



ICMGP 2024
CAPE TOWN • SOUTH AFRICA • 21 - 26 JULY

Forest harvesting impacts on methylmercury production and export in central Canadian boreal watersheds

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Watershed Responses to Forest Harvest



Wetter and more erodible landscapes = greater Hg/MeHg issues?



Forestry Practices Increase Mercury and Methyl Mercury Output from Boreal Forest Catchments

PETRI PORVARI,^{*,†} MATTI VERTA,[†]
JOHN MUNTHE,[‡] AND MERJA HAAPANEN[†]

Forest harvest effects on mercury in streams and biota in Norwegian boreal catchments

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No significant treatment effects on concentrations of MeHg, HgT and TOC were detected,

MERCURY AND METHYLMERCURY IN RUNOFF FROM A FORESTED CATCHMENT – CONCENTRATIONS, FLUXES, AND THEIR RESPONSE TO MANIPULATIONS

caused MeHg concentrations to increase dramatically in runoff and led to an increase of the annual transport by at least a factor of 3. This indicates that forestry and other activities that disturb forest

Stream Mercury Export in Response to Contemporary Timber Harvesting Methods (Pacific Coastal Mountains, Oregon, USA)

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unharvested (control) catchments. There was no significant difference in particulate-bound Hg concentrations or loads in the harvested and unharvested catchments



Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales

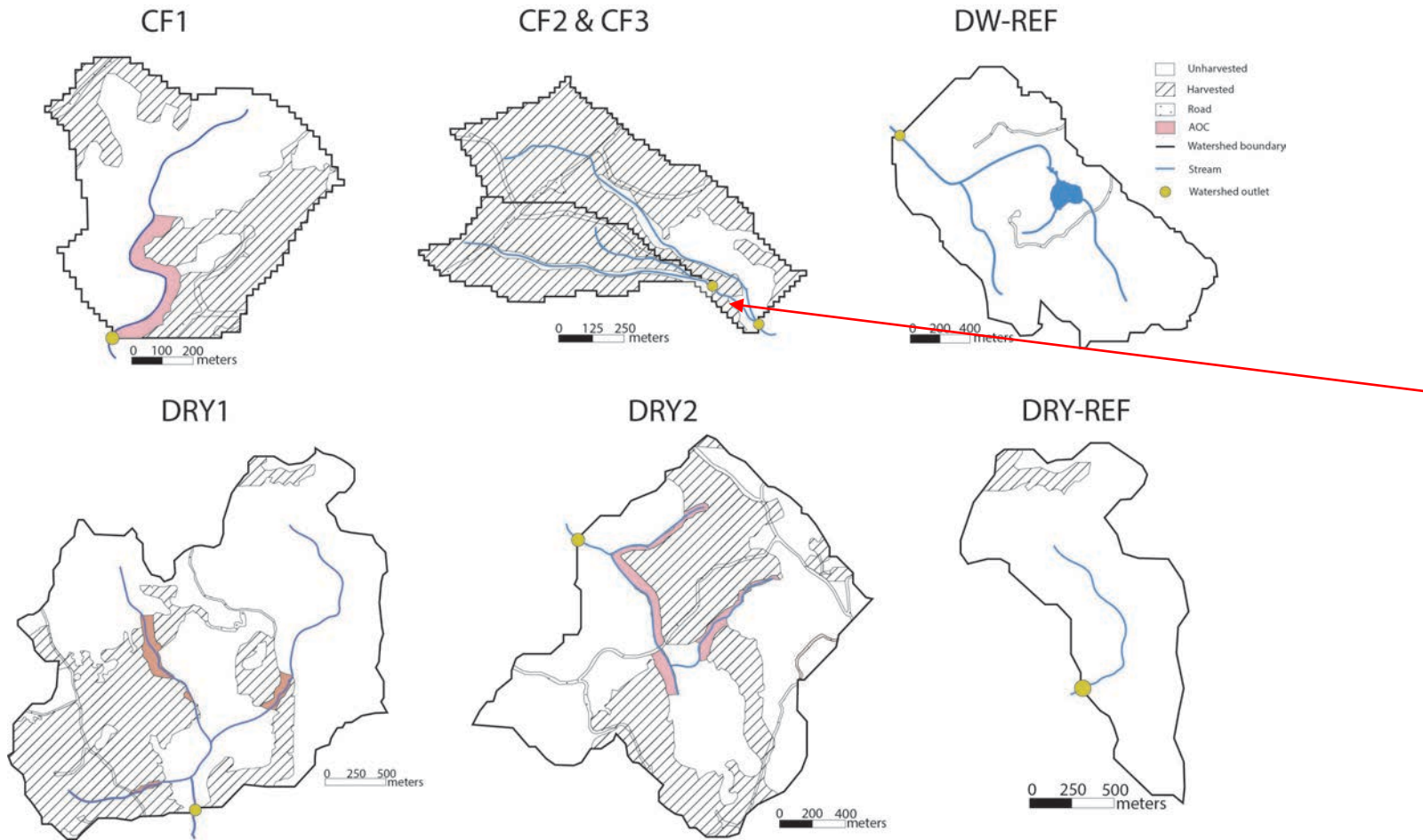
- The magnitude and direction of effects of forest harvesting on mercury in streams, methylmercury production and bioaccumulation are disputed.
- Ontario in midst of revising “Stand and Site Guide” (*left*), which includes operational requirements.
- Forest industry seeking to be sustainable and highly interested in understanding Ontario context of mercury and best management practices.
- Initiated research partnership for field investigation/experiment from 2019-2023.



