Environmental radioactivity in Denmark in 1988 and 1989

Aarkrog, Asker; Bøtter-Jensen, L.; Chen, Q.J.; Dahlgaard, H.; Hansen, H.; Holm, E.; Lauridsen, B.; Nielsen, Sven Poul; Søgaard-Hansen, J.

Publication date:
1991

Document Version
Publisher's PDF, also known as Version of record

RISØ

Risø-R-570

Environmental Radioactivity in Denmark in 1988 and 1989

A. Aarkrog, L. Bøtter-Jensen, Chen Qing Jiang, H. Dahlgaard, Heinz Hansen, Elis Holm+, Bente Lauridsen, S.P. Nielsen and J. Søgaard-Hansen

+University of Lund, Sweden

Risø National Laboratory, Roskilde, Denmark
July 1991

Risø-R-570

Environmental Radioactivity in Denmark in 1988 and 1989

A. Aarkrog, L. Bøtter-Jensen, Chen Qing Jiang, H. Dahlgaard, Heinz Hansen, Elis Holm+, Bente Lauridsen, S.P. Nielsen and J. Søgaard-Hansen

+University of Lund, Sweden

Risø National Laboratory, Roskilde, Denmark
July 1991

Abstract. Strontium-90, radiocesium, and other radionuclides were determined in samples from all over the country of air, precipitation, stream water, lake water, ground water, drinking water, sea water, soil, sediments, dried milk, fresh milk, meat, fish, cheese, eggs, grain, bread, potatoes, vegetables, fruit, grass, moss, lichen, sea plants, total diet, and humans. Estimates are given of the mean contents of radiostrontium and radiocesium in the human diet in Denmark during 1988 and 1989. Tritium was determined in precipitation, ground water, other fresh waters, and sea water. The γ-background was measured regularly by TLD's and a NaI detector. The marine environments at Barsebäck and Ringhals were monitored for ^{137}Cs and corrosion products (^{58}Co, ^{60}Co, ^{65}Zn, ^{54}Mn).

During 1988 and 1989 the expanded programme initiated after the Chernobyl accident in 1986 was brought back to the pre-Chernobyl level.

ISBN 87-550-1720-7
ISSN 0106-2840
ISSN 0106-407X

Grafisk Service, Risø, 1991

Contents

Abbreviations and Units

J: joule: the unit of energy; 1 J = 1 Nm (= 0.239 cal)
Gy: gray: the unit of absorbed dose = 1 J kg^{-1} (= 100 rad)
Sv: sievert: the unit of dose equivalent = 1 J kg^{-1} (= 100 rem)
Bq: becquerel: the unit of radioactivity = 1 s^{-1} (= 27 pCi)

cal: calorie = 4.186 J
rad: 0.01 Gy
rem: 0.01 Sv
Ci: curie: 3.7×10^{10} Bq (= 2.22×10^{12} dpm)

E: exa: 10^{18}
P: peta: 10^{15}
T: tera: 10^{12}
G: giga: 10^{9}
M: mega: 10^{6}
k: kilo: 10^{3}
m: milli: 10^{-3}
μ: micro: 10^{-6}
n: nano: 10^{-9}
p: pico: 10^{-12}
f: femto: 10^{-15}
a: atto: 10^{-18}

pro capite: per individual
TNT: trinitrotoluol; 1 Mt TNT: nuclear explosives equivalent to 10^{9} kg TNT.

yr^{-1}: per year (a^{-1})
cpm: counts per minute
dpm: disintegrations per minute
OR: observed ratio
CF: concentration factor
FP: fission products
μR: micro-roentgen, 10^{-6} roentgen
S.U.: pCi ^{90}Sr (g Ca$)^{-1}$
O.R.: observed ratio
M.U.: pCi ^{137}Cs (g K$)^{-1}$
V: vertebrae
m: male
f: female
nSr: natural (stable) Sr

eqv. mg KCl: equivalents mg KCl: activity as from 1 mg KCl
(~0.96 dpm = 0.016 Bq; 1 g K = 30.65 Bq)

S.D.: standard deviation: $\sqrt{\frac{\Sigma(\bar{x} - x_i)^2}{(n-1)}}$

S.E.: standard error $\sqrt{\frac{\Sigma(\bar{x} - x_i)^2}{n(n-1)}}$

U.C.L.: upper control level
L.C.L.: lower control level
S.S.D.: sum of squares of deviation: $\Sigma(\bar{x}-x_i)^2$
f: degrees of freedom
s^2: variance
v^2: ratio of the variance in question to the residual variance
P: probability fractile of the distribution in question
η : coefficient of variation, relative standard deviation
anova: analysis of variance
A: relative standard deviation 20-33%
B: relative standard devition >33%, such results are not considered significantly different from zero activity
B.D.L.: below detection limit

In the significance test the following symbols were used:
* : probably significant (P > 95%)
** : significant (P > 99%)
***: highly significant (P > 99.9%)

1. Introduction

1.1.

The present report is the thirty-second of a series of periodic reports (Risø Reports 1957-1989) dealing with measurements of radioactivity in Denmark. The organization of the material in the present report corresponds to the report of last year. However, this report covers two years: 1988 and 1989. The tables (and figures) representing 1988 are marked with an A and those from 1989 with a B. Tables and Figures are placed after the text in each chapter, and the text has been reduced compared to previously. After the introduction and a chapter on organization and facilities, there follows a chapter on environmental monitoring around nuclear facilities (Risø, Barsebäck, and Ringhals). Chapter four deals with fallout nuclides in the abiotic environment, i.e. air, water, and soil. Chapters five and six comprise fallout nuclides in the human diet, various vegetation and human tissues. Chapter seven is devoted to a general discussion of environmental tritium studies. External radiation is treated in chapter eight. The names of the authors of each chapter appear at its head.

1.2.

The methods of radiochemical analysis (*Osmond* et al. 1959, *Bryant* et al. 1959, *Harley* 1972) and the statistical treatment of the results (*Hald* 1958, *Vestergaard* 1964) are still based on the principles established in previous reports (Risø Reports 1957-1989).

1.3.

The detailed tables of the environmental monitoring programme for Risø National Laboratory appear in semiannual reports: Radioactivity in the Risø district January-June 1988, July-December 1988, January-June 1989 and July-December 1989 which are available from Risø Library.

1.4.

The report contains no information on sample collection and analysis except in cases where these procedures have been altered.

1.5.

In 1988 and 1989 the personnel of the Environmental Control Section of the Health Physics Department consisted of three chemists (incl. one guest scientist), one biologist, one physicist, ten laboratory technicians, three sample collectors, and two laboratory assistants. The group for Electronics Development and Maintenance gave assistance with the maintenance of counting equipment.

1.6.

The composition of the average Danish diet used in this report is identical with that proposed in 1962 by the late Professor E. Hoff-Jørgensen, Ph.D.

2. Facilities

By S.P. Nielsen

2.1. Detectors

The samples are measured as follows:

Alpha (^{239}Pu, ^{241}Am and ^{210}Po): 22 semiconductor detectors connected to multichannel analyzers (512 channels per detector) and another two for total alpha counting.

Beta (^{90}Y and ^{99}Tc): Six "multidetector"-systems each containing 5 sample counters and a common anticoincidence shield are used.

Gamma (natural and fallout isotopes): A total of 11 germanium detectors in 10 cm lead shields are used for gamma spectrometric measurements. Four detectors are connected to a hard-wired multichannel analyzer and 7 to MCA-cards in personal computers. The efficiencies of the detectors are in the range 4-40% relative to a 3" × 3" NaI(Tl) detector. An 8" × 4" NaI(Tl) detector and a detector unit with three 4" × 4" × 16" NaI(Tl) crystals are used in an underground shielded room for gamma-spectrometric whole-body measurements.

2.2. Data Treatment

Measured spectra are transferred to a Unisys A6 computer for evaluation.

A program system STATDATA (*Lippert* 1975) is developed for registration and treatment of environmental measurements including multichannel analyzer spectra. To date, approximately 110 000 sets of results have been registered covering the period from 1957.

3. Environmental Monitoring at Risø, Barsebäck, and Ringhals

by H. Dahlgaard

3.1. Environmental Monitoring at Risø

From the four semiannual reports: Radioactivity in the Risø district January-June 1988, July-December 1988, January-June 1989 and July-December 1989, the results of the environmental monitoring at Risø are presented. The reports are available from the Risø Library.

The various anthropogenic radionuclides measured outside the Risø area came from non-Risø sources.

3.2. Marine Environmental Monitoring at Barsebäck and Ringhals

The radiological monitoring of the marine environment around the two nuclear power plants at Barsebäck and Ringhals in Sweden (Risø Reports 1957-1989) was continued throughout 1988 and 1989. At the end of 1989 the samplings in Barsebäck and Ringhals have been brought to an end.

Figures 3.2.1.1 and 3.2.1.2 show the sampling locations.

3.2.1. γ-Emitting Radionuclides in Brown Algae

Tables 3.2.1.1 and 3.2.1.2 show the radionuclide concentrations found by γ-spectrometric analysis in brown algae sampled near Ringhals in 1988 and 1989. Monthly data on radionuclides in seaweed from Barsebäck and Ringhals are reported in Chapter 3.2.5. The data are expressed on the basis of dry weight. Dry matter contents are given.

Table 3.2.1.3 shows a comparison of the 3 fucoids Fucus vesiculosus, Fucus serratus, and Ascophyllum nodosum. The levels of significance of differences from unity are indicated.

3.2.2. γ-Emitting Radionuclides in Benthic Invertebrates and Fish

Table 3.2.2.1 shows results of the γ-countings on benthic animals and fish from Ringhals and Barsebäck in 1988 and 1989. The dose commitment to a hypothetical critical individual consuming 20 kg Mytilus edulis soft parts (fresh weight) yearly would be less than 1 μSv yr^{-1} based on mussels from Ringhals, location 95 (Table 3.2.5.4). This dose is insignificant compared to natural background doses.

Consumption of 100 kg flatfish meat would give approximately 1-2 μSv from radiocesium based on data in Table 3.2.2.1. The cesium isotopes come mainly from the Chernobyl accident.

3.2.4. γ-Emitting Radionuclides in Sea Sediments

Results from sediment samples collected at Barsebäck and Ringhals with the HAPS bottom corer are shown in Tables 3.2.4.1 and 3.2.4.2.

At both power plants the ^{60}Co that has been detectable in the sediments for several years has been compared with the reported annual discharges from Tables 3.2.5.2 and 3.2.5.10. The total amount of ^{60}Co accumulated in the sediments at Ringhals location 2 and Barsebäck location 38 expressed as Bq m^{-2} has been divided for each year with the total amount of ^{60}Co discharged from each power plant (GBq, decay corrected) summed up till the year of sampling. The result is a transfer factor from the total accumulated discharge to one square meter of sediment at the specified location, i.e. Bq m^{-2}/GBq or $m^{-2} \times 10^{-9}$.

These sediment transfer factors are shown in Figs. 3.2.4.1 and 3.2.4.2. These transfer factors based on total accumulated discharges do not show a clear decreasing tendency, as they should if a significant part of the sedimented cobalt was remobilized. Thus, the results indicate an irreversible sedimentation of cobalt.

3.2.5. Monthly Time Series at Ringhals and Barsebäck

For historical reasons the monthly data sets are reported in this chapter.

Ringhals Results

Tables 3.2.5.1-3.2.5.8 give the Ringhals data. The concentrations of anthropogenic gamma emitters as well as of ^{7}Be in Fucus outside the northern cooling water intake channel was as discussed in the previous report lower than in Fucus sampled in the channel even if the last site is 200 m further away from the power plant. Table 3.2.5.5 gives annual average values for the ratio.

Barsebäck Results

Tables 3.2.5.9-3.2.5.13 give the Barsebäck data.

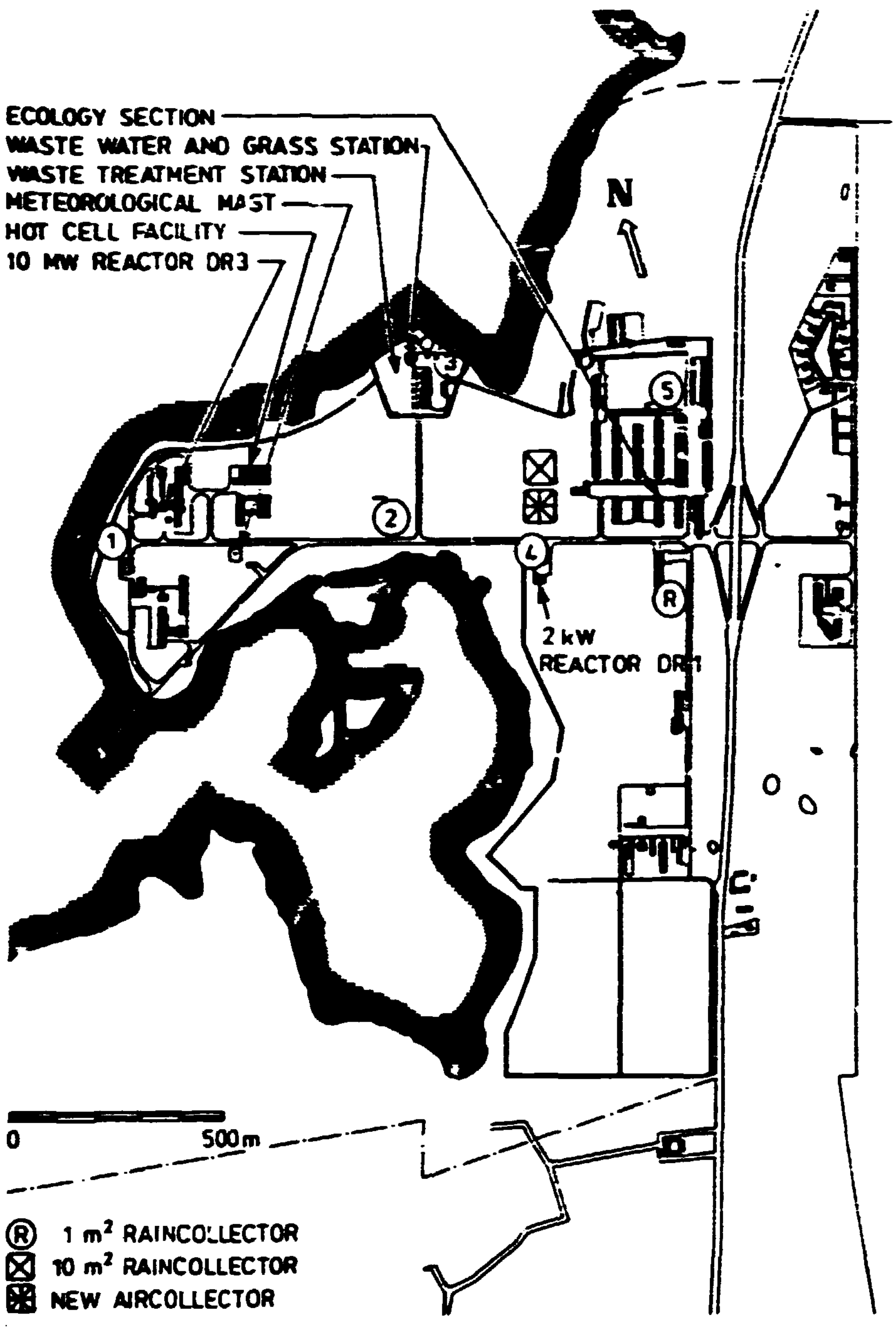


Fig. 3.1.1. Sampling locations at Risø National Laboratory. 1-5: locations for rain bottles (0.03 m² each), ion-exchange columns (0.06 m² each), and grass samples.

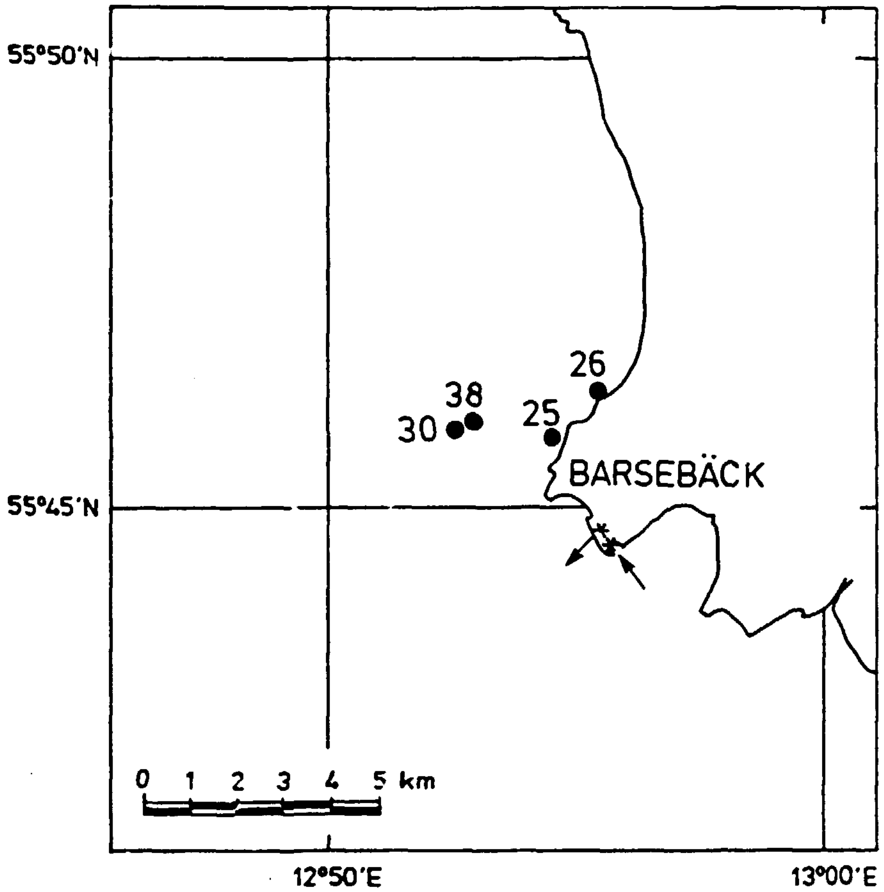


Fig. 3.2.1.1. Sampling locations at Barsebäck. Arrows indicate cooling water intake and outlet.

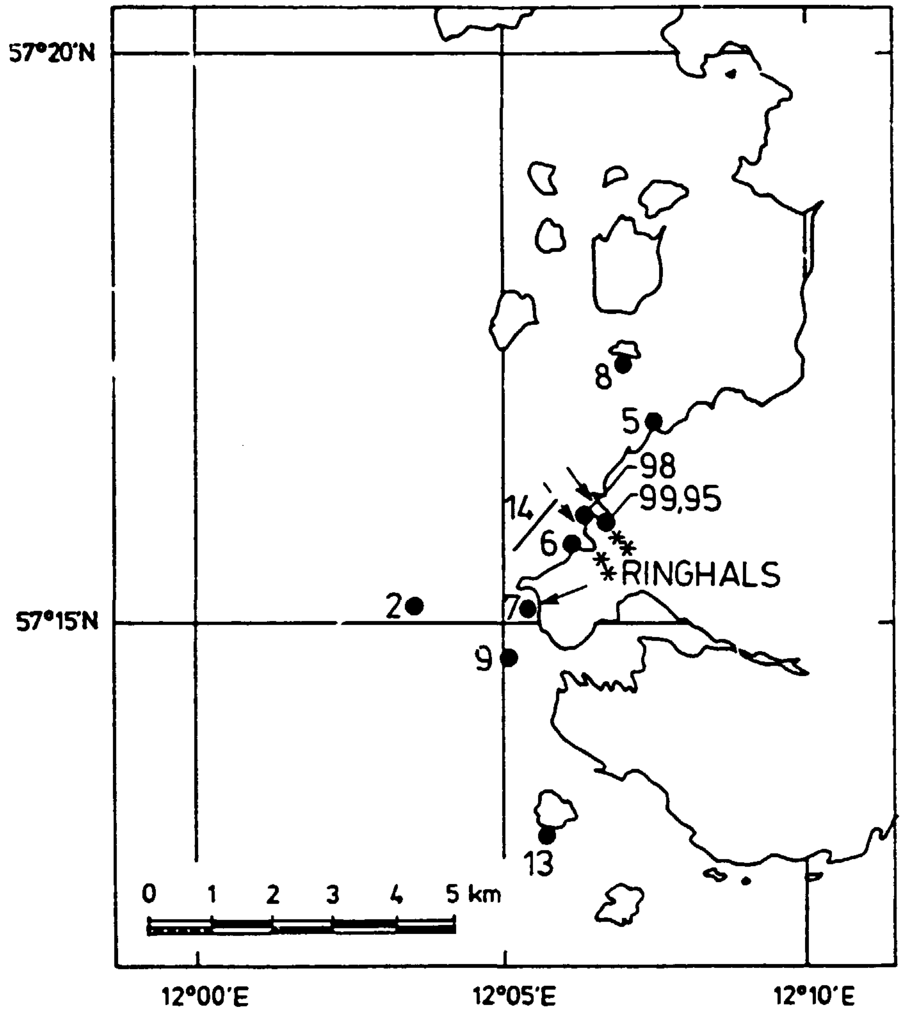


Fig. 3.2.1.2. Sampling locations at Ringhals. 14 indicates fishing tracks. Arrows indicate cooling water intake and outlet.

