CHERPAC Results for the Agricultural Scenario

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The features and capabilities of CHERPAC code were introduced to this Working Group (WG) in January 2010

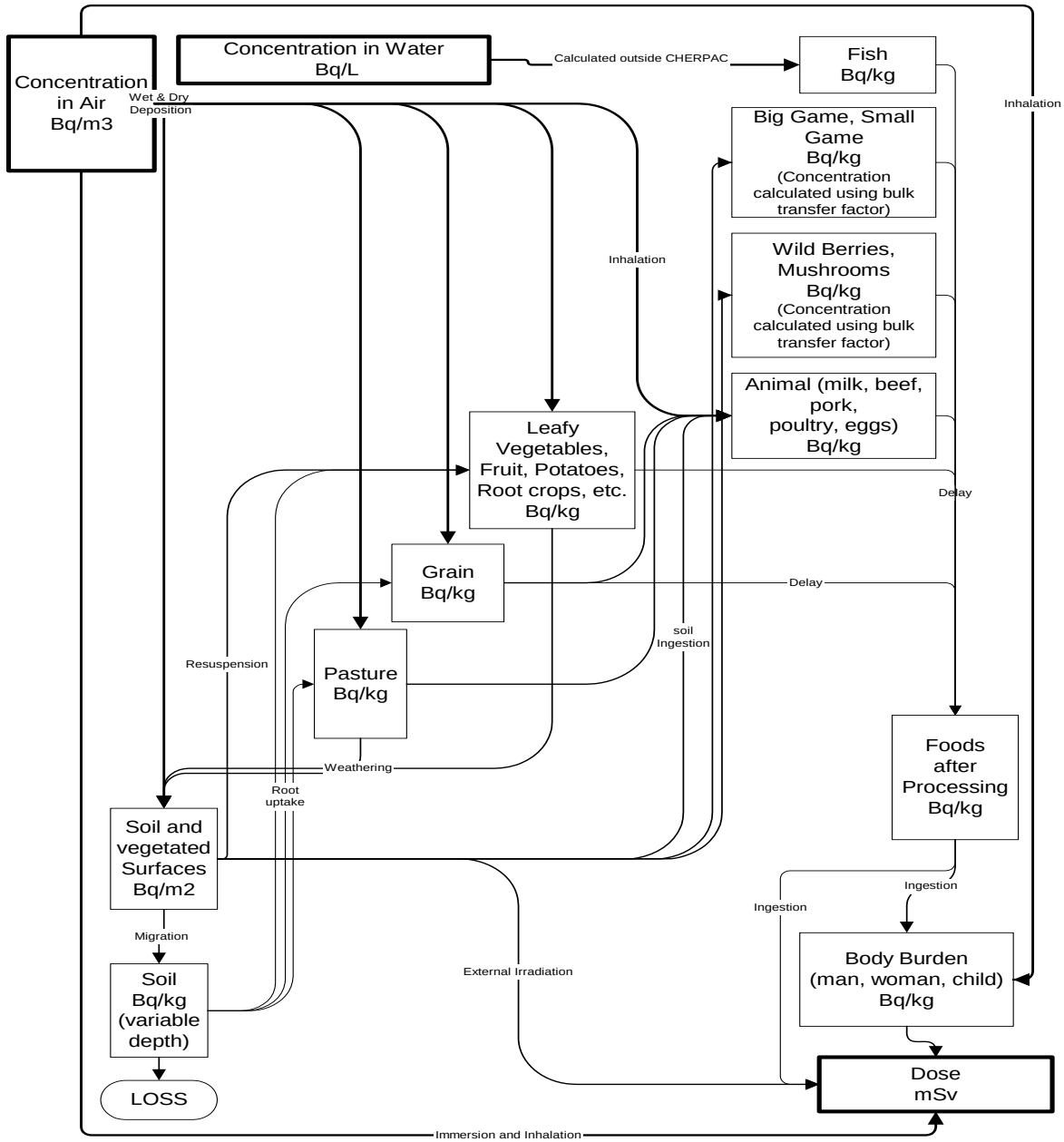


Figure 1. Simplified structure of CHERPAC

Adapting CHERPAC to the scenario and the assumptions made

- Best estimate predictions made; stochastic predictions and parametric sensitivities to be done in the future
- CHERPAC's Canadian specific default parameter values (including the growing and harvest months for various crops) used
- All three radionuclides assumed to be deposited in the particulate form
- CHERPAC started with the air concentration, calibrated to achieve the given deposition on grass and soil surface
- Attempted to set deposition to other surfaces at ~ 1000 Bq/m2
- Direct contribution from air to animal products disabled

Adapting CHERPAC to the scenario and the assumptions made (continued)

- Originally CHERPAC had a lake and fish model for Cs-137 only. This model was adapted for Sr-90 and I-131 also by combining it with the CSA N288.1 (2008) pond model
- I-131 concentrations decreased very quickly in water because of its radioactive half-life of only 8 days
- The Clay soil type was used in this model
- CHERPAC originally considered combined intake rates by humans from the agricultural and the forest pathways, with forest products intake rates being much lower than those for agricultural products. In this exercise, the two pathways were separated and the forest product intake rates were increased, based on the assumption that people living closer to the forest consume more forest food.

