

Wetlands scenario intercomparison – SCK•CEN approach and results

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Objectives

- Three wetland areas: Steel Creek, Duke Swamp and Utnora Swamp.
- Two radionuclides: ^{137}Cs and ^{14}C (for Duke Swamp).
- Model-model comparisons of whole organism activity concentrations and doses
- Model-measurement comparisons of whole organism activity concentrations and, for one species, external dose rate in soil.
- Activity concentrations of ^{137}Cs and ^{14}C in soil, water, and air from the three wetlands.

Key assumptions

- 1 Use the ERICA assessment tool (current officially released version).
- 2 Keep it simple: use existing reference organisms and occupancy factors where possible.
- 3 Use the CRs from the new IAEA TRS for wildlife (latest draft version) and default K_d 's from ERICA.
- 4 Calculate minimum, maximum and mean from the concentration ranges reported in the data sheet - assume proportionality with medium concentrations. In reality this could vary orders of magnitude, as evidenced by the EMRAS intercomparison studies.
- 5 For ^{14}C content in air then we use an soil/air CR of $133 \text{ m}^3/\text{kg}$ (see below)
- 6 Aquatic environments are freshwater except Utnora swamp which is marine
- 7 Steel Creek and Utnora are assessed ^{137}Cs ; Duke swamp for ^{14}C .
- 8 To calculate the concentration in an animal exposed to both terrestrial and aquatic, the total internal dose is internal dose (terrestrial) \times fraction of time (terrestrial) + internal dose (aquatic) \times fraction of time (aquatic) + sum of external dose. The external doses are just summed because they already include the occupancy factors in them.
- 9 In Duke Swamp the aquatic exposure pathway is considered to be zero as volatilised ^{14}C is the main contamination pathway. Assessment could be refined by dividing the soil/air CR of $133 \text{ m}^3/\text{kg}$ by a sediment/water K_d of $5000 \text{ m}^3/\text{kg}$ to generate water concentrations from air concentrations, but one can already see that the importance of this pathway would be low.

Extra organism dimensions

- Non-standard organisms reviewed in online ecology databases.
- Dimensions deduced from mass and length assuming width = depth

| Organism dimensions for 'ratties' | | (mass in kg and dimensions in m) | | | |
|-----------------------------------|-------------------------|----------------------------------|----------|----------|----------|
| Northern short-tailed shrew | Blarina brevicauda | 2.16E-02 | 9.90E-02 | 2.04E-02 | 2.04E-02 |
| White-footed mouse | Peromyscus leucopus | 2.30E-02 | 9.50E-02 | 2.15E-02 | 2.15E-02 |
| Deer mouse | Peromyscus maniculatus | 2.05E-02 | 9.00E-02 | 2.09E-02 | 2.09E-02 |
| Meadow vole | Microtus pennsylvanicus | 4.90E-02 | 1.60E-01 | 2.42E-02 | 2.42E-02 |
| Average | | 2.85E-02 | 1.11E-01 | 2.17E-02 | 2.17E-02 |
| ERICA mammal (ICRP rat) | | 3.14E-01 | 2.00E-01 | 6.00E-02 | 5.00E-02 |
| New Mammal (Small mouse) | | 3.30E-02 | 7.00E-02 | 3.00E-02 | 3.00E-02 |

| Organism dimensions for 'froggies' | | (mass in kg and dimensions in m) | | | |
|------------------------------------|----------------------|----------------------------------|----------|----------|----------|
| American toad | Bufo americanus | 2.18E-02 | 7.00E-02 | 2.44E-02 | 2.44E-02 |
| Grey treefrog | Hyla versicolor | 7.20E-03 | 4.45E-02 | 1.76E-02 | 1.76E-02 |
| American bullfrog | Rana catesbeiana | 5.44E-02 | 1.20E-01 | 2.94E-02 | 2.94E-02 |
| Green frog | Rana clamitans | | 7.50E-02 | 0.00E+00 | 0.00E+00 |
| Northern leopard frog | Rana pipiens | 2.90E-02 | 1.10E-01 | 2.24E-02 | 2.24E-02 |
| Mink frog | Rana septentrionalis | | 6.20E-02 | 0.00E+00 | 0.00E+00 |
| | Rana arvalis | | 5.75E-02 | | |
| Amphibian (ICRP Frog) | | 3.14E-02 | 7.99E-02 | 3.00E-02 | 2.50E-02 |
| Small frog | | 7.20E-03 | 4.45E-02 | 1.76E-02 | 1.76E-02 |