Table 3.2.1.1.A. Radionuclides in Fucus vesiculosus (Fu.ve.) and Fucus serratus (Fu.se.) collected at Ringhals 8 June 1988. (Unit: Bq kg⁻¹ dry matter)

Station No.**	7	7	6	6	5	8	8	9*	9*	13*
% dry matter	23.2	23.7	23.2	24.6	24.3	19.5	23.3	21.8	20.0	19.1
Species	Fu.ve.	Fu.se.	Fu.ve.	Fu.se.	Fu.se.	Fu.ve.	Fu.se.	Fu.ve.	Fu.se.	Fu.ve.
Distance from outlet in km	0.2	0.2	1.9	1.9	4.1	4.8	4.8	1.1	1.1	4.1
^{54}Mn	10.5	12.8	2.1	2.6	2.1	1.1 A	1.30	4.1	5.3	
^{57}Co	3.0	1.24							0.79 A	
^{58}Co	250	330	37	48	30	16.3	25	108	185	22
^{60}Co	166	240	34	57	34	11.8	23	53	92	8.9
^{65}Zn		18.8		4.1					5.1 A	
^{110m}Ag			1.6 B		1.2 B				4.1 A	
^{134}Cs	6.1	6.6	4.9	3.9	4.1	3.9	4.0	6.2	7.2	5.0
^{137}Cs	22	22	21	16.9	18.9	18.0	17.0	21	24	18.7
^{141}Ce	5.1	6.1								
^{144}Ce	12.7	14.0							9.9	

* Locations south of the outlet; the other locations were situated north of the outlet.
**Cf. Fig. 3.2.1.2.

Table 3.2.1.1.B. Radionuclides in Fucus vesiculosus (Fu.ve.) and Fucus serratus (Fu.se.) collected at Ringhals 12 May 1989. (Unit: Bq kg⁻¹ dry matter)

Station No.**	6	6	5	5	8	8	9*
% dry matter	17.3	17.7	17.4	19.2	17.0	17.8	18.2
Species	Fu.ve.	Fu.se.	Fu.ve.	Fu.se.	Fu.ve.	Fu.se.	Fu.se.
Distance from outlet in km	1.9	1.9	4.1	4.1	4.8	4.8	1.1
^{54}Mn	1.52 A	1.40 A				0.61 A	1.35 A
^{58}Co	10.4	10.4	7.6	10.7	8.5	5.8	17.0
^{60}Co	35	35	23	31	21	14.8	54
^{134}Cs	2.8	2.9	2.7	2.2	3.2	4.5	2.8
^{137}Cs	17.2	16.6	15.6	15.2	21	22	17.7

* Locations south of the outlet; the other locations were situated north of the outlet.
**Cf. Fig. 3.2.1.2.

Table 3.2.1.2.A. Radionuclides in Fucus serratus (Fu.se.) collected at Ringhals 15 December 1988 (Unit: Bq kg^{-1} dry matter)

Station No.**	7	6	5	8	9*
% dry matter	19.9	19.8	19.4	20.2	23.7
Species	Fu.se.	Fu.se.	Fu.se.	Fu.se.	Fu.se.
Distance from outlet in km	0.2	1.9	4.1	4.8	1.1
^{54}Mn	3.6	2.8	2.4 A	1.47 A	14.3
^{57}Co	0.5 B				1.15 A
^{58}Co	101	70	56	52	170
^{60}Co	121	76	48	33	450
^{65}Zn					21
^{110m}Ag	4.9	3.2 A	3.0	1.93	6.0
^{134}Cs	2.1	2.8	2.5	2.0	2.7 A
^{137}Cs	12.0	15.4	13.1	10.1	12.1

*Locations south of the outlet; the other locations were situated north of the outlet.
**Cf. Fig. 3.2.1.2.

Table 3.2.1.2.B. Radionuclides in Fucus vesiculosus (Fu.ve.), Fucus serratus (Fu.se.) and Ascophyllum nodosum (As.no.) collected at Ringhals 31 October 1989 (Unit: Bq kg^{-1} dry matter)

Station No.**	7	7	7	5	5	8	8	9*	13*	13*
% dry matter	23.2	21.8	21.7	23.8	20.8	21.5	19.8	19.1	20.6	21.5
Species	Fu.ve.	Fu.se.	As.no.	Fu.ve.	Fu.se.	Fu.ve.	Fu.se.	Fu.ve.	Fu.ve.	Fu.se.
Distance from outlet in km	0.2	0.2	0.2	4.1	4.1	4.8	4.8	1.1	4.1	4.1
^{54}Mn	22	16.7	5.4	3.4	2.5 A	3.2	2.5	15.7	3.7	2.2 A
^{57}Co	1.0 A							1.0 A		
^{58}Co	138	136	62	35	39	37	46	197	37	41
^{60}Co	350	350	200	61	76	50	81	325	47	49
^{65}Zn	16.0	9.7 A					14.4			
^{110m}Ag	3.6	7.7 A	6.6	2.8 A	2.5	2.3 A	2.3 A			
^{134}Cs	2.1	2.5 A	2.0	1.64	1.43	1.58	1.95	1.68	2.2	2.2
^{137}Cs	8.8	15.6	13.7	9.6	10.6	11.8	15.0	11.1	13.4	15.1

*Locations south of the outlet; the other locations were situated north of the outlet.
**Cf. Fig. 3.2.1.2.

Table 3.2.1.3. Ratios of activity concentrations on dry weight basis in Fucus vesiculosus (Fu.ve.), Fucus serratus (Fu.se.) and Ascophyllum nodosum (As.no.) collected at Ringhals 1978-1989

Isotope	Fu.ve./Fu.se.			Fu.ve./As.no.		
^{60}Co	0.82***	±0.039	(n=43)	1.32*	±0.12	(n=18)
^{58}Co	0.84***	±0.033	(n=42)	2.43***	±0.25	(n=16)
^{54}Mn	1.02	±0.056	(n=36)	3.60***	±0.30	(n=9)
^{65}Zn	0.85*	±0.061	(n=28)	1.23	±0.17	(n=16)
^{110m}Ag	1.38*	±0.138	(n=23)	1.13	±0.17	(n=12)
^{137}Cs	1.00	±0.029	(n=42)	1.35***	±0.07	(n=16)
^{131}I	0.94		(n=1)	1.2		(n=1)
^{95}Zr	0.89		(n=1)			
^{124}Sb	0.70		(n=1)	1.3		(n=1)
^{57}Co	1.68	±0.780	(n=2)	0.8		(n=1)
^{134}Cs	0.98	±0.037	(n=18)	1.5	±0.04	(n=2)
^{103}Ru	1.29	±0.249	(n=5)	2.5	±1.17	(n=2)
^{106}Ru	1.25	±0.261	(n=5)	2.3	±0.38	(n=2)
^{144}Ce	0.69	±0.218	(n=2)			
^{141}Ce	0.83		(n=1)			

The error term was 1 S.E.

Table 3.2.2.1.A. Gamma-emitting radionuclides in benthic animals and fish collected at Ringhals and Barsebäck in 1988. (Unit: Bq kg⁻¹ fresh)

Species	Flatfish meat	Flatfish meat	Flatfish meat	Cod meat	Lumpsucker meat	Buccinum* undatum meat	Mytilus* edulis meat	Mytilus* edulis meat	Mytilus* edulis meat	Mytilus* edulis meat
Date	May 24	June 8	Nov 30	Nov 30	May 24	June 8	June 8	June 8	Dec 15	Dec 1
Location	Barsebäck	Ringhals	Barsebäck	Barsebäck	Barsebäck	Ringhals	Ringhals	Ringhals	Ringhals	Barsebäck
Station No.△	30	14	30	30	30	14	7	13	6	26
% dry matter	-		-	-	-	20.7	12.6	11.5	16.8	12.2
Depth in m	15-22	11-14	6-10	6-10	15-22	11-14	0.5	0.6	0.6	0.3
^{58}Co							94	42 B	10.3	
^{60}Co							66	12.6	9.0	11.8
^{65}Zn							14.7			
^{110m}Ag						8.7				
^{134}Cs	0.82	0.42	1.38	1.23	0.086				0.8 B	5.7
^{137}Cs	3.7	2.9	6.4	7.1	0.43	2.8	7.3	5.1	3.4	14.8

△Cf. Figs. 3.2.1.1 and 3.2.1.2.
*Unit: Bq kg⁻¹ dry matter

Table 3.2.2.1.B. Gamma-emitting radionuclides in benthic animals and fish collected at Ringhals and Barsebäck in 1989. (Unit: Bq kg⁻¹ fresh)

Species	Flatfish meat	Flatfish meat	Lumpsucker meat	Mytilus edulis* meat	Cancer pagurus* total	Buccinum un-* datum meat
Date	May 12	May 19	May 19	May 12	May 12	May 12
Location	Ringhals	Barsebäck	Barsebäck	Ringhals	Ringhals	Ringhals
Station No.△	14	30	30	6	14	14
% dry matter	-	-	-	15.0	38.4	21.1
Depth in m	20	7-12	7-12	0.7	20	20
^{58}Co				1.3 B		
^{60}Co				7.2	1.15	1.18
^{110m}Ag					3.6	2.4
^{134}Cs	0.20	0.70	0.20 A	0.86 A	0.43 A	
^{137}Cs	1.70	4.0	0.87	4.6	2.3	2.1

△Cf. Figs. 3.2.1.1 and 3.2.1.2.
*Unit: Bq kg⁻¹ dry matter

Table 3.2.2.2. Activity ratios on dry weight basis, Mytilus edulis soft part (from Tables 3.2.2.1.A and B) to Fucus vesiculosus (from Tables 3.2.1.1.A and B) collected at Ringhals in 1988 and 1989

Location	Date	^{60}Co	^{58}Co	^{65}Zn	^{137}Cs	^{110m}Ag	^{54}Mn	^{95}Zr	^{144}Ce	^{134}Cs
7	June 8 1988	0.40	0.38		0.33					
13	June 8 1988	1.42	1.91		0.27					
Mean	1988	0.91	1.14		0.30					
S.E.		0.51	0.77		0.030					
n		2	2		2					
6	May 12 1989	0.21	0.125		0.27					0.31
Mean	1977-89	0.39	0.35	1.12	0.34	0.75	0.160	0.22	0.60	0.44
S.E.		0.057	0.082	0.140	0.032	0.156	0.068	0.05	0.05	0.14
n		26	21	22	17	8	4	3	4	2

Table 3.2.4.1.A. Gamma-emitting radionuclides in sediment samples collected at Barsebäck, 55°45'N 12°52'E, location 38, in 1988. (Area: 0.0145 m²)

Date	Layer in cm	^{60}Co Bq kg^{-1} dry	^{60}Co Bq m^{-2}	^{134}Cs Bq kg^{-1} dry	^{134}Cs Bq m^{-2}	^{137}Cs Bq kg^{-1} dry	^{137}Cs Bq m^{-2}
May 25	0-3	11.9	102	4.8	41	76	650
	3-6	5.7	60			63	670
	6-9					32	370
	9-12					15.9	200
	12-15					6.0	76
	0-15		Σ 162		Σ 41		Σ 1970
Dec 1	0-3	10.9	80			61	450
	3-6	8.5	53			50	310
	0-6		Σ 133				Σ 760

Table 3.2.4.1.B. Gamma-emitting radionuclides in sediment samples collected at Barsebäck, 55°45'N 12°53'E, location 38, in 1989. (Area: 0.0145 m²)

Date	Layer in cm	^{54}Mn Bq kg^{-1} dry	^{54}Mn Bq m^{-2}	^{60}Co Bq kg^{-1} dry	^{60}Co Bq m^{-2}	^{125}Sb Bq kg^{-1} dry	^{125}Sb Bq m^{-2}	^{134}Cs Bq kg^{-1} dry	^{134}Cs Bq m^{-2}	^{137}Cs Bq kg^{-1} dry	^{137}Cs Bq m^{-2}
May 20	0-3			15.9	111	10.0	70	8.7	61	79	550
	3-6			12.7	129	5.6 A	57 A	4.6	47	72	730
	6-9			3.8	46			0.23 A	2.8 A	59	710
	9-12							1.3 B	16 B	34	420
	12-15									22	280
	0-15				Σ 290		Σ 127		Σ 127		Σ 2700
Nov 17	0-3			15.1	108	10.2 A	72 A	7.2	51	80	570
	3-6			14.4	158	5.2 A	57 A	3.9	42	74	820
	6-9			7.2	84			1.32 A	15.4 A	68	790
	9-12			4.0	48			0.68 A	8.0 A	58	680
	12-15	0.99A	11.5 A	1.0 A	11.8 A					35	410
	0-15		Σ 11.5		Σ 410		Σ 129		Σ 116		Σ 3300

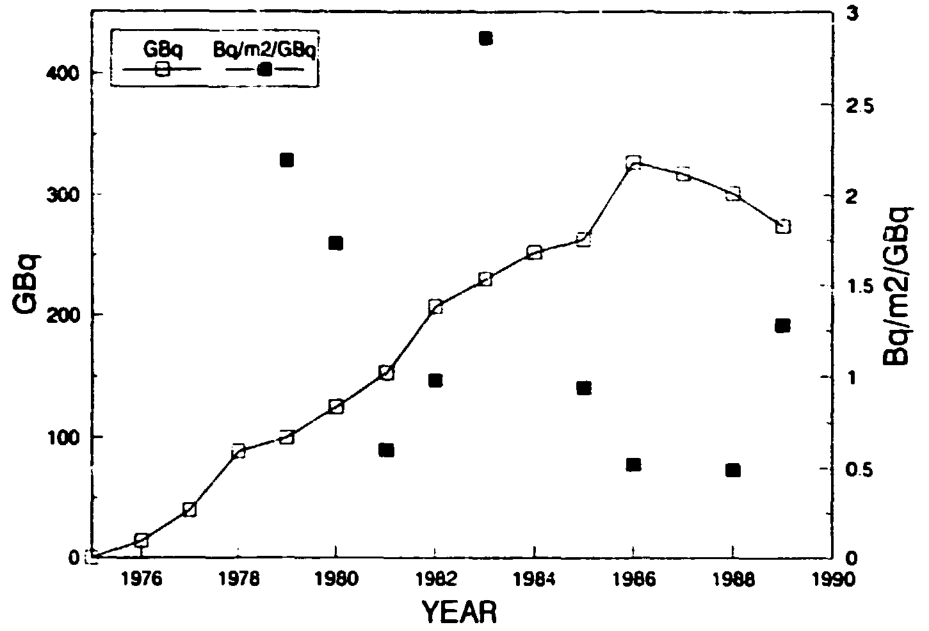


Fig. 3.2.4.1. Total accumulated discharge of ^{60}Co (GBq, decay-corrected) from Barsebäck (▭) and transfer factor to one square meter of sediment at location 38 (■) calculated as Bq m^{-2}/GBq.

Fig. 3.2.4.2. Total accumulated discharge of ^{60}Co (GBq, decay-corrected) from Ringhals (▭) and transfer factor to one square meter of sediment at location 2 (■) calculated as Bq m^{-2}/GBq.

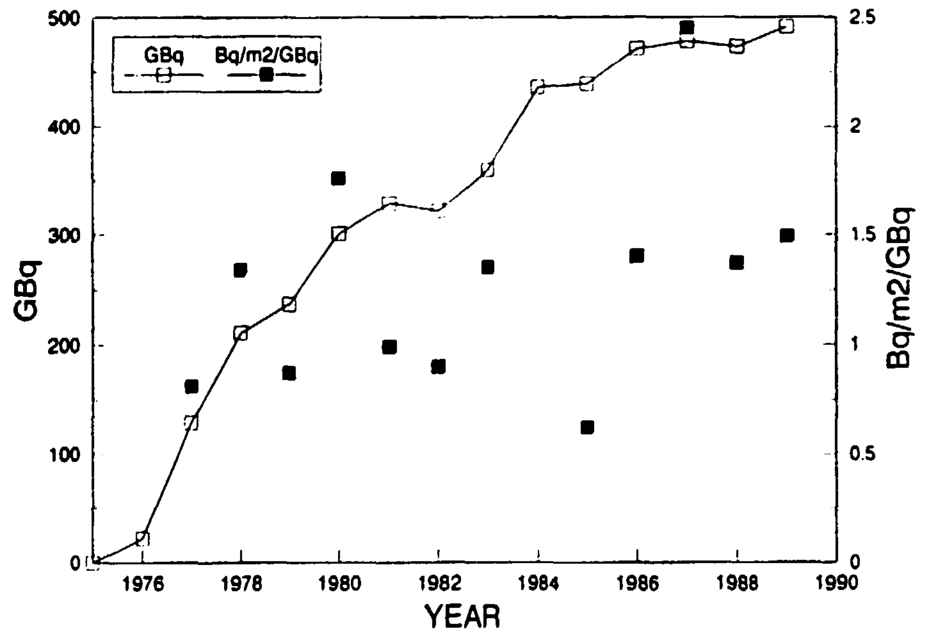


Table 3.2.4.2.A. Gamma-emitting radionuclides in sediment samples collected at Ringhals, 57°15'N 12°04'E, location 2, in 1988. (Area: 0.0145 m²)

Date	Layer in cm	^{60}Co Bq kg⁻¹ dry	^{60}Co Bq m⁻²	^{125}Sb Bq kg⁻¹ dry	^{125}Sb Bq m⁻²	^{134}Cs Bq kg⁻¹ dry	^{134}Cs Bq m⁻²	^{137}Cs Bq kg⁻¹ dry	^{137}Cs Bq m⁻²
June 8	0-3	11.2	148			2.6	34	19.6	260
	3-6	7.4	172			1.09	25	17.6	410
	6-9							7.7	320
	9-12							3.1	112
	12-15							1.82	78
	0-15		Σ 320				Σ 59		Σ 1180
Dec 16	0-3	26	270	6.4 A	68 A	5.0	53	38	410
	3-6	21	360			1.42	25	41	730
	6-9	10.2	270					29	760
	9-12	2.1	75					17.9	630
	12-15							9.2	330
	0-15		Σ 980		Σ 68		Σ 78		Σ 2900

Table 3.2.4.2.B. Gamma-emitting radionuclides in sediment samples collected at Ringhals, 57°15'N 12°04'E, location 2, in 1989. (Area: 0.0145 m²)

Date	Layer in cm	^{60}Co Bq kg⁻¹ dry	^{60}Co Bq m⁻²	^{125}Sb Bq kg⁻¹ dry	^{125}Sb Bq m⁻²	^{134}Cs Bq kg⁻¹ dry	^{134}Cs Bq m⁻²	^{137}Cs Bq kg⁻¹ dry	^{137}Cs Bq m⁻²
May 12	0-3	16.0	350	3.2 A	70 A	1.34	29	18.8	410
	3-6	11.2	280	4.0 B	98 B	1.26 A	32	21	510
	6-9	3.5	121			0.97 A	34 A	14.0	480
	9-12							5.8	240
	12-15							2.9	135
	0-15		Σ 750		Σ 168		Σ 95		Σ 1780
Oct 31	0-3	19.1	370	3.1 B	59 B	1.2[illegible]	24	15.0	290
	3-6	6.9	220					14.5	470
	6-9	2.2	87					7.7	310
	9-12	0.79	36					3.6	163
	12-13							2.0	24
	0-13		Σ 710		Σ 59		Σ 24		Σ 1260

Table 3.2.5.1.A. Reported monthly liquid discharges from Ringhals in 1988 (Sydkraft 1988). (Unit: Bq month^{-1})

Isotope	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
^{51}Cr	7.7×10^{8}	1.6×10^{8}	7.9×10^{7}	3.5×10^{7}	8.3×10^{8}	5.9×10^{8}	4.1×10^{9}	4.6×10^{8}	1.6×10^{9}	1.4×10^{9}	6.6×10^{8}	1.2×10^{8}
^{54}Mn	1.4×10^{8}	1.4×10^{8}	1.6×10^{8}	1.3×10^{8}	1.7×10^{8}	1.6×10^{8}	5.0×10^{8}	4.1×10^{8}	4.0×10^{8}	3.3×10^{8}	4.5×10^{8}	1.5×10^{8}
^{57}Co	5.9×10^{6}	1.7×10^{7}	7.3×10^{6}	4.3×10^{6}	9.1×10^{6}	1.4×10^{7}	5.5×10^{7}	3.7×10^{7}	3.9×10^{7}	4.0×10^{7}	4.8×10^{7}	3.6×10^{7}
^{58}Co	1.6×10^{9}	1.4×10^{9}	5.4×10^{8}	2.2×10^{8}	2.9×10^{9}	3.2×10^{9}	2.3×10^{10}	1.3×10^{10}	1.2×10^{10}	1.3×10^{10}	7.6×10^{9}	5.5×10^{9}
^{59}Fe	6.1×10^{7}	6.3×10^{7}	1.8×10^{7}	5.4×10^{8}	3.5×10^{7}	2.0×10^{7}	1.6×10^{8}	2.3×10^{8}	1.6×10^{8}	1.8×10^{8}	2.3×10^{8}	1.6×10^{7}
^{60}Co	1.7×10^{9}	5.5×10^{9}	3.3×10^{9}	2.2×10^{9}	2.6×10^{9}	2.2×10^{9}	5.9×10^{9}	6.4×10^{9}	4.9×10^{9}	3.4×10^{9}	6.9×10^{9}	9.3×10^{9}
^{65}Zn	8.2×10^{7}	6.6×10^{7}	5.8×10^{7}	2.6×10^{7}	3.9×10^{7}	3.7×10^{7}	3.3×10^{7}	1.2×10^{8}	8.4×10^{7}	3.3×10^{7}	8.0×10^{7}	1.2×10^{8}
^{110m}Ag	4.0×10^{7}	1.4×10^{8}	4.2×10^{7}	5.4×10^{7}	3.4×10^{7}	3.2×10^{7}	7.7×10^{7}	2.0×10^{7}	3.2×10^{8}	1.7×10^{8}	2.4×10^{8}	3.2×10^{7}
^{131}I	6.9×10^{6}	5.2×10^{6}	0.0	5.6×10^{6}	1.5×10^{8}	1.2×10^{7}	0.0	1.4×10^{6}	1.5×10^{8}	1.3×10^{7}	7.0×10^{5}	2.2×10^{6}
^{134}Cs	1.5×10^{6}	1.7×10^{8}	9.9×10^{7}	3.7×10^{7}	4.3×10^{8}	1.8×10^{9}	2.1×10^{9}	1.8×10^{8}	1.0×10^{9}	2.4×10^{8}	1.2×10^{8}	3.7×10^{8}
^{137}Cs	2.3×10^{8}	2.9×10^{8}	2.1×10^{8}	7.9×10^{7}	6.8×10^{8}	2.5×10^{9}	3.2×10^{9}	4.6×10^{8}	9.4×10^{8}	3.1×10^{8}	2.7×10^{8}	2.4×10^{9}

