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LEAD IN SEA OTTERS

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Abstract: : As yet there is no direct evidence that environmental pollutants affect sea otter populations. However, this may be from lack of looking. The first steps in these investigations are to measure levels of potential environmental contaminants in sea otters, determine whether these levels vary among populations, and compare the findings with those from other mustelids/otters for which there is a known or suspected impact. Our approach is to compare measurements between Alaska, where sea otter populations are thriving, and California where the otter population is at best showing a sluggish increase

As yet there is no direct evidence that environmental pollutants affect sea otter populations. However, this may be from lack of looking and an interest is developing in the environmental toxicology of sea otters for three main reasons. First, other mustelids are known or thought to be adversely affected by certain environmental toxicants. The decline or local extinction of *Lutra lutra* from much of Europe and *L. canadensis* from parts of North America are believed to be largely the result of PCB contamination (Foster-Turley et al. 1990). Second, a number of environmental pollutants occur at alarmingly high levels in the eastern North Pacific Ocean. And third, population growth of the California sea otter population has been less than one-third that measured in other sea otter populations (Estes 1990).

The first steps in these investigations are to measure levels of potential environmental contaminants in sea otters, determine whether these levels vary among populations, and compare the findings with those from other mustelids/otters for which there is a known or suspected impact. Our approach is to compare measurements between Alaska, where sea otter populations are thriving, and California where the otter population is at best showing a sluggish increase.

In this report we summarize initial results from measurements of lead in the teeth of sea otters from Amchitka Island in the western Aleutian archipelago, and central California. Lead is preserved in bone and teeth because it competes with calcium in the biosynthesis of calcified tissues, and is retained in the calcified tissue matrix. Lead also occurs as one of several stable isotopic forms that can be accurately detected and quantified by using ultra-clean trace metal techniques. Because isotopic ratios vary in natural leads from different geographic regions, and because local leads with distinctive isotopic signatures are used in different regional petroleum refineries, it is possible to identify both the level and source of lead in sea otters. Teeth were collected from extant populations and aboriginal middens at Amchitka Island (western Aleutian Islands) and central California. The midden teeth provide background levels and isotopic signatures from before the industrial revolution. Results from the Aleutian Islands are summarized from Smith et al 1990: those from California are presently being written up for publication by Smith et al. (unpubl. ms.).

Aleutian Islands

Carbon-14 dates indicated that midden teeth from Amchitka Island were about 1900±230 years old, predating the Industrial Revolution by a substantial margin. We were surprised initially to find that total lead burdens had not changed significantly from pre-industrial revolution times (on average, teeth from extant animals contained about 1.5x more lead than did the midden teeth), contrasting with 10-100x increases in many other marine organisms. The explanation for low lead levels in present-day sea otters is not simply that ambient lead levels are low in the remote Aleutian Islands since lead has been

broadly and rapidly dispersed on global scales via winds and ocean currents. Rather, it is probably due largely to biodepletion at higher trophic levels owing to the abundance of marine calcium and lead replacement as tissues are reprocessed by consumers. Despite this low increase in total lead, the isotopic ratios indicated a marked change in the source of lead between prehistoric and present times. Lead in the preindustrial sea otters was derived from natural deposits in the Aleutian arc, presumably having arisen from plio-pleistocene volcanic material. In contrast, contemporary otters contained a mixture of Asian and Canadian industrial leads with loss than 10 % having been derived from natural Aleutian arc materials. The presence of Asian and Canadian leads, and the virtual absence of U.S. industrial leads in contemporary Aleutian Island sea otters, is explainable through transport via ocean currents. Asian lead presumably is picked up by the northward flowing Kuroshio Current, which swings eastward well south of the Aleutian Islands to form the Subarctic Current. This, in turn, swings northward to form the Alaska current along the coast of British Columbia, then westward bathing the Aleutian Islands.

In addition to demonstrating that total lead burdens in Aleutian Islands sea otters have not increased markedly from prehistoric times, these results indicate that total lead measures by themselves can be highly misleading indicators of anthropogenic lead input to marine systems. The relatively low lead levels in contemporary sea otters was likely due to biodepletion in a system that undoubtedly contained markedly increased lead levels from contemporary industrial sources.

California

Similar methods and comparisons were made for lead levels in California sea otters. All materials were from the Big Sur/Monterey Bay coast and the midden teeth were radiocarbon dated at 800-3000 years old. On average, midden teeth in California contained about twice as much total lead as those from the Aleutian Islands. Isotopic ratios indicated that these older leads were derived mainly from natural continental-derived sources. Contemporary specimens varied broadly in total lead burden, from about 2x to > 10x average levels in the rnidden teeth and contrasting markedly with the similar load burdens found between pro-industrial revolution and contemporary teeth in the Aleutian Islands. The explanation for the difference between California and the Aleutian Islands remains uncertain, although the broadly elevated lead burdens in teeth of contemporary sea otters probably results from ambient lead levels in the modern California environment, that are sufficiently high to override biodepletion at increased trophic levels. The high variation among individuals is also puzzling, although it may result from variable lead inputs associated with individual dietary patterns or the possibility that the home ranges of some of these animals were centered near local lead "hot spots". Lead isotopic ratios again indicated a change in source of accumulated lead, from natural continental-derived lead in the preindustrial animals to industrial sources dominated by particulate aerosol leads in the contemporary animals. One exception was a single contemporary animal from Monterey Bay which contained high levels of lead derived from an industrial waste lead deposit in Monterey Harbor.

REFERENCES

Estes, J.A. 1990. Growth and equilibrium in sea otter populations. *J. Anim. Ecol*. **59**:385-401.
Foster-Turley.P., Macdonald, S., and Mason, C. (eds.). 1990. Otters. An Action Plan for their Conservation. IUCN/SSC, Gland, Switzerland
Smith, D.R., Niemeyer, S., Estes, J.A. and Flegel, A.R. 1990. Stable lead isotopes evidence anthropogenic contamination in Alaskan sea otters. *Environ. Sci. & Tech*. **24**: 1517-1522