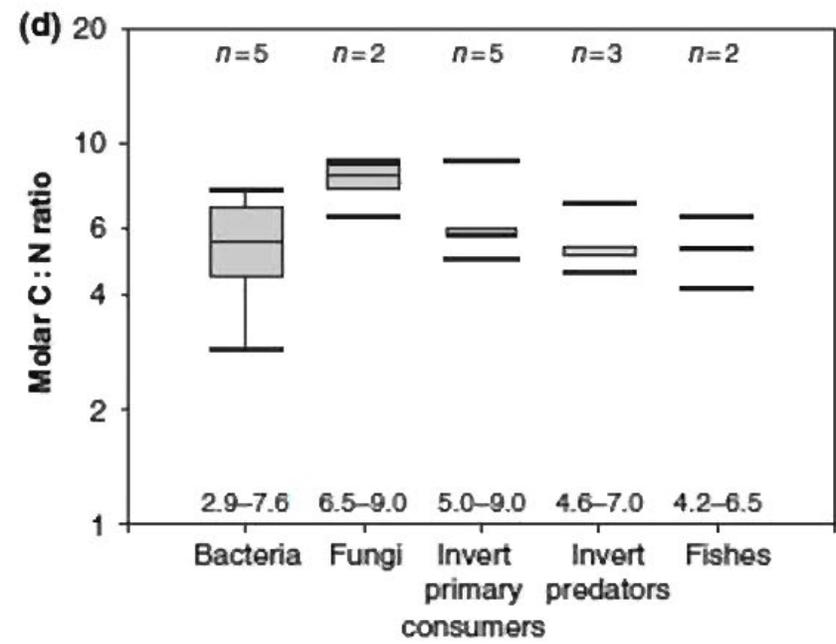
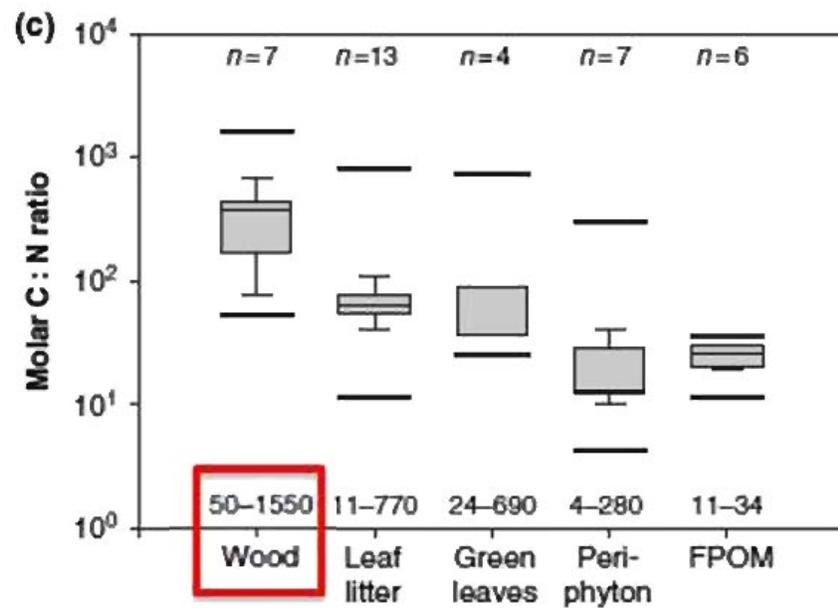
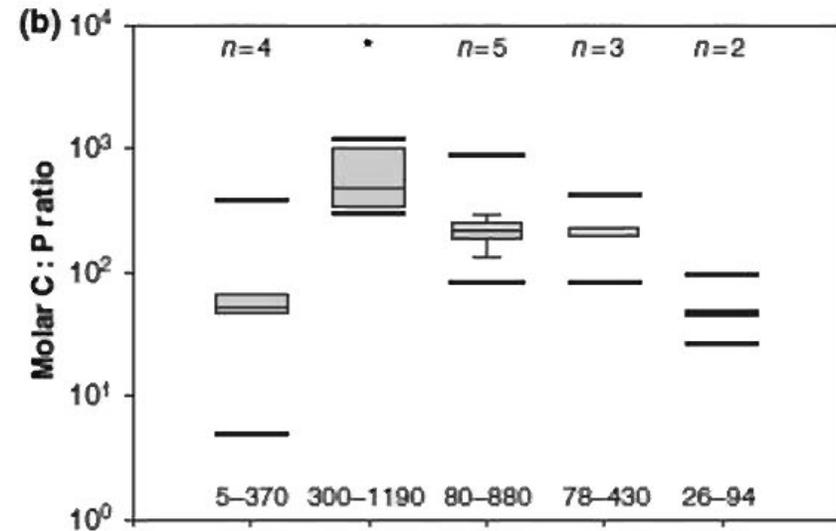
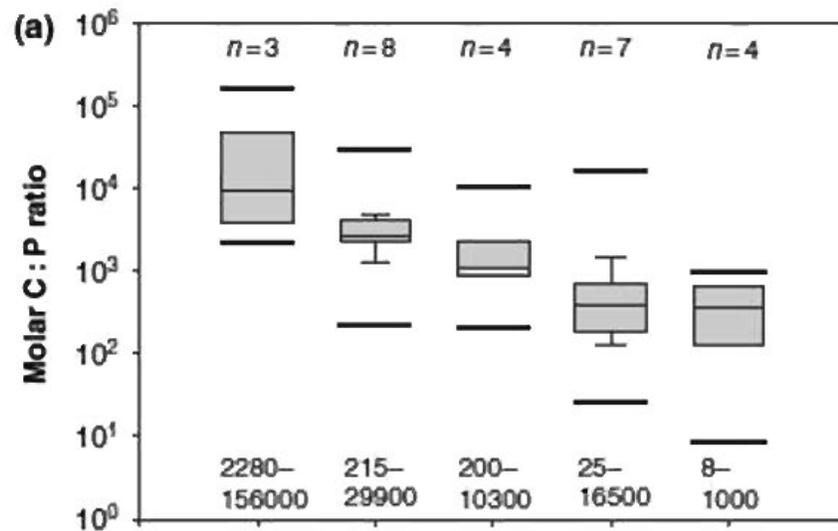
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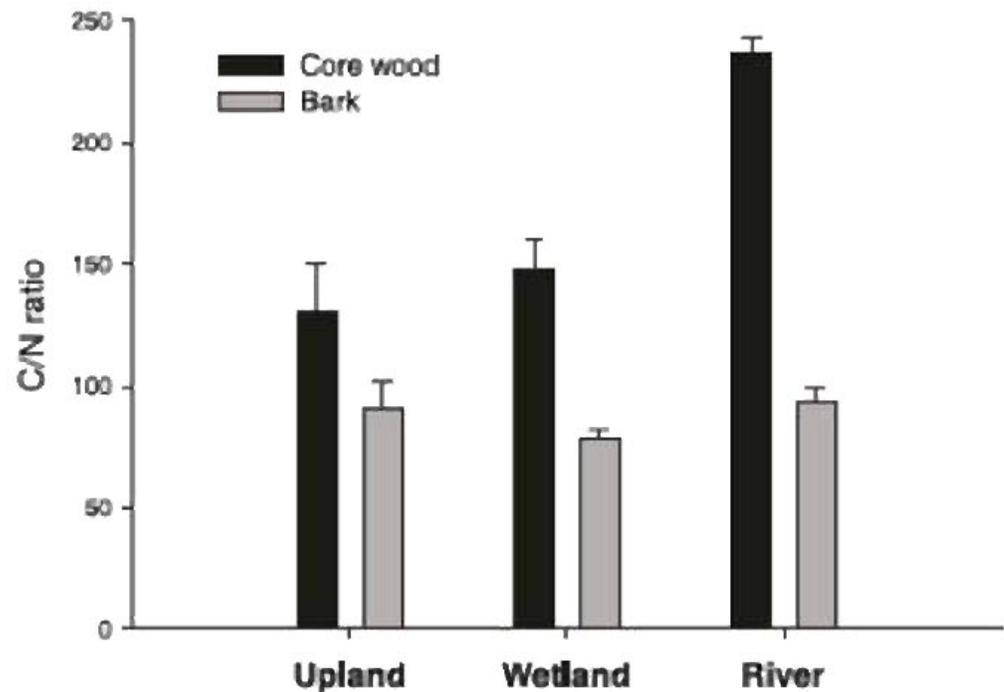




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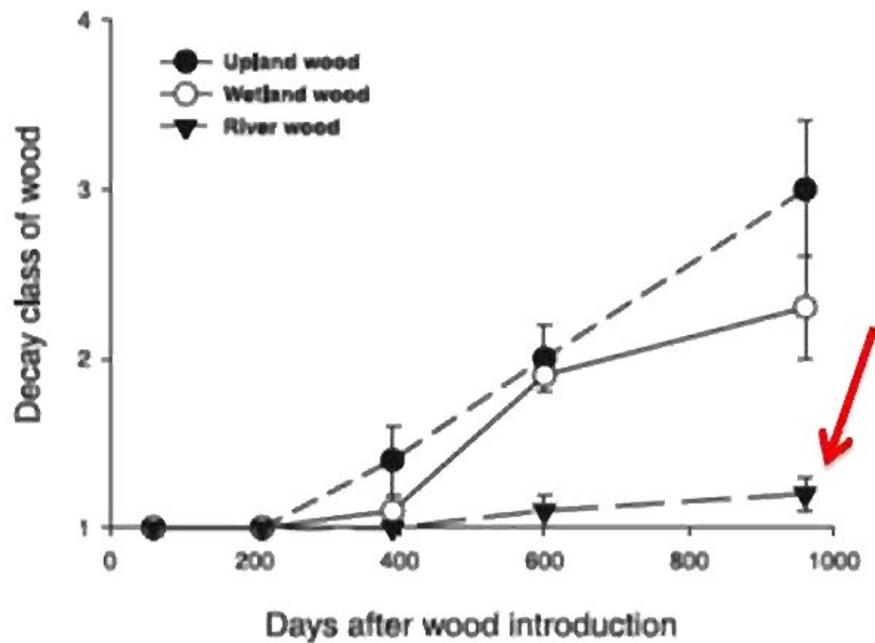
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Wood C:N ratio after 2.7 years in upland, riparian wetland or stream habitats



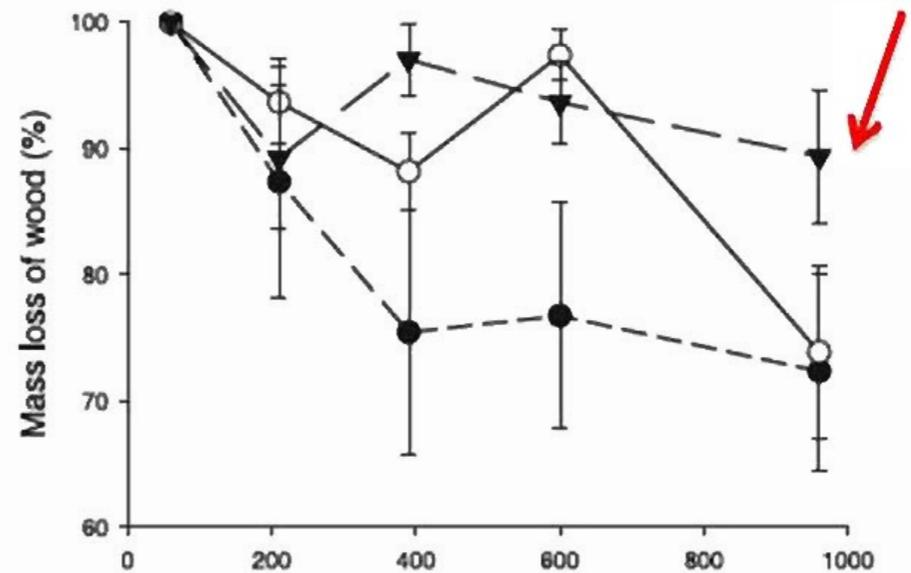
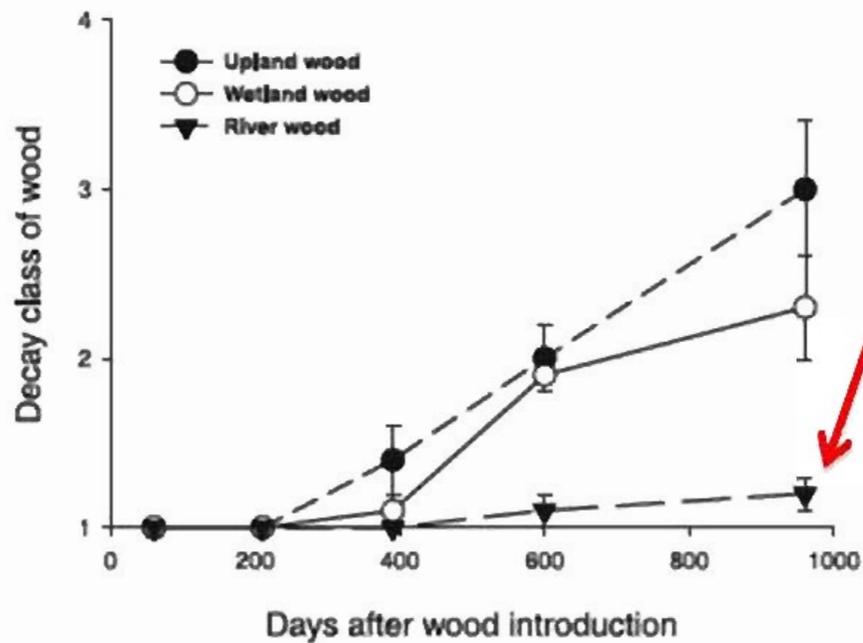
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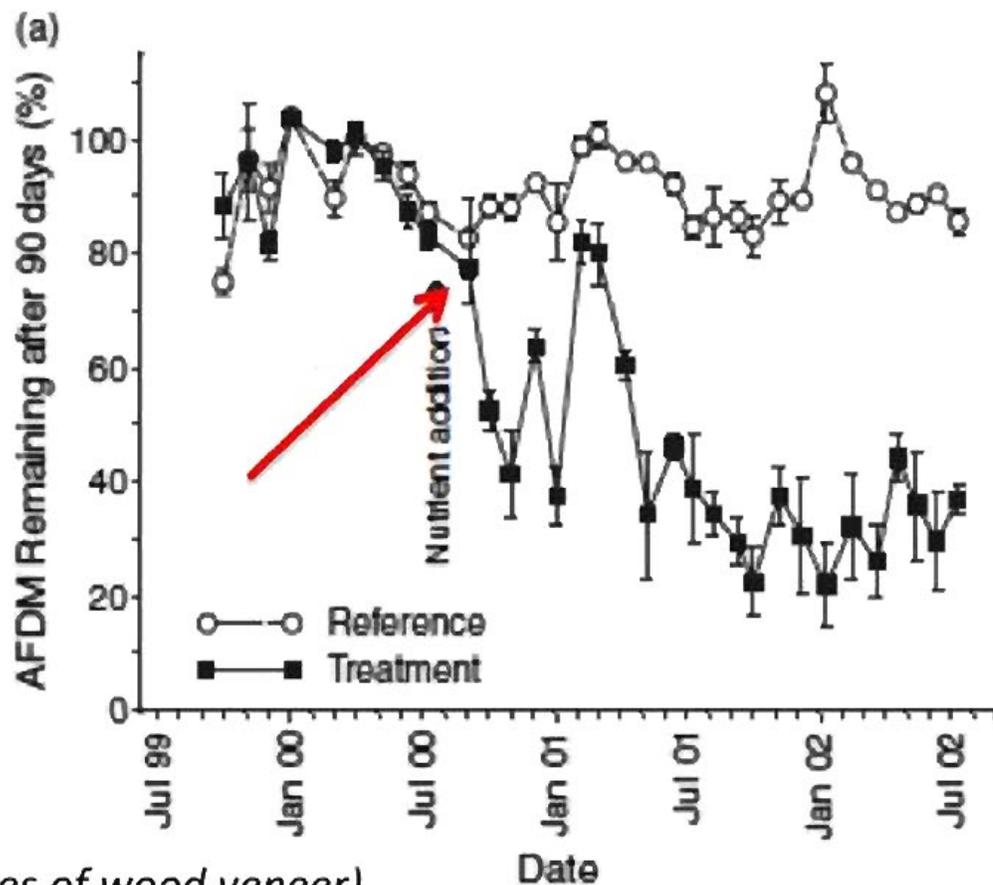
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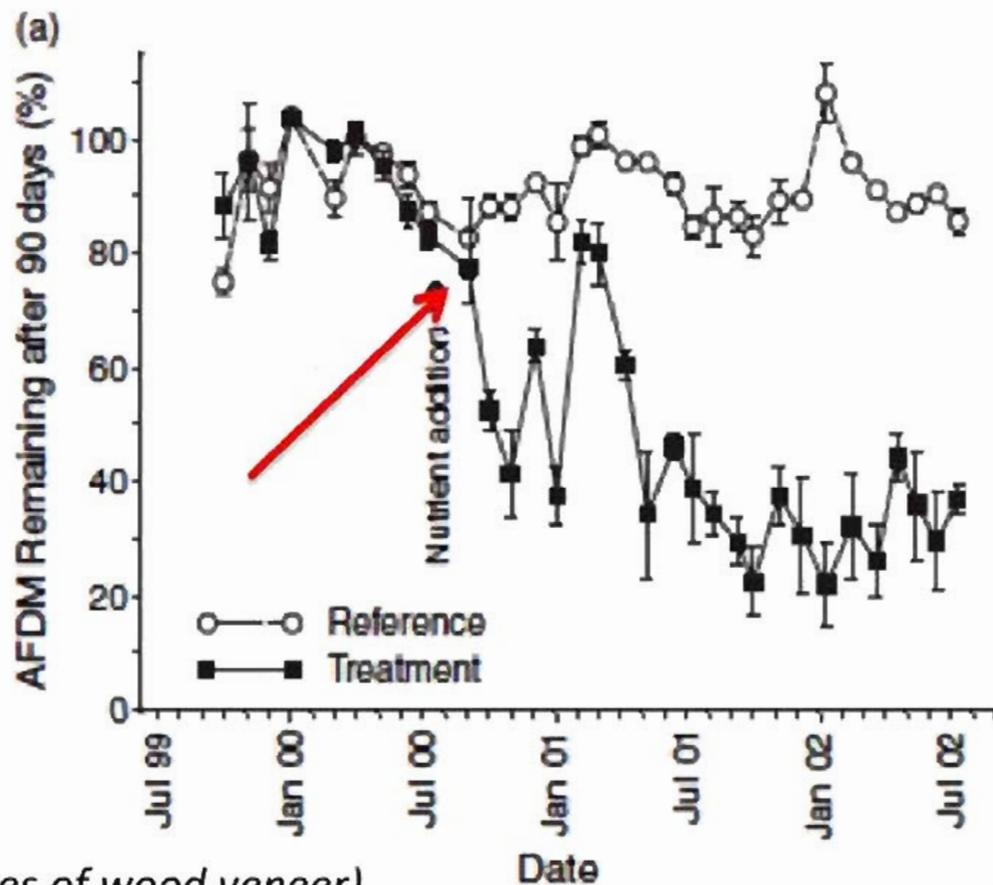
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(for pieces of wood veneer)

