

ARCTIC AND FOREST SCENARIOS

Presentation for:

**Working Group 8 on Environmental Sensitivity
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Problem Formulation:

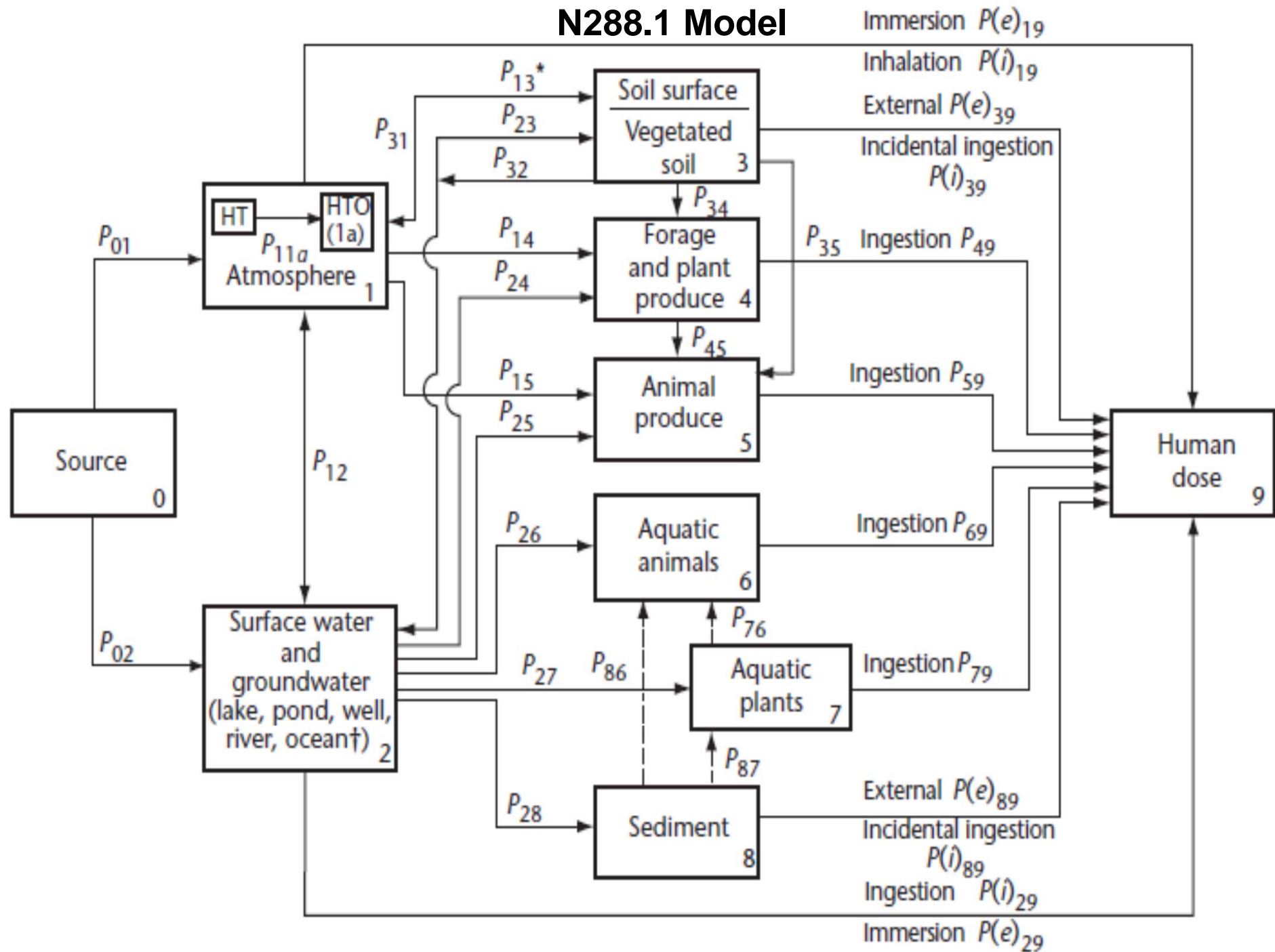
Source term: ^{137}Cs , ^{90}Sr , and ^{131}I ; A single deposition of 1000 Bq/m² each under both dry conditions and heavy rainfall.

Seasons: Winter, spring, summer, fall.

Radionuclide concentrations: In soil, water, and plants or animals either consumed directly by humans, or as members of food chains leading to humans.

Radiation doses: To adult, 10-year old, and one-year old – during the 1st year, 2nd year and 10th year after the accident.

N288.1 Model



P₁₄ Deposition on plant surfaces

$$\frac{\text{Deposition (Bq/m}^2\text{)} \times A}{\text{Yield (kg/m}^2\text{)}} = \text{Plant conc (Bq/kg)}$$

A = Foliar interception fraction
= 1 for lichens, 0.3 for vascular plants

Yield = 0.48 kg/m² for lichens
= 1.0 kg/m² for vascular plants

P₃₄ Root uptake by plant

$$\text{Soil conc (Bq/kg)} = \frac{\text{deposition (Bq/m}^2\text{)}}{\text{density (kg/m}^3\text{)} \times \text{depth (m)}}$$

