

Circumpolar Climate-Mediated Environmental Threats to rural Alaska Native Food and Water Security: *A One Health Approach to Community Adaptation*

Presented to:

**Health Surveillance in the Arctic Agenda
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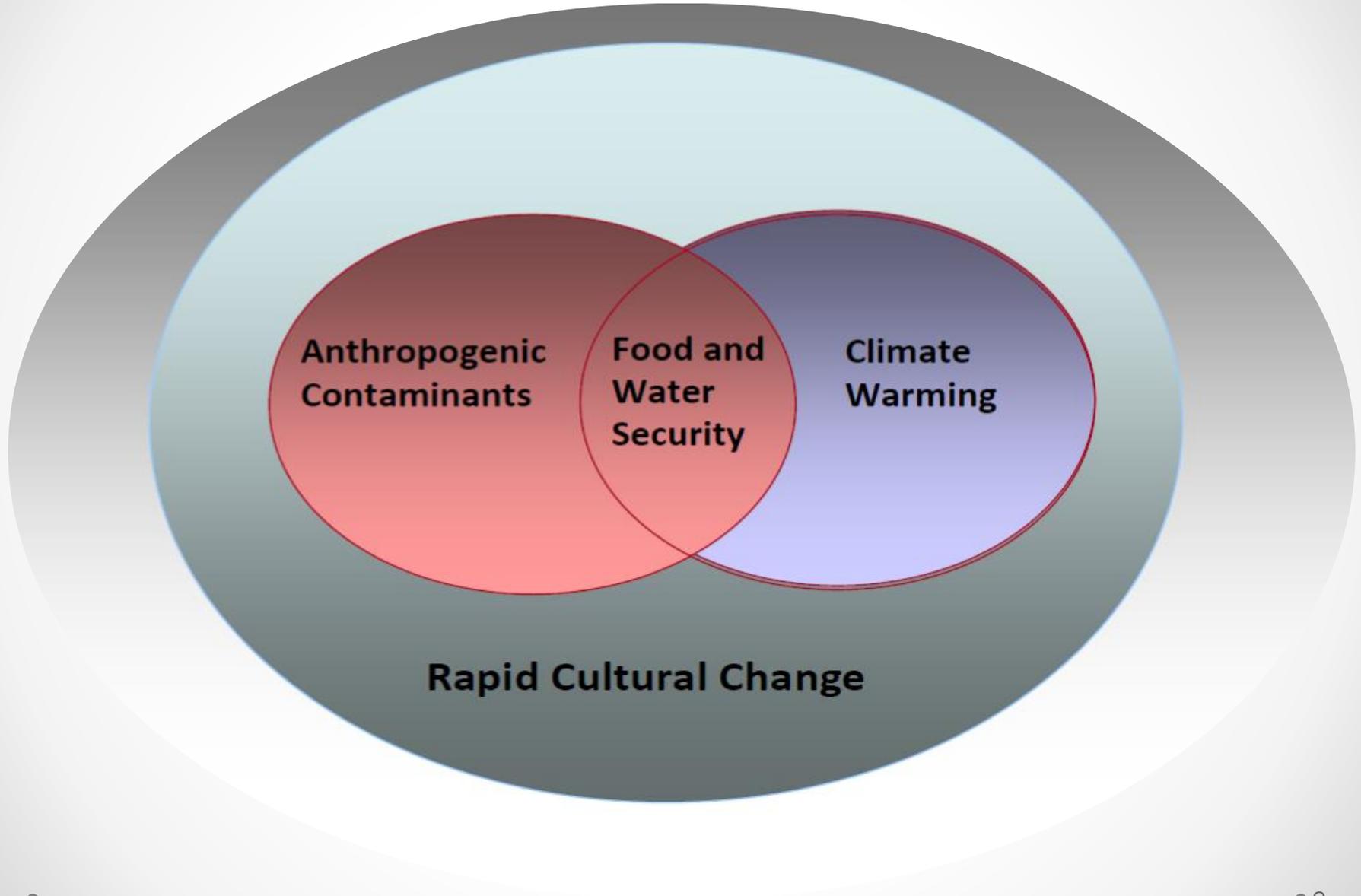


