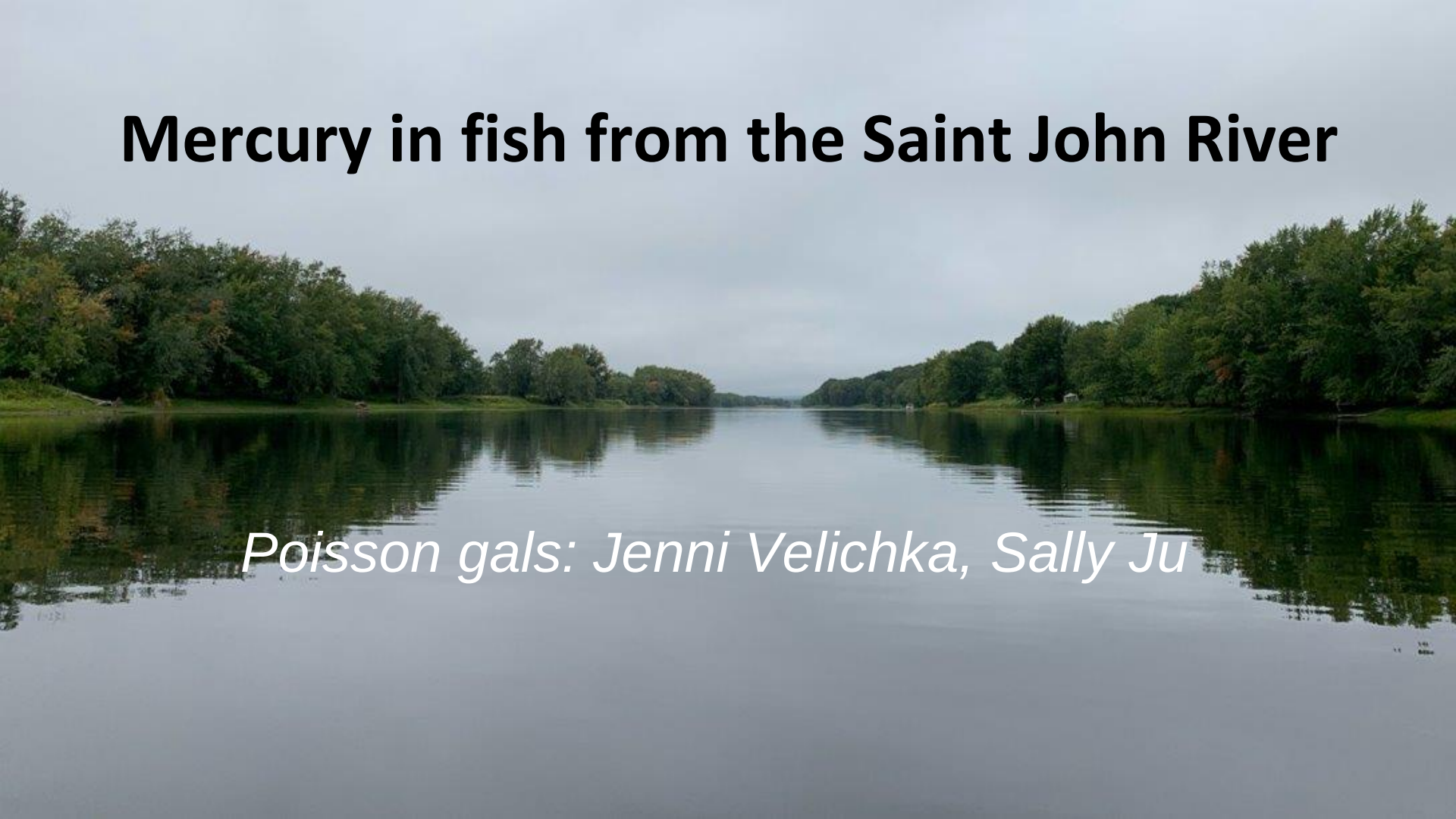
# Mercury in fish from the Saint John River



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# Study design

- Mercury is a bioaccumulating neurotoxin
- Dams and fish size can increase mercury concentration
- 50 Smallmouth Bass (SMB) and Yellow Perch (YP) caught at each of 3 sites (no SMB at FF)
- Fish dissected and various physical attributes measured
- Muscle tissue analyzed for mercury

# Questions

1. Does mercury concentration increase with fish size?

2. Is mercury concentration higher in fish upstream from the dam than downstream, since mercury methylation increases in flooded soils?