Adapting CHERPAC to the scenario and the assumptions made (continued)

- Originally CHERPAC contained the bulk transfer factors for forest food products for Cs-137 only. Transfer factors for Sr-90 were derived by comparing Cs-137 and Sr-90 concentrations in fruits, forest plants, beef, and forest animal products. Transfer factors for I-131 were derived considering its 8-day half-life for radioactive decay.

- CHERPAC's input files contain relatively outdated dietary intakes (best estimates as well as PDFs); CSA N288.1 (2008) has newer best estimate values. The original CHERPAC values were used in this best estimate analysis in view of their convenience for the future uncertainty and sensitivity analysis.

- Only monthly predictions were made, although daily predictions can also be made using CHERPAC

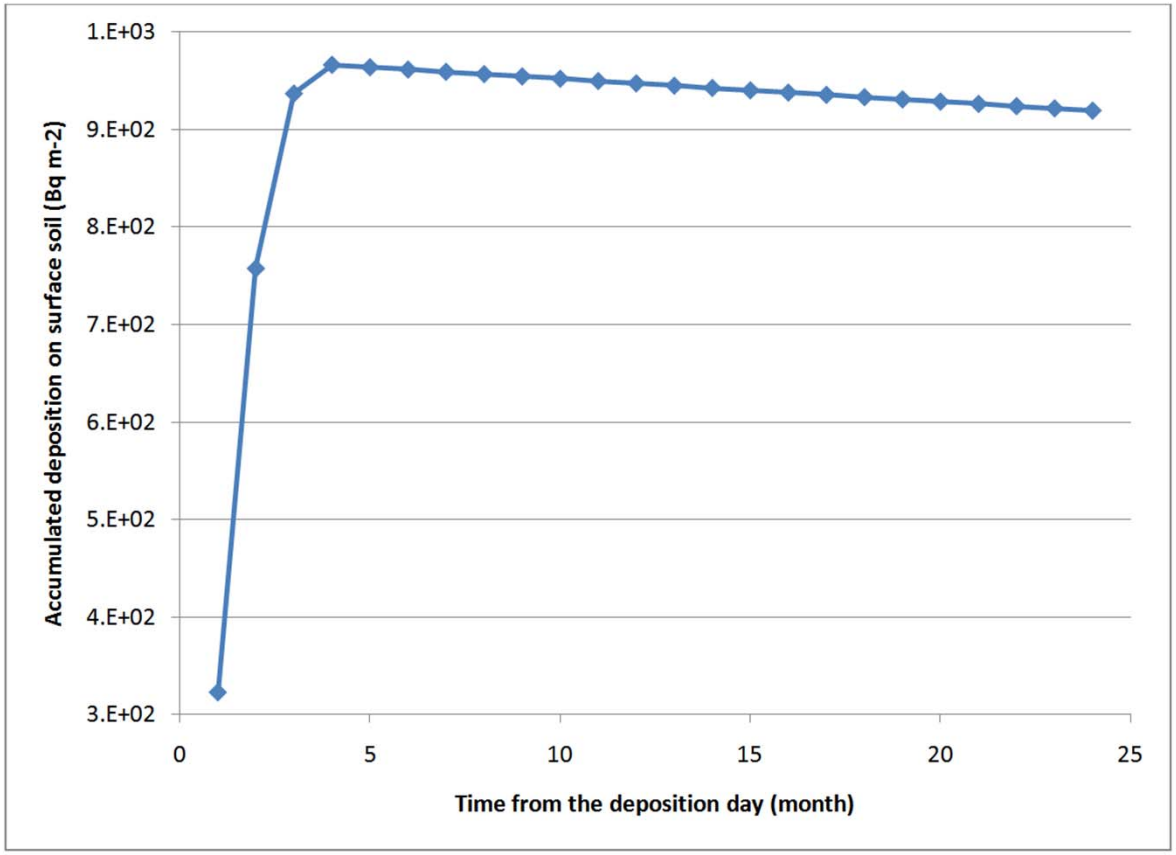
Adapting CHERPAC to the scenario and the assumptions made (continued)

- An 1-year-old infant age class was added to CHERPAC
- Only whole body effective doses from ingestion and groundshine were predicted

