The Human Health Criteria Formula

Presentation #2: Risk, Exposure, and Uncertainty in HHC Formula

Alaska Department of Environmental Conservation
Division of Water- Water Quality Standards
Brock Tabor
October 29-30, 2015

How are HHC derived?

- The HHC formula determines the degree of risk to humans from exposure to certain pollutants

  - Risk = Toxicity * Exposure * Uncertainty

-Science provides us with basic information

-Policy tells us how to apply that information

-Risk Management is a matter of publicly weighing options and making a decision

Input Variables (2015 recommended)

BW = Human Body Weight (adult = 80 kg = 176 lbs

DI = Drinking Water Rate (2.4 liters/day)

CSF = Cancer Slope Factor (mg/Kg-day) AKA (RSD)

FCR = Fish Intake Rate (? grams/day)

BCF/BAF = Bioconcentration v. bioaccumulation factor (L/Kg, chemical specific

RfD = Reference Dose, Non-Carcinogens (mg/Kg-day)

RL = Risk Level (10^{-5}) in Alaska

RSC = Relative Source Contribution

	Freshwater Criteria (Consumption of Organisms **and** Water)	Marine Criteria (Consumption of Organisms **Only**)
Criteria for Carcinogens	$\dfrac{RL \times BW}{CSF \times [(FCR \times BCF) + DI]}$	$\dfrac{RL \times BW}{CSF \times FCR \times BCF}$
Criteria for Non-Carcinogens	$\dfrac{RfD \times RSC \times BW}{(FCR \times BCF) + DI}$	$\dfrac{RfD \times RSC \times BW}{FCR \times BCF}$

Slide Images and Inspiration courtesy of Washington Ecology

HHC Formula- Carcinogens

Freshwater Criteria (Consumption of Organisms **and** Water)

Marine Criteria (Consumption of Organisms **Only**)
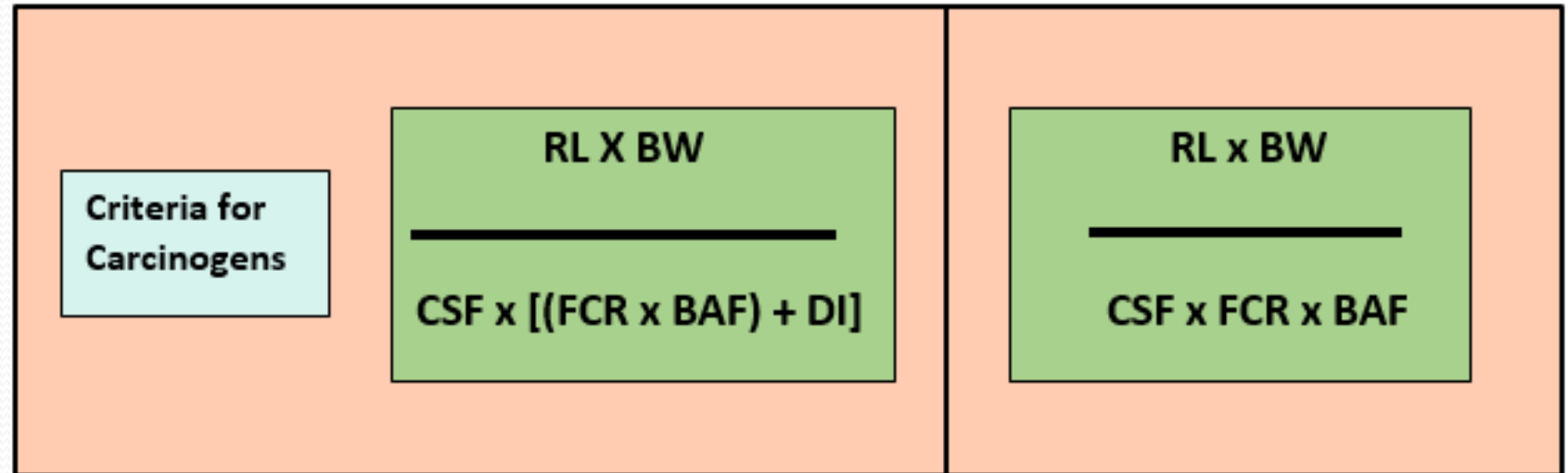
RL: Risk Level (10^{-5})