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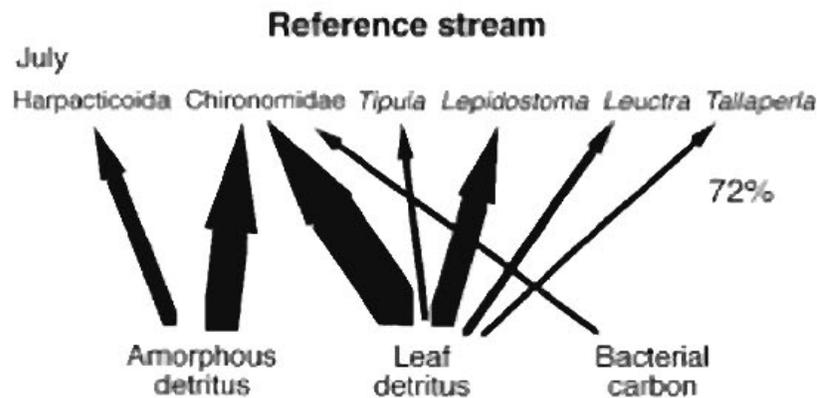
Wood decay in streams is driven primarily by fungi

Decay is often nutrient limited

(for pieces of wood veneer)

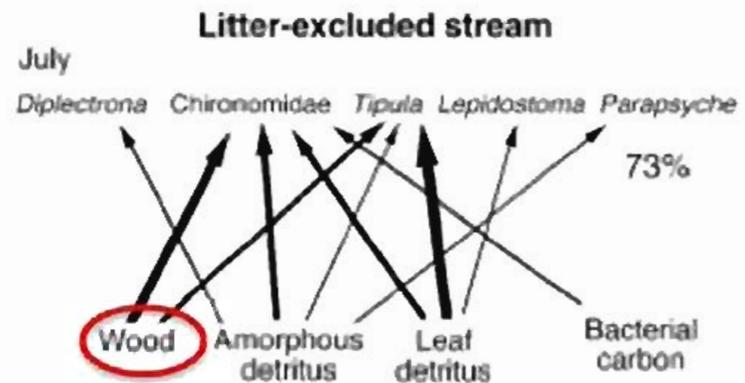
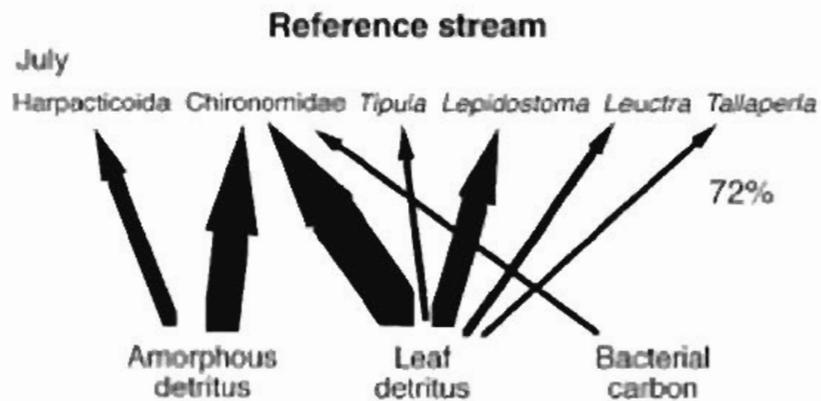
Wood as a carbon source

- Wood in the stream food web
 - *Litter exclusion experiment . . .*



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 - Organic matter retention
 - As a substrate
 - Pool formation and flow alteration

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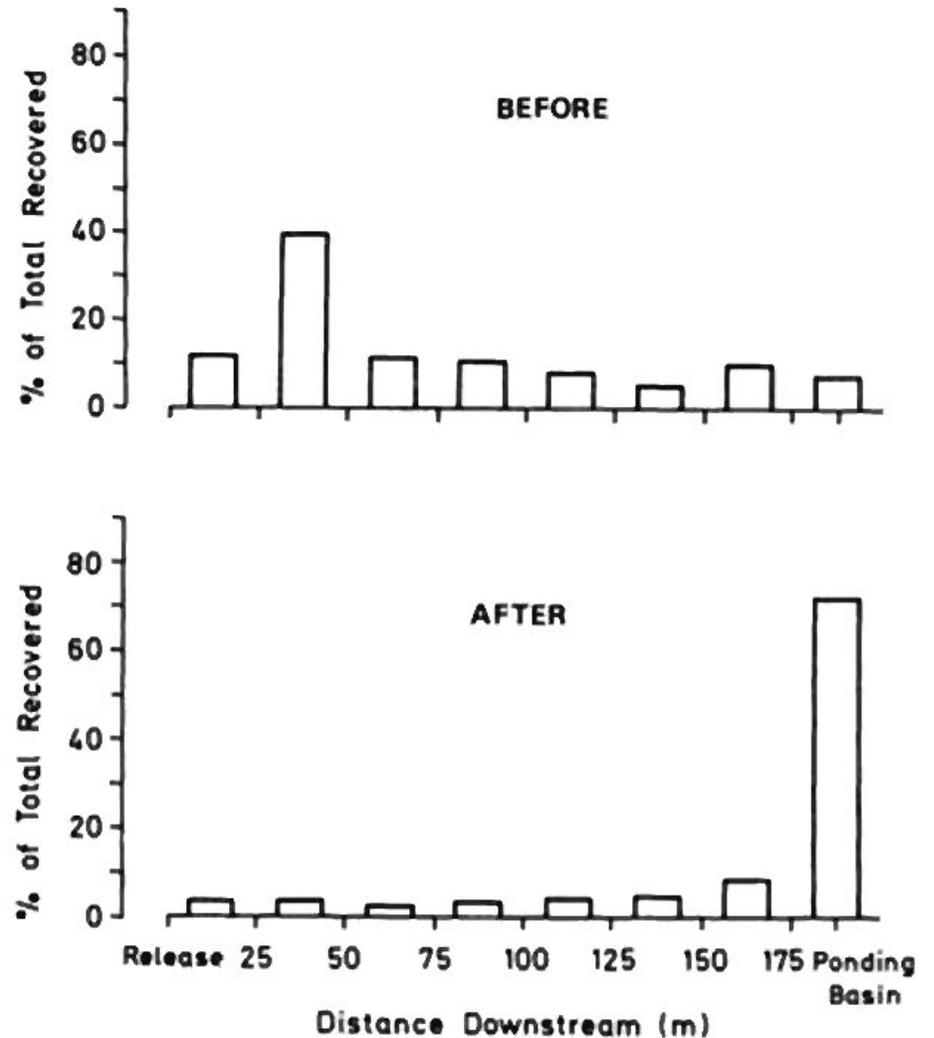
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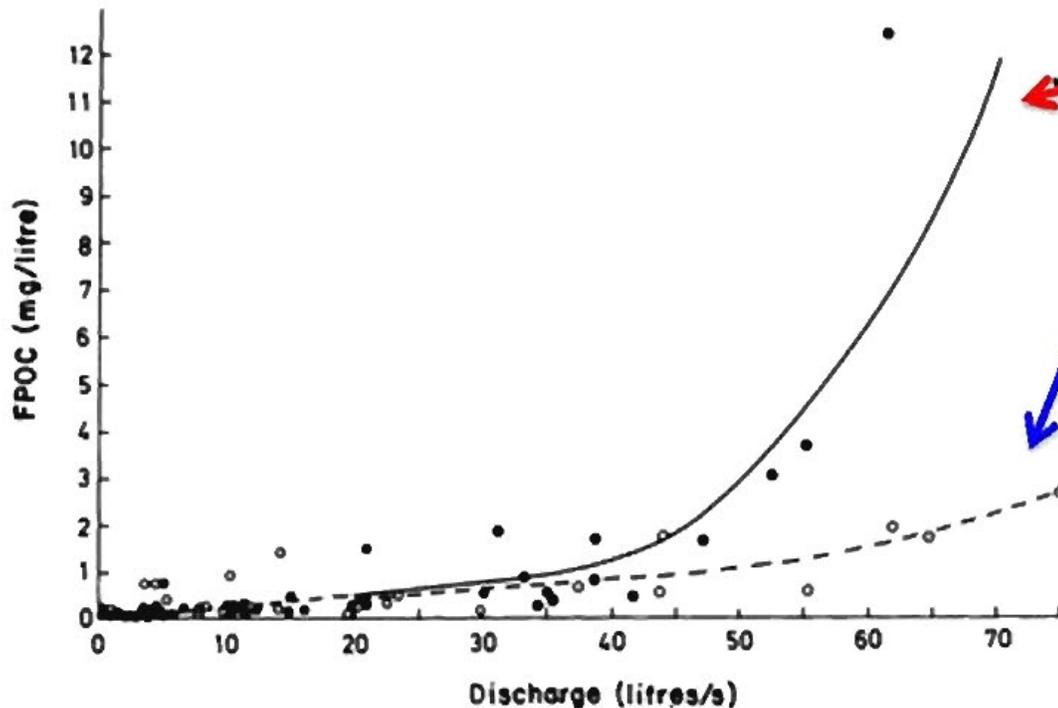
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Surrogate leaf
(flagging) transport
before and after
wood removal



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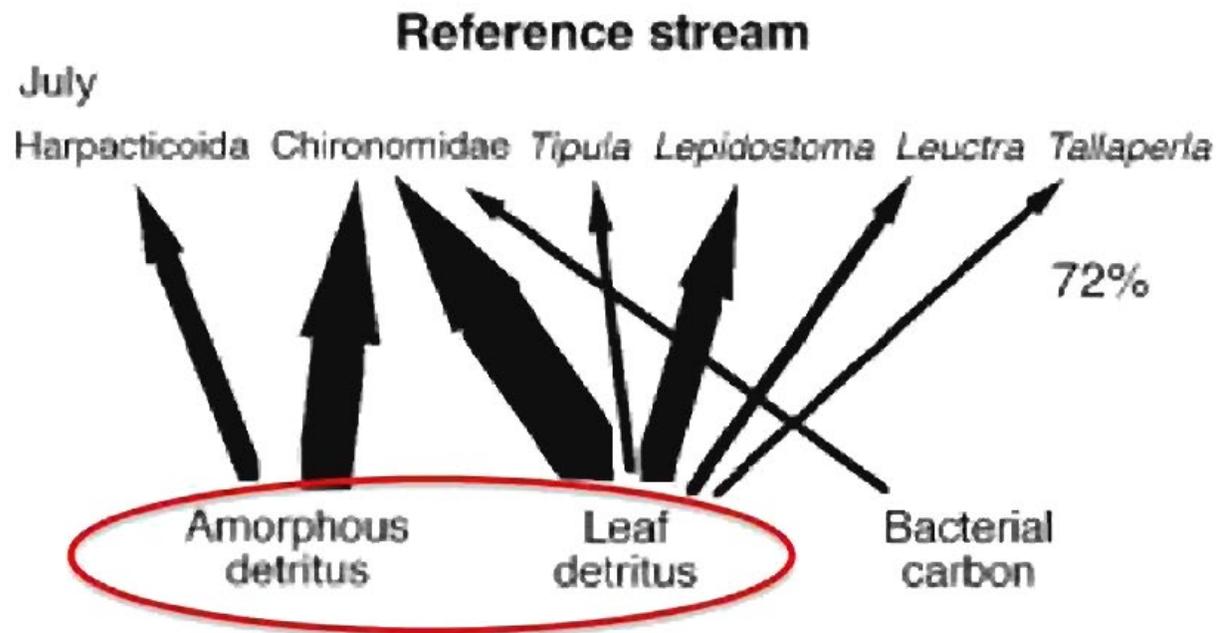


Fine Particulate Organic Carbon (FPOC) export **before** (open circles) and **after** (closed circles) debris dam removal



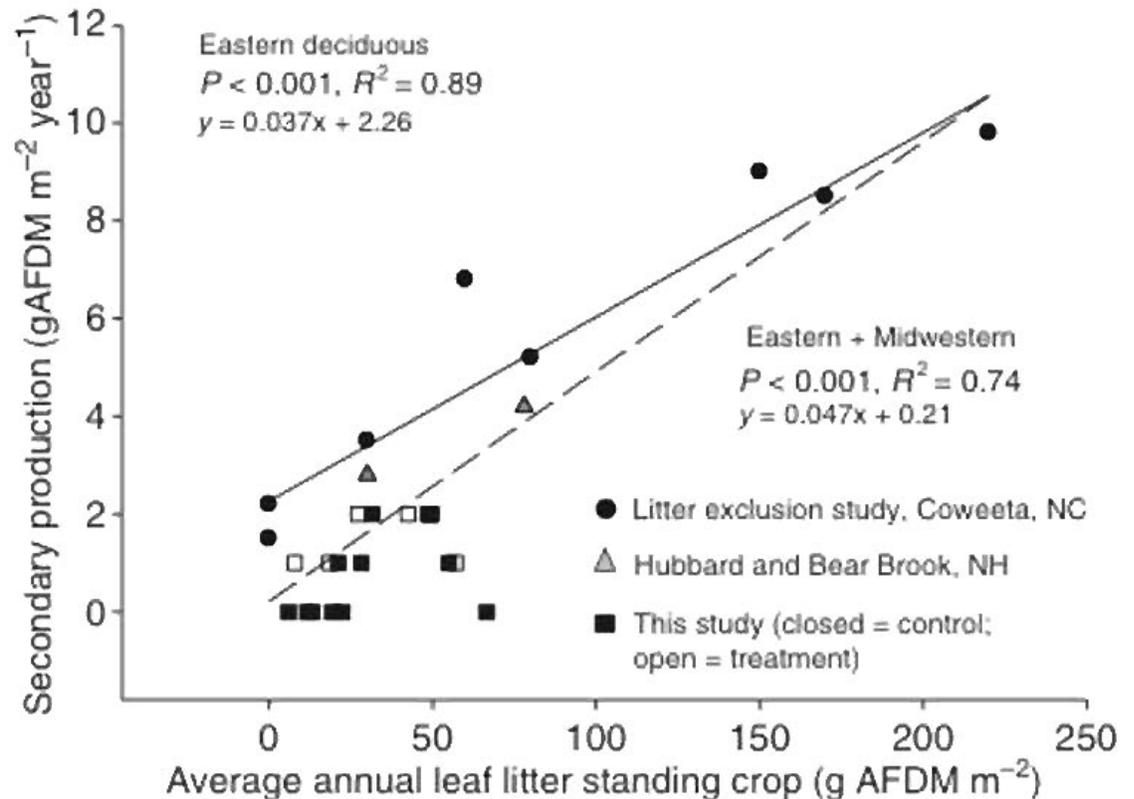
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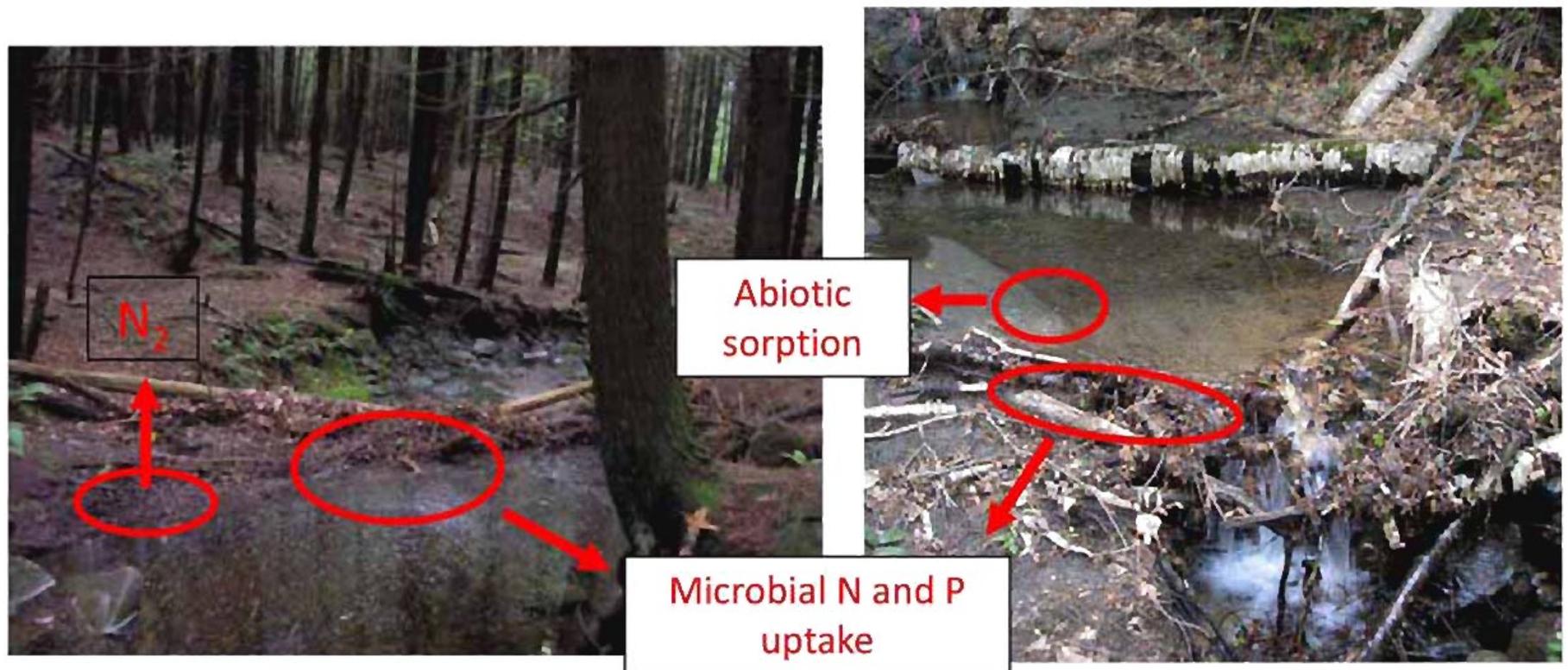
OM retention and stream nutrients

