



# Evaluating Tribal Dietary, Lifestyle, and Ceremonial Exposures for use in EPA Superfund Risk Assessments

Research and presentation by Isabel Alexander



# About the Project



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This work expands on a project completed last year by US EPA Intern Grace Maley. Grace researched plants and animals found in Native American diets to increase the scope and inclusivity of EPA risk assessments. The goal of this project is to incorporate even more dietary factors, as well as consider tribal lifestyle and ceremonial exposures.

## EPA Contacts

Stuart Walker – Office of Superfund Remediation and Technology Innovation  
Michele Burgess – Office of Superfund Remediation and Technology Innovation  
Jon Richards – Region 4

# Previous Work by Grace Maley (2019-2020)

- Study basis: Manning et al. 2016
  - Updated risk assessment modeling for consumed plant and animal products
  - Land and water contaminants
- Additions made last year
  - Focus on products consumed by Native Americans
  - 30 new produce items
  - 20 new animal products

ORNL/TM-2016/328

**Biota Modeling in EPA's Preliminary Remediation Goal and Dose Compliance Concentration Calculators for Use in EPA Superfund Risk Assessment: Explanation of Intake Rate Derivation, Transfer Factor Compilation, and Mass Loading Factor Sources**



Approved for public release.  
Distribution is unlimited.

Karessa L. Manning  
Fredrick G. Dolislager  
Michael B. Bellamy

November 2016

## 2019-2020 Sources for Produce Additions

- Environment International Ltd. For the Confederated Tribes of the Colville Reservation (2012)
- Harper and Ranco in conjunction with five federally recognized Tribal Nations in Maine for the EPA (2009)
- New York State Energy and Development Administration (NYSERDA) (2015)
- CB&I Federal Services LLC for the EPA (2017)
- Harper (2008) for the Quapaw Tribe in Oklahoma
- Harper (2006) for the Elem Pomo Tribe at Clear Lake, CA
- Integral Consulting Inc. (2007) for International Paper at a St. Regis Paper company site
- Garvin et al. (2015) of Tribal Environmental Management Services LLC for the Six Treaty Tribes of Oklahoma

# 2019-2020 Produce Additions

## **Roots**

- Root vegetables
- Indian carrot
- Leek
- Wild potato vine
- Wild onion

## **Fruits**

- Oregon Grape
- Chokecherries
- Plantain
- Pawpaw
- Mayapple

## **Other Vegetables**

- Beans
- Buckbrush
- Cattail shoot
- Peas
- Squash
- River birch
- Wild rose

## **Greens**

- Leafy Greens
- Herbaceous flowering plants
- Wild lettuce
- Lichen

- Buckbrush
- Wild mint
- Sage

## **Seeds and Nuts**

- Tree Nuts
- Acorns
- Sunflower
- Chia seeds
- Wild rice

## **Other**

- Wild mushroom

## 2019-2020 Sources for Animal Product Additions

- Various reports by Harper et al. for the Spokane Tribal Cultural Resources Program (2002), the Washoe Tribe of Nevada and California (2005), Elem Pomo Tribe at Clear Lake, CA (2006), the Quapaw Tribe in Oklahoma (2008), and the Tribal Nations in Maine (2009)
- Integral Consulting Inc. (2007) for International Paper at a St. Regis Paper company site
- Environment International Ltd. For the Confederated Tribes of the Colville Reservation (2012)
- Garvin et al. (2015) of Tribal Environmental Management Services LLC for the Six Treaty Tribes of Oklahoma
- New York State Energy and Development Administration (NYSERDA) (2015)
- Polissar et al. (2016) for the EPA, Nez Perce Tribe and Shoshone-Bannock Tribe
- CB&I Federal Services LLC for the EPA (2017)

# 2019-2020 Animal Product Additions

## **Aquatic Biota**

- Freshwater fish
- Marine fish
- Invertebrates
- Mollusk
- Reptiles

## **Large Herbivorous Mammals**

- Deer
- Moose
- Elk
- Caribou

- Horse
- Big horn sheep

## **Small Mammals**

- Rabbit
- Squirrel
- Beaver
- Muskrat

## **Large Mammals**

- Bear
- Wild cats

## **Birds**

- Duck eggs
- Turkey
- Duck
- Quail
- Pheasant

# 2020-2021 Produce Additions

## **Seeds and Nuts**

- Bedstraw
- Tarweed
- Wild cucumber
- Tule
- Bay
- Hazelnut
- Butternuts

## **Fruits and Berries**

- Manzanita
- Strawberry
- Gooseberry (Sierra)
- Thimbleberry
- Toyon

- Salmonberry
- Salal
- Currant (Desert and golden varieties)
- Western chokecherry
- Buckberry
- Saskatoon serviceberry
- Sierra Plum

