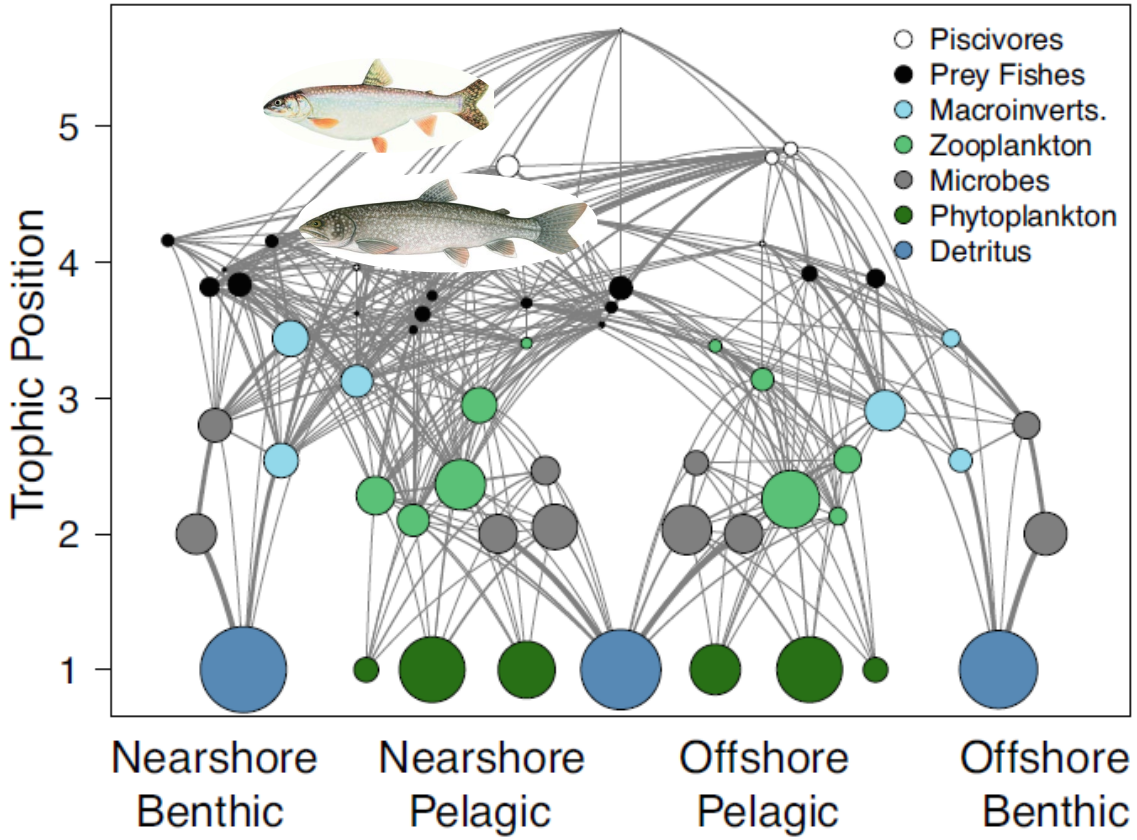
Importance of studying trophic overlap

- Food web studies are critical to ecosystem-based management
  - Understanding carrying capacity
  - Predator-prey balance
- Aid natural resource agencies by providing information on potential limitations or enhancements to production, particularly as it relates to the ongoing maintenance of a rehabilitated Lake Trout population



Lake Superior food web diagram from Matthias et al., 2021

Importance Lake Superior

- Least anthropogenic impact, dominated by native species
  - Example for future food webs with native fish restoration
- Focal point for research on climate change
  - Historically thicker ice in winter compared to other great lakes
- Why focus on the Western Arm Of Lake Superior?
  - Diverse assemblage of native and non-native salmonids
  - Habitat type has made sampling nearly impossible in large-scale efforts