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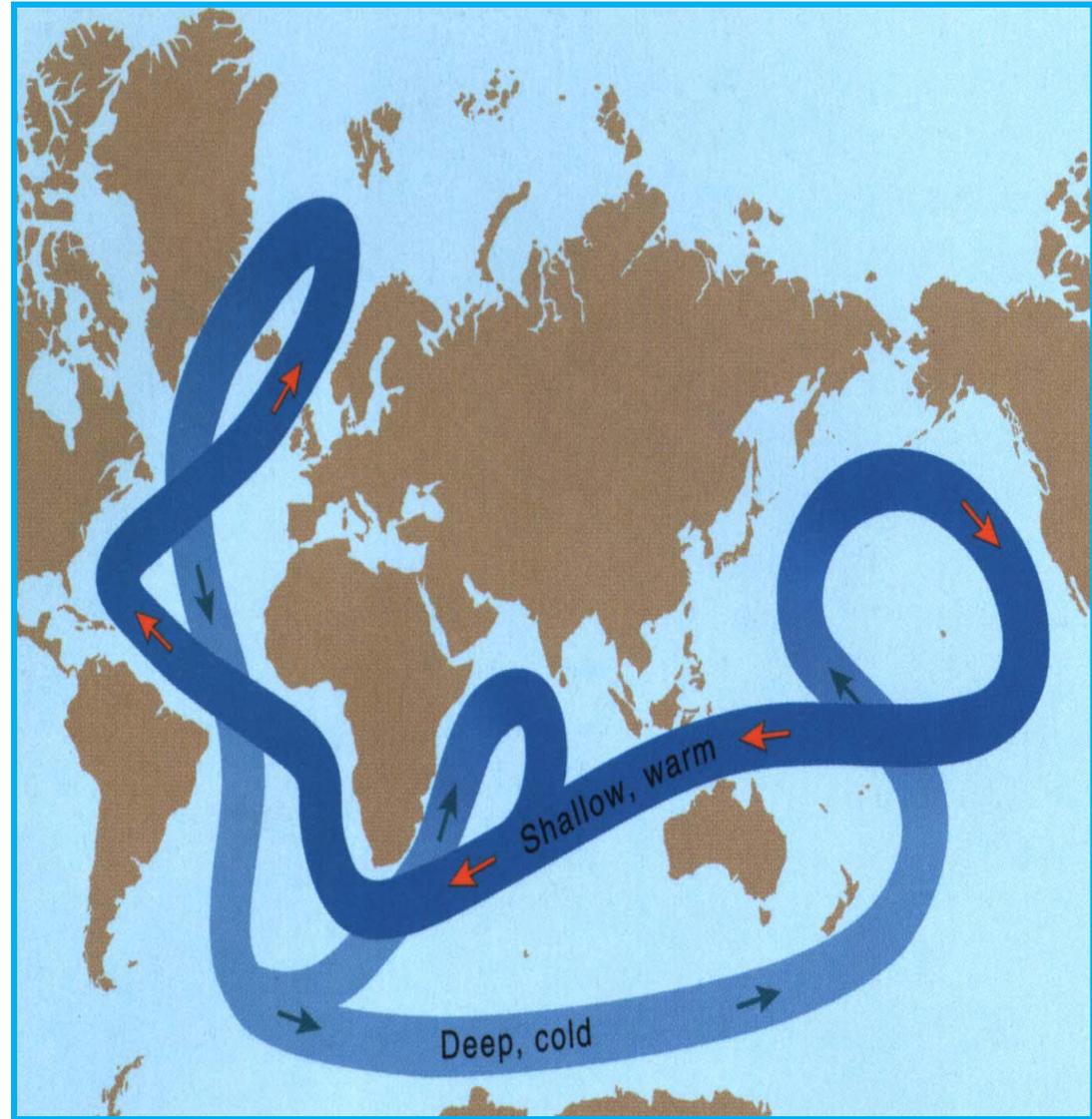
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Major Threats for Circumpolar Communities



Arctic Influence on Ocean Circulation

The Arctic plays a fundamental role in circulation of water in the oceans of the world. When warm, salty North Atlantic water reaches the cold Arctic around Greenland and Iceland and in the Labrador Sea, it becomes denser as it cools, and therefore sinks to deeper layers of the ocean. This process of forming deep water is slow, but takes place over a huge area. Every winter, several million cubic kilometers of water sink to deeper layers, which move water slowly south along the bottom of the Atlantic Ocean.