Table 3.2.5.1.B. Reported monthly liquid discharges from Ringhals in 1989 (Sydkraft 1989). (Unit: Bq month^{-1})

Isotope	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
^{51}Cr	4.2×10^{7}	9.1×10^{7}	4.3×10^{7}	6.8×10^{8}	3.4×10^{9}	1.0×10^{9}	2.5×10^{9}	5.5×10^{8}	1.6×10^{9}	4.3×10^{8}	4.3×10^{5}	1.9×10^{8}
^{54}Mn	4.9×10^{7}	2.4×10^{8}	1.8×10^{8}	5.5×10^{7}	1.7×10^{8}	3.3×10^{8}	4.9×10^{8}	7.3×10^{8}	7.7×10^{8}	3.9×10^{8}	9.5×10^{7}	1.3×10^{8}
^{57}Co	7.9×10^{6}	2.4×10^{7}	2.6×10^{7}	7.3×10^{6}	1.4×10^{7}	3.7×10^{7}	6.8×10^{7}	3.1×10^{7}	5.0×10^{7}	2.1×10^{7}	7.5×10^{6}	1.7×10^{7}
^{58}Co	1.3×10^{9}	2.1×10^{9}	2.2×10^{9}	5.7×10^{8}	3.0×10^{9}	5.6×10^{9}	1.9×10^{10}	8.8×10^{9}	1.4×10^{10}	4.3×10^{9}	3.9×10^{9}	$2.6\ 10^{9}$
^{59}Fe	0.0	0.0	0.0	0.0	1.3×10^{8}	3.8×10^{7}	4.6×10^{7}	5.6×10^{6}	5.3×10^{7}	3.6×10^{7}	7.4×10^{6}	4.8×10^{5}
^{60}Co	1.3×10^{9}	3.7×10^{9}	2.3×10^{9}	1.1×10^{9}	6.2×10^{9}	9.4×10^{9}	1.7×10^{10}	9.2×10^{9}	1.3×10^{10}	7.0×10^{9}	2.9×10^{9}	3.1×10^{9}
^{65}Zn	2.4×10^{7}	2.7×10^{7}	1.1×10^{7}	2.6×10^{7}	5.5×10^{7}	2.6×10^{7}	1.3×10^{8}	8.5×10^{7}	2.9×10^{8}	1.4×10^{8}	4.8×10^{7}	2.5×10^{7}
^{110m}Ag	1.0×10^{7}	2.9×10^{7}	1.3×10^{7}	5.2×10^{6}	2.2×10^{8}	5.9×10^{7}	3.3×10^{8}	2.0×10^{8}	4.4×10^{7}	1.1×10^{7}	9.7×10^{7}	1.6×10^{7}
^{131}I	9.3×10^{5}	2.1×10^{6}	3.5×10^{6}	0.0	8.1×10^{7}	1.4×10^{7}	0.0	3.2×10^{7}	29800	9.7×10^{5}	0.0	0.0
^{134}Cs	7.7×10^{7}	1.0×10^{8}	3.7×10^{8}	5.0×10^{7}	3.7×10^{8}	2.0×10^{8}	4.6×10^{8}	2.4×10^{8}	4.8×10^{8}	1.4×10^{8}	9.3×10^{7}	1.1×10^{8}
^{137}Cs	[illegible]	[illegible]	3.7×10^{8}	1.9×10^{8}	6.2×10^{8}	6.9×10^{9}	8.3×10^{9}	$4.2 \cdot 60^{9}$	2.4×10^{9}	1.1×10^{9}	2.0×10^{9}	5.5×10^{9}

Table 3.2.5.2. Reported annual liquid discharges from Ringhals 1975-1989, (Sydkraft 1975-1989). (Unit: Bq year^{-1})

Isotope	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
^{51}Cr		2.3×10^{9}	1.3×10^{11}	3.9×10^{10}	7.5×10^{9}	6.0×10^{9}	1.6×10^{10}	5.5×10^{9}	1.4×10^{10}	8.1×10^{9}	1.9×10^{10}	1.0×10^{10}	1.3×10^{10}	1.5×10^{10}	1.1×10^{10}
^{54}Mn		3.4×10^{9}	3.3×10^{10}	1.1×10^{10}	5.2×10^{9}	5.4×10^{9}	4.0×10^{9}	2.2×10^{9}	7.8×10^{8}	8.1×10^{9}	5.1×10^{9}	5.5×10^{8}	4.2×10^{9}	3.1×10^{8}	3.1×10^{8}
^{57}Co						1.6×10^{8}	1.1×10^{8}	2.2×10^{7}	4.9×10^{7}	1.1×10^{8}	2.6×10^{8}	3.1×10^{8}	5.6×10^{8}	3.1×10^{8}	3.1×10^{8}
^{58}Co	0	1.5×10^{10}	3.1×10^{11}	5.1×10^{10}	2.7×10^{10}	1.8×10^{10}	2.6×10^{10}	1.8×10^{10}	5.9×10^{10}	1.2×10^{11}	6.7×10^{10}	9.1×10^{10}	7.3×10^{10}	8.4×10^{10}	6.8×10^{10}
^{59}Fe		0	1.1×10^{9}	1.1×10^{10}	1.3×10^{9}	9.9×10^{8}	1.1×10^{9}	1.1×10^{8}	6.5×10^{8}	6.6×10^{9}	2.7×10^{9}	8.0×10^{8}	2.2×10^{9}	1.2×10^{9}	3.2×10^{8}
^{60}Co	4.4×10^{5}	2.2×10^{10}	1.1×10^{11}	9.8×10^{10}	5.2×10^{10}	9.3×10^{10}	6.5×10^{10}	3.3×10^{10}	7.8×10^{10}	1.2×10^{11}	5.7×10^{10}	8.6×10^{10}	6.5×10^{10}	5.4×10^{10}	7.6×10^{10}
^{65}Zn		8.1×10^{9}	3.8×10^{10}	4.0×10^{10}	8.5×10^{10}	4.2×10^{10}	8.8×10^{10}	2.2×10^{10}	2.0×10^{10}	9.7×10^{9}	3.6×10^{9}	4.6×10^{9}	4.1×10^{9}	7.7×10^{8}	8.8×10^{8}
^{110m}Ag		3.0×10^{8}	9.3×10^{8}	4.6×10^{9}	1.1×10^{9}	1.1×10^{9}	9.8×10^{8}	6.0×10^{8}	5.2×10^{8}	5.1×10^{8}	3.1×10^{8}	6.0×10^{8}	5.8×10^{8}	1.2×10^{9}	1.0×10^{9}
^{131}I		2.4×10^{9}	0	3.6×10^{7}	0	2.4×10^{9}	1.8×10^{9}	3.0×10^{9}	3.4×10^{9}	4.8×10^{8}	951	6.1×10^{8}	1.7×10^{9}	3.5×10^{8}	1.3×10^{8}
^{134}Cs			6.2×10^{9}	1.2×10^{10}	4.9×10^{10}	1.5×10^{10}	1.5×10^{10}	2.5×10^{10}	8.8×10^{9}	2.8×10^{9}	1.8×10^{9}	7.9×10^{9}	4.5×10^{9}	6.8×10^{9}	2.7×10^{9}
^{137}Cs			8.4×10^{9}	2.6×10^{10}	6.6×10^{10}	2.1×10^{10}	2.0×10^{10}	3.3×10^{10}	1.5×10^{10}	6.2×10^{9}	3.8×10^{9}	1.5×10^{10}	7.7×10^{9}	1.2×10^{10}	8.1×10^{9}

***Table 3.2.5.3.A.** Gamma-emitting radionuclides in Fucus vesiculosus (Fu.ve.) and Fucus serratus (Fu.se.) outside the northern cooling-water intake at Ringhals (location 98, 2.3 km north of the outlet) in 1988. (Unit: Bq kg^{-1} dry weight)*

Date		1/2	1/3	29/3	2/5	1/6	30/6	1/8	31/8	29/9	1/11	30/11	Mean 1988	S.E.	%
% dry matter	Fu.ve	20.8	22.2	24.3	19.3	20.0	26.8	26.9	19.1	22.6	-	23.2			
	Fu.se	19.0	21.5	25.6	22.0	19.8	25.4	26.0	22.8	21.5	29.2	23.1			
^{54}Mn	Fu.ve	-	3.8	1.93	0.95A	1.88A	4.5	3.0	2.7	3.1	-	2.5			
	Fu.se	4.3	3.3	2.4	1.66A	1.66	2.5	2.6	2.0	2.8	1.05A	1.18A			
	Fu.ve./Fu.se	-	1.30	0.82	0.57	1.13	1.73	1.17	1.32	1.10	-	2.11	1.26	0.155	9
^{57}Co	Fu.se	-	-	0.58	-	-	-	-	-	0.48	0.38	-			
^{58}Co	Fu.ve	24	18.4	11.0	3.9	10.0	29	47	45	40	-	47			
	Fu.se	33	17.3	13.4	8.5	11.7	42	54	46	56	40	35			
	Fu.ve./Fu.se	0.75	1.06	0.82	0.46	0.85	0.69	0.89	0.97	0.71	-	1.34	0.86	0.075	10
^{60}Co	Fu.ve	57	54	39	18.3	40	49	32	29	30	-	43			
	Fu.se	76	51	53	41	42	59	39	35	45	33	31			
	Fu.ve./Fu.se	0.75	1.05	0.72	0.44	0.95	0.83	0.82	0.84	0.67	-	1.39	0.85	0.079	10
^{65}Zn	Fu.ve	7.0	-	-	1.58	-	-	-	-	-	-	-			
	Fu.se	8.9	5.5	5.0A	2.9A	2.3A	-	1.58	1.75A	-	-	-			
	Fu.ve./Fu.se	0.79	-	-	0.53	-	-	-	-	-	-	-	0.66	0.131	2
^{110m}Ag	Fu.ve	-	-	-	-	-	-	-	2.2A	2.6A	-	2.6A			
	Fu.se	3.4A	2.7A	-	-	1.17	1.25	-	1.73	2.3A	3.2	2.18			
	Fu.ve./Fu.se	-	-	-	-	-	-	-	1.28	1.20	-	1.32	1.27	0.034	3
^{125}Sb	Fu.ve	-	-	-	-	-	3.1A	-	-	-	-	-			
^{134}Cs	Fu.ve	2.2	2.5	2.2	1.83	3.4	5.0	4.1	3.4	3.0	-	2.8			
	Fu.se	2.9	1.45	2.3	1.50	3.1	3.4	5.0	3.6	3.0	-	1.36			
	Fu.ve./Fu.se	0.76	1.73	0.97	1.22	1.12	1.46	0.82	0.95	1.00	-	2.0	1.20	0.130	10
^{137}Cs	Fu.ve	10.4	11.6	10.7	8.6	15.8	18.3	17.3	15.8	13.7	-	13.2			
	Fu.se	15.3	9.7	11.0	8.6	14.4	16.1	20.3	15.1	16.7	2.5	8.2			
	Fu.ve./Fu.se	0.68	1.20	0.97	1.00	1.10	1.13	0.85	1.05	0.82	-	1.61	1.04	0.061	10

Table 3.2.5.3.B. Gamma-emitting radionuclides in Fucus vesiculosus (Fu.ve.) and Fucus serratus (Fu.se.) outside the northern cooling-water intake at Ringhals (location 98, 2.3 km north of the outlet) in 1989. (Unit: Bq kg⁻¹ dry weight)

Date		2/1	1/2	1/3	30/3	1/5	1/6	29/6	31/7	31/8	2/10	[illegible]	30/11	Mean 1989	S.E.	N	Mean 1983-89	S.E.	N
% dry	Fu.ve	23.6	21.4	20.0	17.0	22.8	17.6	17.6	-	19.5	21.8	21.5	21.3						
matter	Fu.se	21.1	20.0	20.1	18.3	21.4	27.9	19.6	21.9	24.1	22.7	22.3	21.1						
^{54}Mn	Fu.ve	2.1	1.88	1.80A	1.42	1.06	-	3.0	-	1.59A	5.4	4.5	5.1						
	Fu.se	1.95	2.3A	1.55A	1.72	1.96	1.03	2.1	-	1.81	2.5	5.0	4.4						
	Fu.ve/Fu.se	1.09	0.82	1.16	0.82	0.54	-	1.41	-	0.88	2.1	0.91	1.17	1.09	0.139	10	1.06	0.049	50
^{57}Co	Fu.se	0.27A	-	-	-	-	-	-	-	-	-	-							
	Fu.se	-	-	-	0.28	0.38	-	-	0.45	0.32A	0.39A	-	0.38						
^{58}Co	Fu.ve	34	29	21	17.5	10.7	8.9	24	-	30	48	46	67						
	Fu.se	41	31	23	21	12.2	12.0	26	54	36	51	54	66						
	Fu.ve/Fu.se	0.83	0.95	0.92	0.85	0.88	0.74	0.93	-	0.83	0.93	0.85	1.01	0.88	0.022	11	0.83	0.032	62
^{60}Co	Fu.ve	50	52	43	36	30	25	51	-	46	103	105	111						
	Fu.se	58	54	52	45	42	27	57	138	78	130	147	138						
	Fu.ve/Fu.se	0.86	0.95	0.84	0.79	0.71	0.92	0.88	-	0.59	0.80	0.72	0.80	0.81	0.031	11	0.81	0.027	60
^{65}Zn	Fu.ve	-	-	-	-	-	-	-	-	-	-	-	4.7A						
	Fu.se	2.1B	-	-	-	-	-	-	-	-	4.4		3.9A						
	Fu.ve/Fu.se	-	-	-	-	-	-	-	-	-	-	-	1.20	1.20	-	1	0.84	0.039	31
^{110m}Ag	Fu.ve	1.67	-	-	1.52	-	-	-	-	2.1	-	-	4.1						
	Fu.se	1.80	-	-	-	-	-	-	1.89	3.2	5.1	2.9	4.2						
	Fu.ve/Fu.se	0.93	-	-	-	-	-	-	-	0.65	-	-	0.98	0.85	0.104	3	1.08	0.065	22
^{125}Sb	Fu.ve	1.58	-	-	-	-	-	2.9A	-	-	-	-	-						
^{134}Cs	Fu.ve	0.98	1.61	1.46	2.1	2.3	3.0	3.1	-	1.91	1.66	0.76	0.95A						
	Fu.se	1.95	2.2	1.88	2.7	2.5	3.1	2.5	-	1.74	1.19A	1.92	1.49						
	Fu.ve/Fu.se	0.50	0.74	0.77	0.79	0.93	0.95	1.24	-	1.09	1.39	0.40	0.64	0.86	0.091	11	1.05	0.065	29
^{137}Cs	Fu.ve	7.9	8.5	8.5	13.1	11.9	14.9	19.9	-	13.9	11.4	9.1	9.0						
	Fu.se	11.3	12.2	10.6	13.6	13.9	19.8	15.3	20A	12.4	3.5	12.2	9.8						
	Fu.ve/Fu.se	0.70	0.69	0.81	0.96	0.86	0.75	1.30	-	1.12	3.2	1.75	0.92	1.10	0.218	11	1.01	0.045	60

Table 3.2.5.4.A. Gamma-emitting radionuclides in Fucus vesiculosus (Fu.ve.) and Mytilus edulis (My.ed.) collected from the northern cooling-water intake channel at Ringhals in 1988 (location 95 (local), 2.5 km north of the outlet). (Unit: Bq kg⁻¹ dry weight)

Date		Feb 1	Mar 1	Mar 29	May 2	June 1	June 30	Aug 31	Sep 30	Nov 1	Nov 30	Mean 1988	S.E.	N
% dry	My.ed.	-	-	-	-	-	-	14.4	17.9	27.1	17.8			
matter	Fu.ve.	19.5	17.7	21.2	16.3	18.1	19.5	15.2	-	16.9	13.4			
Salinity in ‰		19.6	27.0	18.5	18.8	17.0	17.1	19.2	-	20.9	27.1			
^{51}Cr	Fu.ve.	-	-	-	-	-	-	58A	-	28B	-			
^{54}Mn	Fu.ve.	7.5	5.4	-	4.3	4.9	6.2	9.3	-	11.5	5.6			
^{57}Co	Fu.ve.	-	-	-	-	0.67A	-	-	-	-	-			
^{58}Co	My.ed.	-	-	-		-		17.8	21	13.9	8.0			
	Fu.ve.	33	16.3	9.6	9.1	21	55	169	-	142	69			
My.ed./Fu.ve.		-	-	-	-	-	-	0.106	-	0.098	0.115	0.107	0.005	3
^{60}Co	My.ed.	-	-	-	-	-	-	26	12.2	7.6	7.1			
	Fu.ve.	104	66	67	73	80	110	122	-	450	69			
My.ed./Fu.ve.		-	-	-	-	-	-	0.210	-	0.0170	0.102	0.110	0.056	3
^{65}Zn	My.ed.	-	-	-	-	-	-	-	-	14.8	-			
	Fu.ve.	-	-	-	-	3.3A	-	-	-	-	-			
^{95}Zr	Fu.ve.	-	-	-	-	-	15.5	15.9	-	13.2	-			
^{95}Nb	Fu.ve.	-	-	-	-	-	28	29	-	-	7.1			
^{103}Ru	Fu.ve.	-	-	-	-	-	3.3A	-	-	-	-			
^{106}Ru	Fu.ve.	-	-	-	26A	17.6A	-	-	-	-	-			
^{110m}Ag	My.ed.	-	-	-	-	-	-	20.8	5.8	4.0	2.0A			
	Fu.ve.	-	-	-	-	2.6	4.3A	-	-	-	4.5B			
My.ed./Fu.ve.		-	-	-	-	-	-	-	-	-	0.45	0.45	0	1
^{125}Sb	Fu.ve.	-	-	-	-	-	-	-	-	40	-			
^{134}Cs	My.ed.	-	-	-	-	-	-	1.18A	0.89	0.84	1.02			
	Fu.ve.	7.5	7.0	6.3	9.2	10.2	6.4	6.2A	-	8.1	3.8A			
My.ed./Fu.ve.		-	-	-	-	-	-	0.190	-	0.103	0.27	0.187	0.047	3
^{137}Cs	My.ed.	-	-	-	-	-	-	5.5	7.0	4.5	4.7			
	Fu.ve.	37	30	34	43	46	24	24	-	33	22			
My.ed./Fu.ve.		-	-	-	-	-	-	0.23	-	0.138	0.22	0.194	0.028	3

Table 3.2.5.4.B. Gamma-emitting radionuclides in Fucus vesiculosus (Fu.ve.) and Mytilus edulis (My.ed.) collected from the northern cooling-water intake channel at Ringhals in 1989 (location 95 (local). 2.5 km north of the outlet). (Unit: Bq kg^{-1} dry weight)

Date		Jan 2	Feb 1	Mar 1	Mar 30	May 1	June 1	June 29	Aug 31	Oct 2	Nov 1	Nov 30	Mean 1983	S.E.	N	Mean 1984-1989	S.E.	N
% dry	My.ed.	15.7	15.4	16.1	16.0	17.8	24.3	12.9	16.4	19.8	20.4	19.1						
matter	Fu.ve.	17.3	14.8	16.8	15.4	20.1	[illegible].7	17.9	20.0	19.6	18.8	19.3						
Salinity in ‰		23.9	20.5	20.4	17.7	18.3	17.9	18.1	21.6	22.9	22.2	26.6						
^{54}Mn	My.ed.	-	-	1.30 A	-	-	-	-	-	-	-	-						
	Fu.ve.	4.5 A	-	3.7	2.6	3.4	-	7.2	4.3	8.6	8.4	5.9						
My.ed./	Fu.ve.	-	-	0.35	-	-	-	-	-	-	-	-	0.35	0	1	0.35	0	1
^{57}Co	My.ed.	0.09 B	-	-	-	-	-	-	-	-	-	-						
	Fu.ve.	-	-	-	-	0.42 B	-	-	-	-	-	-						
^{58}Co	My.ed.	4.6	2.8	6.1	1.52	1.03	1.22	16.1	30	13.6	9.3	6.4						
	Fu.ve.	63	37	33	24	14.4	11.3	61	71	86	74	89						
My.ed./	Fu.ve.	0.073	0.076	0.188	0.064	0.072	0.107	0.26	0.43	0.158	0.126	0.072	0.148	0.034	11	0.157	0.026	17
^{60}Co	My.ed.	7.4	5.4	18.6	3.3	2.8	2.8	27	18.6	26	15.3	7.9						
	Fu.ve.	340	66	62	65	68	40	151	107	139	137	116						
My.ed./	Fu.ve.	0.022	0.081	0.30	0.051	0.041	0.071	0.180	0.174	0.186	0.111	0.068	0.117	0.025	11	0.117	0.018	20
^{65}Zn	My.ed.	0.93 B	-	-	-	-	-	-	-	3.9	2.4 A	-						
My.ed./	Fu.ve.															0.784	0.327	4
^{95}Nb	Fu.ve.	11.4	-	-	-	4.3	-	-	-	-	-	-						
^{106}Ru	My.ed.	3.3 A	-	-	-	-	-	-	-	-	-	-						
	Fu.ve.	-	-	-	11.9 A	14.1 A	-	-	-	-	-	-						
^{110m}Ag	My.ed.	0.83	-	-	-	0.40 A	1.07	2.5 A	9.8	4.8	2.8	8.3						
	Fu.ve.	3.1 A	-	-	-	-	-	-	-	-	-	6.5						
My.ed./	Fu.ve.	0.27	-	-	-	-	-	-	-	-	-	1.27	0.77	0.501	2	0.623	0.221	4
[illegible]Sb	My.ed.	0.6 B	-	-	-	-	-	-	-	-	-	-						
	Fu.ve.	10.4	-	-	-	-	-	-	-	-	-	-						
My.ed./	Fu.ve.	0.054	-	-	-	-	-	-	-	-	-	-	0.054	0	1	0.054	0	1
^{134}Cs	My.ed.	0.67	0.88	0.8[illegible] A	1.05	1.99	0.68	1.34 A	-	-	0.47 A	-						
	Fu.ve.	4.1	3.6	3.6	6.2	8.4	4.5	5.2	3.0 A	1.59 A	1.97 A	1.68 A						
My.ed./	Fu.ve.	0.163	0.249	0.229	0.170	0.142	0.152	0.255	-	-	0.236	-	0.199	0.017	8	0.196	0.016	11
^{137}Cs	My.ed.	4.2	4.3	5.4	6.0	6.4	3.6	4.4	3.6	3.6	3.0	2.0						
	Fu.ve.	20	22	22	40	50	29	25	17.4	15.8	15.6	13.0						
My.ed./	Fu.ve.	0.212	0.191	0.247	0.151	0.127	0.122	0.177	0.210	0.228	0.195	0.157	0.183	0.012	11	0.191	0.011	20