- “biogeochemical hotspots”



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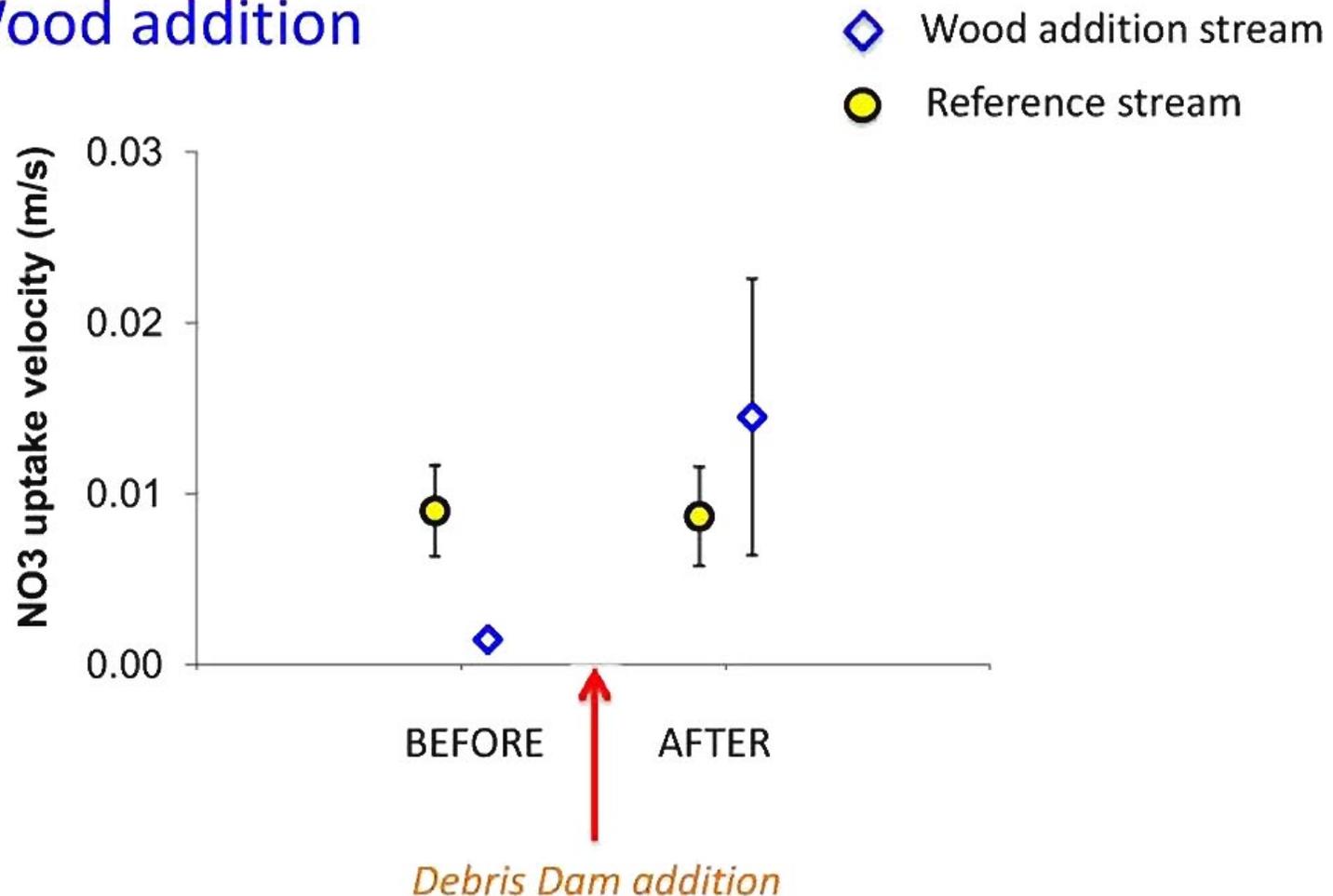
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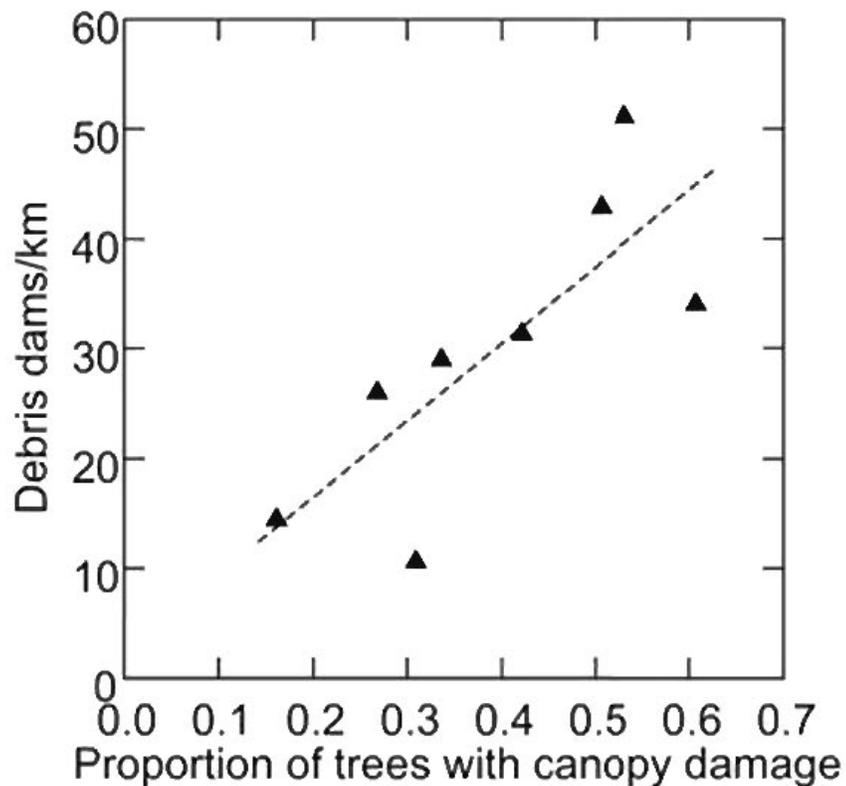
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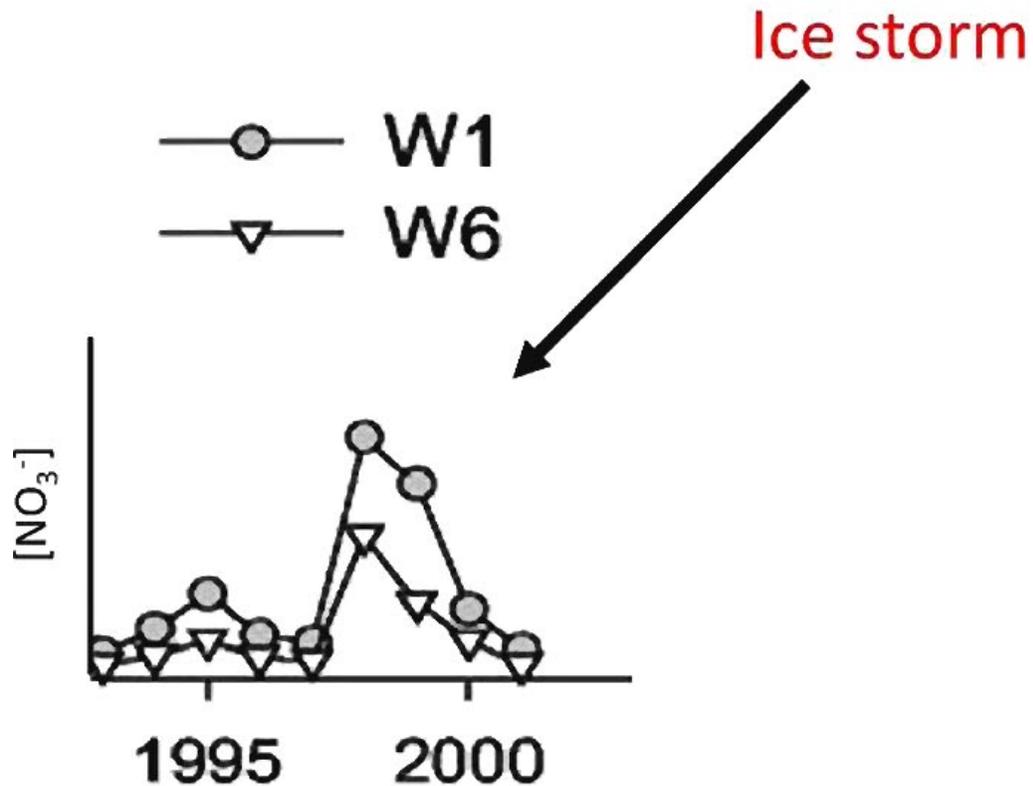
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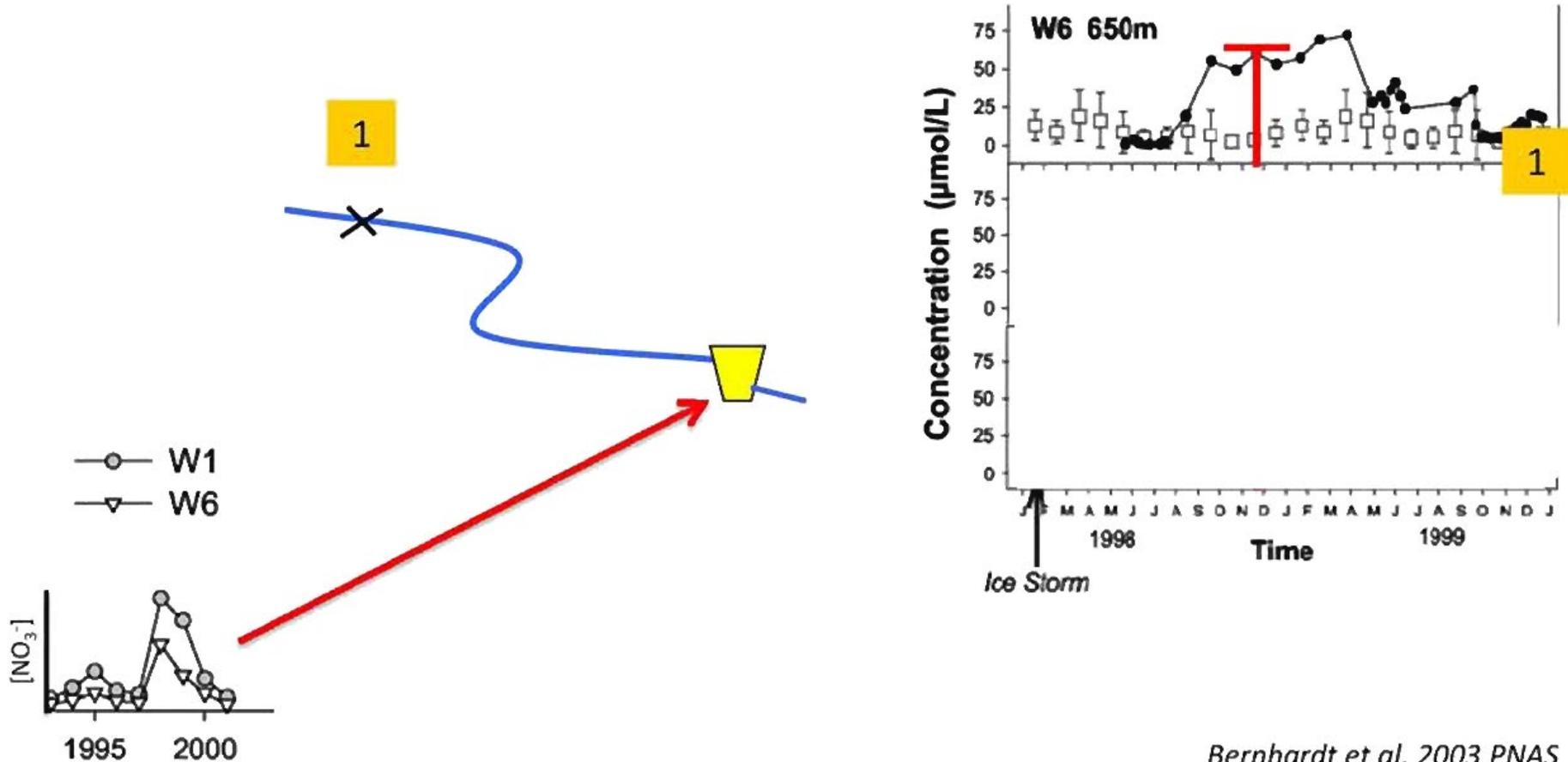
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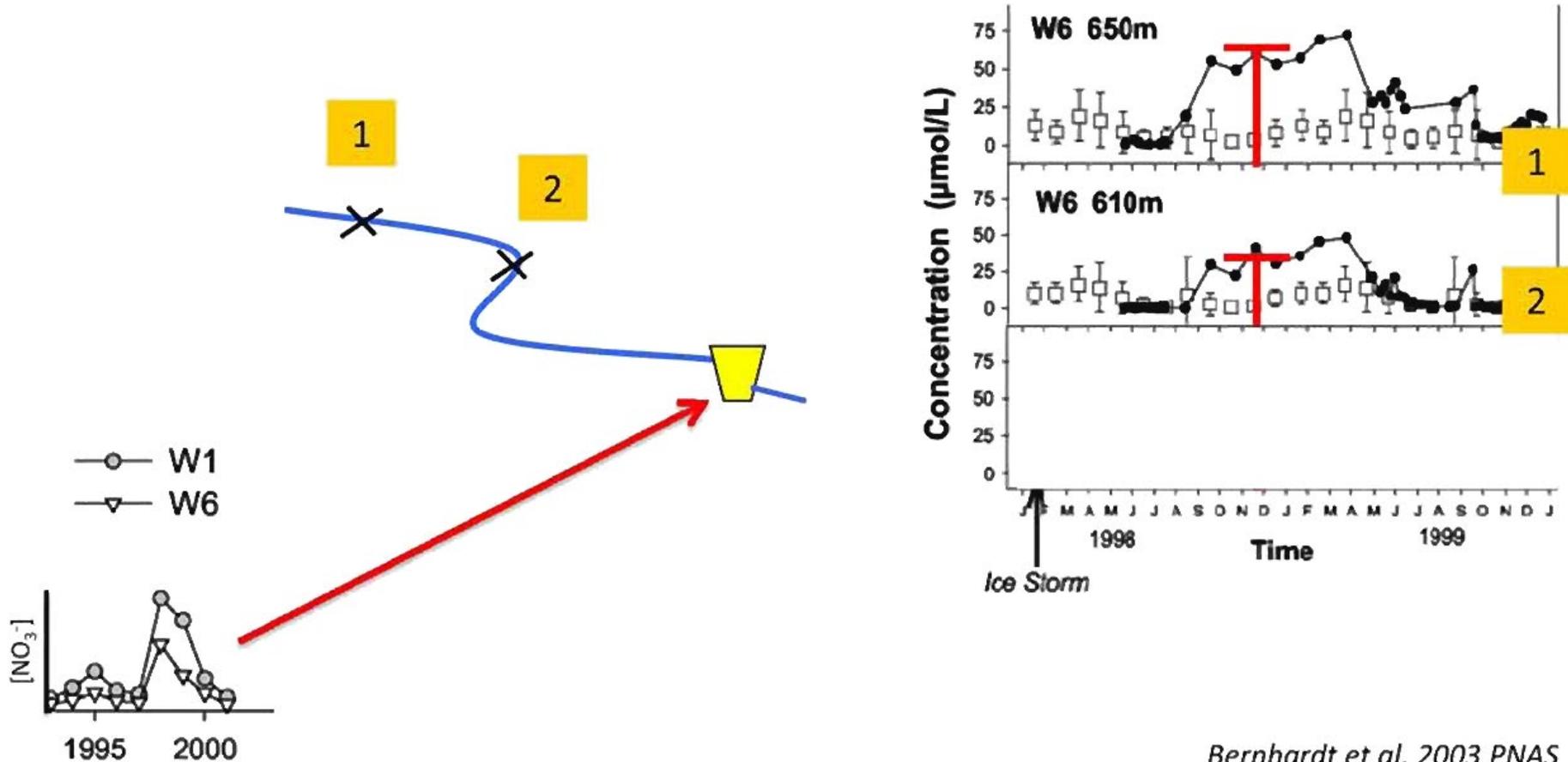
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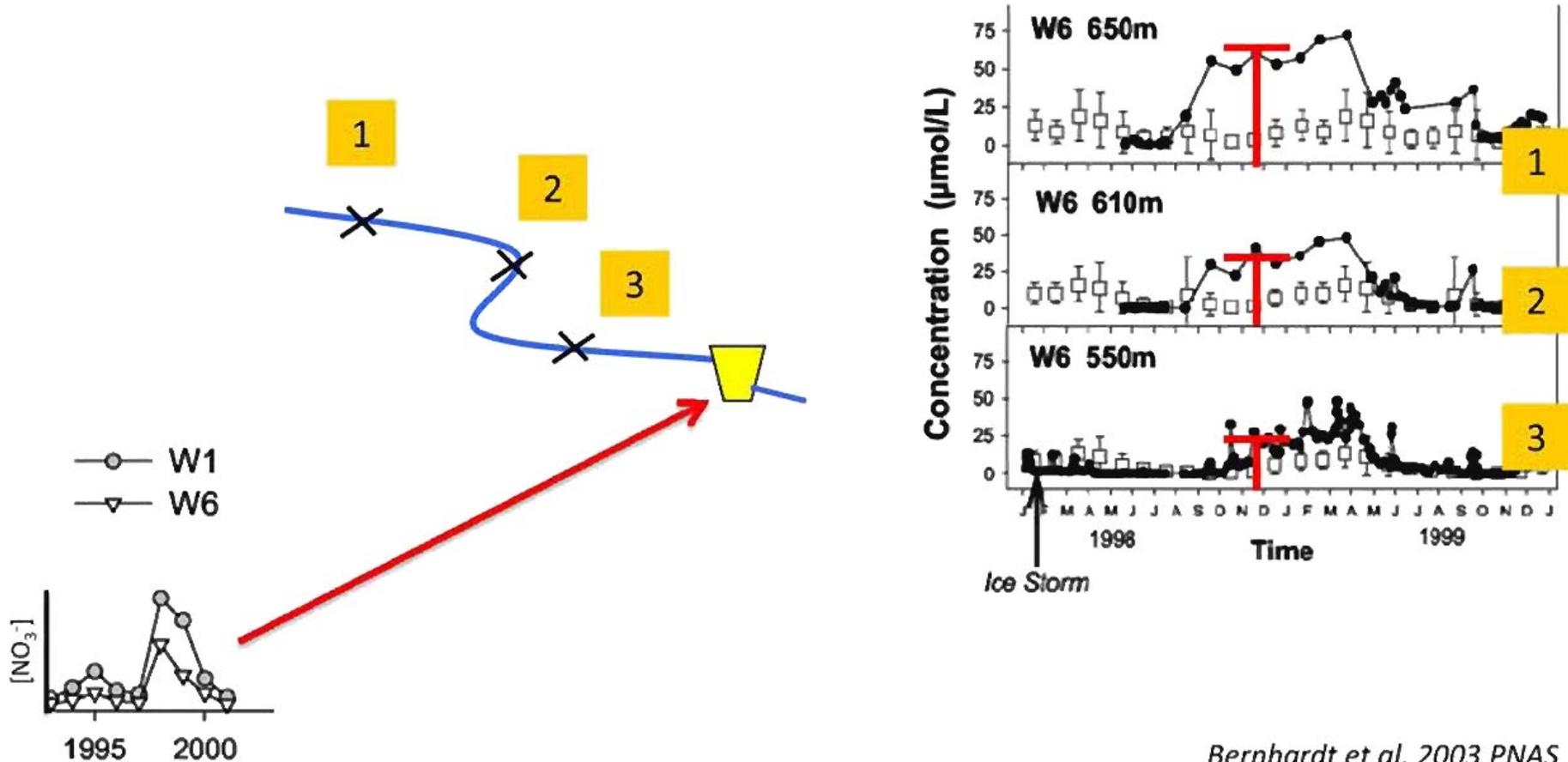
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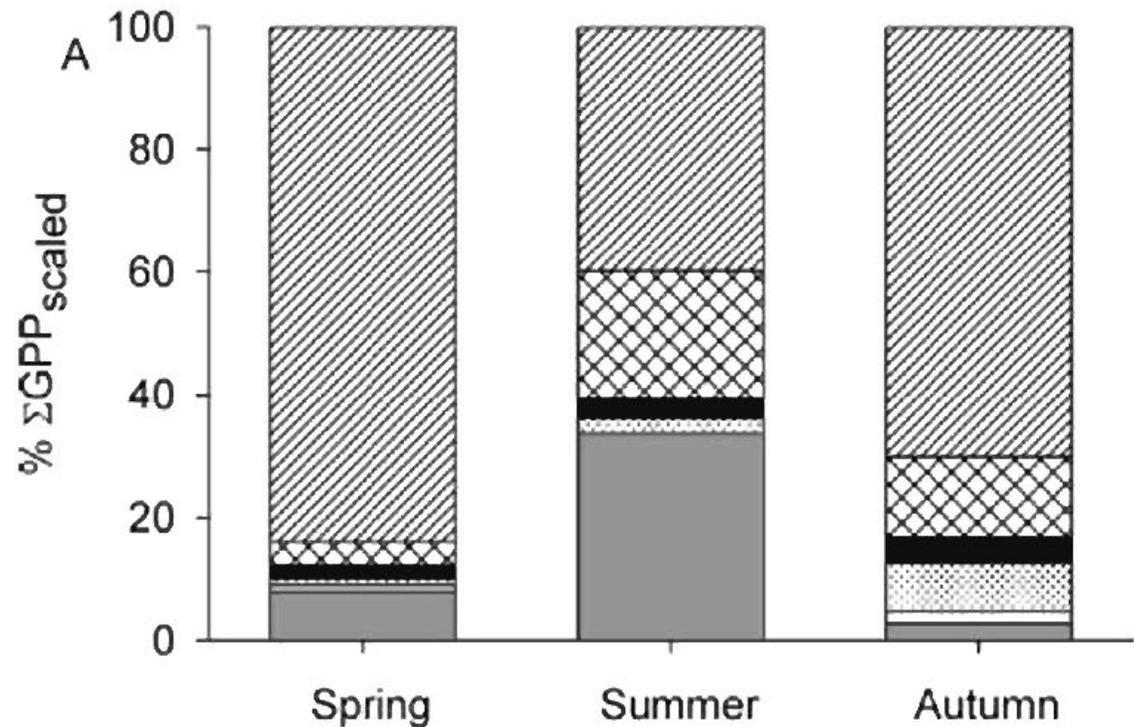
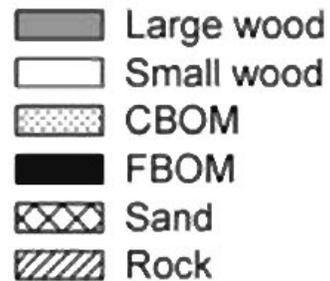
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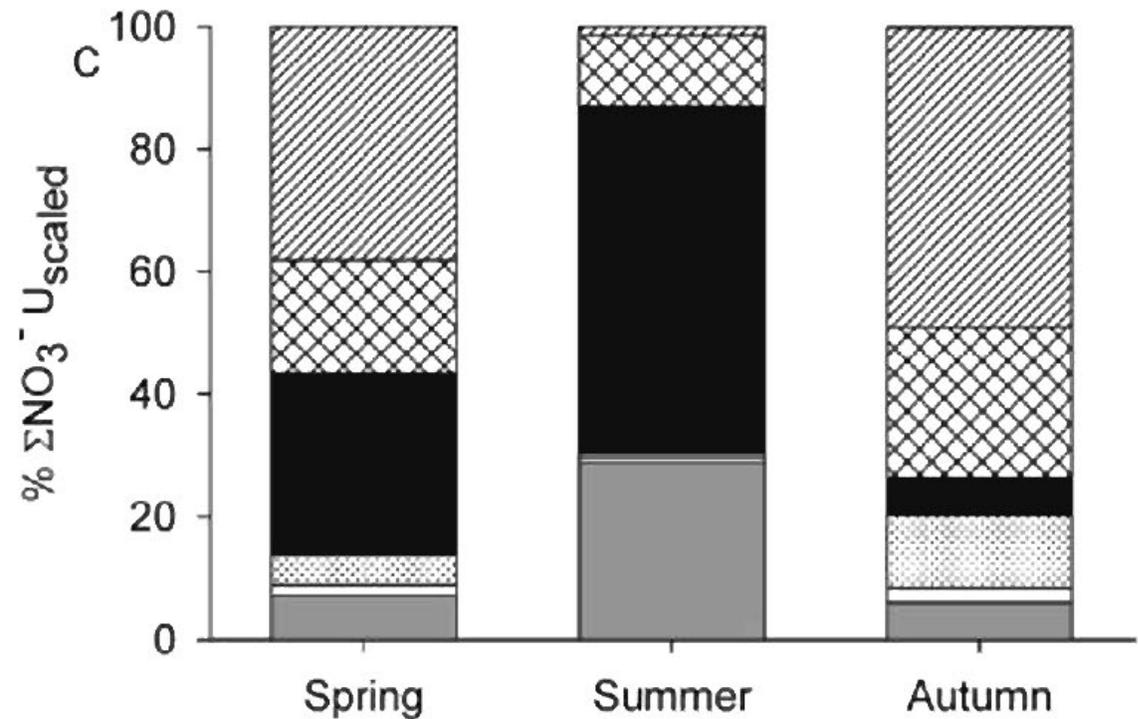
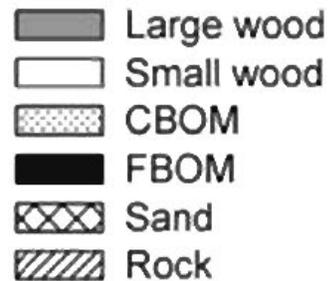
Primary Production