Study Area – Dryden, Ontario



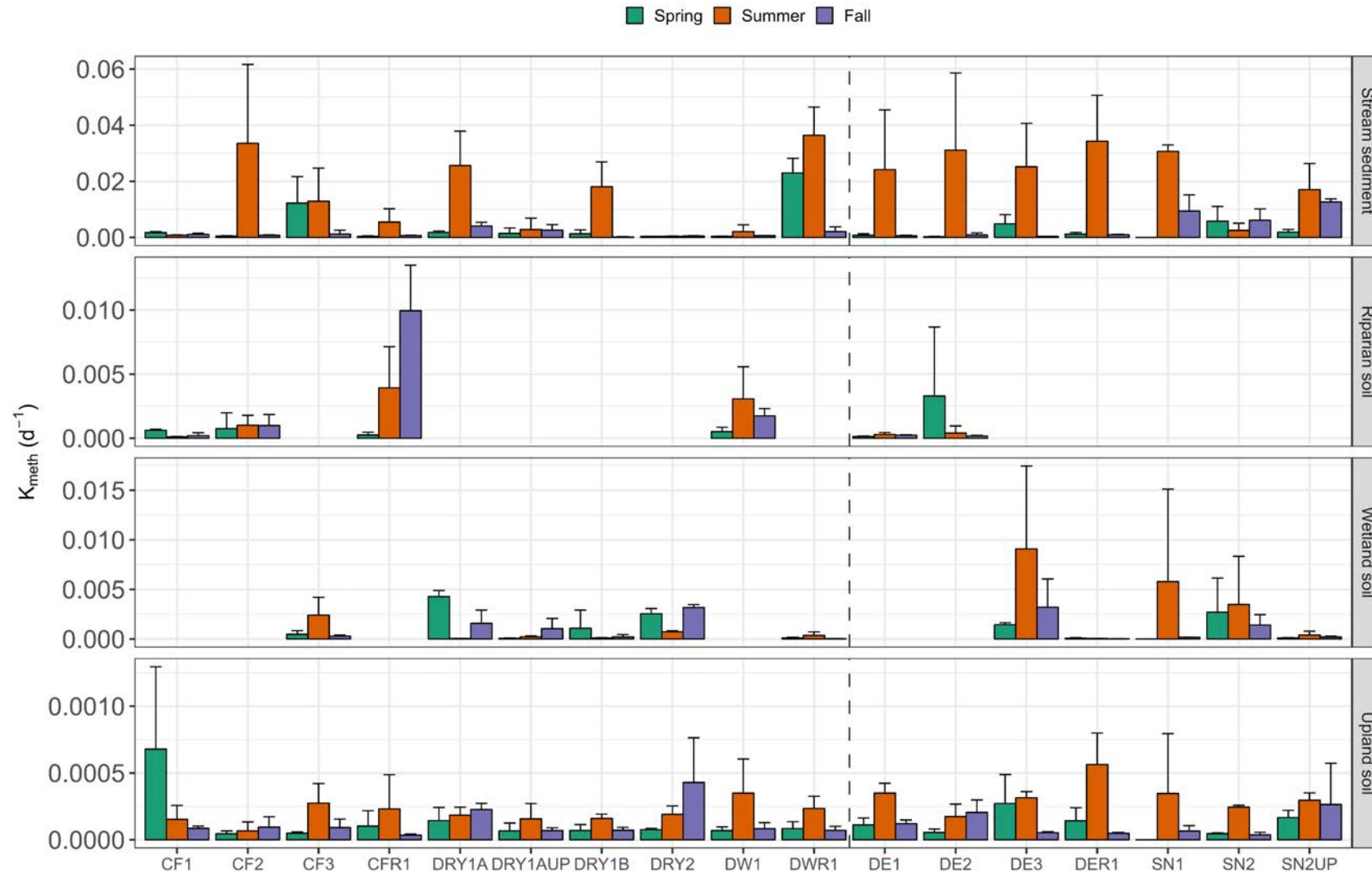
Before, During and After Harvest with Management and Machinery Impacts



