

## **Chapter 26: Ecological Risk: Terrestrial Dose Modeling**

Terrestrial exposure methods and the ability to input toxicity reference values are available to estimate exposure for commonly used ecological risk assessment endpoints. In addition, the SADA GIS provides a platform for additional exposure/risk assessment methods that account for spatial dependence, including combining interpolation methods with the exposure models to visualize areas of exposure at the site. These tools provide methods that can minimize remedial action decision errors, provide spatial designs for more efficient and cost effective remedial design under selective remediation conditions, and provide a rationale and context for additional sampling efforts at contaminated sites. The integral combination of spatial assessment approaches with screening (Chapter 22) and exposure assessment capabilities has the advantage of improving the quality of ecological risk-based decisions without overly complicating the assessment.

The ecological exposure and risk models follow USEPA guidance, and can be customized to fit site-specific exposure conditions for generating risk results and calculating PRGs. Exposure and risk assessment calculations are based on an initial conceptual model for the site that includes the contaminated media, routes of contaminant transport, representative ecological receptors, and pathways of exposure for these receptors. Calculations can be limited to those contaminants that exceeded relevant SVs in the screening process. The next step for higher tier ecological risk assessments is determining the bioavailability of these chemicals to exposed receptors; this can be done through physiological or food chain models that model the bioaccumulation and biomagnification of the contaminants in different trophic levels of the food chain. The magnitude of exposures to the individual receptors can then be calculated using exposure models for the relevant exposure pathways. In the next step, a toxicity reference value (TRV) from a dose-response model is needed. This may call for inter-species extrapolation of the contaminant effects from a laboratory study to a species of interest at the contaminated site. Results of the exposure modeling are then compared to decision criterion (the TRV); the exposure models can then be modified for different exposure scenarios to determine the feasibility of available alternative remedial actions.

SADA provides terrestrial dose exposure models to estimate the daily doses of contaminants at a site. Modeling dose to wildlife receptors requires numerous chemical-specific and species-specific exposure parameters. The ecological dose modeling capabilities are located in the ecological risk module, and default exposure parameters are distributed with the software for over 20 terrestrial species (Table 1) representing a variety of wildlife receptors, including characteristic herbivores, insectivores, and carnivores. These species can be parameterized individually for males, females, and juveniles, as well as USEPA Soil Screening Level (SSL) defaults that combine male and female parameters. Default values for males and females are based on available literature sources, but can be user modified to reflect site-specific conditions.

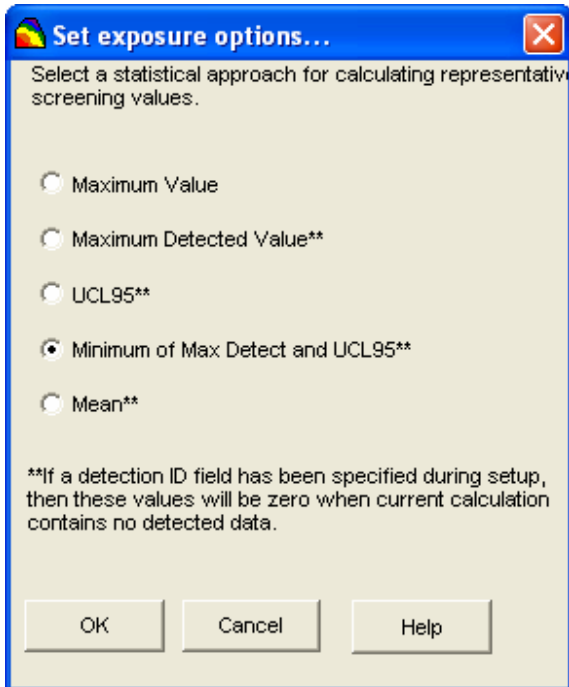
Table 1. Terrestrial species with default exposure parameters.

Common Name	Scientific name	Receptor Group
American kestrel	<i>Falco sparverius</i>	Avian carnivore
American robin	<i>Turdus migratorius</i>	Avian insectivore
American woodcock	<i>Scolopax minor</i>	Avian ground insectivore
Black-tailed jackrabbit	<i>Lepus californicus</i>	Mammalian herbivore
Burrowing owl	<i>Speotyto cunicularia</i>	Avian carnivore
Deer mouse	<i>Peromyscus maniculatus</i>	Mammalian omnivore
Eastern cottontail	<i>Sylvilagus floridanus</i>	Mammalian herbivore
Great Basin pocket mouse	<i>Perognathus parvus</i>	Mammalian granivore
Kit fox	<i>Vulpes macrotis</i>	Mammalian carnivore
Little brown bat	<i>Myotis lucifugus</i>	Mammalian insectivore
Long-tailed weasel	<i>Mustela frenata</i>	Mammalian carnivore
Meadow vole	<i>Microtus pennsylvanicus</i>	Mammalian herbivore
Mexican free-tailed bat	<i>Tadarida brasiliensis</i>	Mammalian insectivore
Mourning dove	<i>Zenaida macroura</i>	Avian granivore
Northern bobwhite	<i>Colinus virginianus</i>	Avian granivore
Prairie vole	<i>Microtus ochrogaster</i>	Mammalian herbivore
Red fox	<i>Vulpes vulpes</i>	Mammalian carnivore
Red-tailed hawk	<i>Buteo jamaicensis</i>	Avian carnivore
Short-tailed shrew	<i>Blarina brevicauda</i>	Mammalian insectivore

