

Mercury isotopic compositions in paired experimental forest watersheds with long-term forest management

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Jim Coleman, Yener Ulus -- *University of North Carolina at Greensboro*

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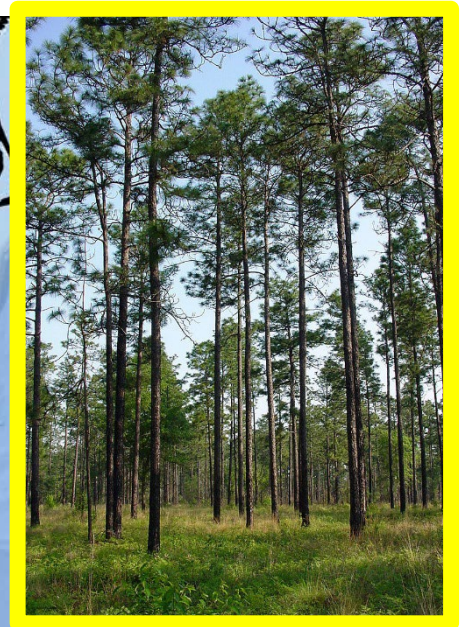
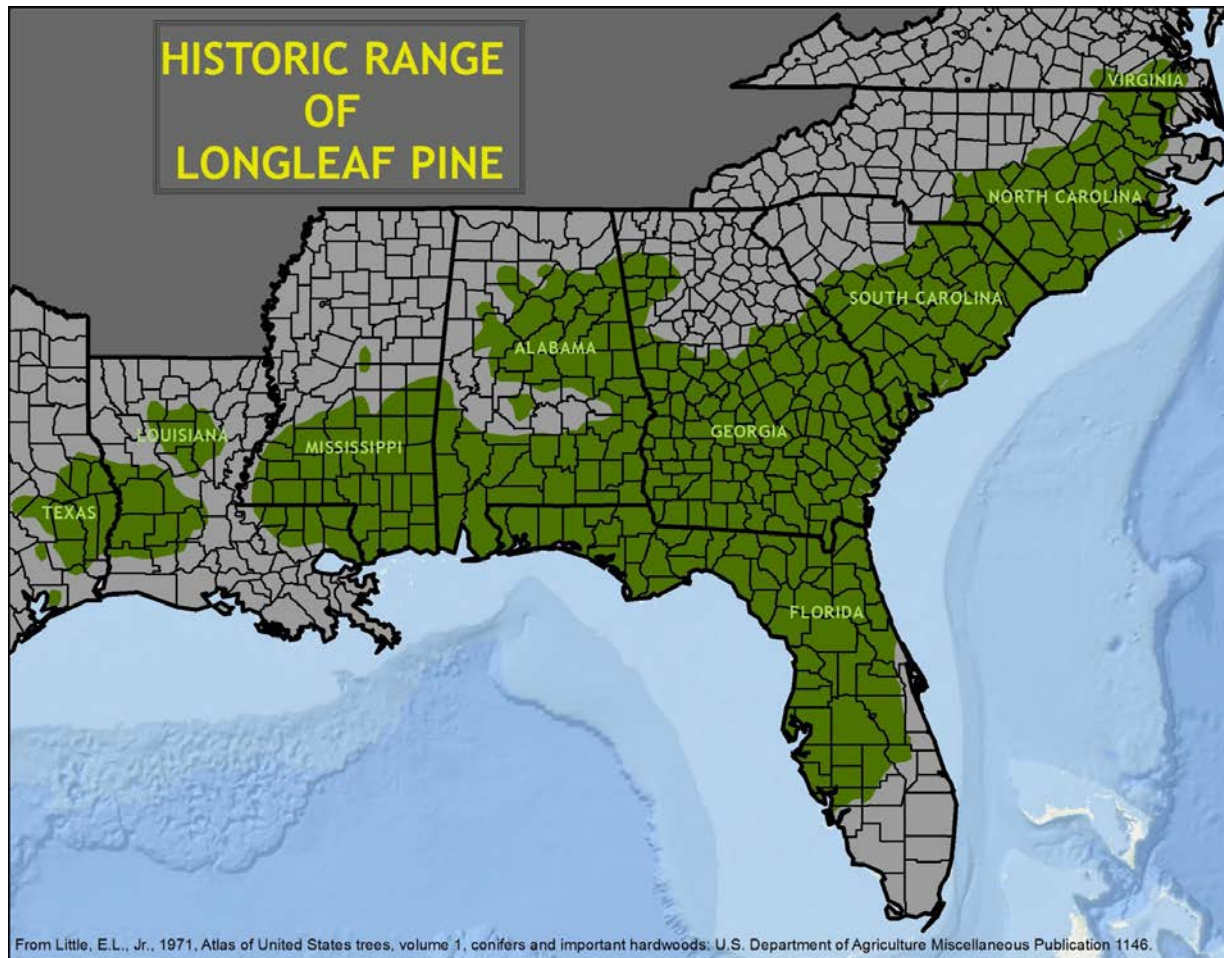
Joel Blum, Marcus Johnson -- *University of Michigan*