MeHg Production – Bed Sediment Important



Inject enriched $^{200}\text{Hg(II)}$ and incubate



K_{meth}
 0.02 d^{-1}

0.003 d^{-1}

0.003 d^{-1}

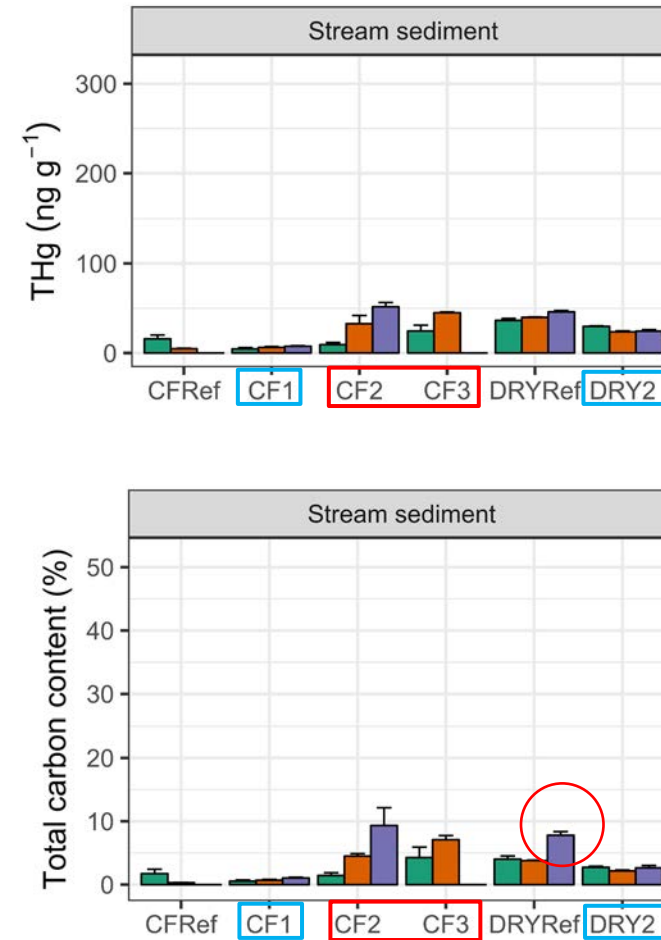
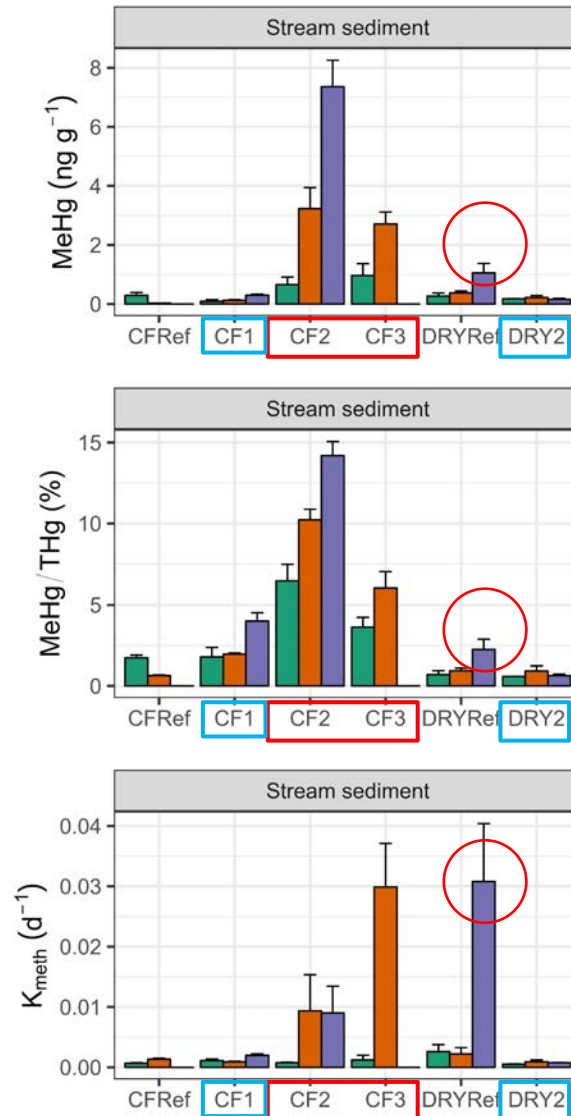
0.0002 d^{-1}