BW: Body Weight

CSF: Cancer Slope Factor

FCR: Fish Consumption Rate

BAF: Bioaccumulation

DI: Drinking Water Intake

Criteria for Carcinogens

$$\frac{RL \times BW}{CSF \times [(FCR \times BAF) + DI]}$$

$$\frac{RL \times BW}{CSF \times FCR \times BAF}$$

HHC Formula- Non Carcinogens

RfD: Reference Dose (mg/Kg-day)

RSC: Relative Source Contribution

BW: Body Weight

FCR: Fish Consumption Rate

BAF: Bioaccumulation

DI: Drinking Water Intake

Freshwater Criteria
(Consumption of Organisms
and Water)

Marine Criteria
(Consumption of
Organisms **Only**)

Criteria for Non - Carcinogens

$$\frac{RfD \times RSC \times BW}{(FCR \times BAF) + DI}$$

$$\frac{RfD \times RSC \times BW}{FCR \times BAF}$$

Toxicity: Reference Dose (Non-carc)

- RfD/CSF is a toxicity value derived by EPA and published in the IRIS catalogue.

  - **Uncertainty is accounted for in the RfD/CSF.**
  - Typically has a safety factor of 10-1000 is built into the value to account for intra-species and differences between animals and humans.
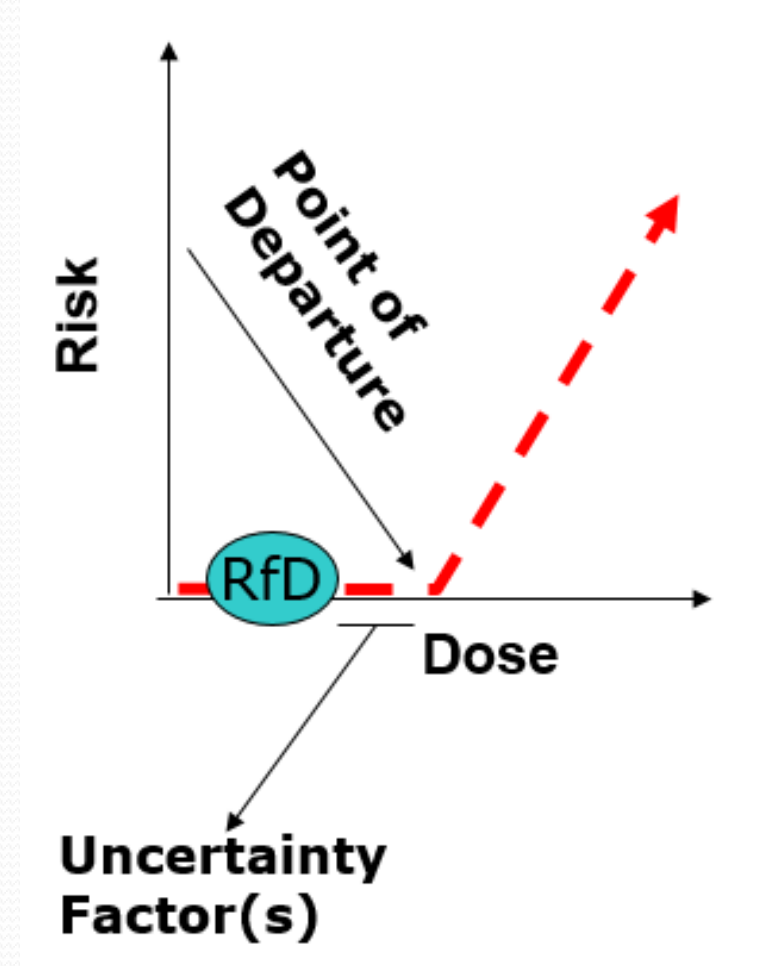

Image: Oregon DEQ

Toxicity: Cancer Slope Factor

- CSF is a toxicity value derived by EPA and published in the IRIS catalogue.
  - Doesn't consider a toxicity threshold or point of departure
  - CSF accounts for uncertainty
    - Typically has a safety factor of 10-1000 is built into the value to account for intra-species and differences between animals and humans.

