Conference or Workshop Item

Beresford, Nicholas A.; Copplestone, David; Hosseini, A.; Brown, Justin E; Johansen, Matthew P.; Hirth, Gillian; Sheppard, Steve; Dagher, Elias; Yankovich, Tamara; Uchida, Shigeo; Napier, Jon; Outola, Iisa; Wells, Claire; Howard, Brenda J.; Barnett, Catherine L.; Wood, Michael D. 2014. **Recent development of wildlife transfer databases**. [Poster] In: *3rd International Conference on Radioecology and Environmental Radioactivity, Barcelona, 7-12 Sept 2014*.

Recent development of wildlife transfer databases

Nicholas A. Beresford[1,12], David Copplestone[2], A. Hosseini[3], Justin E. Brown[3], Mathew P. Johansen[4], Gillian Hirth[5], Steve Sheppard[6], Elias Dagher[7], Tamara Yankovich[8], Shigeo Uchida[9], Jon Napier[10], [11]Iisa Outola, Claire Wells[1], Brenda J. Howard[1], Catherine L. Barnett[1] and Michael D. Wood[12]

*[1]NERC Centre for Ecology & Hydrology, LancasterEnvironment Center, Library Av., Bailrigg, Lancaster, LA1 4AP, UK; [2]Biological and Environmental Sciences, University of Stirling, Stirling, FK9 4LA, UK; [3]Norwegian Radiation Protection Authority, P.O. Box 55, N-1332 Østerås, Norway; [4]Australian Nuclear Science and Technology Organisation, New Illawarra Rd, Menai, NSW, Australia; [5]Australian Radiation Protection and Nuclear Safety Agency, 619 Lower Plenty Rd, Yallambie, 3085, Victoria, Australia; [6]ECOMatters Inc, WB Lewis Business Centre, 24 Aberdeen Avenue, Suite 105, Pinawa, Manitoba, Canada R0E 1L0 [7]Canadian Nuclear Safety Commission, Environmental Risk Assessment Division, 280 Slater, Ottawa, Canada, K1A0H3; [8]International Atomic Energy Agency, Vienna International Centre, 1400, Vienna, Austria; [9]*National Institute of Radiological Sciences, Chiba, Japan; *[10]Oregon State University, Oregon,* USA; [11]STUK, P.O. Box 14, 00881 Helsinki, Finland; [12]School of Environment *& Life Sciences, University of Salford, Manchester, M4 4WT, UK*.

INTRODUCTION

The transfer of radionuclides to wildlife in the environmental radiological assessment models developed over the last two decades is most often described by the whole-organism concentration ratio ($CR_{wo\text{-}media}$). This parameter relates activity concentrations in wildlife to those in environmental media (typically soil for terrestrial ecosystems and water for aquatic ecosystems).

When first released in 2007, the ERICA Tool (Brown *et al*. 2008) contained the most comprehensive and well documented $CR_{wo\text{-}media}$ database available for wildlife. The ERICA database was based upon databases established in the EU funded FASSET (https://wiki.ceh.ac.uk/x/ZILJBg) and EPIC (https://wiki.ceh.ac.uk/x/ZoLJBg) projects. It was subsequently used in an update of the USDOE RESRAD-BIOTA model (http://web.evs.anl.gov/resrad/home2/biota.cfm) to enable uncertainty analyses.

Evaluation of the various models available to conduct environmental radiological assessments identified that the transfer component contributed significantly to the uncertainty of assessments (e.g. Beresford *et al*. 2008). Consequently, the wildlife transfer database (WTD; www.wildlifetransferdatabase.org/) (Copplestone *et al*. 2013) was established to collate wildlife transfer parameter values and assist the IAEA and ICRP in the production of reports on recommended transfer parameter values. The WTD was initially populated using the ERICA Tool database. Many additional data were subsequently input including, a review of Russian language literature, and data from Canadian monitoring programmes associated with nuclear power plants, U-mining and related industries.

In 2011, data in the WTD were summarised and used by the ICRP to produce a report on recommended transfer parameters for its Reference Animals and Plants (RAPs) (Strand *et al*. 2009). There were few data for many radionuclides for the RAPs which are defined at the taxonomic level of family. For instance, there were no data for bee (the Apidea family).