Harvest Effects on Stream Sediment MeHg

Pre-harvest Post-harvest

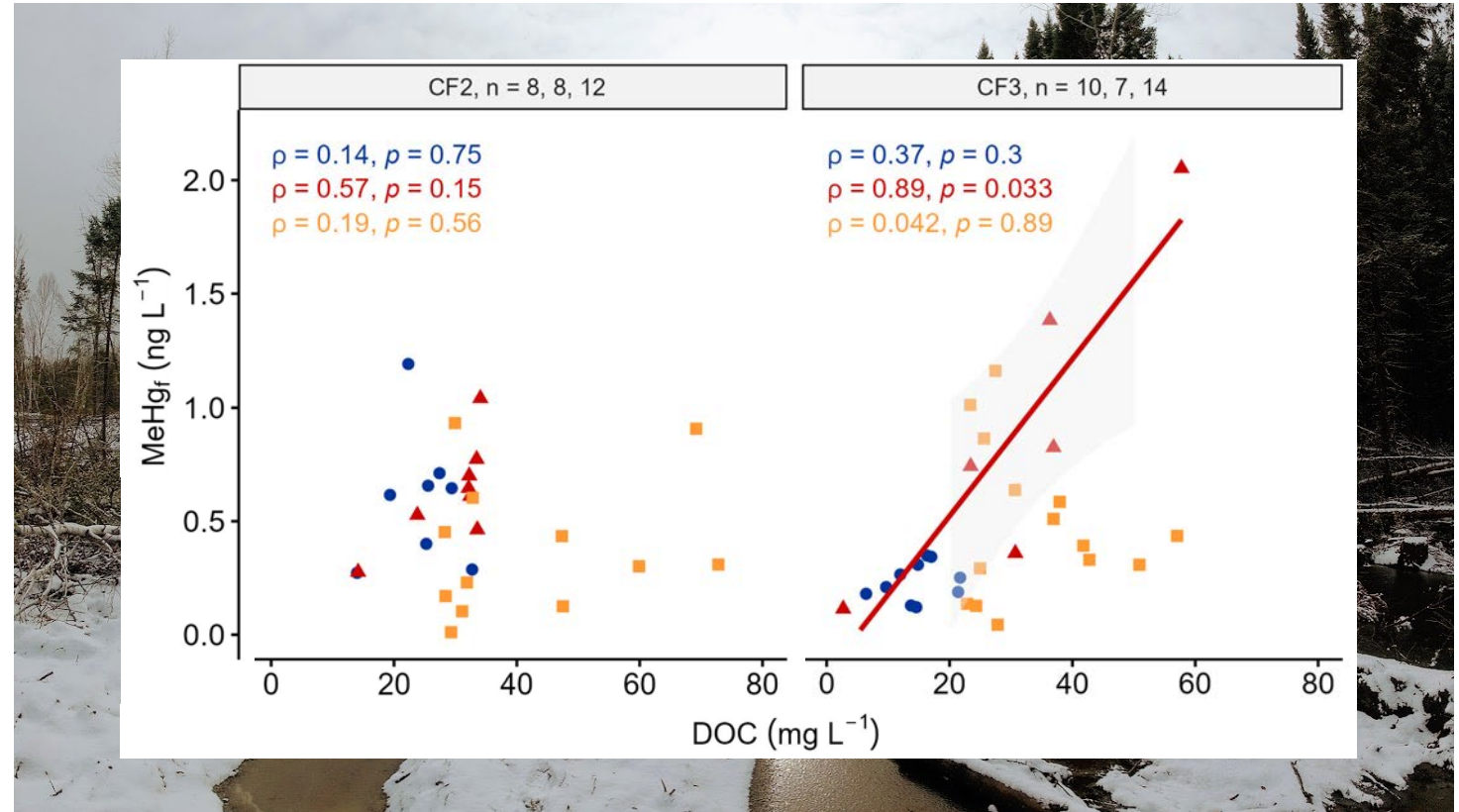
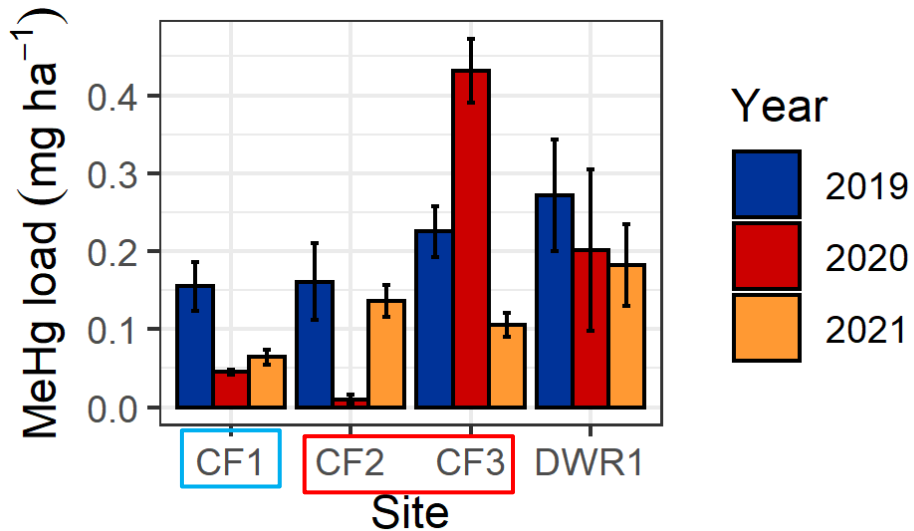
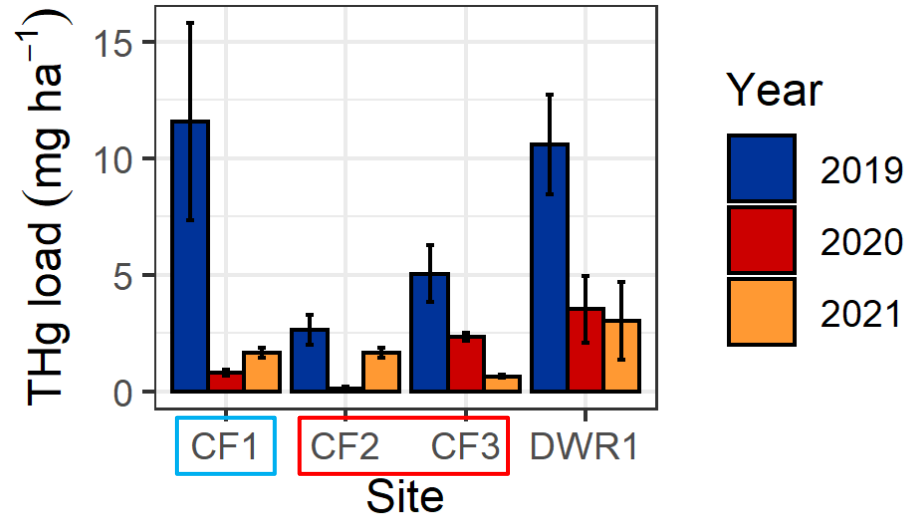
■ 2019 ■ 2020 ■ 2021
■ During



