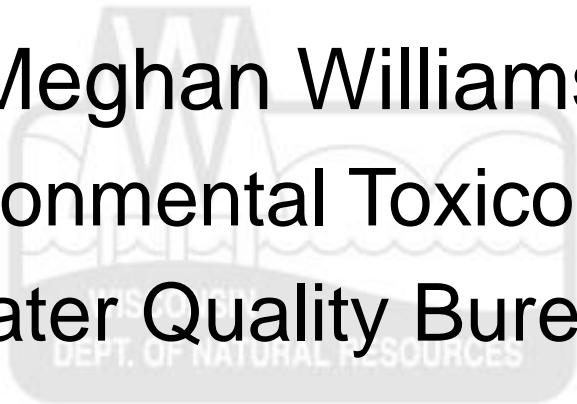


# Bioaccumulation Factors

Stakeholder Group Meeting  
PFOS & PFOA Surface Water Criteria  
23 March 2020

Meghan Williams  
Environmental Toxicologist  
Water Quality Bureau

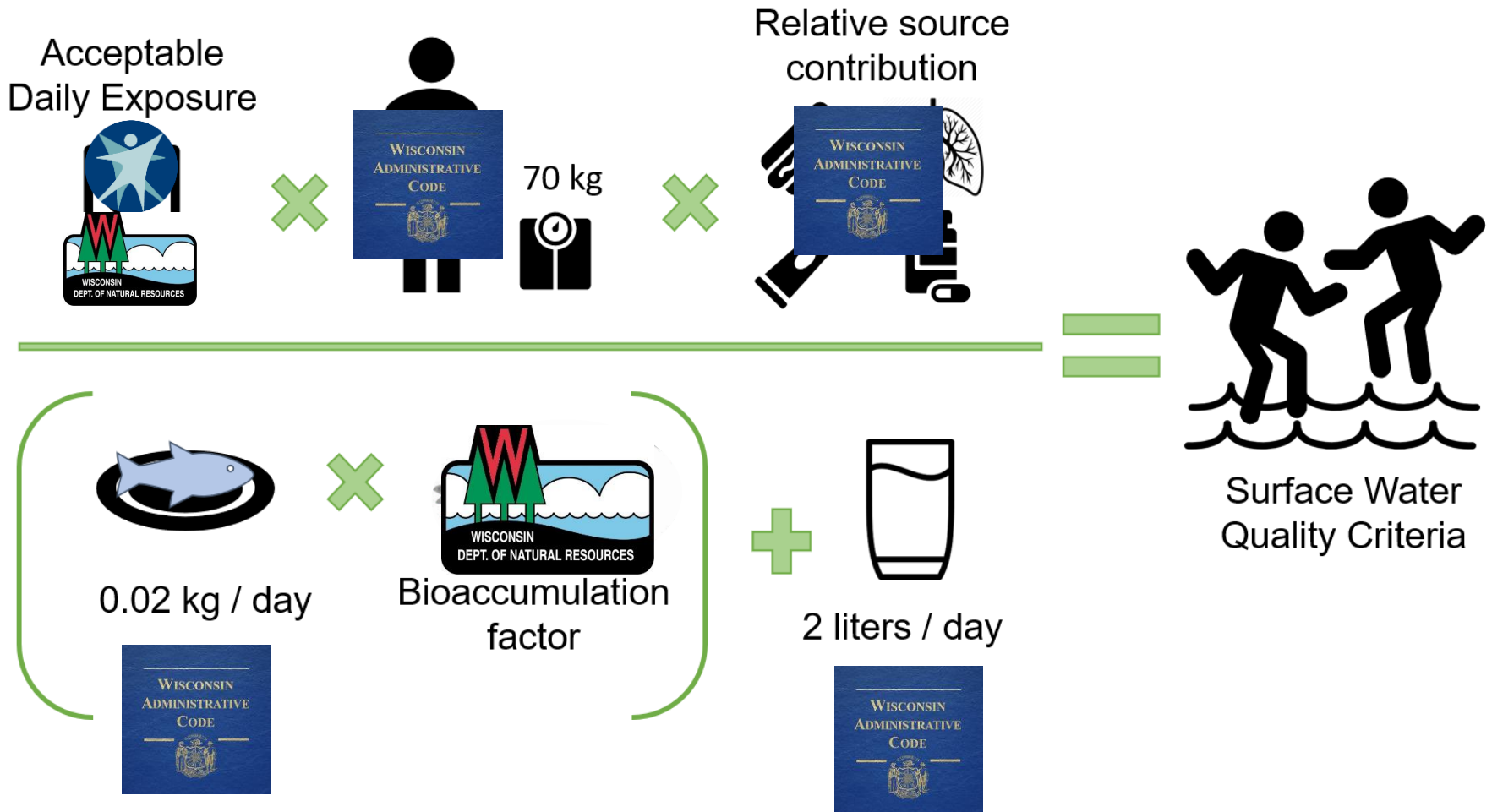




# Today's presentation

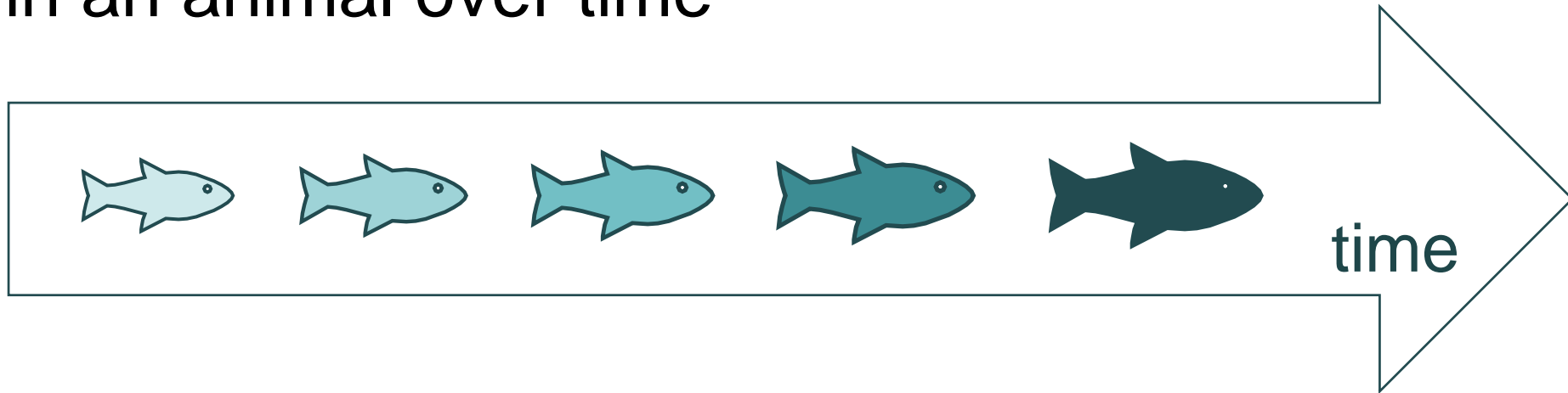
- **What is bioaccumulation?**
- What does NR105 say about BAFs?
- How is are BAFs calculated?
- What BAF data is available for PFOS and PFOA?
- Likely range of PFOS and PFOA surface WQC to protect human health