Uncertainty is factored into the slope

Risk

CSF

Dose
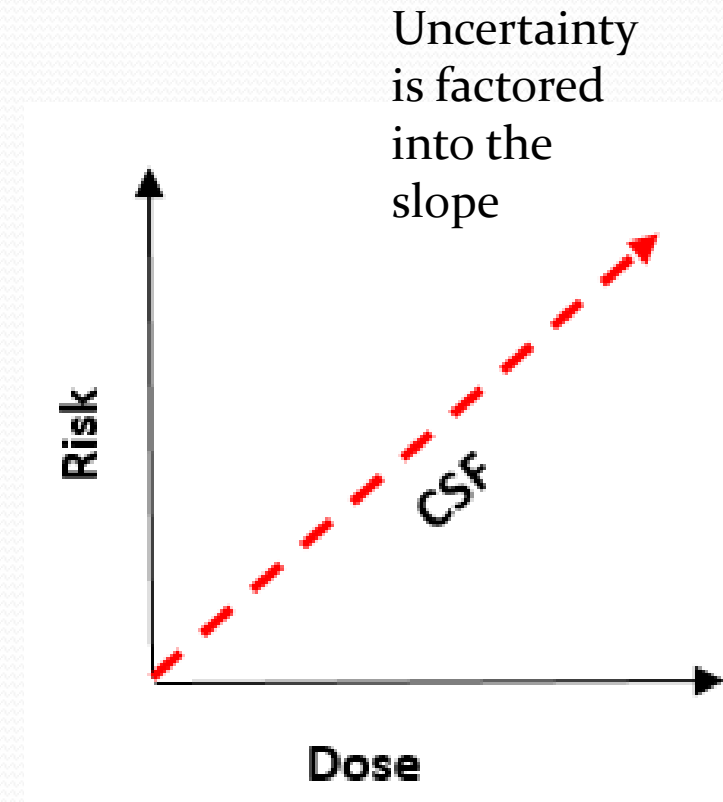
Exposure

- Exposure = contact between an agent and the visible exterior of a person

    (Exposure (magnitude, frequency, duration) / Time)

- HHC Exposure Factors
  - BI= Body weight (fixed at 70 kg (80kg)) (176 lbs)
  - DI= Drinking water intake (fixed 2 liters (2.4 L))(2.5 quarts)
  - FCR = Fish Consumption (varies per state)
  - BAF= Bioaccumulation Factor (varies by trophic level but fixed at specific values)

Exposure: Body Weight
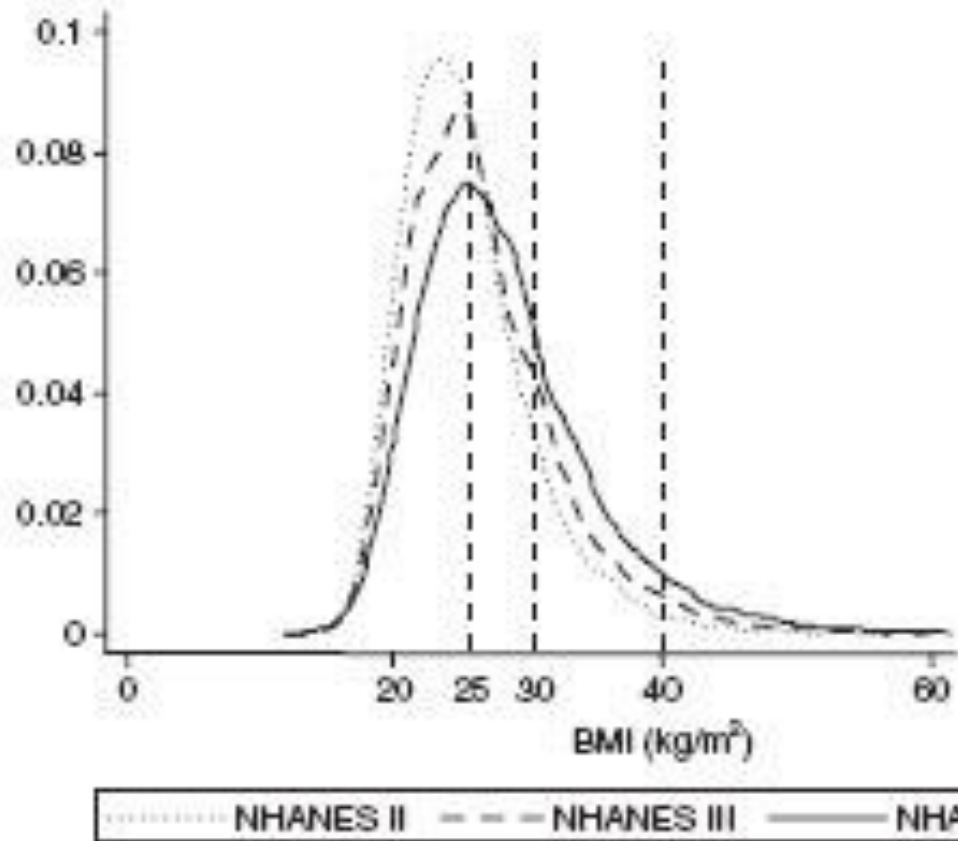
- Bodyweight is based on a fixed EPA-recommended value

- Updated 2015 = 80 kg (176 lbs)

- Update based on NHANES (1999-2006) data

Exposure: Drinking Water Intake

- Drinking Water is based on fixed EPA-recommended value.