The polar front influences global ocean currents

Range Expansion of Zoonotic Disease Host Species

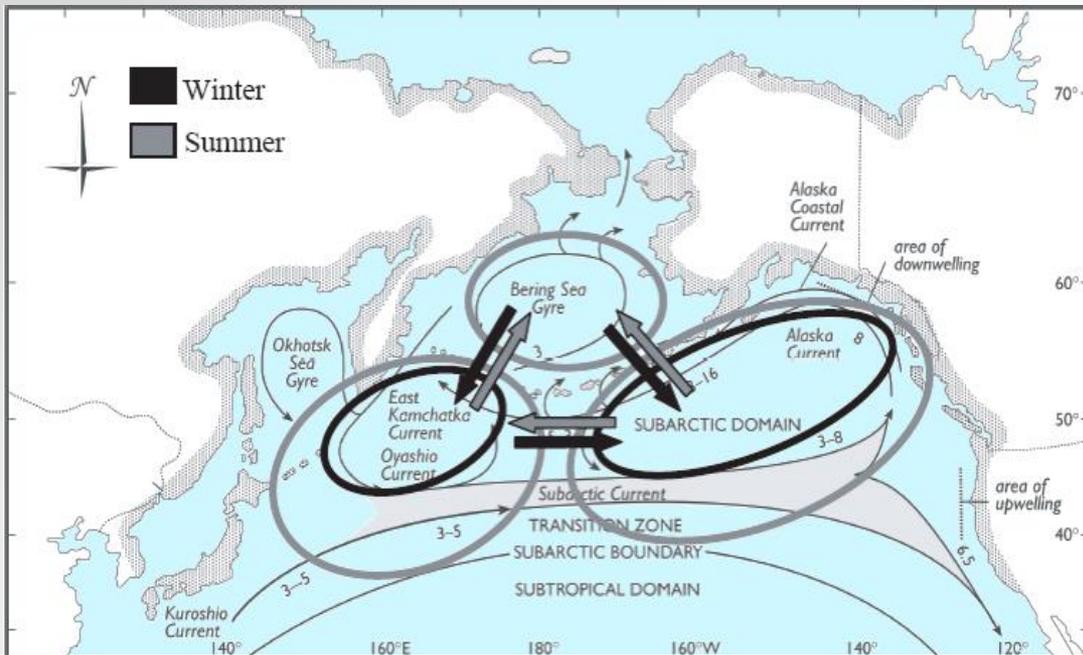


Range expansion of beaver and the potential of new carriers of giardiasis, cryptosporidium and tularemia are other concerns for water quality.

Alaska Native (AN) Biomonitoring Programs

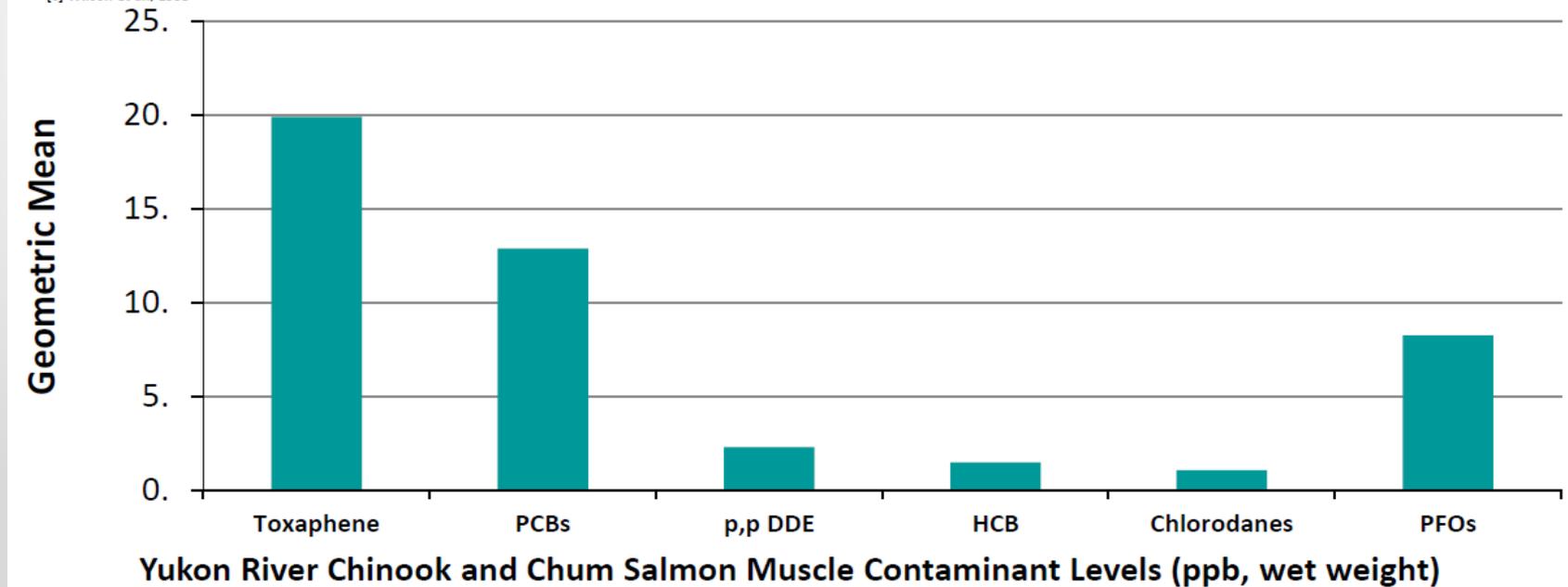
Two biomonitoring programs, and one village based observer program are currently gathering data in rural Alaska. All three programs have been supported by the EPA.