Table 3.2.5.5. Ratios of activity conc-ntrations in Fucus vesiculosus samples in the northern cooling-water channel at Ringhals (locations 95 and 99) to those just outside the channel (location 98). Mean values and S.E. for 1983 - 1989 are given

	^{7}Be	^{40}K	^{54}Mn	^{58}Co	^{60}Co	^{65}Zn	^{103}Ru	^{106}Ru	^{110m}Ag	^{134}Cs	^{137}Cs
1983	2.79±0.63	0.92±0.03	2.43±0.58	2.37±0.69	1.67±0.16	1.12±0.08			1.20±0.33		1.42±0.12
	(n = 6)	(n = 7)	(n = 7)	(n = 7)	(n = 7)	(n = 7)			(n = 5)		(n = 7)
1984	3.36±0.32	0.99±0.04	1.91±0.17	1.81±0.17	2.03±0.28	0.99±0.08			0.94±0.19		1.81±0.20
	(n = 11)	(n = 11)	(n = 11)	(n = 11)	(n = 11)	(n = 11)			(n = 2)		(n = 11)
1985	3.42±0.51	0.91±0.05	1.99±0.32	1.82±0.30	2.01±0.42	1.05±0.14			1.12±0.14		1.69±0.12
	(n = 7)	(n = 10)	(n = 10)	(n = 10)	(n = 10)	(n = 8)			(n = 2)		(n = 10)
1986	3.67±1.07	0.99±0.08	2.45±0.27	2.30±0.43	1.97±0.22	0.89±0.10	3.38±0.64	2.56±0.33	1.38±0.20	1.99±0.19	2.71±0.48
	(n = 4)	(n = 7)	(n = 6)	(n = 8)	(n = 8)	(n = 2)	(n = 4)	(n = 3)	(n = 3)	(n = 4)	(n = 8)
1987		0.84±0.08	2.36±0.49	2.30±0.42	2.32±0.27	0.72±0.00			2.77±0.00	1.94±0.26	1.97±0.24
		(n = 7)	(n = 5)	(n = 7)	(n = 7)	(n = 2)			(n = 1)	(n = 6)	(n = 7)
1988	4.77±0.82	0.99±0.08	2.61±0.50	1.84±0.33	2.36±0.39	1.62±0.00				2.70±0.44	2.70±0.43
	(n = 8)	(n = 8)	(n = 6)	(n = 8)	(n = 8)	(n = 1)				(n = 8)	(n = 8)
1989	3.16±0.30	1.02±0.03	2.11±0.20	1.67±0.14	2.21±0.50	0.97±0.00			1.72±0.13	2.32±0.30	2.18±0.28
	(n = 11)	(n = 11)	(n = 9)	(n = 11)	(n = 11)	(n = 1)			(n = 2)	(n = 11)	(n = 11)
1983-	3.52±0.23	0.96±0.02	2.20±0.13	1.97±0.13	2.09±0.14	1.01±0.05	3.38±0.64	2.56±0.33	1.38±0.15	2.30±0.18	2.06±0.12
1989	(n = 47)	(n = 61)	(n = 54)	(n = 62)	(n = 62)	(n = 31)	(n = 4)	(n = 3)	(n = 16)	(n = 29)	(n = 62)

Table 3.2.5.8.A. Gamma-emitting radionuclides in Fucus vesiculosus (Fu.ve.) and Fucus serratus (Fu.se.) collected at Stora Näss, Varberg (57°07'N 12°11'E) in 1988. (Unit: Bq kg^{-1} dry weight)

Date	Feb 1	Mar 1	Mar 29	May 2	June 1	June 30	Aug 1	Aug 31	Sep 29	Nov 1	Nov 30
% dry matter	17.7	17.0	22.8	14.0	21.6	25.9	25.0	21.1	23.3	20.3	21.0
Species	Fu.ve.	Fu.ve.	Fu.ve.	Fu.ve.	Fu.ve.	Fu.ve.	Fu.se.	Fu.ve.	Fu.se.	Fu.se.	Fu.se.
^{58}Co	-	-	-	-	-	-	2.4	1.85	2.9	2.1	1.94
^{60}Co	5.5	5.3	3.8	4.5	3.7	2.8	3.2	2.7	3.9	4.2	4.5
^{106}Ru	-	-	-	-	-	-	-	-	-	-	11.8 A
^{134}Cs	3.7	3.2	2.7	4.3	3.9	5.3	3.8	3.5	3.8	2.9	2.7
^{137}Cs	13.5	14.6	12.4	21	19.6	23	19.5	18.2	17.9	15.3	14.3

Table 3.2.5.8.B. Gamma-emitting radionuclides in Fucus vesiculosus collected at Stora Näss, Varberg (57°07'N 12°11'E) in 1989. (Unit: Bq kg^{-1} dry weight)

Date	Jan 2	Feb 1	Mar 1	Mar 30	May 1	June 1	June 29	July 31	Aug 31	Oct 2	Nov 1	Nov 30
% dry matter	21.3	20.0	19.9	16.6	21.1	24.3	19.8	18.9	19.9	21.4	20.0	20.2
^{54}Mn	0.88 A	-	-	-	-	-	-	-	-	-	-	-
^{58}Co	1.23 A	-	-	-	-	-	-	1.6 B	2.1 A	2.8	2.8	2.1 A
^{60}Co	3.8	3.5	2.6	2.4	2.4	1.60	1.76	2.4 A	3.3	5.6	6.7	6.3
^{134}Cs	2.2	1.57	1.97	2.7	3.0	3.3	4.1	3.2	3.1	2.2	1.86	1.58
^{137}Cs	12.4	10.6	11.3	14.8	17.7	17.5	23	22	17.6	16.8	13.1	12.5

Table 3.2.5.9.A. Reported monthly liquid discharges from Barsebäck in 1988, (Sydkraft 1988) (Unit: Bq month^{-1})

Isotope	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
^{51}Cr	8.6×10^7	1.3×10^9	1.3×10^8	5.4×10^8	1.1×10^8	5.1×10^8	3.1×10^8	3.7×10^7	3.7×10^8	5.2×10^8	8.7×10^7	4.6×10^8
^{54}Mn	3.7×10^7	7.2×10^8	1.0×10^8	3.5×10^8	2.8×10^8	2.3×10^8	7.6×10^8	1.8×10^9	2.8×10^8	2.4×10^8	7.5×10^7	1.5×10^8
^{58}Co	5.7×10^7	7.0×10^8	8.0×10^7	2.8×10^8	9.9×10^7	1.3×10^8	1.5×10^9	1.9×10^9	6.4×10^8	5.9×10^8	2.0×10^8	6.0×10^8
^{59}Fe	0	0	0	0	0	0	3.5×10^7	0	0	0	0	0
^{60}Co	7.0×10^6	2.8×10^9	3.6×10^8	2.2×10^9	1.2×10^9	1.5×10^9	4.0×10^9	1.0×10^9	1.9×10^9	4.3×10^9	8.8×10^8	1.3×10^9
^{65}Zn	0	9.7×10^7	0	0	2.5×10^7	0	3.2×10^7	0	0	4.8×10^7	0	0
^{110m}Ag	0	0	0	0	0	0	0	0	0	0	0	0
^{131}I	0	0	0	0	0	0	0	0	1.5×10^8	0	2.2×10^8	1.3×10^9
^{134}Cs	0	1.4×10^7	0	1.7×10^7	9.5×10^6	3.1×10^7	0	0	2.5×10^7	1.7×10^7	0	0
^{137}Cs	8.7×10^6	4.9×10^7	0	4.5×10^7	3.1×10^7	9.3×10^7	7.6×10^7	4.2×10^7	5.2×10^7	7.5×10^7	2.2×10^7	5.7×10^7

Table 3.2.5.9.B. Reported monthly liquid discharges from Barsebäck in 1989, (Sydkraft 1989) (Unit: Bq month^{-1})

Isotope	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
^{51}Cr	1.6×10^8	5.5×10^7	3.8×10^7	5.5×10^7	6.6×10^7	0	7.2×10^8	1.6×10^6	2.8×10^8	7.1×10^8	8.4×10^8	5.1×10^8
^{54}Mn	9.2×10^7	2.7×10^7	7.2×10^7	6.7×10^7	3.4×10^7	2.4×10^7	1.5×10^8	7.0×10^7	3.1×10^8	1.9×10^8	7.0×10^7	1.3×10^8
^{58}Co	2.0×10^3	3.2×10^7	8.9×10^7	1.4×10^8	4.9×10^7	3.1×10^7	2.7×10^8	1.8×10^8	1.0×10^9	3.4×10^8	1.5×10^8	3.1×10^8
^{59}Fe	0	0	0	0	0	0	0	0	0	0	0	0
^{60}Co	8.2×10^8	2.6×10^8	4.3×10^8	5.1×10^8	2.3×10^8	1.6×10^8	1.3×10^9	5.5×10^8	1.4×10^9	1.8×10^9	4.7×10^8	1.9×10^9
^{65}Zn	8.6×10^6	3.6×10^7	0	0	0	0	0	0	0	0	0	0
^{110m}Ag	0	0	0	1.7×10^7	5.4×10^6	0	0	0	0	0	0	0
^{131}I	6.5×10^8	5.8×10^8	8.2×10^7	3.3×10^9	1.3×10^9	1.5×10^9	0	3.5×10^8	8.5×10^8	1.3×10^8	2.7×10^8	3.7×10^8
^{134}Cs	1.5×10^7	5.3×10^6	0	0	3.4×10^6	3.9×10^6	0	2.5×10^7	1.8×10^8	5.1×10^7	2.4×10^7	6.3×10^8
^{137}Cs	6.9×10^7	1.9×10^7	5.3×10^6	4.4×10^7	2.1×10^7	9.5×10^6	0	6.0×10^7	1.6×10^8	9.3×10^7	3.2×10^7	5.9×10^8

Table 3.2.5.10. Reported annual liquid discharges from Barsebäck 1975-1989, (Sydkraft 1975-1989) (Unit: Bq year^{-1})

Isotope	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
^{51}Cr	1.2×10^{10}	1.7×10^{10}	1.3×10^{10}	3.2×10^{10}	1.7×10^{10}	4.2×10^9	2.7×10^{10}	6.7×10^9	7.2×10^9	4.7×10^9	6.6×10^9	1.8×10^{10}	1.5×10^{10}	4.5×10^9	3.4×10^8
^{54}Mn	5.6×10^7	2.0×10^9	2.1×10^9	3.9×10^9	[illegible]	1.7×10^9	2.0×10^9	3.3×10^9	2.7×10^9	3.7×10^9	3.7×10^9	1.5×10^{10}	5.0×10^9	3.4×10^9	1.2×10^9
^{58}Co	6.6×10^9	2.6×10^{10}	1.3×10^{10}	3.4×10^{10}	7.8×10^9	[illegible]	6.3×10^9	4.0×10^9	1.8×10^9	4.9×10^9	2.6×10^9	9.0×10^9	8.6×10^9	5.1×10^9	2.8×10^9
^{59}Fe					2.4×10^8	9.3×10^7	1.5×10^8	1.2×10^8	1.3×10^8	5.5×10^8	7.8×10^7	1.1×10^9	1.1×10^8	3.5×10^7	0
^{60}Co	2.6×10^8	1.4×10^{10}	2.8×10^{10}	5.4×10^{10}	2.2×10^{10}	3.7×10^{10}	4.3×10^{10}	7.3×10^{10}	4.9×10^{10}	5.0×10^{10}	4.2×10^{10}	9.6×10^{10}	3.2×10^{10}	2.2×10^{10}	9.8×10^9
^{65}Zn	3.7×10^7	[illegible]	7.0×10^9	1.0×10^{10}	5.5×10^9	5.8×10^9	5.5×10^9	7.7×10^9	2.6×10^9	1.2×10^9	7.5×10^8	2.2×10^9	2.6×10^8	2.0×10^8	4.5×10^7
^{110m}Ag	0	2.2×10^9	1.8×10^9	3.6×10^9	8.6×10^8	2.9×10^8	2.4×10^8	1.3×10^8	3.8×10^7	5.7×10^7	0	1.3×10^7	9.4×10^6	0	2.2×10^7
^{131}I									7.5×10^8	2.2×10^8	3.7×10^7	1.2×10^8	7.5×10^7	1.7×10^9	9.4×10^9
^{134}Cs					0	0	4.6×10^9	1.9×10^{10}	6.5×10^9	4.0×10^9	4.7×10^8	1.2×10^9	1.6×10^8	1.1×10^8	9.4×10^8
^{137}Cs	0	0	6.5×10^8	1.9×10^7	0	0	6.1×10^9	2.6×10^{10}	1.2×10^{10}	9.2×10^9	1.9×10^9	5.1×10^9	4.6×10^8	5.5×10^8	1.1×10^9

Table 3.2.5.11.A. *Gamma-emitting radionuclides in Fucus vesiculosus collected at Barsebäck, location 25 (55°48'80N 12°54'45E) in 1988. (Unit: Bq kg^{-1} dry weight)*

Date	Feb 2	Mar 2	May 2	May 25	June 2	July 1	Aug 2	Sep 1	Sep 30	Nov 2	Dec 1	Dec 2
% dry matter	18.7	18.3	14.5	11.7	10.6	15.8	22.4	17.5	17.1	21.1	18.3	17.2
Salinity in ‰	7.7	15.3	8.1	-	8.5	8.4	14.0	9.0	13.4	20.6	18.6	-
^{54}Mn	75	57	22	26	32	39	41	45	45	40	27	24
^{58}Co	37	31	7.6	7.6	7.8	7.5	28	30	77	66	40	22
^{60}Co	320	250	128	135	179	198	147	210	220	290	183	146
^{65}Zn	-	7.0 A	-	-	-	4.9 A	-	-	3.8 B	-	-	-
^{131}I	-	-	-	-	-	-	-	-	30	2.2 A	19.4	-
^{134}Cs	9.0	8.7	12.7	14.3	17.5	15.7	10.0	13.2	7.8	8.7	6.0	7.0
^{137}Cs	32	32	44	50	65	61	40	53	37	35	27	31

Table 3.2.5.11.B. *Gamma-emitting radionuclides in Fucus vesiculosus collected at Barsebäck, location 25 (55°48'80N 12°54'45E) in 1989. (Unit: Bq kg^{-1} dry weight)*

Date	Jan 3	Feb 2	Mar 2	Mar 31	May 2	May 19	May 19*	June 2	June 30	July 31	Sep 1	Oct 3	Nov 2	Dec 1
% dry matter	17.6	18.1	15.8	14.8	13.5	15.1	9.3	16.0	19.8	22.3	18.3	18.3	17.7	18.1
Salinity in ‰	10.5	11.5	9.7	11.1	9.9	-	-	9.9	10.8	8.2	10.8	17.4	10.0	13.7
^{54}Mn	31	24	16.8	12.0	10.6	12.5	-	10.7	10.1	6.1	9.0	12.1	13.2	11.0
^{58}Co	33	24	14.9	8.7	6.7	5.1	-	1.6 A	2.4	3.2	7.5	16.7	19.3	14.8
^{60}Co	220	194	142	106	94	93	-	87	69	52	70	76	102	94
^{65}Zn	3.6 A	-	-	-	-	-	-	-	-	-	-	-	-	-
^{125}Sb	-	-	-	1.3 B	-	-	-	2.3 B	4.7	-	6.4	-	-	-
^{131}I	-	-	-	-	-	14.2 A	55 B	-	-	-	-	4.8	-	-
^{134}Cs	6.1	5.8	5.4	6.4	10.5	9.3	10.9	8.7	7.1	4.6	6.8	6.9	5.9	4.6
^{137}Cs	27	27	28	33	49	48	55	41	36	26	37	37	35	28

*Location 23, cf. Fig. 3.2.1.1.

Table 3.2.5.13.A. Gamma-emitting radionuclides in Fucus vesiculosus collected at Limhamn (55°35'N 12°55'E) in 1988. (Unit: Bq kg^{-1} dry weight)

Date	Feb 2	Mar 2	Mar 30	May 2	June 2	July 1	Aug 2	Sep 1	Sep 30	Nov 1	Dec 1
% dry matter	17.7	17.0	16.3	14.5	13.6	16.9	21.6	16.0	19.9	19.4	17.6
^{54}Mn	-	-	-	-	0.8 A	0.7 A	-	1.52	-	1.3 A	0.9 B
^{60}Co	4.3	3.0	2.1	2.5	1.80	1.41	2.2	2.3	3.3	3.3	3.3
^{110m}Ag	-	-	-	-	-	-	-	3.0 A	-	-	-
^{131}I	-	-	-	-	-	-	-	-	-	-	5.3
^{134}Cs	10.3	11.2	8.5	12.8	14.0	15.1	10.5	12.5	8.9	8.6	7.4
^{137}Cs	36	39	32	50	53	58	40	49	39	38	32

Table 3.2.5.13.B. Gamma-emitting radionuclides in Fucus vesiculosus collected at Limhamn (55°35'N 12°55'E) in 1989. (Unit: Bq kg^{-1} dry weight)

Date	Jan 1	Feb 2	Mar 2	Mar 31	May 2	June 2	June 30	July 31	Sep 9	Oct 3	Nov 2	Dec 1
% dry matter	16.9	15.5	14.7	15.7	12.5	16.9	16.6	18.4	19.8	21.1	19.3	16.6
^{54}Mn	0.8 B	-	-	0.4 B	-	-	-	-	-	-	-	-
^{60}Co	3.5	2.7	2.0	2.7	1.49	1.22	-	1.36	1.38	1.36	1.41	1.20
^{131}I	2.2 A	-	-	-	-	-	-	-	-	2.0 A	-	-
^{134}Cs	7.0	5.7	6.5	7.0	9.7	12.1	11.7	7.3	7.0	6.1	4.6	5.7
^{137}Cs	29	28	31	35	51	61	59	37	38	35	29	34

4. Fallout Nuclides in Abiotic Samples

by A. Aarkrog and Heinz Hansen

4.1. Air

Air samples are collected at Risø and at Rønne, Bornholm. Weekly samples are measured by Ge-γ-spectroscopy and ^{90}Sr is determined in annual aliquots. The sampling equipment is described in Risø Report No. 421 (Risø Reports 1957-1989).

Figure 4.1.1 shows how the ^{90}Sr concentrations have varied in Risø air since sampling began in 1957. The level in 1989 (0.07 $\mu Bq\ m^{-3}$) is so far the lowest observed.

Table 4.1.2.2 summarizes the ^{137}Cs air concentrations throughout the years. Since Chernobyl the decrease in concentrations has become slower with time. Tables 4.1.2.1 (A & B) suggest a spring peak around March-May. From Figures 4.1.2.1 and 4.1.2.2 it appears, however, that the peak is not very prominent. It is thus an open question whether there actually is a stratospheric component of the Chernobyl fallout or whether all measured Chernobyl ^{137}Cs in air and precipitation now is due to resuspension.

Figure 4.1.2.4 shows how the resuspension factor for Chernobyl ^{137}Cs in Denmark has decreased with time. A power function seems to give the best fit to the observations.

The ^{137}Cs concentrations in air at Risø are about ¾ of those measured at Bornholm. We believe this is due to a higher local and perhaps regional (from Eastern Europe) resuspension at Bornholm.

At a few occasions shorter-lived γ-emitters from unknown sources have been detected (Table 4.1.3), but the concentrations have been very low.

4.2. Precipitation

Precipitation is collected monthly from the ten »State experimental farms« (Figure 4.2) and from Risø (Figure 3.1.1). The samples are combined to bimonthly samples before analysis for ^{90}Sr and radiocesium.

Since 1987 the ^{90}Sr deposition in Denmark has decreased with a halflife of about 1.4 year while ^{137}Cs has decayed with 0.4 year halflife. Most of the ^{137}Cs is from Chernobyl while ^{90}Sr preferentially comes from global fallout. Local resuspension plays an important role as a source for the ^{137}Cs deposit. We still notice a relationship between the original Chernobyl fallout and the depositions in 1988 and 1989 at the various State experimental farms (*Aarkrog* 1988, *Aarkrog* 1989).

Since 1982 (Risø Reports 1957-1989) the ^{90}Sr deposition at Tornbygård, Bornholm, has been about twice that of the country mean and the concentration in rain has been nearly 3 times higher. However, prior to 1982 and in the »Chernobyl year«, 1986, Bornholm did not differ markedly from the country mean. We believe that Bornholm has an enhanced resuspension of ^{90}Sr fallout compared to the remaining part of the country. The contribution from this resuspension to the activity in rain will only be observable when the fallout rate is low, i.e. about 2-3 Bq $^{90}Sr\ m^{-2}$. This was the case in 1982-1985 and again since 1987. Before Chernobyl we have no systematic measurements of ^{137}Cs in precipitation from Bornholm, however, the observations since 1986 indicate that also ^{137}Cs shows higher concentrations in rain water from Bornholm than from the remaining part of Denmark. In order to examine whether the difference was connected to special local conditions at Tornbygård, we began sampling in 1989 at another location at Bornholm, Nexø situated in the eastern part of the island (Tornbygård is to the west). It appears from Tables 4.2.1.1.B and 4.2.1.2.B that the ^{90}Sr levels at Nexø were compatible with those in the remaining part of Denmark but a factor of 2.7 times lower than those at Tornbygård.