Results

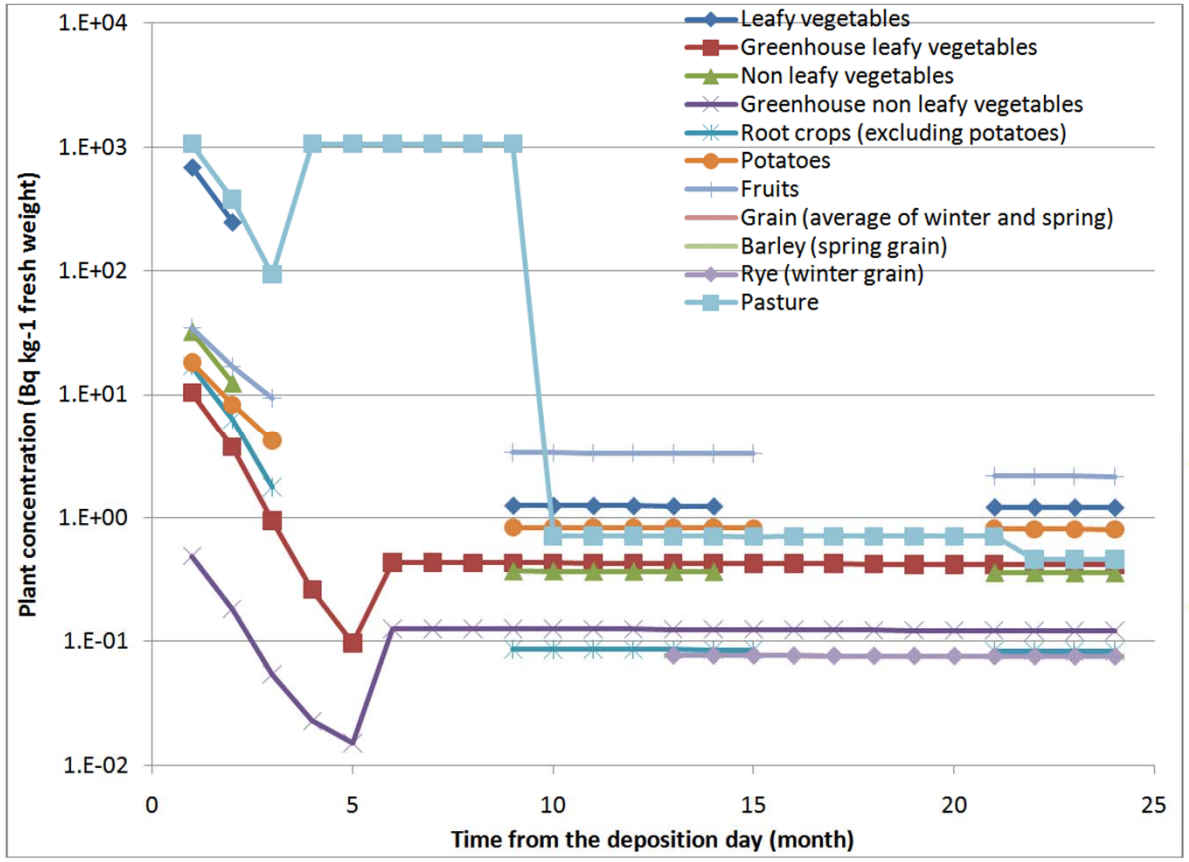
- Detailed results were submitted to the WG Leader
- Graphs and discussion here are mostly for one case (dry deposition of Cs-137 in a summer month). Many observations will apply for other cases also. Some points are made for other cases also