# Human Health Threshold Criteria

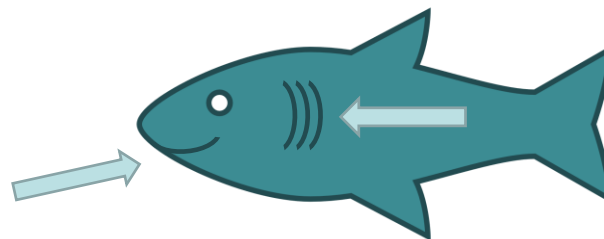


# What is bioaccumulation?

Increase in the concentration of a contaminant in an animal over time

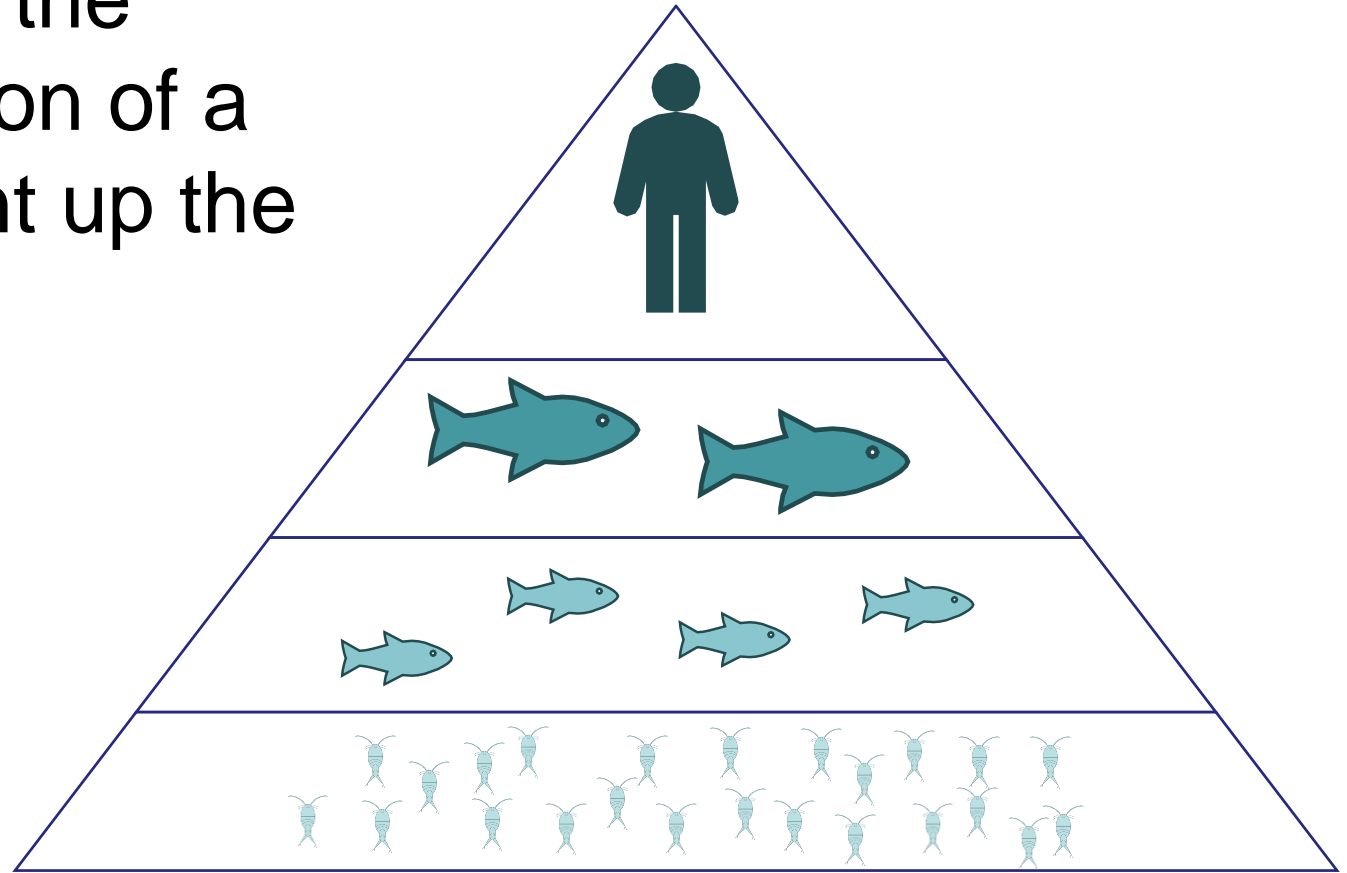


Incorporates uptake from diet and through gills



# Bioaccumulation vs. biomagnification

Increase in the concentration of a contaminant up the food chain





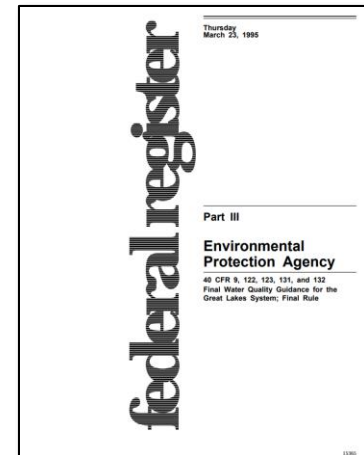
# Today's presentation

- What is bioaccumulation?
- **What does NR105 say about BAFs?**
- How is are BAFs calculated?
- What BAF data is available for PFOS and PFOA?
- Likely range of PFOS and PFOA surface WQC to protect human health



# What does NR105 say about bioaccumulation factors?

105.10(1): The BAF used to derive surface water criteria is determined using the methodology in 40 CFR part 132, Appendix B



105.10(3): Measured BAFs shall be obtained from available sources, including: EPA Ambient Water Quality Criteria documents, published scientific literature, reports issued by EPA or other reliable sources, or unpublished data



# What does NR105 say about bioaccumulation factors?

105.10(5): BAFs for **inorganic** substances