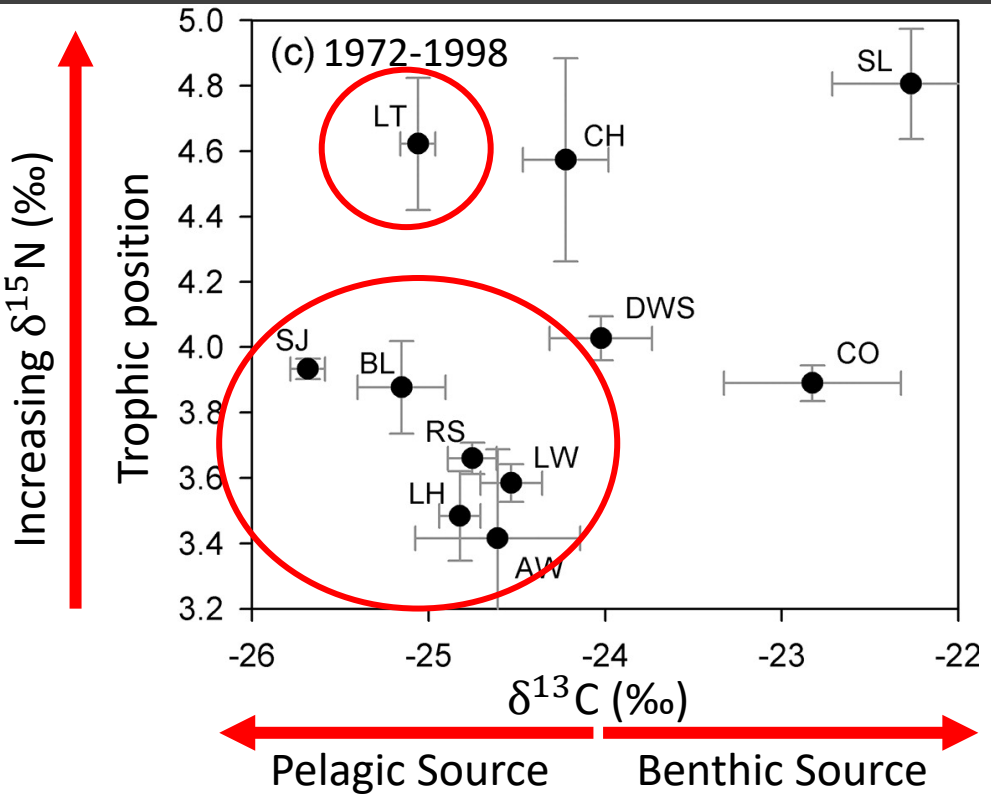

Credit: Kelly House

Objectives and hypotheses

- Objective: Delineate the trophic relationships among the nearshore salmonid complex and other nearshore predators
  - Metrics are niche overlap and trophic position based on stable isotope ratios (SIR)
  - Hypothesis 1, the size of the species will be a significant factor; however, sex will not be a significant factor with respect to SIR
    - Fisheries management zone (MN1-MN3, W12) in which they were caught will be a significant factor with respect to SIR (owing to size differences)
  - Hypothesis 2, there will be niche and trophic position differences among species
    - High potential for trophic overlap among our non-native Salmonids

Measuring food webs using SIR

- Delta 13C values pelagic vs. benthic
- Delta 15N values trophic position
- Shift in ratio



Schmidt et al., 2009. DWS, deepwater sculpin; LW, lake whitefish; LH, lake herring; SN, shortnose cisco; SJ, shortjaw cisco; BL, bloater; KY, kiyi; BF, blackfin cisco; LT, lake trout; SL, sea lamprey; RS, rainbow smelt; AW, alewife; CH, Chinook salmon; CO, coho salmon.

Methods

Lab

Field

Fish and Invert stable isotope processing

Fish collection

Invertebrate collection

Angler

DNR Trolling

Rock bags

Tributaries

Size and location patterns

Examine niche overlap

Estimate trophic position

Assign diet contribution from major prey items

Data analysis

Fish Sampling locations from 2020-2022

- 24 sampling locations, grouped into four zones
- Fisheries dependent
- Fish tissue extracted for stable isotope analyses