- 1. The Alaska Native Maternal Organics Monitoring Study (MOM) Study** *(Part of a circumpolar network of maternal monitoring programs, sponsored by the Arctic Council).*
- 2. The Rural Alaska Monitoring Program (RAMP)**
- 3. The Local Environmental Observer (LEO) Program**



A general conceptual model of seasonal distribution and movements of Pacific salmon in the open ocean. Salmon are distributed in both the Bering Sea and North Pacific Ocean in the summer and primarily in the North Pacific Ocean in the winter. Immature salmon generally move to the south and east in winter (black arrows) and to the north and west in summer (grey arrows). Base map showing oceanographic features and approximate current speed (km/d) is from Quinn (2005).

[a] USFWS, Unpublished Data
 [b] AT SDR, 2000
 [c] Wilson et al., 1995



Chukotka Contaminant Studies

Photos by: M. Brubaker



Chukotka Contaminant Studies



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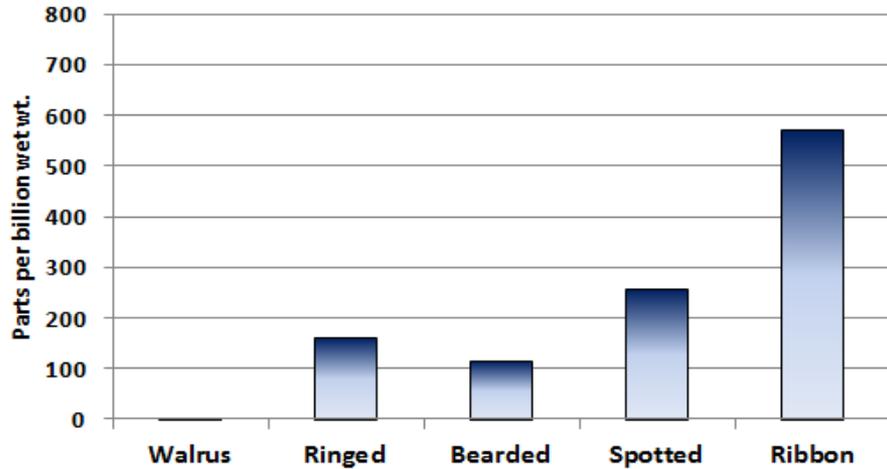
Contaminant	Fresh Walrus	Walrus 'kopalchen'
	n = 2	n = 1
Σ PCB	2.9 - 3.2	623
Σ HCB	0.1 - 0.3	0.16
HCH	0.16 - 0.19	0.73
p,p'-DDE	0.17 - 0.23	6.71
Σ DDT	0.17 - 0.42	7.76

Concentrations of contaminants ($\mu\text{g}/\text{kg}$ wet wt) in fresh walrus meat, and walrus meat fermented for 4 months by traditional methods in a ground pit ('kopalchen').

