NRPA Bulletin

Statens strålevern

Caesium-137 in Arctic marine mammals

The common perception of the Arctic as a pristine wilderness and the vulnerability of its ecosystems have contributed to an increase in the amount of interest and attention focused on these regions. Much of this attention has been in relation to pollutant levels in the Arctic and its ecosystems, with concern over bioaccumulation of part of this pollution load and possible biomagnification through food webs. Current investigations reveal that activity concentrations of ^{137}Cs in arctic marine mammals are low and far below national food intervention limits.

Contamination of the Arctic Marine Environment

Caesium-137 (^{137}Cs) contamination of the Arctic marine environment has occurred directly through global fallout from atmospheric weapon testing conducted in the 1950's and 1960's and through long-range transport of discharges from European reprocessing facilities and coastal water contaminated by Chernobyl fallout. Additional contamination may also result from the transport and melting of contaminated sea-ice.

The Vulnerability of marine mammals to radionuclide contamination

There is a rich abundance and diversity of marine mammal fauna within the Arctic. Ice-edge effects and nutrient rich up wellings give rise to areas of high primary production, supporting a range of resident and seasonally migrating marine mammals. Chief among these are the polar bear, walrus and several seal and whale species. The short food chains that are typical of Arctic ecosystems can result in a rapid and efficient transfer of contaminants to top consumers. Certain marine biota such as crustaceans, molluscs and marine algae exhibit very high uptake rates of certain anthropogenic and natural radionuclides, which may then biomagnify through the food chain. Additionally, the tendency for Arctic food chains to depend on benthic and sympagic systems provides an efficient mechanism for the biomagnification of contaminants, while the longevity of top consumers in these food chains allows for the potential accumulation of contaminants over long periods of time.

Figure 2. The specific nature of Arctic food chains, may allow the efficient transfer of radionuclides to consumers such as the bearded seal (pictured).

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Monitoring of Caesium-137 in marine mammals

In association with the Norwegian Polar Institute, the Norwegian Radiation Protection Authority has conducted monitoring of ^{137}Cs contamination in Arctic marine mammals.

Cs-137 activity concentrations in all marine mammals were low or below the limits of detection. Average activity concentrations of ^{137}Cs in muscle from Arctic marine mammals were highest in polar bears. The average activity concentration of ^{137}Cs in polar bears from Svalbard in 2000 to 2003 was lower compared to values in animals from Svalbard in 1980, but higher than those reported in polar bears from other Arctic regions in the 1990's.

Cs-137 activity concentrations in muscle from ringed seals, harp seals and bearded seals were comparable to previously reported values for these species within the Arctic. No previous assessment of ^{137}Cs in hooded seals has been reported.

Cs-137 activity concentrations in muscle from single samples of two whale species were within the range of the other marine mammals in this study, but below the limits of detection in a single sample of a walrus.

The activity concentrations of ^{137}Cs in marine mammals are principally dependent on the concentrations within prey species and so differences in diet may account for some of the observed variation between species. In addition to diet, differences in ^{137}Cs assimilation efficiencies between species, prey availability, feeding rates and migration patterns may all impact on the observed ^{137}Cs activity concentration within the muscle of a given marine mammal.

In seals, ^{137}Cs activity concentrations, although often similar in magnitude, are typically higher than those for lower trophic levels, suggesting that ^{137}Cs is biomagnified through marine food chains to these consumers.

In the case of polar bears, it is difficult to assess any degree of ^{137}Cs biomagnification through the marine food chain to these top predators due to the lack of information on recent feeding histories on animals prior to their death.

Future Directions

Continued monitoring of marine and mammals and other marine biota in the Svalbard region is required to provide information on trends in radionuclide levels and the long-term consequences of existing and future sources of radioactive contaminants.

Species	n.	Year	Location	^{137}Cs (Bq/kg w.w.)
Polar bear (*Ursus maritimus*)	12	2000-2003	Svalbard	0.72 ±0.65
Ringed seal (*Phoca hispida*)	17	2003	Svalbard	0.49 ±0.07
Harp seal (*Phoca groenlandica*)	12	2003	Barents Sea	0.39 ±0.10
Hooded seal (*Cystophora cristata*)	6	2002	N. Greenland Sea	0.32 ±0.07
Bearded seal (*Erignathus barbatus*)	7	2000/2002	Svalbard	0.22 ±0.12
White Whale (*Delphinapterus leucas*)	1	2000	Svalbard	0.67 ±0.06
Blue Whale (*Balaenoptera musculus*)	1	2001	Jan Mayen	0.24 ±0.04
Walrus (*Odobenus Rosmarus*)	1	2002	Jan Mayen	<0.2

Table 1. Activity concentrations of ^{137}Cs in muscle of Arctic marine mammals in the period 2000 to 2003. Where n is greater than one, average value ±S.D is shown.