Sae Yun Kwon -- *Pohang University of Science and Technology*

Juang Chong, Troy Farmer, Alex Chow – *Clemson University*

Devendra Amatya, Carl Trettin – *United States Forest Service*

Team & project introduction 1



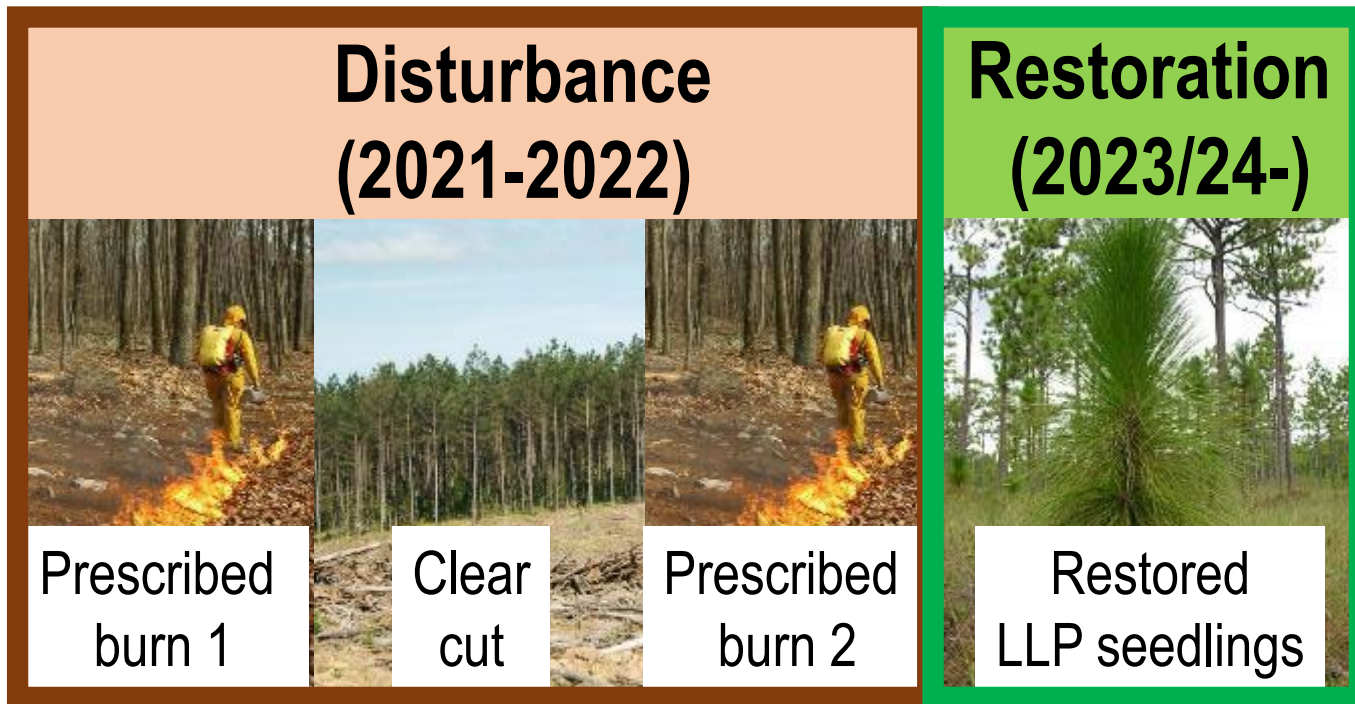
A longleaf pine stand

Historic range of native longleaf pine in the southeastern USA (Little et al. 1971)

Team & project introduction 2

- Longleaf pine restoration at Santee Experimental Forest (SC, USA)

Soil saturation $\uparrow$ $\rightarrow$ anaerobic Hg methylation $\uparrow$ $\rightarrow$ MeHg output $\uparrow$???



Team & project introduction 3



- Martin Tsui
- Jim Coleman
- Peijia Ku
- Yener Ulus

Coordinating
Sample processing
Concentration analyses

**Hg/MeHg
team**

- Joel Blum
- Marcus Johnson
- Sae Yun Kwon

High-precision Hg isotope
ratios analyses

**Hg
isotope
team**

- Alex Chow
- Troy Farmer
- Juang Chong

Aquatic & terrestrial
biota sampling

**Field
collection
team**

- Carl Trettin
- Devendra Amatya

Site management and *in-situ*
measurements

**Field
station
team**

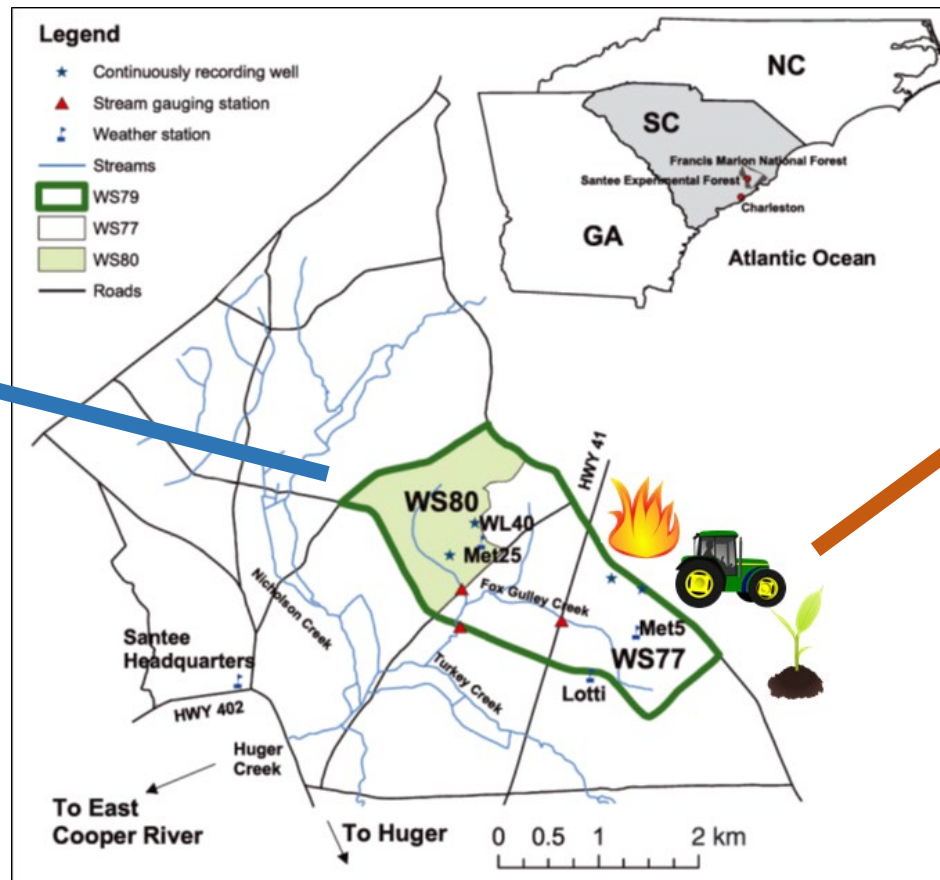


Background information

Santee Experimental Forest

(before the long leaf pine restoration)