Wood function

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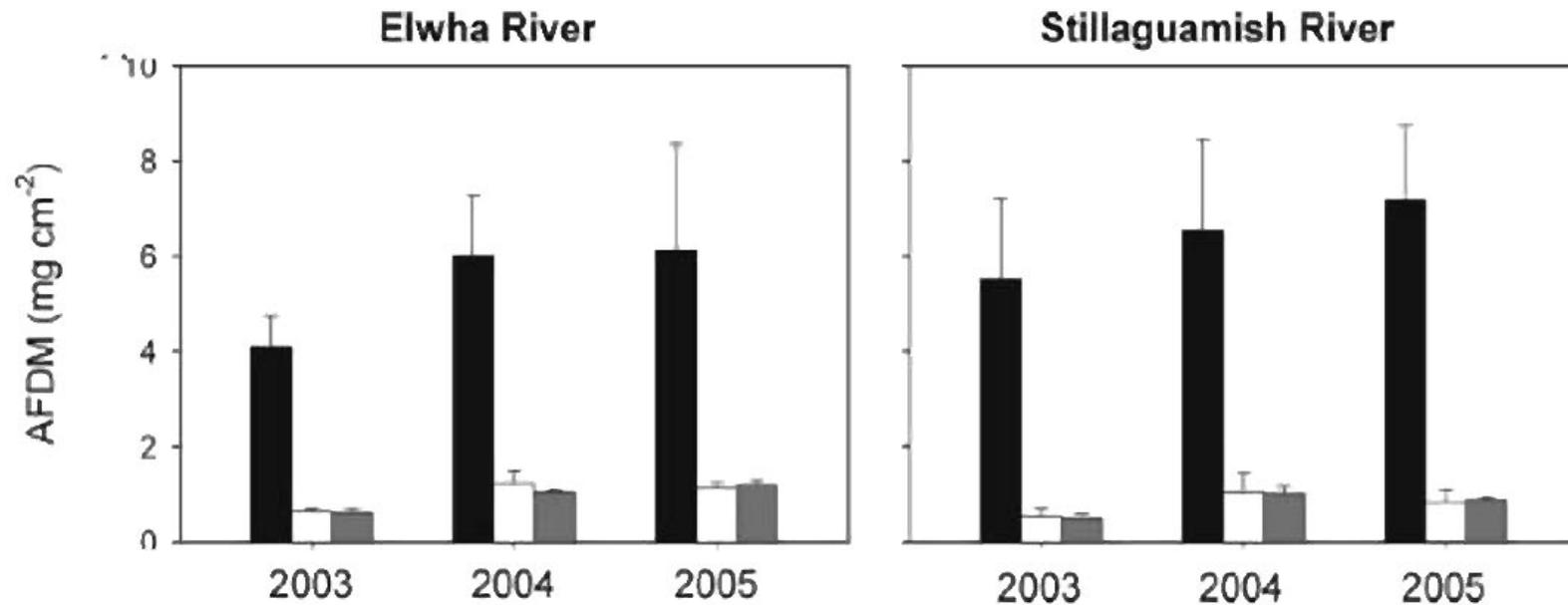
Nitrogen uptake