Density of soil = 1300 kg/m³

Contaminated depth = 0.2 m

Deposition of 1000 Bq/m² → soil conc 3.85 Bq/kg

Plant conc (Bq/kg) = Soil conc (Bq/kg) x conc ratio

P₄₅ Transfer from plant to animal

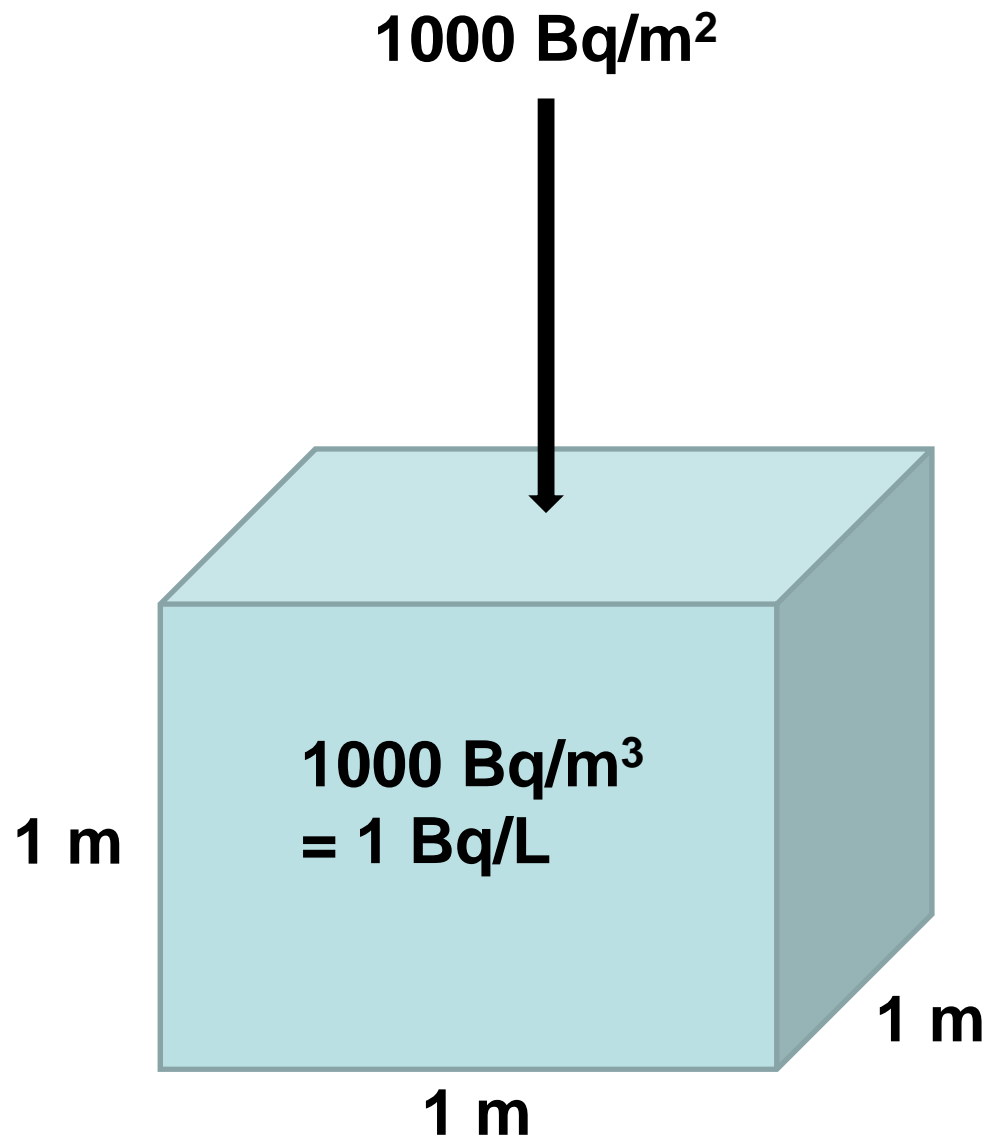
$$\begin{aligned} \text{Plant conc (Bq/kg)} \times A \times \text{feed intake (kg/d)} \\ \times \text{transfer factor (d/kg)} \\ = \text{Meat conc (Bq/kg)} \end{aligned}$$

**A = Fraction of feed from contaminated source
= 1**

**Feed intake = 1.96 kg dw/d for caribou
= 5.22 kg dw/d for moose
(dry wt)/(wet wt) = 0.19**

**Transfer factor = 0.15 d/kg for cesium
= 0.04 d/kg for strontium
= 0.032 d/kg for iodine**

P_{12} Deposition on water



P₂₆ Transfer from water to fish

Fish conc (Bq/kg) = water conc (Bq/kg) x BAF

BAF = Bioaccumulation factor
= 3500 for cesium
= 2 for strontium
= 6 for iodine

**$P(e)_{39}$ Groundshine dose factors
(Sv/year)/(Bq/m²) [Oak Ridge]**

	Adult and Children	Infants
Cs-137	1.75E-08	2.28E-08
Sr-90	5.18E-11	5.18E-11
I-131	3.65E-10	4.76E-10

Human doses from ingestion of radioactivity

$$\begin{aligned} \text{Dose (mSv/year)} = & \text{conc in food (Bq/kg)} \\ & \times \text{dietary intake (kg/year)} \\ & \times \text{dose coefficient (Sv/Bq)} \\ & \times 1000 \text{ (mSv/Sv)} \end{aligned}$$

Dietary intakes

	grams/day	kg/year
Caribou	66.4	24.2
Moose	15.8	5.8
Fish	21.9	8.0
Wild plants	11.0	4.0

Water consumption (L/d)
[US Environmental Protection Agency]

	Mean	90th %ile
Infant	0.5	0.98
Child	0.72	1.4
Adult	1.4	2.3

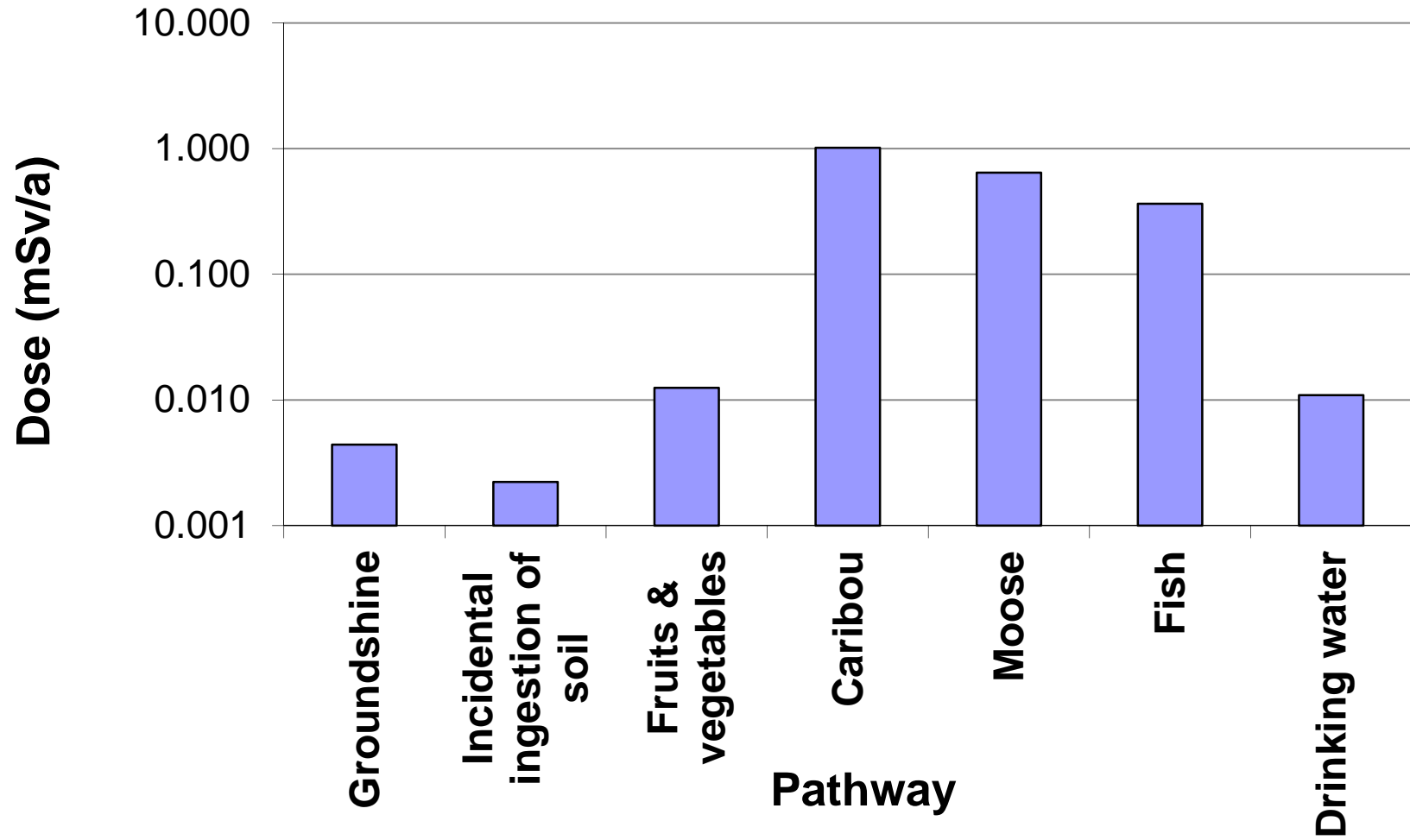
Dose coefficients for ingestion intakes (Sv/Bq)

