A One Health Community-Based Monitoring Program in rural Alaska: Current progress and future research opportunities

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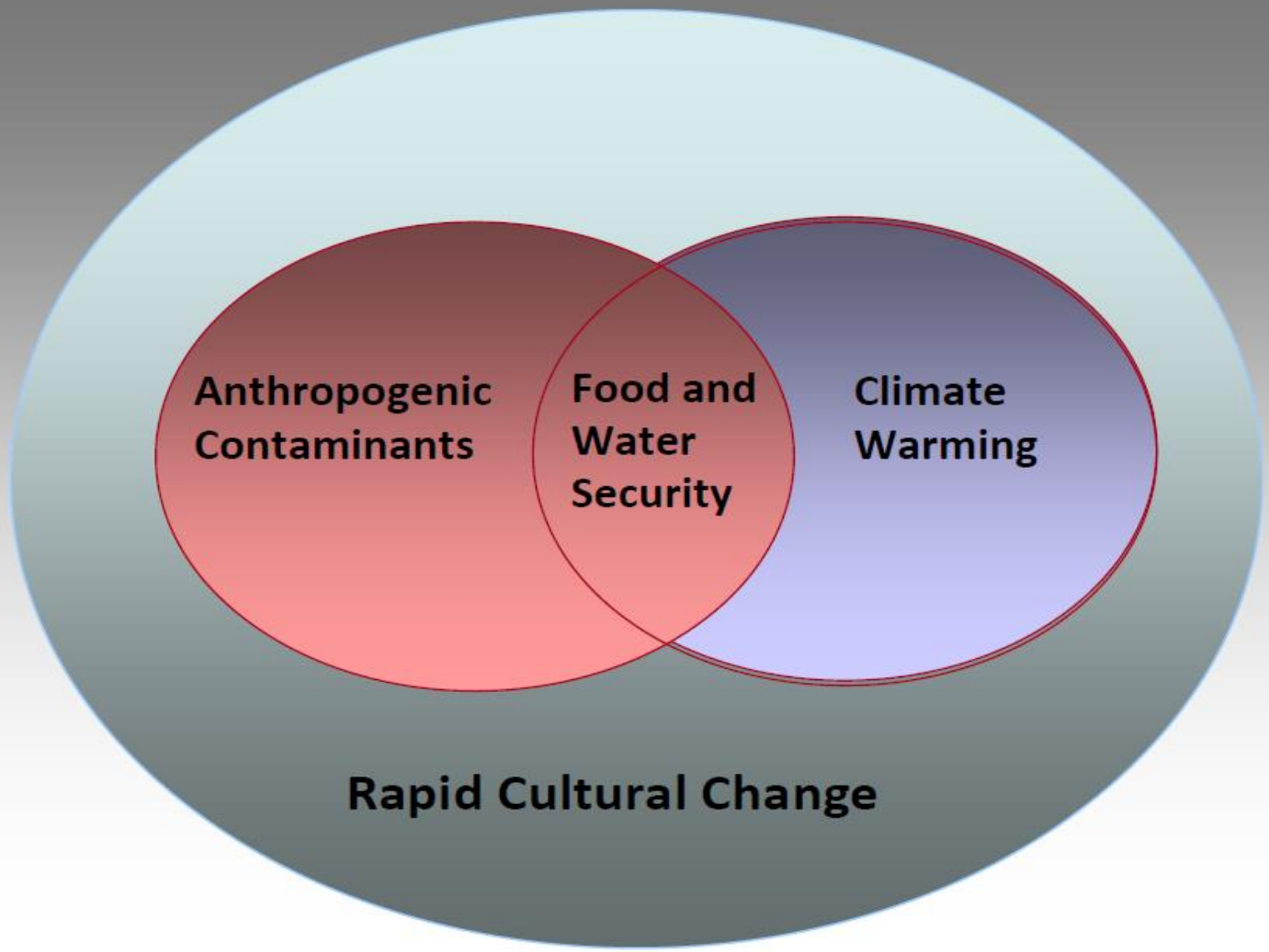
Major Threats for Rural Alaska Natives



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
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.**

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).**

- **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) 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.**