## **Vegetables and Greens**

- Clover
- Angelica
- Anise
- Poppy
- Fiddlehead

- Fescue grasses
- Tule shoots
- Squash
- Leeks
- Dandelion greens
- Miner's lettuce
- Watercress
- Nettle
- Rose hips
- Seaweeds

## **Bulbs and Roots**

- Watercress
- Sego lily
- Camas

- Bitterroot
- Wild lilies
- Tule
- Chicory root
- Burdock root

## **Other**

- Maple syrup



# 2020-2021 Animal Product Additions

## **Fish Species**

- Anadromous fish (e.g. salmon)
- Resident fish
- Sockeye salmon
- Trout (Lake, Rainbow, & Brook)
- Minnow
- Shad
- Herring
- Pollock
- Eel
- Walleye
- Northern Pike
- Whitefish
- Tullibee
- Perch
- Panfish
- White Sucker

## **Shellfish Species**

- Crawfish
- Lobster
- Bay mussels
- Dungeness crab
- Japanese oysters
- Clams
  - Macoma
  - Native littleneck
  - Butter
  - Manila
  - Horse
  - Eastern softshell

## **Other**

- Honey
- Squirrel (Marmot and ground species)
- Buffalo
- Moose (muscle and liver)
- Deer liver
- Snail
- Seal
- Whale (Gray, Humpback, and Beluga species)
- Turtle (Snapper, muscle and liver)
- Grouse

## Harper et al. (2002) for the Spokane Tribe

### High Fish Diet Consumption Estimates

Food	Quantity (g/day)
<b>Fish (sockeye and mixed trout)</b>	885
<b>Big game</b>	100
<b>Local small game, fowl</b>	50
<b>Aquatic foods</b>	175
<b>Vegetal calories</b>	1600
<b>Dairy (children only)</b>	0.5 L/day milk

### High Game Diet Consumption Estimates

Food	Quantity (g/day)
<b>Big game</b>	885
<b>Fish</b>	75
<b>Local small game, fowl</b>	50 (25 birds and 25 rabbits)
<b>Aquatic foods</b>	175
<b>Vegetal calories</b>	1600
<b>Dairy (children only)</b>	0.5 L/day milk

Other sources of exposure: burning contaminated firewood to heat houses, plants used in herbal tea, plants used in sweat lodges, smudging ceremonies, medicinal uses of plants, other ceremonial exposures.

# Harper et al. (2007) for the Elem (Pomo) Tribe

## Seeds

- Acorns
- Chia
- Bedstraw\*
- Tarweed\*
- Wild cucumber\*
- Tule\*
- Bay\*
- Fescue grasses\*
- Helianthae (sunflower)

## Berries

- Manzanita\*
- Strawberry
- Gooseberry\*
- Raspberry
- Thimbleberry\*
- Blackberry
- Elderberry
- Toyon\*
- Salmonberry\*
- Salal \*
- Currant

## Greens

- Clover\*
- Angelica\*
- Anise\*
- Poppy\*
- Fiddlehead\*
- Tule shoots\*
- Raw chicory root\*
- Leeks\*
- Raw dandelion greens\*

Food Category	Percent of Total Calories
<b>Acorns</b>	30
<b>Fish</b>	20
<b>Game (large, small, fowl)</b>	15
<b>Roots, tubers, rhizomes, corms</b>	10
<b>Bulbs</b>	5
<b>Seeds</b>	5
<b>Fruits, berries</b>	5
<b>Greens, shoots</b>	5
<b>Teas, medicines, sweeteners</b>	5

\* Denotes additions or additional species specificity

## Harper et al. (2007) for the Elem (Pomo) Tribe

Resource	% of 2000 kcal	Kcal per 100g (representative species)	Daily Amount (grams/day)
Acorns	30	Dried acorns and acorn flour: 500	120
Fish	20	Mixed trout, cooked: 190	200
Game (large and small; waterfowl)	15	Deer, roasted: 158; Rabbit, wild, roasted: 173; Quail, cooked: 234	200
Roots, tubers rhizomes, corms	10	Raw chicory root: 73; potato: 93	250
Bulbs	5	Leek, onions, and bulbs: 31	20
Seeds, pinole, atole	5	Raw, dried sunflower seeds: 570; sesame seed flower: 526	20
Fruits and berries	5	Raw elderberries: 73	140
Greens, shoots	5	Raw dandelion greens: 45	333
Teas, medicines, sweeteners	5	Honey: 304	36