BAFs for **organic** substances are calculated by incorporating the **lipid content** of fish.

However...PFAS do **not accumulate in fats** like other organic compounds, so the procedures to calculate BAFs for **inorganic compounds are more appropriate.**

**This is the same rationale also used by Michigan and Florida when deriving SWQC.**





# What does NR105 say about bioaccumulation factors?

## 105.10(5): BAFs for inorganic substances

Measured BAFs shall be based on **edible tissue** (e.g., muscle) of freshwater fish.

BAFs based on measurements of aquatic plants and invertebrates may not be used.

If >1 field measured BAFs are available from studies in the Great Lakes system, the **geometric mean of the species mean BAFs** shall be used as the human health BAF for that substance.

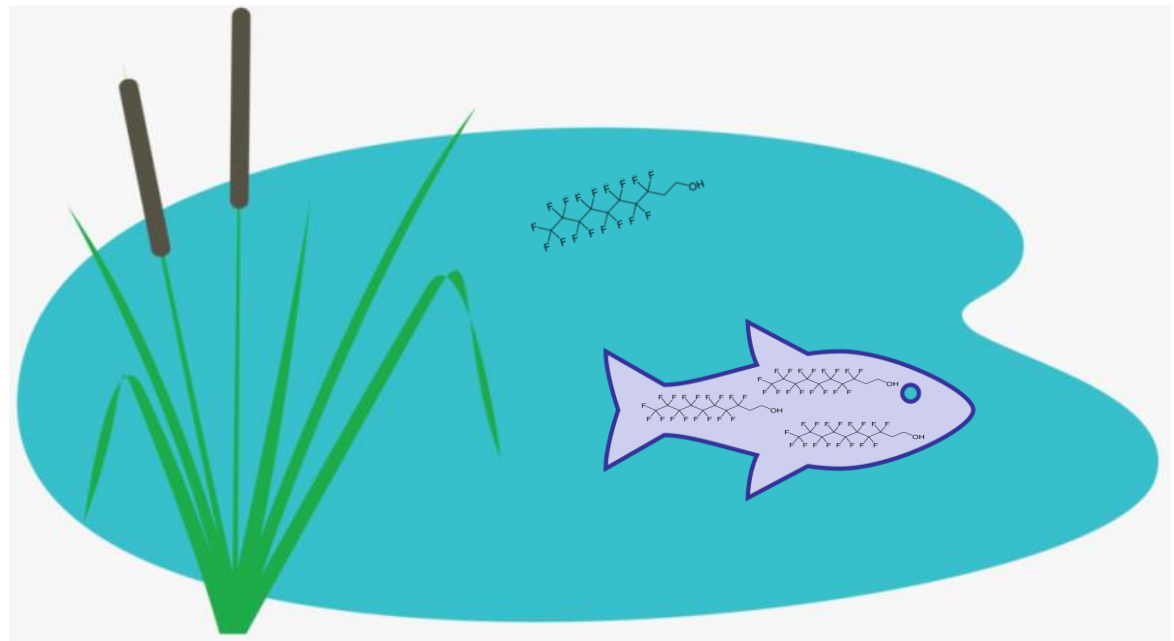


# Today's presentation

- What is bioaccumulation?
- What does NR105 say about BAFs?
- **How is are BAFs calculated?**
- What BAF data is available for PFOS and PFOA?
- Likely range of PFOS and PFOA surface WQC to protect human health