Tables 4.2.2.1.B and 4.2.2.2.B show that the ^{137}Cs levels at Nexø also were lower than those at Tornbygård, but only by a factor of 1.5. We conclude that Tornbygård shows an anomaly with enhanced resuspension in particular of old global fallout (^{90}Sr and ^{137}Cs ?). The phenomenon was also discussed in the previous report Risø-R-563, p. 34 (Risø Reports 1957-1989).

The washout ratio (Bq m^{-3} rain/μBq m^{-3} air) calculated from monthly ^{137}Cs values at Risø (Tables 4.1.2.1.A & B and Tables 4.2.2.5.A & B) was 3.4 ± 2.4 (1 S.D.; n = 12) in 1988 and 5.0 ± 5.0 in 1989, in 1987 we found 6.5.

Table 4.2.5 shows a retrospective study of ^{137}Cs and ^{3}H in precipitation collected since 1963 at Funen. Compared with measured ^{90}Sr levels at Blangstedgård throughout the years the ^{137}Cs levels may be a little too high probably due to evaporation during the storage. The geometric mean of $^{137}Cs/^{90}Sr$ was 2.4, the expected value is 1.6-1.7.

4.3. Fresh Water

4.3.1. Ground Water

The collection of ground water takes place annually from nine selected locations (Figure 4.3.1.1). The median ^{90}Sr concentrations since 1961 appear in Figure 4.3.1.2, and those from the outlier location: Feldbak in Figure 4.3.1.3.

The concentrations of ^{137}Cs in Feldbak ground water were 0.14 Bq m^{-3} in 1988 and 0.06 (B) in 1989. This demonstrates how efficiently ground water is protected against ^{137}Cs contamination, even at a location with a high transfer of ^{90}Sr.

4.3.2. Lakes and Streams

The sampling location for lake and stream water are shown in Figure 4.3.2.1

Since 1986 Chernobyl ^{137}Cs have been measured along with ^{90}Sr. In the period 1987-1990 the ^{137}Cs concentrations in lake water have shown an effective halflife of 2.7 years and those in streams have decreased with 1.8 years halflife. The corresponding halflives of ^{90}Sr were 3.5 and 4.1 years, respectively.

4.3.3. Drinking Water

Potable water was collected from the towns used for total diet sampling (cf. Section 5.7) in June 1989. The ^{90}Sr concentrations were half of those in 1987, while the ^{137}Cs levels were nearly twice as high in 1989 as in 1987, which may indicate a delay in the penetration of Chernobyl ^{137}Cs to the ground water.

4.4. Sea Water

Since 1962 samples of surface and bottom sea water have routinely been collected around Zealand summer and winter (Figure 4.4.3).

The ^{90}Sr and the ^{137}Cs concentrations throughout the years are shown in

Figures 4.4.1 and 4.4.2, respectively.

Since Cernobyl the Baltic Sea has been the main source to the ^{137}Cs contamination of Danish waters. The percentage of Chernobyl ^{137}Cs increased in the inner waters from 1988 to 1989 by a factor of 1.03 ± 0.02 (± 1 S.D.; $n = 6$) (cf. Table 4.4.3 and Figure 4.4.4), although the total ^{137}Cs concentrations decreased from 1988 to 1989 (cf. Figures 4.4.9 and 4.4.10).

The ^{99}Tc measurements (Figures 4.4.5-4.4.10) illustrate that ^{99}Tc enters the Danish inner waters from the North Sea by the Jutland Current.

4.5. Soil

South-East Jutland (Figure 4.5.4) received the highest amounts of Chernobyl radiocesium. The samplings from 1986 (Risø Reports 1957-1989) were repeated in 1988 and the samples were measured for radiocesium as untreated raw samples and as treated samples (drying, crushing, blending and sifting with removal of stones). The mean ratio between ^{137}Cs in treated and untreated samples (Table 4.5.1) was: 0.95 ± 0.05 (± 1 S.D.; $n = 20$). The corresponding ratio for ^{134}Cs was 0.89 ± 0.14 (± 1 S.D.; $n = 17$). Hence minor amounts of radiocesium may adhere to the discarded stones.

A soil sampling of uncultivated soils at the 10 State experimental farms was carried out in September 1989 (Table 4.5.2). A similar sampling took place in 1987. The mean ratio between 1989 and 1987 (Bq ^{137}Cs m^{-2}, 0-30 cm) for the 10 locations was: 1.31 ± 0.29 (± 1 S.D.; $n = 10$) and for ^{134}Cs (decay corrected to 26 April 1986) 0-10 cm we found 1.00 ± 0.22 (± 1 S.D.; $n = 10$). Hence it was not possible to ascertain any field loss (runoff etc.) of radiocesium from uncultivated soils from 1987 to 1989 (cf. Figures 4.5.1 and 4.5.2).

In order to investigate the importance of windbreak for the deposition and resuspension of radiocesium two experimental soil samplings were carried out after an idea of Marianne Wichman, FOA 4, Umeå, Sweden (Figure 4.5.3 and Table 4.5.3).

The Tågerup station did not differ very much with the distance from the windbreak. The highest Chernobyl values were observed at a distance of 10 times the height of the hedge. At Nustrup in South Jutland, where the Chernobyl fallout was nearly 20 times higher, the highest Chernobyl levels were observed at a distance of 6 times the height of the hedge. At longer distances the deposition decreased markedly. With regard to global fallout the maximum in the 0-5 cm layer occurred at a distance of 10 times the height of the hedge. These results are difficult to interpret and further studies are needed in order to explain the significance of windbreaks for the deposition and resuspension of fallout.

Tables 4.5.4 and 4.5.5 show the ^{90}Sr levels in Danish soils collected in 1987. Compared with the theoretical mean deposit in Denmark by 1987: 1555 Bq ^{90}Sr m^{-2} (Appendix D2) the mean measured inventory to a depth of 30 cm is low by a factor of two. Hence ^{90}Sr has penetrated to greater depth or – as suggested from the data from St. Jyndevad in Table 4.5.5 – may have disappeared with runoff.

4.6. Marine Sediments

As previously sediments have been collected by the HAPS sampler off Risø in 1988 and in 1989. The variation from year to year has been great. The contribution from Chernobyl ^{137}Cs to total ^{137}Cs has varied between 14 and 44%.

Table 4. Geometric means of Strontium-90 and Cesium-137 levels in Danish environmental abiotic samples collected in 1988 and 1989

Sample type and unit	Strontium-90		Cesium-137	
	1988	1989	1988	1989
Air at Risø, μBq m^{-3}	0.19	0.07	2.1	1.4
Air at Bornholm, μBq m^{-3}	0.12	0.11	2.9	1.9
Countrywide deposition with rain, Bq m^{-2}	0.99*	0.54*	11.9*	3.5*
Countrywide rain samples, Bq m^{-3}	1.35*	1.02*	16.3*	6.6*
Countrywide stream water, Bq m^{-3}	-	6.4	1.9	1.5
Countrywide lake water, Bq m^{-3}	-	12.0	7.6	5.9
Countrywide ground water, Bq m^{-3}	0.12	0.06	-	-
Countrywide drinking water, Bq m^{-3}	-	0.17	-	0.11
Surface sea water around Zealand, Bq m^{-3}	17.8*	15.8*	82*	80*
Bottom sea water around Zealand, Bq m^{-3}	10.4*	12.8*	61*	46*
Baltic Sea water (Bornholm), Bq m^{-3}	22†	19†	106*	95*
North Sea water 50°-60°N, Bq m^{-3}	-	15*	26*	17*

*Arithmetic means
†Single values.

Table 4.1.1.1. Strontium-90 in air collected at Risø in 1988 and 1989. (Unit: μBq m^{-3})

Year	Big air sampler
1988	0.188
1989	0.073

Table 4.1.1.2. Strontium-90 in air collected at Bornholm in 1988 and 1989. (Unit: μBq m^{-3})

Year	Big sampler, glass fibre filter, shunt
1988	0.124 A
1989	0.107 B

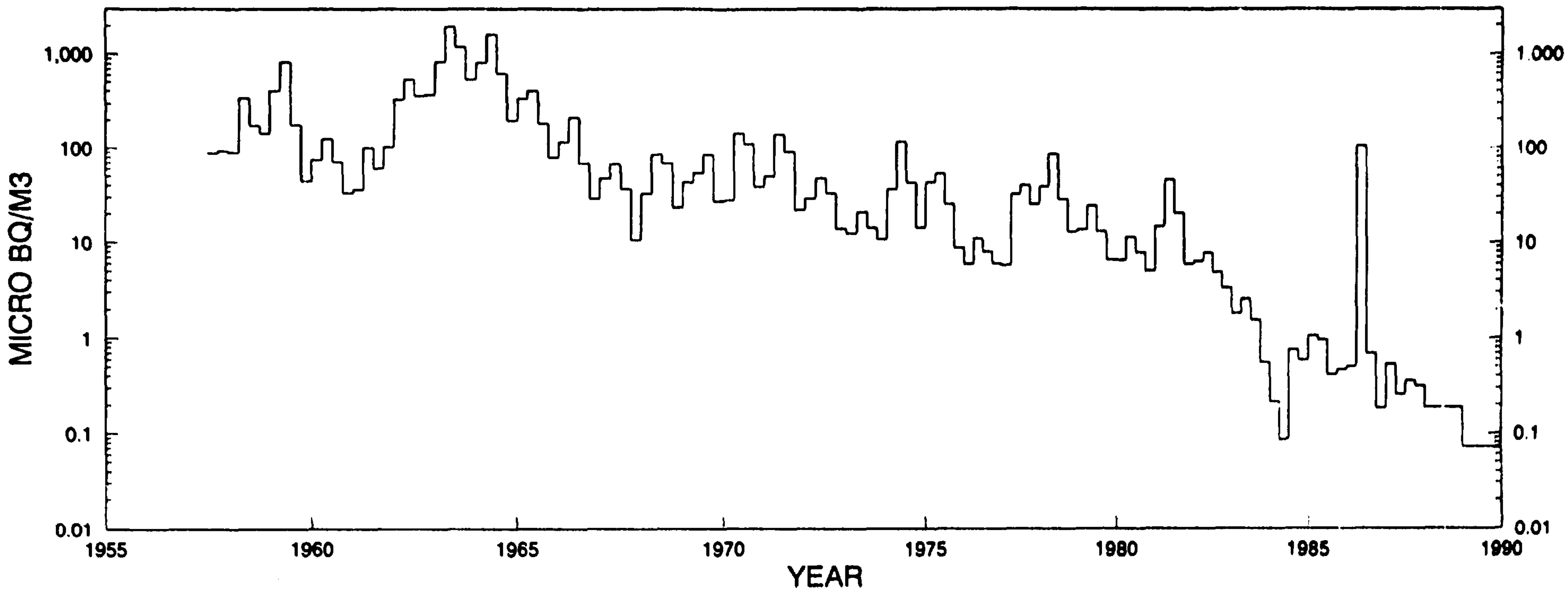


Fig. 4.1.1. Strontium-90 in ground level air at Risø, 1957-1989.

Table 4.1.2.1.A. Cesium-137 in air collected in glass-fibre filters by the large air sampler at Risø and Bornholm in 1988. (Unit: μBq m⁻³) (The error term is 1 S.D.)

Month	Risø	(N)	Bornholm	(N)
January	2.60 ± 0.80	(4)	3.29 ± 1.04	(4)
February	2.26 ± 1.28	(5)	6.00 ± 7.69	(5)
March	7.10 ± 7.33	(4)	4.72 ± 2.05	(4)
April	3.06 ± 1.28	(4)	5.05 ± 3.01	(4)
May	3.94 ± 3.65	(5)	5.28 ± 3.96	(5)
June	2.54 ± 1.20	(4)	4.27 ± 1.29	(4)
July	0.74 ± 0.21	(4)	1.02 ± 0.26	(4)
August	1.06 ± 0.32	(5)	1.38 ± 0.35	(5)
September	1.14 ± 0.27	(4)	1.88 ± 0.84	(4)
October	3.32 ± 3.33	(5)	4.94 ± 4.49	(5)
November	1.98 ± 1.24	(4)	2.18 ± 1.04	(4)
December	1.02 ± 0.24	(4)	1.32 ± 0.26	(4)
1988: Geometric mean	2.10		2.93	
1988: Arithmetic mean	2.56		3.44	

Table 4.1.2.1.B. Cesium-137 in air collected in glass-fibre filters by the large air sampler at Risø and Bornholm in 1989. (Unit: μBq m^{-3}) (The error term is 1 S.D.)

Month	Risø	(N)	Bornholm	(N)
January	1.21 ± 0.73	(5)	1.83 ± 0.92	(5)
February	0.98 ± 0.30	(4)	1.81 ± 0.58	(4)
March	1.18 ± 0.52	(4)	1.99 ± 0.87	(4)
April	3.74 ± 3.90	(4)	4.66 ± 3.83	(4)
May	1.35 ± 0.69	(5)	2.09 ± 0.93	(5)
June	1.30 ± 1.01	(4)	2.97 ± 2.29	(4)
July	1.08 ± 0.74	(5)	1.61 ± 0.84	(5)
August	1.20 ± 0.33	(4)	1.44 ± 0.36	(4)
September	1.06 ± 0.27	(4)	1.73 ± 0.13	(4)
October	0.93 ± 0.40	(5)	1.32 ± 0.82	(5)
November	1.59 ± 0.84	(4)	1.42 ± 0.10	(4)
December	3.31 ± 3.03	(4)	1.60 ± 0.93	(4)
1989: Geometric mean	1.41		1.90	
1989: Arithmetic mean	1.58		2.04	

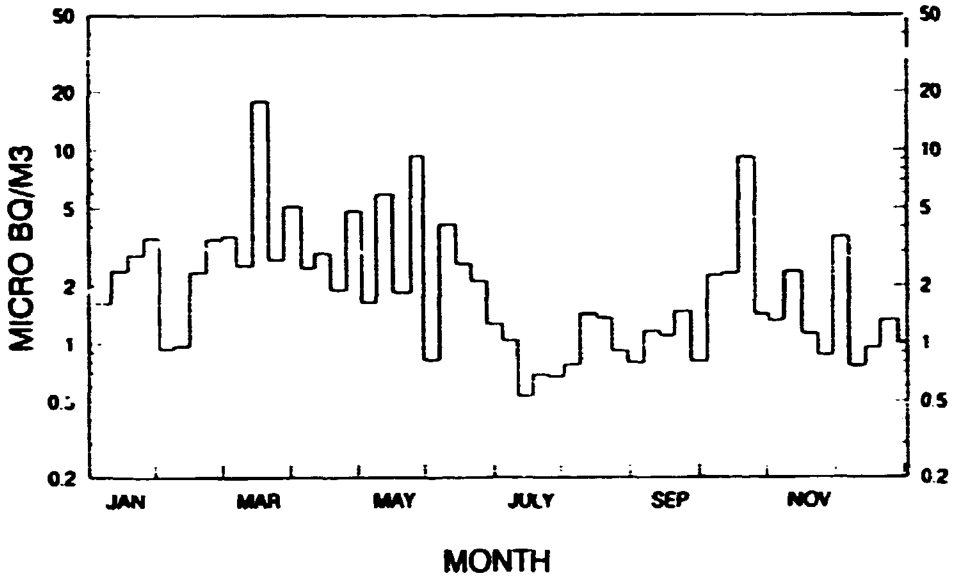
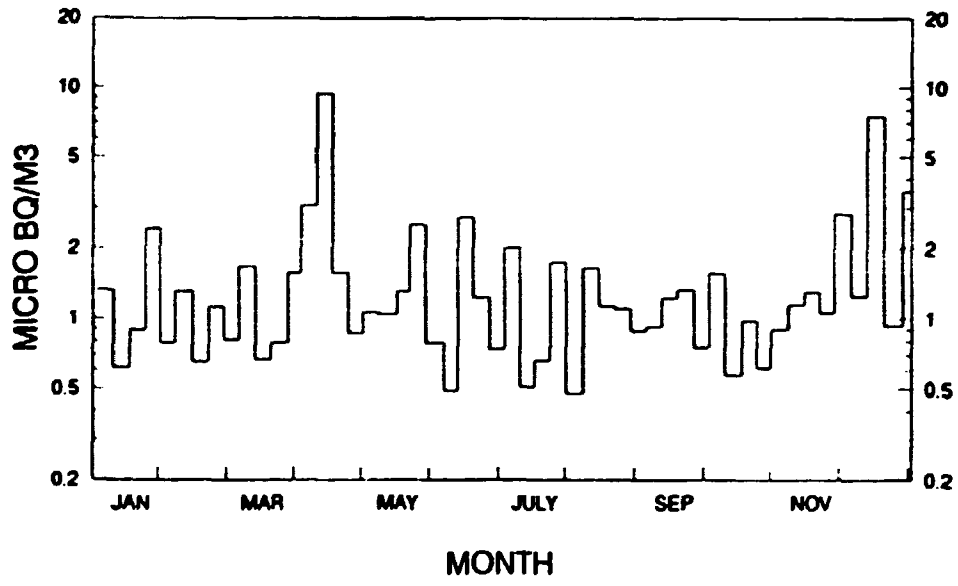


Fig. 4.1.2.1.A. Cesium-137 in air collected at Risø, Denmark in 1988.

Fig. 4.1.2.1.B. Cesium-137 in air collected at Risø, Denmark in 1989.



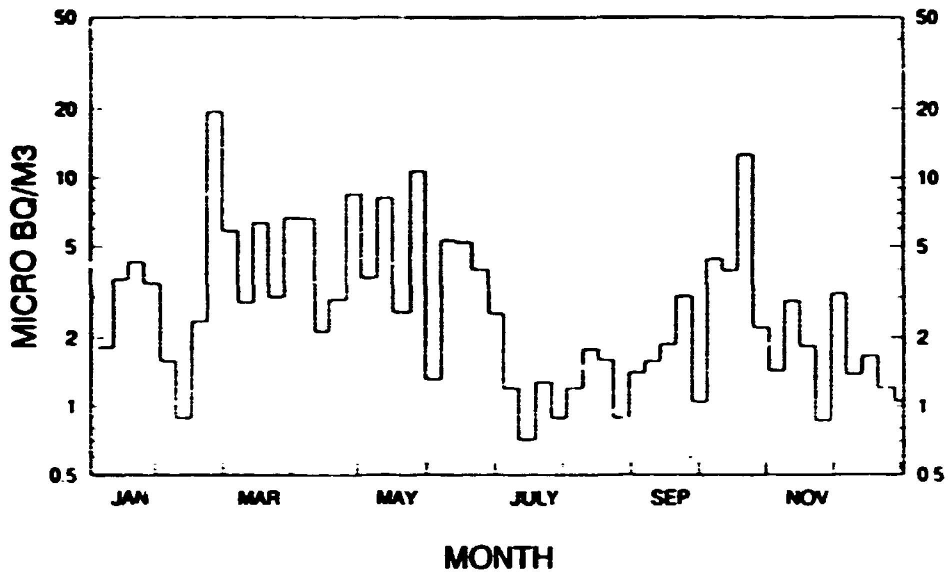
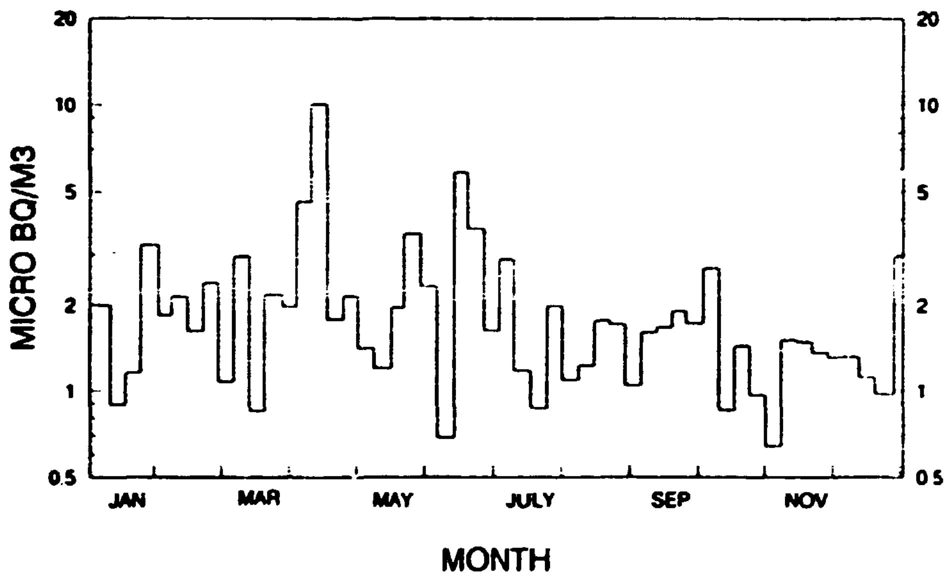


Fig. 4.1.2.2.A. Cesium-137 in air collected at Bornholm, Denmark in 1988.

Fig. 4.1.2.2.B. Cesium-137 in air collected at Bornholm, Denmark in 1989.



