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North Pacific Marine Mammals Populations Rocked by Heavy Metal Concentrations

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BACKGROUND

- Heavy metals may have negative effects on the environment and living organisms
- Anthropogenic and natural sources
- Essential (Cu, Cr, Mn, Ni, Se, Zn) and non-essential (As, Cd, Co, Hg, Pb, V) metals
- Bioaccumulation and biomagnification may cause toxicity
- Body tissues (organ and soft tissue and vibrissae)
- **Harbor seal** (*Phoca vitulina*)
  - Alaska Species of Special Concern
  - From 1978-1988 species decline from 11,000 to 1,000 seals
  - 63% decline of seals in Prince William Sound from 1984-1997
  - Strong site-fidelity and non-migratory
  - Vibrissae n= 9; Body tissues n= 26

- **Northern fur seal** (*Callorhinus ursinus*)
  - Vulnerable under the IUCN Red List
  - Declined up to 50% since the 1950s
  - Pribilof Islands, Bering Sea constitute the largest rookeries
  - Eight-month pelagic migration from breeding grounds to forage at Gulf of Alaska, northern Pacific Ocean, or California Current
  - Vibrissae n= 6

- **Steller sea lion** (*Eumetopias jubatus*)
  - Two populations: eastern and western stock
  - Western stock is federally endangered
  - Do not migrate, but may travel hundreds of kilometers as they move between rookeries, haul-out sites, and feeding locations
  - Vibrissae n= 16; Body tissues n= 15

- **Northern sea otter** (*Enhydra lutris*)
  - Three stocks: southeastern, southcentral, and southwestern Alaska; Southwest Alaska stock is threatened under the ESA
  - Populations declined by 90% in some areas
  - Remain in a home location that can range up to 40 sq. km
  - Vibrissae n= 19

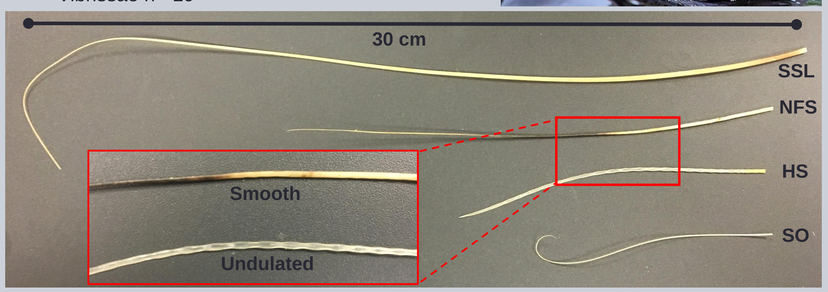


Figure 1. Comparison of vibrissae (whiskers) from Steller sea lions (SSL), northern fur seals (NFS), harbor seals (HS), and northern sea otters (SO).

OBJECTIVES

- Are heavy metals recorded in keratinous tissues? (Figure 1)
- Do concentrations of different heavy metals vary among body tissues in pinnipeds and fissipeds?
- Establish a baseline of heavy metal concentrations in the four target marine mammal species to better understand the potential role of heavy metal exposure in their population dynamics.

METHODS

- Body tissues and vibrissae collection (Figure 2):
  - 1990s adult and subadult, subsistence harvested animals
  - Vibrissae, muscle, liver, blubber, kidney, brain, collagen, heart, skin, fur, tendon, toenail

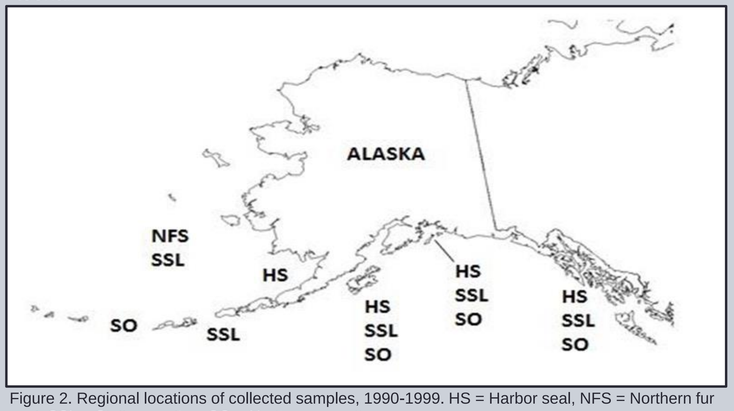


Figure 2. Regional locations of collected samples, 1990-1999. HS = Harbor seal, NFS = Northern fur seal, SSL = Steller sea lion, SO = Northern sea otter

- Arsenic (As), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), selenium (Se), vanadium (V), zinc (Zn)
- All samples were cleaned, dried, weighed, and measured for length
- Digestion process:
  - 5 mL concentrated, trace metal grade nitric acid
  - Modblock at 60˚C until completely digested
  - Diluted to 50 mL with ultrapure deionized water
- Atomic absorption (AA) flame emission spectrometry - Shimadzu AA-6200 equipped with a Hydride Vapor Generator (Shimadzu HVG-1)
- Five standard solutions were used to create the calibration curves
- Quality control consists of a blank of combined ultrapure deionized water and nitric acid before each sample, and metal standards every fifth sample

	Number of Reps	Max. Number of Reps	RSD limit	SD limit
Blank	2	2	99.9	0
Standard	2	3	5	0.005
Sample	3	5	7	0.008
Reslope	2	3	5	0.005

- All data were calculated as µg of metal ions per gram of sample (µg/g), also known as parts per million (ppm)