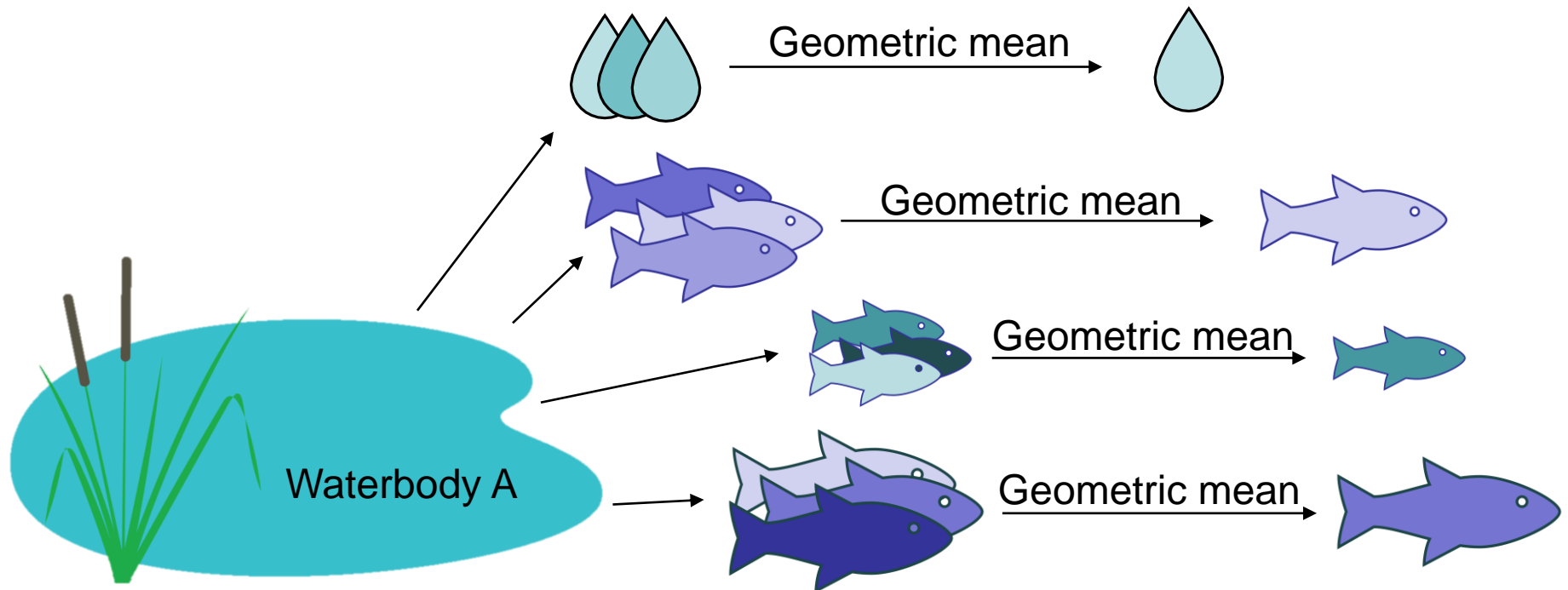
# How are bioaccumulation factors calculated?

Ratio of the concentration of a substance in fish tissue to its concentration in the ambient water



# How are bioaccumulation factors calculated?

For each waterbody, calculate geometric mean concentration in water samples and in fillets of each species



# How are bioaccumulation factors calculated?

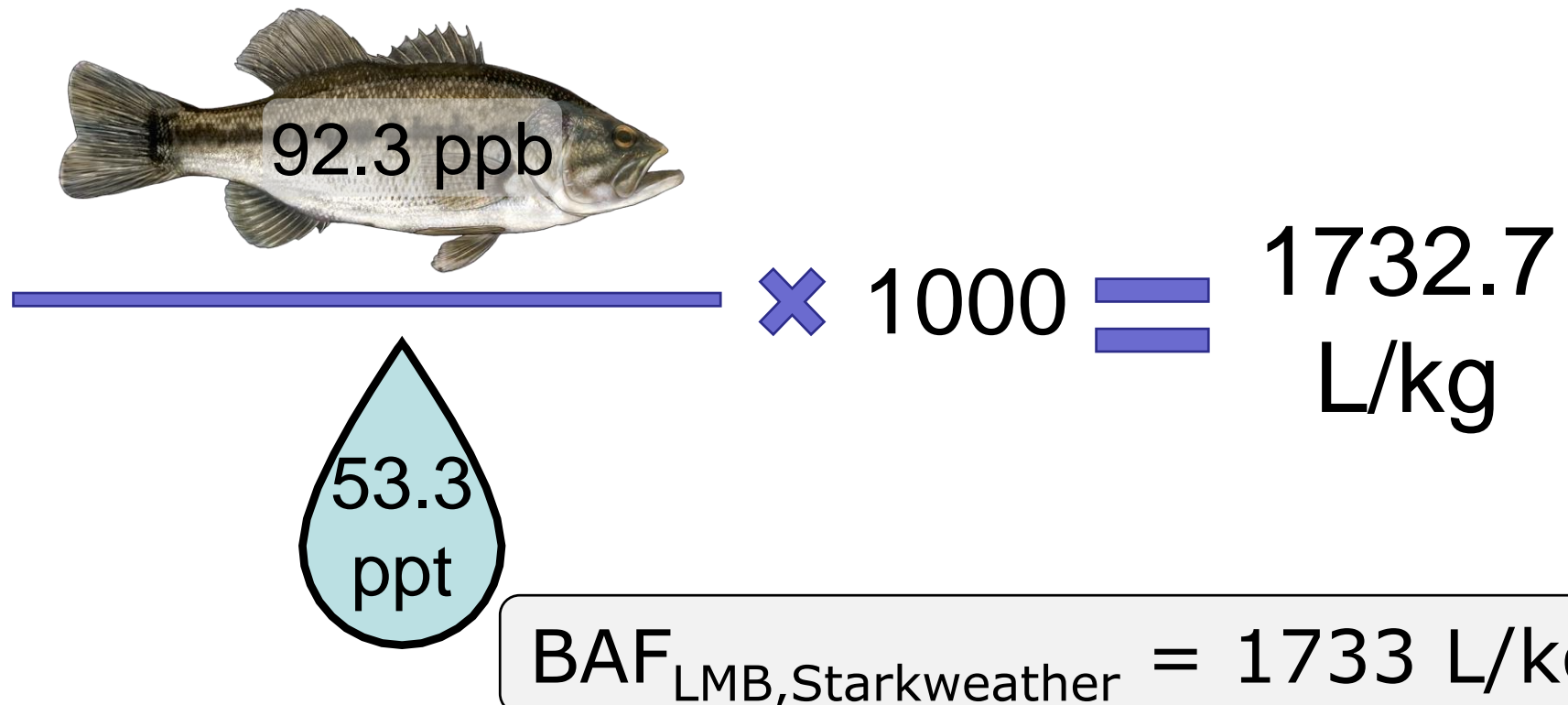
Water and fillet concentrations used to calculate BAFs for each species from each waterbody