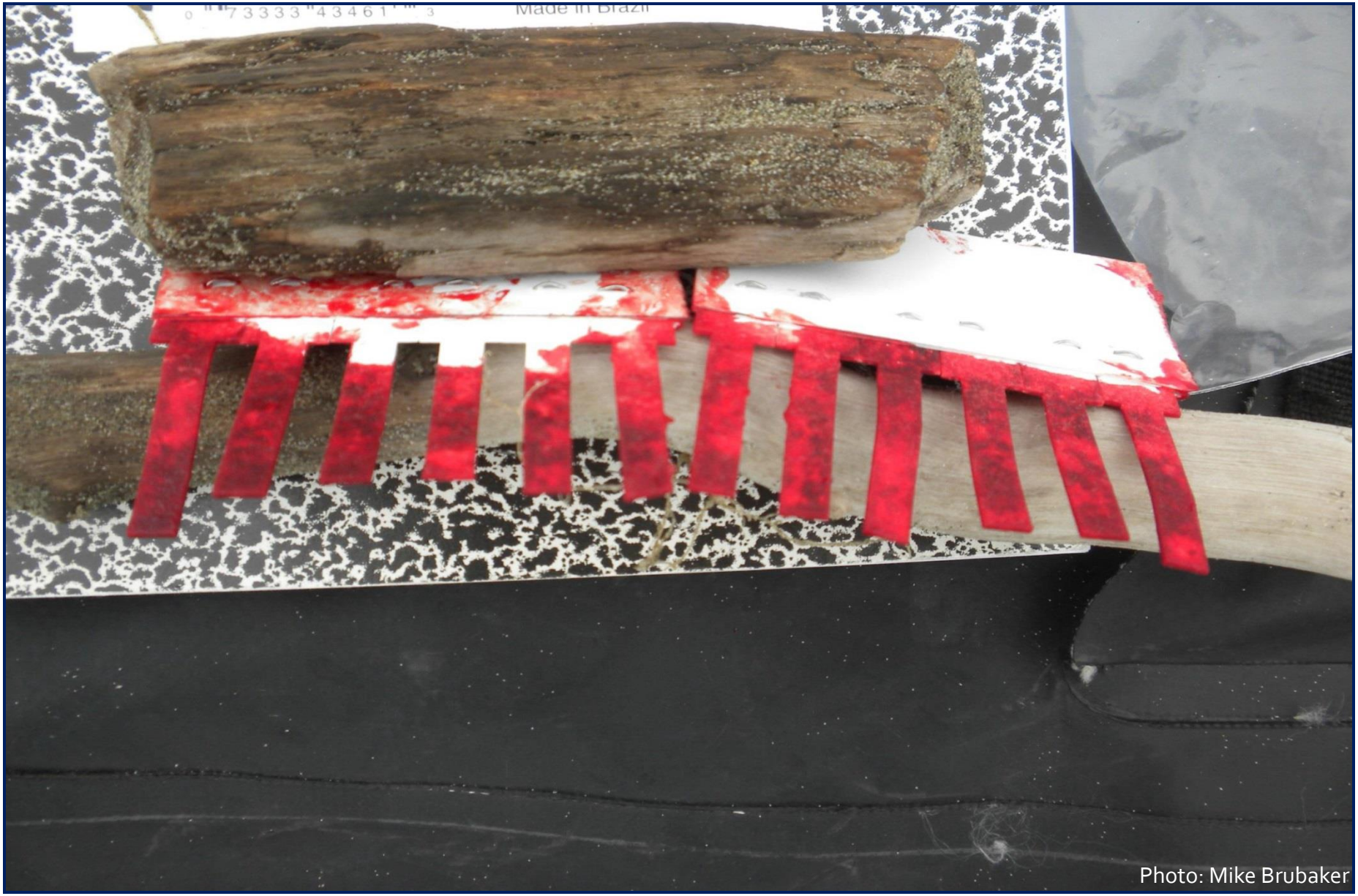


Photo: Mike Brubaker

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.