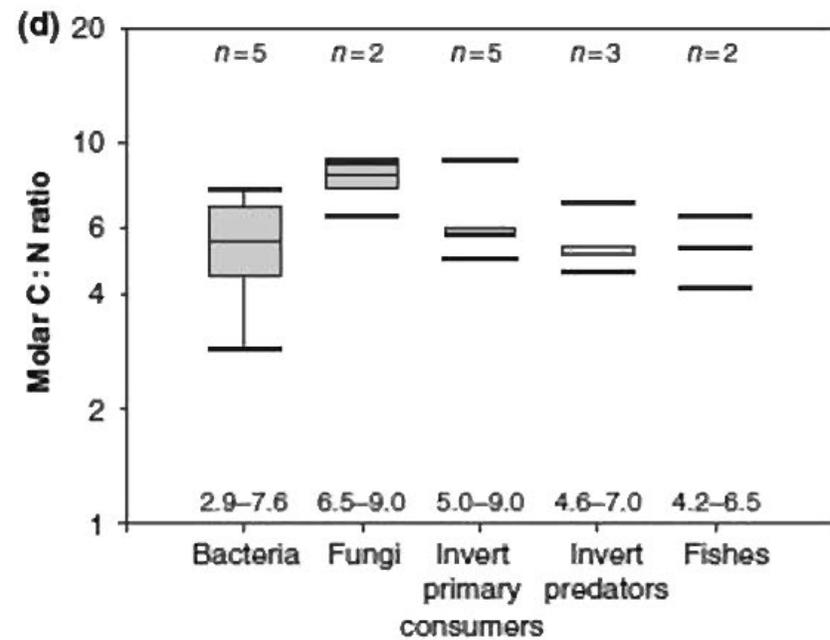
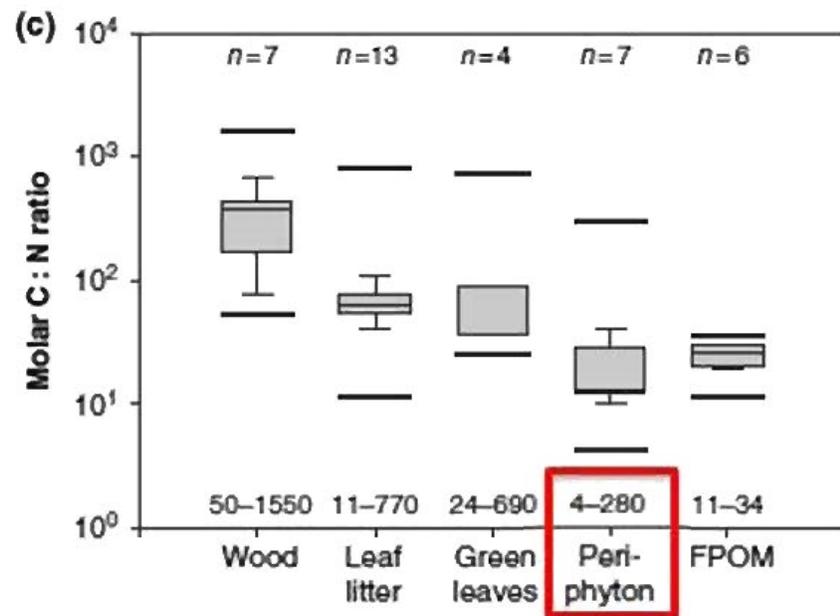
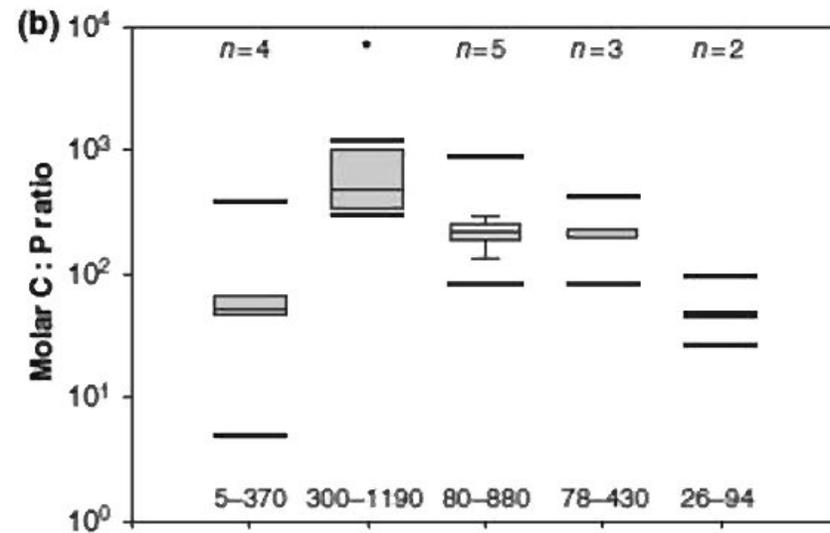
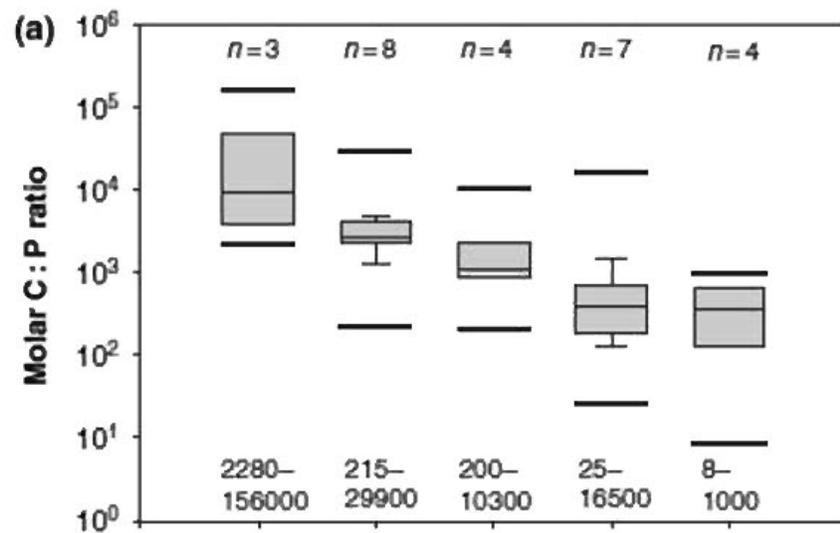


Wood function

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Periphyton

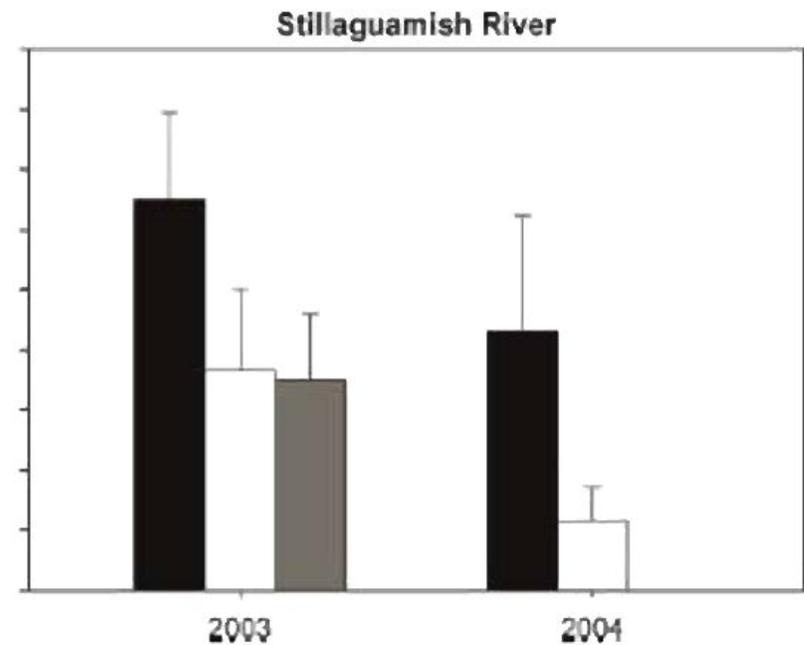
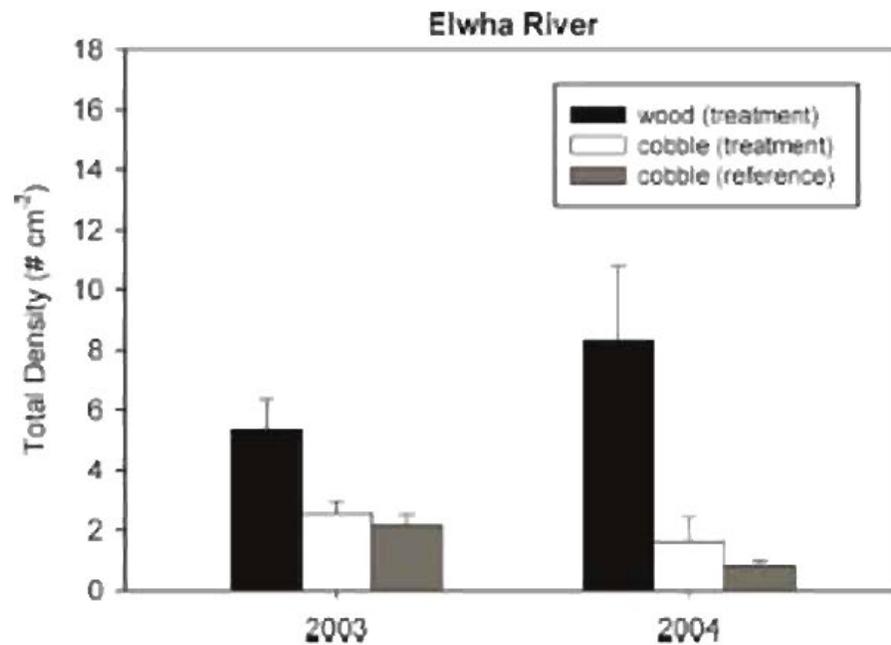




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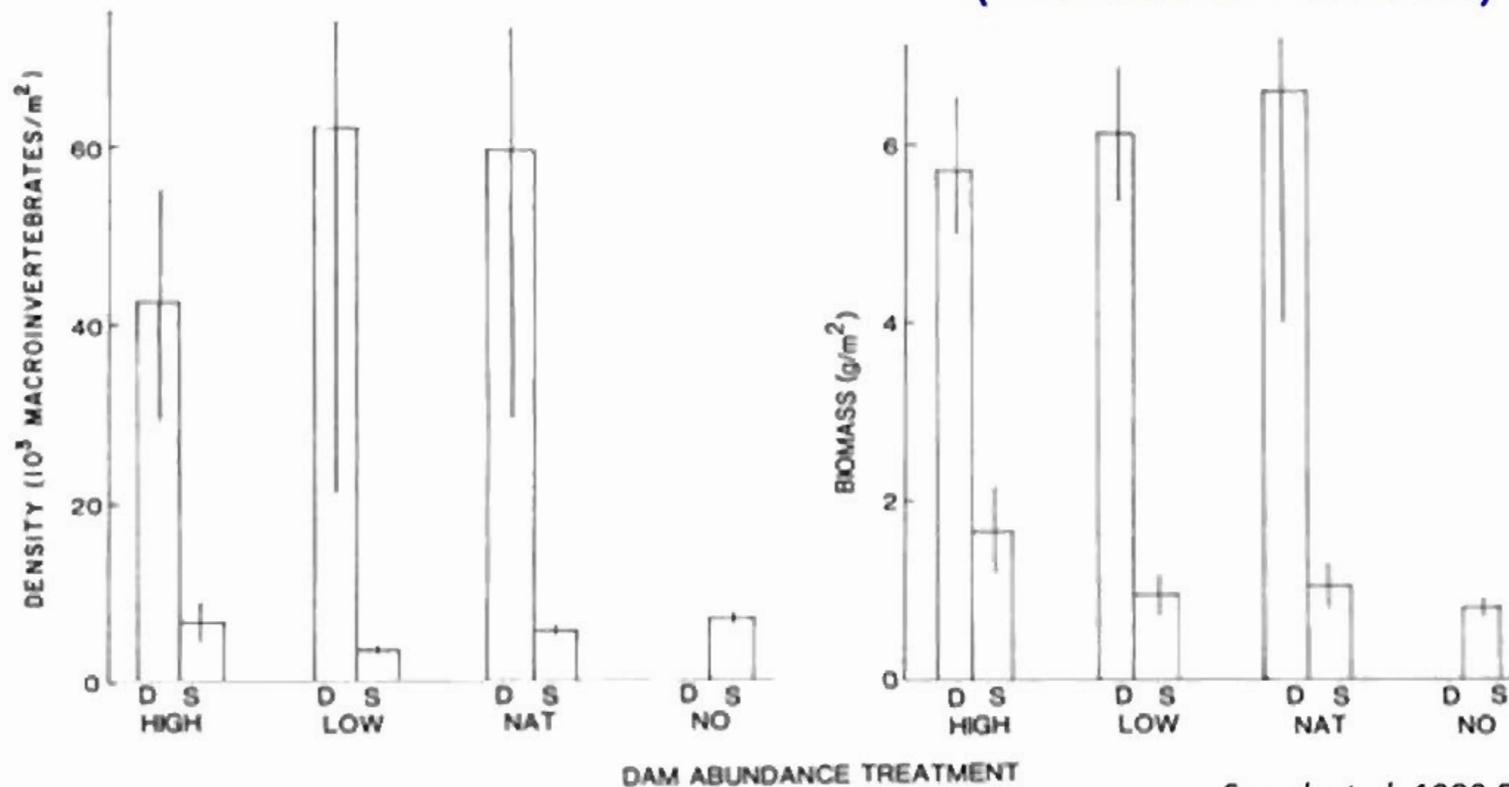
Invertebrate densities (cobble substrate stream)



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Invertebrate densities (sandbed stream)



Wood function

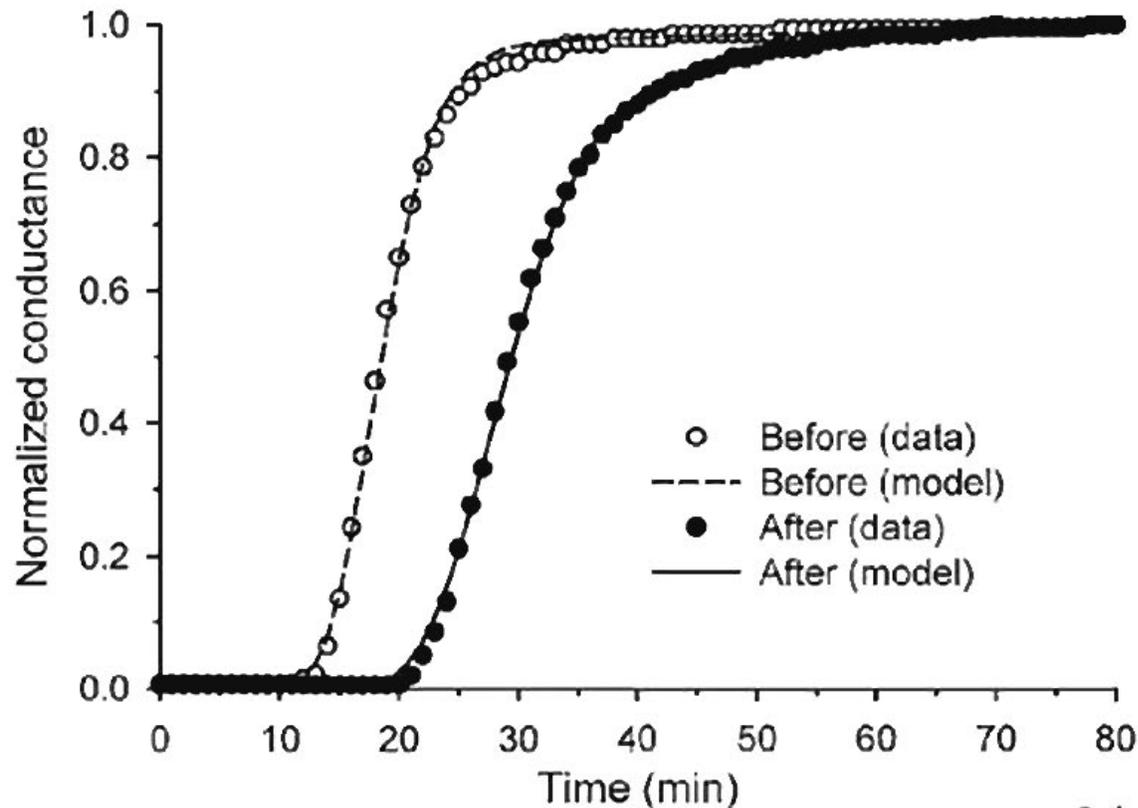
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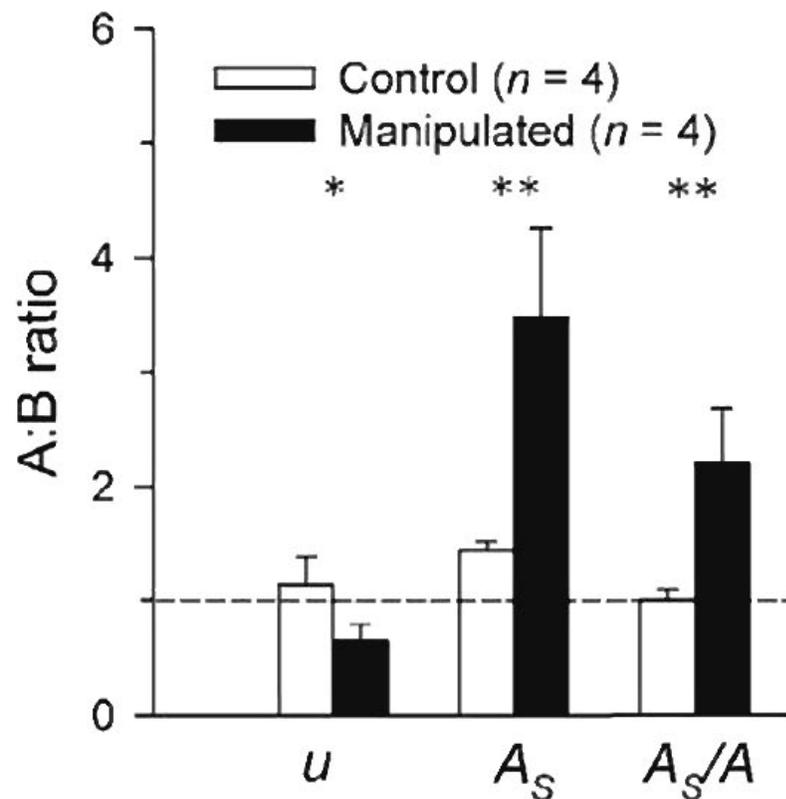
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Solute
breakthrough
curves before
and after wood
addition

Wood function

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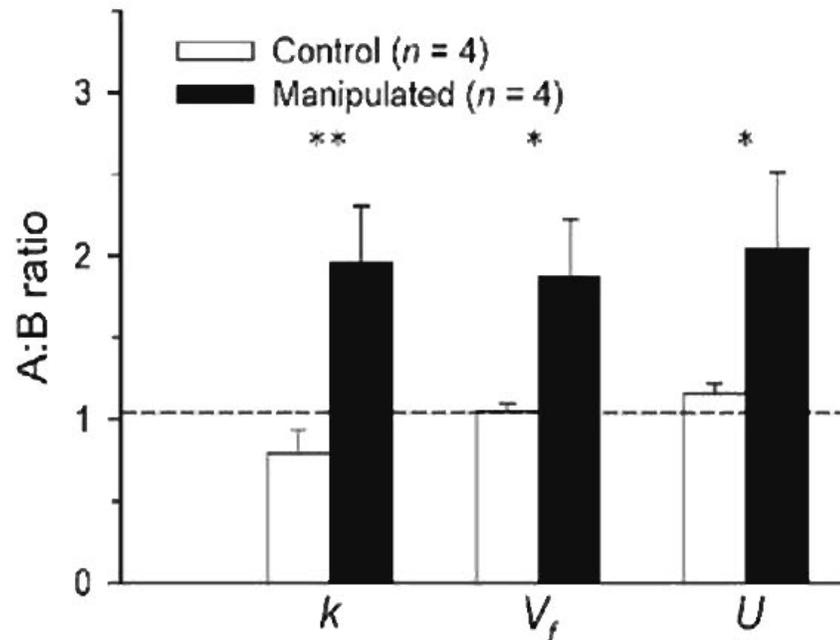


- u : mean water velocity
- A_S : transient storage zone size
- A_S/A : normalized transient storage size

Wood function

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NH₄ dynamics before and after
(ratio) wood addition



- k: fractional uptake per distance(m)
- V_f: uptake velocity (m/s)
- U: uptake rate (ug/m²)

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Fig. 1. Snapping Turtle Canal with baffles installed, January 2004.