- 2000: 2 liters per day. Inc. all sources of water (e.g., drinking water, coffee, other beverages/food derived water)

- 2015: Settled on 2.4 liters per day. Consistent with 2011 EPA Exposure Handbook values

Exposure: Fish Consumption Rate/Range (FCR)

- Per EPA: States/Tribes should consider developing criteria that uses the best local data available that is representative of their target population group(s)

- Geographic/demographic differences are anticipated therefore EPA developed a preference hierarchy:
  - EPA default intake rates (22 g/d for general /142.4 g/d for subsistence)
  - Data from national surveys (NHANES or other)
  - Data reflecting similar geography/population groups (Region 10 states (175))
  - **Local Data** (Alaska-specific)

FCR Preference Hierarchy, Cont.

- **Use of Local or Regional Data**
  - Use local data for freshwater/estuarine species
  - Use of uncooked weight intake values
  - Use high-end values (90th or 95th percentile) **or** average values for high consuming fish population (if using mean, should base on consumers only).

- Fairly common practice for states to develop HHC values based on local data (ME, NY, MN, WI, OR, WA (Regional approach), ID (in progress))

HHC: Population of interest: General or subset?

The fish consumption rate (FCR) in the HHC should reflect the rate of consumption by the population of concern
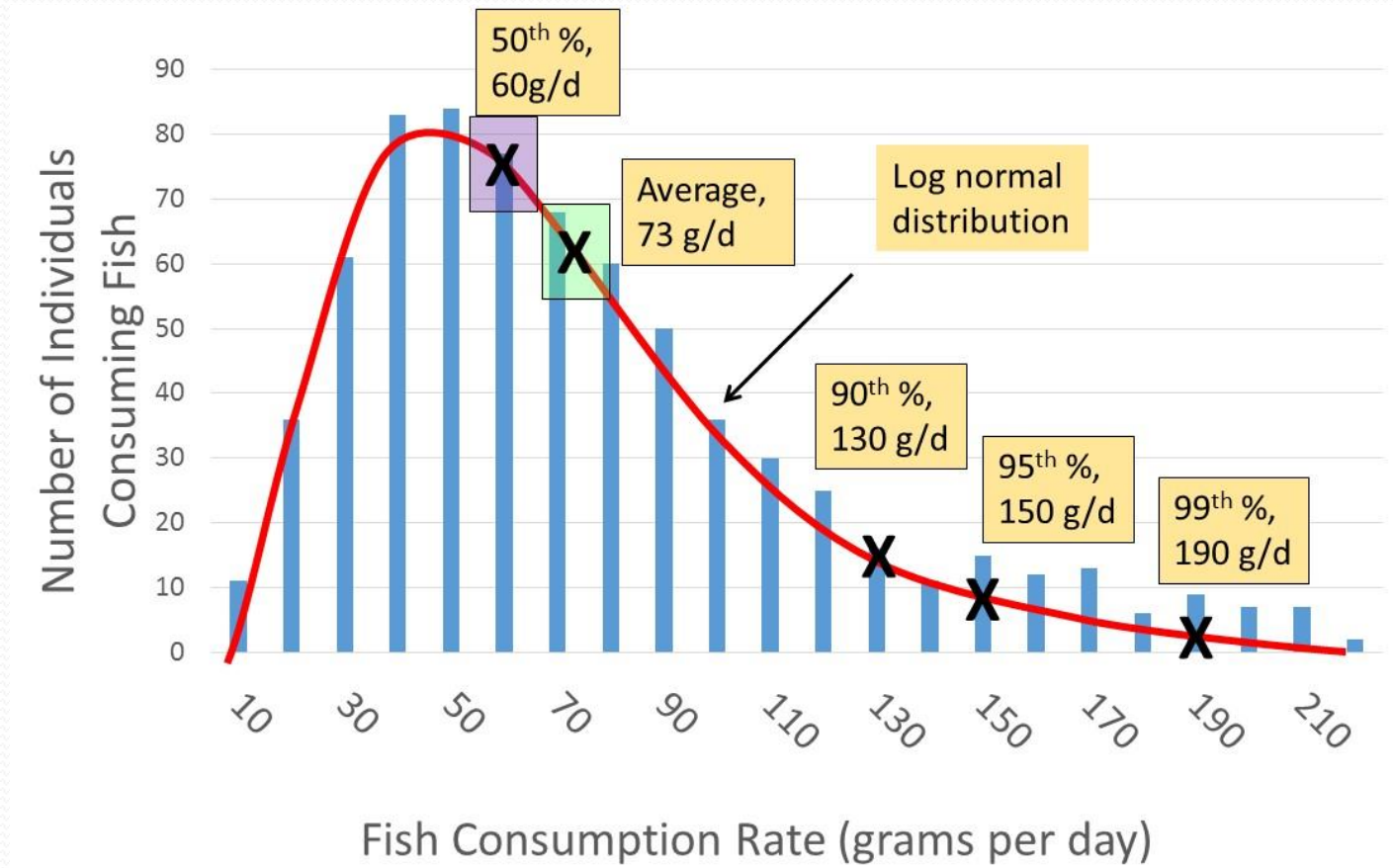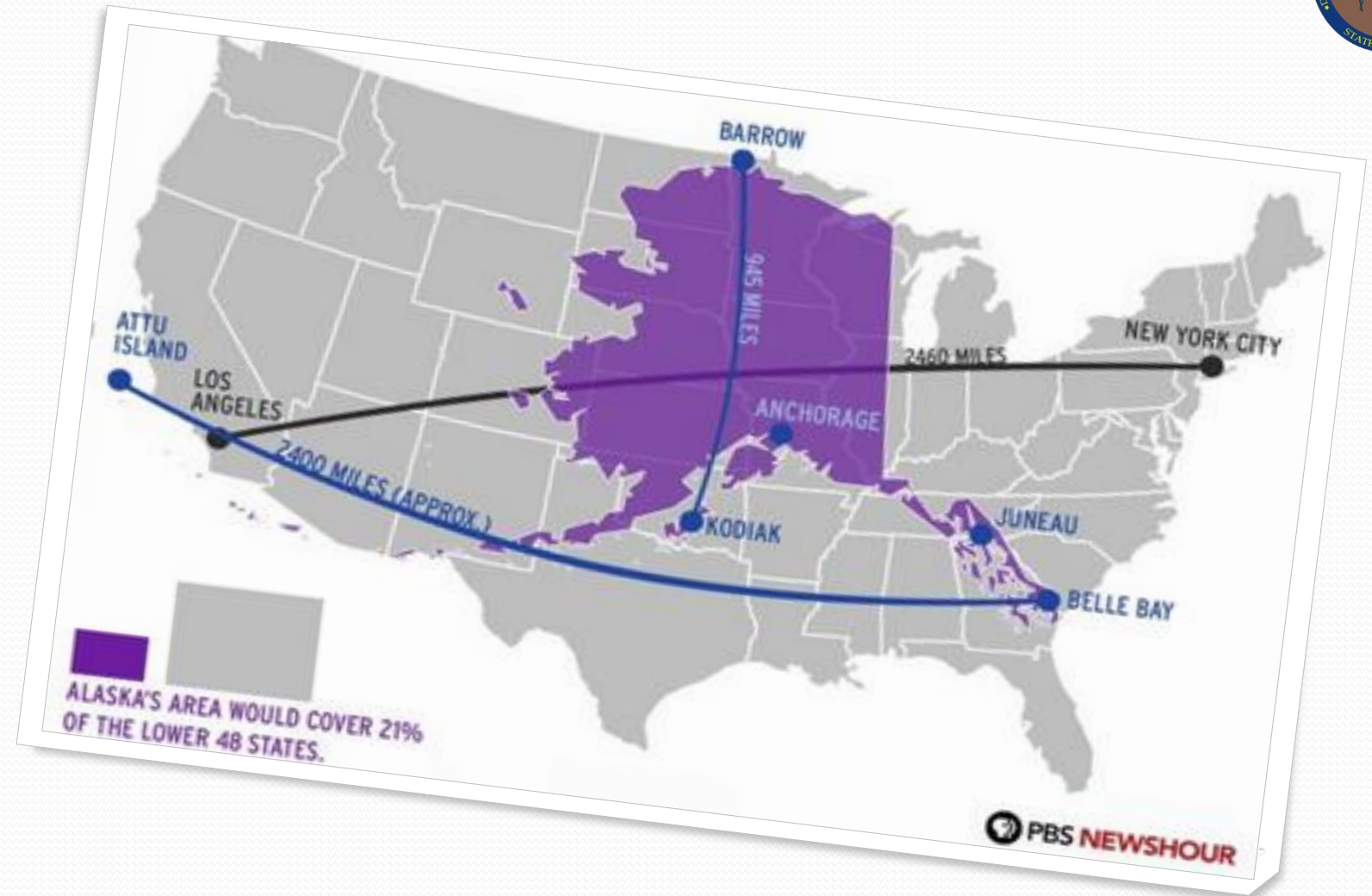
(Mean, 90th, 95th, 99th)