The diagram illustrates the calculation of the Bioaccumulation Factor (BAF). It features a horizontal line. Above the line is a purple fish icon containing the text "ng/g (ppb)". Below the line is a light blue water drop icon containing the text "ng/L (ppt)". To the right of the line is a purple multiplication symbol "×", followed by the number "1000", an equals sign "=", and the text "BAF (L/kg)".

$$\frac{\text{ng/g (ppb)}}{\text{ng/L (ppt)}} \times 1000 = \text{BAF (L/kg)}$$

# How are bioaccumulation factors calculated?

Calculate BAFs for each species from each waterbody: Example



92.3 ppb

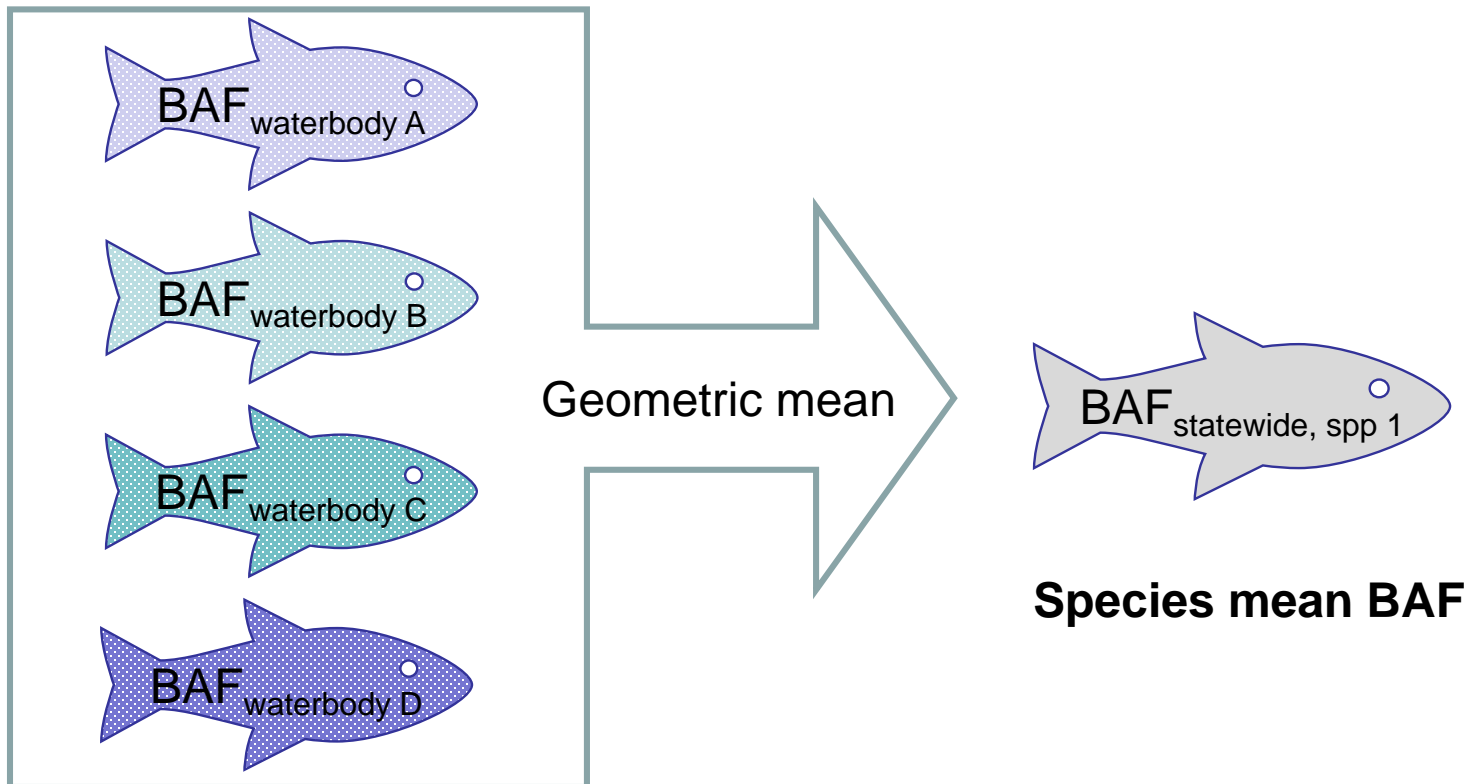
53.3 ppt

$$\frac{92.3 \text{ ppb}}{53.3 \text{ ppt}} \times 1000 = 1732.7 \text{ L/kg}$$