Approach for Carbon-14

- The key assumption is full specific activity equilibrium throughout the terrestrial environment. This is completely satisfactory if the ^{14}C is emitted as $^{14}\text{CO}_2$. Accordingly, the ^{14}C concentration in Bq g^{-1} stable carbon is the same in the plant as it is in air.
- On the basis of 2.5% elementary carbon content of soil, it is assumed that 0.25 Bq per g C are in equilibrium with 1000 Bq m^{-2} (Winteringham, 1989). Assuming carbon content in air is 0.2 g C m^{-3} , there follows that 0.05 Bq m^{-3} ^{14}C is in equilibrium with 1000 Bq m^{-2} . Here, for converting Bq m^{-2} to Bq kg^{-1} we use a density of 1500 kg m^{-3} and a contamination depth of 10 cm, so:

$$\begin{aligned}
 \text{CF} &= \frac{A_{\text{soil}} (\text{Bq kg}^{-1})}{A_{\text{air}} (\text{Bq m}^{-3})} = \frac{1000 \text{ Bq m}^{-2} \times \frac{1}{0.1 \text{ m}} \times \frac{1}{1500 \text{ kg m}^{-3}}}{0.25 \text{ Bq g C}^{-1} \times 0.2 \text{ g C m}^{-3}} = \\
 &= \frac{6.66\text{E} + 00 \text{ Bq kg}^{-1}}{0.05 \text{ Bq m}^{-3}} = 1.33\text{E} + 02 \text{ m}^3 \text{ kg}^{-1}
 \end{aligned}$$

Assumptions - Steel Creek

| Organism | Scientific name | Geometry | Define new organism | What organism | Mass (kg) | height (m) | width (m) | length (m) |
|---------------------------------|-----------------|----------------------------|---------------------|--|-----------|------------|-----------|------------|
| Grasses / sedges | Andropogon | Grasses and herbs | No | Grasses & herbes (ICRP Wild Grass) | 2.62E-03 | 5.00E-02 | 1.00E-02 | 1.00E-02 |
| Alder tree | Alnus | Tree | No | ICRP pine tree | 4.71E+02 | 1.00E+01 | 3.00E-01 | 3.00E-01 |
| Shrubs | Myrica | Shrub | No | Shrub | 2.62E-03 | 5.00E-02 | 1.00E-02 | 1.00E-02 |
| Willows | Salix | Tree | No | ICRP pine tree | 4.71E+02 | 1.00E+01 | 3.00E-01 | 3.00E-01 |
| Green treefrog | Hyla cinerea | Small frog | Yes | Small frog | 7.20E-03 | 1.76E-02 | 1.76E-02 | 4.45E-02 |
| Aquatic snakes | | Reptile | No | FASSET snake | 7.39E-01 | 3.49E-02 | 3.49E-02 | 1.16E+00 |
| Terrestrial snakes | | Reptile | No | FASSET snake | 7.39E-01 | 3.49E-02 | 3.49E-02 | 1.16E+00 |
| Ducks (ringneck, mallard) | | Bird | No | Bird (ICRP Duck) | 1.26E+00 | 1.00E-01 | 8.02E-02 | 3.00E-01 |
| Spiders | Araneae | Small spider | Yes | Spider (non-detritivorous invertebrate) | 1.05E-05 | 2.00E-03 | 2.00E-03 | 5.00E-03 |
| Beetles | Coleoptera | detritivorous invertebrate | No | Detritivorous invertebrate (FASSET Woodlouse, used in cAt for Ground Beetle) | 1.70E-04 | 6.13E-03 | 3.05E-03 | 1.74E-02 |
| Aphids, leafhoppers and cicadas | Homoptera | detritivorous invertebrate | No | Detritivorous invertebrate (FASSET Woodlouse, used in cAt for Ground Beetle) | 1.70E-04 | 3.05E-03 | 6.13E-03 | 1.74E-02 |
| Grasshoppers and crickets | Orthoptera | Flying insect | No | Flying insects (ICRP Bee, used in cAt for Grasshopper) | 5.89E-04 | 7.50E-03 | 7.50E-03 | 2.00E-02 |