3. Is mercury concentration higher in Smallmouth Bass than Yellow Perch, since Smallmouth Bass are positioned higher on the food web?

# Our Data:

**Fish ID -** *Unique Fish ID*

**Date** - *Date Collected*

**Site -** NF/FF/REF

**Species -** Smallmouth Bass/Yellow Perch

**Total Length (mm) -** *Fish total length*

**Fork Length (mm) -** *Fish fork length*

**Total Weight (g) -** *Fish total wet weight*

**Liver Weight (g) -** *Wet weight of liver*

**Gonad Weight (g) -** *Wet weight of gonad*

**Sex -** M/F

**Correlated physical parameters**

**Sample Wet Weight (g) -** *Wet weight of muscle sample*

**Sample Dry Weight (g) -** *Dry weight of muscle sample*

**Mass Analyzed (g) -** *Mass used for Mercury analysis*

**Hg (ng) -** *Mercury reading from Direct Mercury Analyzer*

**Hg (ug/kg dw) -** *Mercury of sample per kg of dry sample mass*

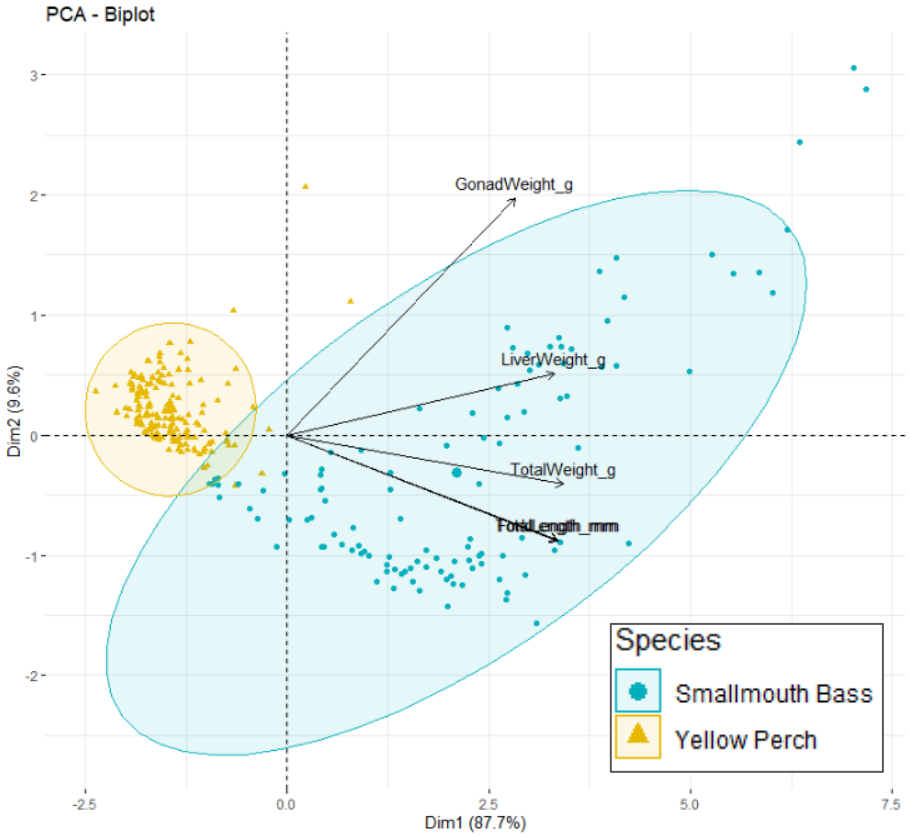
**Hg (ug/kg ww) -** *Mercury of sample per kg of wet sample mass (customary unit of reporting to compare to consumption guidelines)*

# Principal Component Analysis of fish physical measurements

A **Principal Component Analysis** takes several input parameters and reduces it into 2 dimensions that explain the majority of the variability in the data

- Use a PCA on the fish measurements because there are several physical parameters that could be correlated

# PCA of Fish Physical Parameters




Variables in PCA:

- Total length
- Fork length
- Total weight
- Liver weight
- Gonad weight

Smallmouth Bass:

- Total length, fork length, total weight, liver weight and gonad weight all respond in the same positive direction

Yellow Perch:

- PCA shows that this species has a different relationship between increasing gonad/liver weight and increasing size

# PCA of fish physical measurements

A **Principal Component Analysis** takes several input parameters and reduces it into 1 or 2 dimensions that should explain most of the variability in the data

