

Some maternal Steller sea lion diets elevate fetal mercury concentrations in the western Aleutian Island area of population decline.

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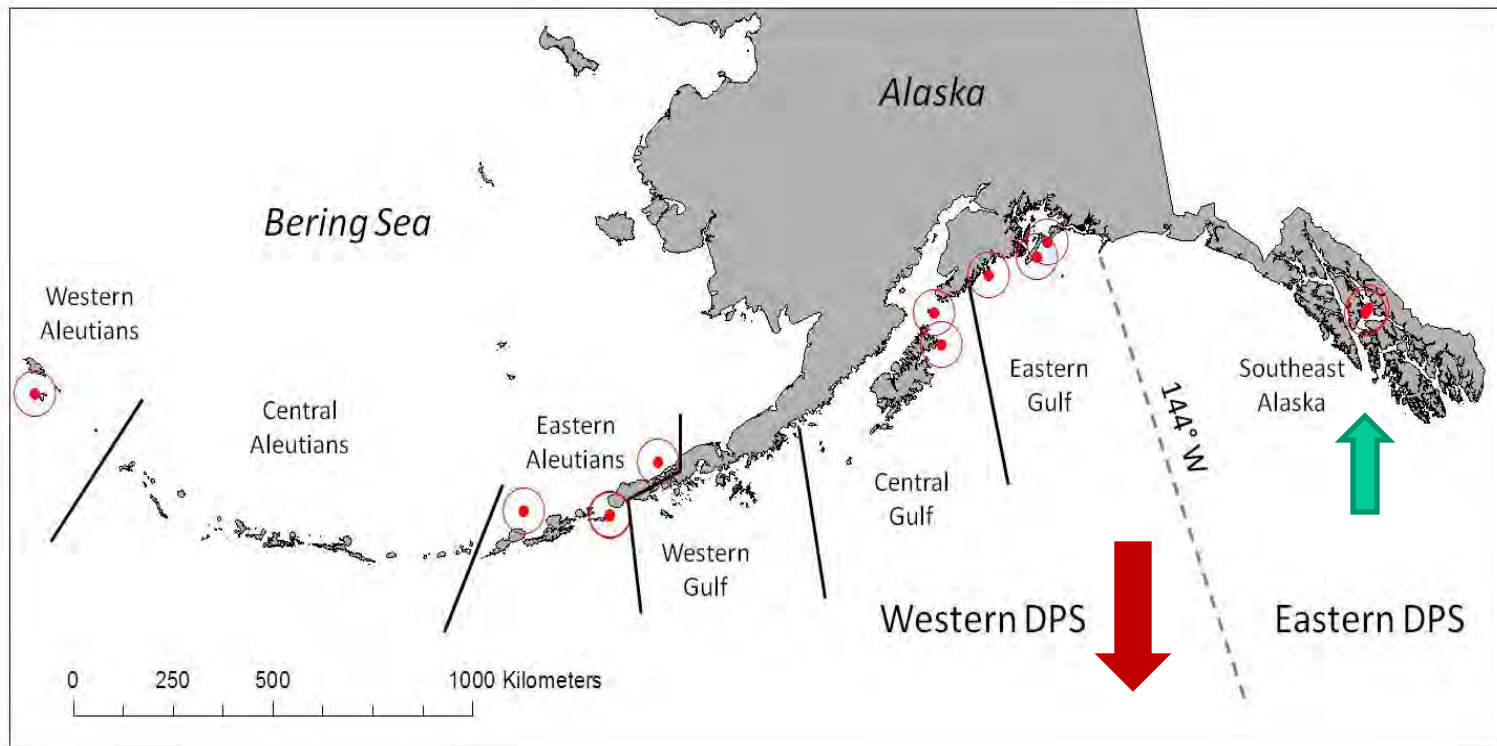
Todd O'Hara



