

REB wildlife transfer issue

Radiation Environmental Biophysics have published an issue with papers arising from IAEA supported workshops on the transfer of radionuclides to wildlife held in Monaco and Vienna in 2009. The full text is available [here](#); Abstracts can be accessed from the links below.

Beresford N.A.

EDITORIAL: The transfer of radionuclides to wildlife.

Radiat. Environ. Biophys., 49, (4), 505-508

- Strontium-90 and caesium-137 activity concentrations in bats in the Chernobyl exclusion zone. Gashchak S, Beresford N.A., Maksimenko A., Vlaschenko A.S.
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- Estimating transfer parameters in the absence of data. Higley K.A.

Strontium-90 and caesium-137 activity concentrations in bats in the Chernobyl exclusion zone. **Gashchak S, Beresford N.A., Maksimenko A., Vlaschenko A.S.**

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Bats are a protected species and as such may be an object of protection in radiological assessments of the environment. However, there have previously been only few radioecological studies of species of bats. In this paper, results for 140 measurements of ⁹⁰Sr and ¹³⁷Cs in 10 species of bats collected within the Chernobyl zone are presented. There was some indication of a decreasing transfer of ⁹⁰Sr with increasing deposition, although this was inconsistent across species and explained little of the observed variability. There was no difference between male and female bats in the transfer (expressed as the ratio of whole-body activity concentrations to those in soil) of either radionuclide. There was considerable variability in transfer across all species groups. At two sites where there were sufficient data, *Eptesicus serotinus* was found to have higher transfer than other species.

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Radionuclide transfer to reptiles. Wood M.D., Beresford N.A., Semenov D.V., Yankovich T.L., Coplestone D.

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doi 10.1007/s00411-010-0321-1

Reptiles are an important, and often protected, component of many ecosystems but have rarely been fully considered within ecological risk assessments (ERA) due to a paucity of data on contaminant uptake and effects. This paper presents a meta-analysis of literature-derived environmental media (soil and water) to whole-body concentration ratios (CRs) for predicting the transfer of 35 elements (Am, As, B, Ba, Ca, Cd, Ce, Cm, Co, Cr, Cs, Cu, Fe, Hg, K, La, Mg, Mn, Mo, Na, Ni, Pb, Po, Pu, Ra, Rb, Sb, Se, Sr, Th, U, V, Y, Zn, Zr) to reptiles in freshwater ecosystems and 15 elements (Am, C, Cs, Cu, K, Mn, Ni, Pb, Po, Pu, Sr, Tc, Th, U, Zn) to reptiles in terrestrial ecosystems. These reptile CRs are compared with CRs for other vertebrate groups. Tissue distribution data are also presented along with data on the fractional mass of bone, kidney, liver and muscle in reptiles. Although the data were originally collected for use in radiation dose assessments, many of the CR data presented in this paper will also be useful for chemical ERA and for the assessments of dietary transfer in humans for whom reptiles constitute an important component of the diet, such as in Australian aboriginal communities.

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Whole-body to tissue concentration ratios for use in biota dose assessments for animals. Yankovich T. L., Beresford N.A., Wood M., Aono T., Andersson P., Barnett C.L., Bennett P., Brown J., Fesenko S., Hosseini A., Howard B.J, Johansen M, Phaneuf M., Tagami K., Takata H., Twining J., Uchida S.

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Environmental monitoring programs often measure contaminant concentrations in animal tissues consumed by humans (e.g. muscle). By comparison, demonstration of the protection of biota from the potential effects of radionuclides involves a comparison of whole-body doses to radiological dose benchmarks. Consequently, methods for deriving whole-body concentration ratios based on tissue-specific data are required to make best use of the available information. This paper provides a series of look-up tables with whole-body:tissue-specific concentration ratios for non-human biota. Focus was placed on relatively broad animal categories (including molluscs, crustaceans, freshwater fishes, marine fishes, amphibians, reptiles, birds and mammals) and commonly measured tissues (specifically, bone, muscle, liver and kidney). Depending upon organism, whole-body to tissue concentration ratios were derived for between 12 and 47 elements. The whole-body to tissue concentration ratios can be used to estimate whole-body concentrations from tissue-specific measurements. However, we recommend that any given whole-body to tissue concentration ratio should not be used if the value falls between 0.75 and 1.5. Instead, a value of one should be assumed.

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Radionuclide transfer to marine biota species: review of Russian language studies. Fesenko S., Fesenko E., Titov I., Karpenko E., Sanzharova N., Gondin Fonseca A., Brown J.