Image provided by EPA-R10

Alaska has regional differences

There may be obvious differences in the amount, species, and frequency of fish consumed depending on where you live (think Georgia v. California)
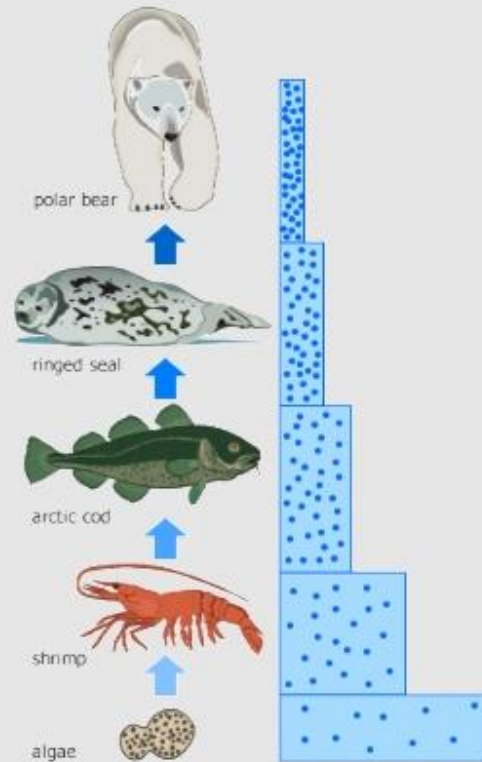
NOTE: This image doesn't capture the differences that may exist when comparing rural and urban locations.

Exposure: Bioaccumulation Factor (BAF)

biomagnification and bioaccumulation

polar bear
ringed seal
arctic cod
shrimp
algae

Sanctuary

- BAF = exposure to a pollutant through diet, water contact, and trophic position (where in the food chain)

- BAF can range from 1- 1000's for highly bioaccumulative compounds (e.g., PCBs)

  - Low bioaccumulation = ⬆ exposure from drinking water
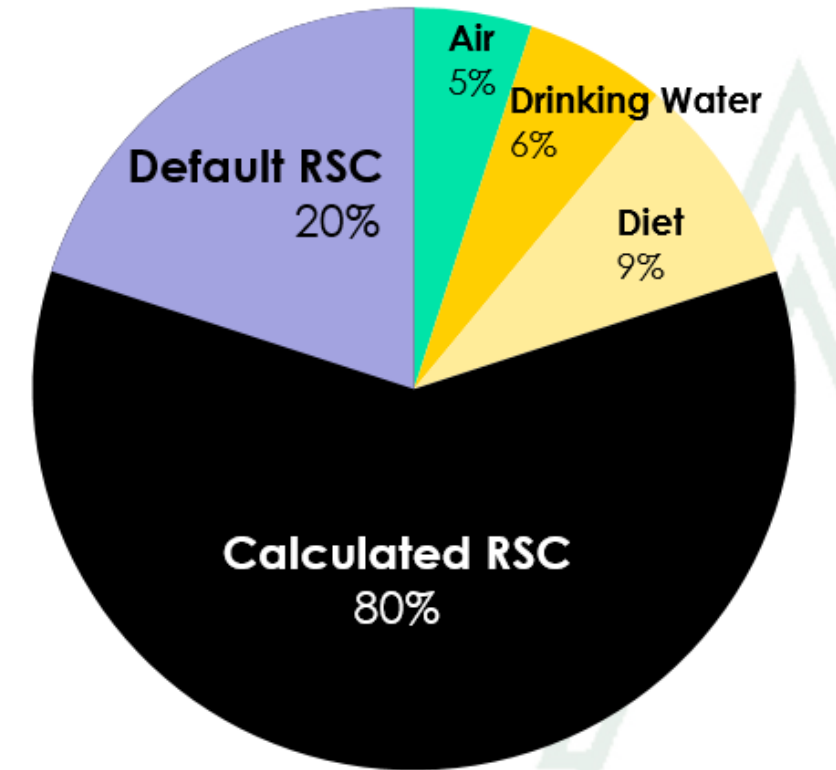 - High bioaccumulation = ⬆ exposure from eating fish