Results (continued): Accumulated deposition on surface soil



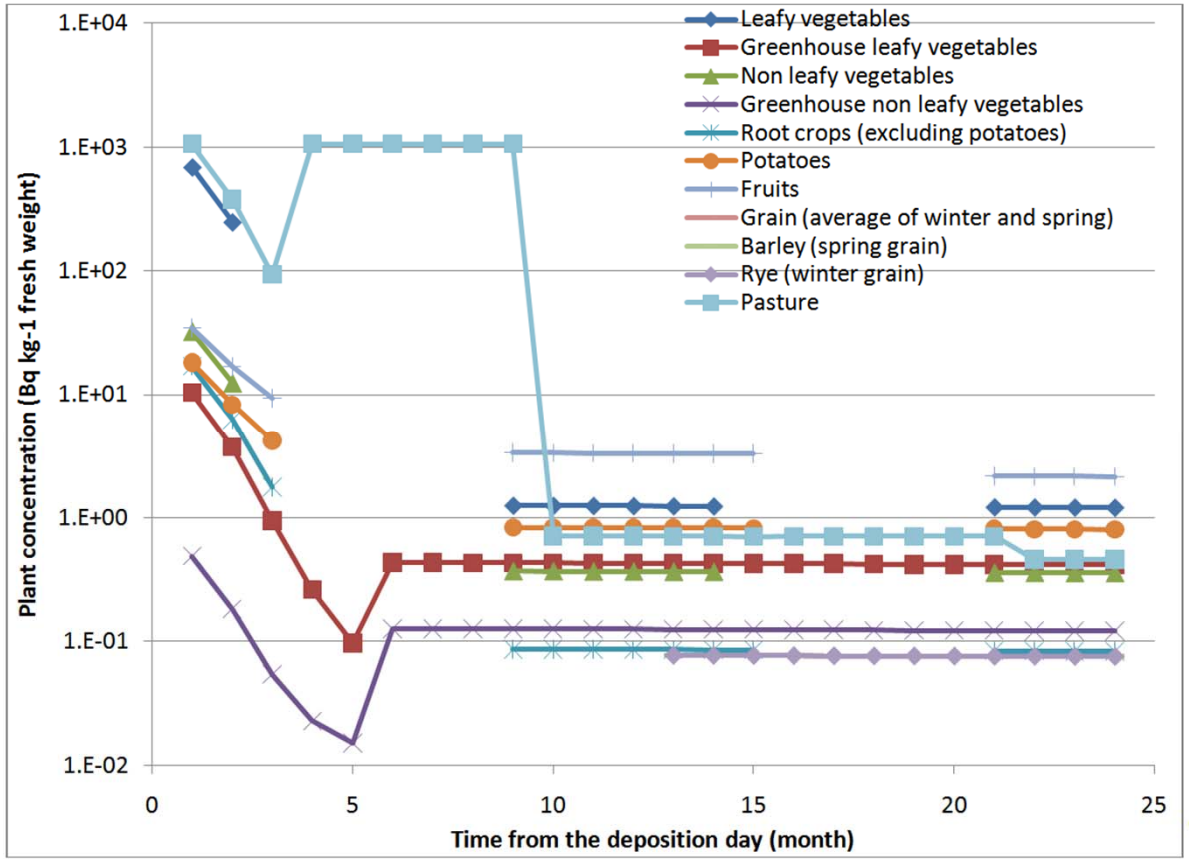
- Same soil model for agricultural and forest environments
- Some wet deposition retained by plant leaves and some washed off
- Results for dry and wet deposition cases similar because CHERPAC adds both depositions together
- Soil deposition lower in the first 3 months because material is retained by the plant leaves, but it gradually washes off and transfers to soil.
- Soil concentration peaks at 4 months, then decreases very slowly with radioactive decay and loss rate from the rooting zone
- Soil predictions sensitive to the deposition season. If deposition occurs close to harvest season, then some deposition gets removed by cropping, which reduces soil inventory