Age group	Cs-137	Sr-90	I-131
1-year old	1.20E-08	7.30E-08	1.80E-07
10-year old	1.00E-08	6.00E-08	5.20E-08
Adult	1.30E-08	2.80E-08	2.20E-08

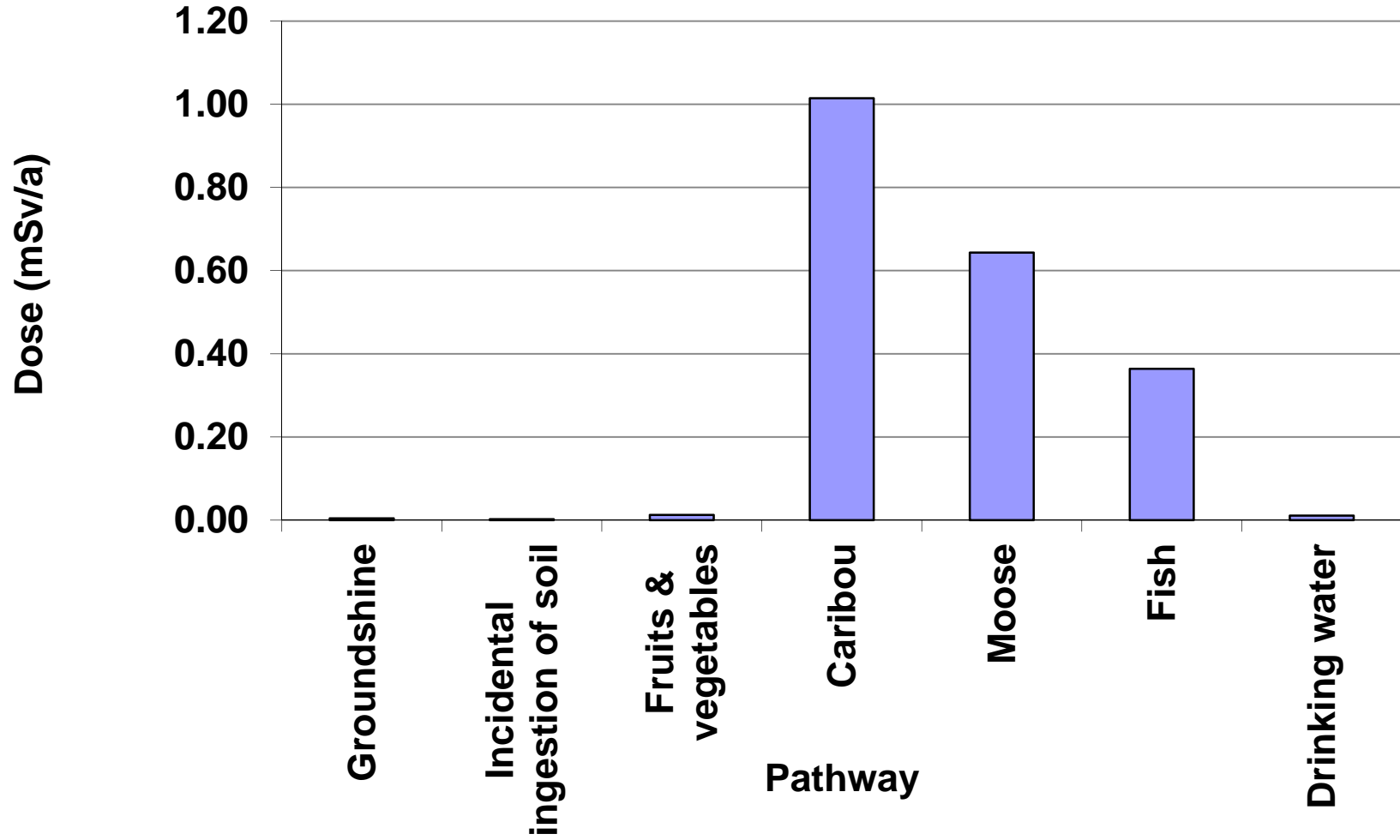
Doses to adults (mSv/year) in 1st year

Pathway	Cs-137	Sr-90	I-131
Groundshine	4.41E-03	1.31E-05	2.93E-06
Soil ingestion	2.23E-03	4.80E-03	1.20E-04
Fruit & vegetable ingestion	1.25E-02	2.69E-02	6.72E-05
Caribou ingestion	1.01E+00	5.83E-01	1.07E-03
Moose ingestion	6.43E-01	3.70E-01	6.77E-04
Fish ingestion	3.64E-01	4.48E-04	3.36E-05
Drinking water ingestion	1.09E-02	2.35E-02	5.87E-04
Total	2.05E+00	1.01E+00	2.56E-03