Bering Sea Contaminant Studies; Sea Mammals

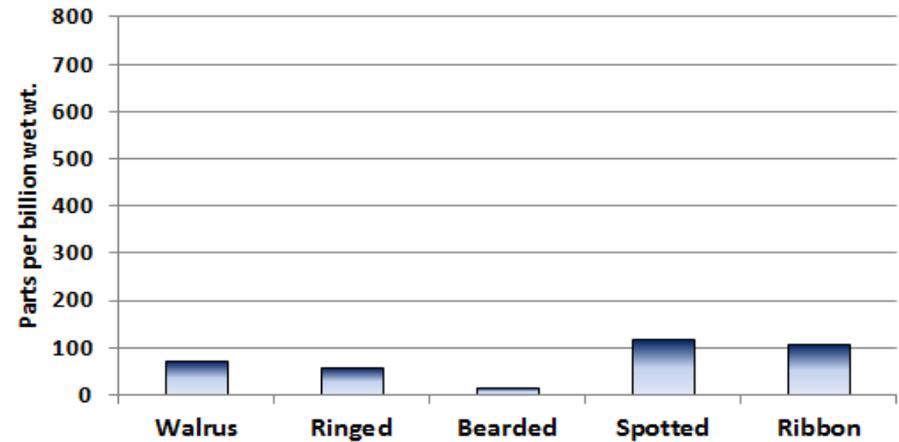
DDT

Blubber



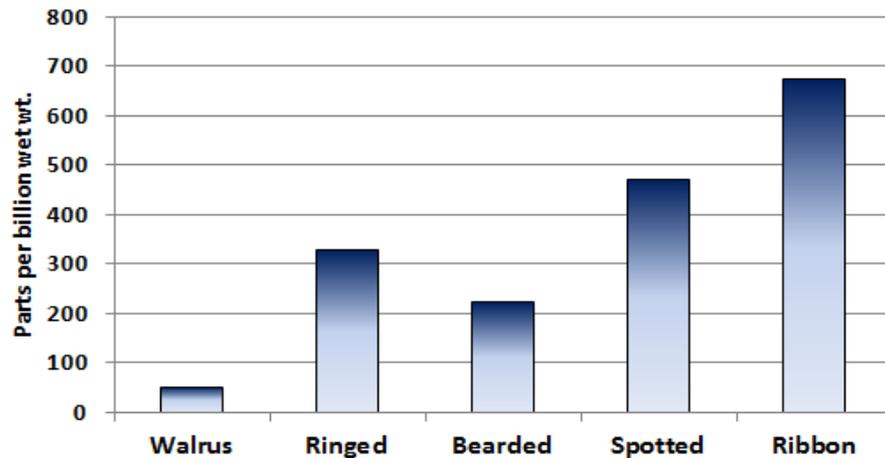
HCH

Blubber



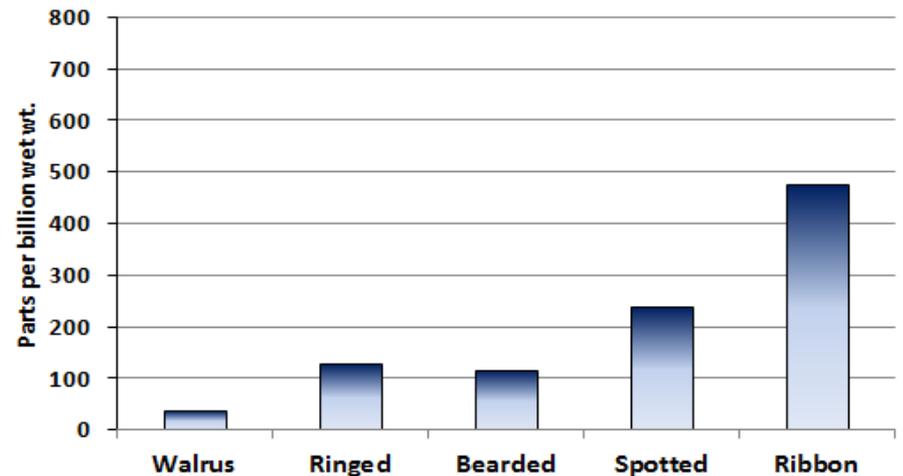
PCB

Blubber



Chlordane

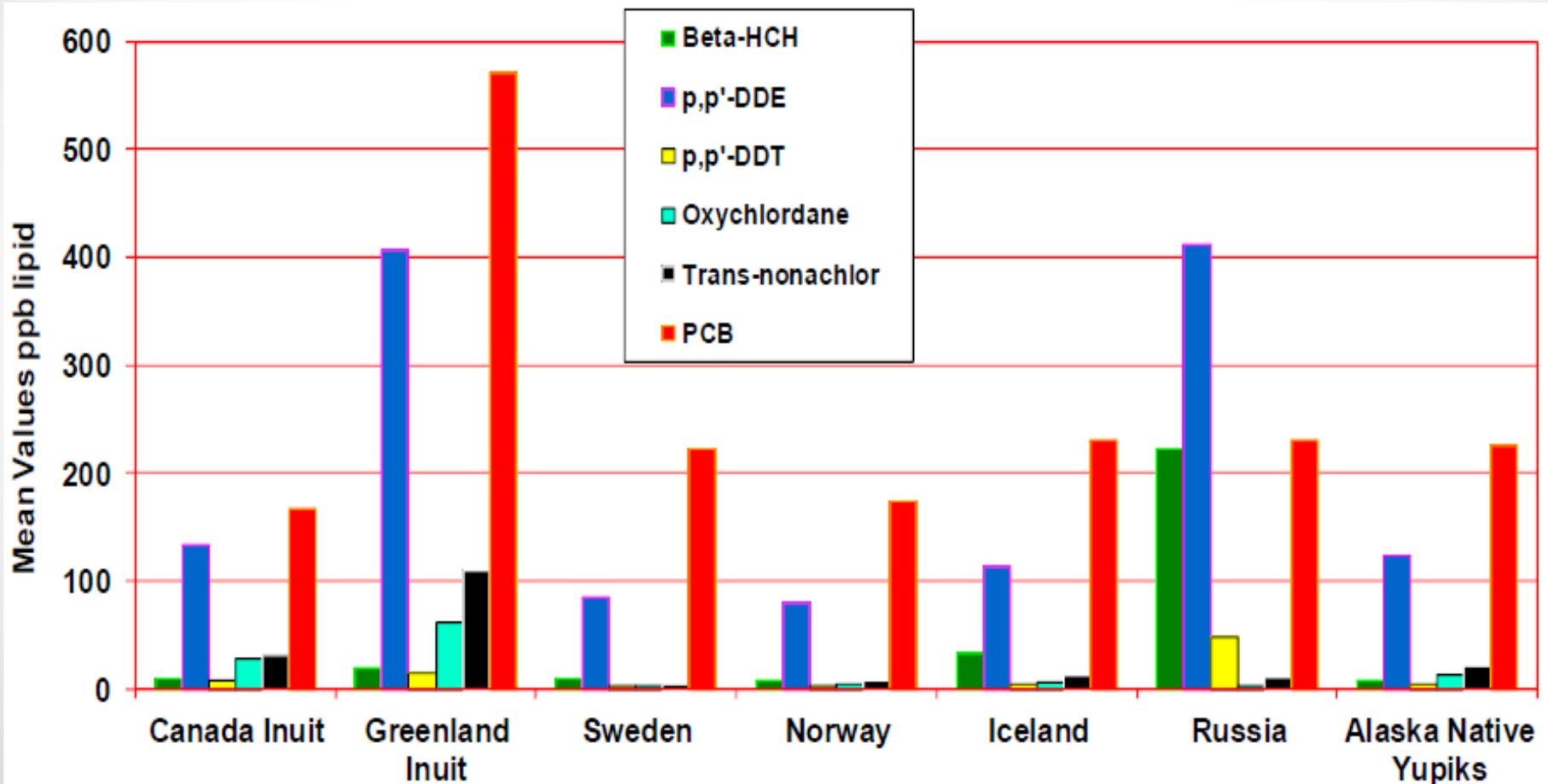
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Biomonitoring Programs

Alaska Native MOM Study 1999 – 2006

Blood Levels of Persistent Organic Compounds in Circumpolar Pregnant Women



Data From: Arctic Monitoring and Assessment Program, The Human Health Assessment - 2009