Assumptions - Steel Creek

| Organism | Occupancies (when split between terrestrial and aquatic both assessments are done and the dose is summed) | | | | | | | 137Cs CR (kg/kg) | 137Cs CR (L/kg) | Source of CF from TRS |
|---------------------------------|---|---------|--------|----------|----------|--------|--------|------------------|-----------------|--------------------------------------|
| | On soil | In soil | In air | In water | On water | In sed | On sed | terrestrial | Freshwater | |
| Grasses / sedges | 0.75 | 0.25 | 0 | 0 | 0 | 0 | 0 | 1.20E+00 | N/A | Grasses and herbs |
| Alder tree | 0.75 | 0.25 | 0 | 0 | 0 | 0 | 0 | 1.40E-01 | N/A | Tree (broadleaf) |
| Shrubs | 0.75 | 0.25 | 0 | 0 | 0 | 0 | 0 | 2.30E+00 | N/A | Shrub |
| Willows | 0.75 | 0.25 | 0 | 0 | 0 | 0 | 0 | 1.40E-01 | N/A | Tree (broadleaf) |
| Green treefrog | 0.25 | 0 | 0 | 0.25 | 0 | 0.5 | 0 | 4.40E-01 | 3.10E+03 | TER: Amphibian - FW: Fish |
| Aquatic snakes | 0.25 | 0 | 0 | 0.25 | 0 | 0 | 0.5 | 5.20E-01 | 4.00E+03 | Reptile (carnivorous) |
| Terrestrial snakes | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 5.20E-01 | N/A | Reptile (carnivorous) |
| Ducks (ringneck, mallard) | 0.5 | 0 | 0 | 0 | 0.5 | 0 | 0 | 5.70E-01 | 4.00E+03 | TER: Bird (omnivorous) - FW: reptile |
| Spiders | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3.00E-02 | N/A | Arachnid |
| Beetles | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 9.00E-02 | N/A | Arthropod (detritivorous) |
| Aphids, leafhoppers and cicadas | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 9.80E-03 | N/A | Arthropod (herbivorous) |
| Grasshoppers and crickets | 0.5 | 0 | 0.5 | 0 | 0 | 0 | 0 | 1.10E-01 | N/A | Arthropod |

Assumptions - Utnora Swamp

| Organism | Scientific name | Geometry | Define new organism | What organism | Mass (kg) | height (m) | width (m) | length (m) |
|-------------------|--|-------------------|---------------------|------------------------------------|-----------|------------|-----------|------------|
| Spruce | Picea abia | Tree | No | ICRP pine tree | 4.71E+02 | 1.00E+01 | 3.00E-01 | 3.00E-01 |
| Fern | Matteuccia struthiopteris | Grasses and herbs | No | Grasses & herbes (ICRP Wild Grass) | 2.62E-03 | 5.00E-02 | 1.00E-02 | 1.00E-02 |
| Alder tree | Alnus Glutinosa | Tree | No | ICRP pine tree | 4.71E+02 | 1.00E+01 | 3.00E-01 | 3.00E-01 |
| Forbs and sedges | F. ulmaria, U. dioica, S. sylvaticus, L. thyrsofolia | Grasses and herbs | No | Grasses & herbes (ICRP Wild Grass) | 2.62E-03 | 5.00E-02 | 1.00E-02 | 1.00E-02 |
| Moor frog | Rana arvalis | Amphibian | Yes | Small frog | 7.20E-03 | 1.76E-02 | 1.76E-02 | 4.45E-02 |
| Moor frog in soil | Rana arvalis | Amphibian | Yes | Small frog | 7.20E-03 | 1.76E-02 | 1.76E-02 | 4.45E-02 |