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An extensive programme of experiments on transfer of radionuclides to aquatic species was conducted in the former USSR starting from the early 1950s. Only a few of these studies were made available in the English language literature or taken into account in international reviews of radionuclide behaviour in marine ecosystems. Therefore, an overview of original information on radionuclide transfer to marine biota species available from Russian language literature sources is presented here. The concentration ratio (CR) values for many radionuclides and for marine species such as: ^{239}Pu , ^{106}Ru and ^{95}Zr (crustacean), ^{54}Mn , ^{90}Sr , ^{95}Nb , ^{106}Ru , ^{137}Cs , ^{239}Pu , ^{241}Am and natural U (molluscs), and ^{54}Mn , ^{90}Sr , ^{137}Cs and ^{144}Ce (fish) are in good agreement with those previously published, whilst for some of them, in particular, for ^{32}P and ^{110}Ag (crustaceans), ^{35}S (molluscs), ^{32}P , ^{35}S , ^{95}Nb , and ^{106}Ru (macroalgae) and ^{60}Co and $^{239,240}\text{Pu}$ (fish) the data presented here suggest that changes in the default CR reference values presented in recent marine reviews may be required. The data presented here are intended to supplement substantially the CR values being collated within the handbook on Wildlife Transfer Coefficients, coordinated under the IAEA EMRAS II programme.

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Can elemental composition data of crop leaves be used to estimate radionuclide transfer to tree leaves? Tagami K., Uchida S.

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Estimation of radionuclide concentrations in trees may be required to estimate their radiation exposure. However, concentration ratios of radionuclides from soil to tree species are limited for many radionuclide-tree combinations. To fill this gap, it is investigated in the present paper whether stable element concentration data for leafy vegetables are representative of those for wild tree leaves, and consequently, if these stable element data for leafy vegetables can be used as analogues to describe radionuclides transfer from soil to trees. Data for stable elements in leafy vegetables collected in Japan were compared with those in leaves of about 20 tree species worldwide. The correlation coefficients of element concentrations between leafy vegetables and tree leaves were higher than 0.90 with $p < 0.001$ by Student's t test, and geometric means of concentration data for most elements were within the range of data for leafy vegetables. Thus, transfer parameters derived from stable element data for leafy vegetables could generally be used to estimate concentrations in tree leaves if data for the latter are not available. However, some trees accumulate a few elements (e.g., Al, Co, Mn and Si) in their leaves to higher concentrations than observed for leafy vegetables.

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Concentration ratios of stable elements for selected biota in Japanese estuarine areas. Takata H., Aono T., Tagami K., Uchida S.

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For the estimation of radiation doses to organisms, concentration ratios (CRs) of radionuclides are required. In the present study, CRs of various elements were obtained as analogues of radionuclides for algae, molluscs, and crustaceans, in eight estuarine areas around Japan. The elements measured were Na, Mg, K, Ca, V, Mn, Fe, Co, Ni, Cu, Rb, Sr, Y, Mo, Cd, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Pb, and U. The geometric mean (GM) values of CRs (GM-CRs) for alkali and alkaline earth elements, Mo, and U for all biota, as well as V for crustaceans, were less than 100 L/kg, while GM-CRs for the other elements were higher. When the obtained GM-CRs were compared with the CRs recommended in IAEA Technical Report Series 422 for marine organisms, no big differences between them were found; however, several elements (i.e. Cd and U for algae, Mn for molluscs, and Pb for crustaceans) were lower than the recommended CRs. In the present study, conversion factors (the ratio of CR for the whole body to that for muscle) for molluscs and crustaceans were also calculated, since data on edible parts of these organisms are generally available in the literature. For crustaceans, GM conversion factors of all the elements were more than one. For molluscs, GM conversion factors of rare earth elements and U were slightly higher than those for crustaceans, while GM conversion factors of the other elements were almost the same and less than 10. These results indicate that some elements tend to be concentrated in the internal organs of biota collected in the estuarine areas. For environmental radiological assessment, conversion factors from tissue to whole-body CR values are useful parameters.

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Radionuclide concentration ratios in Australian terrestrial wildlife and livestock: data compilation and analysis. Johansen M.P., Twining J.R.

