

# Relationship between trophic level and total mercury concentrations in 5 Steller sea lion prey species

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## Abstract:

Total mercury concentrations [THg] were measured in 5 Steller sea lion finfish prey species collected in the eastern Aleutian Islands to determine if the amount and/or variation in mercury in select prey could explain the wide range of [THg] in sea lion pup hair and blood (Castellini et al. 2012, Rea et al. 2013). Atka mackerel (ATMA; *Pleurogrammus monopterygius*), Pacific cod (PACO; *Gadus macrocephalus*), walleye pollock (WAPO; *Theragra chalcogramma*), arrowtooth flounder (ARFL; *Atheresthes stomias*), and Kamchatka flounder (KAFL; *Atheresthes evermanni*) are known or suspected Steller sea lion diet items (Sinclair and Zeppelin 2002) and thus were chosen as the first focal prey species for this preliminary study. Fish samples (20 individuals per species) were collected and donated by Ocean Peace Inc. from winter 2013 commercial operations in fisheries management area 541. Fish were frozen whole at sea and subsampled at the UAF Wildlife Toxicology Lab for mercury and stable isotope ( $\delta^{13}C$  and  $\delta^{15}N$ ) analyses. The [THg] increased with fork length (fish length) and mass in PACO, KAFL and ARFL ( $p < 0.05$ ) suggesting mercury bioaccumulates with age. PACO and KAFL showed significantly higher [THg] than WAPO, ATMA, and ARFL ( $p < 0.05$ ) although no concentrations exceeded  $0.18 \mu\text{g/g}$ , ww. Thresholds of concern for human consumption of fish are  $1 \mu\text{g/g}$ , ww. More enriched stable nitrogen isotope values in PACO and KAFL ( $12.9 \pm 0.9$  and  $12.2 \pm 0.3$  respectively) suggest that these fish were feeding at a higher trophic levels than the ATMA, ARFL, WAPO ( $10.5 \pm 0.4$ ,  $11.5 \pm 0.5$  and  $10.5 \pm 0.8$  respectively) which could explain the slightly higher mercury levels in these two species.

## Introduction:

Recent research has shown that high total mercury concentrations ([THg]) occur in the lanugo (natal hair) of young Steller sea lion pups, resulting from exposure of the adult female (dam) to dietary mercury while fetal hair was grown *in utero* (Castellini et al. 2012). In addition, research has shown that the highest [THg] were seen in some sea lion pups sampled in the western Aleutian Islands, and that carbon and nitrogen stable isotope values in the whiskers of pups with the highest [THg] indicated that their mothers were feeding on higher trophic level prey species (Rea et al. 2013).

This research has generated a great deal of interest in where these sea lions might be exposed to mercury in their diet (as sentinels and species of concern, Castellini et al. 2012). The purpose for this project was to generate preliminary data on the [THg] and stable isotope signature in 5 different prey species from the fish we had available from the eastern Aleutian Islands, where Steller sea lion [THg] are relatively low. Future studies will measure [THg] and stable isotopes in western and central Aleutian fish to help understand the higher Steller sea lion [THg] in those regions.

## Research Goals:

- Measure [THg] in muscle samples from 5 Steller sea lion prey species to determine the range of mercury concentrations within and between Aleutian finfish species.
- Determine  $\delta^{15}N$  stable isotope levels in muscle (primary protein source in the diet) to determine if [THg] is higher in finfish species that feed at a higher trophic level in the food web.

## Method/Materials:

### Sample Collection

Fish samples included 20 individuals from 5 different species: Atka mackerel (ATMA), Pacific cod (PACO), walleye pollock (WAPO), arrowtooth flounder (ARFL), and Kamchatka flounder (KAFL) subsampled from winter 2013 commercial fishery operations in the eastern Aleutian Islands (fishery management area 541). Fish were shipped frozen and stored at  $-20^{\circ}\text{C}$  until analysis. Muscle samples ( $\sim 5$  g) were collected from the left filet from each partially thawed fish. Samples were freeze dried (percent moisture recorded) and homogenized using a Retsch Cryomill (Retsch Inc, Newton, PA).

### Mercury analysis

Approximately 0.020g of homogenized dried muscle was analyzed in triplicate for total mercury concentrations [THg] in each fish using a DMA-80 direct mercury analyzer (Milestone, Inc, Shelton, CT; EPA Method 7473, QA/QC protocol described in Castellini et al. 2012).

### Stable isotope analysis

Approximately 0.5 mg of homogenized dried muscle was placed into a tin capsule and sealed for analysis of  $\delta^{15}N$  levels relative to standards at the Alaska Stable Isotope Facility, University of Alaska Fairbanks (Federer et al. 2010).