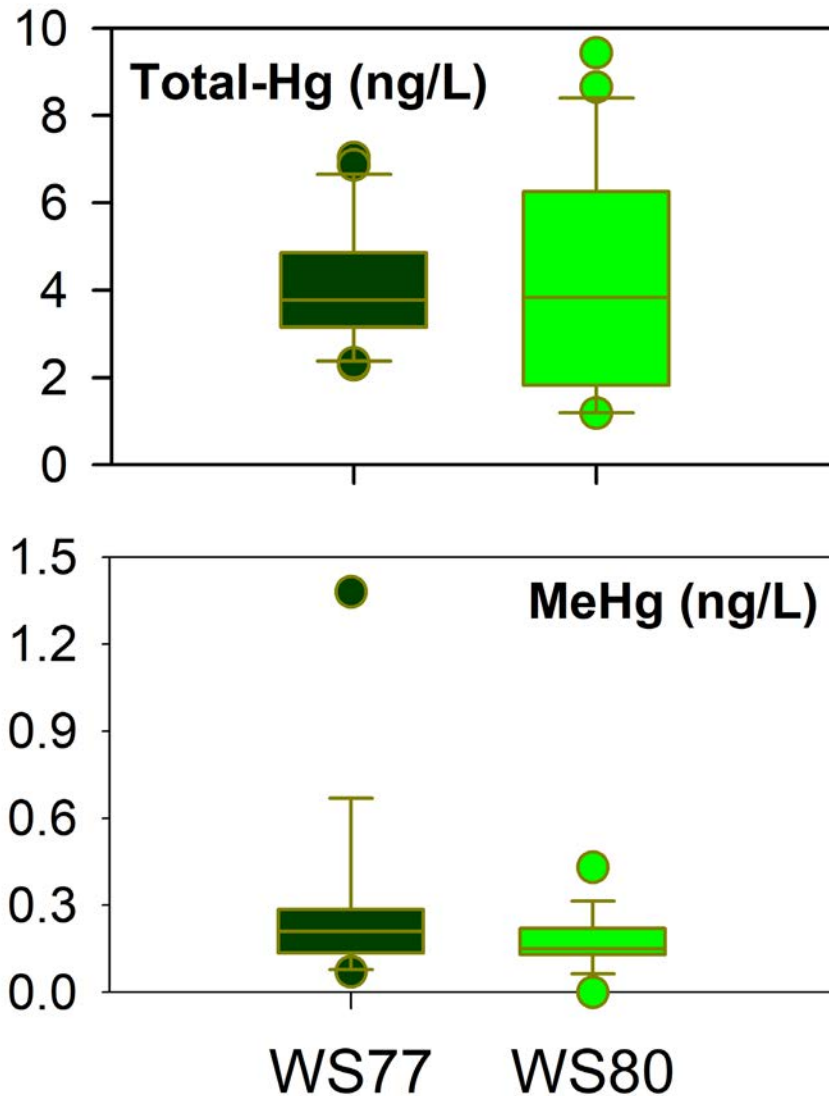
WS80
Control
160 ha



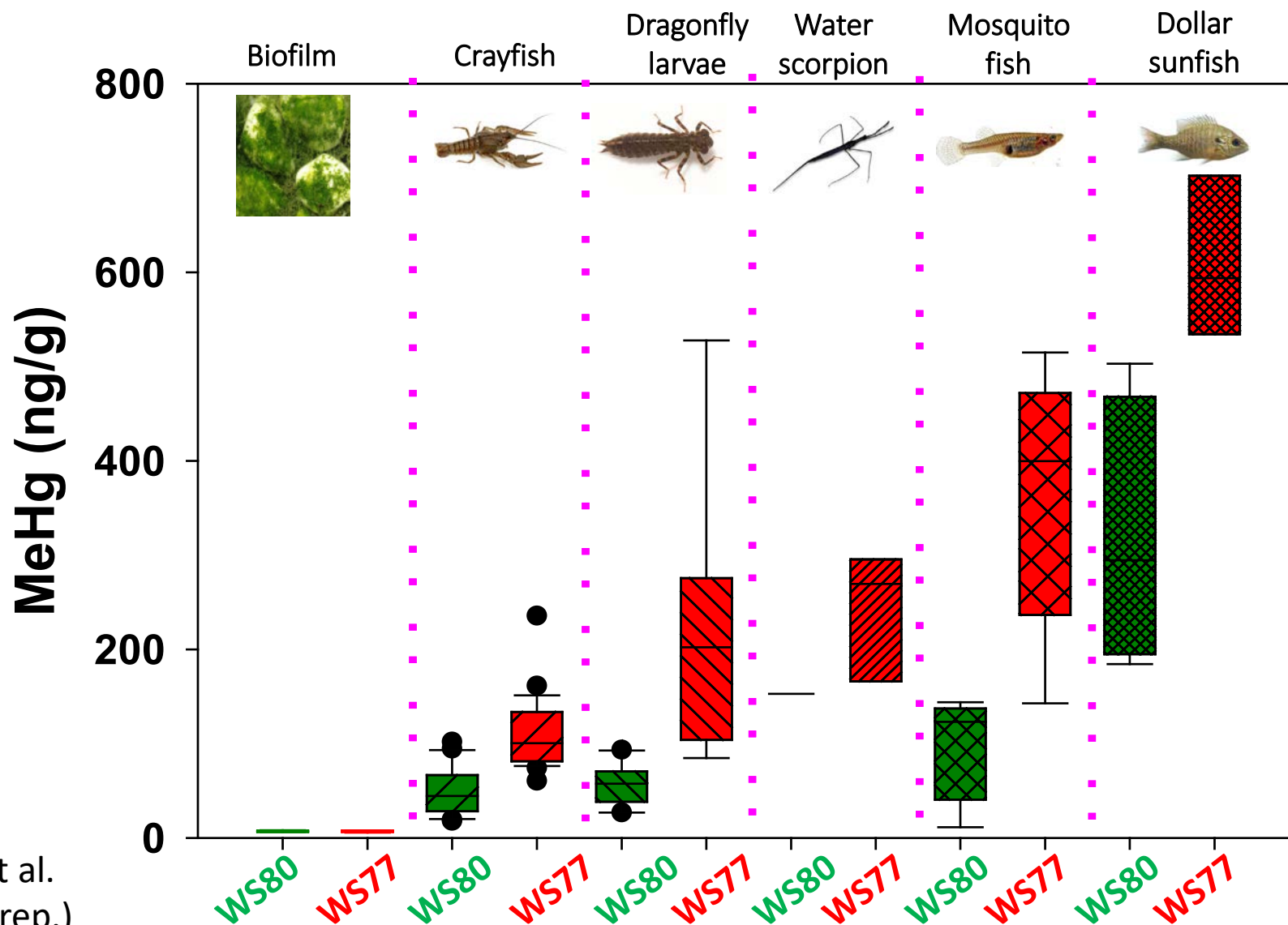
WS77
Treatment
150 ha

**WS 77 was
prescribed
burned on
2-4 year
cycles
2003, 2007,
2009, 2013,
2016, 2018**

Aqueous Hg concentrations



Biota Hg concentrations



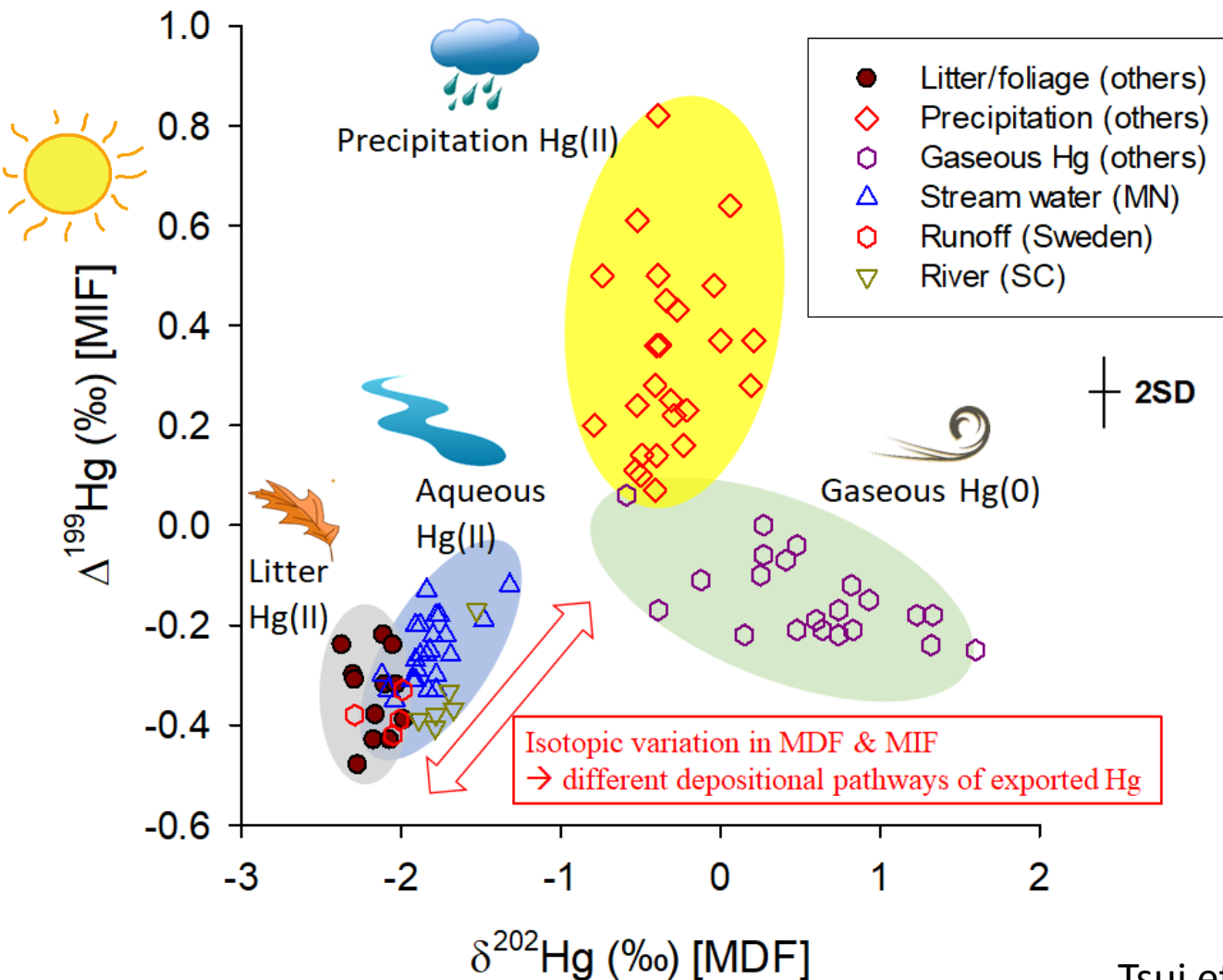
New insight into the Hg cycling?

Stable Hg isotopes

- mass-dependent fractionation [MDF] $\delta^{202}\text{Hg}$
- mass-independent fractionation [MIF]
odd-mass: $\Delta^{199}\text{Hg}$, $\Delta^{201}\text{Hg}$
even-mass: $\Delta^{200}\text{Hg}$, $\Delta^{204}\text{Hg}$

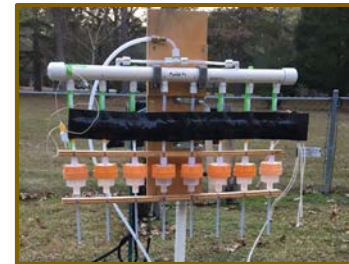


From other studies on North American forested systems



Details for this study

- Last prescribed burn: 3/2018
- Sample collection from 3/2018 to 7/2020
 - Air
 - Rainwater
 - Streamwater
 - Soil
 - Litter
 - Biota (aquatic and terrestrial)