Concurrently summaries of the WTD were used by the IAEA to produce a handbook of transfer parameters for wildlife (see Howard *et al*. (2013) and Yankovich *et al.* (2013)).

At the time the WTD was used to prepare the IAEA and ICRP reports, it contained information from 523 references. There were 50,061 lines of data entered into the WTD representing 86,979 CR values for 1438 species and 71 elements. Of these, 24,884 were $CR_{wo\text{-}sediment}$ values for freshwater organisms; these were used by neither the ICRP nor IAEA as they were likely to be highly site-specific given that they incorporate transfer processes from sediment-to-water and from water-to-biota. The remaining $CR_{wo\text{-}media}$ values were comprised of: terrestrial estuarine (n=141), brackish water (n=4230), freshwater (n=17,687), marine (n=10,189) and terrestrial (n= 29,848) ecosystems.

Here we summarise recent development and application of the WTD and analyses of the data.

DEVELOPMENT OF THE WTD SINCE 2011

Between 2011, when the WTD was used to provide values for the ICRP and IAEA reports, and the end of 2013, *c*. 17,000 additional $CR_{wo\text{-}media}$ values were added. The new inputs include data for: representative species of the ICRPs RAPs from a UK forest; monitoring data from Finland and Japanese estuaries; Canadian wildlife; Pu from US weapons testing programme sites (Johansen *et al.* 2013); wild plants and invertebrates from north western USA; and an *ad-hoc* review of refereed literature published after 2011. Additionally, data already in the WTD from Australia were reviewed with reference to original source reports not previously considered and amended where required (see Hirth *et al.* these proceedings). Amongst the additional entries were the first reported transfer data applicable to the ICRP RAP bee (Barnett *et al*. 2014; Sheppard *et al*. 2010). The number of elements included now totals more than 80.

The revised WTD was quality checked by considering the degree of variation in the data for each organism-element combination and the change between WTD versions. This identified a number of errors (e.g. double entry of data, unit conversion errors and entries based on a dry matter rather than the required fresh weight basis) all of which have now been rectified.

Revised summary values were generated from the WTD in December 2013 (available from: www.wildlifetransferdatabase.org/). Figure 1 presents changes in $CR_{wo\text{-}media}$ values from the ERICA database through the IAEA report to the WTD as of December 2013 using terrestrial reptiles as an example. This demonstrates the amount of additional data added (in this case mostly from the review of Wood *et al*. 2010) and quality control (e.g. the change in the ERICA Cs and Sr values is largely the consequences of errors noted by Barnett *et al*. (2009) whilst the change in natural radionuclide values from IAEA TRS to WTD 2013 is mostly the consequence of the re-evaluation of Australian data (Hirth *et al*., these proceedings).

ANALYSES OF THE WTD VALUES

Evaluations of the WTD to date have demonstrated that there is no statistical justification to summarise data at levels below generic organism (e.g. ‘fish’, ‘mammal’, etc.) (Wood *et al*. 2013; Beresford *et al*. 2013). This is in part a consequence of biases and limitations within the

underlying datasets of the WTD. Given the uncertainty in $CR_{wo\text{-}media}$ data, we suggest that summarised $CR_{wo\text{-}media}$ values are used with caution above initial, highly conservative, screening-level assessments.

Wood *et al.* (2013) demonstrated problems in the method used to calculate geometric statistics from the WTD and we have made a spreadsheet available to better estimate GM statistics (https://wiki.ceh.ac.uk/x/PgC6Cw).