Routines are available in the exposure models for calculating daily intake rates for the selected receptors at each location in the site. The routines in the ecological risk module access the contaminant matching and data management functions, and model parameters and toxicity information are fully parameterized from USEPA guidance when available. SADA calculates dose (mg intake per kg body weight per day) from food ingestion, soil ingestion, dermal contact, and inhalation for terrestrial exposures, plus the total dose summed over all pathways selected. These results are directly comparable to TRVs for risk assessment, and are presented in tabular form commonly used to document risk assessment results.

### Representative Exposure Concentration

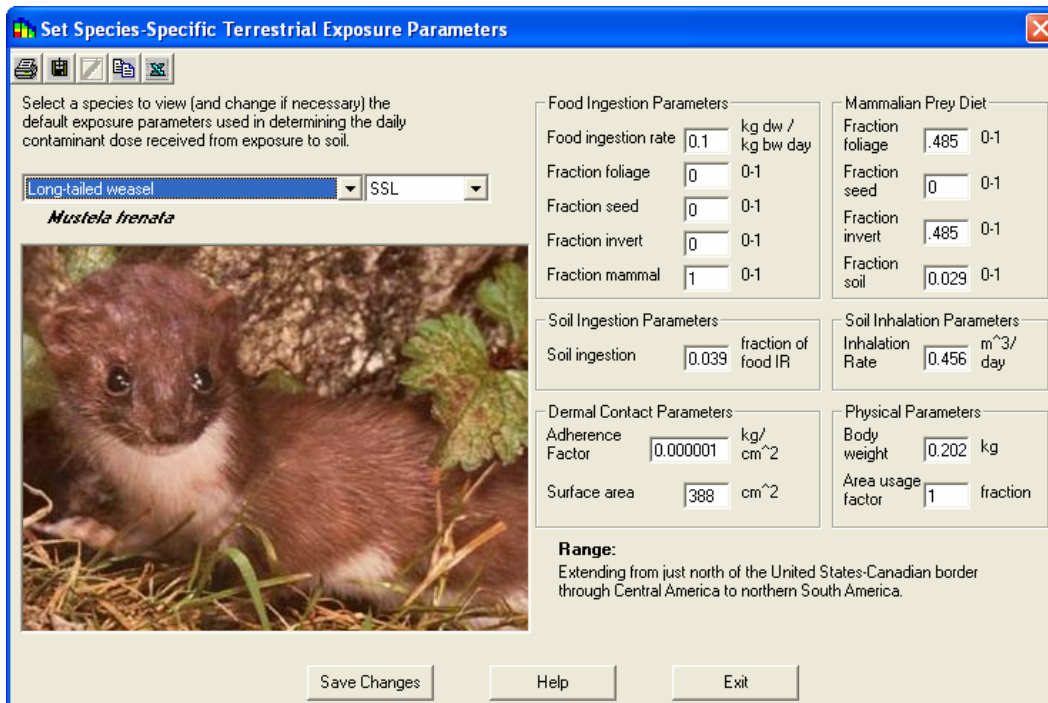
An early decision when performing an exposure assessment is the selection of an appropriate statistic for the exposure concentration. Select Set Exposure Statistics from the Configure Ecological Risk menu, select the desired statistic (the default of minimum of maximum detect and the UCL95 is commonly used for risk assessments), then click OK.



### **Species-specific Exposure Parameters**

The exposure concentration is used with a number of species- and chemical-specific parameters to calculate the total exposure. SADA comes preloaded with default exposure parameters for a variety of wildlife receptors, including representative herbivores, insectivores, and carnivores. Defaults are provided for each parameter, but custom values can be entered in the Set Species-specific Terrestrial Exposure Parameters Window. These parameters are used in modeling dose to each receptor from selected pathways. To view (and change if desired) current exposure parameters, from the Ecological menu, select Configure Ecological Risk, and Set Terrestrial Exposure Parameters.