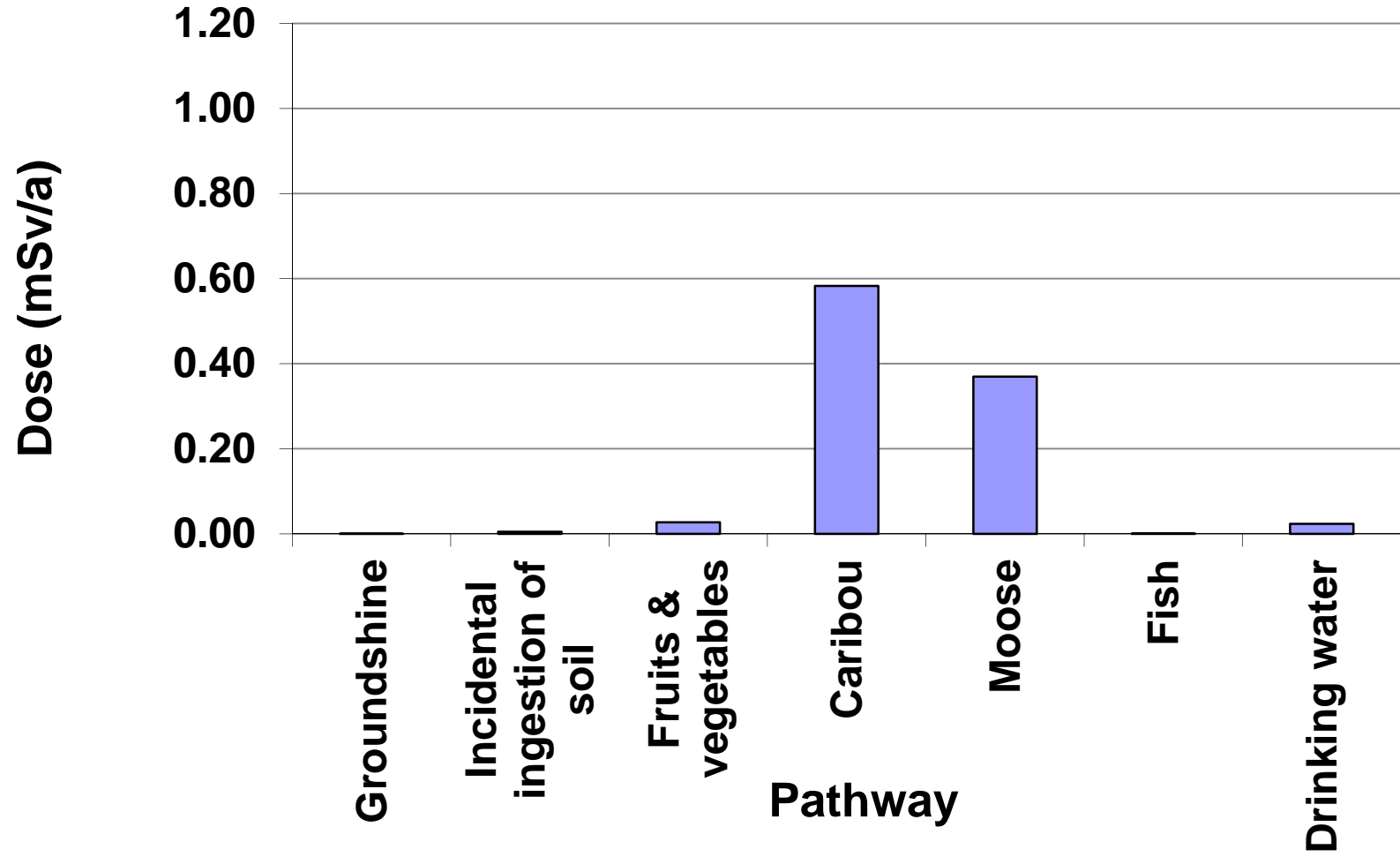
Cs-137 Dose by Pathway



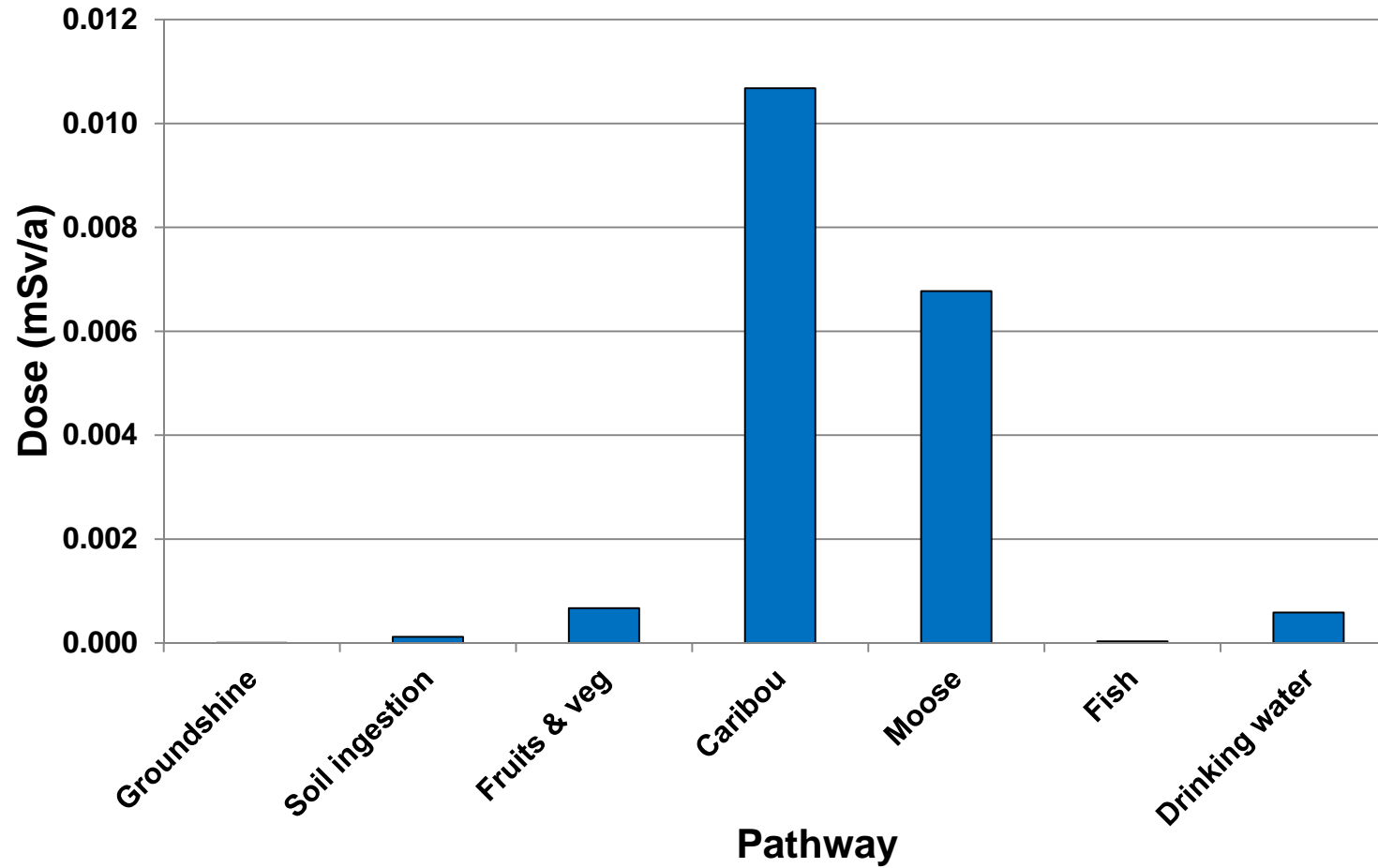
Cs-137 Dose by Pathway



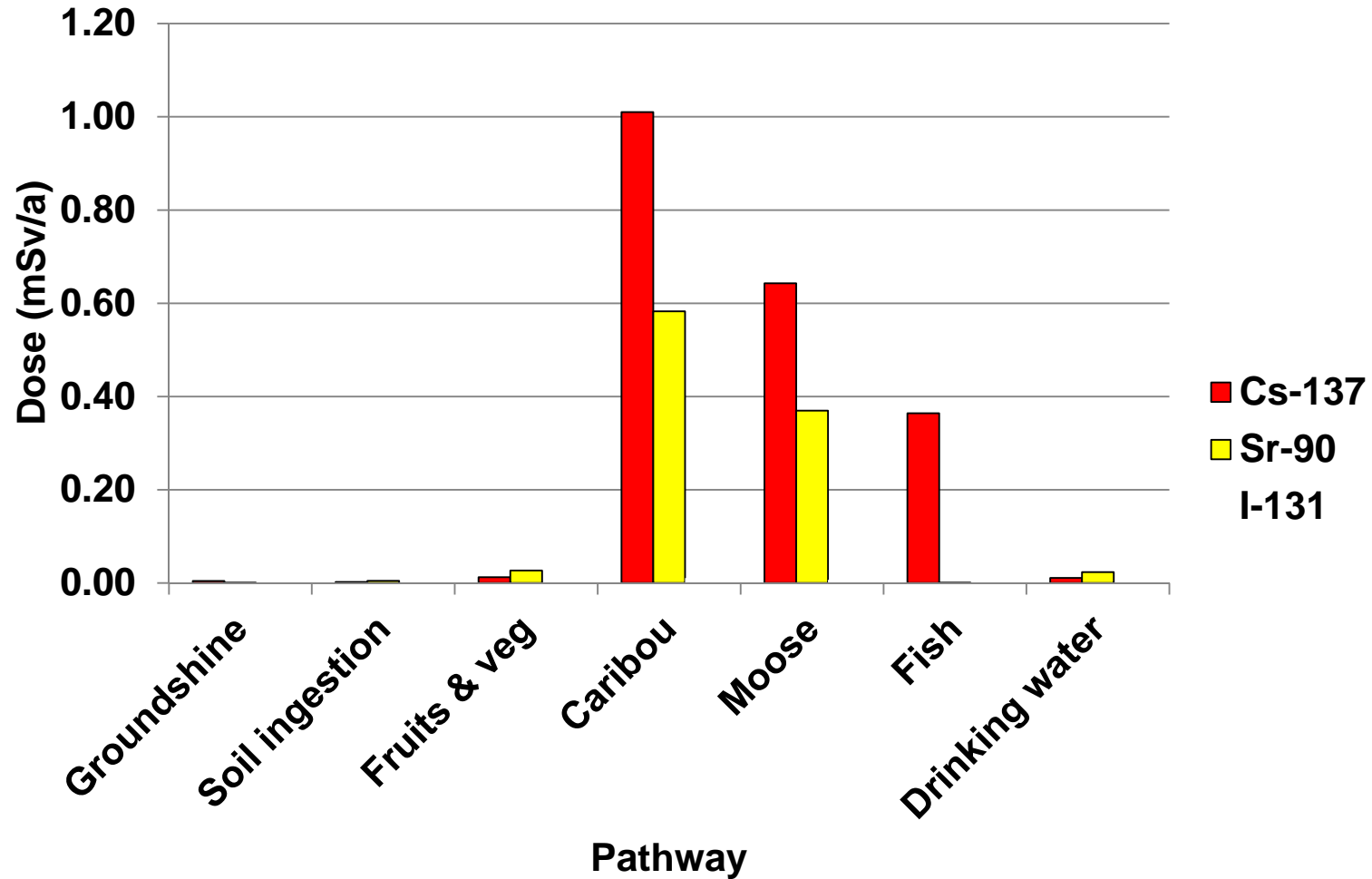
Sr-90 Dose by Pathway



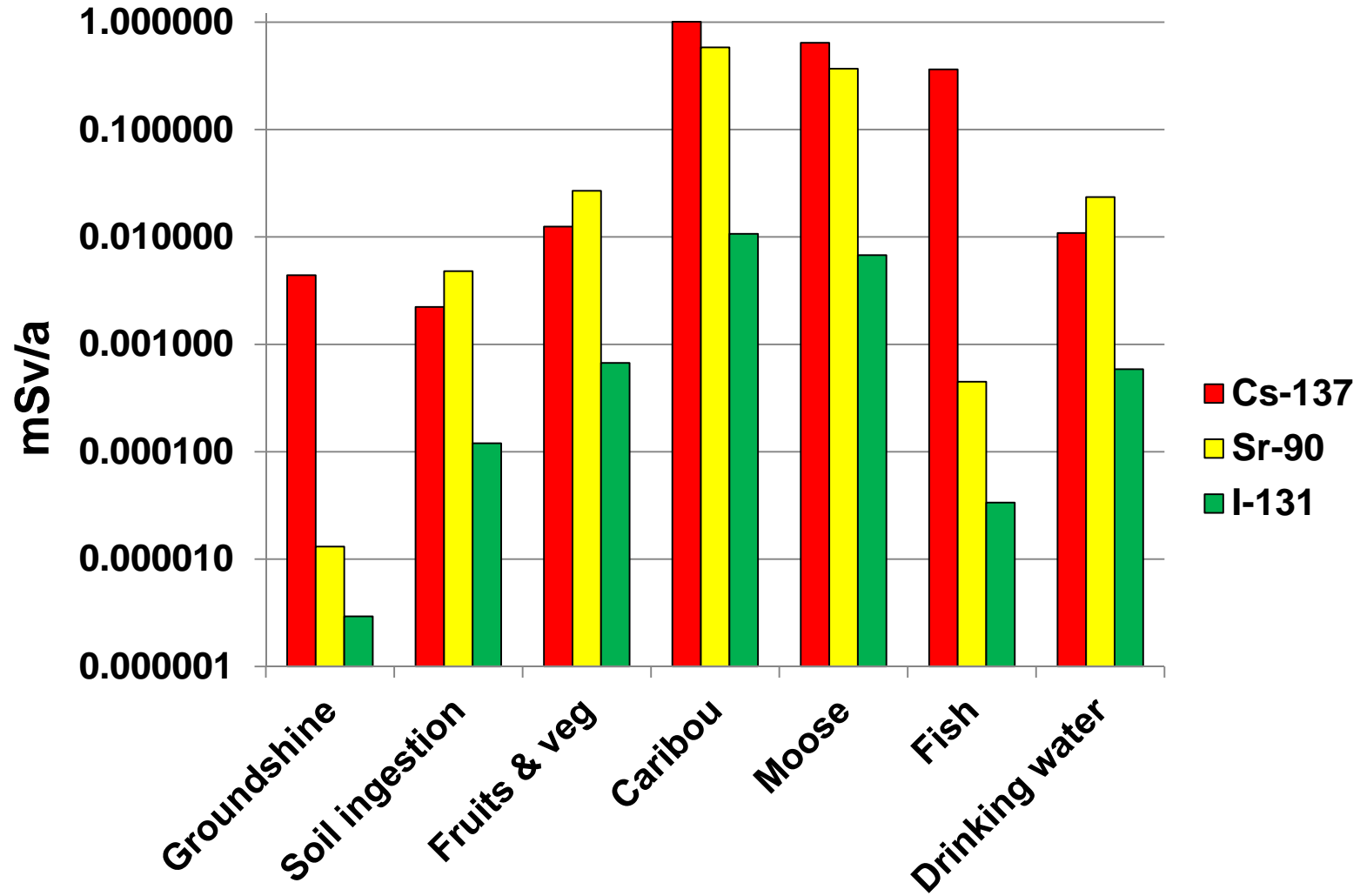
I 131 dose by pathway



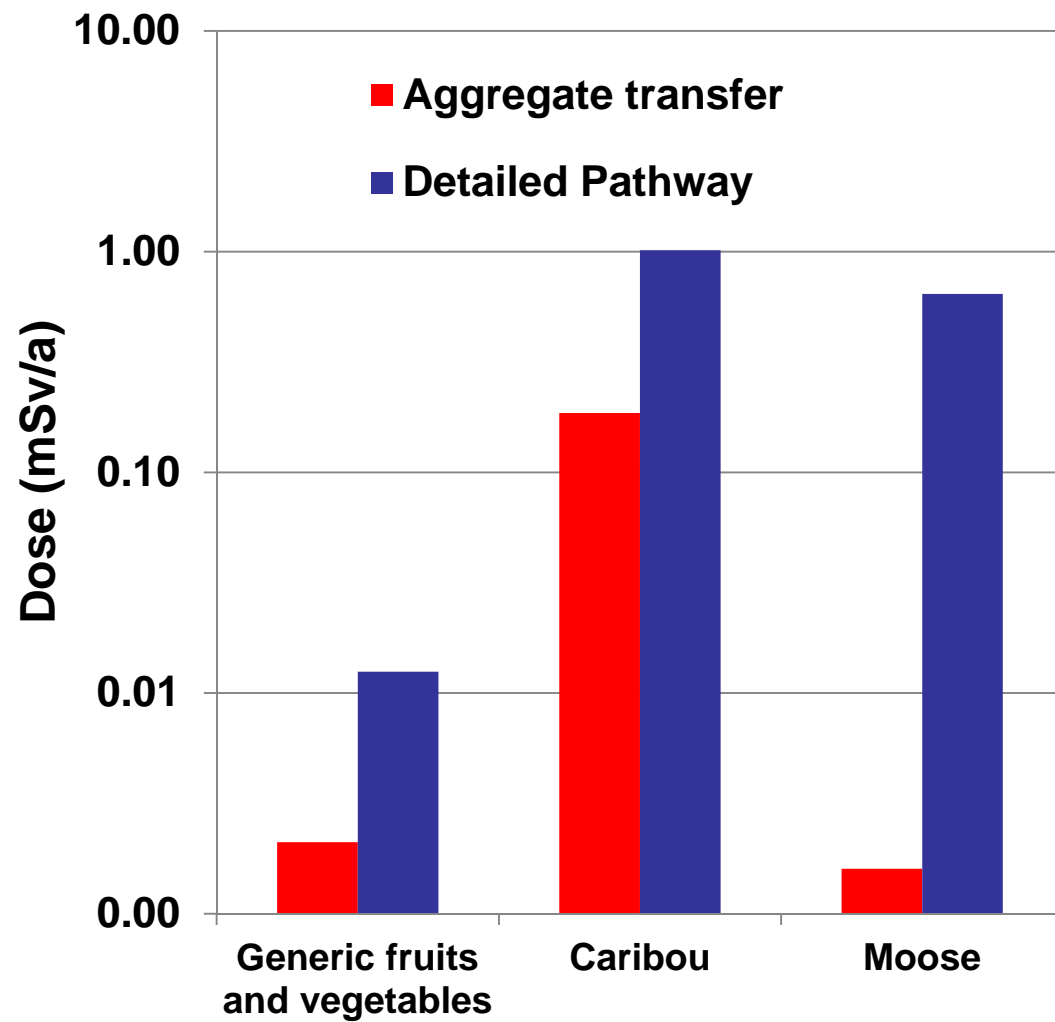