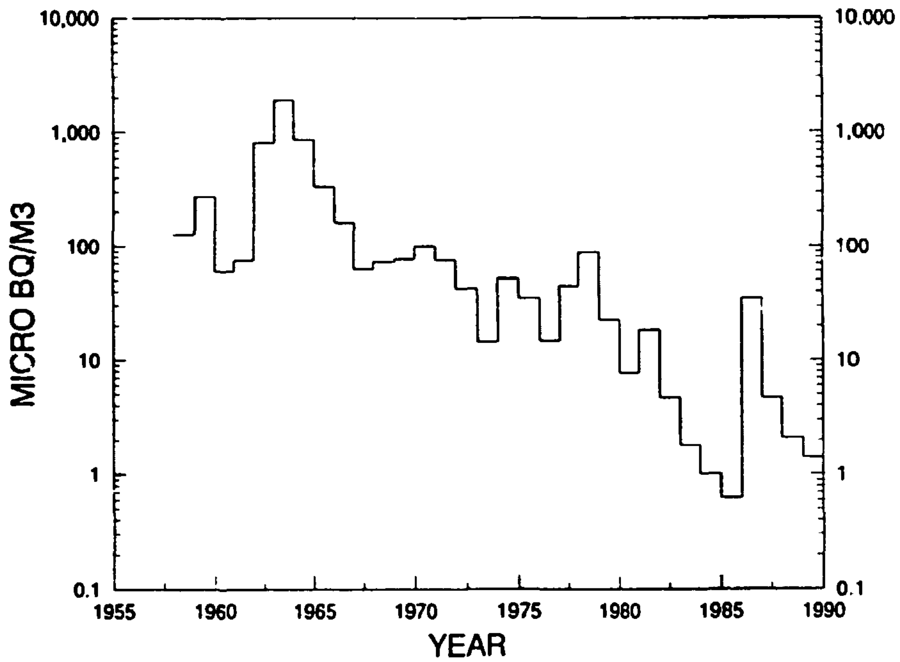


Fig. 4.1.2.3. Cesium-137 in air collected at Risø, Denmark. 1958-1989.

Fig. 4.1.2.4. Cesium-137 resuspension factors after Chernobyl, July 1986 - March 1990 (quarterly values). RF = 1.4 × 10^{-5} $D^{-1.26}$.

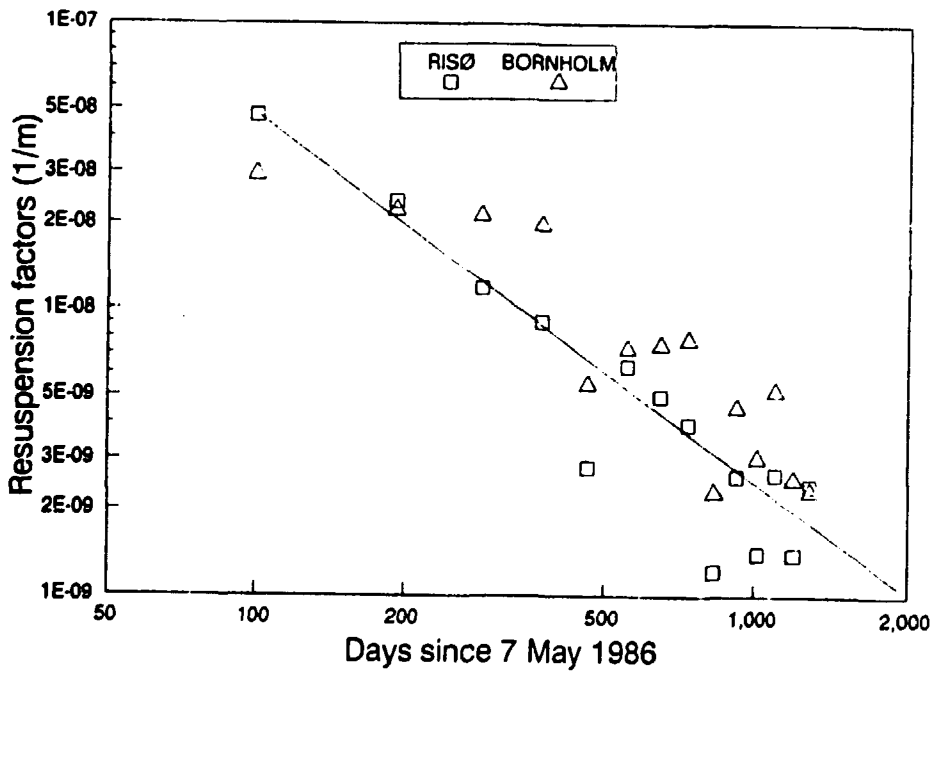


Table 4.1.2.2. Cesium-137 in air collected at Risø 1958-1989.
(Unit: μBq m^{-3})

Year	Arithmetic mean	Geometric mean
1958	155	127
1959	490	270
1960	73	60
1961	84	75
1962	850	810
1963	2400	1910
1964	1160	860
1965	390	340
1966	210	162
1967	79	63
1968	88	72
1969	91	77
1970	127	100
1971	98	75
1972	51	43
1973	17.3	14.4
1974	72	52
1975	48	35
1976	15.5	14.8
1977	60	45
1978	116	88
1979	31	23
1980	9.0	7.7
1981	30	18.4
1982	5.7	4.7
1983	2.1	1.81
1984	1.41	1.00
1985	0.68	0.63
1986	1340	35
1987	6.1	4.7
1988	2.6	2.1
1989	1.58	1.41

Table 4.1.3. γ-emitters in air collected on glass-fibre filters in Denmark in 1988.
(Unit: μBq m^{-3})

Period	Risø		Bornholm
Jan 25-Feb 2	1.2	^{95}Nb	-
	0.5 B	^{110m}Ag	-
Feb 22-29	-		12 ^{106}Ru
March 28-April 5	0.45 A	^{95}Nb	-
Oct 3-10	0.42 A	^{60}Co	-
Dec 12-19	1.6 B	^{131}I	-

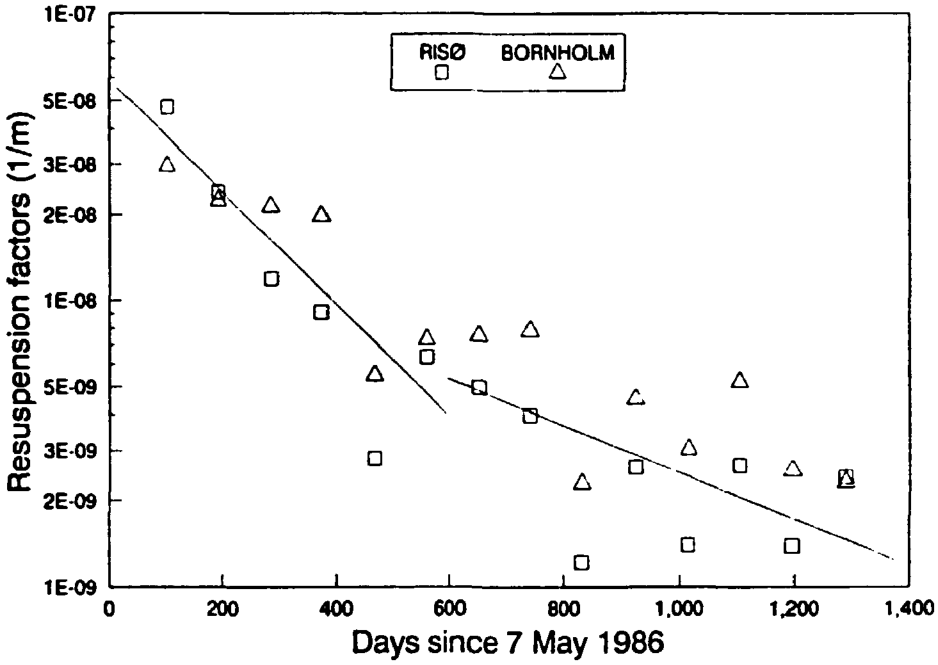
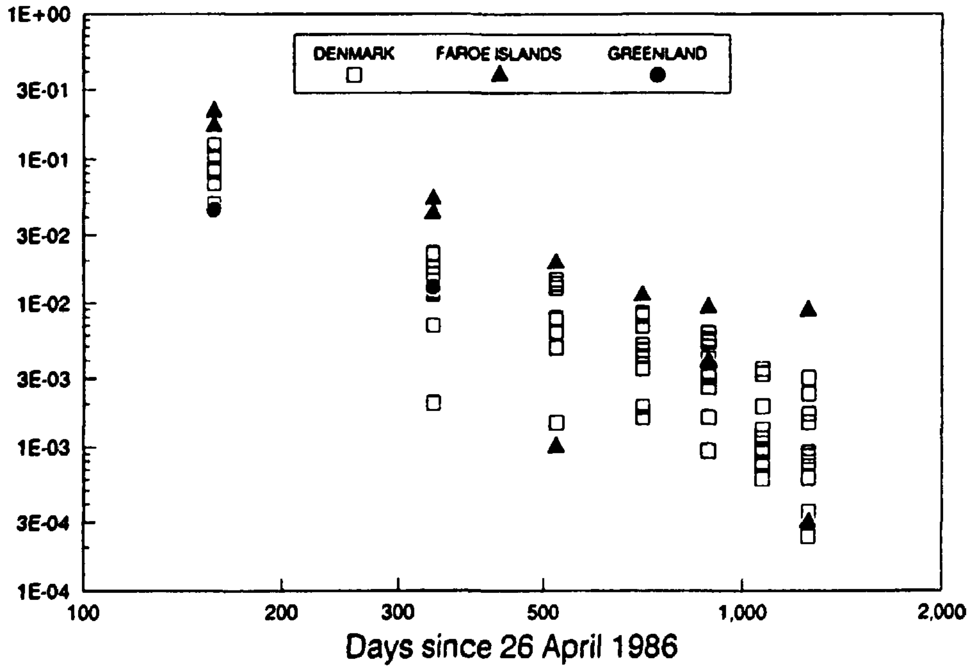


Fig. 4.1.2.5. Cesium-137 resuspension factors after Chernobyl.
July 1986 - December 1987: $RF = 5.5 \times 10^{-8}\, e^{-0.0044\, D}$
Jan 1988 - March 1990: $RF = 1.3 \times 10^{-8}\, e^{-0.0015\, D}$

Fig. 4.1.2.6. Wet deposition of Cs-137 relative to Chernobyl deposit.



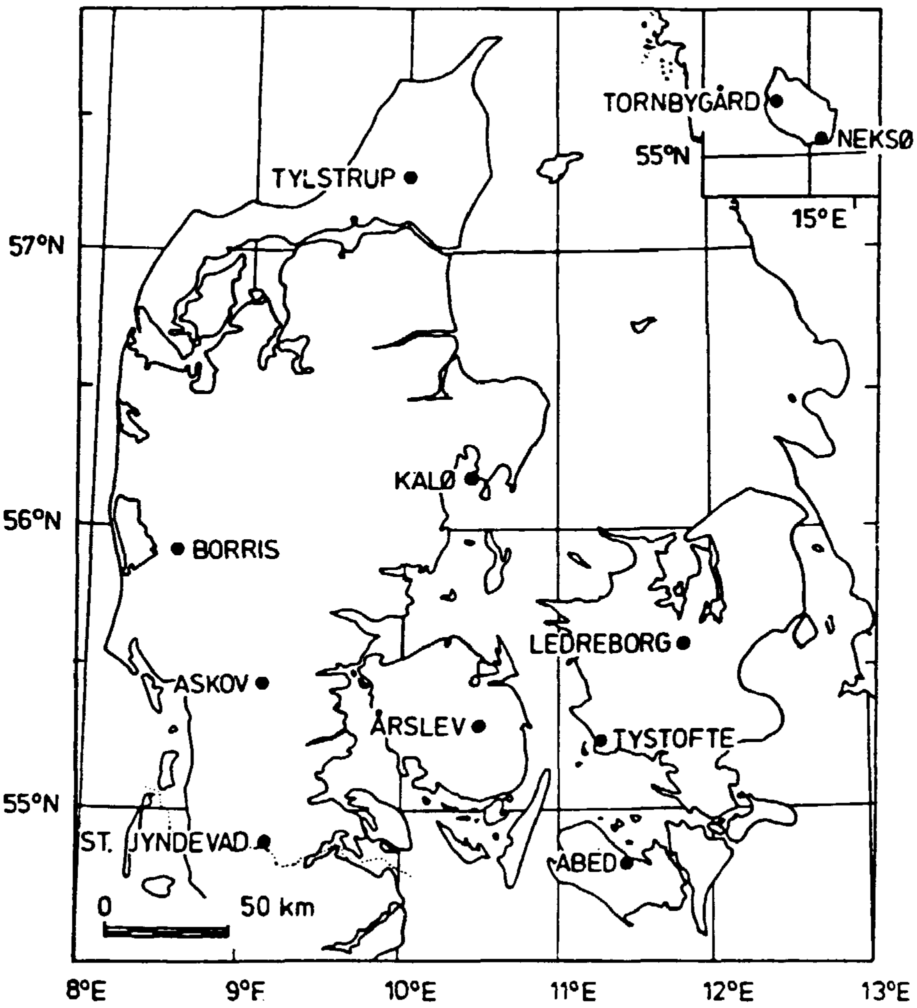


Fig. 4.2. State experimental farms in Denmark.

Table 4.2.1.1.A. Strontium-90 fallout in Denmark in 1988. (Unit: Bq m^{-3})

Location	mm	Jan-Feb	March-April	May-June	July-Aug	Sept-Oct	Nov-Dec	Weighted mean
Tylstrup	832	0.45	0.23 B	1.29 A	0.35	0.89	1.12	0.85
Kalø	616	0.87	1.21	2.6 A	2.4	1.55	1.51	1.61
Borris	1009	0.20 A	0.65	5.7	2.3	0.57	(0.91)	1.25
Askov	1059	(0.35)	0.70	1.29	0.60	0.43	0.52	0.61
St. Jyndevad	983	0.40	0.42 A	2.1	0.82	0.75	0.50	0.78
Aarslev	566	3.6	1.78	2.5	1.85	2.6	2.3	2.3
Tystofte	502	0.32 A	1.13 A	0.47 B	0.61	0.89	0.78 A	0.65
Ledreborg	577	2.2	1.30 A	4.8	0.95	1.46	1.00	1.63
Abed	575	0.64	1.39	4.1 B	4.3	6.2	1.39	2.9
Tornbygaard	579	1.08 A	1.86	1.91	2.9	1.83	2.2	1.99
Weighted mean		0.85	1.05	2.3	1.55	1.47	1.13	1.35
x̄: mm	730	162	82	72	178	143	93	

Table 4.2.1.1.B. Strontium-90 fallout in Denmark in 1989. (Unit: Bq m^{-3})

Location	mm	Jan-Feb	March-April	May-June	July-Aug	Sept-Oct	Nov-Dec	Weighted mean
Tylstrup	580	0.36	0.41	2.0	1.44	0.43	0.43	0.72
Kalø	473	0.87	0.32 A	1.81	1.48	0.46	0.15 B	0.77
Borris	716	0.32 A	0.44	1.17	1.07	0.43	0.18 A	0.50
Askov	634	1.10	0.64	3.3	1.17	0.28	0.43	0.97
St. Jyndevad	636	0.43	0.31	0.99	0.72	0.193	0.38	0.47
Aarslev	516	1.56	0.73	2.0	0.90	0.36	0.57	0.83
Tystofte	434	0.91	0.88	1.48	0.71	0.36 A	0.20 A	0.70
Ledreborg	444	0.87 A	1.20	0.68A	0.55	0.67	1.02	0.77
Abed	468	0.74 A	3.2	2.4	3.6	0.53	1.12	2.4
Tornbygaard	457	1.60	2.2	10.8	0.71	3.6	2.1	2.6
Weighted mean		0.76	0.87	2.4	1.33	0.64	0.58	1.02
x̄: mm	535	66	101	53	118	117	80	
Neksø	550	0.40 B	0.96	0.68 A	0.64 A	0.26	0.82	0.59
Neksø mm	550	47	68	41	163	143	88	

Table 4.2.1.2.A. Strontium-90 fallout in Denmark in 1988. (Unit: Bq m^{-2}). (Figures in brackets are calculated)

Location	mm	Jan-Feb	March-April	May-June	July-Aug	Sept-Oct	Nov-Dec	1988
Tylstrup	832	0.087	0.191 B	0.114 A	0.077	0.131	0.113	0.71
Kalø	616	0.137 A	0.105	0.137 A	0.33	0.148	0.112	0.97
Borris	1009	0.043	0.094	0.32	0.59	0.130	(0.116)	1.29
Askov	1059	(0.061)	0.100	0.151	0.160	0.092	0.061	0.62
St. Jyndevad	983	0.088	0.045 A	0.23	0.20	0.143	0.058	0.76
Aarslev	566	0.30	0.119	0.24	0.30	0.31	0.154	1.42
Tystofte	502	0.045 A	0.059 A	0.041 B	0.062	0.085	0.040	0.33
Ledreborg	577	0.37	0.048 A	0.127	0.119	0.167	0.108	0.94
Abed	575	0.095	0.080	0.24 B	0.48	0.66	0.128	1.68
Tornbygaard	579	0.144 A	0.079	0.108	0.44	0.22	0.163	1.15
Geometric mean	-	0.107	0.084	0.150	0.22	0.171	0.097	0.90
Arithmetic mean	730	0.137	0.092	0.171	0.28	0.21	0.105	0.99

Table 4.2.1.2.B. Strontium-90 fallout in Denmark in 1989. (Unit: Bq m^{-2})

Location	mm	Jan-Feb	March-April	May-June	July-Aug	Sept-Oct	Nov-Dec	1989
Tylstrup	580	0.037	0.049	0.138	0.102	0.059	0.034	0.42
Kalø	473	0.045	0.035 A	0.104	0.120	0.049	0.010 B	0.36
Borris	716	0.040 A	0.061	0.080	0.078	0.080	0.022 A	0.36
Askov	634	0.120	0.098	0.24	0.080	0.036	0.046	0.62
St. Jyndevad	636	0.039	0.040	0.071	0.087	0.025	0.036	0.30
Aarslev	516	0.080	0.064	0.078	0.109	0.047	0.049	0.43
Tystofte	434	0.032	0.053	0.071	0.108	0.024 A	0.014 A	0.30
Ledreborg	444	0.020 A	0.082	0.025 A	0.084	0.074	0.055	0.34
Abed	475	0.023 A	0.23	0.077	0.70	0.045	0.060	1.14
Tornbygaard	457	0.065	0.164	0.40	0.108	0.31	0.140	1.18
Geometric mean	-	0.043	0.073	0.098	0.117	0.055	0.036	0.48
Arithmetic mean	535	0.050	0.088	0.128	0.157	0.075	0.046	0.54
Neksø	550	0.019 B	0.065	0.028 A	0.104	0.037	0.073	0.33

Table 4.2.1.3.A. Analysis of variance of ln Bq ^{90}Sr m^{-3} precipitation, January-December 1988 (from Table 4.2.1.1.A)

Variation	SSD	f	s^2	v^2	P
Between months	7.424	5	1.485	4.923	> 99.5 %
Between locations	17.255	9	1.917	6.357	> 99.95%
Remainder	12.968	43	0.302		

Table 4.2.1.4.A. Analysis of variance of ln Bq ^{90}Sr m^{-2} precipitation, January-December 1988 (from Table 4.2.1.2.A)

Variation	SSD	f	s^2	v^2	P
Between months	8.933	5	0.993	3.875	> 99.5%
Between locations	6.495	9	1.299	5.072	> 99.9%
Remainder	11.015	43	0.256		

Table 4.2.1.3.B. Analysis of variance of ln Bq ^{90}Sr m^{-3} precipitation, January-December 1989 (from Table 4.2.1.1.B)

Variation	SSD	f	s^2	v^2	P
Between months	13.948	5	2.790	8.833	> 99.99%
Between locations	14.782	9	1.642	5.201	> 99.99%
Remainder	14.212	45	0.316		

Table 4.2.1.4.B. Analysis of variance of ln Bq ^{90}Sr m^{-2} precipitation, January-December 1989 (from Table 4.2.1.2.B)

Variation	SSD	f	s^2	v^2	P
Between months	10.876	5	2.175	6.597	> 99.95%
Between locations	10.000	9	1.111	3.370	> 99.5 %
Remainder	14.836	45	0.330		

Table 4.2.1.5.A. Strontium-90 in precipitation collected at Risø in 1988

Month	10 m² ion exchange sampler		Eight rain bottles total area: 0.23 m²	
	Bq m^{-2}	Bq m^{-3}	Bq m^{-2}	Bq m^{-3}
Jan	0.0104	0.121		
Feb	0.0076	0.164	0.037	0.169
March	0.0078	0.21		
April	0.0178	1.35		
May	0.0105	0.39	0.049	0.86
June	0.0060	0.40		
July	0.0111	0.123		
Aug	0.0066	0.25	0.072	0.40
Sep	0.0083	0.136		
Oct	0.0095	0.190		
Nov	0.0088	0.31	0.093	0.52
Dec	0.0085	0.174		
1988	Σ 0.113 (528 mm)	$\bar{x}$: 0.21 (weighted mean)	Σ 0.25 (636 mm)	$\bar{x}$: 0.40 (weighted mean)

Table 4.2.1.5.B. Strontium-90 in precipitation collected at Risø in 1989

10 m² ion exchange sampler			Eight rain bottles total area: 0.23 m²		
Month	Bq m^{-2}	Bq m^{-3}	Month	Bq m^{-2}	Bq m^{-3}
Jan-Feb	0.0170	0.73	Jan-March	0.036	0.46
March-Apr	0.022	0.36	Apr-June	0.124	1.62
May-June	0.024	0.53			
July-Aug	0.0177	0.124	July-Sep	0.060	0.31
Sep-Oct	0.0131	0.194	Oct-Dec	0.088	0.76
Nov-Dec	0.0088	0.23			
1989	Σ 0.103 (380 mm)	$\bar{x}$: 0.27 (weighted mean)	1989	Σ 0.31 (463 mm)	$\bar{x}$: 0.66 (weighted mean)

Table 4.2.2.1.A. Cesium-137 in precipitation in Denmark in 1988. (Unit: $Bq\ m^{-3}$)

