Bioaccumulation Factors

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

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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

Acceptable Daily Exposure

Relative source contribution

0.02 kg / day

Bioaccumulation factor

2 liters / day

Surface Water Quality 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
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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Water Quality Criteria documents, published scientific literature, reports issued by EPA or other reliable sources, or unpublished data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.
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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.

\[
\text{ng/g (ppb)} \times 1000 = \text{BAF (L/kg)}
\]
How are bioaccumulation factors calculated?

Calculate BAFs for each species from each waterbody: Example

\[
\text{BAF_{LMB,Starkweather}} = \frac{92.3 \text{ ppb} \times 1000}{53.3 \text{ ppt}} = 1732.7 \text{ L/kg}
\]
How are bioaccumulation factors calculated?

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

$$\text{BAF}_{\text{waterbody A}}$$
$$\text{BAF}_{\text{waterbody B}}$$
$$\text{BAF}_{\text{waterbody C}}$$
$$\text{BAF}_{\text{waterbody D}}$$

Geometric mean

$$\text{BAF}_{\text{statewide, spp 1}}$$

Species mean BAF
How are bioaccumulation factors calculated?

Calculate the statewide BAF (all species from all waterbodies)

\[
\text{BAF}_{\text{statewide}} = \text{Geometric mean of } \text{BAF}_{\text{statewide, spp 1}}, \text{BAF}_{\text{statewide, spp 2}}, \text{BAF}_{\text{statewide, spp 3}}, \text{BAF}_{\text{statewide, spp 4}}
\]

Human Health BAF
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## Data availability: PFOS

<table>
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<th>Location</th>
<th>Years</th>
<th># Waters</th>
<th># Species</th>
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*additional data forthcoming

Great Lakes basin BAF  Midwest BAF
Data availability: PFOA

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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: ≤ 2 ng/L

PFOA: 35 – 45 ng/L

Photo credits: Flickr users ktgeek, lesterpubliclibrary; https://www.kitchenfrau.com/wp-content/uploads/2015/03/IMG_1394a-fish-sticks-682x1024.jpg
Next steps

Spring-Fall 2020
Stakeholder input and feedback

Stakeholder group meetings focusing on NR106 implementation

Winter 2020-21
Economic Impact Analysis
Questions?

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