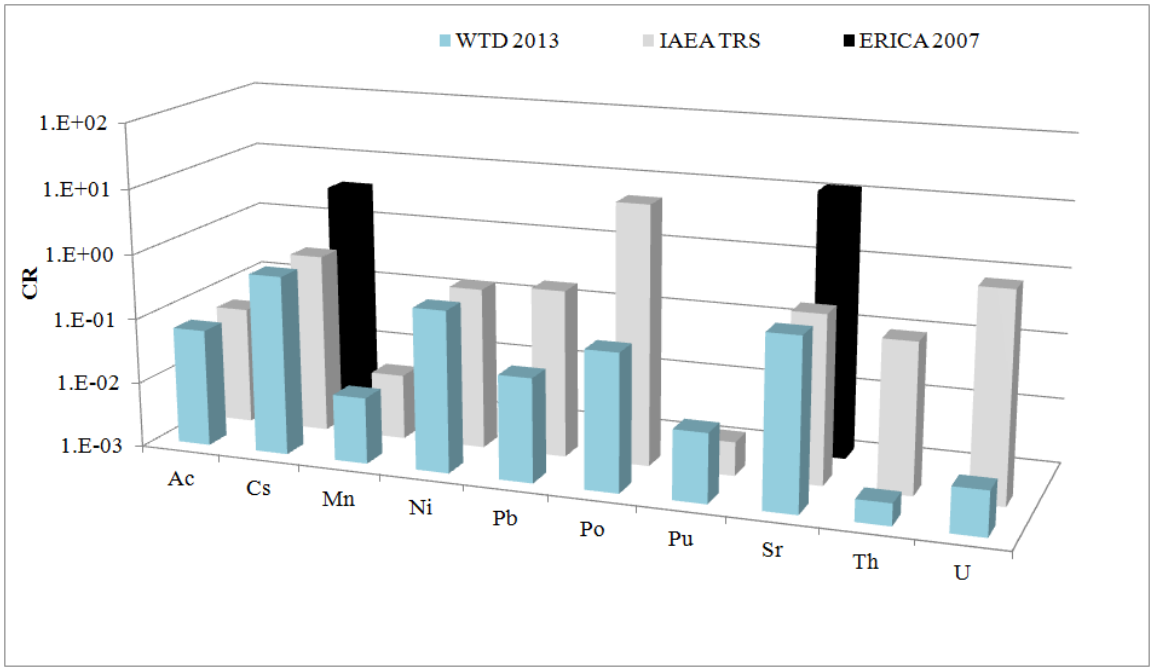

Figure 1. A comparison of $CR_{wo\text{-}soil}$ values for terrestrial reptiles from the ERICA database (*ERICA 2007*), IAEA technical report series handbook (*IAEA TRS*) and WTD in December 2013 (*WTD 2013*).

THE FUTURE

The WTD values as of December 2013 have been used to derive an updated set of default $CR_{wo\text{-}media}$ values for a pending revision of the ERICA Tool (Brown *et al*. these proceedings) and are being used to parameterise a screening methodology being developed by the IAEA.

For the foreseeable future we will continue to maintain and update the WTD by releasing revised summary values as sufficient additional data are added (we envisage releases of new summary values every two years). Please visit www.wildlifetransferdatabase.org/ if you have data to include in future WTD versions.

ACKNOWLEDGEMENTS

The inputs of NERC-CEH staff to this work were funded by NERC-CEH and the STAR network of excellence (www.star-radioecology.org). The inputs of M.D. Wood were funded by a University of Salford Vice Chancellor's Research Scholarship.

REFERENCES

Barnett, C.L., S. Gaschak, N.A. Beresford, B.J. Howard and A. Maksimenko, 2009. Radionuclide activity concentrations in two species of reptiles from the Chernobyl exclusion zone. Radioprotection, 44: 537–542. http://dx.doi.org/10.1051/radiopro/20095099

Barnett, C.L., N.A. Beresford, L.A. Walker, M. Baxter, C. Wells and D. Copplestone, 2014. Transfer parameters for ICRP reference animals and plants collected from a forest ecosystem Radiat. Environ. Biophysics, 53: 125-149. http://dx.doi 10.1007/s00411-013-0493-6

Beresford, N.A., C.L. Barnett, J. Brown, J-J. Cheng, D. Copplestone, V. Filistovic, A. Hosseini, B.J. Howard, S.R. Jones, S. Kamboj, A. Kryshev, T. Nedveckaite, G. Olyslaegers, R. Saxén, T. Sazykina, J. Vives i Batlle, S. Vives-Lynch, T. Yankovich and C. Yu, 2008. Inter-comparison of models to estimate radionuclide activity concentrations in non-human biota. Radiat. Environ. Biophysics, 47: 491–514. http://dx.doi.org/10.1007/s00411-008-0186-8