## Results:

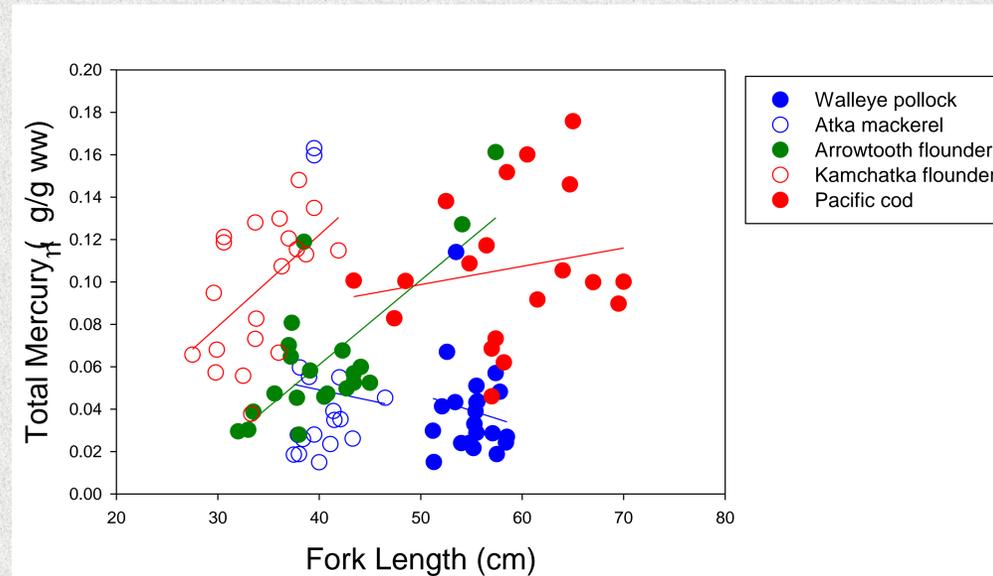


Figure 1. Relationship between total mercury concentration and fork length (cm) in 5 Steller sea lion prey species from the eastern Aleutian Islands.

The [THg] increased with fork length (fish length) and mass in PACO, KAFL and ARFL ( $p < 0.05$ ) suggesting mercury bioaccumulates with age in these species. PACO and KAFL showed significantly higher [THg] than WAPO, ATMA, and ARFL ( $p < 0.05$ ) although no concentrations exceeded  $0.18 \mu\text{g/g}$ , ww. For reference, thresholds of concern for human consumption of fish are  $1 \mu\text{g/g}$ , ww.

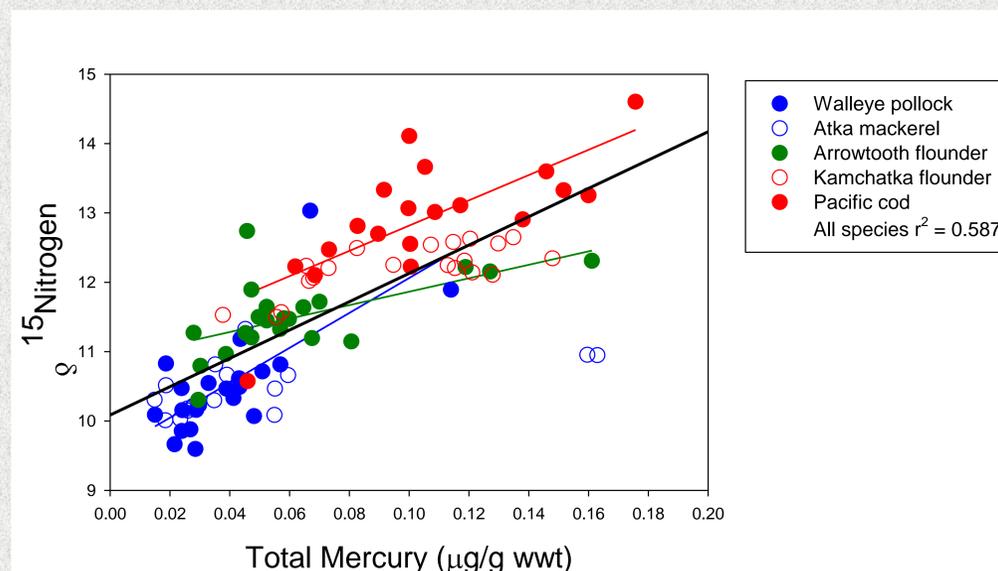


Figure 2. Relationship between stable nitrogen isotope ( $\delta^{15}N$ ) and Total Mercury [THg] in 5 Steller sea lion prey species in the eastern Aleutian Islands.

More enriched stable nitrogen isotope values in PACO and KAFL ( $12.9 \pm 0.9$  and  $12.2 \pm 0.3$  respectively) suggest that these fish were feeding at a higher trophic levels than the ATMA, ARFL, WAPO ( $10.5 \pm 0.4$ ,  $11.5 \pm 0.5$  and  $10.5 \pm 0.8$  respectively) which could explain the slightly higher mercury levels in these two species

## Conclusions:

- In 3 of the 5 prey species (ARFL, KAFL and PACO) [THg] linearly increased with length of the fish suggesting that [THg] bioaccumulates with age in these species. It is possible that this relationship would have been seen in the ATMA and WAPO if there were a wider range of fork lengths in our sample. It is possible that only one age class was sampled in this trawl by the fishery.
- Prey species with higher concentrations of mercury were found to feed at higher trophic levels based on enriched stable nitrogen isotopes, than those species with low concentrations of mercury.

## Literature Cited:

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