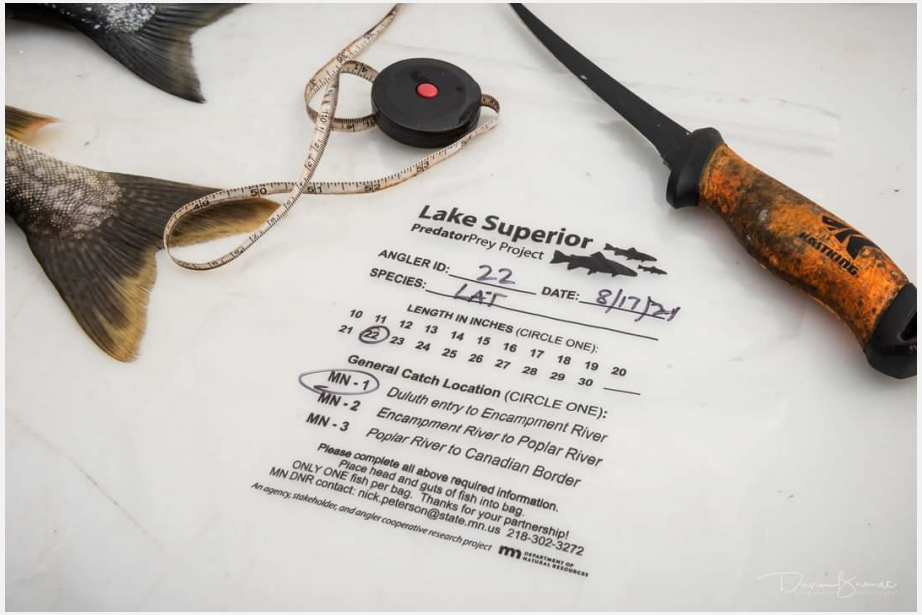


Figure 2. Angler fish tissue collection bags

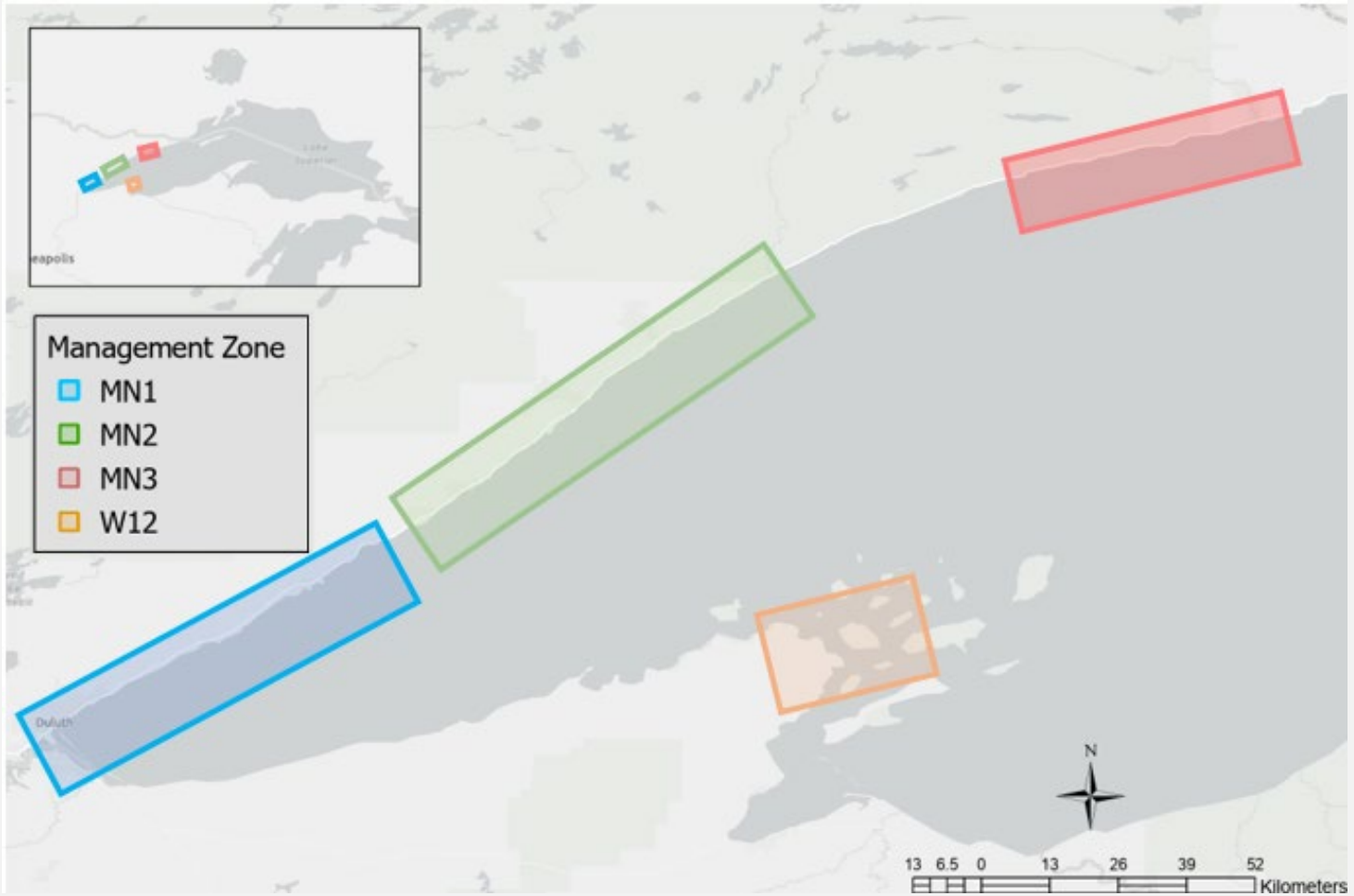
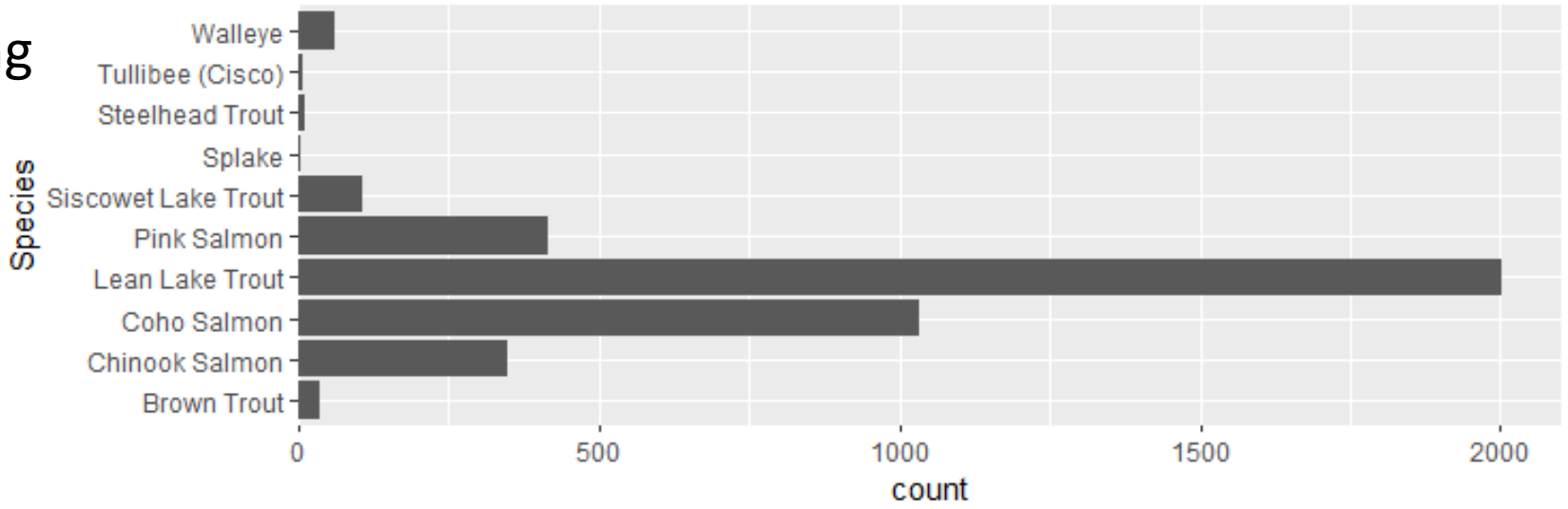


Figure 1. Map showing management zones along Lake Superior's North Shore.