- Use a PCA on the fish measurements because there are several physical parameters that are correlated

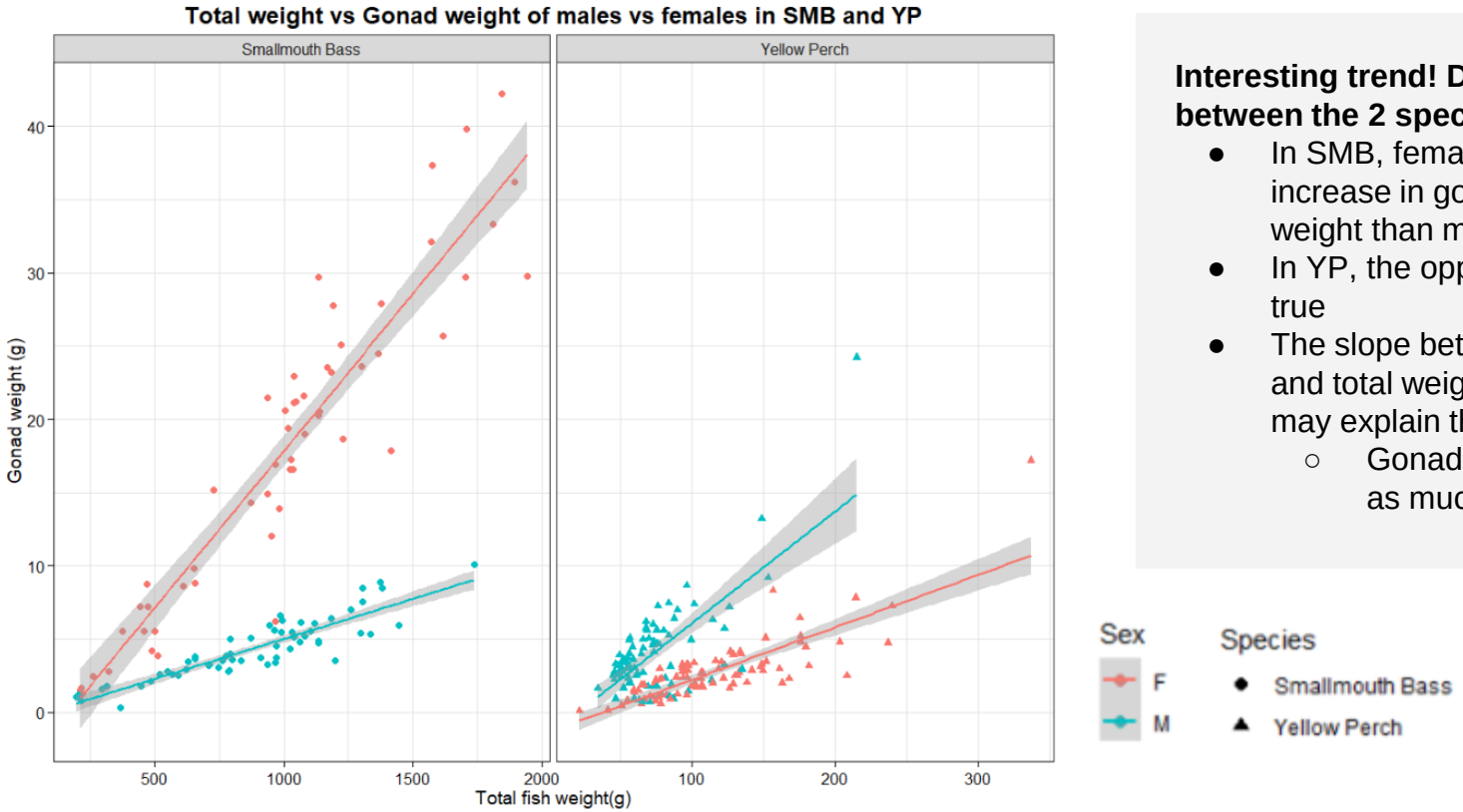
PC1 is driven by variability in total/fork length, total weight

PC2 is driven by variability in gonad and liver weight

In the PCA, it looked like there was a different pattern between YP and SMB

- We graphed total weight vs gonad weight in males/females in the 2 species to compare. Interestingly, there was a different relationship between the 2 different species, as seen in the PCA ellipses