Location	mm	Jan-Feb	March-April	May-June	July-Aug	Sept-Oct	Nov-Dec	Weighted mean
Tylstrup	832	3.7	7.6	10.9	3.7	4.0	3.2 A	4.9
Kalø	616	8.9	22	38	20	6.9	7.4	15.3
Borris	1009	1.6 A	3.3 A	17.4	3.1	2.3	1.9 A	3.3
Askov	1059	28	39	56	21	16.2	85	35
St. Jyndevad	983	12.7	21	30	12.8	6.4	7.8	13.8
Aarslev	566	49	53	44	17.1	19.5	21	30
Tystofte	502	4.3 A	10.6	3.6	2.3 A	4.4 A	2.9 B	4.3
Ledreborg	577	13.2	26	66	16.1	13.0	7.9	16.0
Abed	575	16.0	27	60	31	16.2	14.4	24
Tornbygaard	579	14.9	32	31	12.8	9.4	10.6	15.5
Weighted mean	-	13.2	23	34	13.2	9.6	18.7	16.3
$\bar{x}$: mm	730	162	82	72	178	143	93	

Table 4.2.2.1.B. Cesium-137 in precipitation in Denmark in 1989. (Unit: $Bq\ m^{-3}$)

Location	mm	Jan-Feb	March-April	May-June	July-Aug	Sept-Dec	Weighted mean
Tylstrup	580	1.6 B	1.6 B	3.5 A	3.4 A	1.3 A	1.95
Kalø	473	5.5 A	1.6 A	5.5 A	3.1 A	1.2 A	2.6
Borris	716	2.0 A	1.76	3.3 A	2.5 B	2.2	2.2
Askov	634	23	15.4	28	26	15.0	19.3
St. Jyndevad	636	13.3	9.6	13.6	9.7	8.0	10.0
Aarslev	516	32	4.9	8.2 A	1.9 A	1.2 A	5.6
Tystofte	434	4.8 B	3.1 A	6.7 B	1.8 B	3.4	3.3
Ledreborg	444	22	7.6	10.4	5.4	5.9	7.2
Abed	475	14.1	6.0	3.5 B	1.2 A	3.0 A	3.5
Tornbygaard	457	14.3	13.2	13.4	3.4	6.3	7.7
Weighted mean	-	11.8	6.6	10.1	4.8	4.8	6.6
$\bar{x}$: mm	535	66	102	54	118	197	
Neksø	550	5.8 A	6.8	12.4	2.7 A	3.1	4.36

Table 4.2.2.2.A. Cesium-137 deposition with precipitation in Denmark in 1988.
(Unit: Bq m^{-2})

Location	mm	Jan-Feb	March-April	May-June	July-Aug	Sept-Oct	Nov-Dec	1988
Tylstrup	831	0.72	0.62	0.96	0.81	0.59	0.32 A	4.0
Kalø	617	1.52	1.87	2.0	2.8	0.66	0.55	9.4
Borris	1009	0.34 A	0.47 A	0.98	0.79	0.49	0.23 A	3.3
Askov	1059	5.0	5.6	6.3	5.6	3.7	10.8	37
St. Jyndevad	983	2.8	2.3	3.2	3.1	1.23	0.89	13.5
Aarslev	565	4.1	3.5	3.1	2.7	2.3	1.42	17.1
Tystofte	503	0.49	0.56	0.31 A	0.24 A	0.42 A	0.15 B	2.2
Ledreborg	577	2.2	0.98	1.73	2.0	1.48	0.85	9.3
Abed	576	2.4	1.55	3.5	3.5	1.72	1.33	13.9
Tornbygaard	580	2.0	1.37	1.76	1.95	1.12	0.80	9.0
Geometric mean	-	1.59	1.40	1.82	1.76	1.09	0.77	8.8
Arithmetic mean	730	2.1	1.88	2.4	2.4	1.37	1.74	11.88

Table 4.2.2.2.B. Cesium-137 deposition with precipitation in Denmark in 1989.
(Unit: Bq m^{-2})

Location	mm	Jan-Feb	March-April	May-June	July-Aug	Sept-Dec	1989
Tylstrup	580	0.17 B	0.20 B	0.25 A	0.24 A	0.27 A	1.13
Kalø	473	0.28 A	0.17 B	0.32 A	0.26 A	0.20 A	1.22
Borris	716	0.25 A	0.24	0.23 A	0.19 B	0.68	1.59
Askov	634	2.5	2.3	2.03	1.80	3.5	12.2
St. Jyndevad	636	1.18	1.25	0.97	1.16	1.81	6.4
Aarslev	516	1.65	0.43	0.32	0.23	0.27 A	2.9
Tystofte	434	0.17 B	0.18 A	0.32	0.27	0.46	1.41
Ledreborg	444	0.49	0.52	0.38	0.83	0.96	3.2
Abed	475	0.44	0.44	0.139	0.22	0.42	1.66
Tornbygaard	457	0.58	0.98	0.49	0.51	0.97	3.5
Geometric mean	-	0.51	0.46	0.40	0.41	0.64	2.6
Arithmetic mean	535	0.78	0.68	0.54	0.57	0.96	3.5
Neksø	550	0.27 A	0.46	0.52	0.44 A	0.72	2.40

Table 4.2.2.3.A. Analysis of variance of ln Bq ^{137}Cs m^{-3} precipitation, January-December 1988 (from Table 4.2.2.1.A)

Variation	SSD	f	s^2	v^2	P
Between months	11.924	5	2.385	14.313	> 99.95%
Between locations	39.222	9	4.358	26.157	> 99.95%
Remainder	7.497	45	0.167		

Table 4.2.2.4.A. Analysis of variance of ln Bq ^{137}Cs m^{-2} precipitation, January-December 1988 (from Table 4.2.2.2.A)

Variation	SSD	f	s^2	v^2	P
Between months	5.476	5	1.095	9.701	> 99.95%
Between locations	40.295	9	4.477	39.658	> 99.95%
Remainder	5.080	45	0.113		

Table 4.2.2.3.B. Analysis of variance of ln Bq ^{137}Cs m^{-3} precipitation, January-December 1989 (from Table 4.2.2.1.B)

Variation	SSD	f	s^2	v^2	P
Between months	7.263	4	1.816	6.315	> 99.5 %
Between locations	27.635	9	3.071	10.678	> 99.95%
Remainder	10.352	36	0.288		

Table 4.2.2.4.B. Analysis of variance of ln Bq ^{137}Cs m^{-2} precipitation, January-December 1989 (from Table 4.2.2.2.B)

Variation	SSD	f	s^2	v^2	P
Between months	1.436	4	0.359	2.220	-
Between locations	28.956	9	3.217	19.888	> 99.95%
Remainder	5.824	36	0.162		

Table 4.2.2.5.A. Radiocesium in precipitation collected in the 10 m² ion exchanger at Risø in 1988

Month	Bq ^{137}Cs m^{-2}	Bq ^{137}Cs m^{-3}	$\frac{^{134}Cs}{^{137}Cs}$	mm precipitation	Theoretical $^{134}Cs/^{137}Cs$ ratio
Jan	0.30	3.4	0.29	86	0.32
Feb	0.186	4.0	0.36	46	0.31
March	0.182	5.0	0.25	37	0.30
April	0.26	19.3	0.26	13.2	0.30
May	0.23	8.5	0.32	27	0.29
June	0.24	16.0	0.28	14.9	0.28
July	0.38	4.2	0.28	90	0.27
Aug	0.21	7.8	0.25	27	0.27
Sept	0.153	2.5	0.26	60	0.26
Oct	0.188	3.8	0.21	50	0.25
Nov	0.135	4.8	0.25	28	0.25
Dec	0.171	3.5	0.23	48	0.24
1988	Σ 2.6	$\bar{x}$: 5.0 (weighted mean)		Σ 528	

$\frac{134/137\ Obs}{134/137\ Pred}$ = 0.97 ± 0.10 S.D. 0.03 S.E. (n = 12)

Table 4.2.2.5.B. Radiocesium in precipitation collected in the 10 m² ion exchanger at Risø in 1989

Month	Bq ^{137}Cs m^{-2}	Bq ^{137}Cs m^{-3}	$\frac{^{134}Cs}{^{137}Cs}$	mm precipitation	Theoretical $^{134}Cs/^{137}Cs$ ratio
Jan	0.132	23	0.25	5.7	0.23
Feb	0.167	9.4	0.26	17.7	0.23
March	0.107	3.1	0.32	34	0.22
April	0.161	5.7	0.24	28	0.22
May	0.104	7.9	0.188	13.2	0.21
June	0.129	3.9	0.21	33	0.21
July	0.194	4.8	0.181	40	0.20
Aug	0.145	1.41	0.21	103	0.196
Sept	0.098	5.8	0.109 A	16.8	0.191
Oct	0.144	2.8	0.173	51	0.186
Nov	0.054	4.7	0.152 A	11.7	0.181
Dec	0.109	4.1	0.152 A	26	0.176
1989	Σ 1.54	$\bar{x}$: 4.1 (weighted mean)		Σ 381	

$\frac{134/137\ Obs}{134/137\ Theor}$ = 0.99 ± 0.21 S.D. 0.06 S.E. (n = 12)

Table 4.2.3.A. Tritium in precipitation collected at Risø in 1988

Month	mm precipitation	1 m² rain collector kBq m^{-3}	1 m² rain collector kBq m^{-2}	10 m² rain collector kBq m^{-3}	10 m² rain collector kBq m^{-2}
Jan	86	2.2±0.3	0.187	3.6±0.6	0.31
Feb	46	4.3±0.5	0.200	3.4±0.1	0.155
March	37	5.9±0.9	0.22	1.5±0.1	0.055
April	13.2	27 ±2.6	0.36	14.5±0.2	0.192
May	27	3.1±0.0	0.083	1.7±0.5	0.047
June	14.9	7.2±0.3	0.108	6.6±0.2	0.098
July	90	2.3±0.2	0.21	2.9±0.2	0.26
Aug	27	2.5±0.2	0.068	2.8±0.8	0.076
Sept	60	20.4±1.4	1.22	3.7±0.1	0.22
Oct	50	1.5±0.0	0.075	1.1±0.2	0.055
Nov	28	2.3±0.2	0.064	1.2±0.1	0.034
Dec	48	3.6±0.1	0.173	3.1±0.4*	0.149
1988	Σ 528	$\bar{x}$: 5.6 (weighted mean)	Σ 3.0	$\bar{x}$: 3.1 (weighted mean)	Σ 1.65

The error term is 1 S.E. of the mean of double determinations.
*Triple determinations.

Table 4.2.3.B. Tritium in precipitation collected at Risø in 1989

Month	mm precipitation	1 m² rain collector kBq m^{-3}	1 m² rain collector kBq m^{-2}	10 m² rain collector kBq m^{-3}	10 m² rain collector kBq m^{-2}
Jan	5.7	5.7±0.0	0.034	18.2±0.7	0.109
Feb	17.7	3.2±0.4	0.057	2.6±0.2	0.046
March	34	4.4±0.0	0.151	9.5±0.8	0.32
April	28	5.0±0.3	0.139	7.4±0.3	0.21
May	13.2	3.8±0.2	0.049	6.0±0.0	0.077
June	33	4.8±0.0	0.157	5.7±0.5	0.188
July	40	6.0±0.0	0.24	21 ±0.8	0.85
Aug	103	5.1±0.5	0.52	5.5±0.5	0.57
Sept	16.8	7.9±0.5	0.134	11.7±0.2	0.199
Oct	51	3.5±0.0	0.177	5.5±0.0	0.28
Nov	11.7	4.0±0.1	0.048	5.6±0.0	0.068
Dec	26	1.6±0.5	0.043	19.5±0.2	0.51
1989	Σ 380	$\bar{x}$: 4.6 (weighted mean)	Σ 1.75	$\bar{x}$: 9.0 (weighted mean)	Σ 3.4

The error term is 1 S.E. of the mean of double determinations.

Table 4.2.4.A. Tritium in precipitation collected in Denmark in 1988. (Unit: kBq m^{-3})

Date	Tylstrup	Jyndevad	Tornbygaard
January	2.5±0.3*	2.1±0.3	2.2±0.3
February	1.8±0.1	1.5±0.1	3.2±0.1
March	2.2±0.0	1.9±0.1	2.4±0.0
April	2.9±0.1	4.3±0.0	3.5±0.1
May	3.7±0.2	2.5±0.2	4.6±0.3
June	4.1±0.1	-	4.0±0.1
July	2.8±0.1	2.4±0.3	3.6±0.1
August	2.9±0.0	2.6±0.1	3.5±0.2
September	1.7±0.3	1.6±0.1	2.5±0.2
October	1.7±0.2	1.7±0.0	2.7±0.3
November	1.8±0.1	2.0±0.6	3.4±0.1
December	1.5±0.1	-	2.5±0.1
1988: Geometric mean	2.4	2.2	3.1
1988: Arithmetic mean	2.5	2.3	3.2

The error term is 1 S.E. of the mean of double determinations.
*Triple determinations

Table 4.2.4.B. Tritium in precipitation collected in Denmark in 1989. (Unit: kBq m^{-3})

Date	Tylstrup	Jyndevad	Tornbygaard
January	1.5±0.3	2.4±0.0	2.8±0.2
February	1.7±0.1	1.7±0.4	2.3±0.1
March	1.7±0.1	1.3±0.2	2.1±0.1
April	2.8±0.2	3.3±0.5	3.4±0.3
May	2.8±0.2	2.5±0.0*	-
June	3.7±0.1	2.9±0.4	3.0±0.5
July	3.0±0.0	2.7±0.3	2.8±0.3
August	2.4±0.1	2.1±0.2	3.0±0.4
September	2.3±0.2	2.4±0.3	2.5±0.1
October	1.4±0.1	1.4±0.2	2.2±0.1
November	-	1.5±0.1	2.4±0.3
December	1.6±0.2	1.6±0.1	1.8±0.2
1989: Geometric mean	2.2	2.1	2.5
1989: Arithmetic mean	2.3	2.2	2.6

The error term is 1 S.E. of the mean of triple determinations.
*The error term is 1 S.E. of the mean of double determinations.

Table 4.2.5. Precipitation collected by the waterworks of Odense in 1963-1976

Date			Bq ^{137}Cs m^{-3}	kBq ^{3}H m^{-3}	Measured* Bq ^{90}Sr m^{-3}
Sep	2,	1963	450	300 ±2	760
June	1,	1964	1100	250 ±3	1400
Feb	1,	1965	650	53 ±1	330
Oct	1,	1965	360	46 ±6	140
March	1,	1968	81	11.6±0.5	70
Oct	1,	1968	111	17.9±0.1	35
Dec	2,	1968	156	13.9±0.5	19
Sep	1,	1969	137	19.6±0.1	84
Aug	1,	1970	85	13.7±1.0	100
Aug	1,	1971	120	14.6±0.4	120
Sep	1,	1972	69	17.9±0.6	17
Aug	1,	1973	97	15.5±0.2	4.4
Oct	1,	1974	39	8.0±0.5	20
Sep	1,	1975	89	5.0±0.2	18
Nov	1,	1976	40	9.0±0.1	8

*Blangstedgård, Funen[1] (mean of neighbouring months).

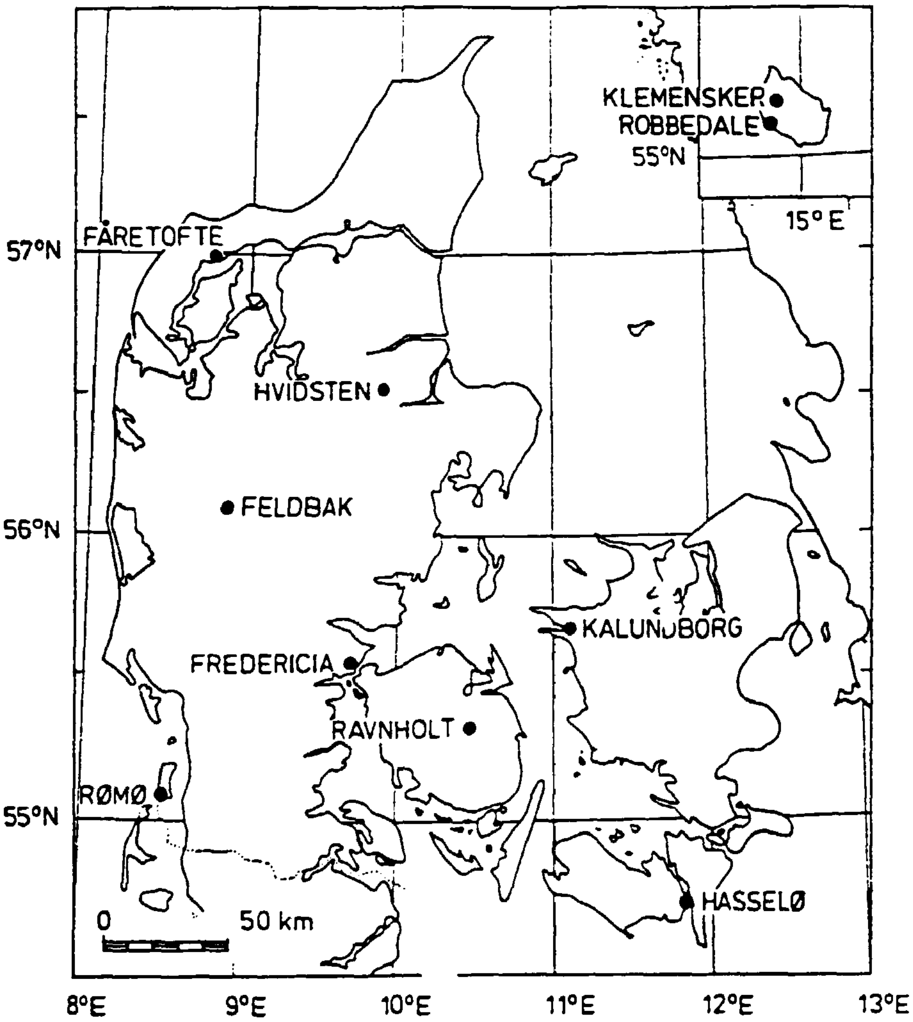


Fig. 4.3.1.1. Ground water sampling locations in Denmark.

Table 4.3.1.A. Radionuclides in ground water collected in 1988

Location	Date	Bq ^{90}Sr m^{-3}	kg Ca m^{-3}	kBq ^{3}H m^{-3}
Hvidsten	March	0.056	0.078	0.6±0.1
Feldbak	March	56	0.032	2.4±0.1
Rømø	March	0.054 A	0.033	0.6±0.1
Klemensker	May	0.047 A	0.024	0.6±0.0
Robbedale	May	0.119	0.0122	0.6±0.4
Hasselø	March	0.059	0.135	0.4±0.1
Fåretofte	March	0.124 A	0.139	5.0±0.0
Kalundborg	March	1.37	0.087	3.0±0.1
Ravnholt	March	0.079 A	0.143	4.1±0.0
Fredericia	March	0.29	0.072	2.1±0.0
Geometric mean		0.116*	0.058	1.3
Arithmetic mean		0.24 *	0.076	1.9
Median		0.099	0.075	1.4

A sample of ground water from Maglekilde in Roskilde contained 1.62 Bq ^{90}Sr m^{-3}, 4.8±0.1 kBq ^{3}H m^{-3}, and 0.22 kg Ca m^{-3}.

*Feldbak was not included in the geometric and arithmetic means.

The error term is 1 S.E. of the mean of double determinations.

Table 4.3.1.B. Radionuclides in ground water collected in 1989

Location	Date	Bq ^{90}Sr m^{-3}	kg Ca m^{-3}	kBq ^{3}H m^{-3}
Hvidsten	March	0.012 B	0.067	1.0±0.2
Feldbak	March	47	0.030	2.0±0.1
Rømø	March	0.087 A	0.034	0.5±0.1
Klemensker	May	0.015 B	0.029	0.5±0.1
Robbedale	May	0.033 A	0.0152	0.4±0.2
Hasselø	March	0.035	0.063	0.4±0.1
Fåretofte	March	0.024 A	0.061	2.5±0.3
Kalundborg	March	0.34	0.088	2.4±0.1
Ravnholt	March	0.093	0.137	4.1±0.6
Fredericia	March	0.45	0.074	1.8±0.3
Geometric mean		0.057*	0.050	1.1
Arithmetic mean		0.122*	0.060	1.6
Median		0.061	0.062	1.4

A sample of ground water from Maglekilde in Roskilde contained 1.33 Bq ^{90}Sr m^{-3}, 3.5±0.7 kBq ^{3}H m^{-3}, and 0.169 kg Ca m^{-3}.

*Feldbak was not included in the geometric and arithmetic means.

The error term is 1 S.E. of the mean of triple determinations.