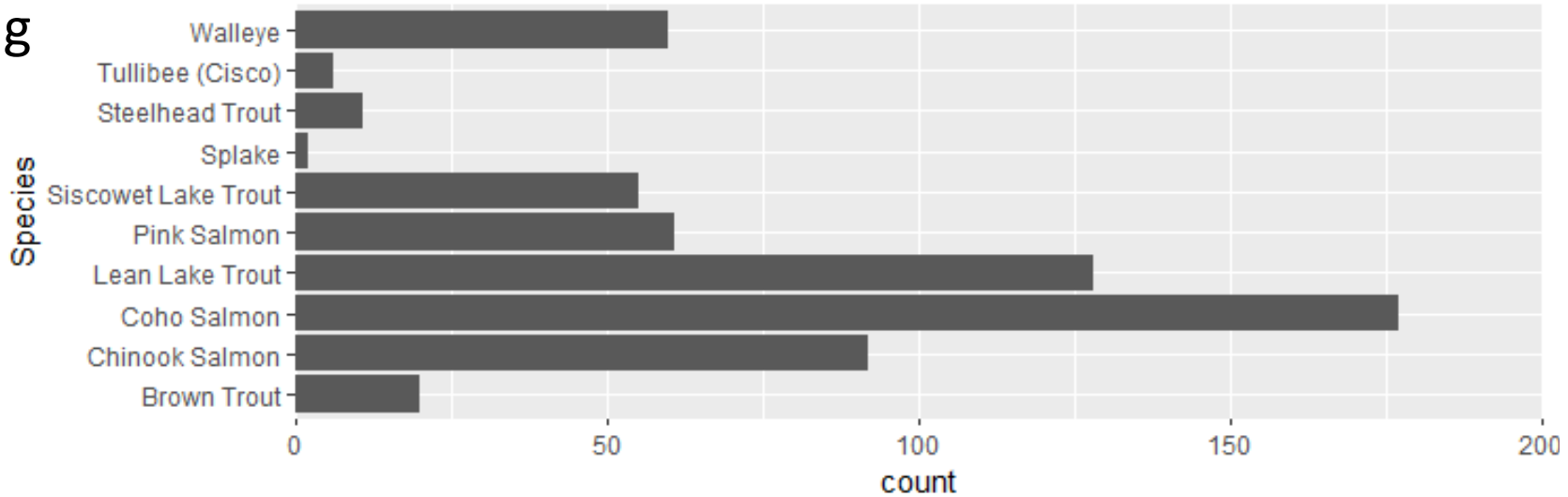
Fish Data Collection (2020-2022)