# Exploratory linear model




**Interesting trend! Different response between the 2 species**

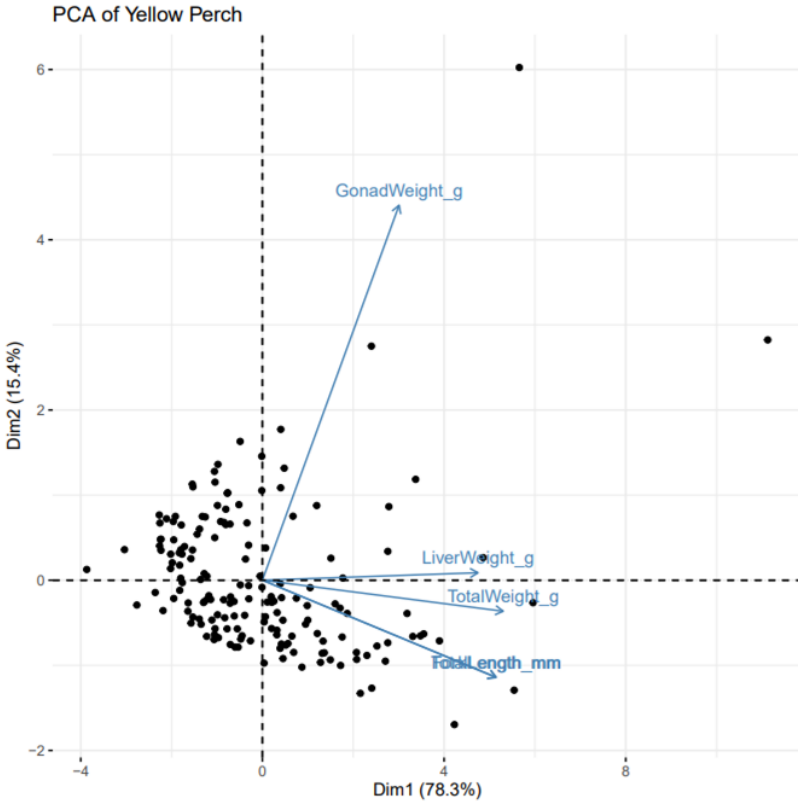
- In SMB, females have a greater increase in gonad weight per total weight than males
- In YP, the opposite pattern holds true
- The slope between gonad weight and total weight is lower in YP which may explain the PCA
    - Gonad weight not increasing as much with size

# Existential crisis after the PCA

Existential crisis: do we want to assess 2 species together, or each species individually?

- We decided to assess species separately..
  - In the 2 species, there is a different relationship between PC1 (driven by length and weight) and PC2 (driven by gonad and liver size)
  - However, this means that we cannot compare between SMB and YP
- We did the PCA separately for each species, and we will use PC1 as the predictor variable separately for each species

# PCA Results - Yellow Perch




Checked and removed outliers, and also checked for influential points (fish with large gonads)

- However, these influential points did seem reasonable in relation to their size (and Jenni remembered seeing the large-gonad fish in the field)

PC1

- PC1 explained 78.3% of the variability in our physical parameters
- All variables are positively associated with PC1

PC2

- PC2 explained 15.4% of the variability in our physical parameters
- Gonad weight is more strongly associated with PC2