EPA currently recommends adoption of a BAF based on trophic level (2-4)

Uncertainty: Relative Source Contribution (non-carcinogens)

- Meant to account for non-water sources of exposure to **non**-carcinogens

- Estimates total amount of exposure from water and FC and potential exposure to other sources (e.g., air, food)


Air 5%
Drinking Water 6%
Diet 9%
Default RSC 20%
Calculated RSC 80%

The pie chart represents 100% of the allowable daily dose (i.e., Reference Dose)

Uncertainty: Relative Source Contribution (non-carcinogens)

- 2015: EPA Default value of 0.20 in most cases- the lower the value, the more is attributed to other sources. Can be adjusted up to 0.80 max.

- Lowering of HHC provides additional room for other sources-but not their regulation.

Air 5%

Drinking Water 6%

Default RSC 20%

Diet 9%

Calculated RSC 80%
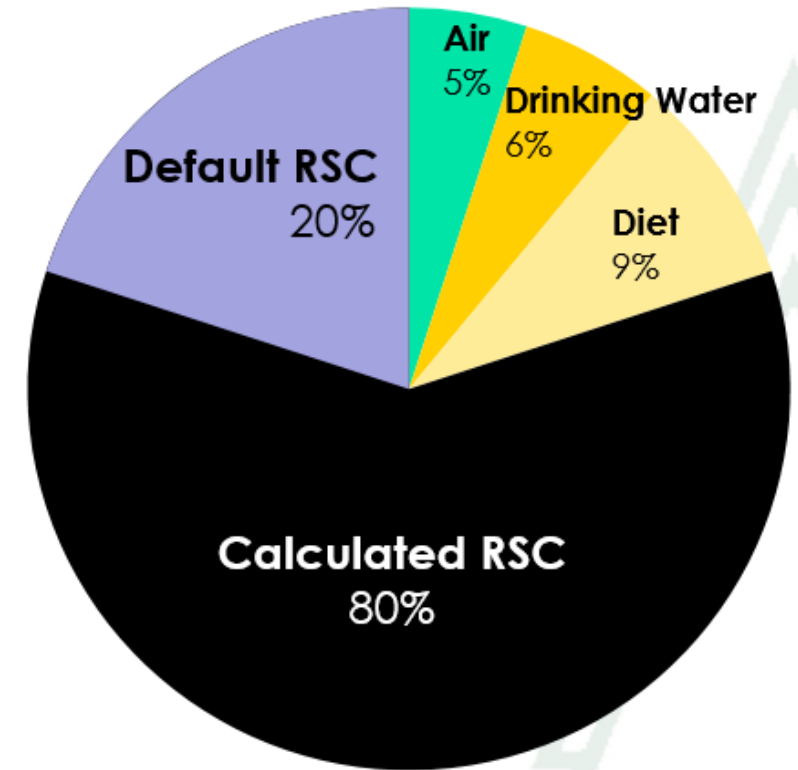
The pie chart represents 100% of the allowable daily dose (i.e., Reference Dose)

Uncertainty: Suppression?

- Suppressed FCR can be attributed to contamination (i.e., polluted water/fish) and/or depletion (lower population)

- EPA *HHC Frequently Asked Questions* (2013)*:* "It is also important to avoid any suppression effect that may occur when a fish consumption rate for a given subpopulation reflects an artificially diminished level of consumption from an appropriate baseline level of consumption for that subpopulation because of a perception that fish are contaminated with pollutants."

- Additional guidance appears to be forthcoming...