Before subsetting



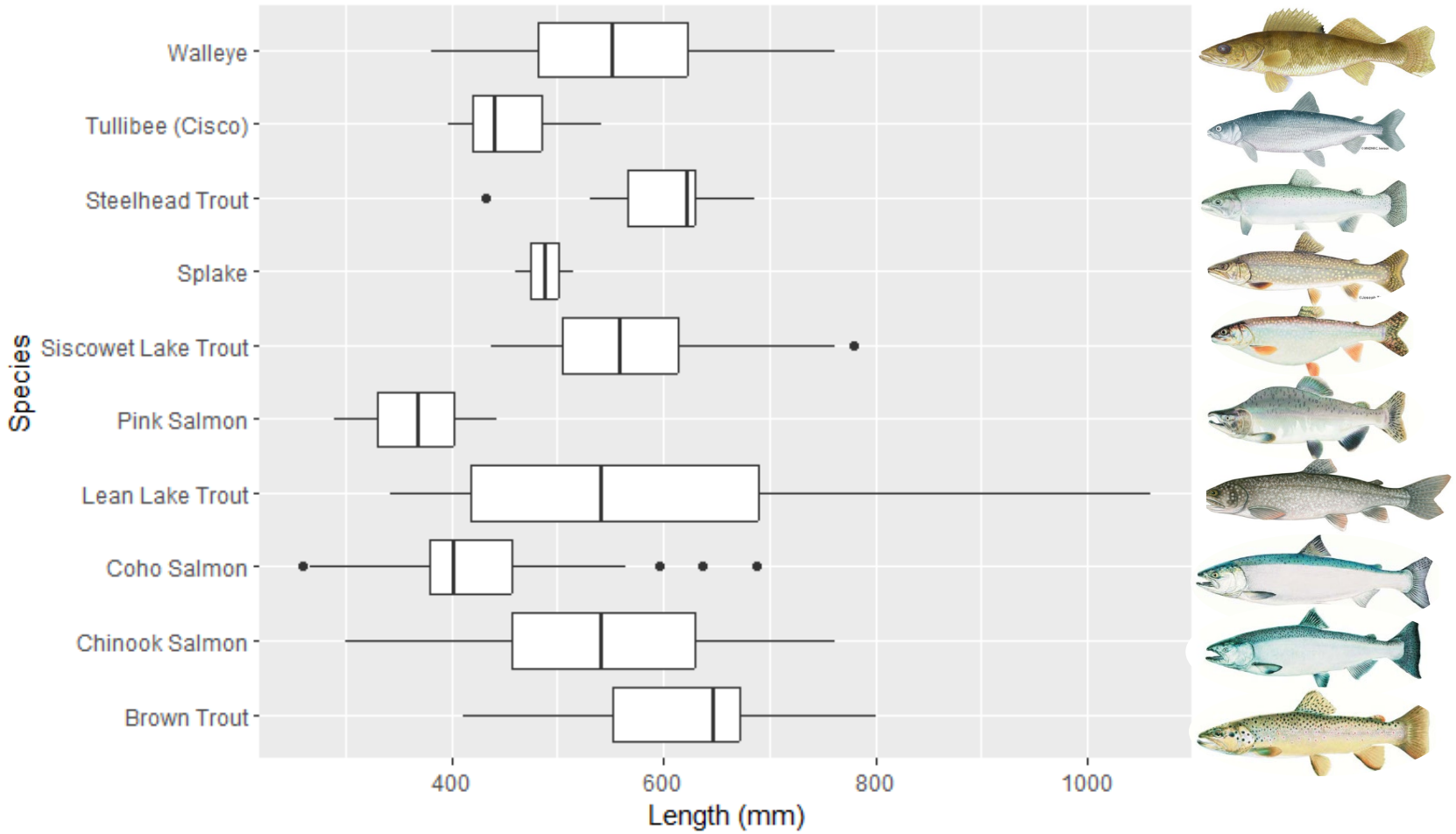
Total = 4,021

After subsetting



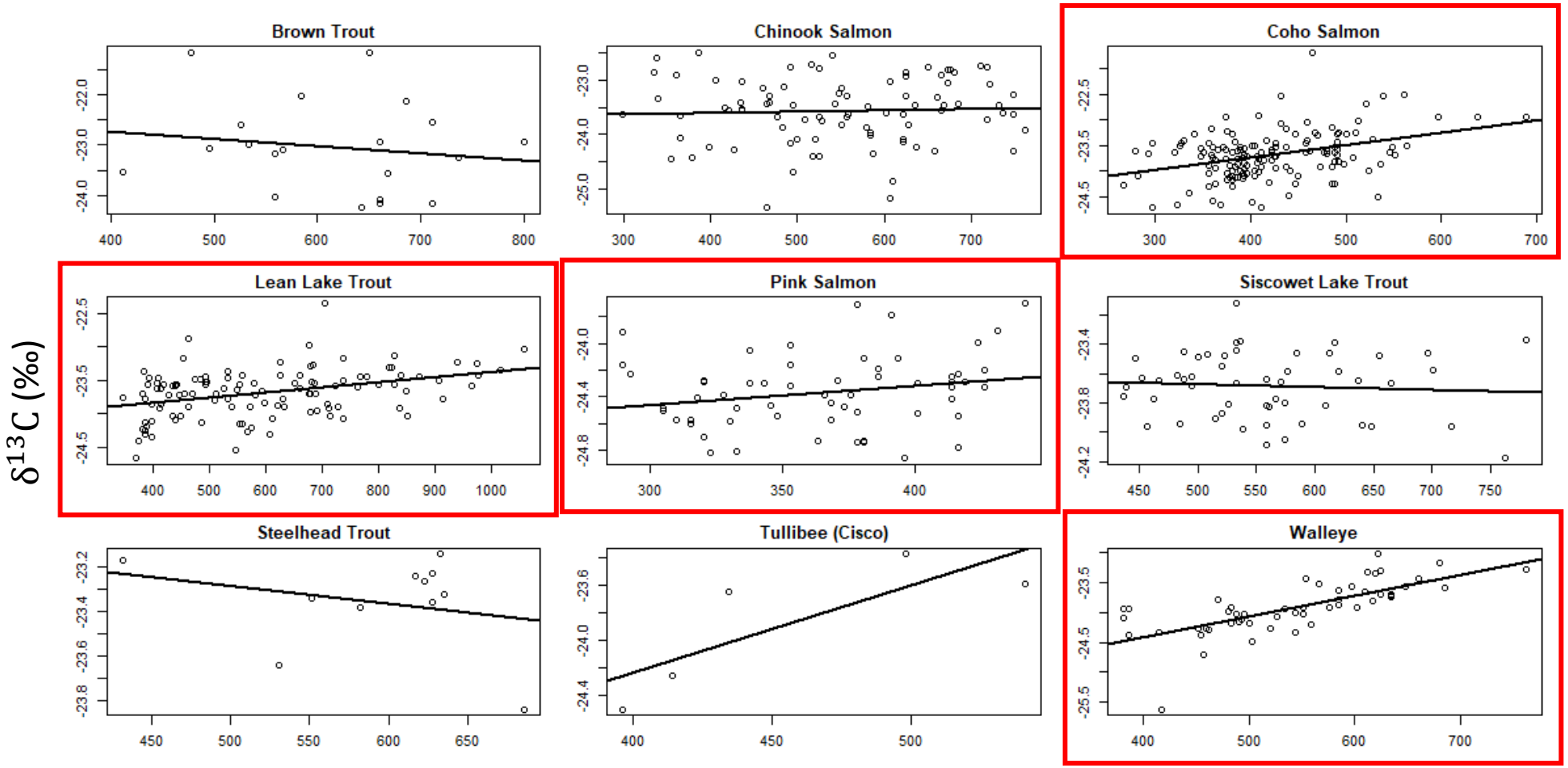
Total = 612

Length range per species, H1