From the resulting window, select a species and whether you want values for adult females, adult males, juveniles, or SSL. SSL follows EPA draft guidance for deriving ecological soil screening levels and combines data from adult males and adult females. While custom values can be entered for juveniles, SADA does not include default values for juveniles.



To change a parameter value, click on the box corresponding to that parameter, and enter the value. It is very important to use the appropriate units for all parameters if entering custom values.

## Chemical Exposure Parameters

Many of the parameters used in modeling dose to wildlife receptors are chemical-specific rather than species-specific. For species-specific parameters, see Set Terrestrial Exposure Parameters. Custom values for contaminant-specific parameters can be entered in the Set Terrestrial Modeling Contaminant Parameters Window. These parameters are used in modeling dose to each receptor from selected pathways. To view (and change if desired) current contaminant-specific exposure parameters, from the Ecological menu, select Configure Ecological Risk, and Set Terrestrial Modeling Contaminant Parameters.

In the resulting window, select an analyte from the drop down list. To change a parameter value, click on the box corresponding to that parameter, and enter the value. When you've finished modifying the parameters for the species, click the Save Changes button, and the changes will be saved to your SADA file. Otherwise, changes will not be saved. It is very important to use the appropriate units for all parameters.

**Set Terrestrial Modeling Contaminant Parameters**

Arsenic

**Chemical Constants**  
 Log Octanol-Water Partitioning Coefficient (Log Kow) [ ] (mg/L)/(mg/L)

**Inhalation**  
 Volatile  Non-Volatile  
 Volatilization Factor (VF) [ ] m<sup>3</sup>/kg  
 Particulate Emission Factor (PEF) 1316239339 m<sup>3</sup>/kg

**Dermal Contact**  
 Absorption Fraction 0.001 mg/mg

**Soil -> Invertebrate Concentration**  
 Custom BAF 0.224 (mg/kg)/(mg/kg)  
 Kow-based BAF (mg/kg)/(mg/kg)  
 Tissue Regression  
 Log-linear slope 0.706  
 Log-linear intercept -1.421

**Soil -> Plant Concentration: Foliage**  
 Custom BAF 0.0375 (mg/kg)/(mg/kg)  
 Kow-based BAF (mg/kg)/(mg/kg)  
 Tissue Regression  
 Log-linear slope [ ]  
 Log-linear intercept [ ]

**Soil -> Plant Concentration: Seed**  
 Custom BAF 0.0375 (mg/kg)/(mg/kg)  
 Kow-based BAF (mg/kg)/(mg/kg)  
 Tissue Regression  
 Log-linear slope [ ]  
 Log-linear intercept [ ]

**Soil -> Small Mammal Concentration**  
 Custom BAF 0.0025 (mg/kg)/(mg/kg)  
 Tissue Regression  
 Log-linear slope 0.8188  
 Log-linear intercept -4.8471

**Diet -> Small Mammal Concentration**  
 Custom BAF [ ] (mg/kg)/(mg/kg)  
 Tissue Regression  
 Log-linear slope [ ]  
 Log-linear intercept [ ]

Save Changes Help Exit

## Terrestrial Daily Exposure Dose Table

SADA calculates dose (mg/kg BW d) from food ingestion, soil ingestion, dermal contact, and inhalation for terrestrial exposures as well as total dose summed over all pathways selected. To select a pathway for dose estimation, select a soil contaminant and from the Ecological menu select Show Daily Exposure Dose.

From the following form, select a receptor and set of parameters from the drop down list. Then, select the pathway(s) for which you want to calculate dose. The parameter sets are SSL, Female, Male, or Juvenile. Choosing SSL will use parameter values from EPA's draft Eco-SSL guidance, which represents data from males and females combined. Choosing Female or Male will restrict the parameter values to those for that gender. SADA does not currently provide parameter values for juveniles, but custom values can be entered via Set Terrestrial Exposure Parameters.

Analyte	Concentration	Food Ingestion	Soil Ingestion	Dermal Contact	Total Dose
Barium	74.4157051	0.0062007	0.2902212	0.0001429	0.2965649
Arsenic	35.1320027	0.0144728	0.1370148	0.000067481272	0.1515551
Anthracene	3.0336929	NA	0.0118314	0.000058270933	0.0118897

Modeling dose to wildlife receptors requires a number of chemical-specific and species-specific exposure parameters. To view (and/or change) the contaminant-specific or species-specific parameter values used in estimation of dose, close the Daily Exposure Dose window, and from the Ecological menu, click Configure Ecological Risk, and either Set Terrestrial Contaminant Parameters or Set Terrestrial Exposure Parameters discussed previously.