Assumptions - Utnora Swamp

| Organism | Occupancies (when split between terrestrial and aquatic both assessments are done and the dose is summed) | | | | | | | | 137Cs CR (kg/kg) | 137Cs CR (L/kg) | Source of CF from TRS |
|-------------------|---|---------|--------|----------|----------|--------|--------|-------------|------------------|---------------------------|-----------------------|
| | On soil | In soil | In air | In water | On water | In sed | On sed | terrestrial | Marine | | |
| Spruce | 0.75 | 0.25 | 0 | 0 | 0 | 0 | 0 | 1.50E-01 | N/A | Tree (coniferous) | |
| Fern | 0.75 | 0.25 | 0 | 0 | 0 | 0 | 0 | 1.20E+00 | N/A | Grasses and herbs | |
| Alder tree | 0.75 | 0.25 | 0 | 0 | 0 | 0 | 0 | 1.40E-01 | N/A | Tree (deciduous) | |
| Forbs and sedges | 0.75 | 0.25 | 0 | 0 | 0 | 0 | 0 | 1.20E+00 | N/A | Grasses and herbs | |
| Moor frog | 0.5 | 0 | 0 | 0.25 | 0 | 0.25 | 0 | 4.40E-01 | 8.40E+01 | TER: Amphibian - SW: Fish | |
| Moor frog in soil | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4.40E-01 | N/A | TER: Amphibian - SW: Fish | |



Assumptions - Duke Swamp

| Organism | Scientific name | Geometry | Define new organism | What organism | Mass (kg) | height (m) | width (m) | length (m) |
|-----------------------|--------------------------------|----------------------------|---------------------|--|-----------|------------|-----------|------------|
| Balsam fir | Abies balsamea | Tree | No | ICRP pine tree | 4.71E+02 | 1.00E+01 | 3.00E-01 | 3.00E-01 |
| Cedar | Thuja spp. | Tree | No | ICRP pine tree | 4.71E+02 | 1.00E+01 | 3.00E-01 | 3.00E-01 |
| Ferns | | Grasses / herbs | No | Grasses & herbs (ICRP) | 2.62E-03 | 5.00E-02 | 1.00E-02 | 1.00E-02 |
| Forbs | | Grasses / herbs | No | Grasses & herbs (ICRP) | 2.62E-03 | 5.00E-02 | 1.00E-02 | 1.00E-02 |
| Grass | | Grasses / herbs | No | Grasses & herbs (ICRP) | 2.62E-03 | 5.00E-02 | 1.00E-02 | 1.00E-02 |
| Peat moss | Sphagnum spp. | Lichen / briophytes | No | Lichen & bryophytes (ICRP) | 1.10E-04 | 4.01E-02 | 2.29E-03 | 2.29E-03 |
| Flies, wasps, moths | Aerial insects (mixed species) | Flying insect | No | Flying insects (ICRP Bee, used in cAt for Grasshopper) | 5.89E-04 | 7.50E-03 | 7.50E-03 | 2.00E-02 |
| Carrion beetles | Silphidae | Detritivorous invertebrate | No | Detritivorous invertebrate (FASSET Woodlouse) | 1.70E-04 | 6.13E-03 | 3.05E-03 | 1.74E-02 |
| American toad | Bufo americanus | Amphibian | No | Amphibian (ICRP Frog) | 3.14E-02 | 3.00E-02 | 2.50E-02 | 7.99E-02 |
| Grey treefrog | Hyla versicolor | Small frog | Yes | Small frog | 7.20E-03 | 1.76E-02 | 1.76E-02 | 4.45E-02 |
| American bullfrog | Rana catesbeiana | Amphibian | No | Amphibian (ICRP Frog) | 3.14E-02 | 3.00E-02 | 2.50E-02 | 7.99E-02 |
| Green frog | Rana clamitans | Small frog | Yes | Small frog | 7.20E-03 | 1.76E-02 | 1.76E-02 | 4.45E-02 |
| Northern leopard frog | Rana pipiens | Amphibian | No | Amphibian (ICRP Frog) | 3.14E-02 | 3.00E-02 | 2.50E-02 | 7.99E-02 |
| Mink frog | R. septentrionalis | Small frog | Yes | Small frog | 7.20E-03 | 1.76E-02 | 1.76E-02 | 4.45E-02 |
| Garter snake | T. sirtalis | Reptile | No | FASSET snake | 7.39E-01 | 3.49E-02 | 3.49E-02 | 1.16E+00 |
| N. short-tailed shrew | Blarina brevicauda | Small mammal | Yes | Mammal (Small mouse) | 3.30E-02 | 3.00E-02 | 3.00E-02 | 7.00E-02 |
| White-footed mouse | Peromyscus leucopus | Small mammal | Yes | Mammal (Small mouse) | 3.30E-02 | 3.00E-02 | 3.00E-02 | 7.00E-02 |
| Deer mouse | P. maniculatus | Small mammal | Yes | Mammal (Small mouse) | 3.30E-02 | 3.00E-02 | 3.00E-02 | 7.00E-02 |
| Meadow vole | M. pennsylvanicus | Small mammal | Yes | Mammal (Small mouse) | 3.30E-02 | 3.00E-02 | 3.00E-02 | 7.00E-02 |