# Harper et al. (2007) for the Washoe Tribe

## Bulbs and Roots

- Wild onions
- Watercress
- Segoly lily\*
- Camas\*
- Bitterroot\*
- Wild lilies\*
- Wild potatoes
- Cattail
- Tule\*

## Berries

- Western chokecherry\*
- Elderberry
- Buckberry\*
- Saskatoon serviceberry\*
- Desert and golden currants\*
- Wild strawberry
- Sierra plum\*
- Sierra gooseberry\*

## Other

- Miner's lettuce\*
- Watercress\*
- Nettle\*
- Mushrooms
- Honey\*
- Marmot or ground squirrel\*
- Crawfish\*
- Snail\*
- Mussels\*
- Minnow fish\*
- Trout\*

Food Category	Percent of total calories
Pine nuts	20
Fish and shellfish	15
Game	15
Roots, bulbs, tubers, rhizomes	15
Greens	10
Berries	10
Seeds	10
Honey, rose hips, medicines, teas	5 (combined)

\* Denotes additions or additional species specificity

## Harper et al. (2007) for the Washoe Tribe

Resource	% of 2000 kcal	Kcal per 100g (representative species)	Daily quantity estimate (grams/day)
Pine nuts	20	630	80
Fish	15	Mixed trout, cooked: 190	200
Roots, tubers rhizomes, bulbs	15	Raw chicory root: 73; potato: 93; Bitterroot, fresh: 90; camas bulb, fresh: 113; leek, onions and bulbs: 31	600 (300 bulbs; 300 of other categories combined)
Game and Fowl	15	Deer, roasted: 158; Rabbit, wild, roasted: 173; Quail, cooked: 234	220 (180 game and 40 fowl)
Berries	10	Raw elderberries: 73	333
Greens	10	Raw dandelion greens: 45; raw watercress: 11	833 (includes watercress, leaves, stems, shoots)
Seeds	10	Raw dried sunflower seeds: 570; sesame seed flour: 526	50
Honey, tea, sweeteners, misc.	5	Honey: 304	40

# Harper et al. (2007) for the Confederated Tribes of the Umatilla Indian Reservation

Food Category	Estimated percent of total calories	Daily amount (grams/day)	Notes
<b>Fish</b>	40	620	75% anadromous fish and 25% resident fish assumed; total does not include consumption of parts with higher lipid content
<b>Roots</b>	32	800	
<b>Greens</b>	12	300	Includes medicinal leaves, tea, stems, pith, and cambium; plants may contain contaminants transferred from roots and dust on leaves
<b>Game (including fowl)</b>	6	125	Does not include consumption of organs with higher contaminant concentration
<b>Berries and fruits</b>	5	125	
<b>Sweeteners, mushrooms, lichens</b>	5	125	General assumption of 1 kcal per gram used

# Fish Consumption

Fish Ingestion Rate	Derivation
6.5 g/day	EPA default; based on national food consumption surveys of the general non-tribal population
17.5 g/day	New EPA recommendation for general non-tribal population and recreational fishers
48.5 g/day	EPA and FDA recommendation for adults to eat two 6 oz meals per week
63.2 g/day	CRITFC (1994) average for current tribal fish consumers, excluding subsistence fishers
142.4 g/day	EPA proposed average rate for tribal subsistence fishers and 99 <sup>th</sup> percentile of the general, non-tribal population; based on water quality standards
389 g/day	CRITFC 99 <sup>th</sup> percentile of non-subsistence fish consumers
454 g/day	Anecdotal subsistence estimate
540 g/day	Harris and Harper (1997) based on averages for traditional CTUIR fishing families
620 g/day	Cited in the Boldt decision in reference to the Columbia Plateau Tribes
650 g/day	Walker (1999) based on Yakama tribe during the 1950s and 1960s
1000 g/day	Walker (1985) estimate of pre-dam rates for Columbia Plateau tribes

Source: Harper et al. (2007)