Beresford, N.A., T.L. Yankovich, M.D. Wood, S. Fesenko, P. Andersson, M. Muikku and N.J. Willey, 2013. A new approach to predicting environmental transfer of radionuclides to wildlife taking account of inter-site variation using Residual Maximum Likelihood mixed-model regression: a demonstration for freshwater fish and caesium. Sci. Tot. Environment, 463-464: 284-292. http://dx.doi.org/10.1016/j.scitotenv.2013.06.013

Brown, J.E., B. Alfonso, R. Avila, N.A. Beresford, D. Copplestone, G. Pröhl and A. Ulanovsky, 2008. The ERICA Tool J. Environ. Radioactivity, 99: 1371–83. http://dx.doi.org/10.1016/j.jenvrad.2008.01.008

Brown, J.E., B. Alfonso, R. Avila, N.A. Beresford, D. Copplestone and A. Hosseini. Updating Environmental Media Concentration Limits and Uncertainty factors in the ERICA Tool. These proceedings.

Copplestone, D., N.A. Beresford, J.E. Brown and T. Yankovich, 2013. An international database of radionuclide concentration ratios for wildlife: Development and uses. J. Environ. Radioactivity, 126: 288-298. http://dx.doi.org/10.1016/j.jenvrad.2013.05.007

Hirth, G.A., J. Carpenter, A. Bollhöfer, M.P. Johansen and N.A. Beresford. Whole-organism concentration ratios in wildlife inhabiting Australian uranium mining environments. These proceedings.

Howard, B.J., N.A. Beresford, D. Copplestone, D.Telleria, G. Proehl, S. Fesenko, R. Jeffree, T. Yankovich, J. Brown, K. Higley, M. Johansen, H. Mulye, H. Vandenhove, S. Gashchak, M.D. Wood, H. Takata, P. Andersson, P. Dale, J. Ryan, A. Bollhöfer, C. Doering, C.L. Barnett and C. Wells, 2013. The IAEA Handbook on Radionuclide Transfer to Wildlife. J. Environ. Radioactivity, 121: 55–74. http://dx.doi.org/10.1016/j.jenvrad.2012.01.027

Johansen M.P., Kamboj S. and WW. Kuhne 2013. Whole-organism concentration ratios for plutonium in wildlife from past US nuclear research data. J. Env Radioactivity, 126: 412-419

Sheppard, S.C., J.M. Long and B. Sanipelli, 2010. Verification of radionuclide transfer factors to domestic-animal food products, using indigenous elements and with emphasis on iodine. J. Environ. Radioactivity, 101: 895–901. doi:10.1016/j.jenvrad.2010.06.002

Strand, P., N.A. Beresford, D. Copplestone, J. Godoy, L. Jianguo, R. Saxen, T. Yankovich and J. Brown, 2009. Environmental Protection: Transfer Parameters for Reference Animals and Plants. ICRP Publication 114. Annual. ICRP Volume 39: 6. Elsevier. http://www.icrp.org/publication.asp?id=ICRP%20Publication%20114

Wood, M.D., N.A. Beresford, D.V. Semenov, T.L. Yankovich and D. Copplestone.2010. Radionuclide transfer to reptiles. Radiation. Environ. Biophysics., 49: 509-530. http://dx.doi.org/10.1007/s00411-010-0321-1

Wood, M.D., N.A. Beresford, B.J. Howard and D. Copplestone, 2013. Evaluating summarised radionuclide concentration ratio datasets for wildlife J. Environ. Radioactivity, 126: 314-325. http://dx.doi.org/10.1016/j.jenvrad.2013.07.022

Yankovich, T.L., N.A. Beresford, S. Fesenko, J. Fesenko, M.Phaneuf, E.Dagher, I. Outola, P. Andersson, K. Thiessen, J. Ryan, M.D. Wood, A. Bollhöfer, C.L. Barnett and D. Copplestone, 2013. Establishing a database of radionuclide transfer parameters for freshwater wildlife. J Environ Radioactivity, 126: 299-313.