Plutonium Transfer to Wildlife at Legacy Sites

M.P. Johansen[1], D.P. Child[1], J.J. Harrison[1], S. Kamboj[2], W. W. Kuhne[3], T.E. Payne[1], S. Thiruvoth[1], and M.D. Wood[4]

[1]*Australian Nuclear Science and Technology Organisation, Lucas Heights, Australia, mjo@ansto.gov.au;* [2] *Argonne National Laboratory, Illinois, US;* [3] *Savannah River National Laboratory, South Carolina, US; and* [4] *Univ. of Salford, Manchester, UK.*

ABSTRACT: When internalized within an organism's body, plutonium (Pu) can be important in dose calculation due to its relatively high-energy alpha emissions (~5-6 MeV). In this paper we quantify transfer of Pu to a range of wildlife types at legacy nuclear weapons sites and evaluate the importance of body tissue Pu distribution in the transfer of Pu through the food chain. The paper presents new data from Maralinga, Australia, as well as past data from terrestrial and marine settings of the US nuclear research program.

Detailed dissections of *Oryctolagus cuniculus* (rabbit) and *Pseudomys hermansburgensis* (sandy inland mouse), followed by accelerator mass spectrometry analysis, indicated Pu activity concentrations were lowest in muscle and blood, about one order of magnitude higher in bone, two-three orders of magnitude higher in cardiovascular organs, and more than three orders of magnitude higher in the gastrointestinal tract and skin/fur. The Pu burdens in lung tissue and in the gastrointestinal tract indicate uptake by both inhalation and ingestion pathways. Whole-organism concentration ratios relative to soil ($CR_{wo\text{-}soil}$) were from 1E-5 to 5E-3 for a range of mice and rats at semi-arid sites when using the convention of considering the eviscerated and skinned carcass alone. When gastrointestinal tract and skin were included, the concentration ratios were typically one–two orders of magnitude higher. The tissue distribution results suggest that accounting for the gastrointestinal tract and skin burdens may be important for modelling food chain transfer to carnivores.

Similar distributions of Pu occur in tissues of freshwater and marine fish with generally muscle<skin, bone<gonad<gill, liver< gastrointestinal tract. Greater gastrointestinal tract burdens were observed in benthic species such as *Crenimugil crenilabis* (mullet), as compared with pelagic/reef fish such as *Lethrinus sp.* (snapper). Muscle-to-whole organism Pu ratios ranged from 18 to 85 for freshwater fish, and 14 to 30 for marine fish.

Most of the $CR_{wo\text{-}media}$ values calculated in this study were generally comparable to values reported elsewhere, with the exception of those for fish living in freshwater bodies receiving direct radioactive liquid discharges, which were two orders of magnitude higher than those for the same species living in freshwater bodies receiving Pu from atmospheric fallout. This suggests that in determining transfer rates, the physico-chemical form of the source Pu can dominate over other factors, such as organism size and feeding behaviour.