Dose by radionuclide and pathway



Dose by radionuclide and pathway



Comparison of methods



Forest ecosystem: Dietary intakes of traditional foods (kg/year) (Hatchet Lake dietary survey)

Food item	2 -10 year old	11-20 year old	Adults
Caribou	88.97	77.56	114.7
Moose	0.29	0.11	0.9
Small mammals	0.00	0.58	1.6
Ground birds	0.04	0.91	1.0
Water birds	1.48	2.57	3.6
Traditional fruits	6.02	4.42	1.2
Fish	29.09	14.22	52.9

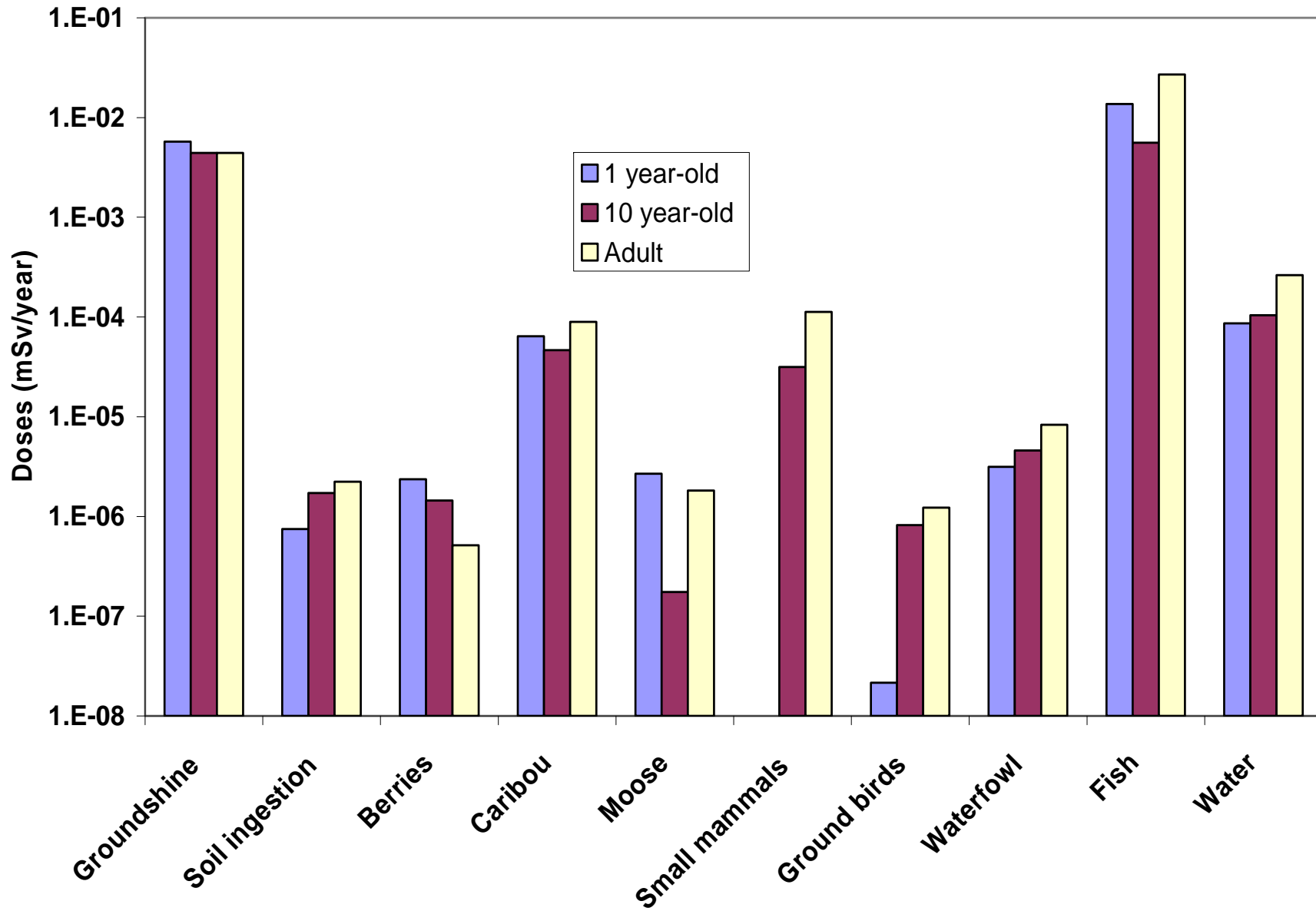
Table 8. Average concentrations in water and fish in year one from Lake Øvre Heimdalsvatn (from Luigi Monte's contribution)