Air sampler



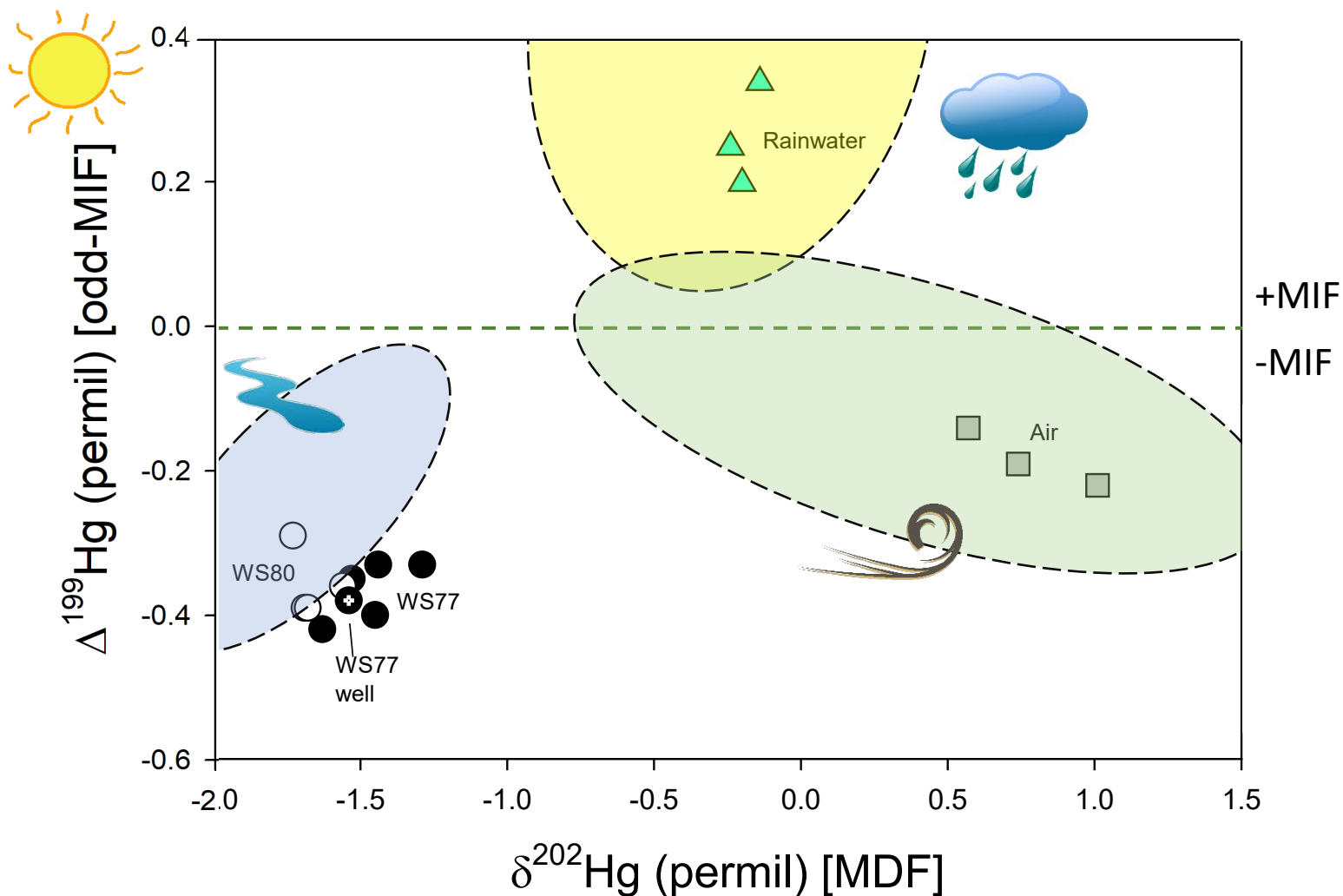
Rain collector

- Total-Hg, MeHg*, stable Hg isotopes, and C & N isotopes*

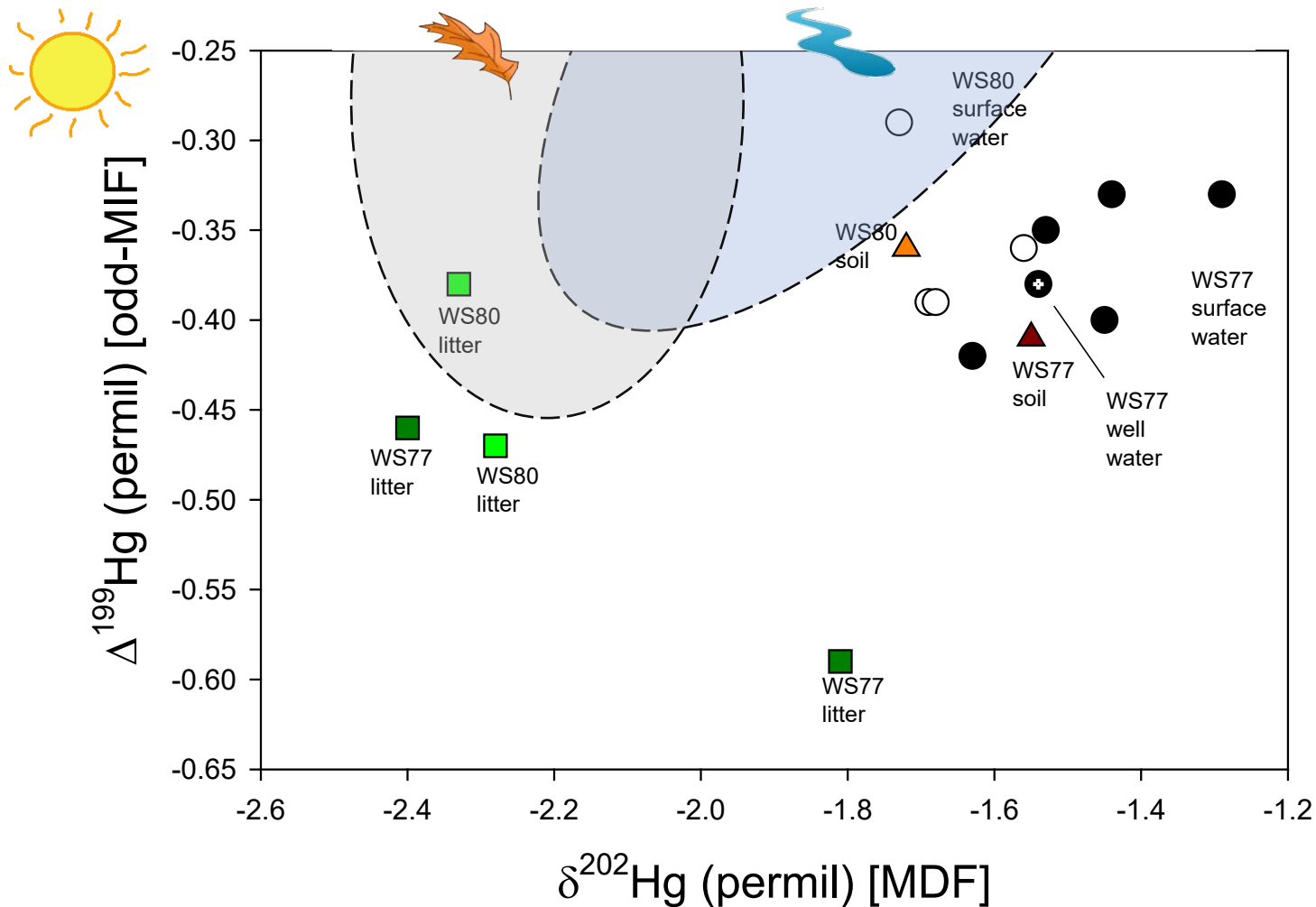
* *biota samples only*

Mercury isotope results