$\text{BAF}_{\text{LMB, Starkweather}} = 1733 \text{ L/kg}$

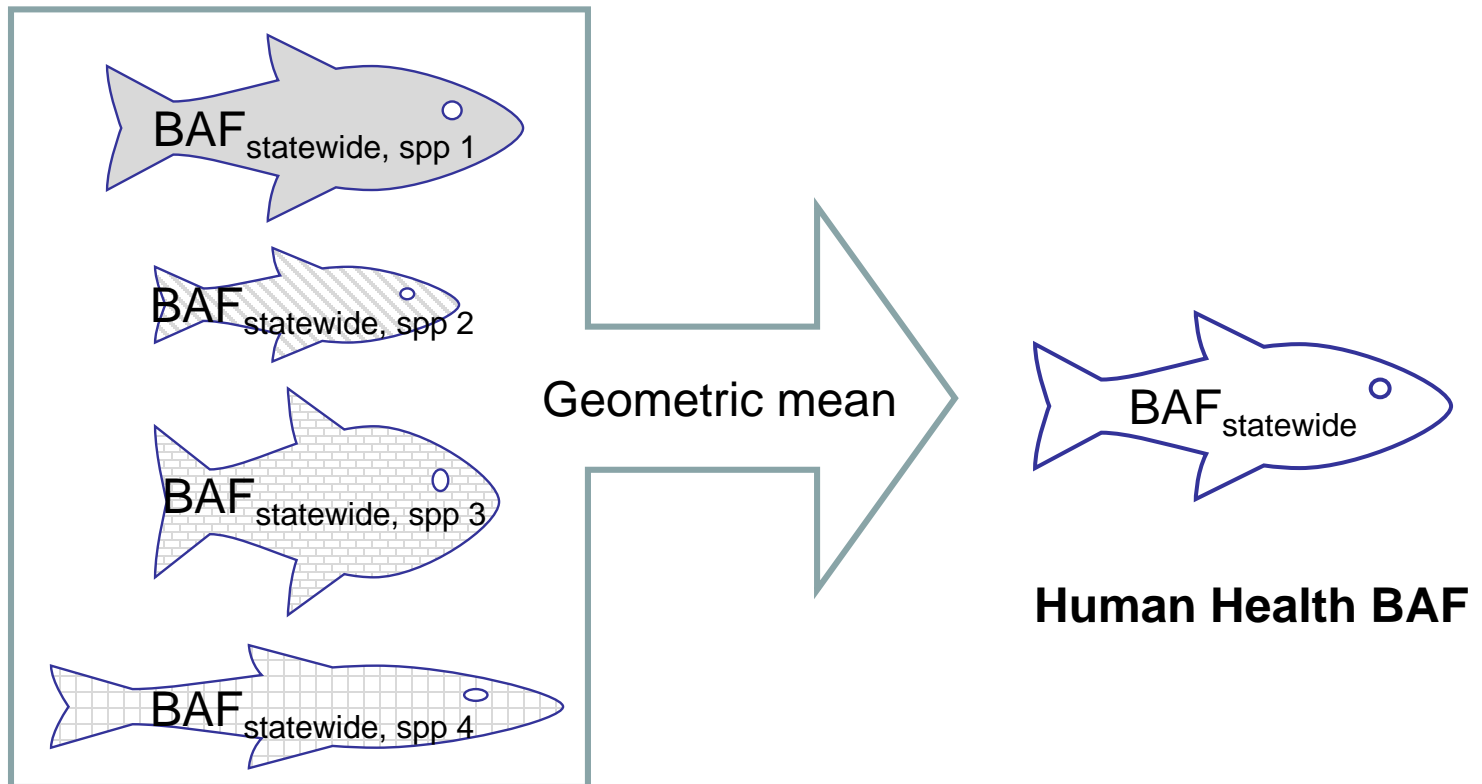
# How are bioaccumulation factors calculated?

Calculate the statewide BAF for each species (from all waterbodies)



# How are bioaccumulation factors calculated?

Calculate the statewide BAF (all species from all waterbodies)







# Today's presentation

- What is bioaccumulation?
- What does NR105 say about BAFs?
- How is are BAFs calculated?
- **What BAF data is available for PFOS and PFOA?**
- Likely range of PFOS and PFOA surface WQC to protect human health



# Data availability: PFOS

<b>Location</b>	<b>Years</b>	<b># Waters</b>	<b># Species</b>
Wisconsin	2019-20	2*	7*
Minnesota	2006-18	27	12
Michigan	2010-13	8	6
Ontario, Canada	2009-12	1	10