Recap: HHC is a **formula** with numerous factors to consider

	Freshwater Criteria (Consumption of Organisms **and** Water)	Marine Criteria (Consumption of Organisms **Only**)
Criteria for Carcinogens	$$\dfrac{RL \times BW}{CSF \times [(FCR \times BCF) + DI]}$$	$$\dfrac{RL \times BW}{CSF \times FCR \times BCF}$$
Criteria for Non-Carcinogens	$$\dfrac{RfD \times RSC \times BW}{(FCR \times BCF) + DI}$$	$$\dfrac{RfD \times RSC \times BW}{FCR \times BCF}$$

Input Variables

BW = Human Body Weight

DI = Drinking Water Rate

CSF = Cancer Slope Factor

FCR = Fish Intake Rate

BCF/BAF = Bioconcentration v. bioaccumulation

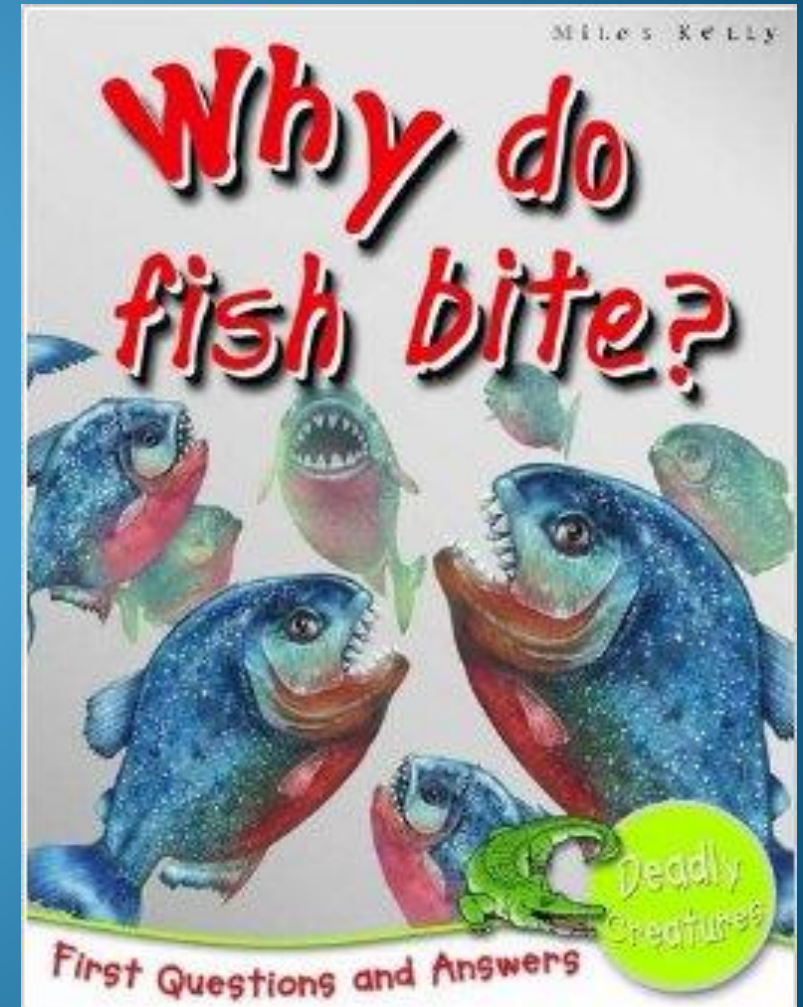**RfD =** Reference Dose, Non-Carcinogens (mg/Kg-day)

RL = Risk Level

RSC = Relative Source Contribution

Questions?
Thank you for your time!

Brock Tabor
Environmental Program Specialist
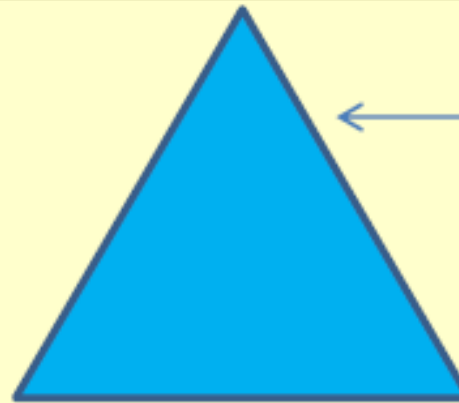(907) 465-5185
brock.tabor@alaska.gov

"Less -protective" decision-bucket

"More protective" decision-bucket

Criteria inputs and risk management decisions that result in **lesser** levels of protection

"Reasonable" level of protection

Criteria inputs and risk management decisions that result in **greater** levels of protection

This teeter-totter represents the balancing point between "over-protection" and "under-protection."

"Under-protection"

"Over-protection"