# Fish Consumption

<b>Survey</b>	<b>Mean finfish g/person/day</b>	<b>Mean shellfish g/person/day</b>	<b>Mean combined finfish and shellfish g/person/day</b>
Columbia River Inter-Tribal Fish Commission (CRITFC)	63.2	-	63.2
Suquamish	81.8	132.7	213.9
Toy-Tulalip/Squaxin	48.8	22.3	72.9

# Donatuto (2003) for the Swinomish Tribe

## Important Species\*

- Dungeness crab
- Japanese oysters
- Bay mussels
- Macoma clams
- Native littleneck clams
- Butter clams
- Manila clams
- Horse clams
- Eastern softshell clams

Stakeholder	Proposed Rates of Fish and Shellfish Consumption
<b>EPA default</b>	6.5 g/day fish or shellfish
<b>Washington State Model Toxic Control Act</b>	23 g/day fish or shellfish
<b>Proposed Ecology Rate (based on studies by tribal groups in 1999)</b>	177 g/day fish 68 g/day shellfish
<b>Study by the Suquamish Tribe</b>	More than double Ecology rates

\* Denotes additions or additional species specificity

# Harper (2017) for the Shoshone-Bannock Tribe

Food Category	Representative species and Kcal per 100g
Resident fish and other aquatic species	Mixed trout, cooked: 90; Wild crayfish, cooked: 82; Turtle, raw*: 89
Anadromous and marine fish and shellfish	Salmon, cooked*: 180; Shad, cooked*: 252; Herring, dry cooked*: 200; Pollock, dry cooked*: 118; Eel, dry cooked*: 236; Oyster, dry cooked*: 70; Clam, moist cooked*: 148; Lobster, moist heat cooked*: 98; Seal, raw*: 142; Beluga, raw*: 111
Game (large and small)	Deer, elk, buffalo*, roasted: 158; moose, roasted: 134; Moose liver, braised*: 155; Rabbit, wild roasted: 173; Beaver, roasted: 212; Muskrat, roasted: 236
Fowl and eggs	Quail, cooked: 234; Duck, cooked: 200; Duck eggs: 185; Pheasant: 247
Bulbs	Leek, onions, and other bulbs: 31
Berries, fruits	Raw elderberries: 73; raw strawberries: 70
Vegetables	Beans, cooked pinto, kidney, or white: 143; Peas, boiled pigeon or split: 120; Squash, cooked winter*: 37; Squash, cooked Navaho*: 16
Greens, Tea	Raw dandelion greens: 45; Raw watercress: 11; Fiddleheads, raw: 34
Honey, Maple syrup, other	Honey*: 304; Maple syrup*: 261
Seeds, Nuts, Grains	Corn, Navaho strain, steamed: 286; Raw dried sunflower seeds: 570; Chia seeds: 490; Hazelnut, dry roast*: 646; butternuts, dried*: 612
Roots, Bulbs, Tubers	Raw chicory root: 73; Boiled burdock root*: 88; Potato, baked tuber: 200

## Harper (2017) for the Shoshone-Bannock Tribe

Food category	Amount (g/day)	Estimate of Daily Calories
Game	225	600
Fish	142.4	200
Fowl	40	80
Roots, tubers, rhizomes	200	150
Greens, bulbs, other	150	100
Berries, fruits	100	75
Seeds, nuts	50	200
Grain	200	400
Honey, teas, etc.	30	100
Fats, oils	30	260
Total	1168	2265