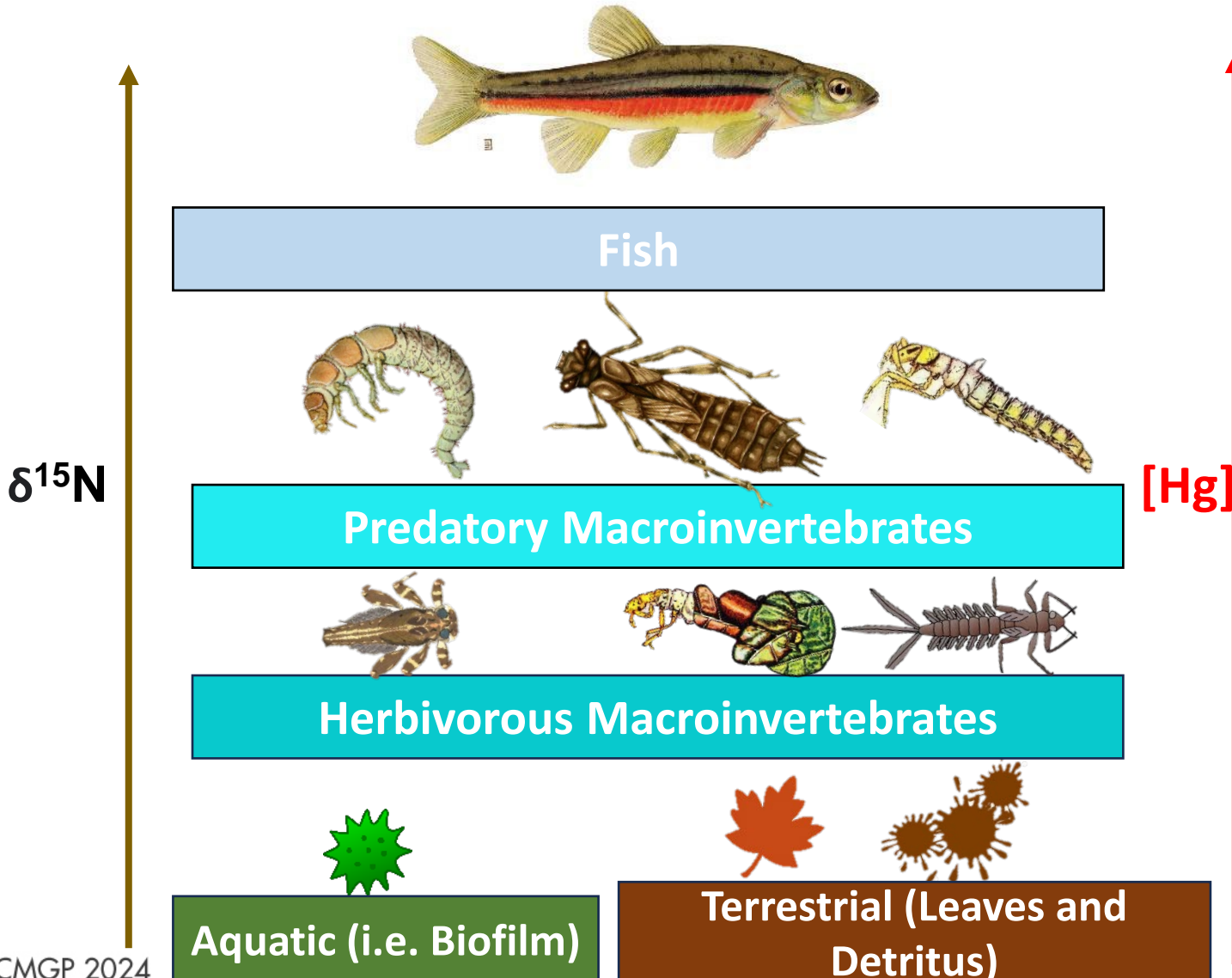
(Huang et al, 2024; Env Pollut)



Harvest Effects on Hg Export are More Subtle



Harvest Effects on Stream Biota



1. Determine effects of forest harvesting on consumer $[\text{Hg}]$
 - MeHg concentrations
2. Determine effect of forest harvesting on $[\text{Hg}]$ biomagnification
 - Nitrogen isotopes for trophic level



CF1 (35% Harvested; good buffers)