Steller sea lion distribution in Alaska

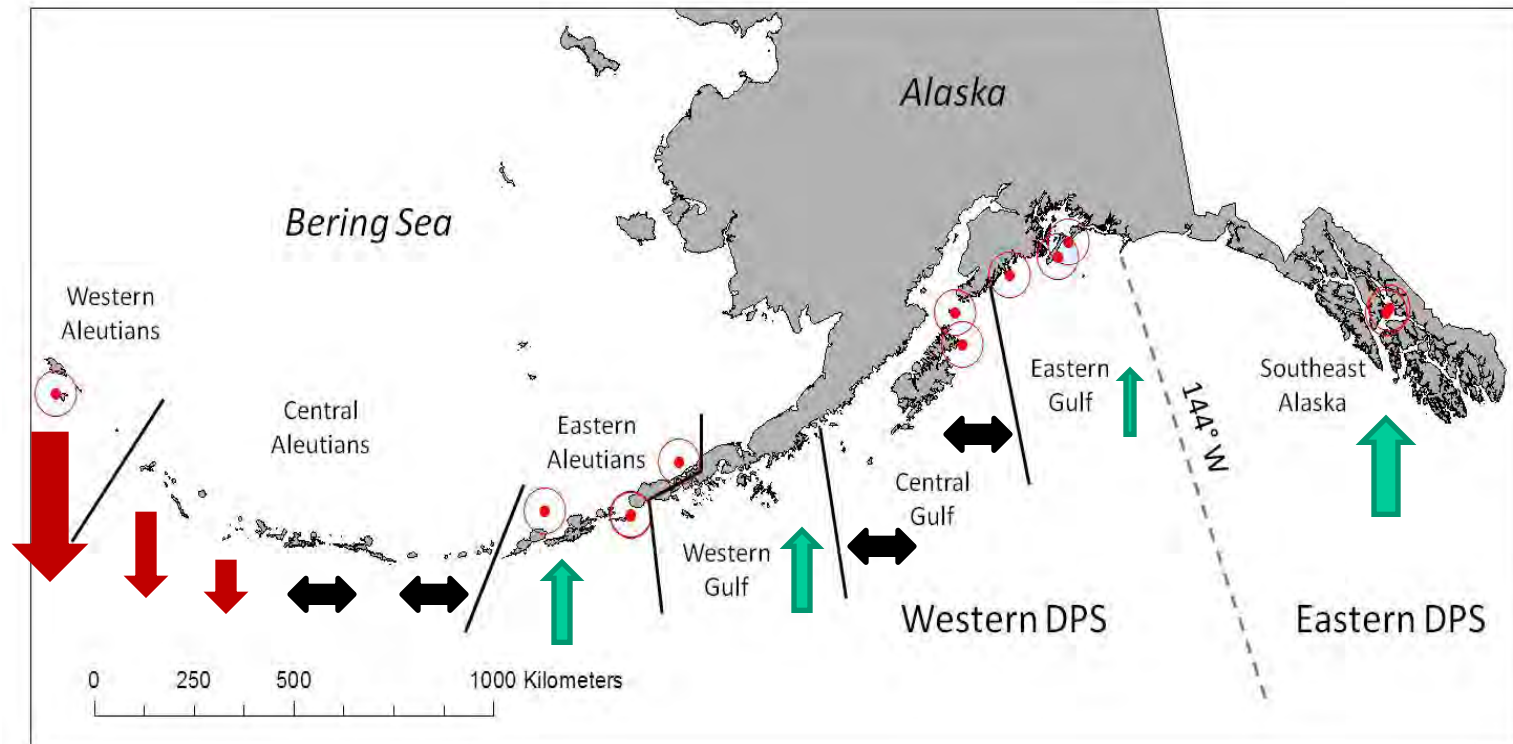
Eastern distinct population segment (DPS) – ESA threatened

Western distinct population segment (DPS) – ESA endangered



Steller sea lion distribution in Alaska

Some propose that low reproductive rates/ poor fecundity may contribute to lack of recovery of the western DPS (Holmes et al. 2007).



Current trend data available in
Fritz and Gelatt 2010

Investigating heavy metal contaminants as a possible contributor to lack of recovery

Mercury (Hg) has been shown to:

- Bioaccumulate and biomagnify
- Be neurotoxic to humans and other fish-eating mammals
- Cause neurochemical changes that impact mammalian health and survival
- Lower reproductive rates in mink
- Be transferred transplacentally to expose fetus

Total mercury concentrations in Alaska Steller sea lions – previous studies

- Beckmen et al. 2002 - young of the year < 3.5 µg/g in hair
juveniles < 7 µg/g in hair
western DPS > eastern DPS
- Holmes et al. 2008 - young pups < 10 µg/g in liver
western DPS > eastern DPS
- Castellini et al. 2012 - young pups > older age classes
young pups < 21.5 µg/g in hair
western DPS > eastern DPS



Young Steller sea lion pups in lanugo (natal pelage)

Total Mercury Concentrations ([THg]) in Steller sea lion hair (young pups highest)