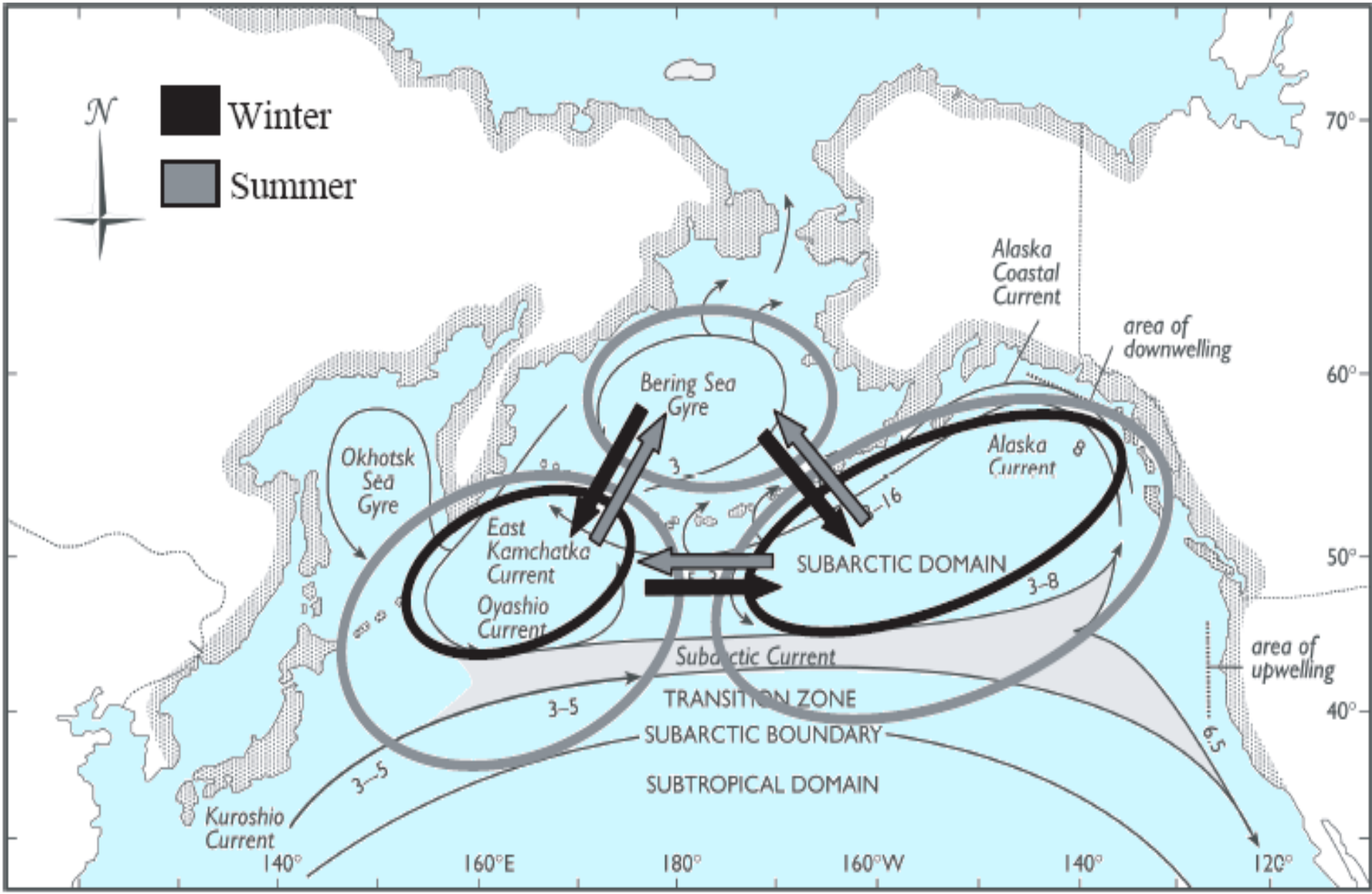
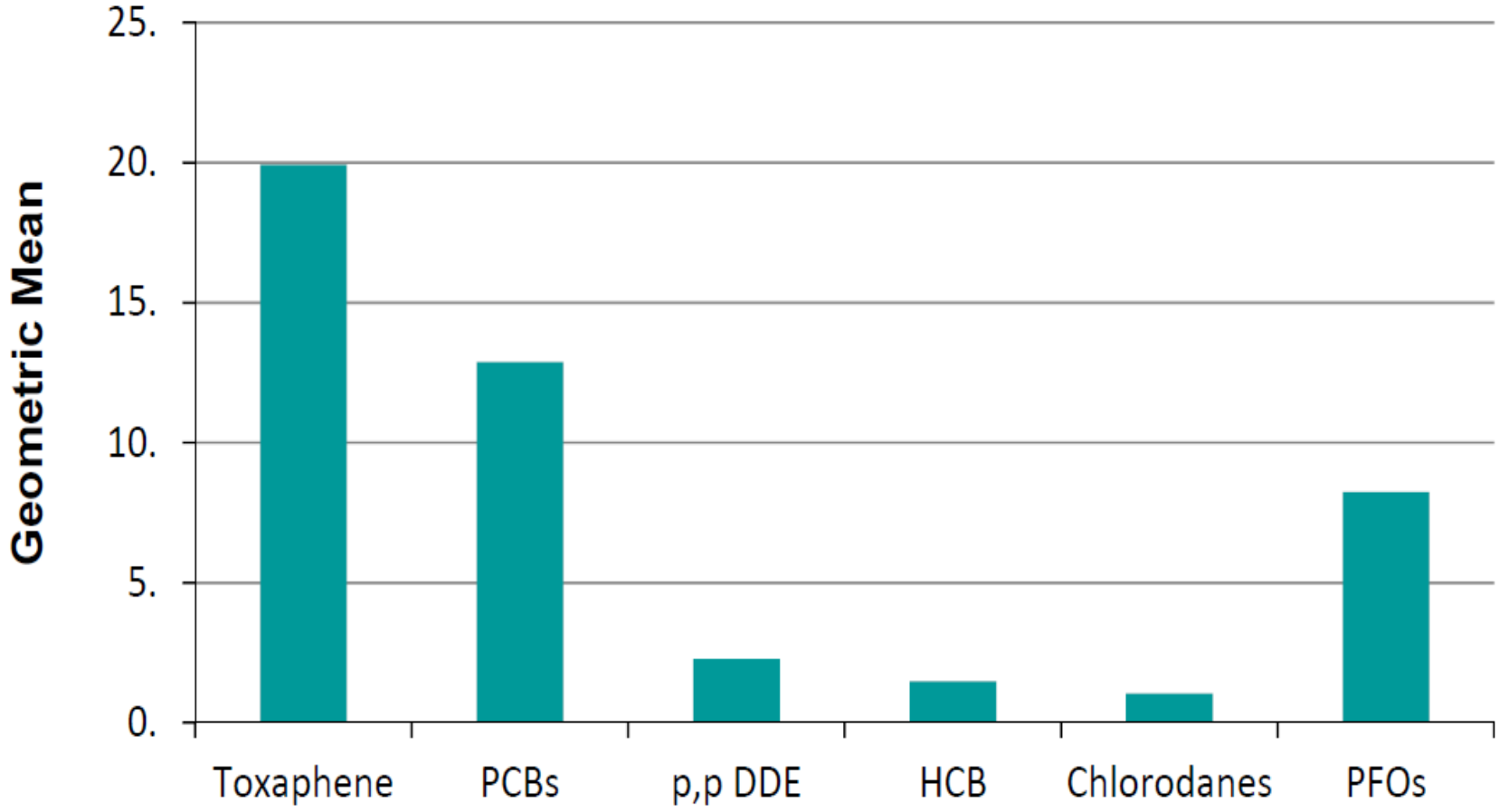


Fig. 1. A general conceptual model of seasonal distribution and movements of Pacific salmon in the open ocean. Salmon are distributed in both the Bering Sea and North Pacific Ocean in the summer and primarily in the North Pacific Ocean in the winter. Immature salmon generally move to the south and east in wither (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).