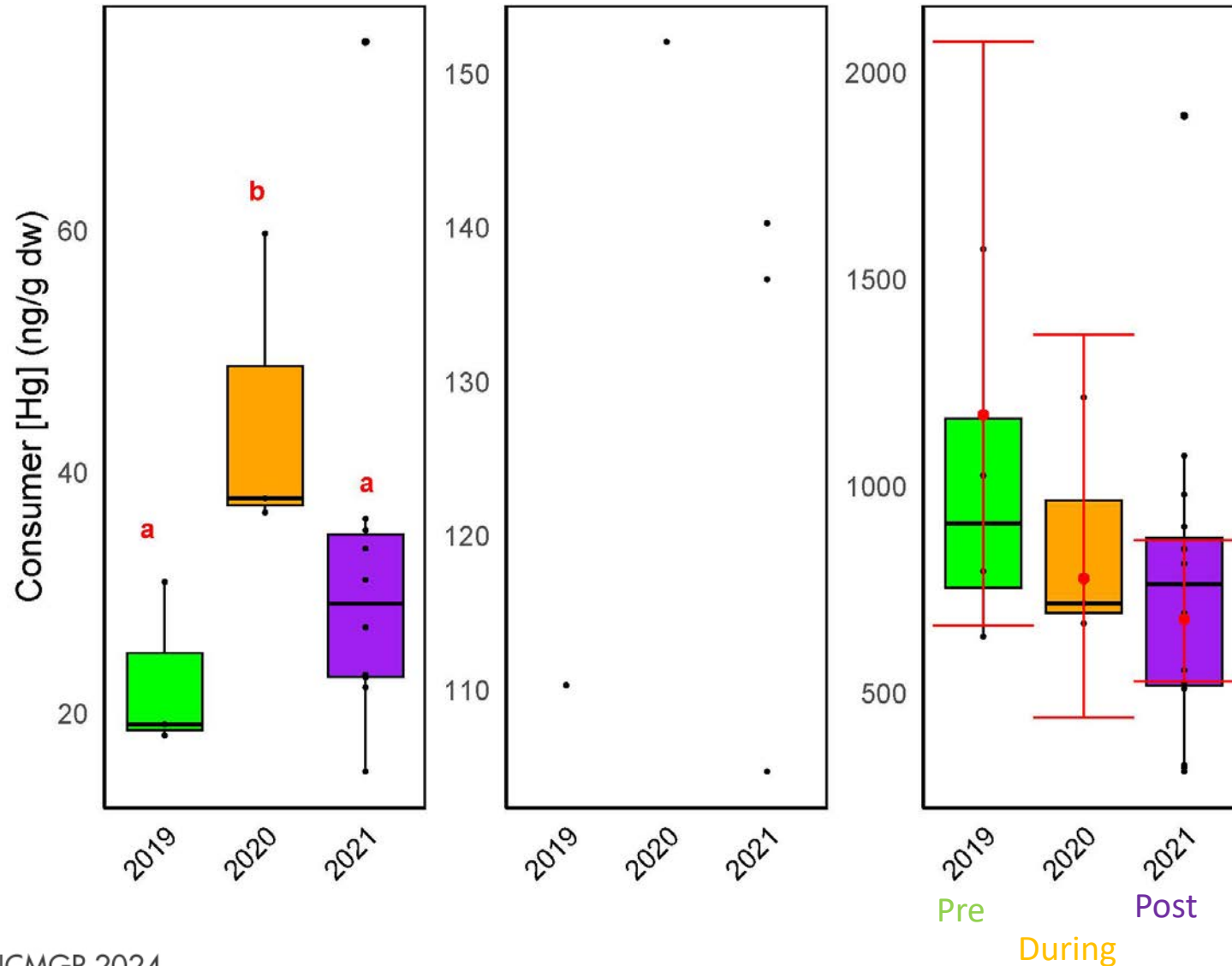
Primary



Secondary



Top Predator



Herbivores: Significantly higher [Hg] **during** than pre-harvest

Predatory Macroinvertebrates: Not enough samples for comparisons

Fish: No significant differences in [Hg]



CF3 (78% Harvested; weak buffers)



