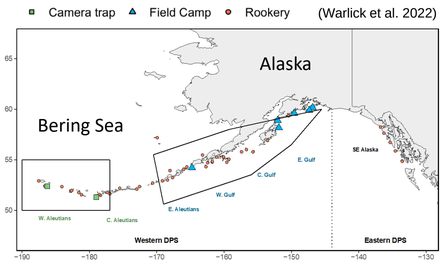


# Relationships among Mercury Concentrations, Sea Surface Temperature, and Survival in Steller Sea Lion Pups in the Aleutian Islands, Alaska

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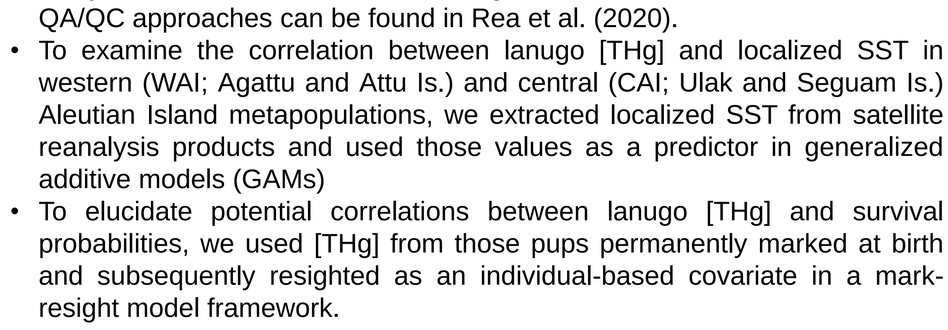
## Background

- Although many Steller sea lion (SSL; *Eumetopias jubatus*) metapopulations within the endangered western Distinct Population Segment have stabilized or shown signs of recovery after declining in the 1970–90's, some Western and Central Aleutian Islands rookeries continue to decline for unknown reasons.
- To examine potential drivers of these divergent abundance trends, we assessed spatio-temporal patterns of total mercury concentration ([THg]) in lanugo (natal hair) of SSL pups and correlations with localized sea surface temperature (SST) and sea lion survival.
- Extensive analyses of lanugo [THg] between 2011 and 2023 show that median [THg] was significantly higher in young pups from natal rookeries in the Western Aleutian Islands (WAI), and at Kiska Island in the Central Aleutian Islands (CAI). (Modified from Rea et al. 2020).