Yukon River Chinook and Chum Salmon Muscle Contaminant Levels *(ppb, wet weight)*

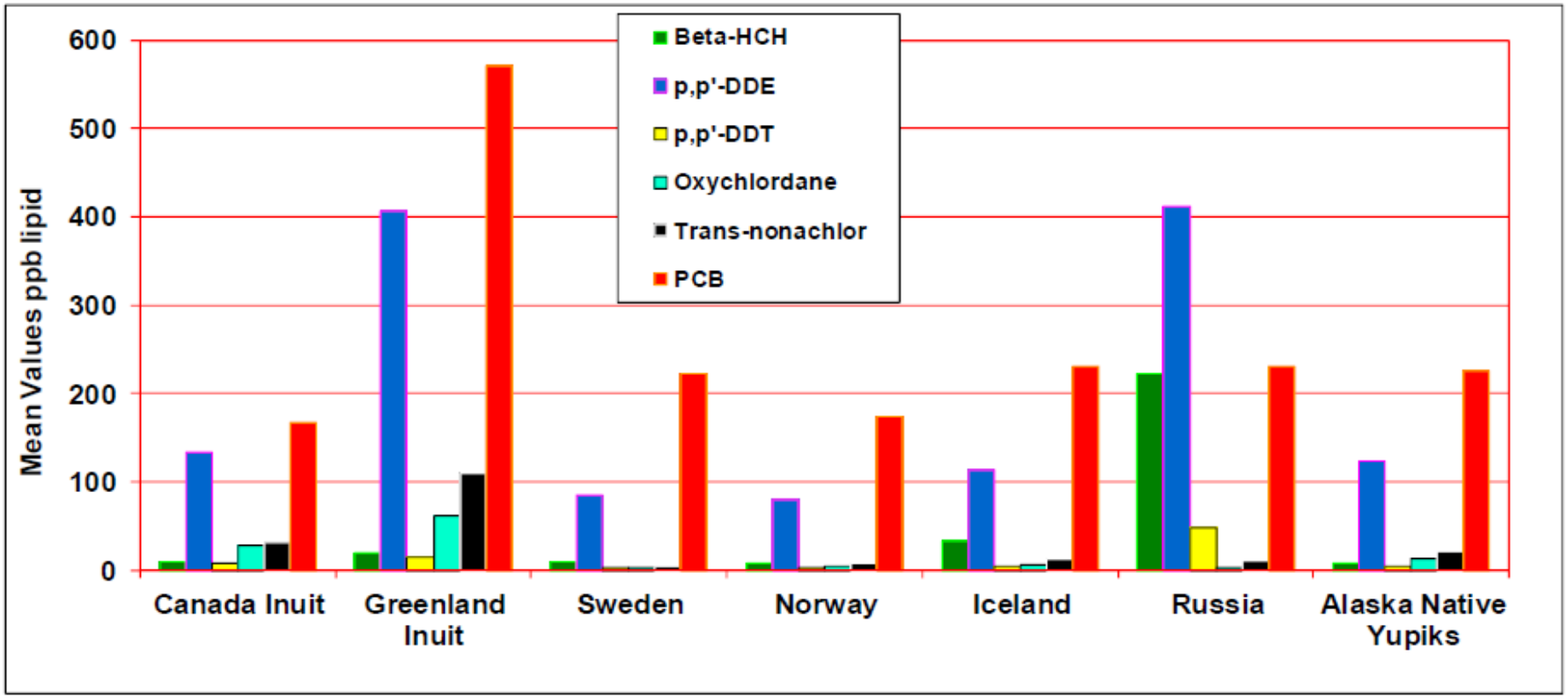


Personal Communication A. Matz, FWS, 2010

Biomonitoring Programs

Alaska Native MOM STUDY 1999-2006

Blood Levels of Persistent Organic Compounds in Circumpolar Pregnant Women



1. Alaska Native Traditional Food Safety Monitoring Program
2. Arctic Monitoring and Assessment Program, The Human Health Assessment - 2009