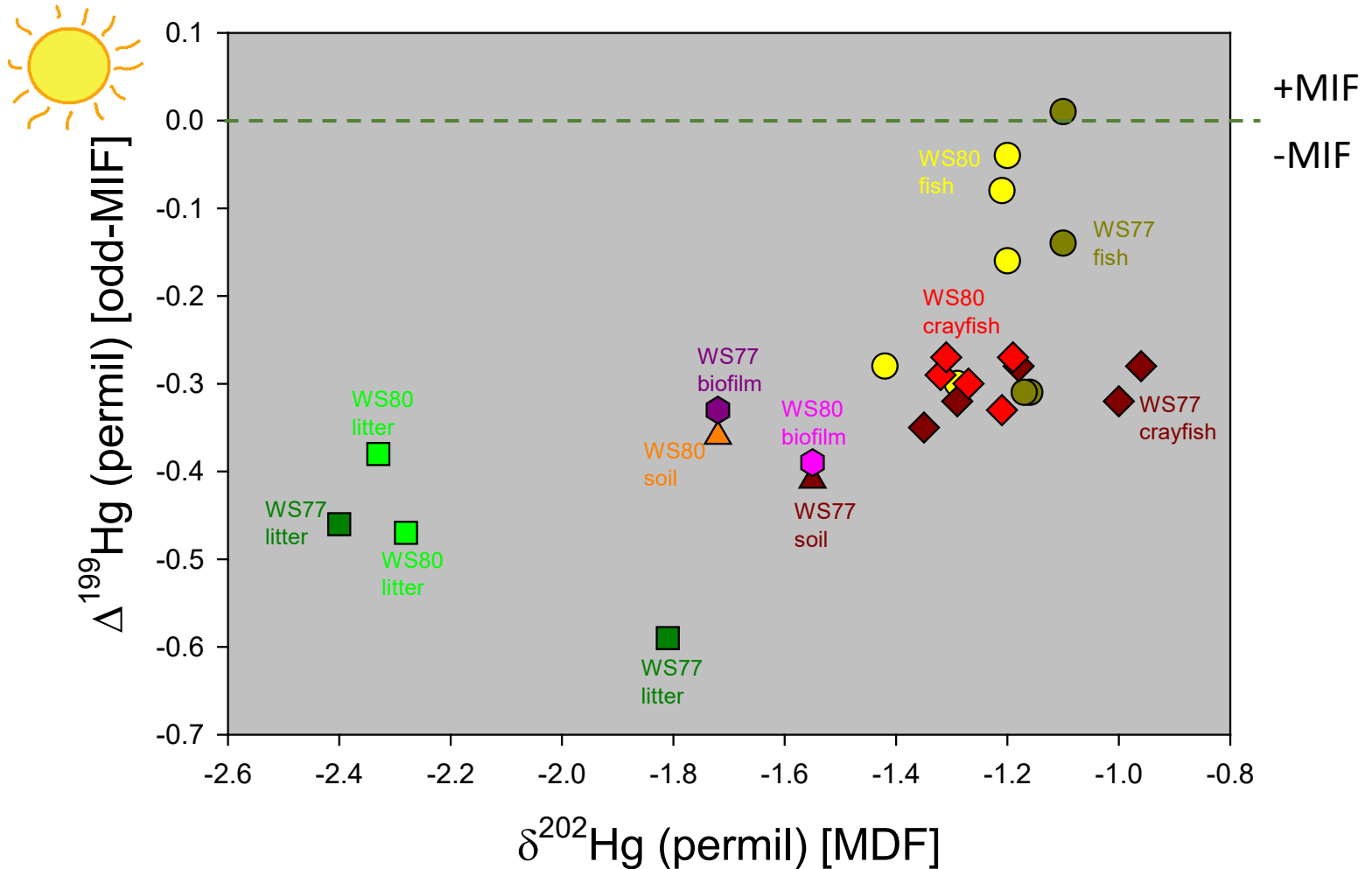
Air, rainwater, and streamwater



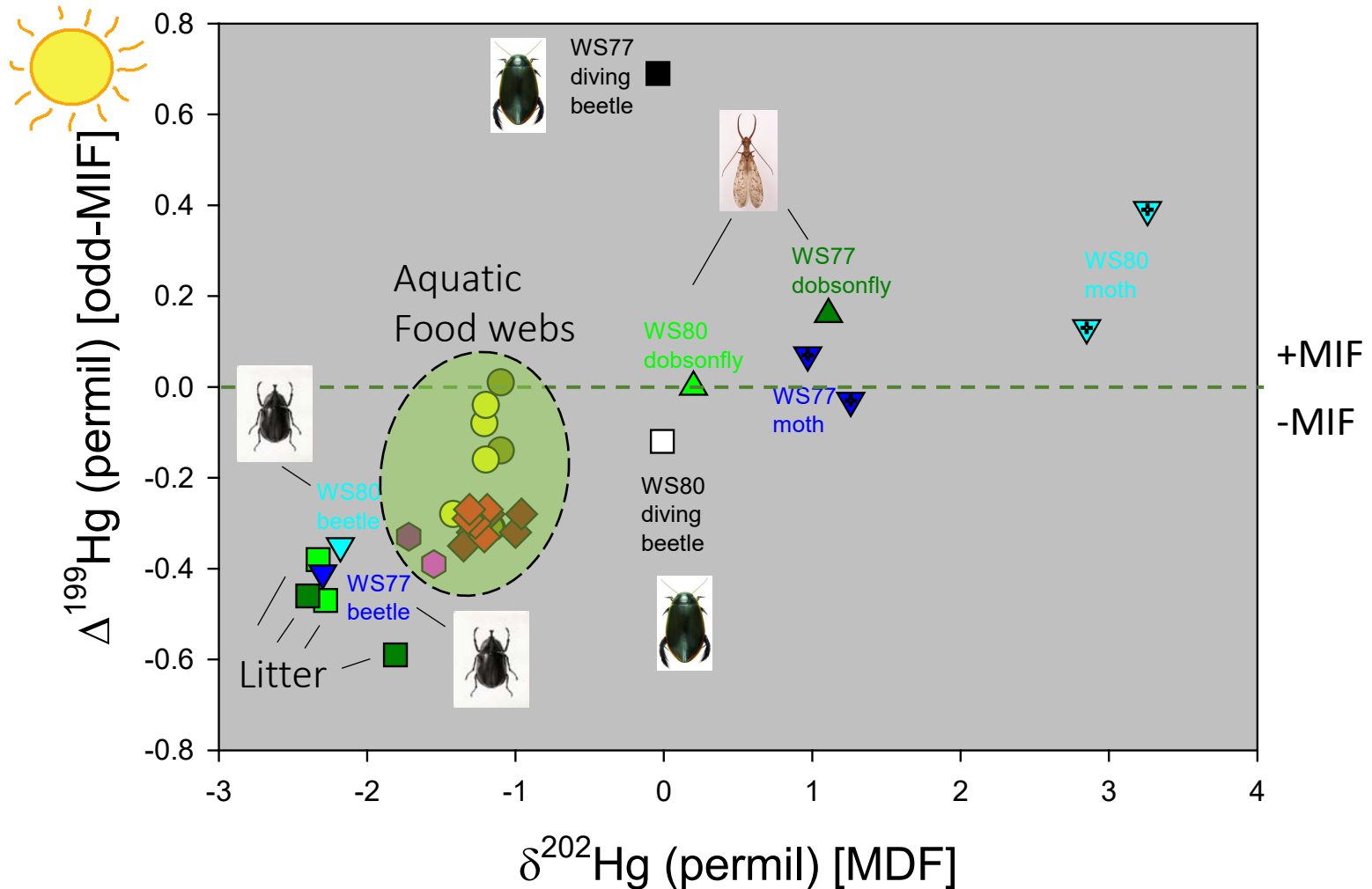
Streamwater, vegetation, and soil



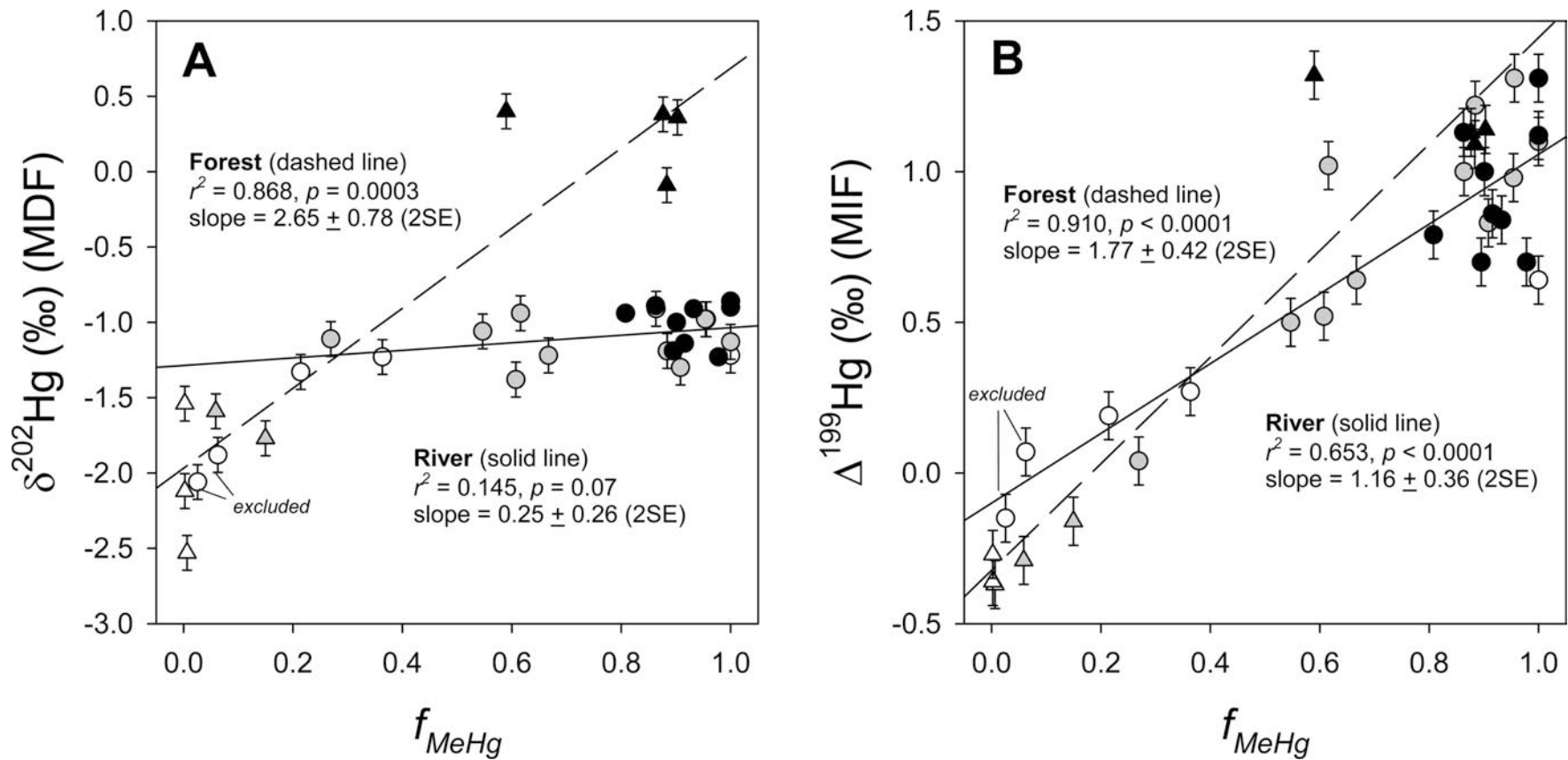
Aquatic food webs



Terrestrial food webs *(including aquatic insects)*