Results (continued): Agricultural plant concentrations



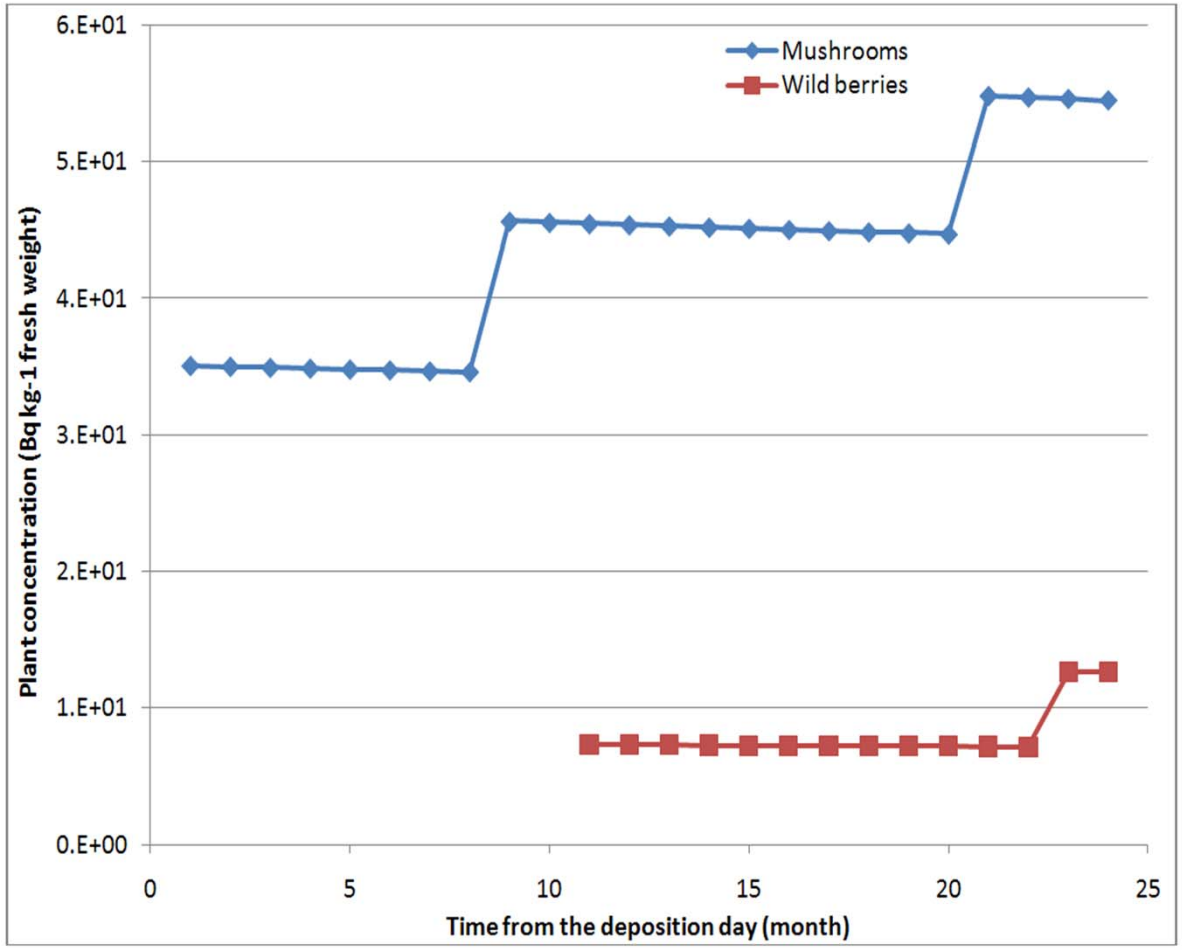
- Seasonal differences noticed; nothing growing in the first 2 months for winter deposition, and 5 months for autumn deposition
- Pasture and leafy vegetables concentrations highest among all plants for summer deposition. Fruits concentrations highest for the winter deposition. The greenhouse non-leafy concentrations were the lowest in the first year for summer release
- The direct deposition on the crops is lost with a weathering (wash-off and any other loss) half-life of 15 days
- Greenhouse vegetables partially open to atmosphere, take less input from atmosphere (lower dry and no wet deposition)

Results: Agricultural plant concentrations (continued)



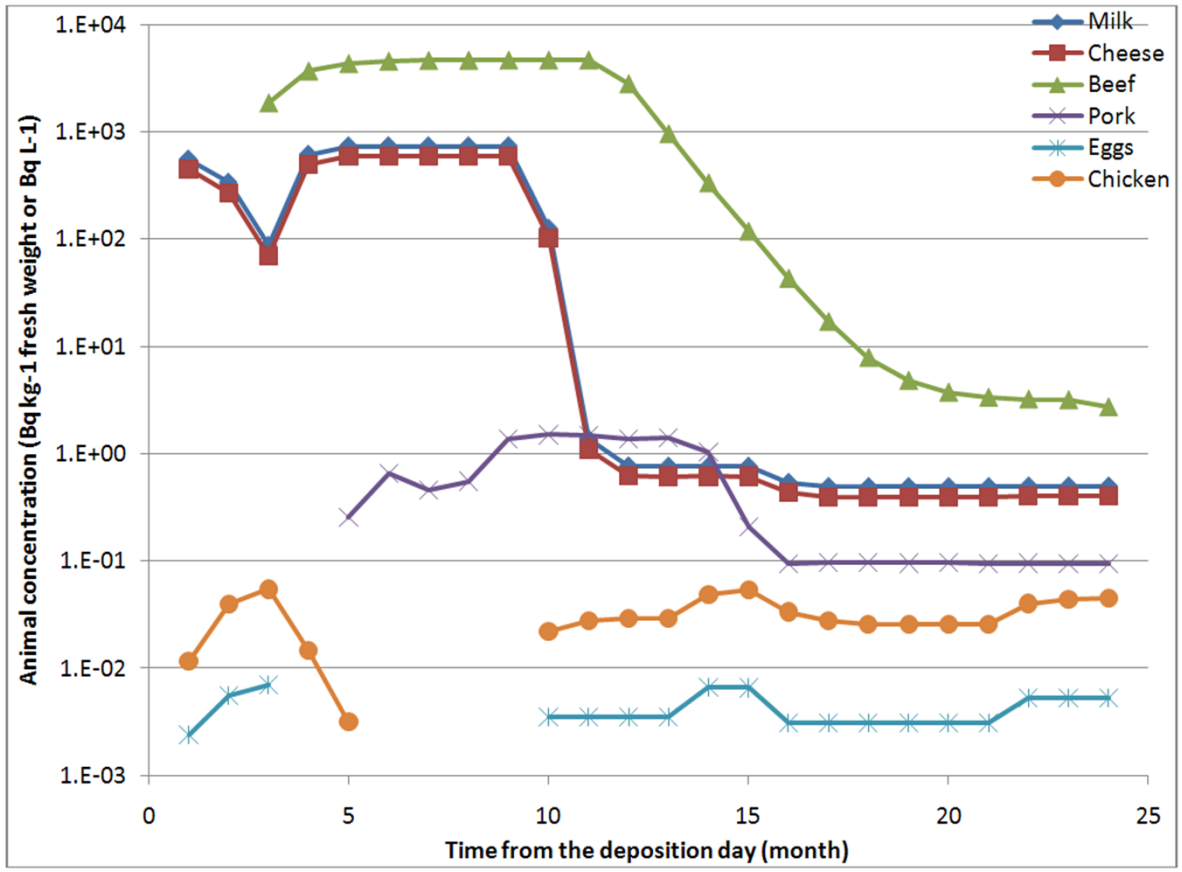
- Deposited activity on vegetables continues to decrease sharply (weathering half-life) in first year. In second year, before the new season, some soil in the greenhouses is replaced with the outdoor soil, and the vegetables gain activity via root-uptake; thus concentrations are stable.
- Pasture shown here is for milk cows, which eat fresh grass from May to October. Grass for them is harvested in August and fed to them from Nov. to Apr. In the first 3 months the decrease in pasture activity is due to the weathering half-life of the fresh grass. The subsequent increase is because of the switch to using harvested grass for feed. In the second year, grass gains activity through root-uptake only.
- Crop concentrations dependent on their rooting depth and yearly migration of activity with depth