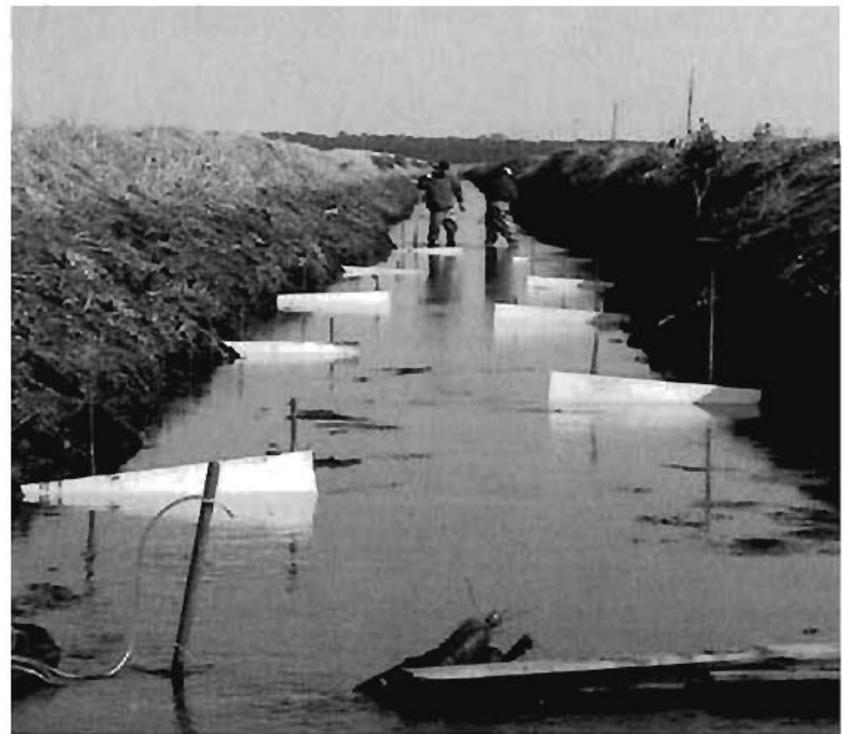
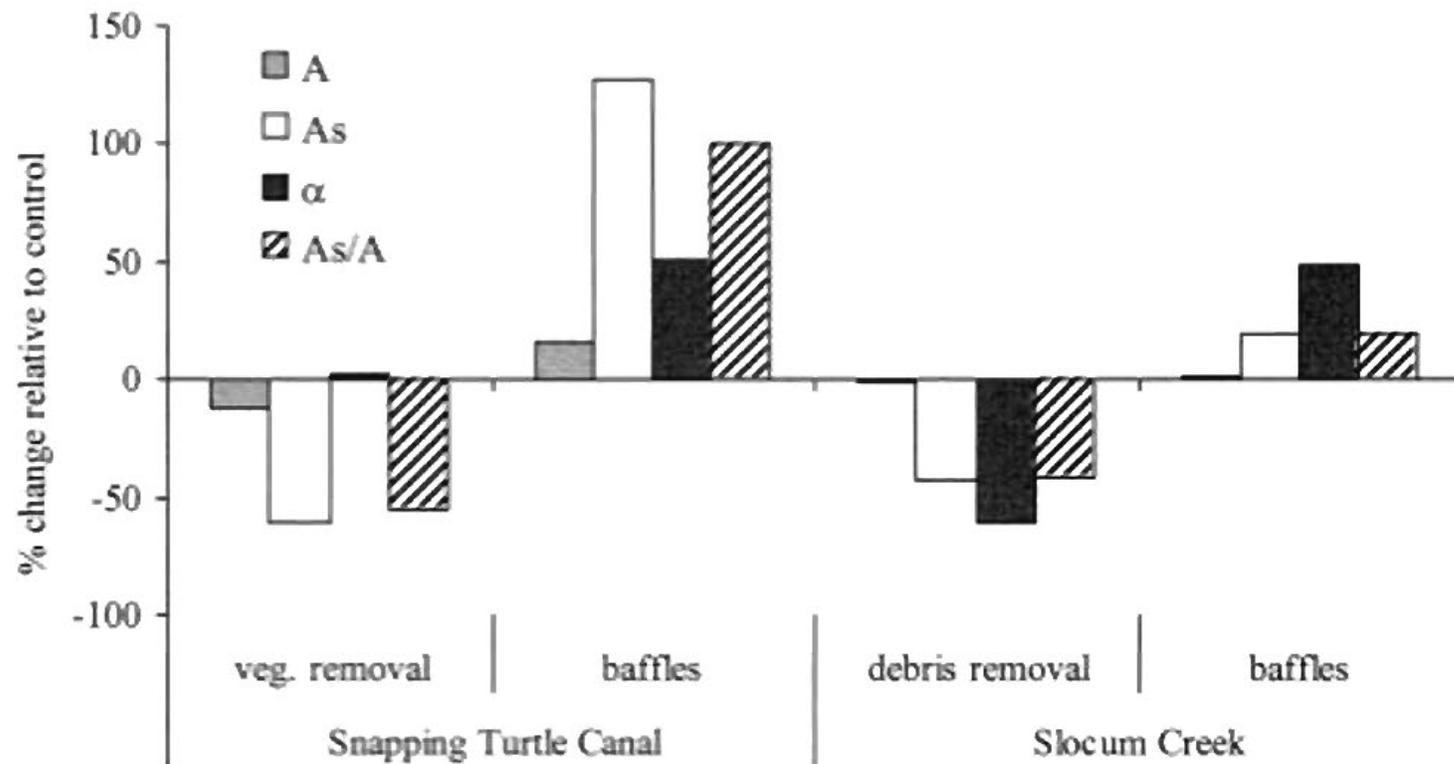


Fig. 2. Slocum Creek with baffles installed, January 2004.

Ensign and Doyle 2005 L&O 50: 1740

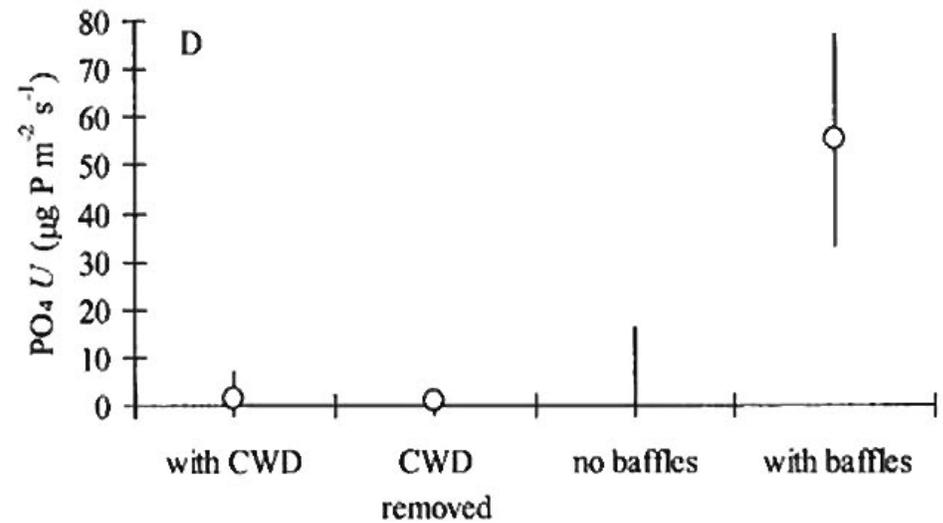
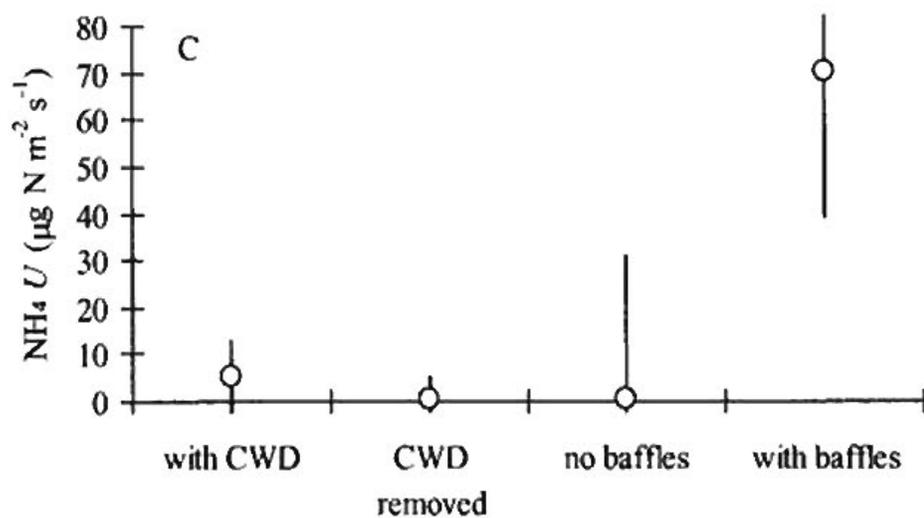
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 - Provides stable structure in soft-bottomed streams

Take-home message(s)

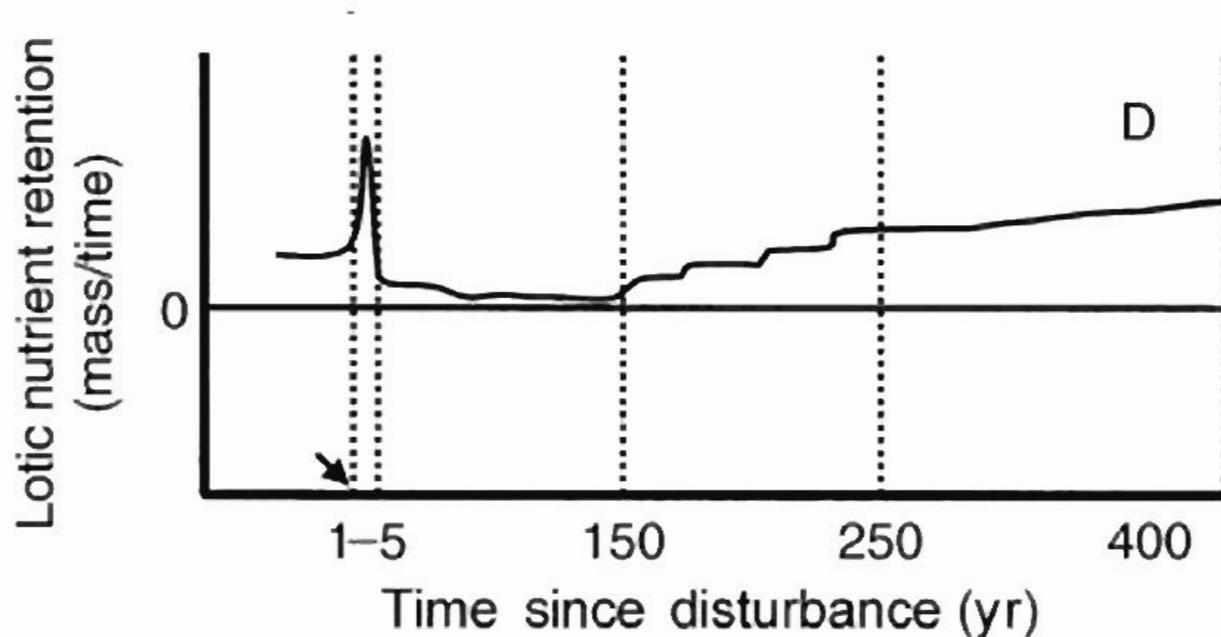
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 - Wood and dams in particular increase transient storage
 - Does not have to promote hyporheic flow can simply be pool and eddy formation

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 - Does not have to promote hyporheic flow can simply be pool and eddy formation
 - Slower water allows for greater nutrient uptake

Implications

(1) Changes in stream wood load in response to natural processes and anthropogenic activities can change stream function over time



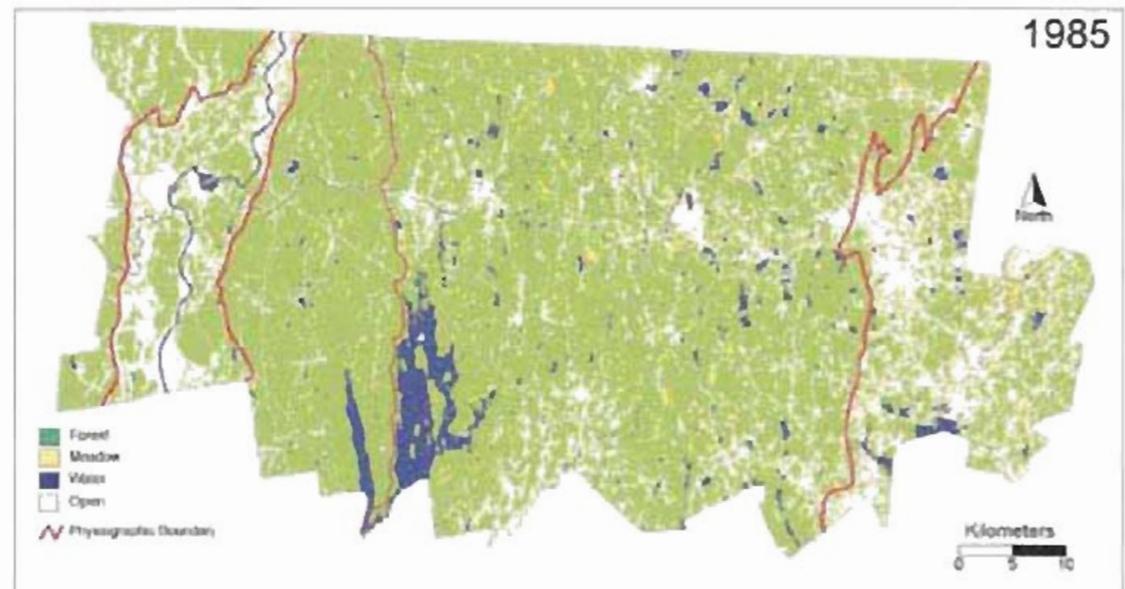
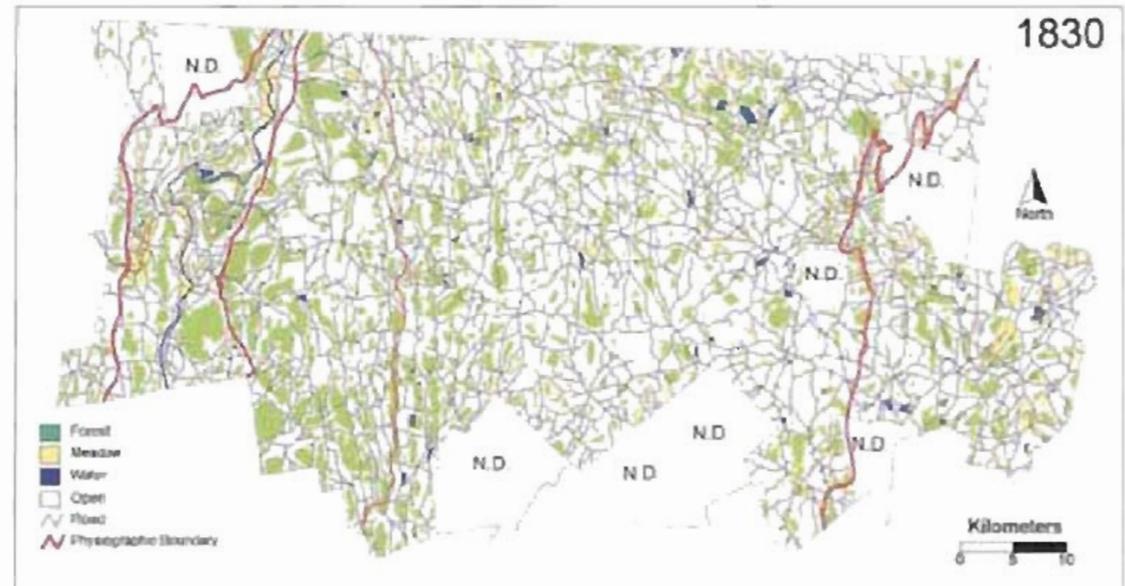
Implications

(2) Even if wood addition doesn't form the habitat intended, it can still benefit aquatic ecosystems

- Retains organic matter and sediment
- Increase basal resources (indirectly)
 - Periphyton
 - detritus
- Promotes nutrient uptake (but there are exceptions *(e.g. Ambrose et al. 1990)*)

Implications: *Changing stream function with forest regrowth*

- Fost
- Open (pasture/field)