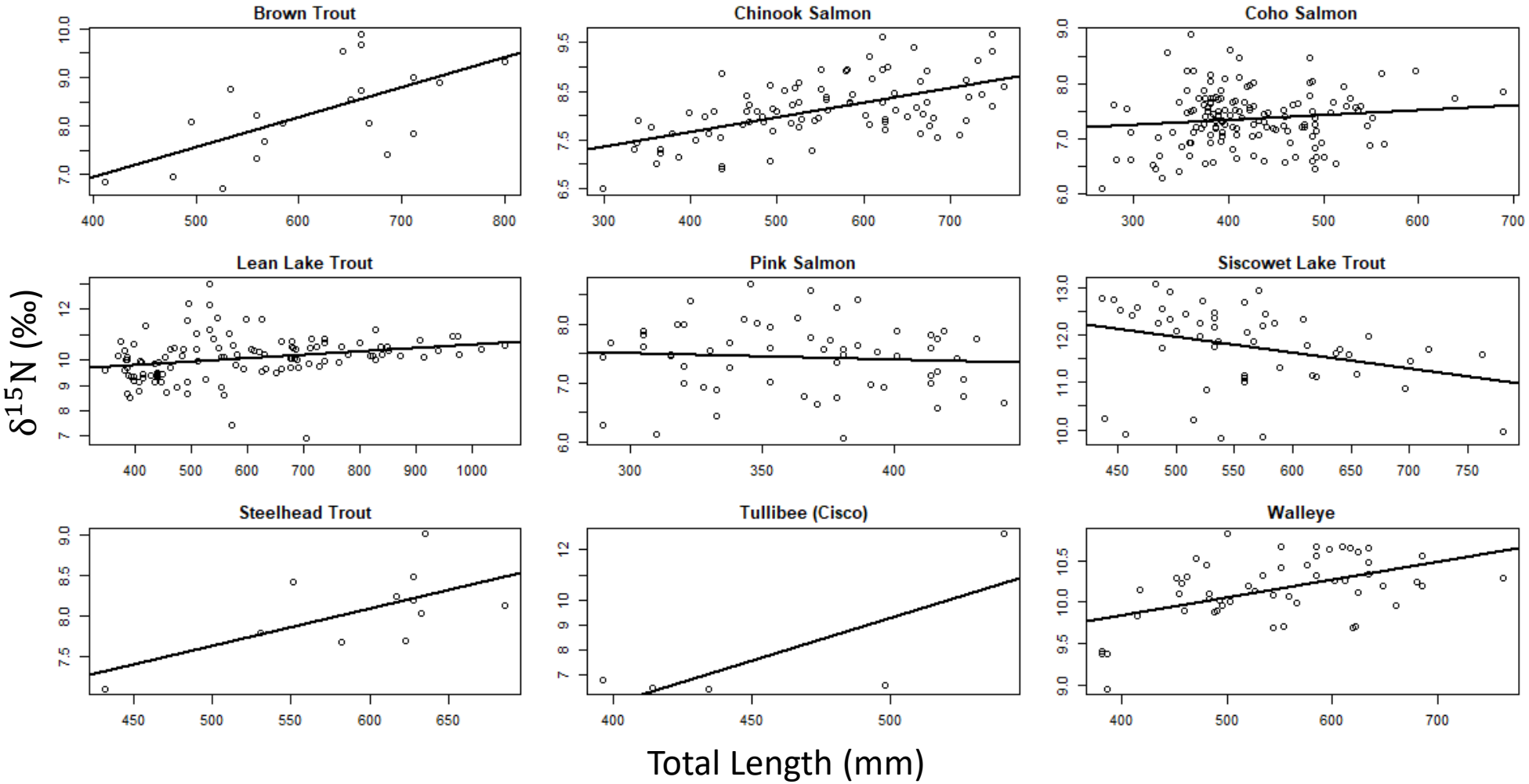


- Within species, size differences between sexes were not apparent
- Size differences across zones not apparent