Zoonotic Disease Antibody Studies

AN Biomonitoring Programs; RAMP Study

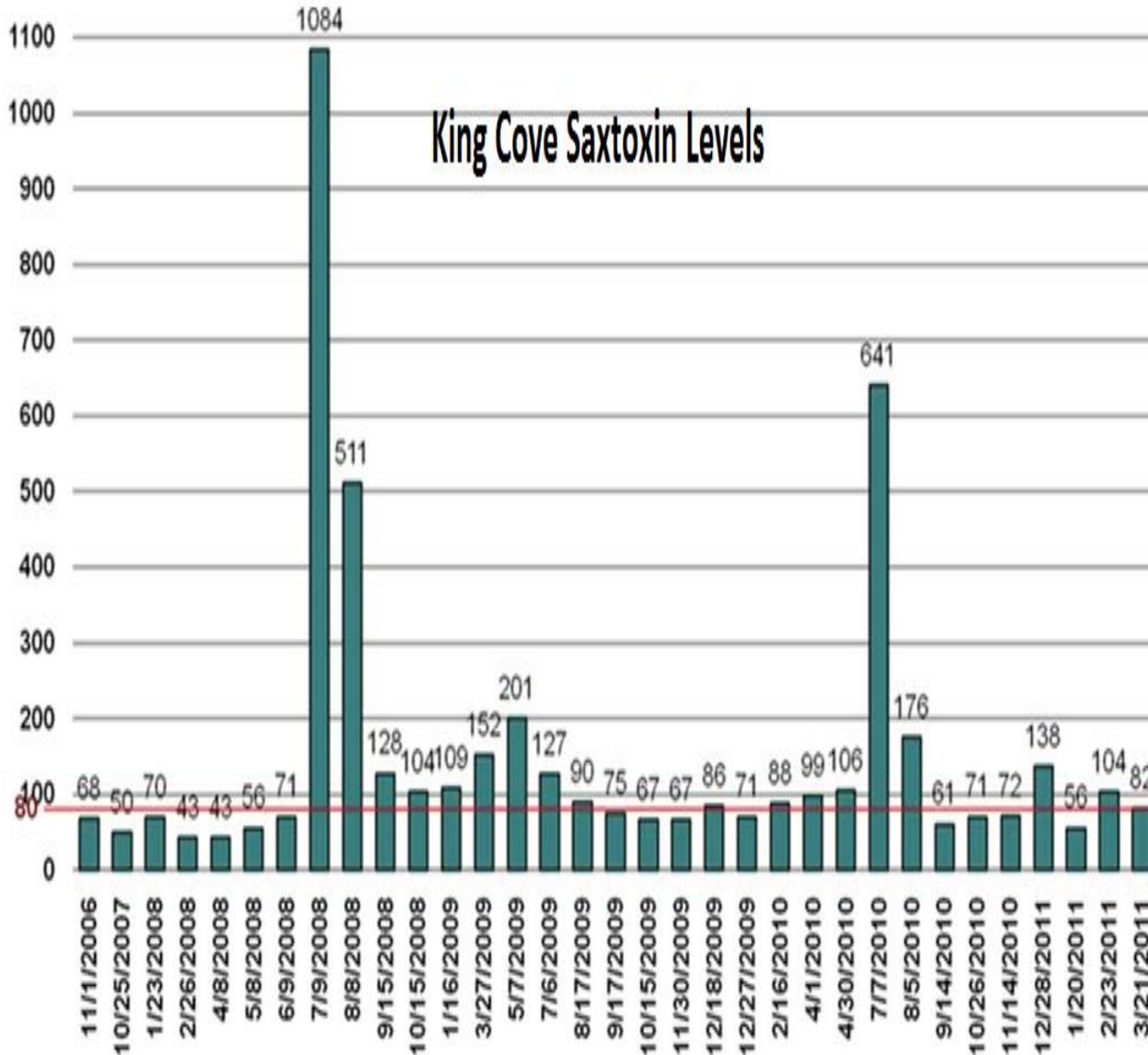
Zoonotic	Diseases
Toxoplasmosis	6 - 10% Caribou ≈ 50% of harbor seals
Trichinosis	Very common in polar bears, walrus
Brucellosis	10. -25% Caribou
Tularemia	Northward movement -beaver, muskrat, snowshoe hare, ticks; it can also be water-borne, and is carried by mosquitos, ticks
Q-Fever (coxiella burnetti)	75% Northern Fur Seals similar prevalence in Stellar Sea Lions on St. Paul Island 25-30% Caribou

Bering and Chukchi Sea HAB Studies

D. Roehl, ANTHC

DA = Domoic Acid

King Cove Saxitoxin Levels



% Positive for DA:

Max conc ng/g:

○ Walrus	40%	(6,457)
○ Bearded Seals	26%	(47.8)
○ Ribbon Seals	24%	(6.6)
○ Ringed Seals	19%	(126.6)
○ Spotted Seals	1%	(39.9)