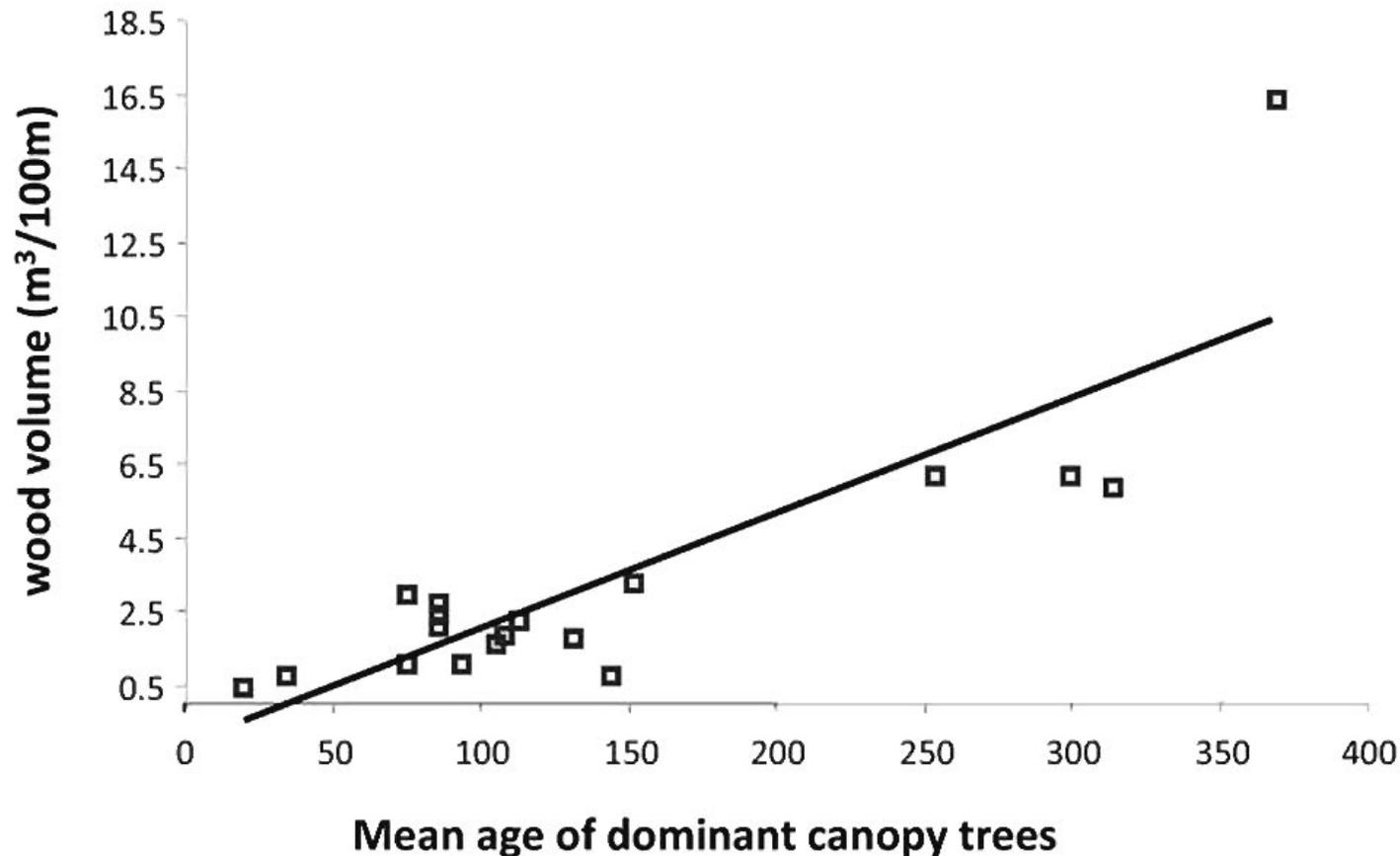


(Foster et al. 1998)

Implications: *Changing stream function with forest regrowth*

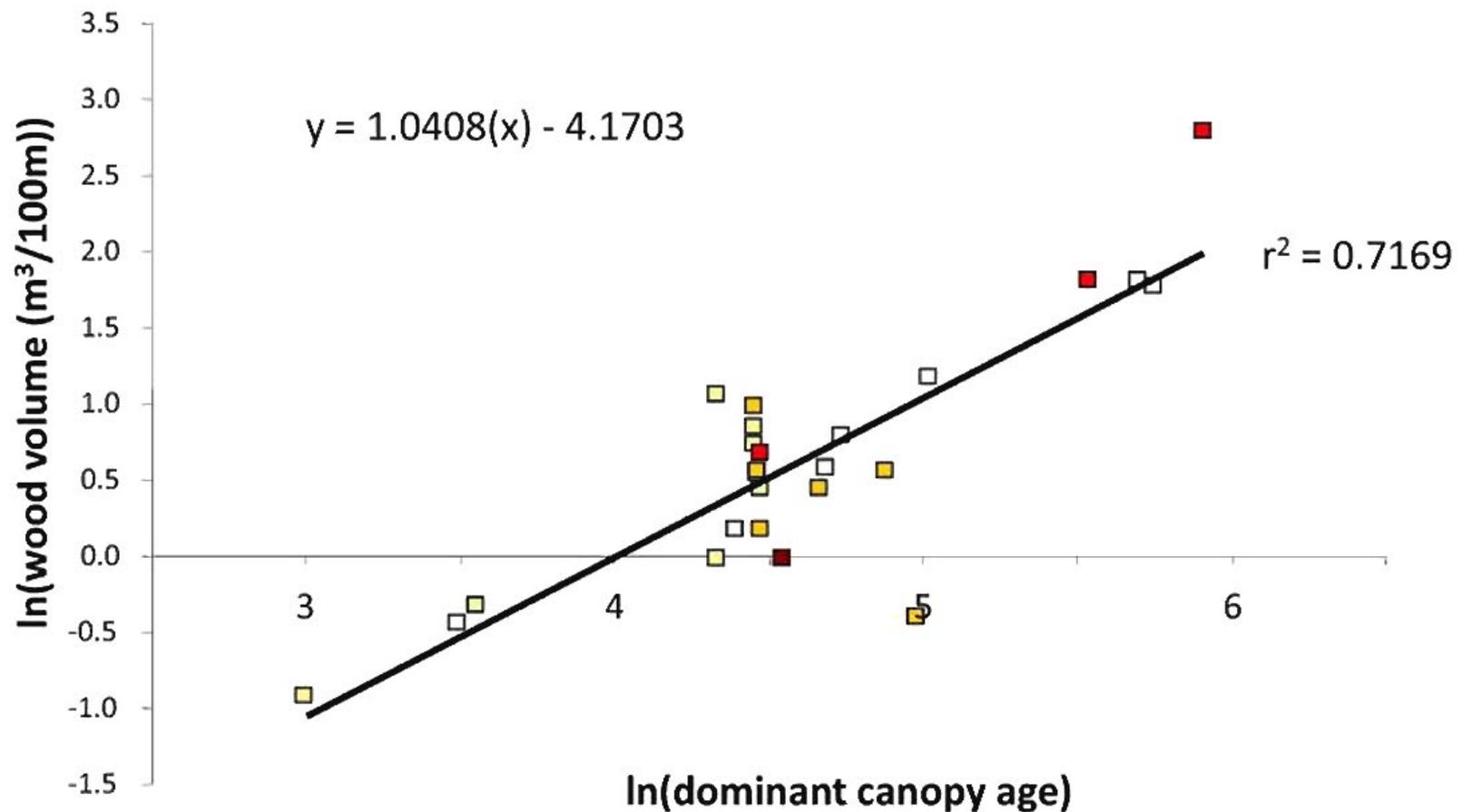
How will stream function change as wood loading recovers from historic landuse?

Wood volume as a function of stand age



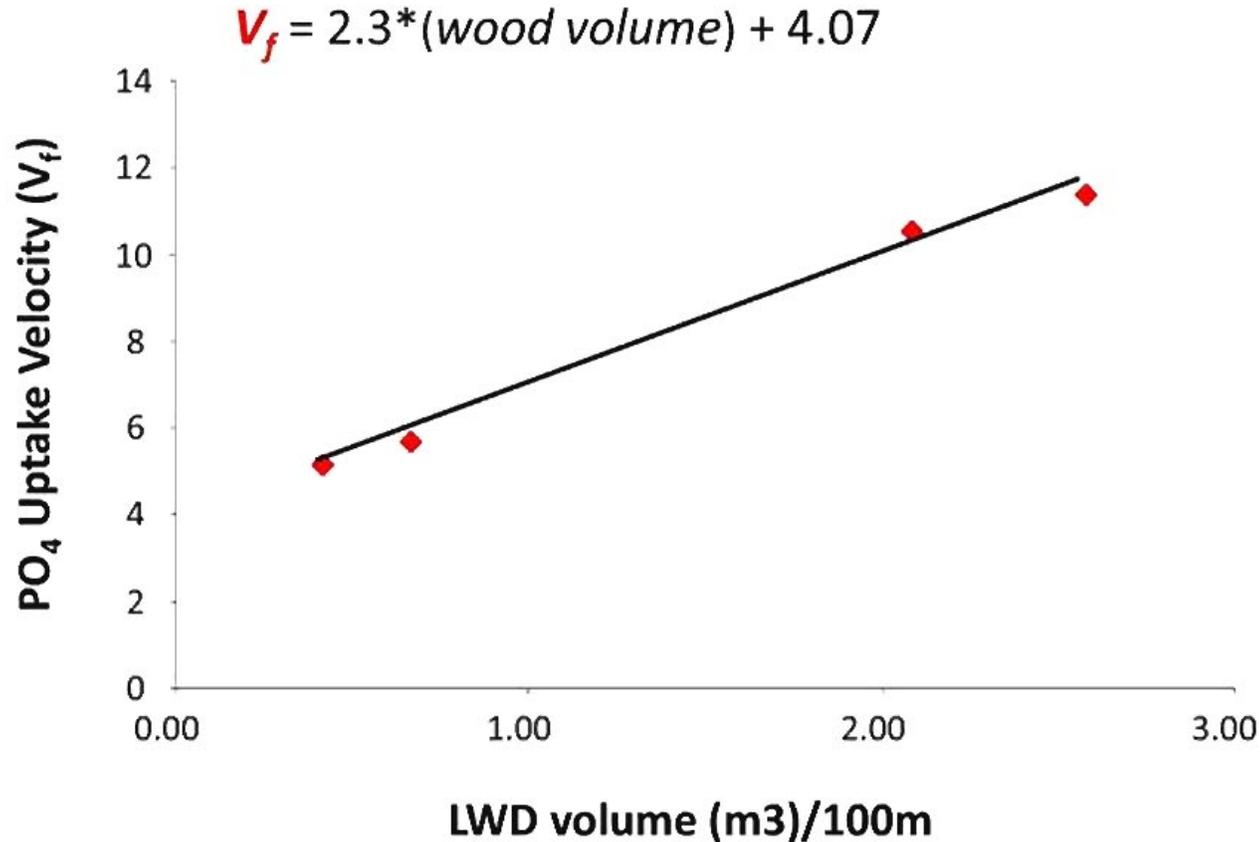
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Wood volume as a function of $\ln(\text{stand age})$



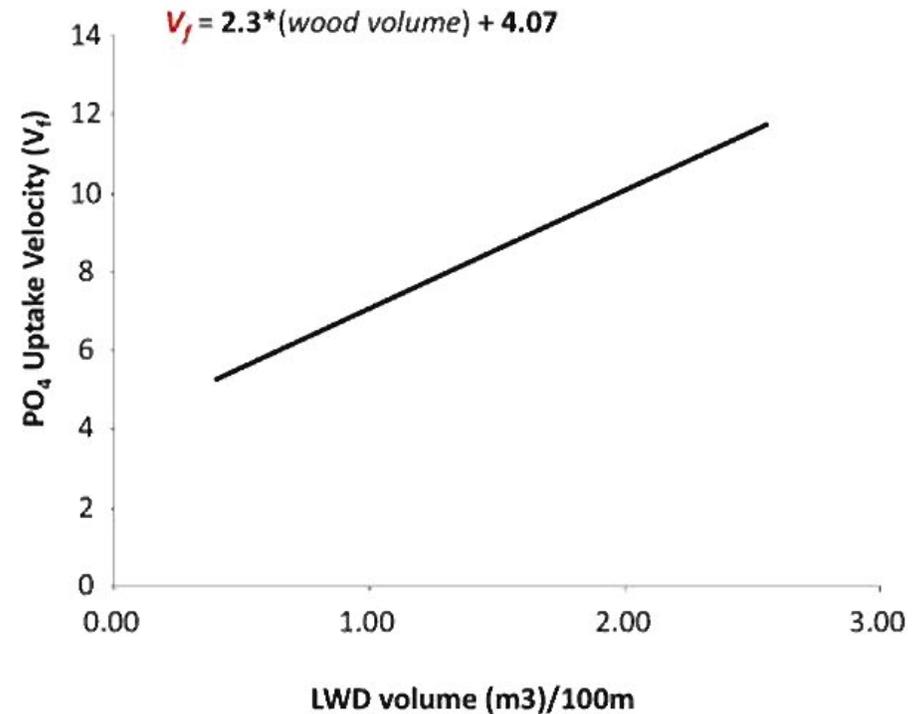
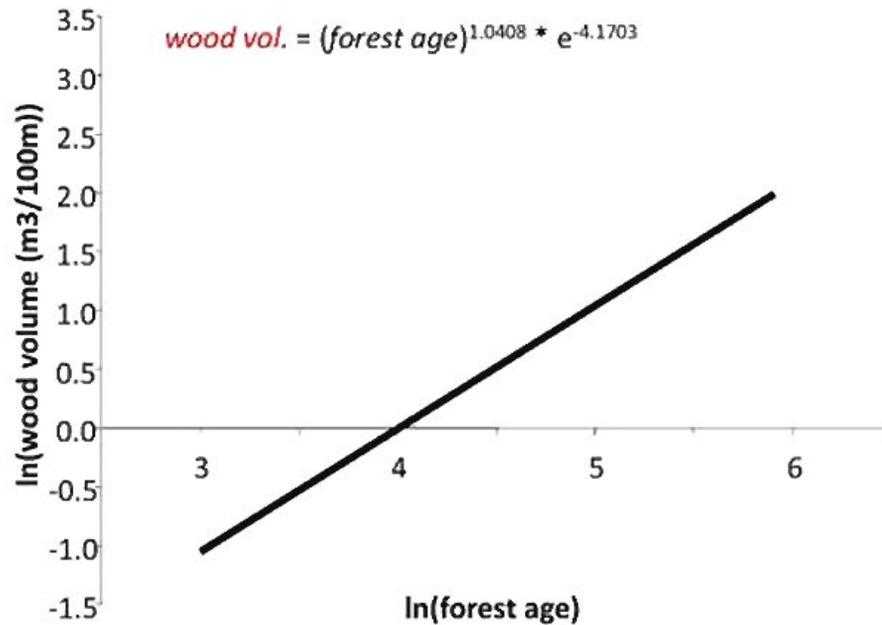
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P uptake as a function of wood volume



Implications: Changing stream function with forest regrowth

Linking these two relationships. . .