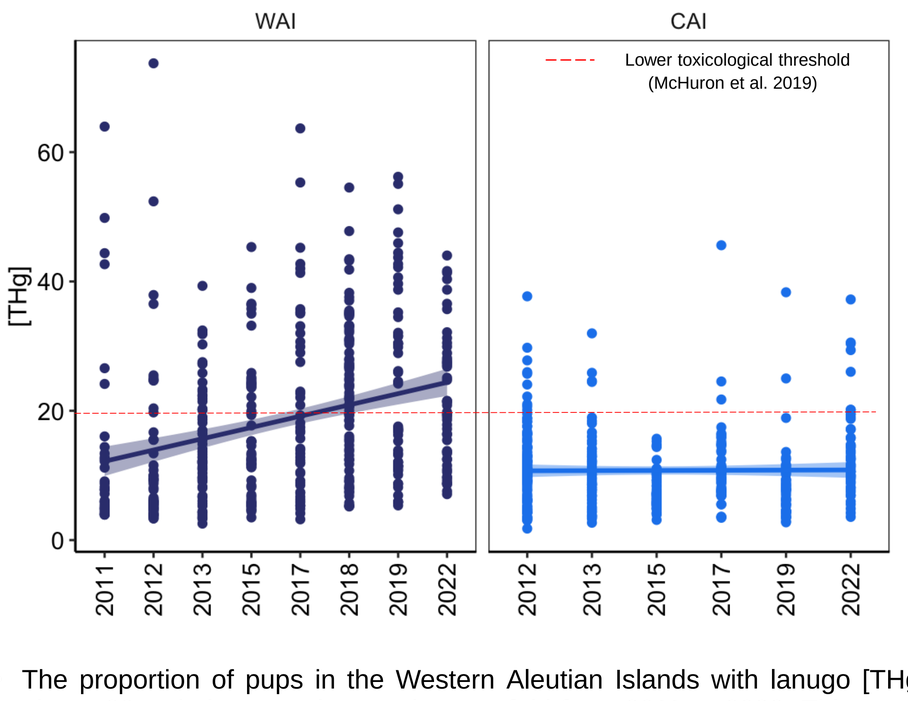



## Methods

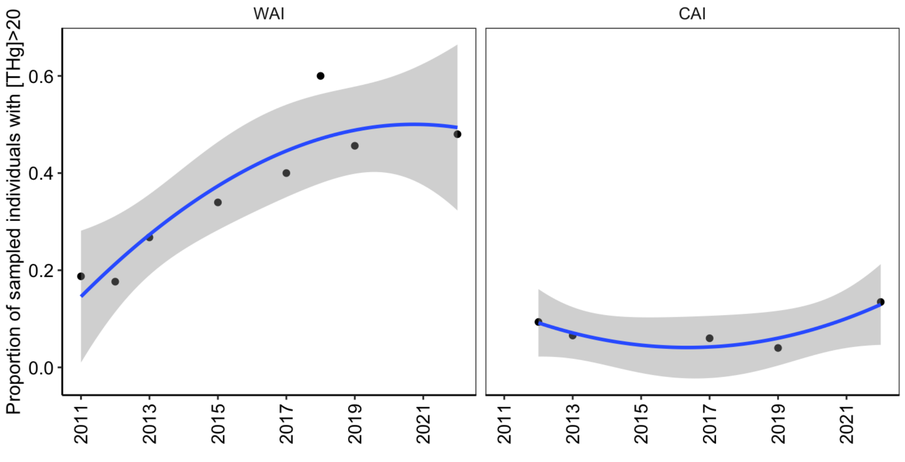
- Lanugo samples (*n*=858) were collected from free-ranging SSL pups on natal rookeries over 8 breeding seasons between 2011-2023. Lanugo [THg] (µg/g dry weight) were quantified in duplicate using a direct mercury analyzer. Detailed methods including standard reference materials and QA/QC approaches can be found in Rea et al. (2020).
- To examine the correlation between lanugo [THg] and localized SST in western (WAI; Agattu and Attu Is.) and central (CAI; Ulak and Seguam Is.) Aleutian Island metapopulations, we extracted localized SST from satellite reanalysis products and used those values as a predictor in generalized additive models (GAMs)
- To elucidate potential correlations between lanugo [THg] and survival probabilities, we used [THg] from those pups permanently marked at birth and subsequently resighted as an individual-based covariate in a mark-resight model framework.

## Results

- In the Western Aleutian Islands we identified a significant doubling in median [THg] in the lanugo from 2011 to 2022, while [THg] in the Central Aleutian Islands did not change significantly.