CHUKOTKA CONTAMINANT STUDIES

Photos by: M. Brubaker

Chukotka Contaminant Studies

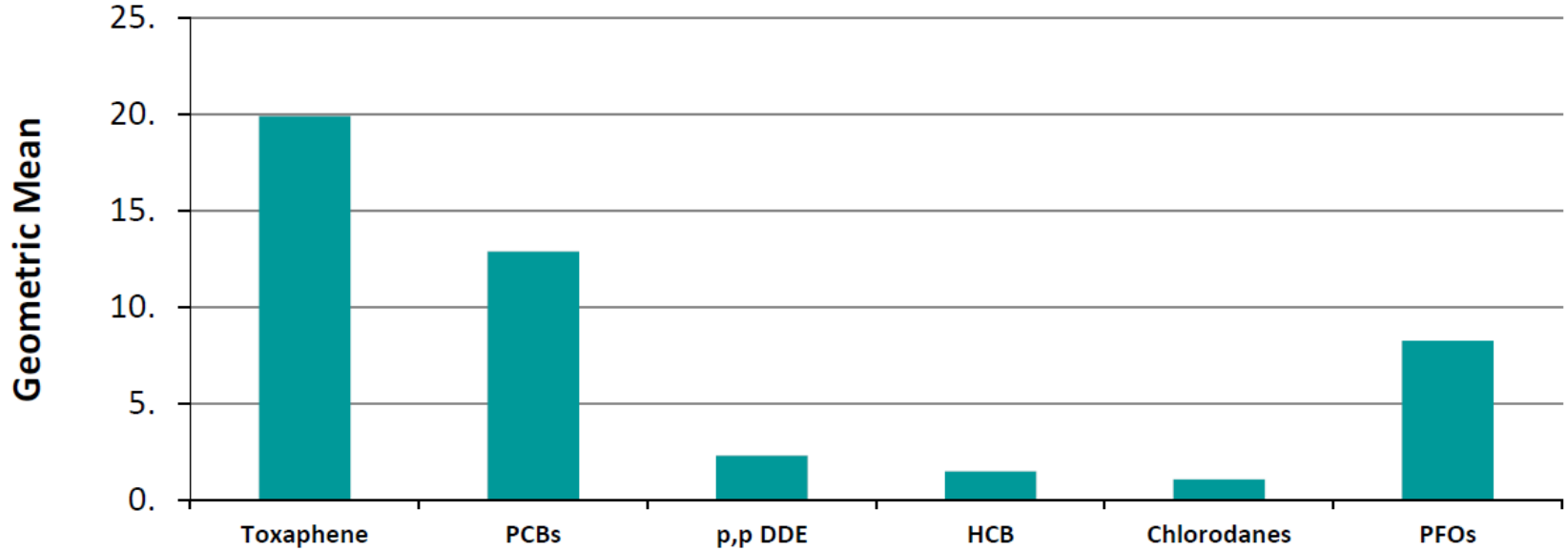
Contaminant	Fresh Walrus	Walrus 'kopalchen'
	n = 2	n = 1
∑ PCB	2.9 - 3.2	623
∑ HCB	0.1 - 0.3	0.16
HCH	0.16 - 0.19	0.73
p,p′-DDE	0.17 - 0.23	6.71
p,p′ -DD	0.13	0.09
∑ DDT	0.17 - 0.42	7.76

Concentrations of POPS (µg/kg wet wt) in fresh walrus meat, and walrus meat fermented for 4 months by traditional methods in a ground pit (‘kopalchen’).