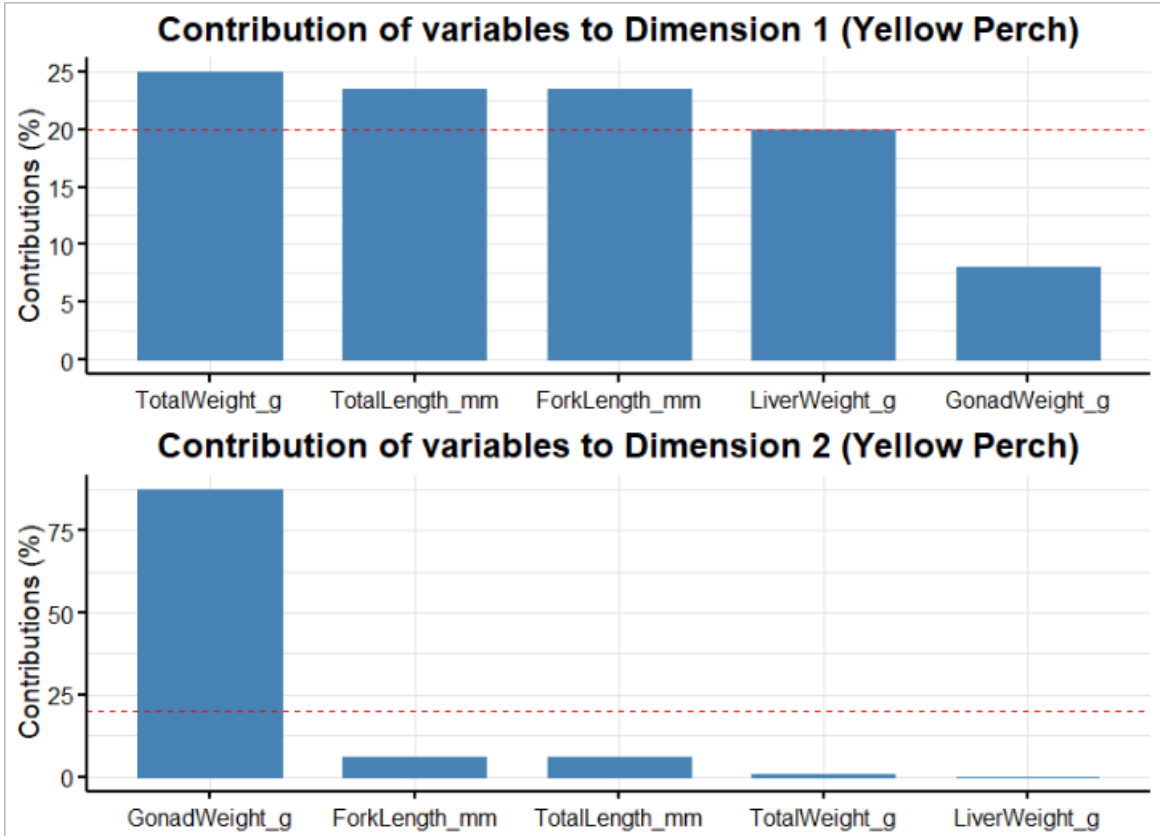
# PCA Results - Yellow Perch

PC1 contributions:

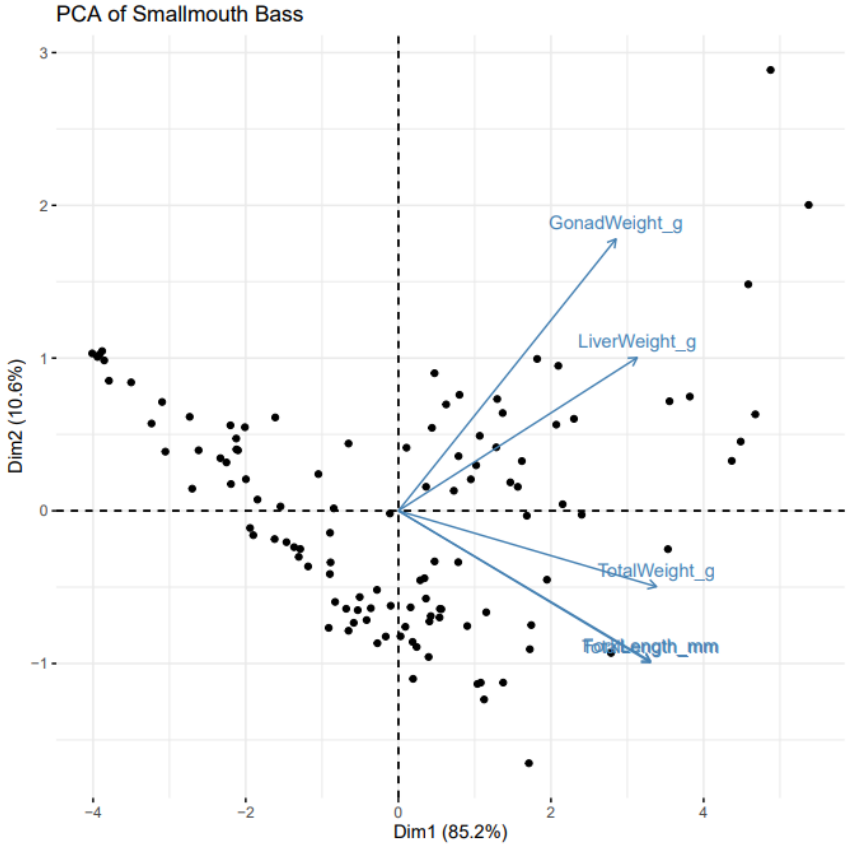
- Relatively equal contributions of total weight, total length, fork length
- Liver weight
- Gonad weight