	Cs-137	Sr-90
Concentrations in water (Bq/L)	0.039	0.081
Concentrations in fish (Bq/kg)	39.16	0.68

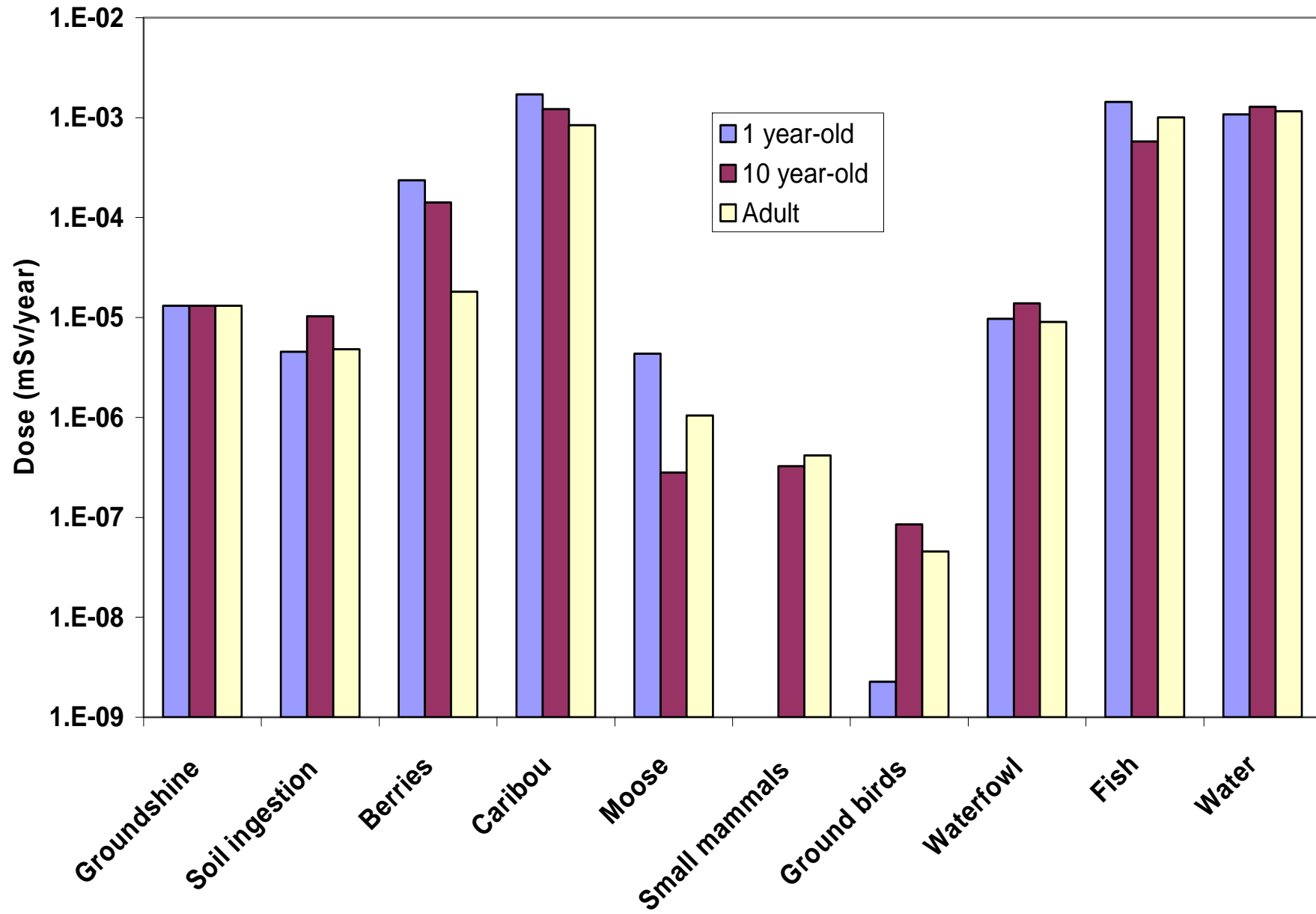
Table 9. Summary of doses to humans during year one (mSv/a)

Radionuclide	one-year old	10-year old	Adult
Cs-137	0.01958	0.01017	0.03184
Sr-90	0.00448	0.00325	0.00305
I-131	0.00015	0.00010	0.00009
Total	0.02421	0.01352	0.03498