## Other Considerations

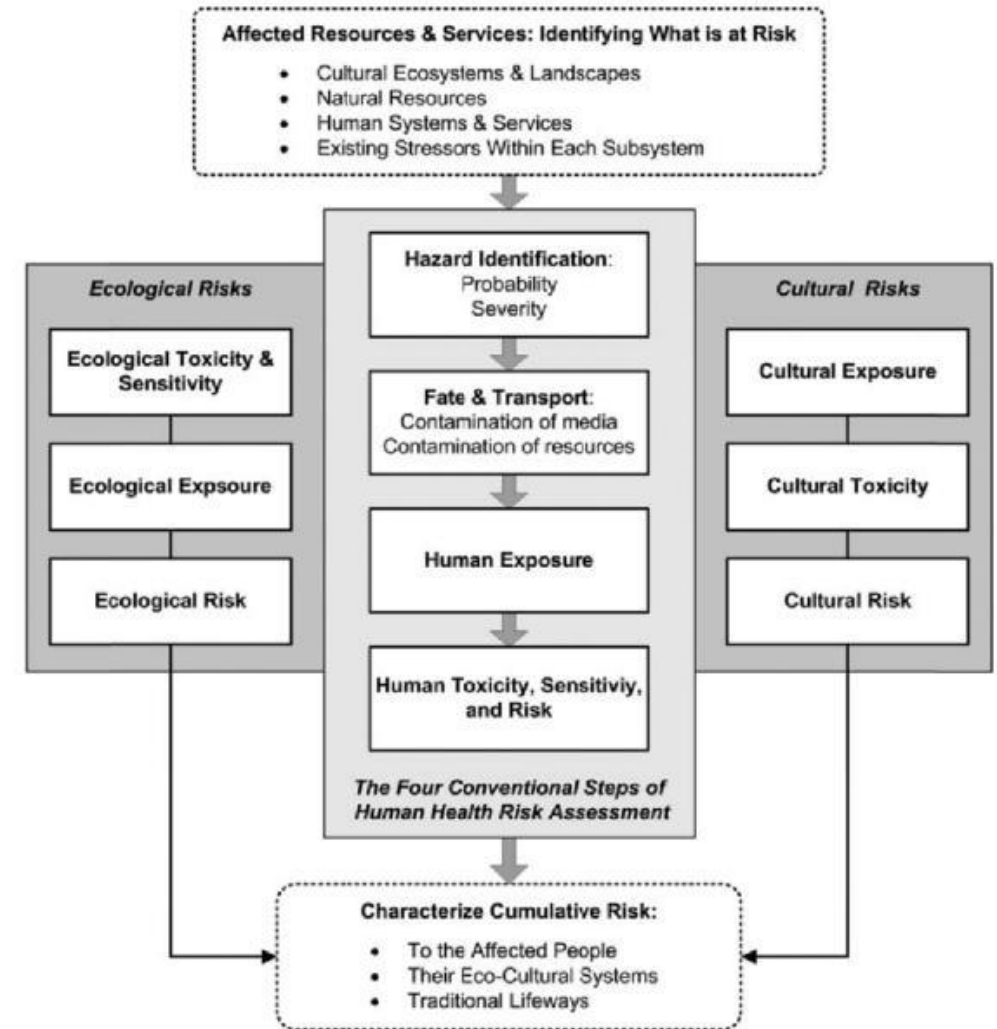
- Reeves (2002)
  - Whale hunting by the Makah Tribe (Gray and Humpback species\*)
  - Subsistence and ceremonial uses
  - Hunt forbidden until 1999; continuing controversy
- Joelynn (2016) for the Hopi Tribe
  - Estimated that 30% of food is gathered from the land
  - Dry farming techniques
  - Basket-making, pottery, other crafts
- Seaweed\* consumption by tribes in the Pacific Northwest
- Place-based recommendations
  - Washington State Dept. of Ecology
  - Old: 54 grams/day fish with diet fraction of 0.5 obtained locally
  - New: 57 grams/day fish with diet fraction of 1.0 obtained locally
- Ceremonial importance of foods
  - Whale, salmon, etc.

\* Denotes additions or additional species specificity

# Comprehensive Risk Assessment

## Elements of risk assessment scenarios (Harper et al. 2012)

- Tribal circumstances and history
- Environmental setting
- Resource use patterns
- Traditional diet
- Direct exposure factors



# Water Consumption and Sweat Lodges

Category	Water Consumption
Suburban Default	2L/day
Rural Residential Gardener	3L/day
Native American / Subsistence Forager	3L/day plus 1L for each sweat lodge use (steam inhaled)

## Risk Assessments and Studies

- Harper et al. (2002) for the Spokane Tribe
- Harper et al. (2007) for the Elem (Pomo) Tribe and Confederated Umatilla Tribes
- Harper (2017) for the Shoshone-Bannock Tribe

## Notes

- Sweat lodge use may be as frequent as once per day (Elem Tribe, Umatilla Tribe)
- Sweat lodge use for Washoe Tribe is estimated at 24 uses per year
- Children as young as 2 may use the sweat lodge (Umatilla Tribe)
- The Shoshone-Bannock Tribe is also known to use sweat lodges
- During sweat lodge use, plants and herbs may be used for ceremonial purposes, thus providing another exposure pathway

## Sweat Lodge Use: Assumptions and parameters used in the calculation of exposure to volatile, semi-volatile, and nonvolatile compounds via inhalation\*

Parameter	Typical Value	Unit
Volume of water used in a sweat	4	L
Radius of hemispherical sweat lodge	1	m
Temperature of sweat lodge	339 (150)	K (F)
Inhalation rate	30	m <sup>3</sup> /day
Length of sweat event	1	hr/event
Number of sweats per year	365	events/yr
Number of years a person sweats in a lifetime	64	years
Average body weight	70	kg
Averaging time	70 (carcinogen) ED (noncarcinogens)	yr

\*Information from Harper et al. (2007) for the Elem Tribe, Washoe Tribe, and the Confederated Tribes of the Umatilla Indian Reservation.