Results (continued): Forest plant concentrations



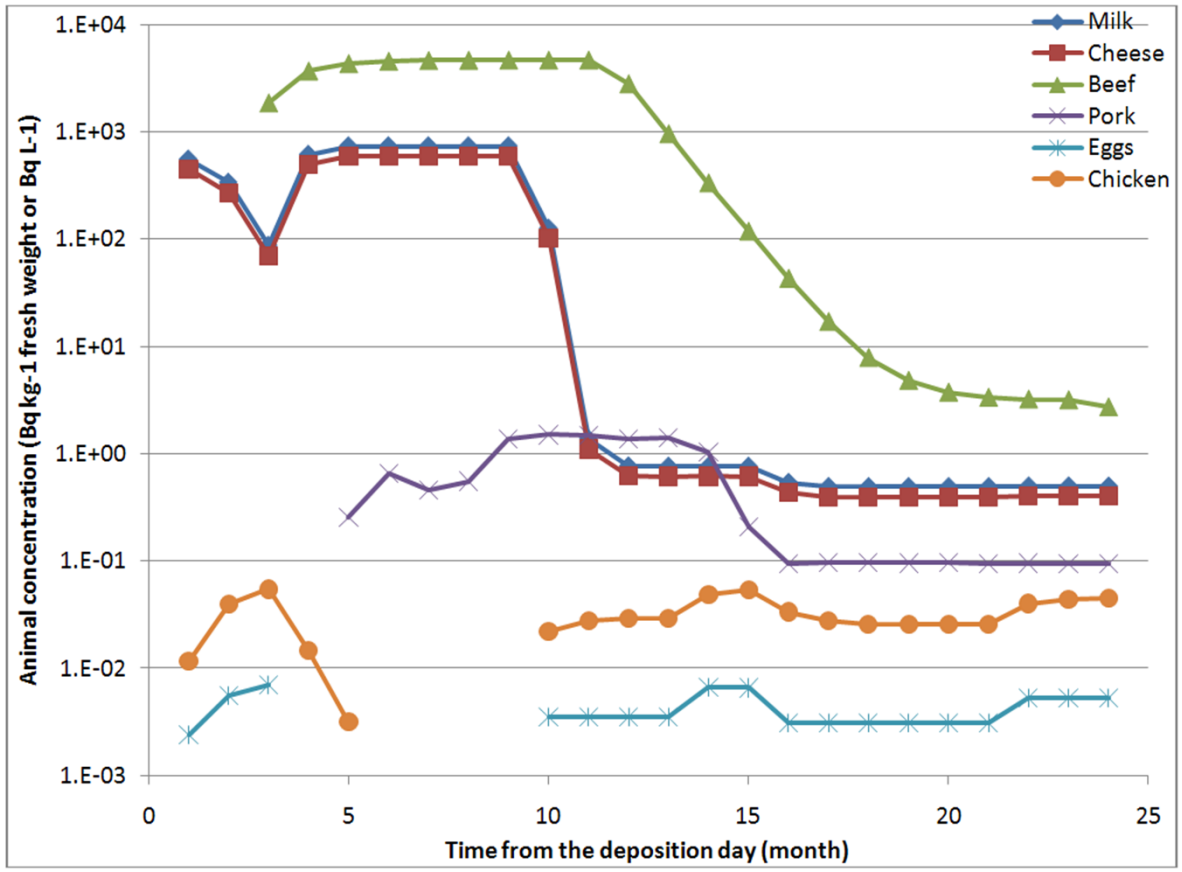
- Mushrooms and berries concentrations for both years are based upon observed bulk transfer factors
- Mushrooms concentration increases for the first few years as the activity passes through the root zone, but it levels off and comes down afterward
- Wild berries concentration are shown as 0 for the first 10 months because the picking season is only June and July