SXT = Saxitoxin

% Positive for SXT:

Max conc ng/g:

○ Walrus	27%	(240)
○ Bearded Seals	14%	(14.8)
○ Ribbon Seals	0%	(NA)
○ Ringed Seals	14%	(172)
○ Spotted Seals	1%	(3.1)

Fig. 1. Locations where algal toxins were detected in stranded (s) and harvested (h) marine mammals. Red images represent species positive for domoic acid (DA) and purple images represent species positive for saxitoxin (STX). Marine mammal species are listed as follows: (A) humpback whales, (B) bowhead whales, (C) beluga whales, (D) harbor porpoises, (E) northern fur seals, (F) Steller sea lions, (G) harbor seals, (H) ringed seals, (I) bearded seals, (J) spotted seals, (K) ribbon seals, (L) Pacific walruses and (M) northern sea otters.





Photo: Mike Brubaker

To test the exposure history of an animal to certain contaminants and disease, RAMP uses a paper blood test strip method developed in Canada. Paper is dipped in the blood of a harvested animal. Each paper tab can be used in the lab for a different test.

RAMP Monitoring Elements

- **Antibodies in land and sea mammal blood collected by soaking filter paper in hunter-killed animals, these show exposure to diseases that can infect both animals and humans, (zoonotic diseases).**
- **Blood levels of mercury, selenium, and stable isotopes of C, N.**
- **In the future, filter paper blood samples will be able to be tested for contaminants, as well.**
- **Stomach and intestinal contents of sea mammals are tested for the toxins of harmful algal blooms (HABs) saxitoxin (paralytic shellfish poisoning, PSP) and domoic acid (amnesic shellfish poisoning).**
- **Test ticks and mosquitos for the bacteria that cause the tularemia infection, a zoonotic disease of beavers, muskrats and rabbits, that has moved north as the tree line has moved north.**
- **Tests on local fresh water sources for the presence of HABs that can occur in fresh water, when it warms, melting permafrost can release nitrogen and phosphorus into the water and stimulate HABS.**

AN Biomonitoring Program

Data Application

- **Community biomonitoring allows for many more specimens, improved local risk-appraisal, correlation with climate and oceanographic data, regional data on pathogen movement trends in a species disease exposure, detections of emerging infectious and contaminant threats, and creation of specimen biobanks.**
- **The most immediate application of RAMP data is the creation of a community-specific adaptation plan, allowing residents to reduce exposure to the subset of vulnerable residents, including pregnant mothers, infants, elders, immunosuppressed residents, and those with chronic diseases.**

Climate, Contaminants, and Human Health

Mechanisms of Multiple Interactions

- **Increased contaminant transport, with increased tissue levels of contaminants in Arctic wildlife may increase susceptibility to active infection with endemic or new pathogens.**
- **This would likely result in mortality in these species, and possibly increased risk of exposure in human consumers to zoonotic diseases, and increased levels of contaminants.**
- **Increased tissue levels of contaminants in subsistence species will negatively impact immune response to endemic zoonotic diseases (e.g.. brucella, toxoplasma).**

AN Biomonitoring Programs

Objectives of Biomonitoring Programs:

- Systematic collection, analysis and interpretation of information.
- Provide data for risk reduction strategy.
- Detection of emerging threats.
- Follow trends in exposure.
- Evaluate interventions.
- Create a specimen bank to allow retrospective analysis of newly emerging threats.

RAMP Biomonitoring Initiative:

- Village-based, resident-operated monitoring program. Program metrics are based on an individual village assessment of environmental change, after the community prioritizes the findings.

Credits

- **The RAMP Study and the MOM Study were supported by generous grants from the US EPA, and the enthusiastic support and participation of the residents of the Y-K Delta and Bering Strait region, the Kawerak Corporation, the Norton Sound Health Corporation, the Yukon Kuskokwim Health Corporation and the efforts of Anahma Shannon and Vanessa Tahnone, Environmental Coordinators for the Kawerak Corporation.**
- **The collaboration of scientists at the Alaska Department of Fish and Game, NOAA, CDC, and Dr. Todd O’Hara at the University of Alaska Fairbanks, Wildlife Toxicology Laboratory, Department of Veterinary Medicine.**

Credits

- **The success of the RAMP and MOM Study would not have been possible without the cheerful, skilled advocacy, technical assistance and oversight of Dr. Cynthia McOliver, the EPA Project Officer.**