## Sweat Lodge Use: Assumptions and parameters used in the calculation of dermal exposure to volatile, semi-volatile, and nonvolatile compounds\*

Parameter	Typical Value	Unit
Body surface area available for contact	1.8	m <sup>2</sup>
Fraction of skin area in contact with vapor	0.0-1.0	Unitless
Fraction of skin area in contact with liquid	0.0-1.0	Unitless
COPC-specific permeability constant for vapor exposure	1 to 1E-5	cm/hr
COPC-specific permeability constant from water contact with skin	1 to 1E-5	cm/hr

\*Information from Harper et al. (2007) for the Elem Tribe, Washoe Tribe, and the Confederated Tribes of the Umatilla Indian Reservation. Some parameters from the following slide also apply including volume of water, radius of sweat lodge, length of sweat event, sweats per year, number of years a person sweats in a lifetime, average body weight, and averaging time, temperature of sweat lodge.

# Soil Ingestion

## Sources of Soil Ingestion

- Outdoor gatherings and ceremonies
- Cultural activities (e.g. basket-making)
- Gathering, processing, and using natural resources
- Residual soil on grown and gathered plants
- High amounts of indoor dust
- Note: episodic events may contribute approximately 1 gram each of soil exposure

## Risk Assessments and Studies

- Harper et al. (2002) for the Spokane Tribe
- Harper et al. (2007) for the Elem (Pomo) Tribe and Confederated Umatilla Tribes
- Harper et al. (2012) “Subsistence Exposure Scenarios for Tribal Applications”

Category	Soil Ingestion (mg/day)
EPA Default (manicured suburban adults)	50
EPA Default (manicured suburban children)	200
EPA Default (conventional suburban adults)	100
EPA Default (subsistence forager)	400
Spokane Tribe (adults)	400 (100 from indoor sources and 300 from outdoor sources)
Spokane Tribe (children)	400

# Inhalation Rates

## Risk assessments and studies

- Harper et al. (2002) for the Spokane Tribe
- Harper et al. (2007) for the Elem (Pomo) Tribe and Confederated Umatilla Tribes
- Harper et al. (2012) “Subsistence Exposure Scenarios for Tribal Applications”

Category	Hours/Day
High Activity	2
Moderate Activity	6
Low and/or Sedentary Activity	8
Rest	8

Category	Inhalation Rate	Notes
Default suburban lifestyle	20m <sup>3</sup> /day	
Rural residential farmer lifestyle	25m <sup>3</sup> /day	EPA does not specify official exposure factors for this lifestyle
Subsistence forager lifestyle	30m <sup>3</sup> /day	Reflects an outdoor, active lifestyle based on EPA activity databases, foraging theories, and ethnography of activities associated with higher respiration rates than suburban activities

# Summary

Category	Tribal Risk Assessment Results Relative to Other Kinds of Risk Assessments
Soil Ingestion	2-4 times higher
Fish Ingestion	Up to 100 times higher
Inhalation Rates	Up to 1.5 times higher
Dietary Exposures	0-10 times higher
Exposure Duration	Lifetime instead of 30 yrs
Cumulative Risk Assessments	10-100 times higher

Source: Harper et al. (2012) “Subsistence Exposure Scenarios for Tribal Applications.”



Questions?

# Poll Questions

1. What is your affiliation?
  - Do you represent a tribal government, EPA, state government, consultant or other group? Please describe.
2. Are you aware of a risk assessment or study that assessed food consumption by a tribe that was not mentioned in this presentation?
  - If yes, is it publicly available?
  - If yes, please provide information (e.g., name of site, name of tribe, how to obtain, website, contact information).
3. Are you aware of a risk assessment or study that assessed lifestyle or ceremonial exposures to tribes that were not mentioned in this presentation?
  1. If yes, is it publicly available?
  2. If yes, please provide information (e.g., name of site, name of tribe, how to obtain, relevant websites, contact information).