Results (continued): Agricultural animal product concentrations



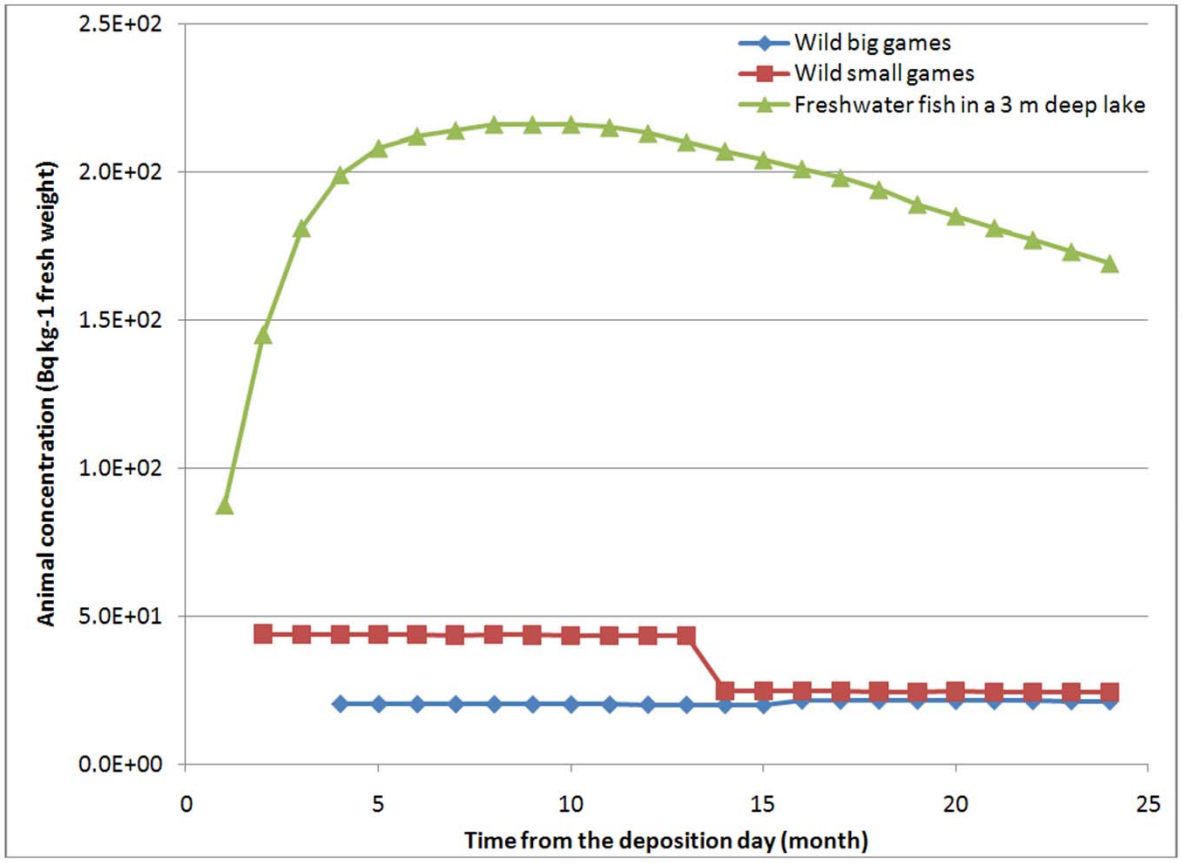
- Highest concentration is in beef. Lowest concentration is in eggs.
- Beef concentration is 0 for the 2 months after deposition because the cows are assumed to eat stored grass. The grass for them harvested twice (June and August). The first harvest is fed from July to September and second harvest for the remaining months. The large decrease in beef cattle concentration from year one to year two is due to the drop in pasture and grain concentrations for the same period. Body burden is modelled for beef, considering biological and radioactive decays.
- Dairy cows eat fresh pasture in the first 3 months from deposition, and the milk and cheese activities decreases with the decrease in freshly deposited activity on the pasture. The milk and cheese concentrations suddenly jump and peak in October when the dairy cows start eating grass, which was harvested at the peak activity time (August)

Results: Agricultural animal product concentrations (continued)