Photos by: M. Brubaker

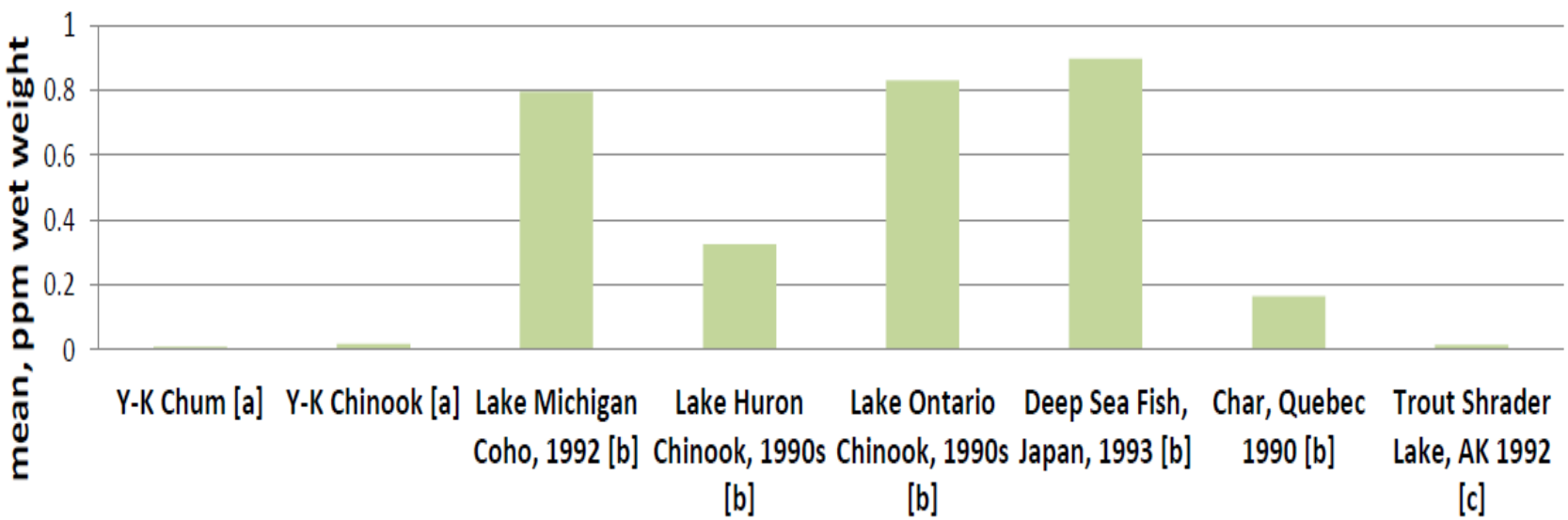
Bering Sea Contaminant Studies

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

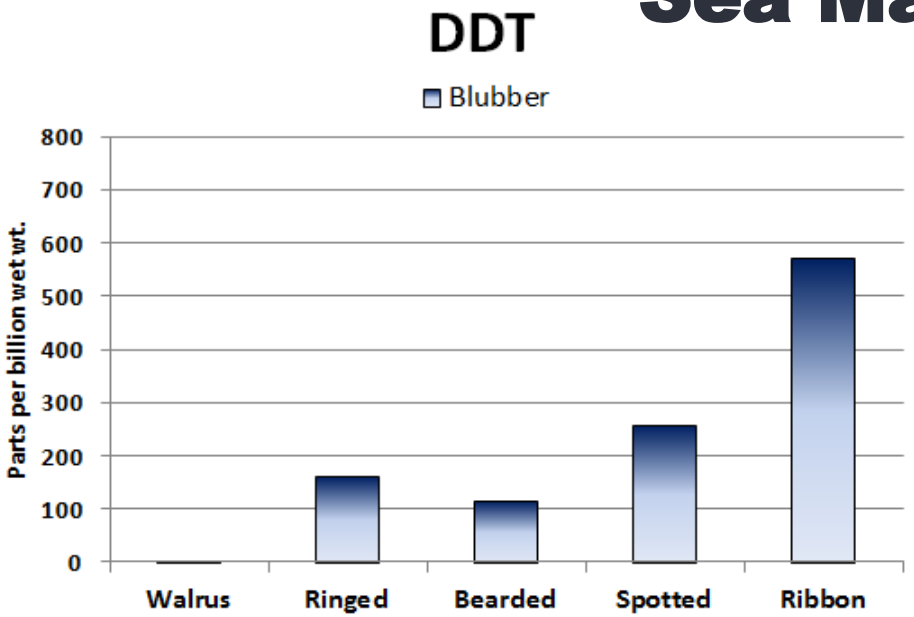


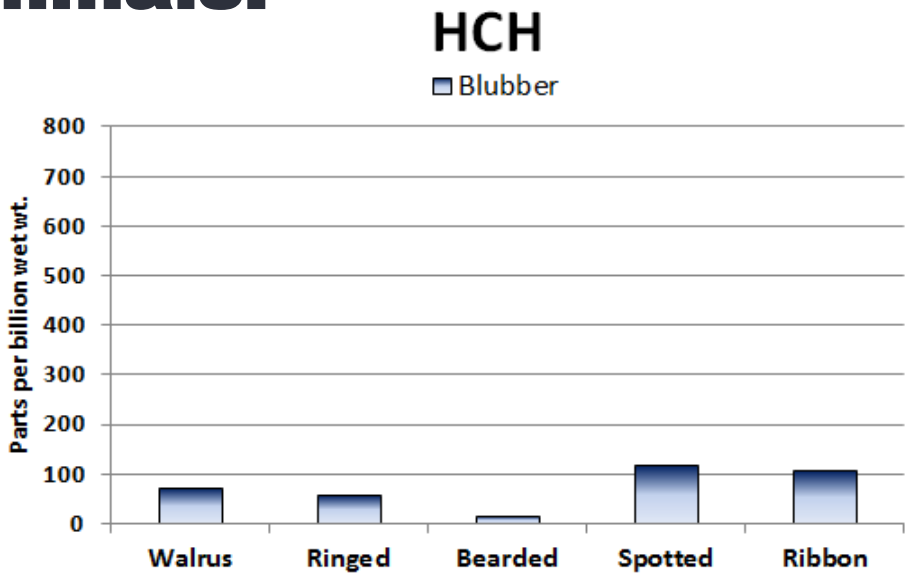
Yukon River Chinook and Chum Salmon Muscle Contaminant Levels (ppb, wet weight)

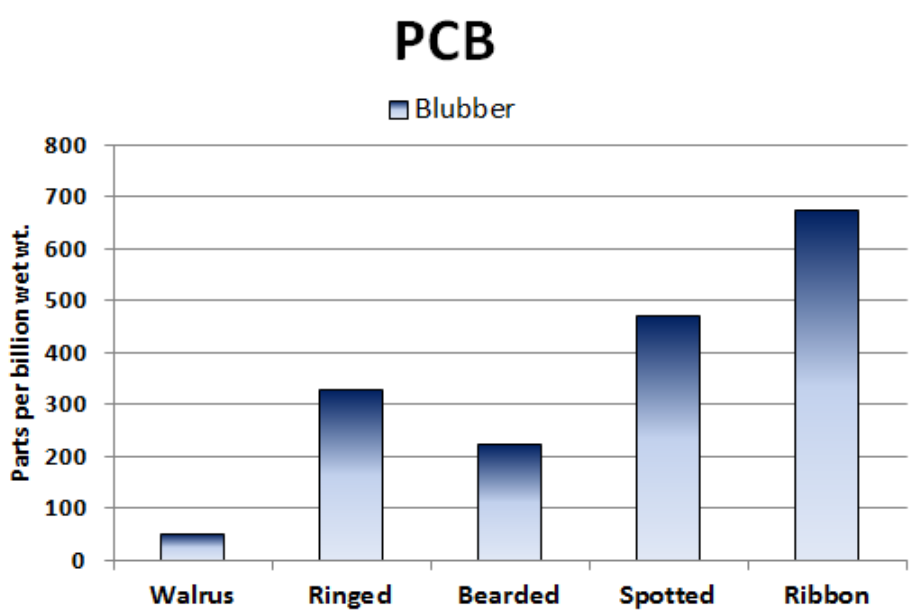
PCB levels in fish from Alaska compared to Great Lakes, other countries