Implications: *Changing stream function with forest regrowth*

(1) Stand age – wood relationships

$$\text{Estimated wood volume} = (\text{forest age})^{1.0408} * e^{-4.1703}$$

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Current wood volumes

$$1.67\text{m}^3/100\text{m} = (90)^{1.0408} * e^{-4.1703}$$

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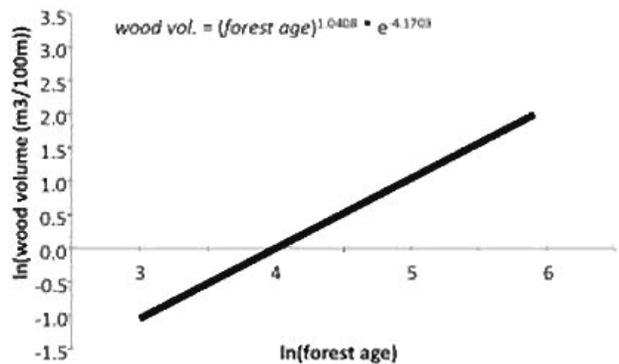
$$1.67m^3/100m = (90)^{1.0408} * e^{-4.1703}$$

Wood volume in 50 years

$$2.68m^3/100m = (140)^{1.0408} * e^{-4.1703}$$

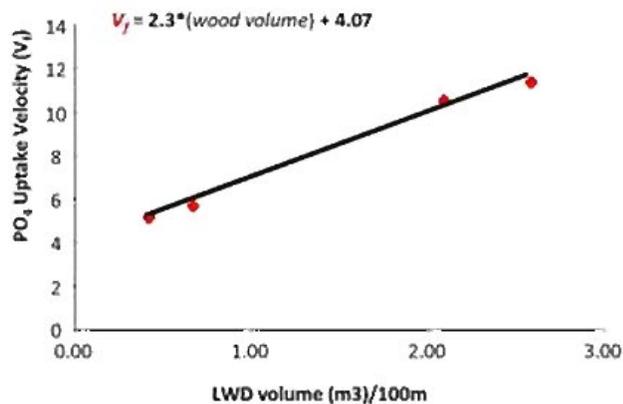
Implications: Changing stream function with forest regrowth

(2) Wood – P uptake relationships



$1.67 \text{ m}^3/100\text{m} = (90)^{1.0408} \cdot e^{-4.1703}$

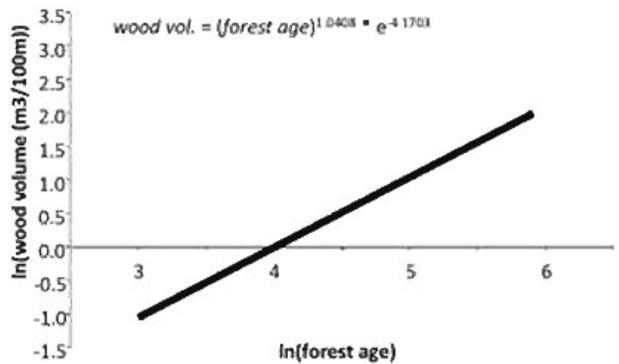
$2.68 \text{ m}^3/100\text{m} = (140)^{1.0408} \cdot e^{-4.1703}$



$9.1 \text{ m/s} = 2.9 \cdot (1.67) + 4.07$

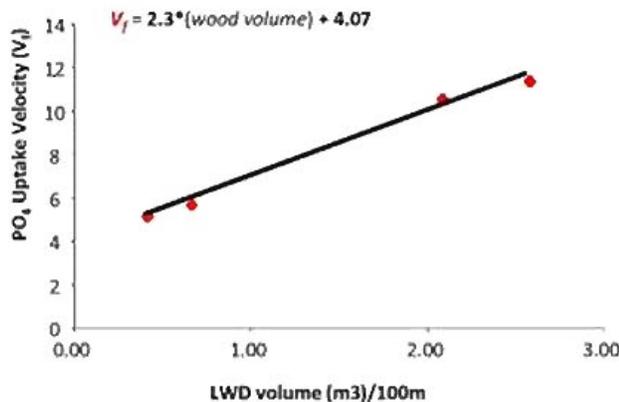
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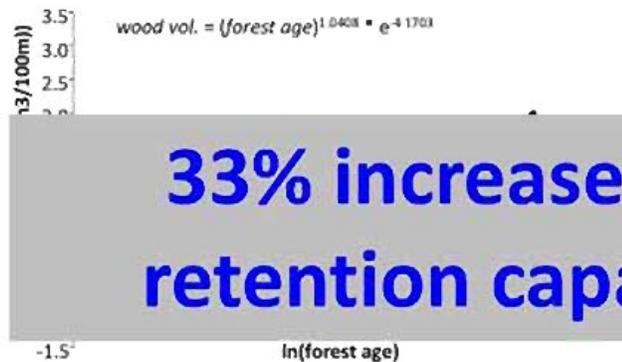


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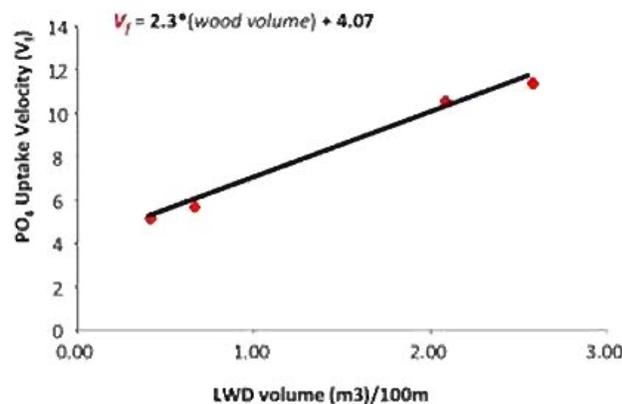
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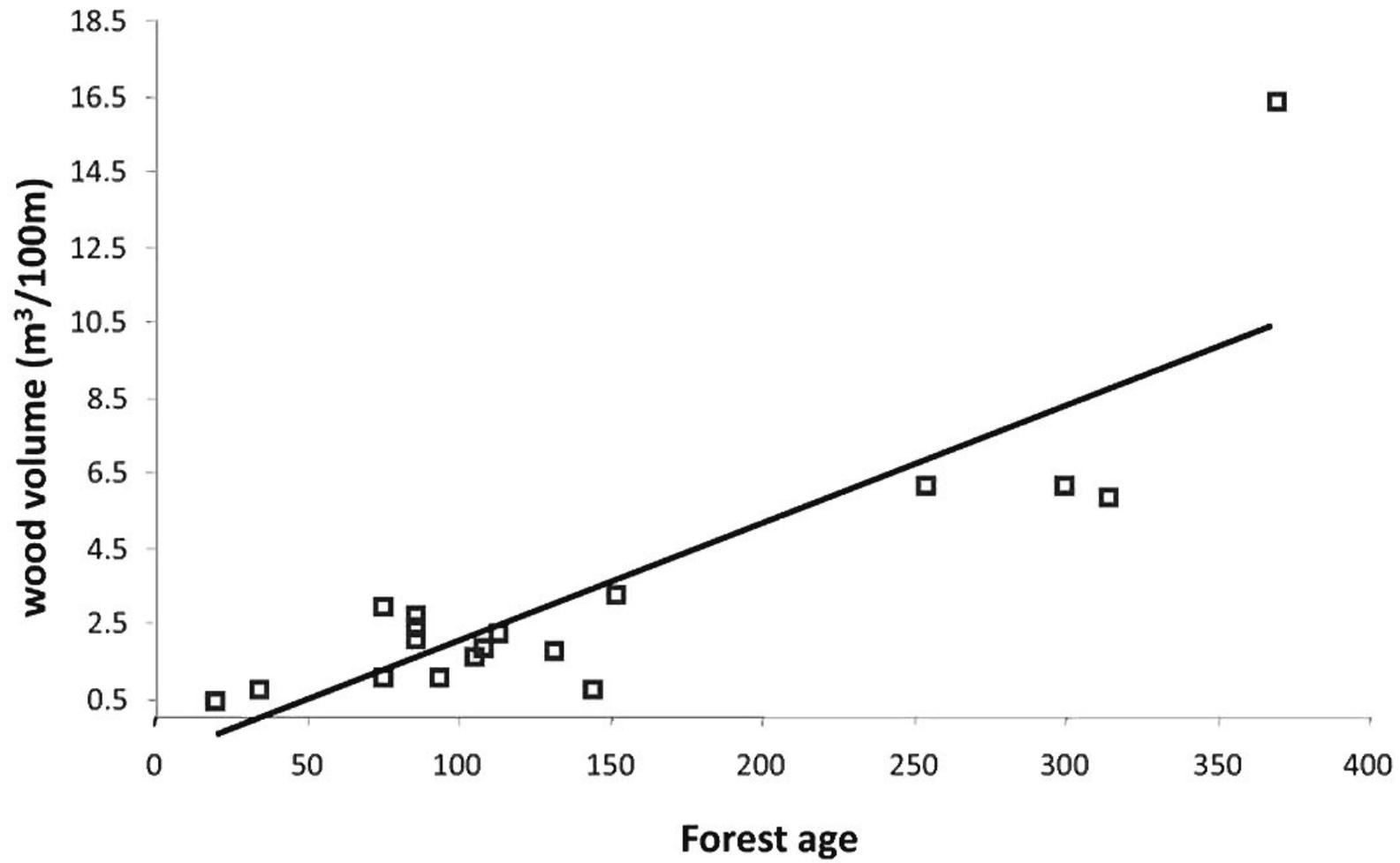
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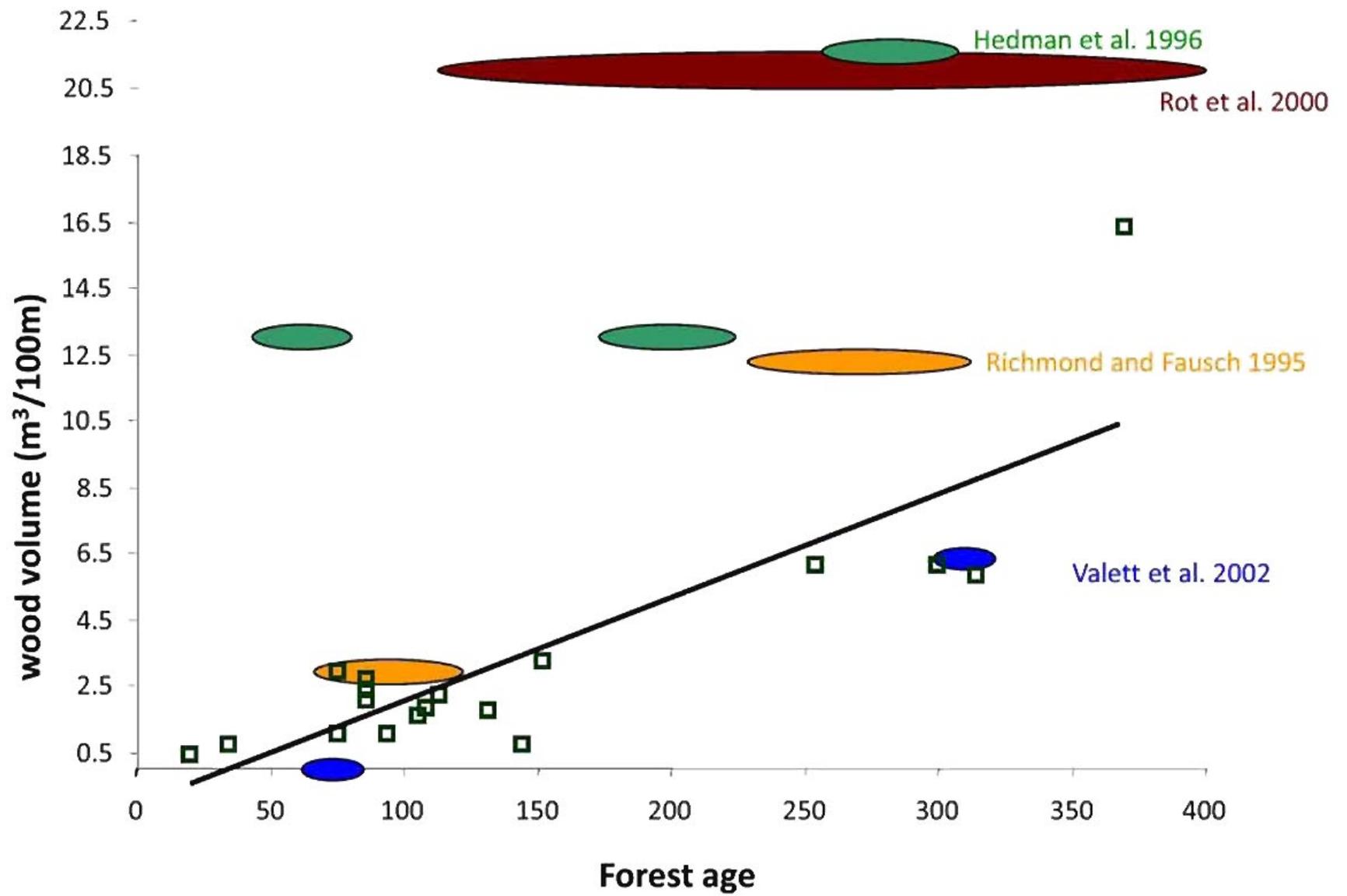
33% increase in stream PO₄ processing/retention capacity over the next 50 years

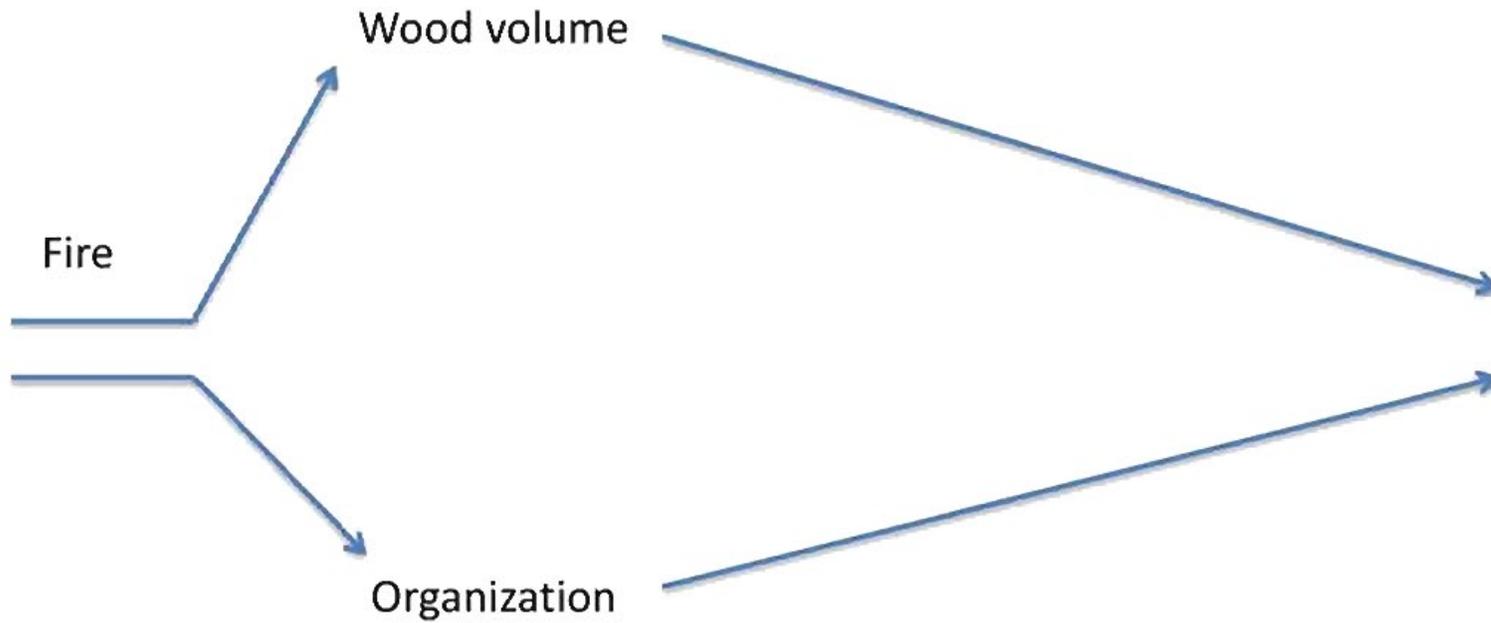


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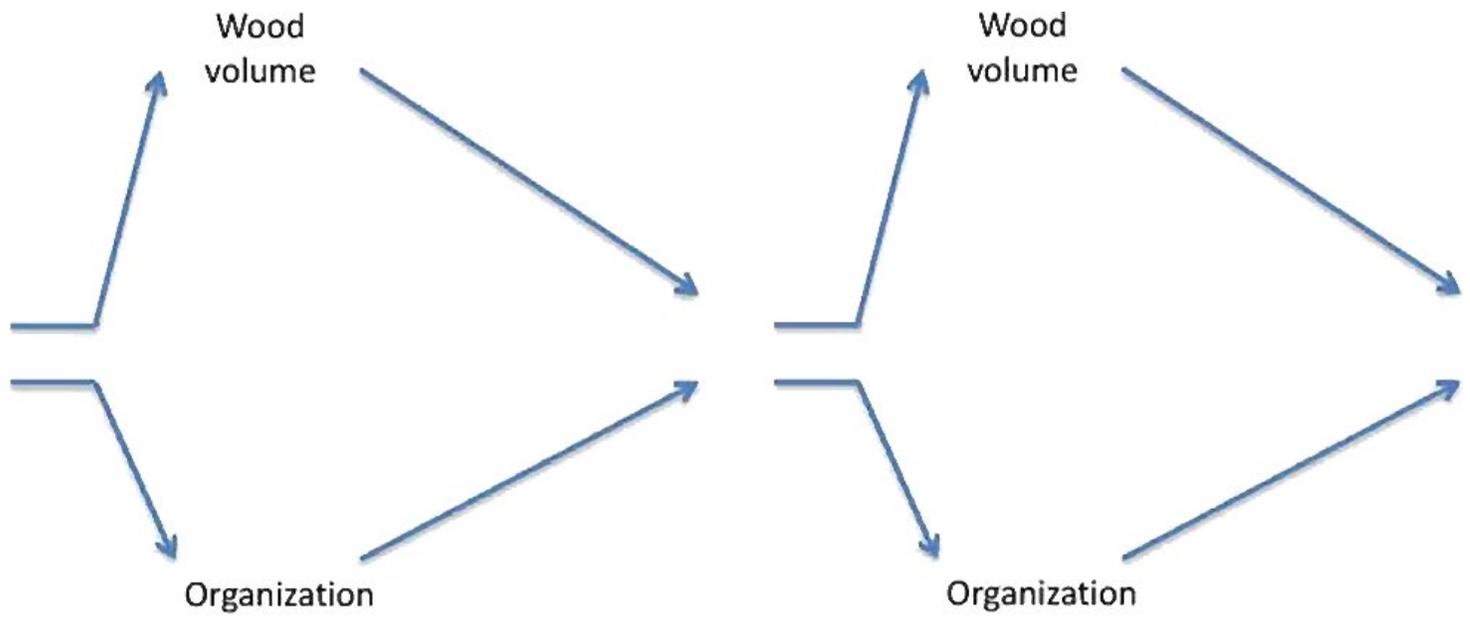






Riparian forest disturbance

Riparian Forest regrowth



Riparian forest disturbance

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