RESULTS

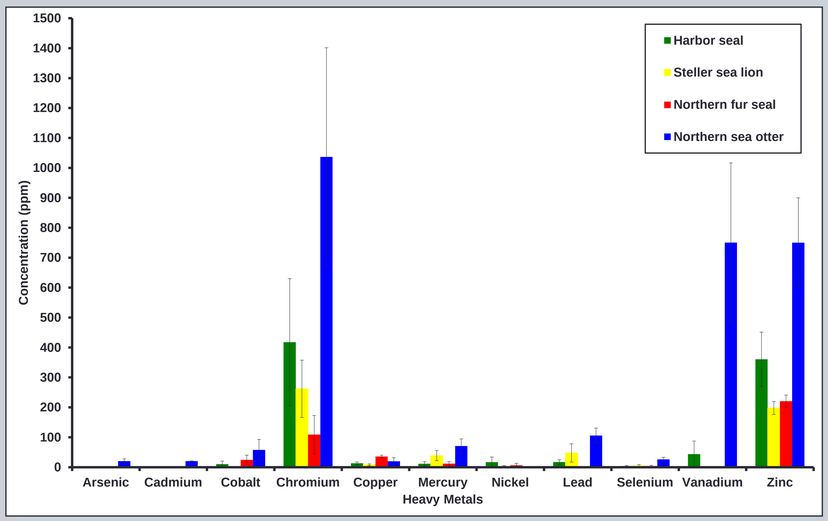
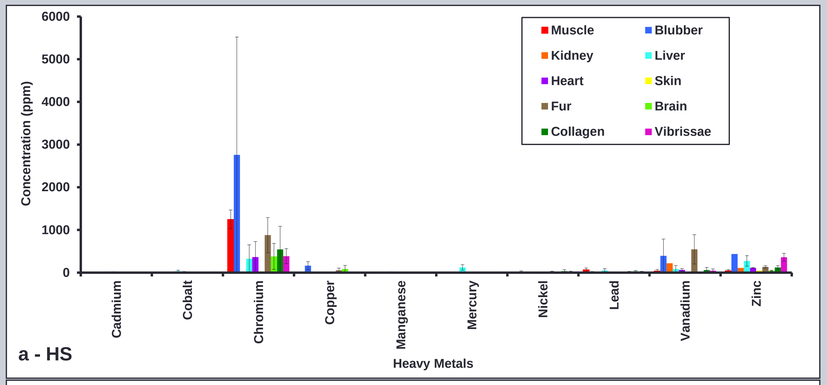


Figure 3. Mean concentration (ppm) of heavy metals in vibrissae of HS, SSL, NFS, and SO

RESULTS



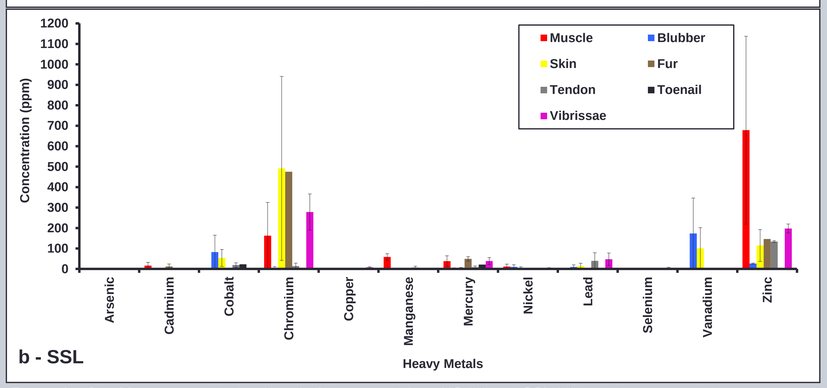


Figure 4 a & b. Mean concentration (ppm) of heavy metals in HS (a) and SSL (b) body tissues and vibrissae.

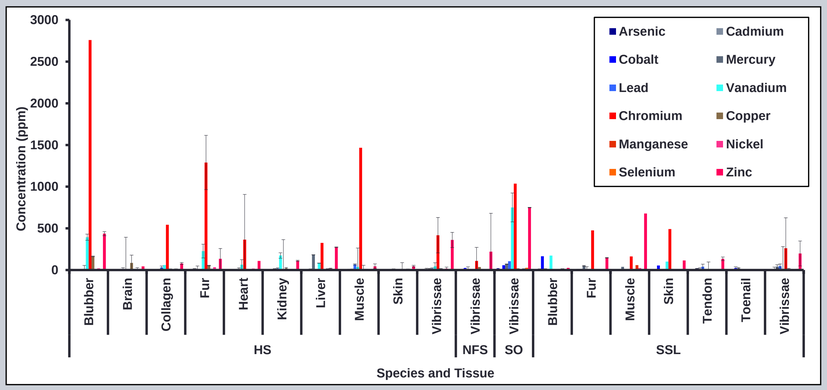


Figure 5. Mean concentrations (ppm) of essential (shades of red) and non-essential (shades of blue) metals in body tissues of HS and SSL and vibrissae of NFS and SO.

KEY FINDINGS

- Significant differences among species were detected for Cd, Cu, Pb, V, Zn in vibrissae (Figure 3)
- No significant differences in metal concentrations among HS or SSL body tissues were detected (Figure 4 a & b)
- A significant difference between essential and non-essential metals among species was detected; however there was no significant difference among body tissue types for all species (Figure 5)

➢ Compare heavy metal concentrations among modern and captive animals and potential prey

➢ Spatial and temporal comparisons for an understanding of source, diet, and bioaccumulation

ACKNOWLEDGMENTS

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