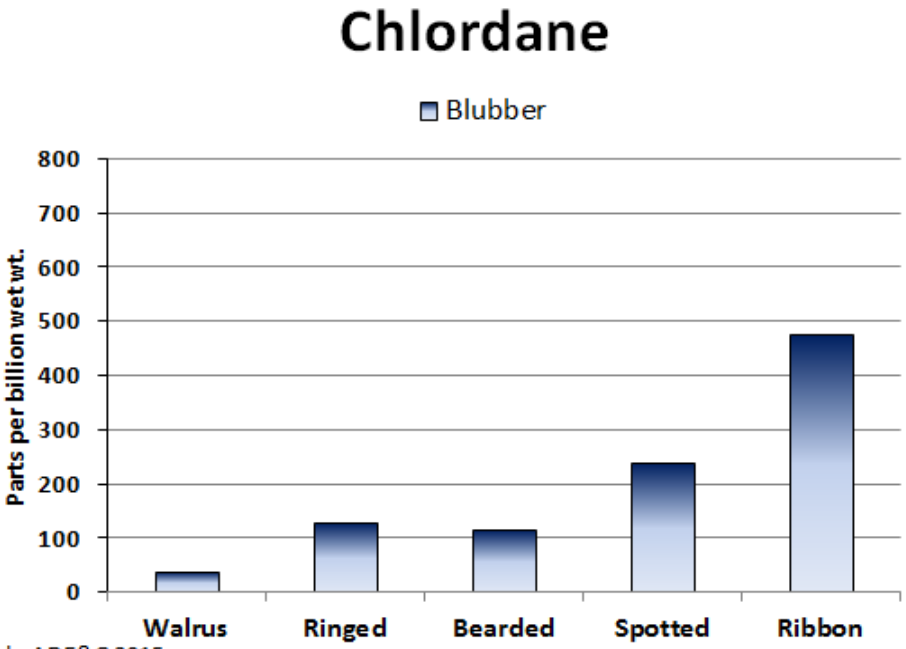


Bering Sea Contaminant Studies; Sea Mammals:









L. Quakenbush, ADF&G 2015

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***

Provided by: Alaska Department of Fish and Game

Zoonotic Disease in Sea Mammals

Walrus

6/151 positive for leptospira bratislova
1/151 positive for toxoplasma gondii
7/151 positive for marine brucella

Bearded seal

13/81 positive for marine brucella
Leptospirosis and toxoplasma all negative

Ringed seal

7/24 positive for marine brucella
8/19 positive for leptospira bratislava.
1/13 positive for toxoplasma gondii

Provided by: Lori Quakenbush ADF&G

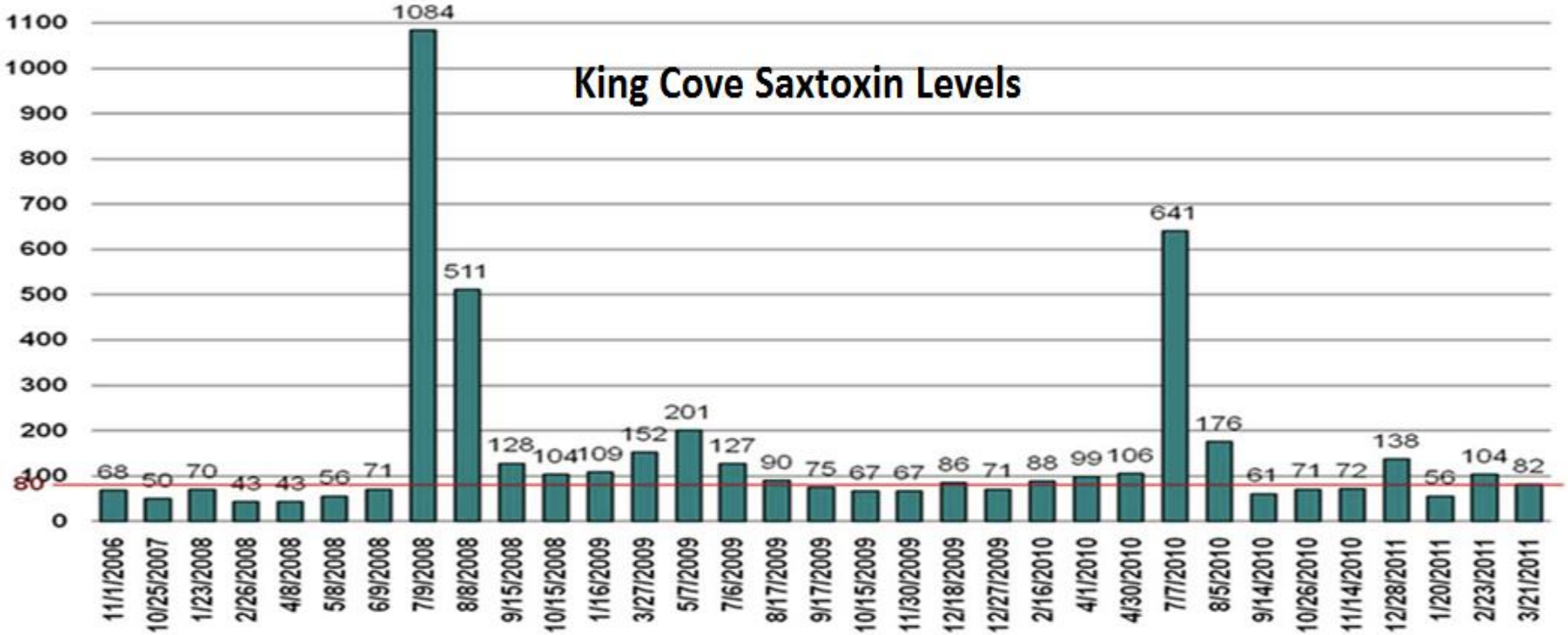
Francisella Detection Data in Mosquito Samples as Part of the Rural Alaska Monitoring Project (RAMP)