Assumptions – Duke Swamp

| Organism | Occupancies (when split between terrestrial and aquatic both assessments done & doses summed) | | | | | | | 14C CR (m ³ of air/kg) | 14C CR (L/kg) | Source of CF from ERICA |
|-----------------------|---|---------|--------|----------|----------|--------|--------|-----------------------------------|---------------|--------------------------|
| | On soil | In soil | In air | In water | On water | In sed | On sed | Terrestrial | Freshwater | |
| Balsam fir | 0.75 | 0.25 | 0 | 0 | 0 | 0 | 0 | 1.30E+03 | N/A | Tree |
| Cedar | 0.75 | 0.25 | 0 | 0 | 0 | 0 | 0 | 1.30E+03 | N/A | Tree |
| Ferns | 0.75 | 0.25 | 0 | 0 | 0 | 0 | 0 | 8.90E+02 | N/A | Grasses / herbs |
| Forbs | 0.75 | 0.25 | 0 | 0 | 0 | 0 | 0 | 8.90E+02 | N/A | Grasses / herbs |
| Grass | 0.75 | 0.25 | 0 | 0 | 0 | 0 | 0 | 8.90E+02 | N/A | Grasses / herbs |
| Peat moss | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 8.90E+02 | N/A | Lichen and briophytes |
| Flies, wasps, moths | 0.5 | 0 | 0.5 | 0 | 0 | 0 | 0 | 4.30E+02 | N/A | Flying insects |
| Carrion beetles | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4.30E+02 | N/A | Detr. Invert. |
| American toad | 0.25 | 0 | 0 | 0.25 | 0 | 0.5 | 0 | 1.34E+03 | 7.30E+03 | Amphibian |
| Grey treefrog | 0.25 | 0 | 0 | 0.25 | 0 | 0.5 | 0 | 1.34E+03 | 7.30E+03 | Amphibian |
| American bullfrog | 0.25 | 0 | 0 | 0.25 | 0 | 0.5 | 0 | 1.34E+03 | 7.30E+03 | Amphibian |
| Green frog | 0.25 | 0 | 0 | 0.25 | 0 | 0.5 | 0 | 1.34E+03 | 7.30E+03 | Amphibian |
| N. leopard frog | 0.25 | 0 | 0 | 0.25 | 0 | 0.5 | 0 | 1.34E+03 | 7.30E+03 | Amphibian |
| Mink frog | 0.25 | 0 | 0 | 0.25 | 0 | 0.5 | 0 | 1.34E+03 | 7.30E+03 | Amphibian |
| Garter snake | 0.6 | 0.2 | 0 | 0.2 | 0 | 0 | 0 | 1.34E+03 | 7.30E+03 | Amphibian |
| N. short-tailed shrew | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 1.34E+03 | N/A | Mammal (rat) |
| White-footed mouse | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 1.34E+03 | N/A | Mammal (rat) |
| Deer mouse | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 1.34E+03 | N/A | Mammal (rat) |
| Meadow vole | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 1.34E+03 | N/A | Mammal (rat) |