\*additional data forthcoming

**Great Lakes basin BAF** **Midwest BAF**

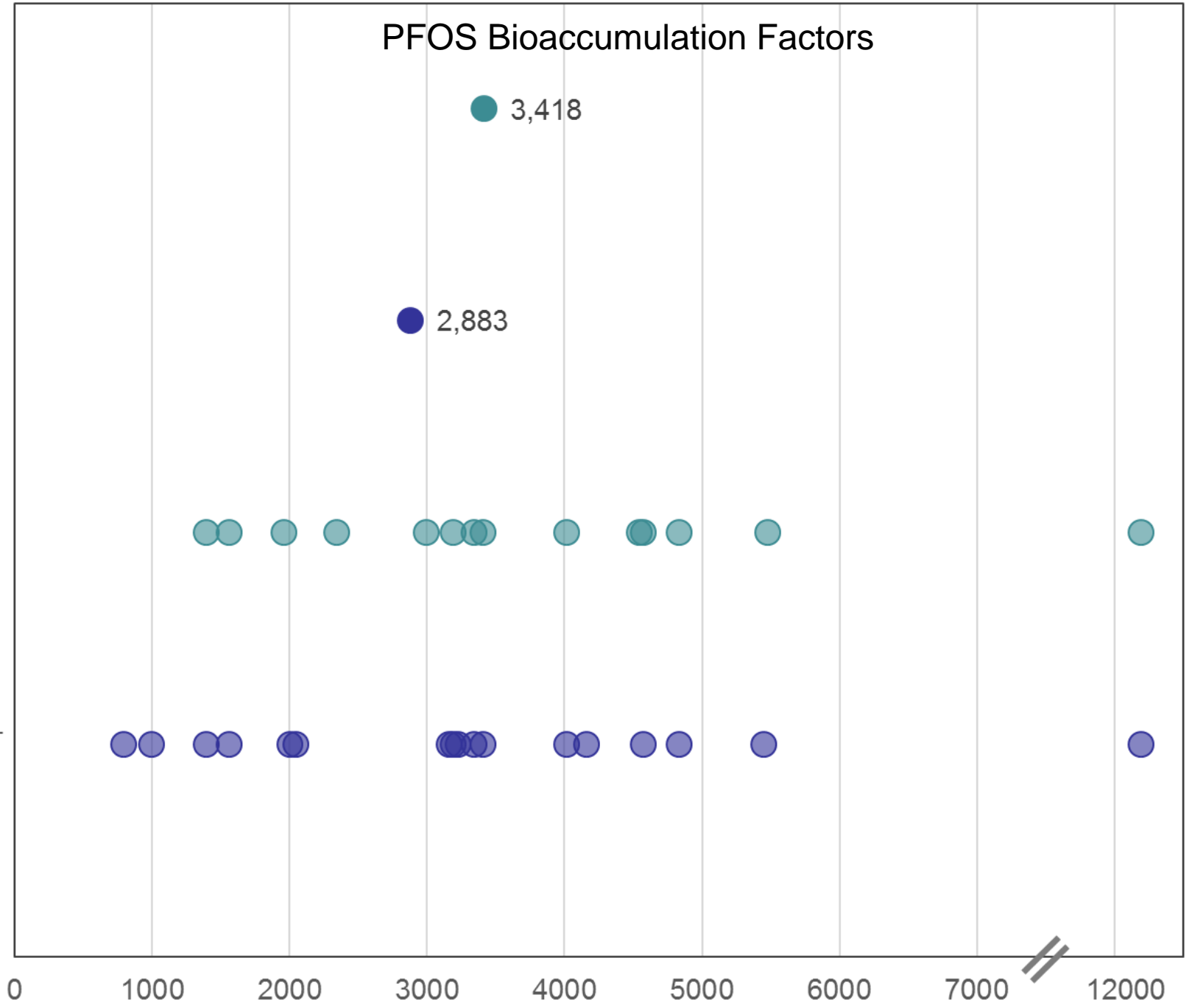
# PFOS Bioaccumulation Factors

● Midwest BAF

● GL Basin BAF

● Midwest - species BAFs

● GL Basin - species BAFs





# Data availability: PFOA

<b>Location</b>	<b>Years</b>	<b># Waters</b>	<b># Species</b>
Wisconsin	2019-20	1*	4*
Minnesota	2006-16	4	7
Ontario, Canada	2009-12	1	10