PC2 contributions:

- Almost completely driven by gonad weight



# PCA Results - Smallmouth Bass




Some influential points from the largest size fish

- We checked these points and they all looked biologically reasonable

PC1

- PC1 explained 85.2% of the variability in our physical parameters
  - This is greater than PC1 in YP, which was 78.3%
- All variables are positively associated with PC1

PC2

- PC2 explained 10.6% of the variability in our physical parameters
  - This is less than PC2 in YP, which was 15.4%
- Gonad weight is more strongly associated with PC2

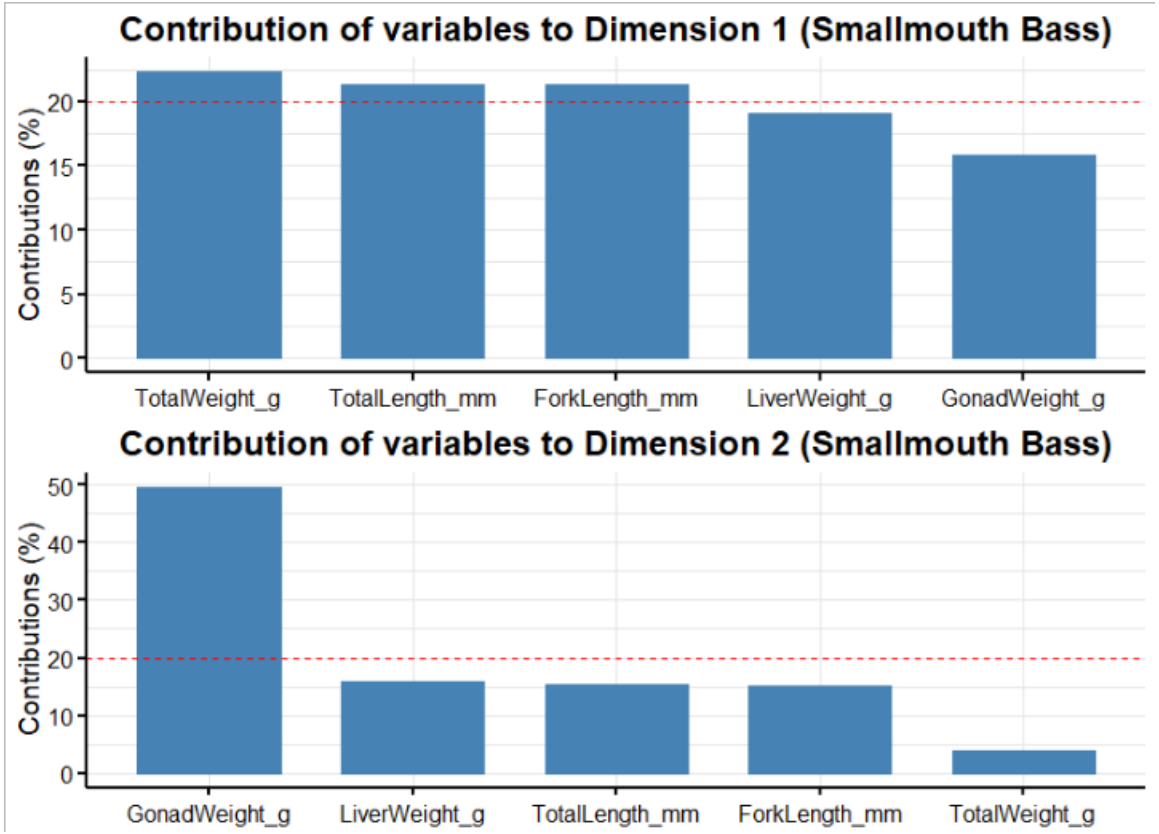
# PCA Results - Smallmouth Bass

PC1 contributions:

- Relatively equal contributions of total weight, total length, fork length
- Liver weight
- Gonad weight has a lower contribution

PC2 contributions:

- Largely driven by gonad weight
- Some small contributions from liver weight, total length, fork length



# Next steps

Does mercury increase with increasing fish size - linear mixed effects model:

- Use PC1 as a function of log THg ug/kg ww
- Fixed effects: sex and site
- Random effects: date

Compare THg ug/kg ww between sites:

- Anova for Yellow Perch (3 sites)
- T-test for Smallmouth Bass (2 sites)

Compare THg ug/kg ww between species:

- Not too sure how to approach this as we decided to use separate PCAs for the species