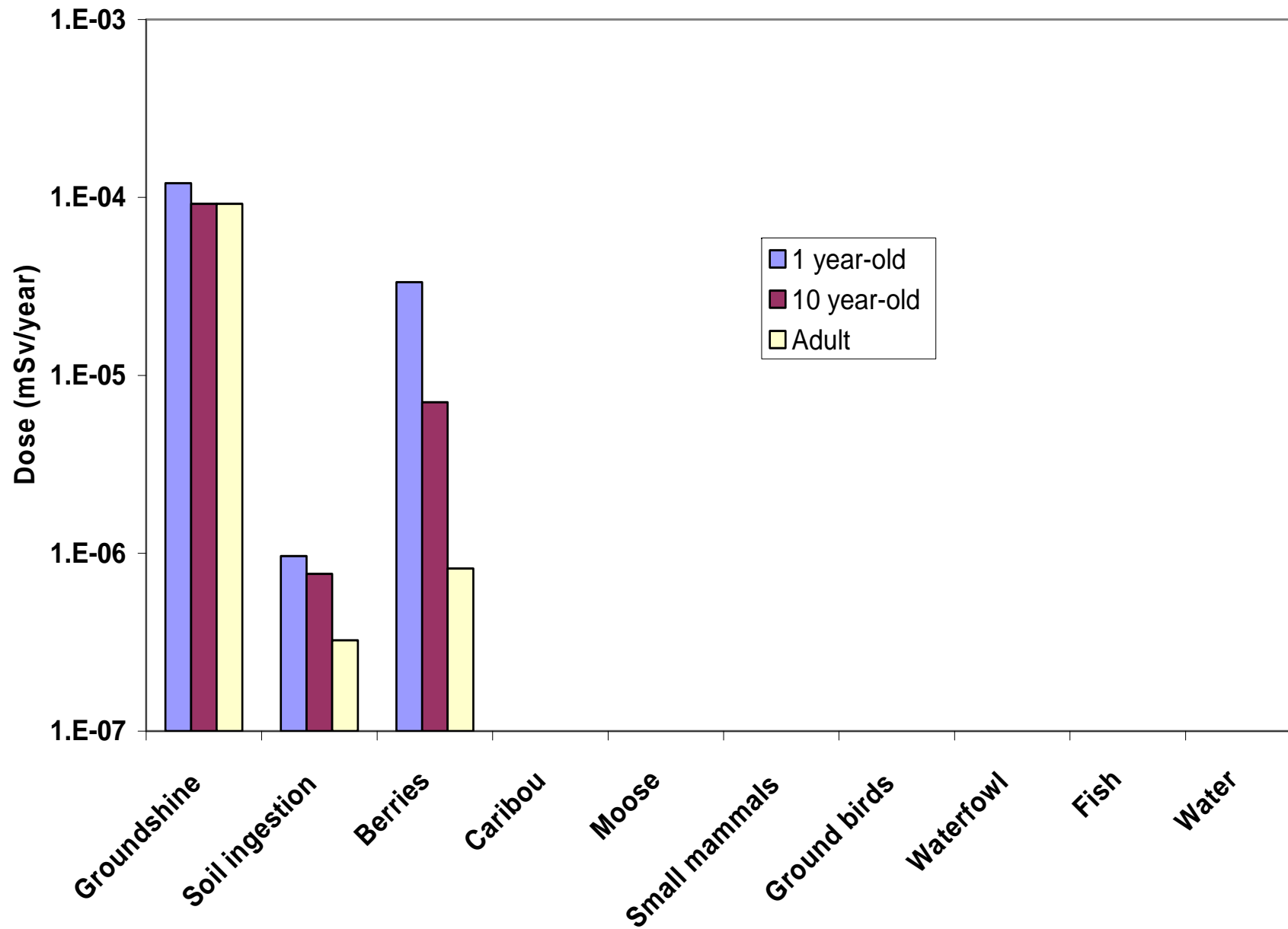
Doses from Cs-137 by pathway



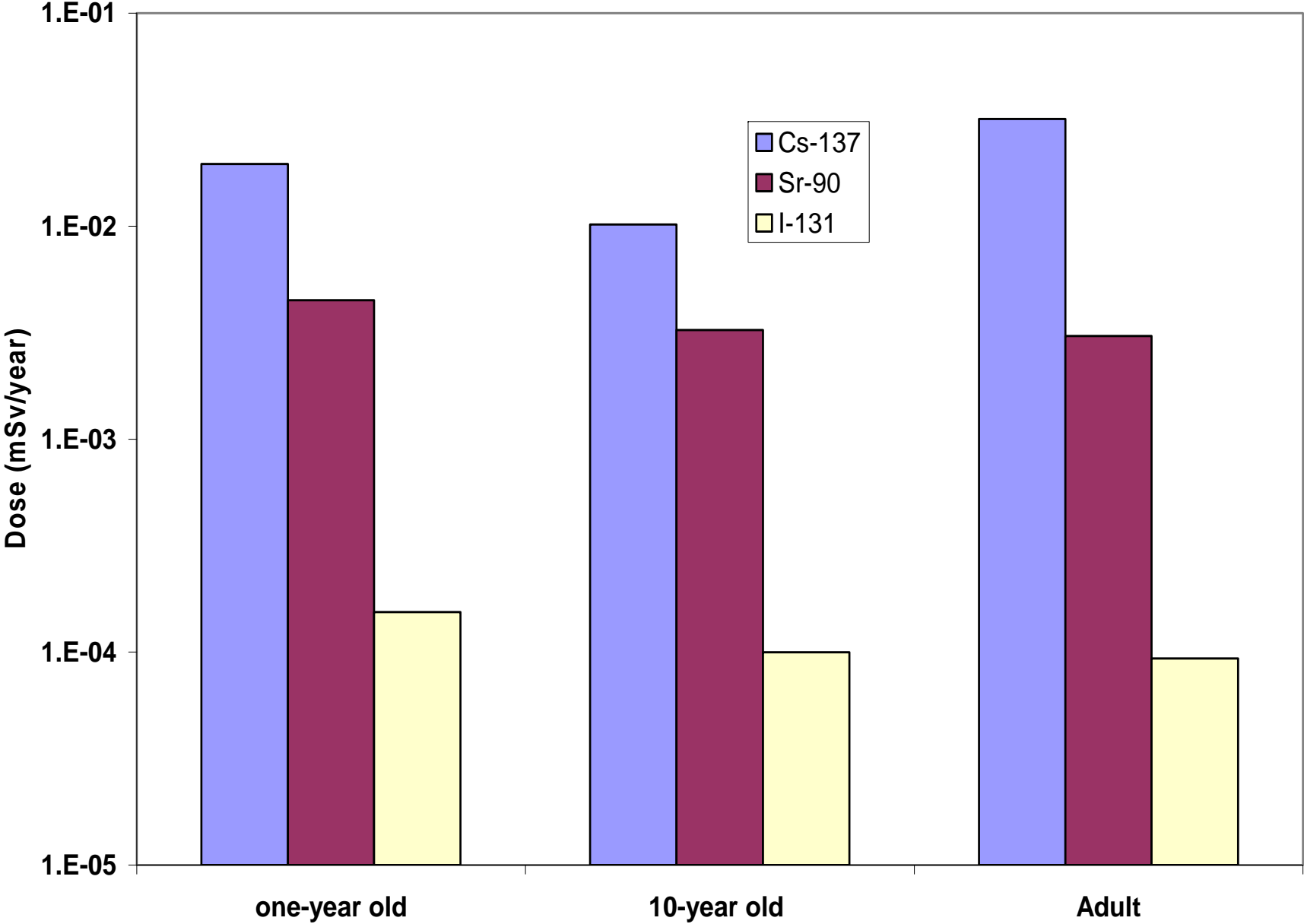
Doses from Sr-90 by pathway



Doses from I-131 by pathway



Doses during first year



Ecological half-lives of Cs-137 and Sr-90

	Food Item	Sampling Region	Observation Period	Ecological Half-life (a)	Decay Constant
Cs-137	Whole Diet	Germany	1967-1985	8.1	0.0856
Sr-90	Whole Diet	Germany	1967-1985	14.1	0.0492