\*additional data forthcoming

**Great Lakes basin BAF** **Midwest BAF**

# PFOA Bioaccumulation Factors

● Midwest BAF

● GL Basin BAF

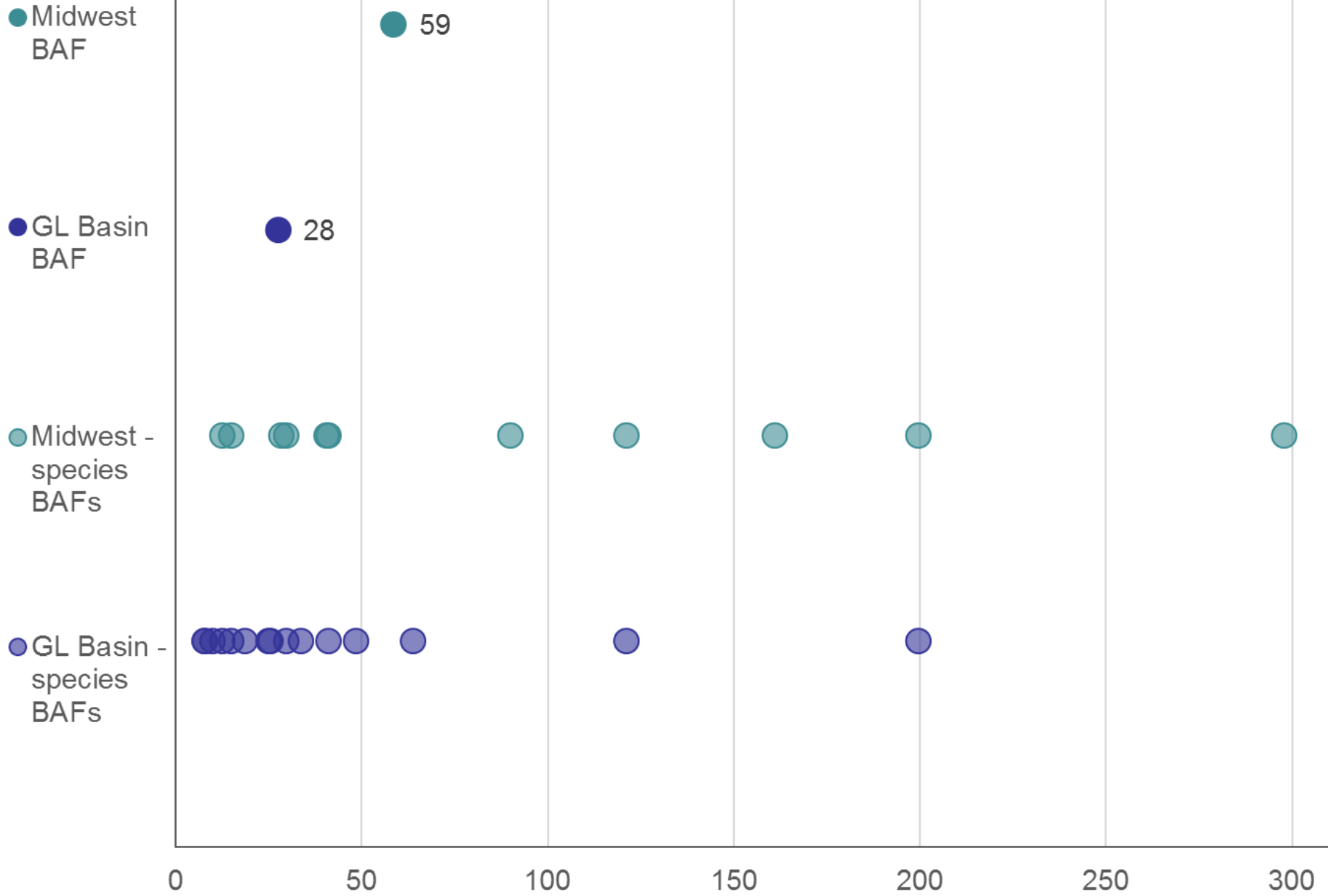
● Midwest - species BAFs

● GL Basin - species BAFs

0 50 100 150 200 250 300

59

28





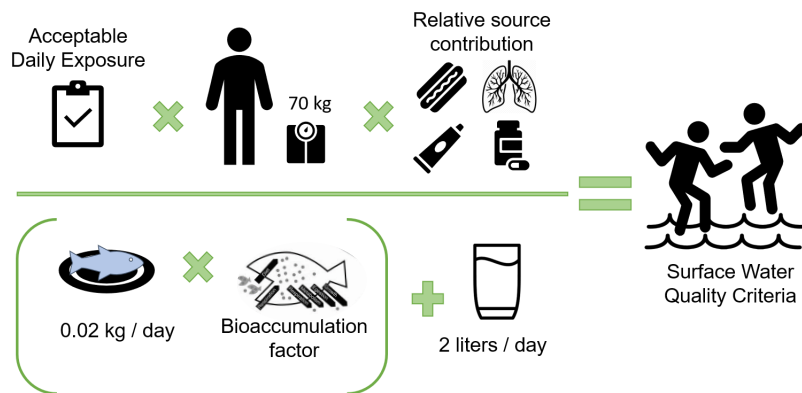
# Today's presentation

- What is bioaccumulation?
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- How is are BAFs calculated?
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- **Likely range of PFOS and PFOA surface WQC to protect human health**

# Derivation of PFOS Surface WQC

GL Basin BAF: 
$$\frac{(2 \times 10^{-6}) \times 70 \times 0.8}{(0.02 \times 2883) + 2} = 1.88 \text{ ng/L}$$

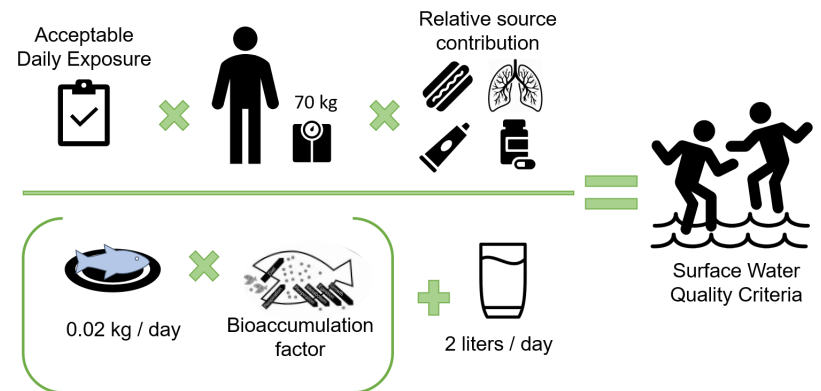
Midwest BAF: 
$$\frac{(2 \times 10^{-6}) \times 70 \times 0.8}{(0.02 \times 3418) + 2} = 1.59 \text{ ng/L}$$



# Derivation of PFOA Surface WQC

GL Basin BAF: 
$$\frac{(2 \times 10^{-6}) \times 70 \times 0.8}{(0.02 \times 28) + 2} = 43.8 \text{ ng/L}$$

Midwest BAF: 
$$\frac{(2 \times 10^{-6}) \times 70 \times 0.8}{(0.02 \times 59) + 2} = 35.2 \text{ ng/L}$$





# Likely range of surface WQC to protect Human Health

PFOS:  $\leq 2$  ng/L

PFOA: 35 – 45 ng/L





# Next steps

Spring-Fall 2020

Stakeholder input and feedback

Stakeholder group meetings focusing  
on NR106 implementation

Winter 2020-21

Economic Impact Analysis



# Questions?

Meghan Williams

Environmental Toxicologist

Water Quality Bureau

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