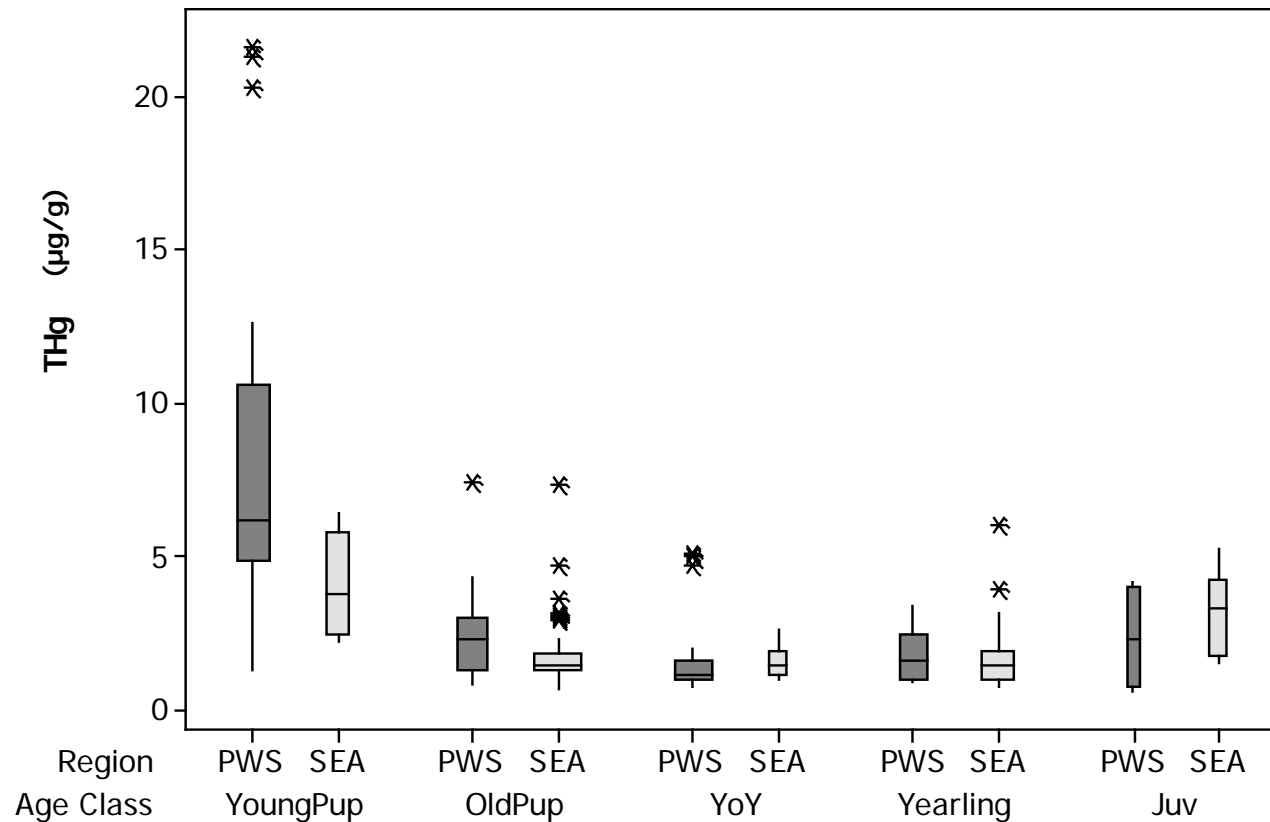
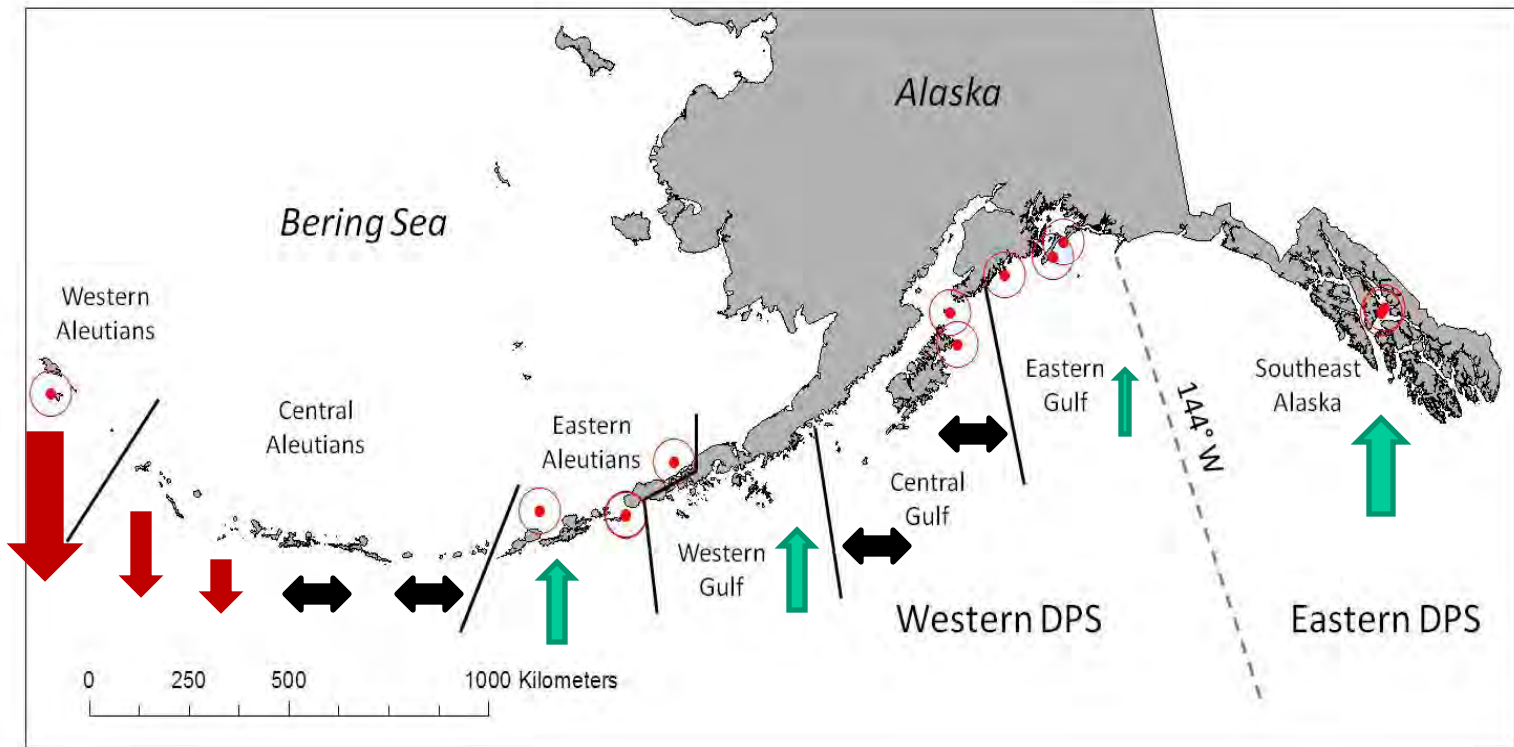