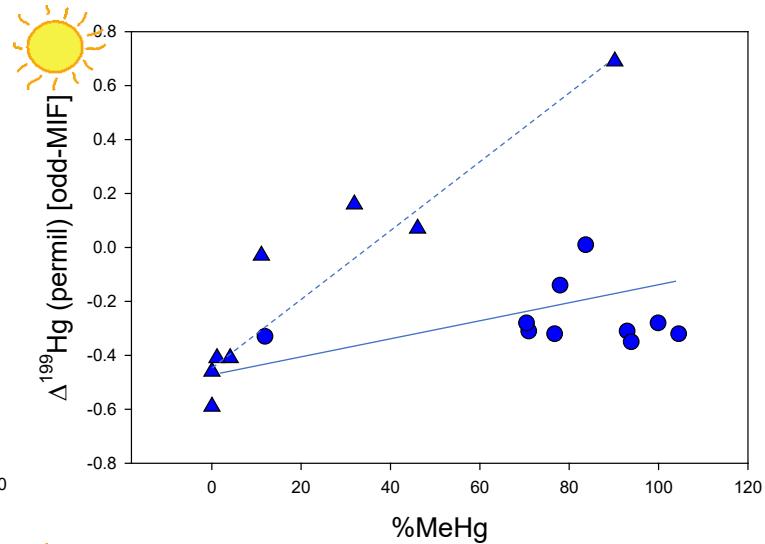
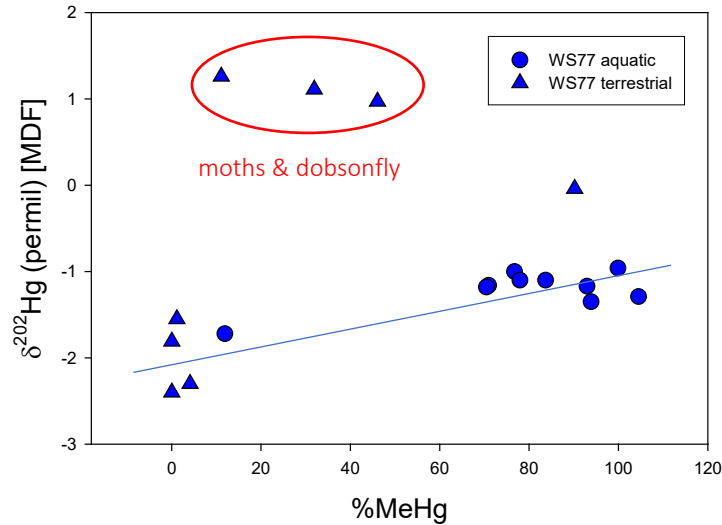


THg isotopes explained by %MeHg (a study on forest vs. river)

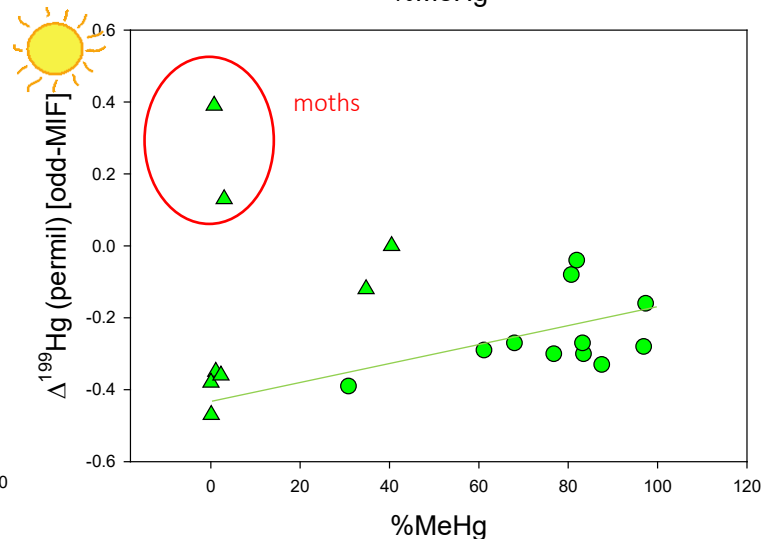
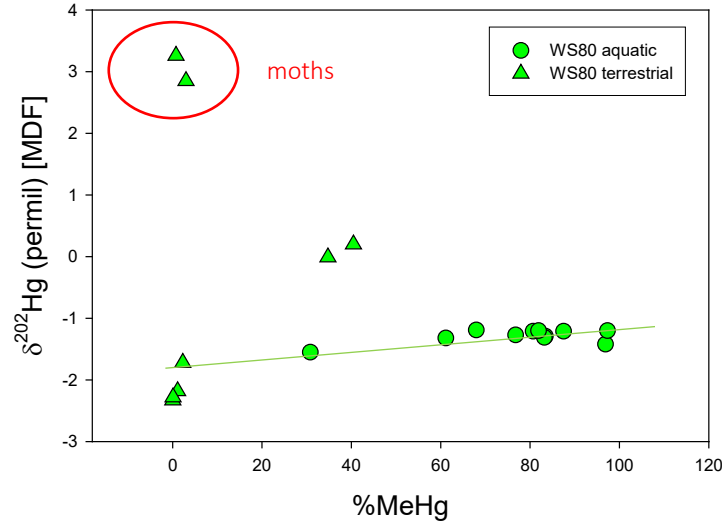