- **Mosquitoes collected in rural western Alaska as a teaching research opportunity for undergraduate students (three students have benefited from active learning in the laboratory on this project).**

- **To date, established three real time quantitative PCR methods at UAF: detect DNA of three *Francisella* genes (lpnA2, fopA, and iQFt1).**

ALASKA NATIVE TRIBAL HEALTH CONSORTIUM

Shellfish is a subsistence resource and vulnerable to changing ocean conditions. Clams and mussels are harvested from beaches in Northwest Alaska, and have historically been free of PSP and from the stomachs of walrus, a regional delicacy.



% 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)

% 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)

DA = Domoic Acid

SXT = Saxitoxin

L. Quakenbush, ADF&G 2015

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.

K. Lefebvre, NOAA

Plans For 2017-2018:

- **More samples of land and sea mammals for zoonotic disease exposure, metals and HAB toxins.**
- **More sampling of mosquitos, ticks and local water, from any community that wants to now more about these.**
- **Increase public and provider awareness about signs of HAB toxin exposure, and risk reduction from zoonotic exposure.**
- **Begin echinococcus surveillance in canids and mustelids.**

One Health research opportunities

1. As with human contaminant levels, continued monitoring is essential for sea mammals, which have a far higher exposure than terrestrial land mammals. Continued development of filter paper sampling will greatly simplify this, as will the development of circumpolar resident-operated biomonitoring programs.
2. Monitoring zoonotic antibody prevalence in subsistence land and sea mammals, is a continuing need.
3. Research into the ecology of zoonotic pathogens, including the role of the largely unknown transport hosts for these organisms, is needed to better understand the potential impact of climate and ocean regime change.

One Health research opportunities

4. There is little known regarding the origin of the algal species responsible for the saxitoxin and domoic acid in the Arctic. Specifically, are they simply transported by Bering Sea current from the North Pacific, what is the seasonality of their presence, are there variations in the epimers of saxitoxin present in Arctic food webs, the variations in temperature and nutrient requirements, and whether the trends in toxin production are increasing with sea ice changes.
5. There is little known about the influence of sea mammal genetics on contaminant or HAB toxin metabolism, or the epigenetic influence of contaminants and HAB toxins on sea mammal genes.

One Health research opportunities

6. There is little known about the influence of sea mammal genetics on contaminant or HAB toxin metabolism, or the epigenetic influence of contaminants and HAB toxins on sea mammal genes.
7. The increasingly longer and more extensive summer sea ice retreat means greater mixing of sea mammals from different areas of the circumpolar regions. There is a need to standardize laboratory procedures in the monitoring systems, so that comparison of biomonitoring data is meaningful.
8. As more data becomes available, correlations with changes in oceanographic and climate data should be examined.

Pending Samples

Serology:
200 caribou serum samples for analysis Of Brucella and Toxoplasma gondii and Coxiella burnetti.
95 whole blood marine mammal eluates as detailed in the table above will be sent after caribou serum analysis has been completed.

Surveillance using blood soaked filter paper sent into the field; analyses to be completed:	THg	Stable Isotopes C & N eluates	Serology WB eluates	Se Validation
* Samples taken over a range of THg concentrations from harbor seals already analyzed during THg validation				
Ribbon Seals	4	13	13	N/A
Spotted Seals	4	4	4	N/A
Bearded Seals	24	24	27	N/A
Ringed Seals	5	5	5	N/A
Steller Sea Lions	0	16	16	N/A
Northern Fur Seals	30	30	30	N/A
Harbor Seals*	-	-	-	30
Total	67	92	95	30

Provided by: Todd O'Hara UAF

Mosquito PCR:
PCR methodology will be used to assess multiple pools of mosquitos from summer 2016 collections (in hand) as well as planned collections during the spring of 2017.

AN Biomonitoring Program
Data Application

- **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.**

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.**