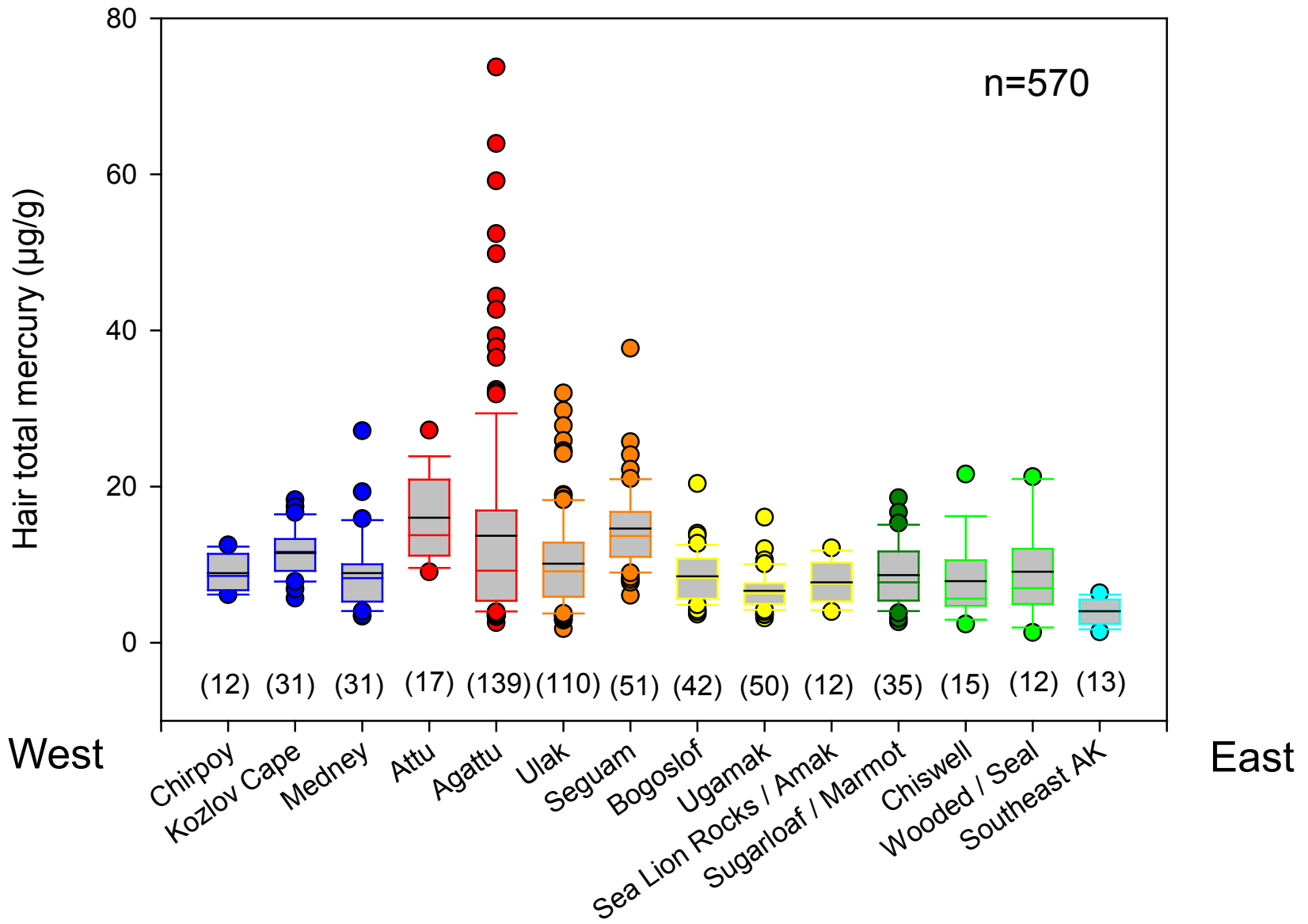