Assessment results

| Model used | | ERICA | | | | Unweighted dose from terrestrial ecosystem | | Unweighted dose from aquatic ecosystem | | Total unweighted absorbed dose | |
|-----------------------------|--------------|--------------------|------------------------------|----------|---------|--|-------------|--|-------------|--------------------------------|---------|
| Participant name | | SCK-CEN | | | | internal (μGy/h) | | internal (μGy/h) | | (μGy/h) | |
| Date run | | June 2011 | | | | external (μGy/h) | | external (μGy/h) | | | |
| Area | Radionuclide | Organism | mean | min | max | annual mean | annual mean | annual mean | annual mean | annual mean | |
| Steel Creek Floodplain | Cs-137 | Grasses, sedges | 4.20E+03 | 2.5E+02 | 2.3E+04 | 5.88E-01 | 3.95E-01 | | | 9.8E-01 | |
| | Cs-137 | Alder tree | 4.90E+02 | 2.9E+01 | 2.7E+03 | 1.59E-01 | 3.16E-01 | | | 4.7E-01 | |
| | Cs-137 | Shrubs | 8.05E+03 | 4.8E+02 | 4.4E+04 | 1.13E+00 | 3.74E-01 | | | 1.5E+00 | |
| | Cs-137 | Willows etc | 4.90E+02 | 2.9E+01 | 2.7E+03 | 1.59E-01 | 3.16E-01 | | | 4.7E-01 | |
| | Cs-137 | Green treefrog | 2.27E+03 | 1.4E+02 | 1.2E+04 | 2.25E-01 | 1.00E-01 | 3.7E-01 | 1.8E+01 | 1.8E+01 | |
| | Cs-137 | Aquatic snakes | 2.89E+03 | 1.7E+02 | 1.6E+04 | 3.04E-01 | 9.58E-02 | 5.4E-01 | 8.4E+00 | 9.0E+00 | |
| | Cs-137 | Terrestrial snakes | 1.82E+03 | 1.1E+02 | 9.9E+03 | 3.04E-01 | 3.83E-01 | | | 6.9E-01 | |
| | | | Ducks (ringneck, mallard) | 2.62E+03 | 1.6E+02 | 1.4E+04 | 3.78E-01 | 1.86E-01 | 6.2E-01 | 5.7E-05 | 6.8E-01 |
| | | Cs-137 | Spiders | 1.05E+02 | 6.3E+00 | 5.7E+02 | 1.32E-02 | 4.04E-01 | | | 4.2E-01 |
| | | Cs-137 | Beetles | 3.15E+02 | 1.9E+01 | 1.7E+03 | 3.89E-02 | 1.07E+00 | | | 1.1E+00 |
| | | Cs-137 | Aphids, leafhoppers, cicadas | 3.43E+01 | 2.1E+00 | 1.9E+02 | 4.24E-03 | 1.07E+00 | | | 1.1E+00 |
| | | Cs-137 | Grasshoppers, crickets | 3.85E+02 | 2.3E+01 | 2.1E+03 | 5.95E-02 | 3.95E-01 | | | 4.5E-01 |
| Utnora Riparian Alder Swamp | Cs-137 | Spruce | 4.5E+03 | 1.8E+03 | 1.1E+04 | 1.5E+00 | 2.7E+00 | | | 4.2E+00 | |
| | Cs-137 | Fern | 3.6E+04 | 1.4E+04 | 8.9E+04 | 5.0E+00 | 3.4E+00 | | | 8.4E+00 | |
| | Cs-137 | Alder tree | 4.2E+03 | 1.7E+03 | 1.0E+04 | 1.4E+00 | 2.7E+00 | | | 4.1E+00 | |
| | Cs-137 | Forbs, sedges | 3.6E+04 | 1.4E+04 | 8.9E+04 | 5.0E+00 | 3.4E+00 | | | 8.4E+00 | |
| | Cs-137 | Moor frog | 6.6E+03 | 2.6E+03 | 1.6E+04 | 1.9E+00 | 1.7E+00 | 2.5E-03 | 6.5E-02 | 2.7E+00 | |
| | Cs-137 | Moor frog | 1.3E+04 | 5.3E+03 | 3.3E+04 | 1.9E+00 | 9.1E+00 | | | 1.1E+01 | |