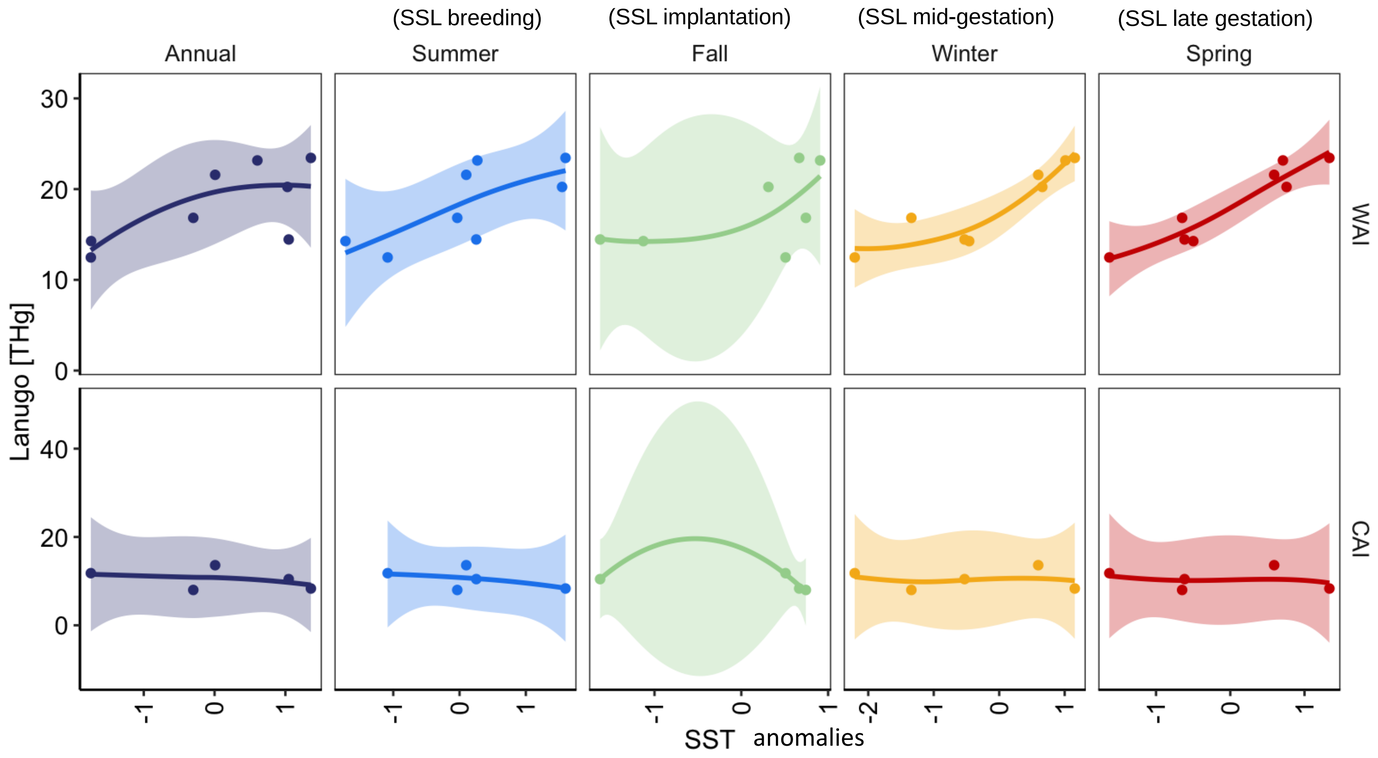



- The proportion of pups in the Western Aleutian Islands with lanugo [THg] above 20 µg/g increased more than twofold from 2011 to 2022. This same pattern was not evident for rookeries in the Central Aleutian Islands.