Figure 2: Box and whisker plot of hair [THg] for all age groups from SEA and PWS. Horizontal line represents median, boxes represent the mid 50% distribution, whiskers represent the upper and lower 25% and individual points represent outliers. The width of each bar is proportional to the sample size which is also listed in Table 1.



Rea et al. 2013
 Ugamak to **Agattu** Islands

Castellini et al. 2012
 Southeast AK to Amak Island

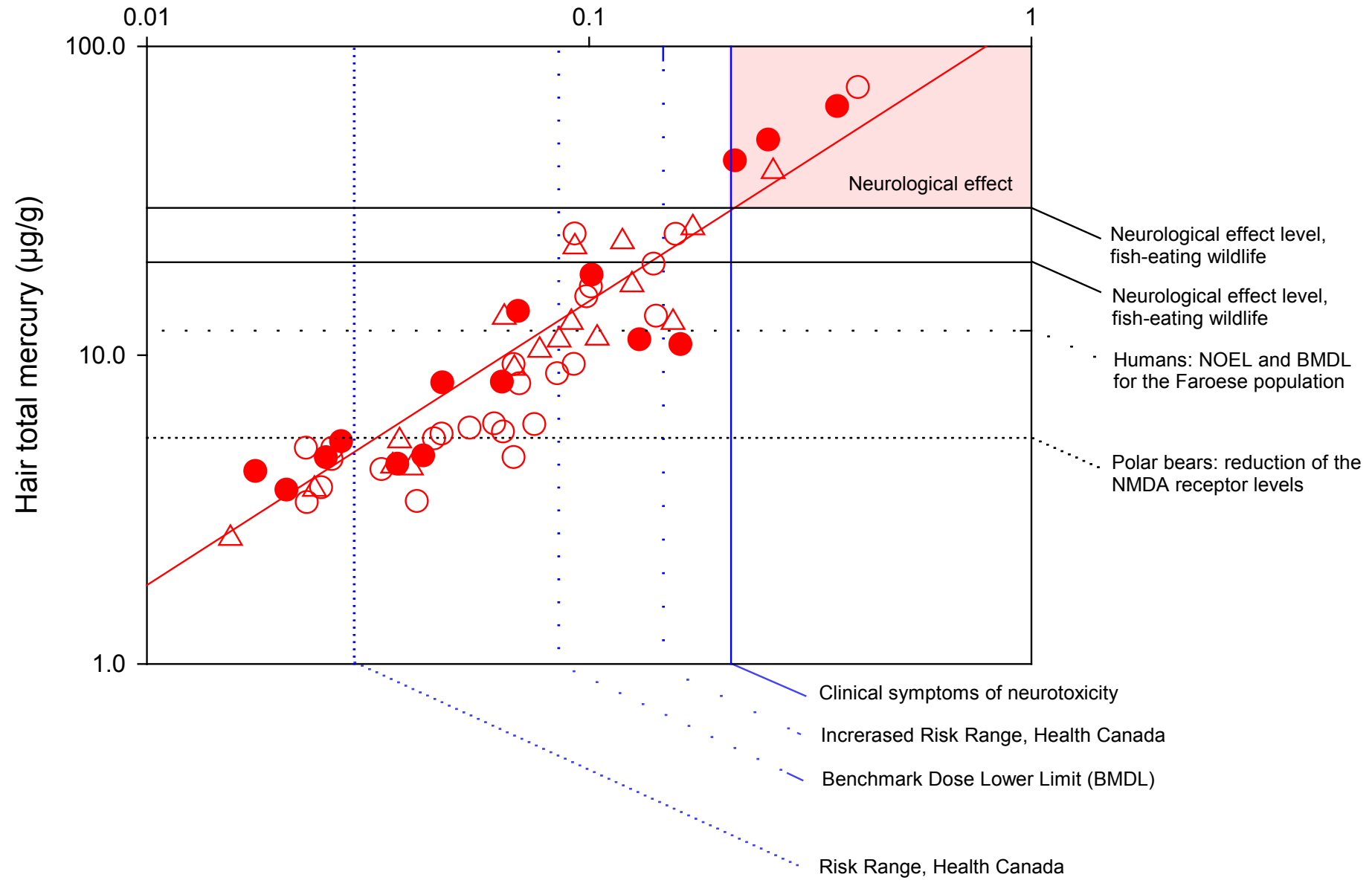


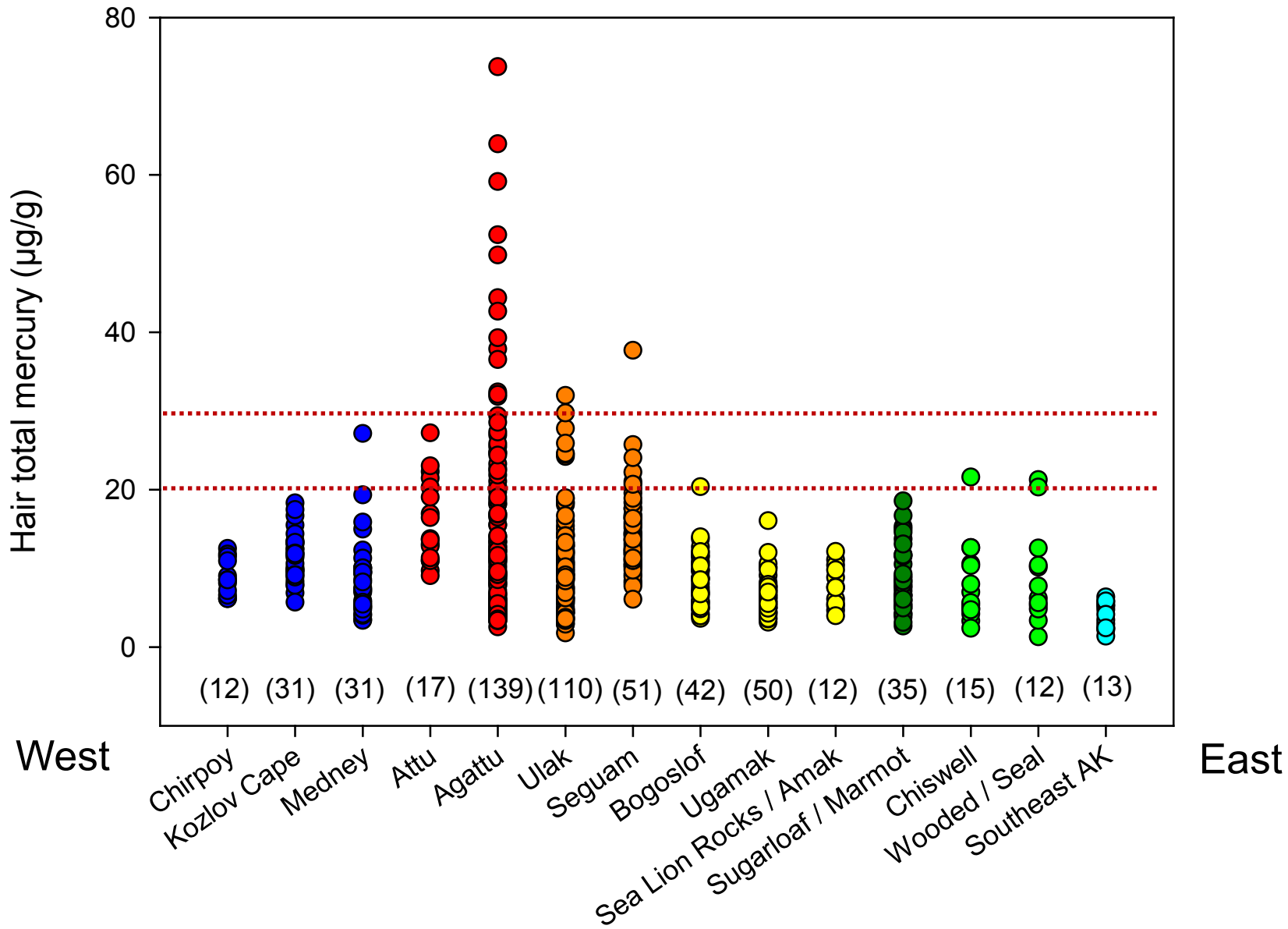
n=570

Rookery Location

Modified from Castellini et al. 2012 and Rea et al. 2013

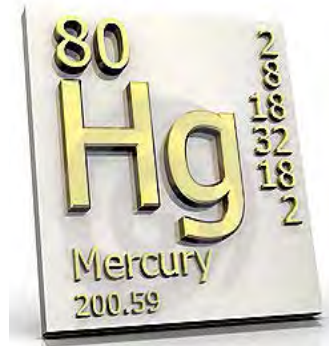
Whole blood total mercury ($\mu\text{g/g}$)