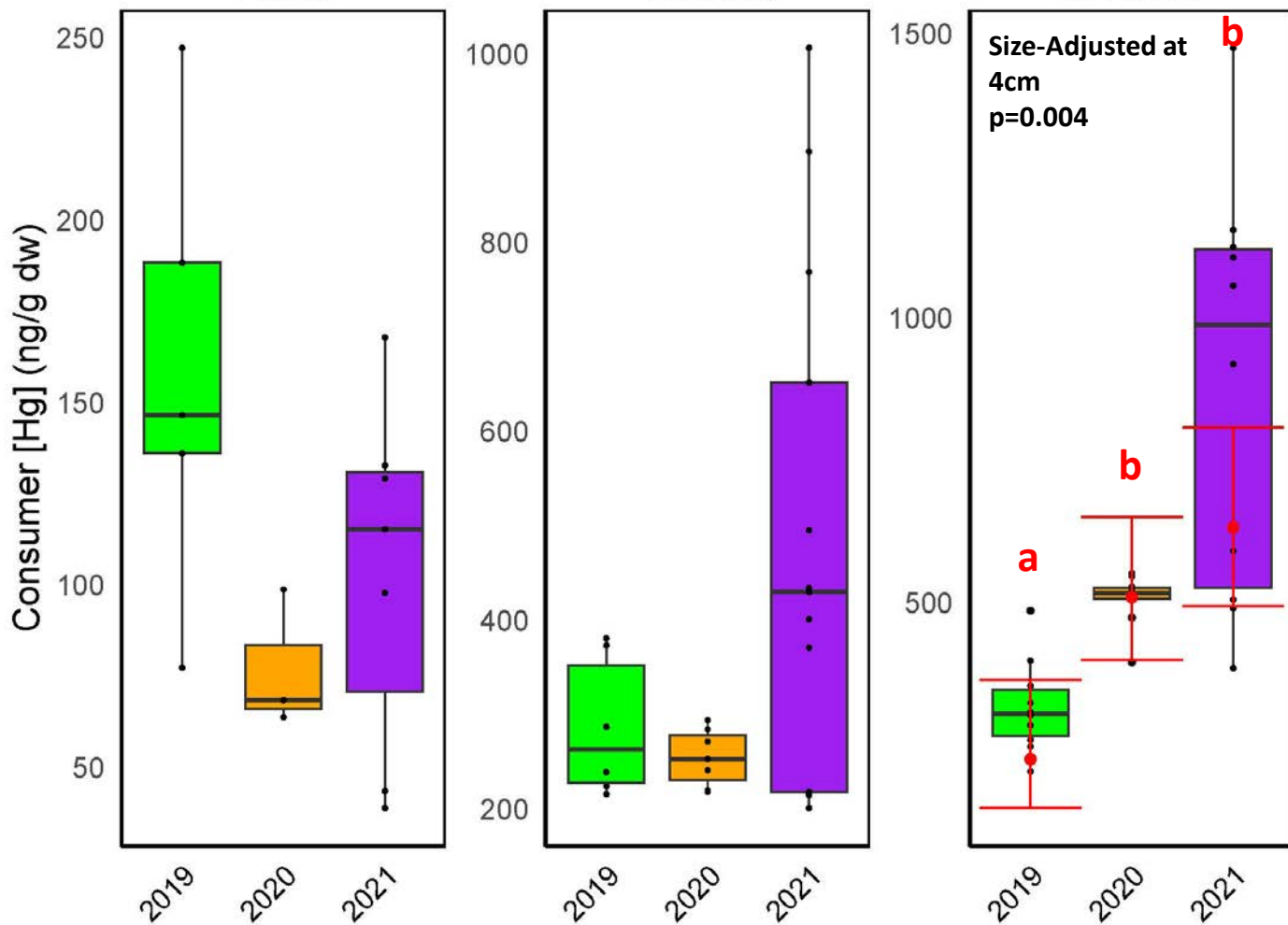
Primary



Secondary



Top Predator



Herbivores: No significant differences

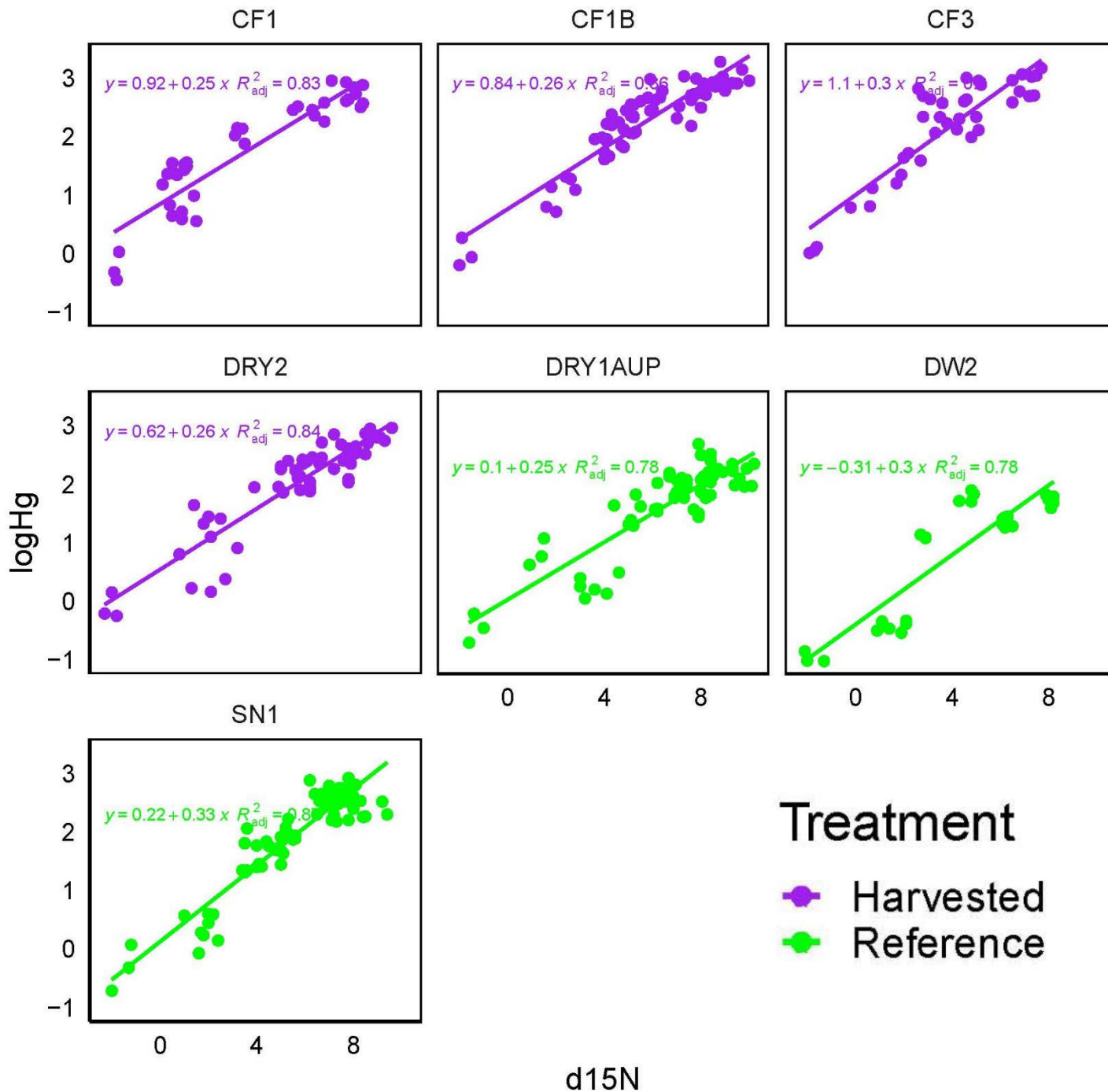
Predatory Macroinvertebrates : No significant differences

- Some genera were 3x higher **post-** than **pre-** and **during** harvest

Fish: [Hg] higher **during** and **post-** harvest

- Pearl Dace collected in 2019, but Northern Redbelly Dace collected in 2020 and 2021





Biomagnification of MeHg: No significant differences in slopes

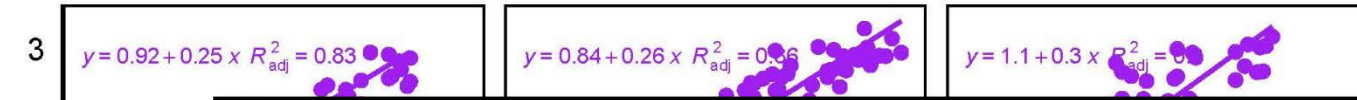
Intercepts: Higher intercepts in **harvested** sites