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Radionuclide concentrations in Australian terrestrial fauna, including indigenous kangaroos and lizards, as well as introduced sheep and water buffalo, are of interest when considering doses to human receptors and doses to the biota itself. Here, concentration ratio (CR) values for a variety of endemic and introduced Australian animals with a focus on wildlife and livestock inhabiting open rangeland are derived and reported. The CR values are based on U- and Th-series concentration data obtained from previous studies at mining sites and ^{241}Am and $^{239/240}\text{Pu}$ data from a former weapons testing site. Soil-to-muscle CR values of key natural-series radionuclides for grazing Australian kangaroo and sheep are one to two orders of magnitude higher than those of grazing cattle in North and South America, and for ^{210}Po , ^{230}Th , and ^{238}U are one to two orders of magnitude higher than the ERICA tool reference values. When comparing paired kangaroo and sheep CR values, results are linearly correlated ($r = 0.81$) for all tissue types. However, kidney and liver CR values for kangaroo are typically higher than those of sheep, particularly for ^{210}Pb , and ^{210}Po , with values in kangaroo liver more than an order of magnitude higher than those in sheep liver. Concentration ratios for organs are typically higher than those for muscle including those for ^{241}Am and $^{239/240}\text{Pu}$ in cooked kangaroo and rabbit samples. This study provides CR values for Australian terrestrial wildlife and livestock and suggests higher accumulation rates for select radionuclides in semi-arid Australian conditions compared with those associated with temperate conditions.

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Phylogeny can be used to make useful predictions of soil-to-plant transfer factors for radionuclides. Willey N.J.

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Soil-to-plant transfer of radionuclides can be related to plant evolutionary history (phylogeny). For some species and radionuclides the effect is significant enough to be useful in predicting Transfer Factors (TFs). Here a Residual Maximum Likelihood (REML)-based mixed model and a recent plant phylogeny are used to compile data on soil-to-plant transfer of radionuclides and to show how the phylogeny can be used to fill gaps in TFs. Using published data, generic means for TFs are used to anchor the data from REML modelling and hence predict TFs for important groups of plants. Radionuclides of Cs are used as an example. With a generic soil-to-plant TF of 0.07, TFs of 0.035 and 0.085 are predicted for monocot and eudicot gaps, respectively. Also demonstrated is how the known effects of soil conditions can be predicted across plant groups – predicted Cs TFs for gap-filling across all flowering plants are calculated for sandy loams with and without waterlogging. Predictions of TFs for Sr, Co, Cl and Ru are also given. Overall, the results show that general predictions of TFs based on phylogeny are possible – a significant contribution to gap filling for TFs.

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Transfer of radionuclides to ants, mosses and lichens in semi-natural ecosystems. Dragovi S., Jankovi Mandi L.

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There is a scarcity of data on transfer of both natural and anthropogenic radionuclides to detritivorous invertebrates for use in the assessment of radiation exposure. Although mosses and lichens have been extensively used in biomonitoring programs, the data on transfer of radionuclides to these species are limited, particularly for natural radionuclides. To enhance the available data, activity concentrations of ^{137}Cs , ^{226}Ra and ^{228}Ra were measured in ants, mosses and lichens and corresponding undisturbed soil collected from semi-natural ecosystems in Serbia and Montenegro and biota/soil concentration ratios (CR) calculated. Since the majority of internal dose to biota is expected to come from ^{40}K , the activity concentrations of this radionuclide were also determined. The mean CR values for ^{137}Cs , ^{226}Ra and ^{228}Ra in ants analyzed in this study were found to be 0.02, 0.06 and 0.02, respectively. The mean CR values of radionuclides in mosses were found to be 2.84 for ^{137}Cs , 0.19 for ^{226}Ra and 0.16 for ^{228}Ra , while those in lichens were found to be 1.08 for ^{137}Cs , 0.15 for ^{226}Ra and 0.13 for ^{228}Ra . The CR values obtained in this study were compared with default CR values used in the ERICA Tool database and also with those reported in other studies.

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Estimating transfer parameters in the absence of data. Higley K.A.

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The calculation of transfer of radionuclides from the abiotic to the biotic environment is a well-established practice in radiological assessments. Concentration ratios provide simple means to estimate radionuclide activity in biota, from measured (or estimated) radionuclide concentrations in either a food source or an abiotic component such as soil or water. They are typically reported by element, and data compilations may include information such as soil type (e.g., sand, loam, clay) and species. The data may be for multiple species at a single location, single species at multiple locations, or represent compilations from multiple sources. Recently published guidance suggests that estimates are best made using data from the same ecosystem. This paper examines this recent guidance, in the context of using measured data from within a single ecosystem and comparing results to more generic values. Results suggest that generic values may be an adequate substitute for site-specific information. It illustrates how ionic potential may be used as an alternative to group chemical properties in estimating transfer factors. Lastly, limited evidence is found to support the concept of allometric scaling functions for elemental concentrations in plants.

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