Modified from Castellini et al. 2012 and Rea et al. 2013

Mercury in the environment



Where are they getting the mercury?

Most wildlife are exposed to methylmercury through their diet

The amount of methylmercury in prey items can vary by geographic location and by trophic position of the prey in the food web (biomagnification)

Utilize suckling pups to monitor changes in foraging ecology of their mothers.

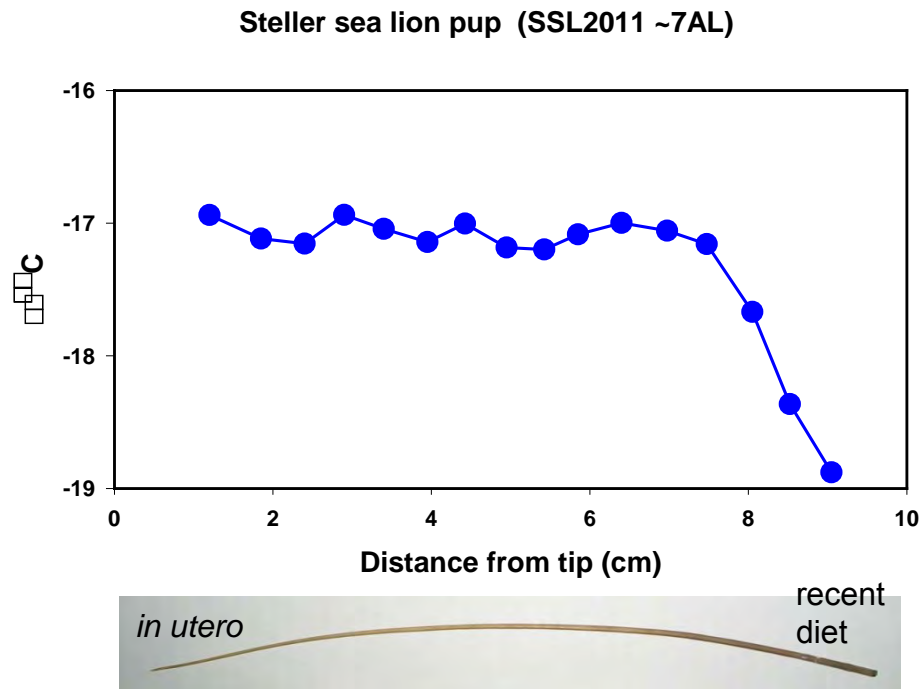


Steller sea lion pups are born with developed vibrissae, thus the tip of the vibrissae represents tissue grown *in utero*, and reflects the maternal diet during this period of fetal development.