CF1

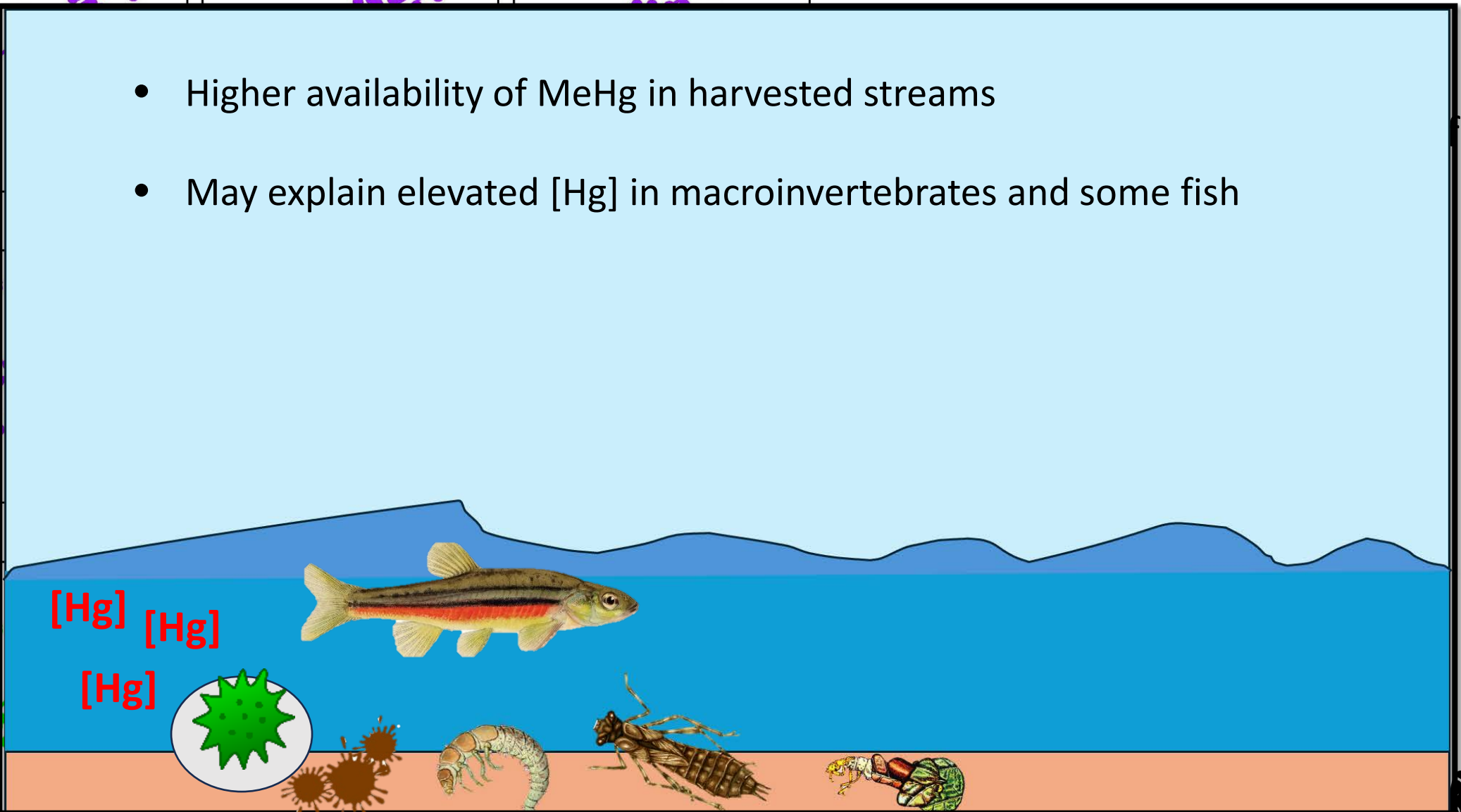
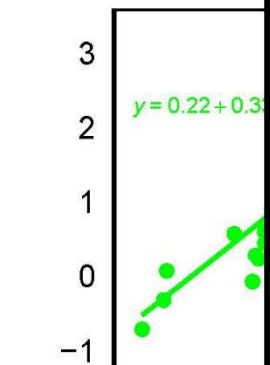
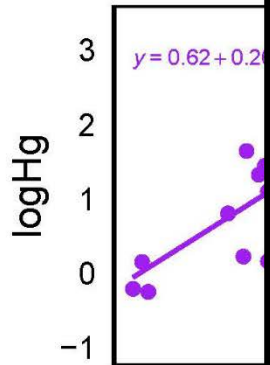
CF1B

CF3



- Higher availability of MeHg in harvested streams
- May explain elevated [Hg] in macroinvertebrates and some fish

ificant



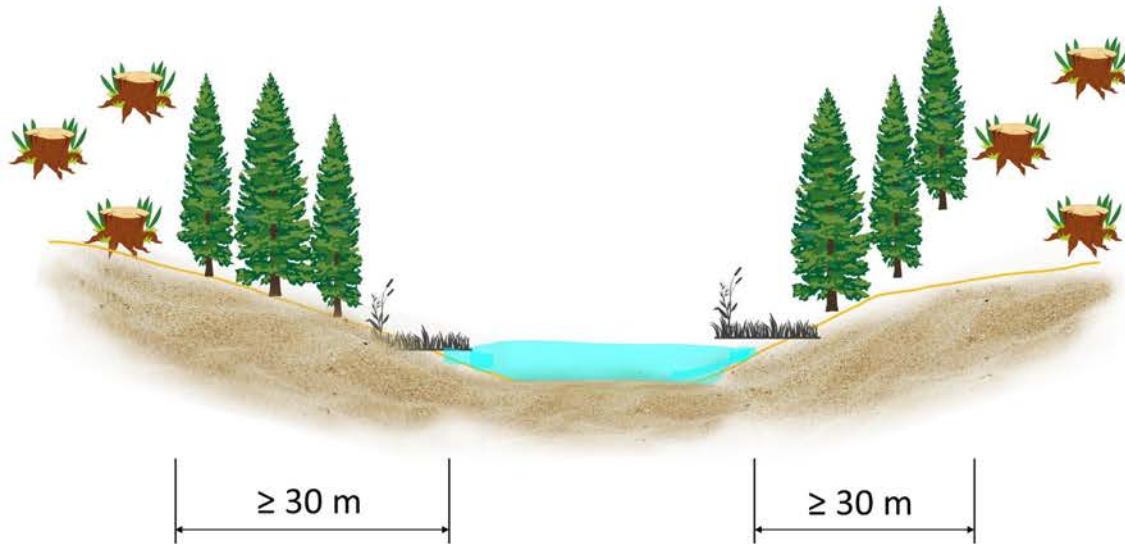
0 4 8

d15N

Wrap Up

“Mapped” streams (CF1, DRY2)

Harvested watersheds with ≥ 30 m riparian buffers
and $\leq 35\%$ of watershed area harvested



- Minimal impacts on MeHg in stream sediment, water and biota



Acknowledgments

- We acknowledge that our field work was conducted in the traditional territory of the Ojibwa, Cree, and Oji-Cree Peoples of Treaty 3 Territory and the Métis/Michif Nation.
- Dr. Karin Eklof provided invaluable advice early on in our planning for this study.
- Numerous undergraduate summer students helped ensure all aspects of sampling succeeded



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