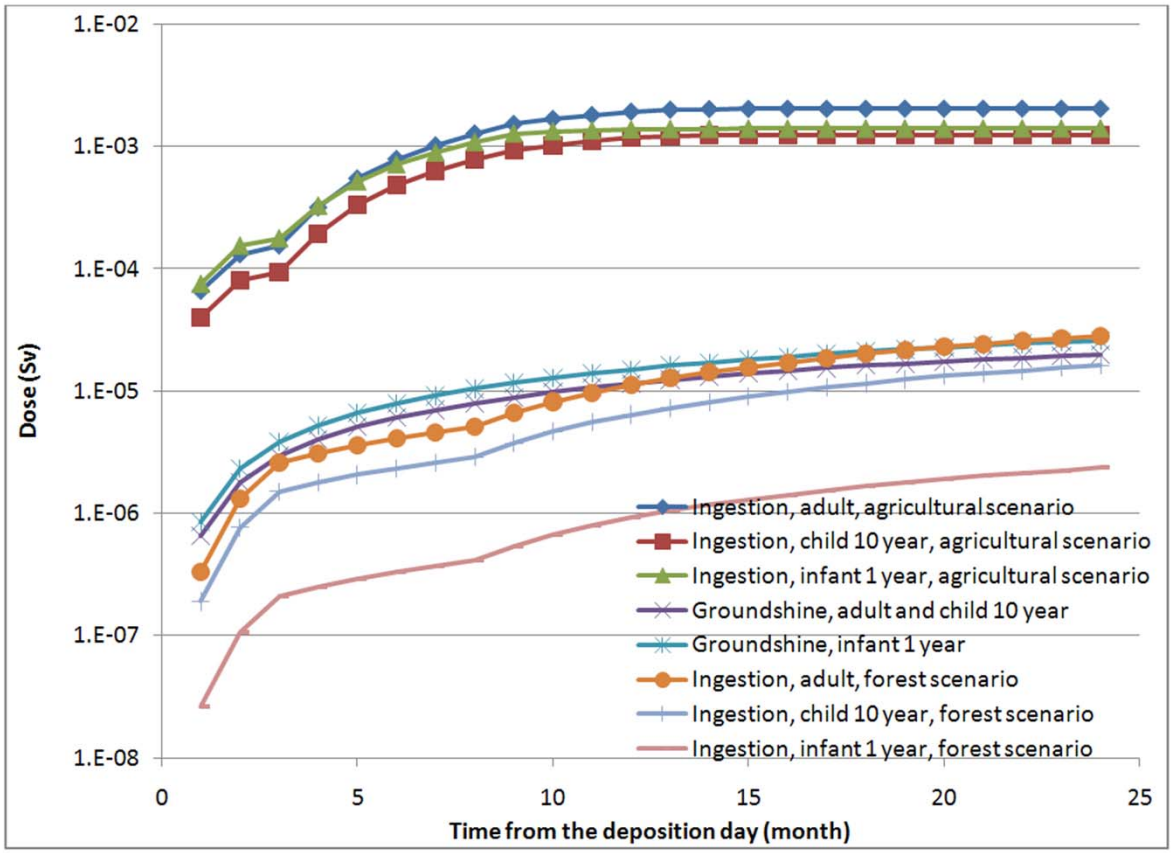
- Concentrations in chicken and eggs builds up in the summer months from grain and soil because the chickens are outdoors. Concentrations decrease to zero in the winter months of the first year because there is no transfer from soil and a slow drop in the concentration in the intakes.
- Predictions are for Canadian indoor pigs which do not ingest soil. Pigs are modelled with body burden and loses, and slaughtered 6 months after the birth. For the first two months, they drink milk, and for all six months they eat grain. Grain they eat can be fresh or from the first harvest or second harvest, depending upon the time of the year.

Results (continued): Forest animal product concentrations



- Big and small game concentrations for year 1 and 2 are from observed bulk transfer factors, differences between the concentration of big and small games are likely due to the difference in the concentration in the food they eat.
- Fish concentrations are higher compared to other animal products because of the higher BAF of Cs-137
- Fish will likely give higher dose than other forest food products

Results (continued): Doses to humans



- Doses from the agricultural food products are higher than doses from groundshine and forest food products.
- Infants have lower dose from forest products because of their lower intake rates compared to the other age classes
- Ingestion doses from summer deposition are high because all crops were at their peak growth and were ingested fresh after the deposition event
- It is conservatively assumed that all agricultural plants and animals are growing around the same house where deposition occurs. In reality, if it is a wheat farm, then there may not be vegetables or animals growing at that location.

Acknowledgement

- Ring Peterson's contribution to CHERPAC development, prior to her retiring from AECL in 1998, is gratefully acknowledged

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