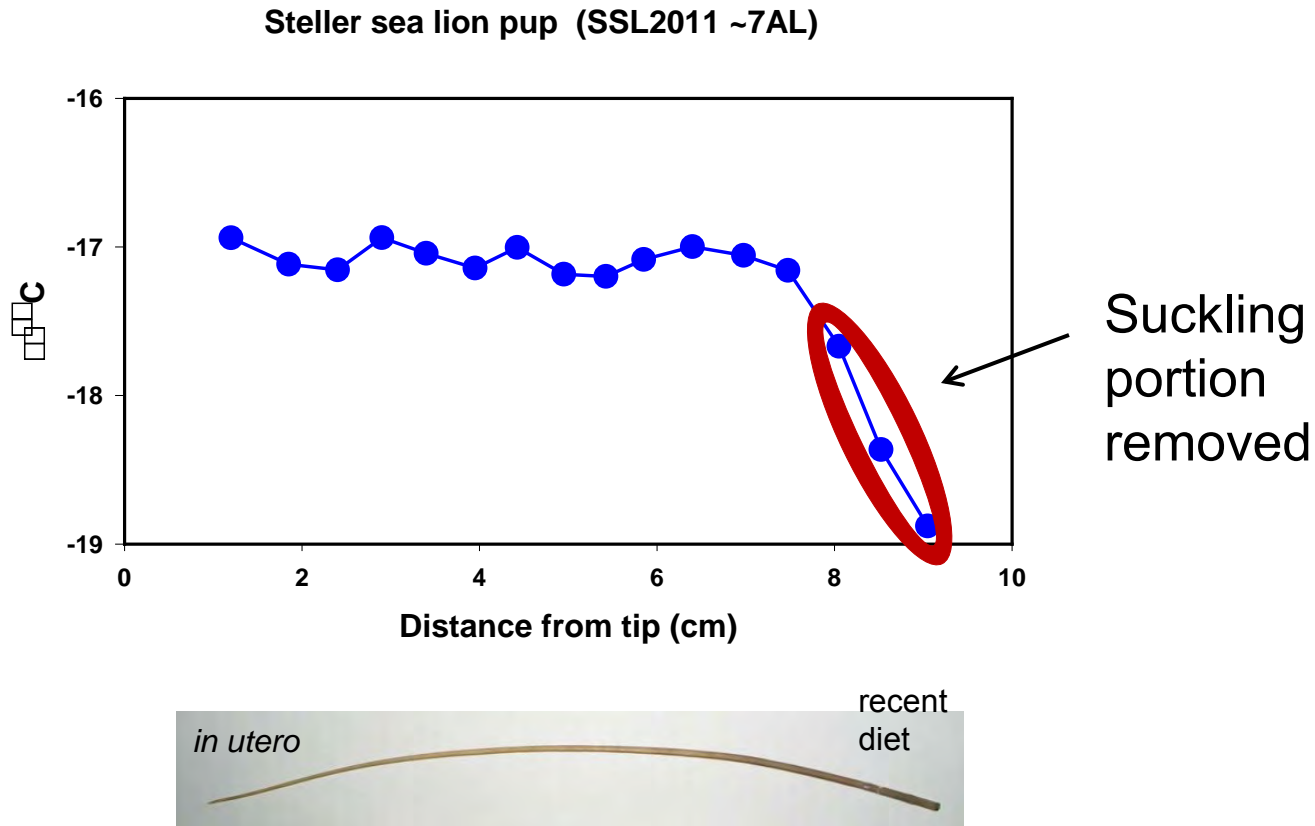
Methods:

- Analyzed the isotope ratios of carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) in pup vibrissae sections ranging from 0.2 to 0.5 mg
- Segments of approximately 0.1 cm were selected every 0.5 cm along the length of the vibrissae from the tip (earliest *in utero*) to the root (representing current nursing signature at capture)



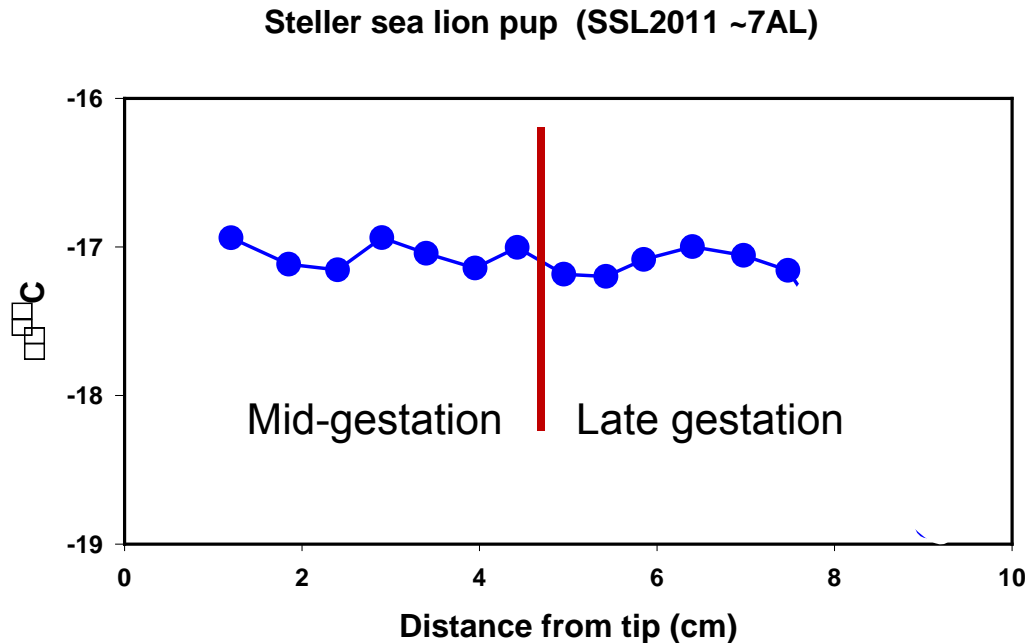
Methods:

- The suckling portion of this vibrissae was identified by the depleted carbon signature seen when feeding on high fat diets