Assessment results

| Model used | Participant name | Date run | Estimated Biota Concentration (Bq/kg) | | | Unweighted dose from terrestrial ecosystem | | Unweighted dose aquatic ecosystem | | Total unweighted absorbed dose |
|------------|------------------|--|---------------------------------------|---------|---------|--|------------------|-----------------------------------|------------------|--------------------------------|
| | | | annual mean | min | max | internal (μGy/h) | external (μGy/h) | internal (μGy/h) | external (μGy/h) | (μGy/h) |
| Area | Radionuclide | Organism | annual mean | min | max | annual mean | annual mean | annual mean | annual mean | annual mean |
| Duke swamp | C-14 | Balsam fir | 7.4E+04 | 3.0E+03 | 2.6E+05 | 2.1E+00 | 0.0E+00 | | | 2.1E+00 |
| | | Cedar | 7.4E+04 | 3.0E+03 | 2.6E+05 | 2.1E+00 | 0.0E+00 | | | 2.1E+00 |
| | | Ferns | 5.1E+04 | 2.1E+03 | 1.8E+05 | 1.4E+00 | 0.0E+00 | | | 1.4E+00 |
| | | Forbs | 5.1E+04 | 2.1E+03 | 1.8E+05 | 1.4E+00 | 0.0E+00 | | | 1.4E+00 |
| | | Grass | 5.1E+04 | 2.1E+03 | 1.8E+05 | 1.4E+00 | 0.0E+00 | | | 1.4E+00 |
| | | Peat moss | 5.1E+04 | 2.1E+03 | 1.8E+05 | 1.4E+00 | 0.0E+00 | | | 1.4E+00 |
| | | deer flies, horse flies, other types of flies, wasps and moths | 2.5E+04 | 1.0E+03 | 8.7E+04 | 7.0E-01 | 0.0E+00 | | | 7.0E-01 |
| | | Carrion beetles | 2.5E+04 | 1.0E+03 | 8.7E+04 | 6.9E-01 | 0.0E+00 | | | 6.9E-01 |
| | | American toad | 7.7E+04 | 3.1E+03 | 2.7E+05 | 2.2E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.2E+00 |
| | | Grey treefrog | 7.7E+04 | 3.1E+03 | 2.7E+05 | 2.2E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.2E+00 |
| | | American bullfrog | 7.7E+04 | 3.1E+03 | 2.7E+05 | 2.2E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.2E+00 |
| | | Green frog | 7.7E+04 | 3.1E+03 | 2.7E+05 | 2.2E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.2E+00 |
| | | Northern leopard frog | 7.7E+04 | 3.1E+03 | 2.7E+05 | 2.2E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.2E+00 |
| | | Mink frog | 7.7E+04 | 3.1E+03 | 2.7E+05 | 2.2E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.2E+00 |
| | | Common garter snake | 7.7E+04 | 3.1E+03 | 2.7E+05 | 2.2E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 2.2E+00 |
| | | Northern short-tailed shrew | 7.7E+04 | 3.1E+03 | 2.7E+05 | 2.2E+00 | 0.0E+00 | | | 2.2E+00 |
| | | White-footed mouse | 7.7E+04 | 3.1E+03 | 2.7E+05 | 2.2E+00 | 0.0E+00 | | | 2.2E+00 |
| | | Deer mouse | 7.7E+04 | 3.1E+03 | 2.7E+05 | 2.2E+00 | 0.0E+00 | | | 2.2E+00 |
| | | Meadow vole | 7.7E+04 | 3.1E+03 | 2.7E+05 | 2.2E+00 | 0.0E+00 | | | 2.2E+00 |

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