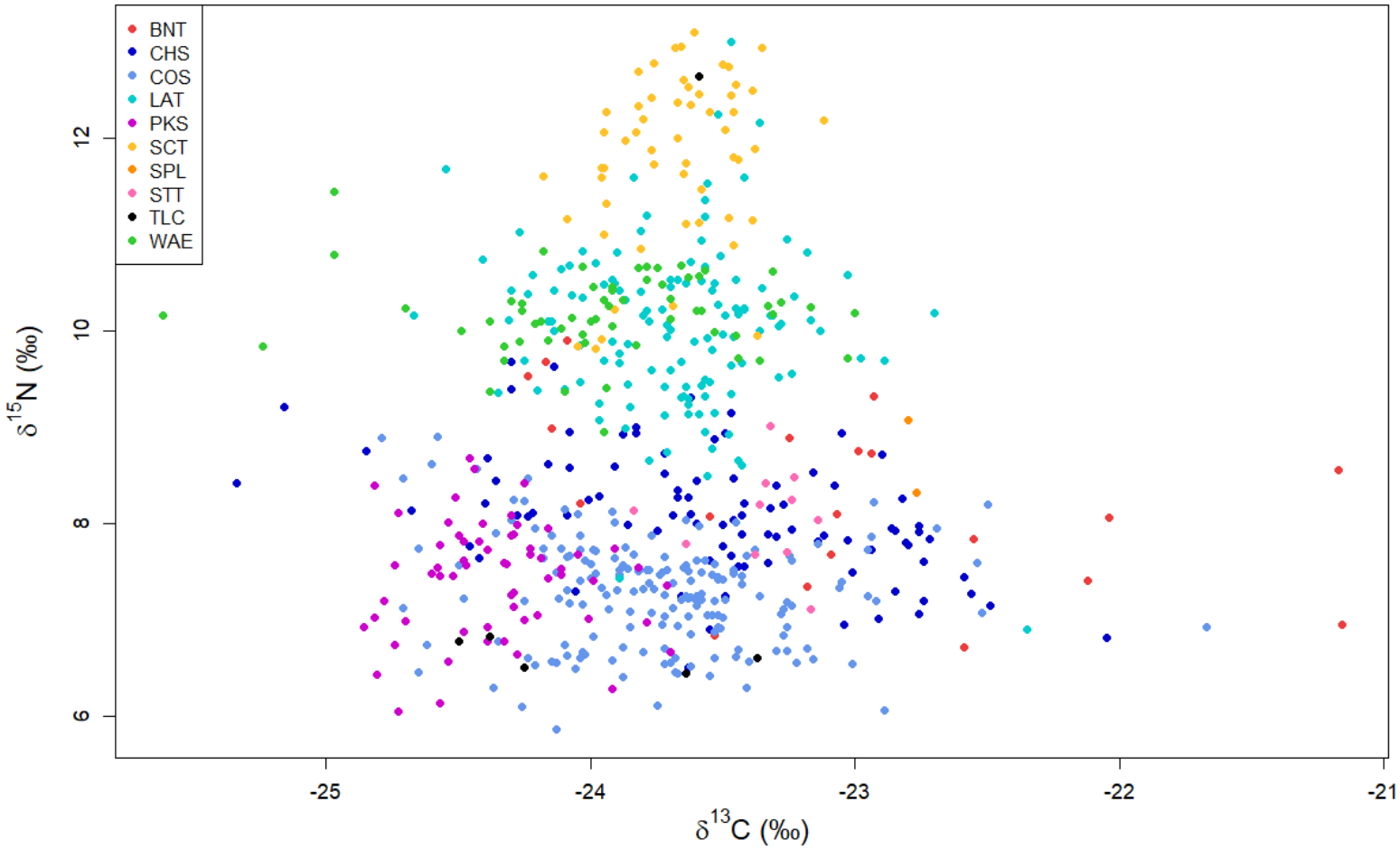
$\delta^{13}C$ (‰) by fish size



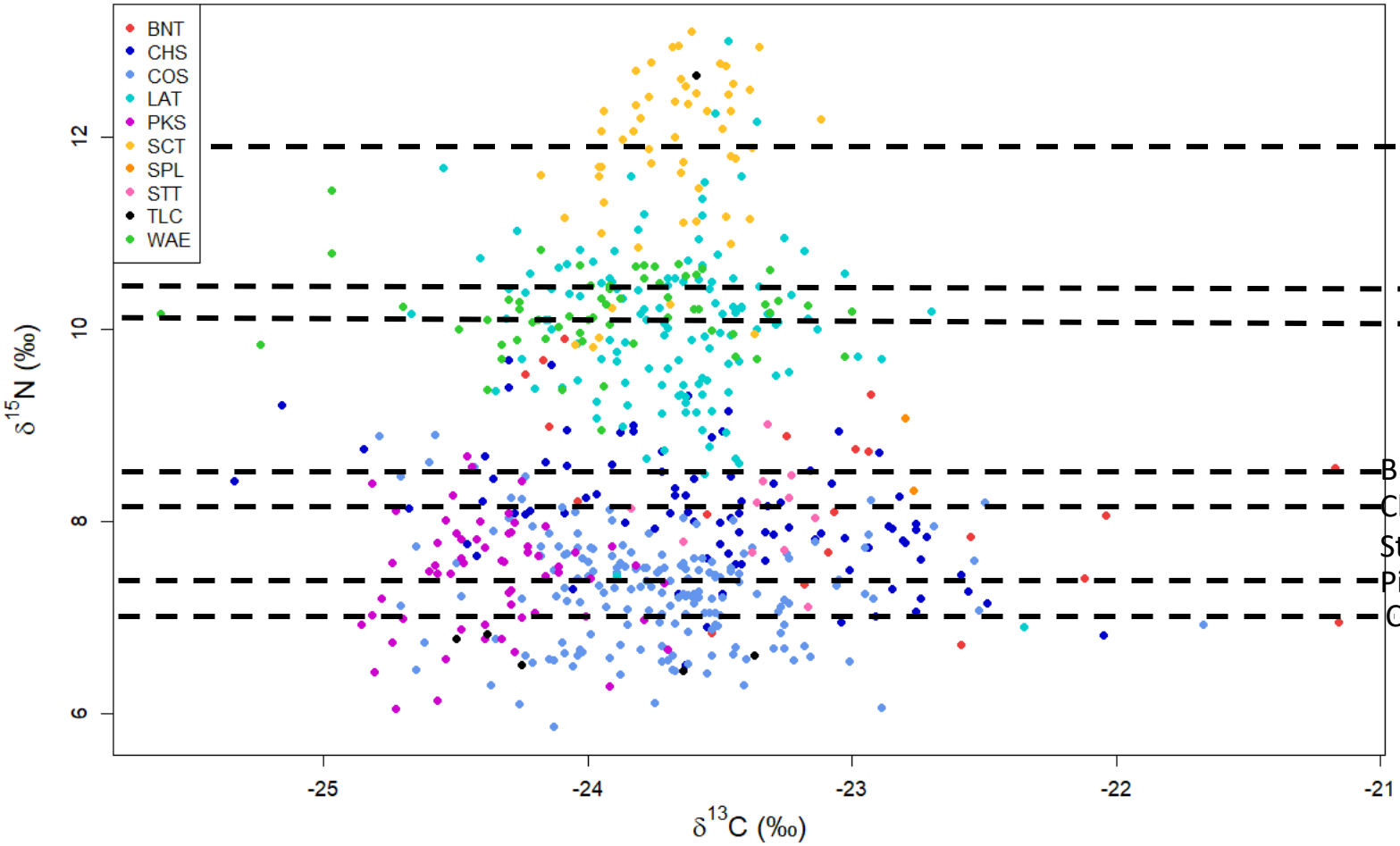
δ^{15}N (‰) by fish size



Stable isotope biplot



Trophic level estimate



Trophic position ± Standard deviation

Siscowet Lake Trout: 4.89 ± 0.25

Walleye: 4.4 ± 0.12

Lean Lake Trout: 4.37 ± 0.25

Brown Trout: 3.85 ± 0.28

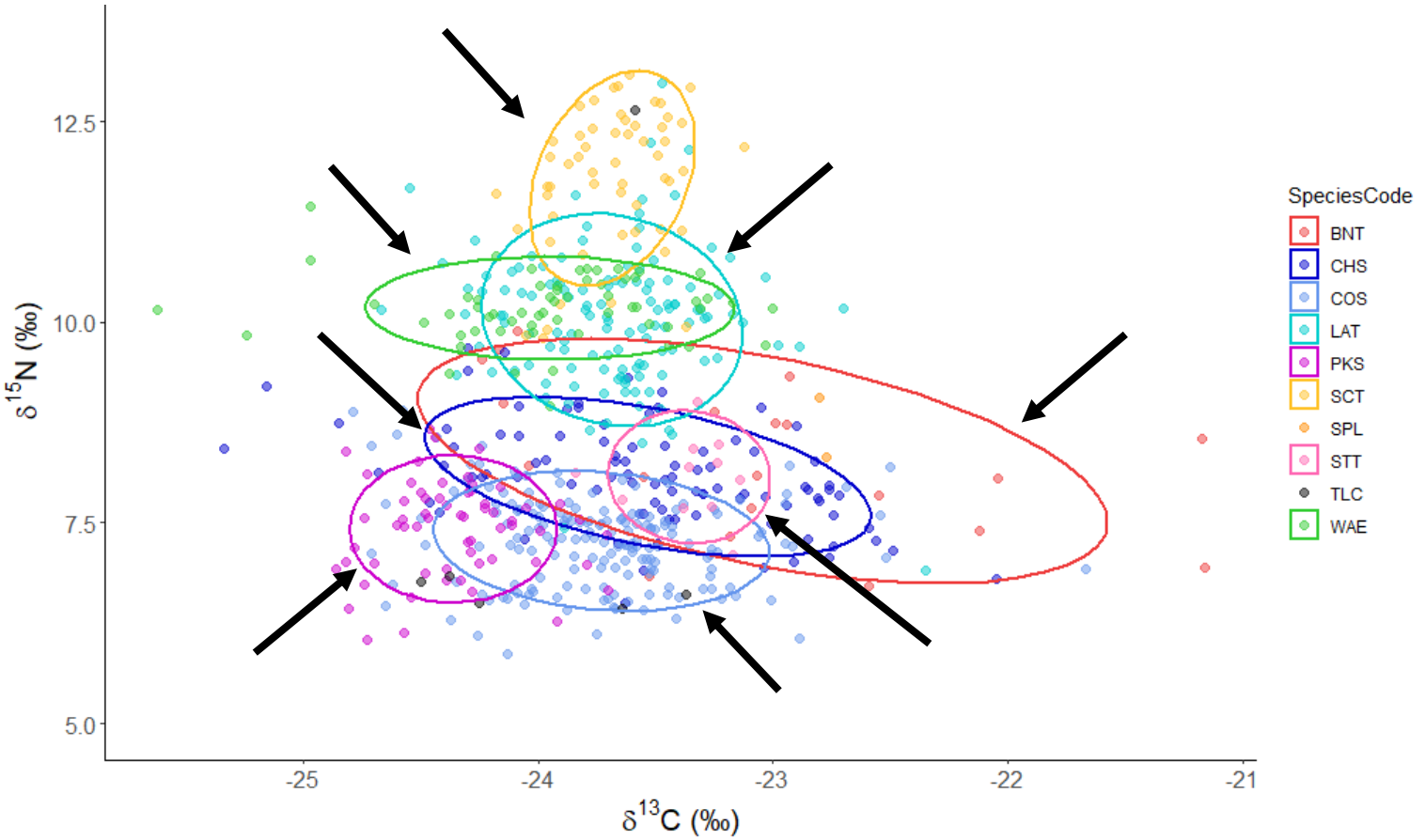
Chinook Salmon: 3.8 ± 0.19,

Steelhead: 3.8 ± 0.15

Pink Salmon: 3.6 ± 0.17

Coho Salmon: 3.56 ± 0.16

Trophic overlap of study fish



- $\delta^{13}C$ range consistent with mix of pelagic and benthic diet
- $\delta^{13}C$ and $\delta^{15}N$ reveal mix of relatively distinct (Siscowet Lake Trout) and overlapping (e.g., Walleye and Lean Lake Trout) niches

Conclusions

- Native species occupy a high trophic position than non-native species
- Minimal overlap between native and non-native
  - Large overlap among non-native species
- High potential for competition between non-native species
- Non-native salmonids are likely directly responsive to shifts in fisheries management strategies among this complex

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