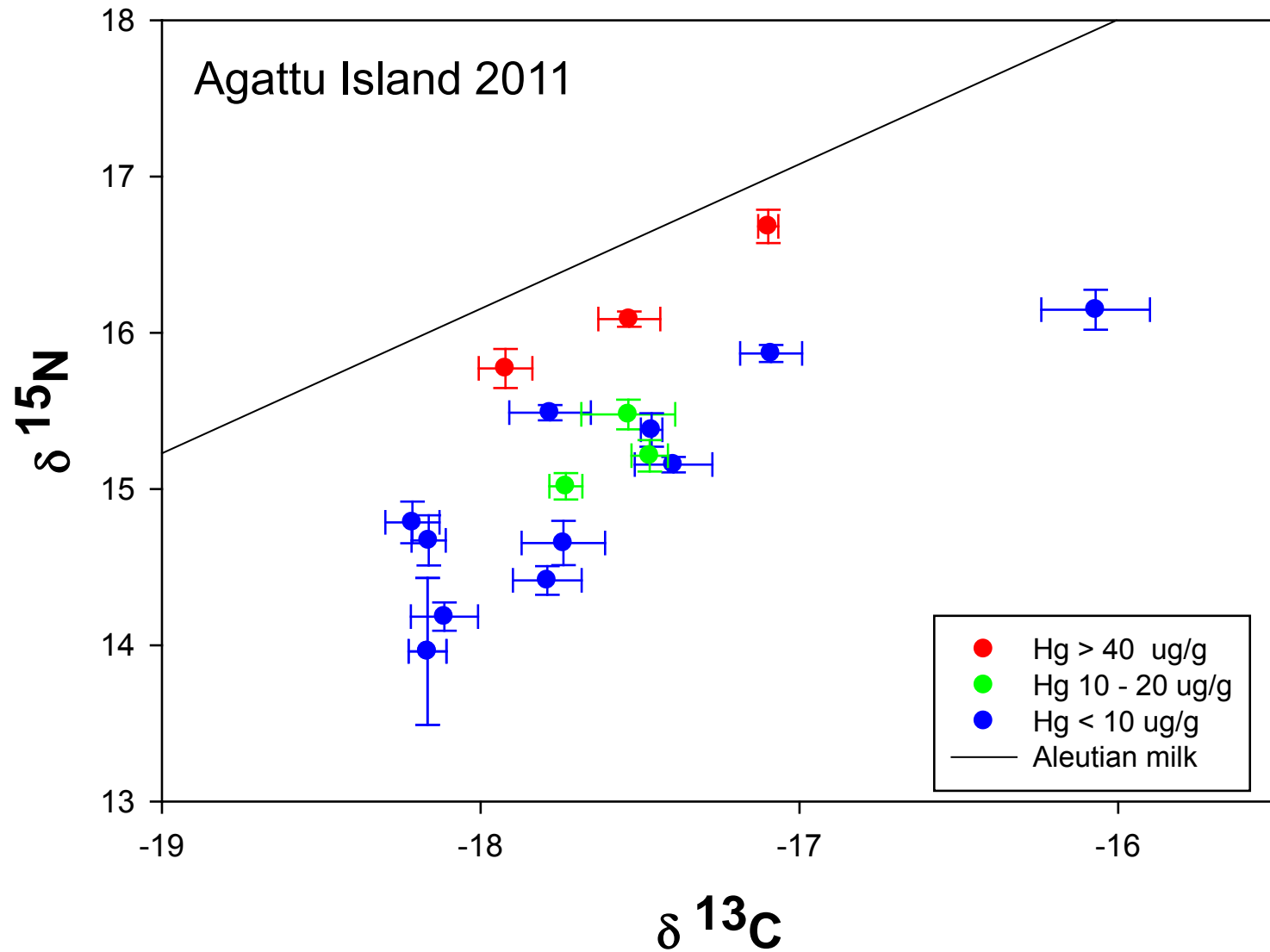


Methods:

- The suckling portion of this vibrissae was identified by the depleted carbon signature seen when feeding on high fat diets - removed
- The remainder of the vibrissa was divided equally in two sections to represent mid- and late-gestation whisker growth



Late gestation mean isotope ratios of the fetal vibrissae



We conclude:

- highest median [THg] found in the hair of young Steller sea lion pups in western Aleutian Islands
- wide range of [THg] in hair at Agattu Island: ~ 20% of surviving fetuses are exposed to relatively high levels of mercury *in utero*
- pups with the highest hair [THg] also showed elevated $\delta^{15}\text{N}$, suggesting that their dams were feeding on higher trophic level prey than pups with low [THg]

The bottom line for Hg...

- Very young (≤ 3 months) pups seem to have the highest total mercury concentrations
- Pups in the more western US populations appear to be exposed to higher levels of mercury through maternal diet
- Higher trophic level prey species likely contribute to the mercury exposure of sea lions
- Need a better understanding of sea lion diet in the western Aleutian Islands



Ongoing and future research:

- Mercury concentration in prey items (overall goal of how contaminants move through food webs)
- Modeling of diet using stable isotopes
- Other contaminants (POPs)
- Adult female contaminants and isotopes
- Retrospective analysis with archive samples
- Protective potential of selenium
- Toxicogenomics
- Immunology impacts

Acknowledgments:

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Questions?



Photo: Shane Moore