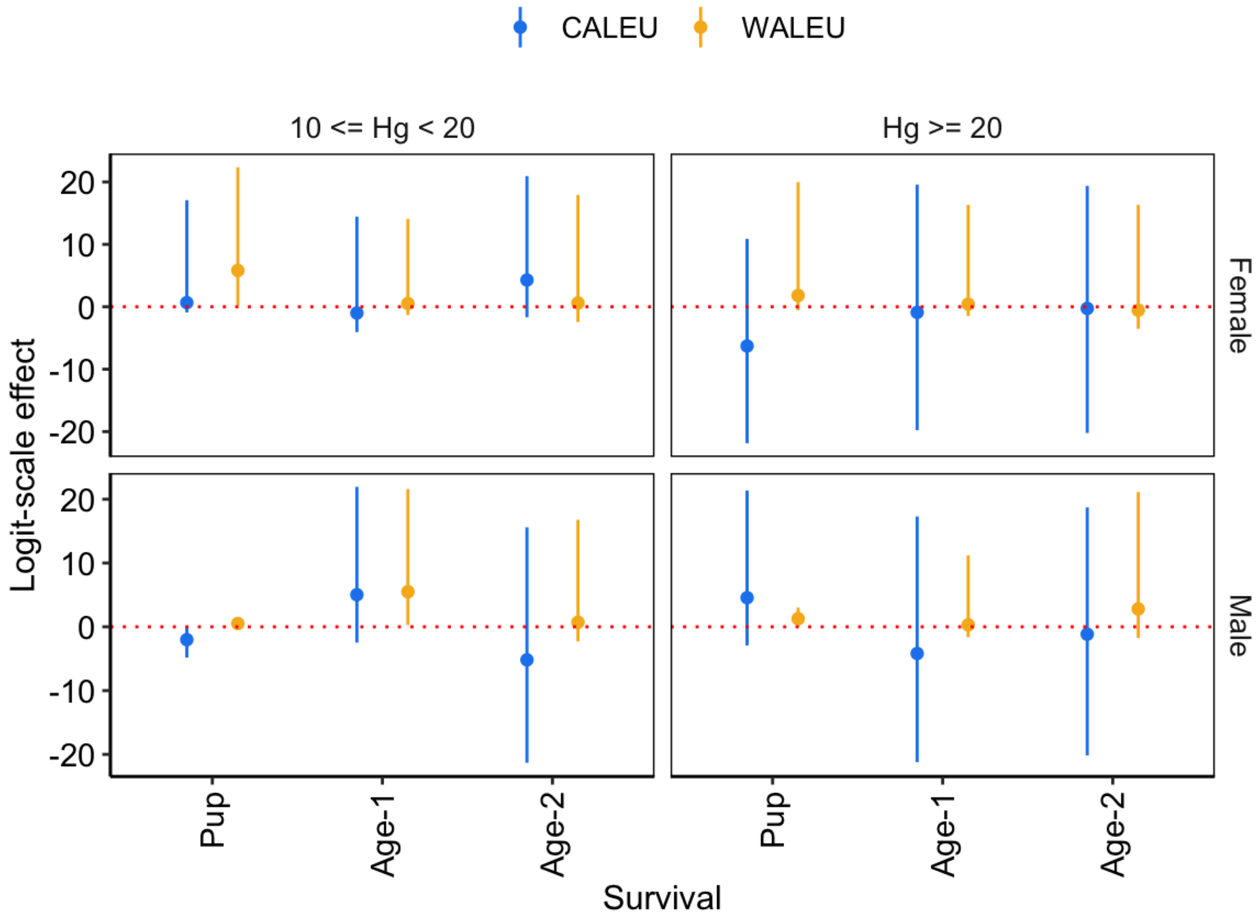



## Results, continued

- Lanugo [THg] and localized sea surface temperatures anomalies showed a positive correlation for individuals sampled from rookeries in the WAI metapopulation born the following summer but not for those from the CAI. Uncertainty ranges were much narrower for the relationship with aggregated seasonal SST values during winter and spring in WAI.




- Preliminary results indicate that having lanugo [THg] above 10 µg/g was weakly positively correlated with pup and yearling sea lion survival over the study period in some metapopulations, though larger sample sizes are needed to elucidate region- and sex-specific effects with greater certainty.




## Conclusions

Increased [THg] in the muscle of fish was also found with increased water temperatures in the Gulf of Maine, even with no increase in environmental Hg emissions (Schartup et al. 2019).

Increasing [THg] with rising sea surface temperatures in the Western Aleutian Islands could indicate increased rates of methylation of inorganic mercury or increased uptake into primary producers in this region – requiring focused research on the base of the food web (e.g., phytoplankton and zooplankton) and baseline mercury concentrations (and transformation dynamics) in water and sediments across this remote region. Finding no increase in [THg] with SST in the Central Aleutian Islands could indicate regionally dependent processes, or that changes in rates of methylation or uptake don't result in large changes in [THg] if environmental sources of THg are low.

Additional years of resighting data will soon be available to further investigate the correlation between [THg] and vital rates in this endangered population.

## Acknowledgements

We thank the members of our field collection teams at Alaska Department of Fish and Game (ADF&G), The Marine Mammal Laboratory/NOAA, the Alaska SeaLife Center and in Russia and the vessel crews who brought them all home safely. We also acknowledge tireless hours of mercury analysis in the laboratory by S. Chandler, K. Corliss, L. Correa, A. Gastaldi, J. Harding, J. Harley, G. Johnson, S. Kennedy, T. Lamken, L. O'Hara, S. Rouse, and M. Templeton.

Research funding was provided through NOAA Cooperative Agreements NA17FX1079, NA04NMF4390170, NA08NMF4390544, NA19NMF4390086, the State of Alaska, UAF (INE and URSA), and Ocean Peace Research Partnership. ADF&G research conducted under MMPA permit #358-1564, 358-1769, 358-1888 and 14325 and ADF&G ACUC #03-002, 06-07, 09-28, 2010-14R, 2011-025Routine and 2012-15Routine. UAF research conducted under IACUC Protocol #594759-2.

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