Different isotope values between Hg(II) vs. MeHg

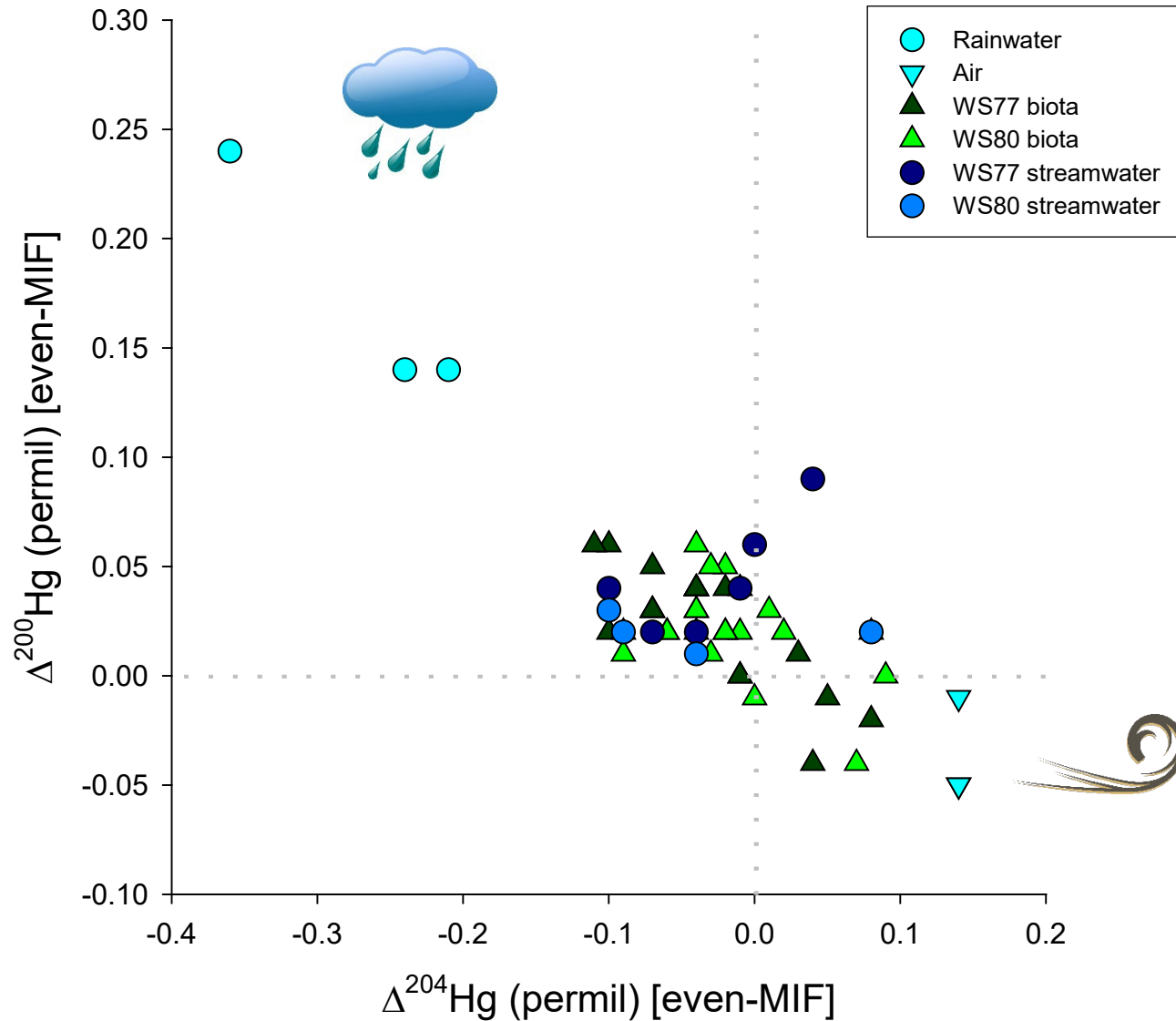
WS77



WS80



Even-mass MIF signature



Summary & next step

Summary (so far)

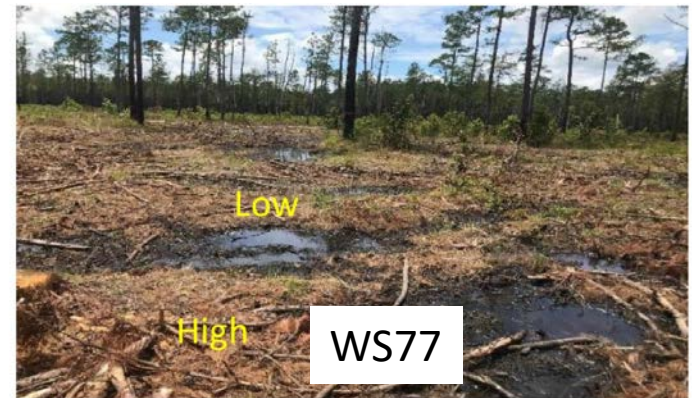
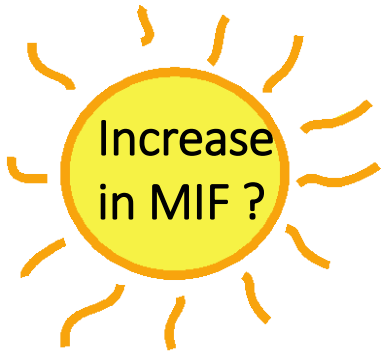
- In aquatic food webs, odd-MIF is mostly at or below zero, implying little photodemethylation of MeHg
- Similar observations found in a blackwater river study in South Carolina (Tsui et al., 2020 L&O) and a wetland study in Acadia National Park (Tsui et al., 2018 ET&C)
- Much larger, yet not well understood, range of MDF and MIF for animal consumers found on the land
- Subtle differences in Hg isotope compositions between WS77 and WS80, but they cannot explain why WS77 consumers are higher in MeHg than those in WS80

Ongoing activities

- Harvest activities in WS77 completed by Nov 2021
- Abiotic changes monitored in WS77
- Prescribed fire set on Sep 2022
- Longleaf pine planting set on Jan 2023

What might happen next for Hg cycling?

- On-going sampling (2021, 22, 23, and 24) to reveal differences in Hg isotope compositions as altered by harvest activities



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WHERE DISCOVERIES BEGIN

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- ***Field support***

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Thank you, any questions?

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