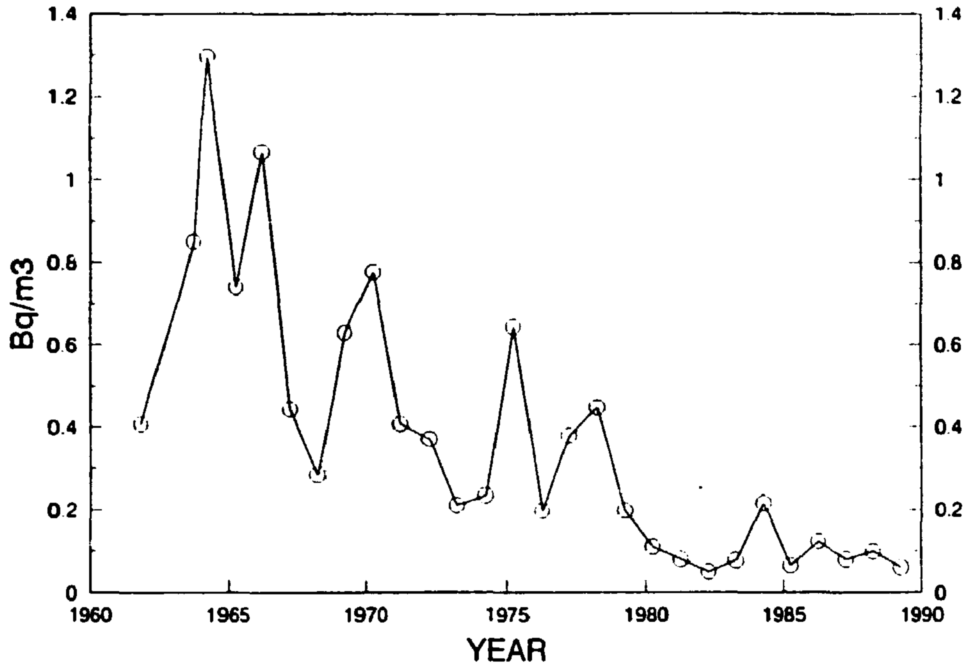
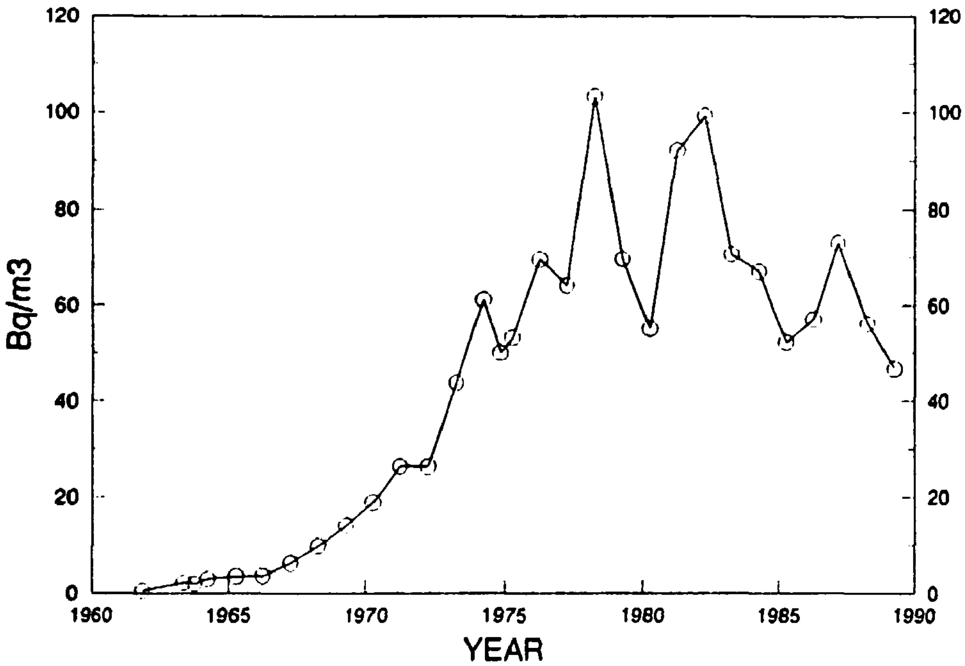


Fig. 4.3.1.2. Median ^{90}Sr levels in Danish ground water, 1961-1989.

Fig. 4.3.1.3. Strontium-90 in ground water at Feldbak 1961-1989.



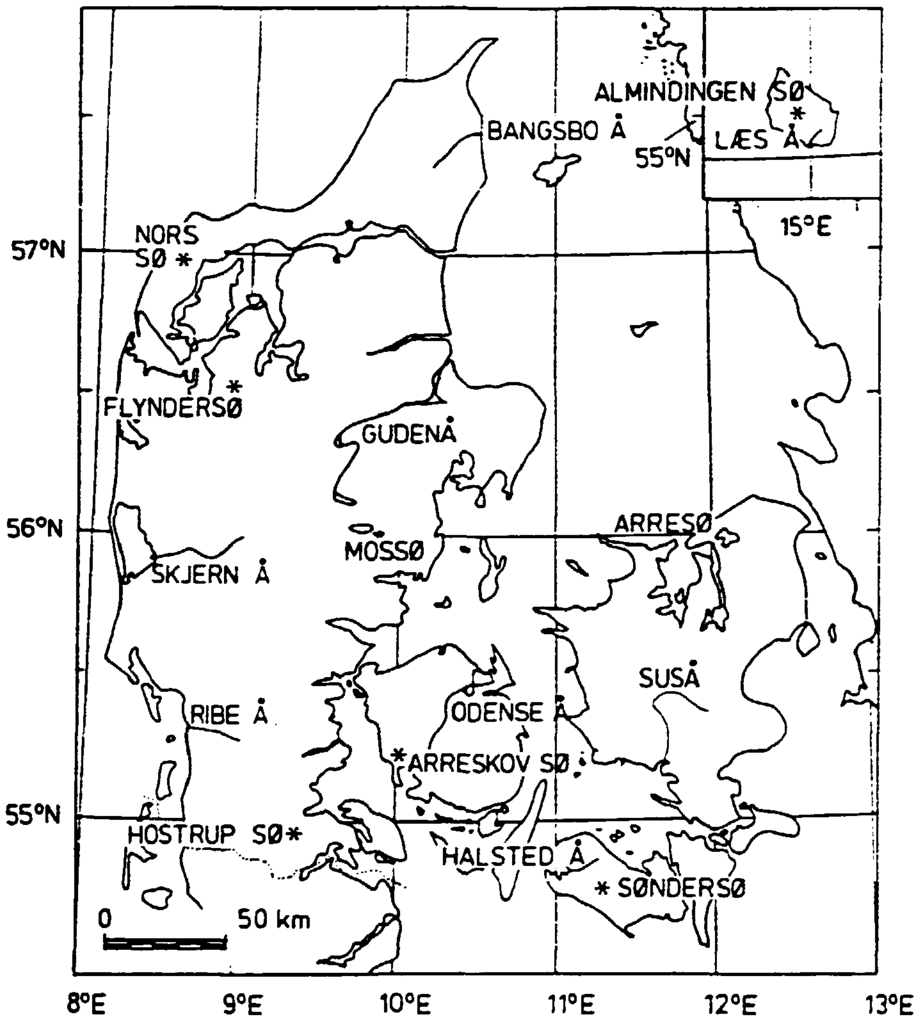


Fig. 4.3.2.1. Sample locations for fresh water from Danish streams (å) and lakes (sø).

Table 4.3.2.1.A. Radiocesium in Danish stream water collected in 1988

Stream	Date	Bq ^{137}Cs m^{-3}	$^{134}Cs/^{137}Cs$
Bangsbo å	Jan 20	2.2 A	
Gudenå	March 15	2.9	0.43 A
Skjern å	Jan 21	3.1	
Ribe å	March 14	2.1	
Odense å	March 16	3.6	0.44 A
Suså	March 18	2.0	0.54 A
Halsted å	March 10	1.25	
Læs å	May 24	0.50 B	
1988: Geometric mean		1.92	
S.E. (factor)		1.25	
1988: Arithmetic mean		2.2	
S.E.		16%	

Table 4.3.2.1.B. Strontium-90, Cesium-137 and Tritium in Danish stream water collected in March 1989

Stream	Bq ^{90}Sr m^{-3}	kg Ca m^{-3}	Bq ^{137}Cs m^{-3}	kBq ^{3}H m^{-3}
Bangsbo å	10.2	0.052	1.44 B	2.8 ± 0.1
Guden å	5.4	0.037	3.0 A	2.1 ± 0.2
Skjern å	9.3	0.034	1.40 A	2.2 ± 0.1
Ribe å	5.1	0.035	1.97 B	2.2 ± 0.1
Odense å	4.6	0.092	2.6 A	2.1 ± 0.3
Suså	4.8	0.084	1.65 B	2.5 ± 0.0
Halsted å	4.5	0.107	0.72 B	2.4 ± 0.2
Læs å (May)	10.5	0.098	0.77 B	3.1 ± 0.1
1989: Geometric mean	6.4	0.061	1.52	2.4
S.E. (factor)	1.14	1.19	1.20	1.05
1989: Arithmetic mean	6.8	0.067	1.69	2.4
S.E.	14%	16%	17%	5%

The error term is 1 S.E. of the mean of triple determinations.

Table 4.3.2.2.A. Radiocesium in Danish lake water collected in 1988

Lake	Date	Bq ^{137}Cs m^{-3}	$^{134}Cs/^{137}Cs$
Norssø	Jan 21	11.3	0.38 A
Mossø	March 15	3.7	
Flyndersø	March 16	12.6	0.29 A
Hostrupsø	March 9	12.1	0.35 A
Arreskovsø	March 9	4.0 A	
Arresø	March 8	16.3	0.34
Søndersø	July 10	10.9	
Almindingen sø	May 24	2.3	0.33 A
1988: Geometric mean		7.6	
S.E. (factor)		1.29	
1988: Arithmetic mean		9.2	
S.E.		20%	

Table 4.3.2.2.B. Strontium-90 and Radiocesium in Danish lake water collected in March 1989

Lake	Bq ^{90}Sr m^{-3}	kg Ca m^{-3}	Bq ^{137}Cs m^{-3}	$^{134}Cs/^{137}Cs$	kBq ^{3}H m^{-3}
Norssø	26	0.052	9.8	0.22 A	2.2 ± 0.1
Mossø	6.1	0.080	1.94 A		2.4 ± 0.2
Flyndersø	4.0	0.048	7.6	0.155 A	2.2 ± 0.1
Hostrupsø	19.7	0.040	12.8	0.199	2.3 ± 0.2
Arreskovsø	11.6	0.073	4.2		2.2 ± 0.3
Arresø	11.7	0.076	14.2	0.23	2.5 ± 0.4
Søndersø	12.2	0.083	9.7	0.22 A	2.4 ± 0.1
Almindingen sø (May)	21	0.034	1.40		3.1 ± 0.2
1989: Geometric mean	12.0	0.058	5.9		2.4
S.E. (factor)	1.25	1.13	1.36		1.04
1989: Arithmetic mean	14.0	0.061	7.7		2.4
S.E.	19%	11%	22%		4.4%

The error term is 1 S.E. of the mean of triple determinations.

Table 4.3.3.1.B. Strontium-90, Cesium-137 and Tritium in drinking water collected in June 1989

Zone		Bq ^{90}Sr m^{-3}	kg Ca m^{-3}	Bq ^{137}Cs m^{-3}	kBq ^{3}H m^{-3}
I:	N. Jutland	0.66	0.076		2.6 ± 0.2
II:	E. Jutland	0.058 A	0.090	0.116	2.1 ± 0.0
III:	W. Jutland	1.19	0.059		1.4 ± 0.4
IV:	S. Jutland	0.042	0.092		1.5 ± 0.0
V:	Funen	0.123	0.111		1.8 ± 0.2
VI:	Zealand	0.090	0.102	0.094*	1.9 ± 0.1
VII:	Lolland-Falster	0.067 A	0.093		0.9 ± 0.3
VIII:	Bornholm	0.40	0.088		1.8 ± 0.0
Geometric mean		0.165	0.088	0.105	1.7
Arithmetic mean		0.33	0.089	0.105	1.8
Median of zones		0.107	0.091		1.8
Copenhagen		0.25	0.123		1.9 ± 0.5

*Including Copenhagen

The error term is 1 S.E. of the mean of triple determinations.

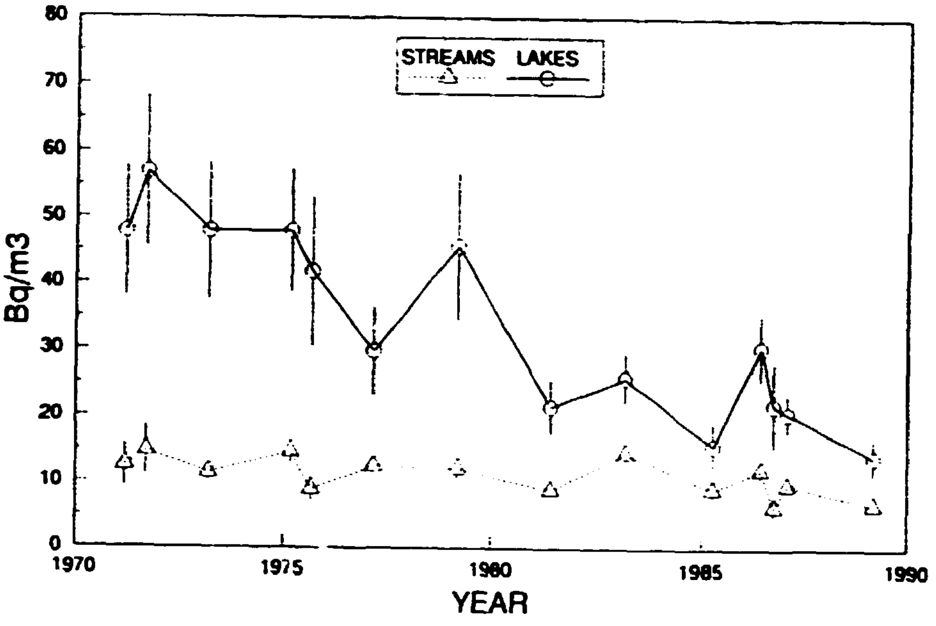


Fig. 4.3.2.2. Strontium-90 concentrations (±1 S.E.) in 8 Danish streams and 8 Danish lakes, collected since 1971.

Fig. 4.4.1. Strontium-90 in surface sea water from inner Danish waters, 1962-1989. (1 S.D. indicated) (from Tables 4.4.1.A and B and 4.4.2.A and B).

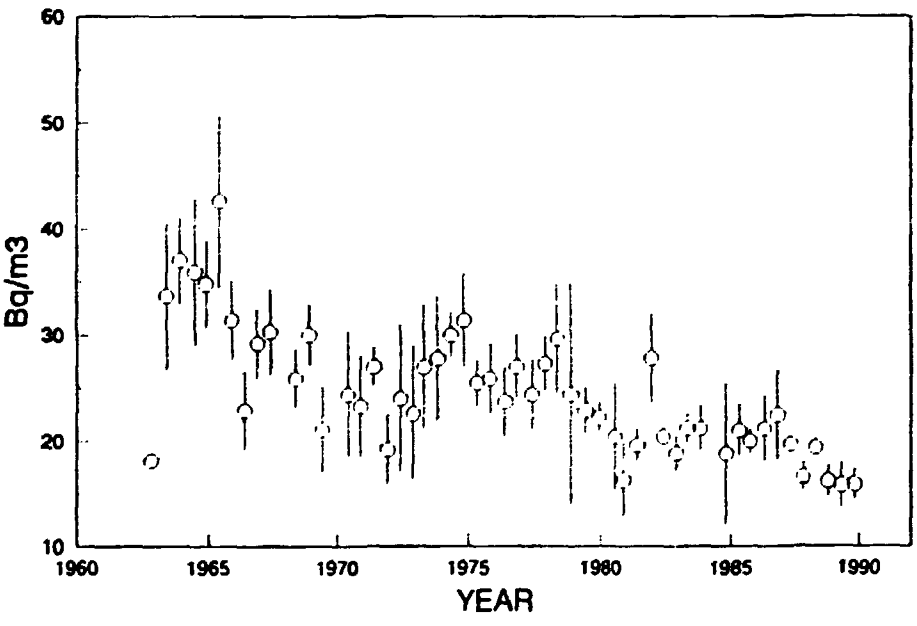


Table 4.4.1.A. Radionuclides in sea water collected around Zealand in May 1988

Location	Date in May	Position N	Position E	Depth in m	^{90}Sr Bq m^{-3}	^{137}Cs Bq m^{-3}	^{134}Cs / ^{137}Cs	^{3}H kBq m^{-3}	Salinity ‰	Chernobyl Bq ^{137}Cs m^{-3}
Kullen	23	56°15'	12°25'	2		80	0 24		15 4	65
-				20	13 2	41	0 136		33 6	20
Hesselø	23	56°10'	11°47'	2		79	0 24	3 9 ± 0 5	14 9	67
-				24	9 4	41	0 097	1 6 ± 0 2	33 7	14 3
Kattegat SW	30	56°07'	11°10'	2	18 4	79	0 25		14 0	70
-				37		39	0 094		33 2	13 2
Asnæs rev	29	55°40'	10°46'	2		92	0 26		11 9	86
- -				30		41	0 123		32 0	17 9
Halskov rev	29	55°23'	11°03'	2	19 6	94	0 26	5 7 ± 0 7	10 2	86
- -				25		50	0 179	3 0 ± 0 2	29 5	32
Langeland bælt	29	54°52'	10°50'	2		99	0 26		8 8	93
- -				21		52	0 179		27 9	33
Femern bælt	29	54°36'	11°04'	2		102	0 28		8 8	100
- -				28		76	0 24		17 7	66
Gedser odde	26	54°28'	11°59'	2		104	0 28		7 8	104
- -				17		96	0 26		10 9	89
Moen	26	54°57'	12°41'	2		105	0 29	5 7 ± 0 2	7 7	111
-				23		98	0 29	5 8 ± 0 3	9 0	100
The Sound - South	25	55°24'	12°37'	2	20 1	109	0 29		7 7	111
- - -				12		97	0 26		9 8	93
The Sound - North A	24	55°48'	12°45'	2		109	0 29		8 4	114
- - -				18		43	0 127		31 5	20
The Sound - North B	24	55°59'	12°42'	2		92	0 26		11 4	86
- - -				26		39	0 118		33 1	16 4
Mean				Surface	19 4	95	0 27	5 1	10 6	91
S D					0 9	11	0 02	1 0	2 9	17
S E					0 5	3	0 01	0 6	0 8	5
Mean				Bottom	11 3	59	0 175	3 5	25 2	43
S D					2 7	25	0 07	2 1	10 2	34
S E					1 9	7	0 02	1 2	2 9	10

The error term is 1 S E. of the mean of double determinations

Table 4.4.1.B. Radionuclides in sea water collected around Zealand in May 1989

Location	Date in May	Position N	Position E	Depth in m	^{90}Sr Bq m^{-3}	^{137}Cs Bq m^{-3}	^{134}Cs/^{137}Cs	^{99}Tc Bq m^{-3}	Salinity ‰	Chernobyl Bq ^{137}Cs m^{-3}
Kullen	20	56°15'	12°25'	2		77	0.21	0.79	12.2	76
"				20		25	0.052 B		33.3	6.2 B
Hesselø	20	56°10'	11°47'	2		69	0.167		16.8	55
"				22		26	B.D.L	1.43	33.0	B.D.L
Kattegat SW	17	56°07'	11°10'	2	17.3	69	0.185		16.3	61
"				36		26	0.060 B	1.58	33.0	7.3 B
Asnæs rev	17	55°40'	10°46'	2	12.5	72	0.184		16.2	63
" "				22		26	0.104 A	2.0	31.7	12.9 A
Halskov rev	17	55°23'	11°03'	2	16.2	80	0.22		14.6	81
" "				21	12.3	33	0.104 A		30.8	16.3 A
Langeland bælt	18	54°52'	10°50'	2		88	0.197		11.1	82
" "				32	11.1	18.4	0.155		28.6	13.5
Femern bælt	18	54°36'	11°04'	2		89	0.20		10.9	85
" "				24	13.6	61	0.180		12.9	52
Gedser odde	18	54°28'	11°59'	2		94	0.199		8.5	88
" "				15	16.7	90	0.20		20.4	84
Møen	18	54°57'	12°41'	2	17.0	95	0.21		8.8	95
"				21		89	0.199		11.3	84
The Sound - South	19	55°25'	12°37'	2		93	0.20		9.7	88
" " "				11	16.0	87	0.21		11.7	84
The Sound - North A	20	55°48'	12°44'	2		100	0.21		9.2	101
" " "				17	11.2	37	0.121		29.9	21
The Sound - North B	20	55°59'	12°42'	2		92	0.21		10.6	91
" " "				27		25	0.084 A		33.4	9.7 A
Mean				Surface	15.8	85	0.199	0.79	12.1	80
S.D.					2.2	11	0.015		3.1	14
S.E.					1.1	3	0.004		0.9	4
Mean				Bottom	13.5	45	0.134	1.67	25.8	36
S.D.					2.4	28	0.058	0.30	9.1	33
S.E.					1.0	8	0.017	0.17	2.6	10

Table 4.4.2.A. Radionuclides in sea water collected around Zealand in November-December 1988

Location	Date	Position N	Position E	Depth in m	^{90}Sr Bq m^{-3}	^{137}Cs Bq m^{-3}	$^{134}Cs/^{137}Cs$	^{3}H kBq m^{-3}	Salinity ‰	Chernobyl Bq ^{137}Cs m^{-3}
Kullen	Nov 30	56°15'	12°25'	2		51	0.20		24.4	42
-				22		51	0.185		24.7	38
Hesselø	Nov 30	56°10'	11°47'	2		49	0.21	2.4±0.1	25.4	42
-				24	6.7	37	0.151	1.9±0.1	30.6	23
Kattegat SW	Dec 8	56°07'	11°10'	2		64	0.20		20.8	53
-				27		43	0.176		27.6	31
Asnæs rev	Dec 7	55°39'	10°46'	2		60	0.194		21.8	48
- -				24		57	0.20		22.1	47
Halskov rev	Dec 7	55°23'	11°03'	2	15.1	64	0.24	4.5±0.5	18.9	63
- -				22		65	0.182	3.4±0.3	20.6	49
Langeland bælt	Dec 7	54°52'	10°50'	2		75	0.21		17.3	63
- -				17						
Femern bælt	Dec 7	54°36'	11°04'	2		76	0.22		16.0	69
- -				27		67	0.20		19.2	56
Gedser odde	Dec 7	54°28'	11°59'	2		85	0.21		11.4	74
- -				17		76	0.21		17.2	67
Møen	Dec 6	54°57'	12°41'	2	17.2	95	0.25	4.1±0.4	9.8	96
-				22		94	0.23	5.1±0.1	9.8	68
The Sound - South	Dec 6	55°25'	12°36'	2		99	0.24		9.1	96
- - -				12		96	0.23		9.2	89
The Sound - North A	Nov 30	55°48'	12°44'	2		66	0.21		18.9	57
- - -				20	12.0	55	0.176		24.5	40
The Sound - North B	Nov 30	55°59'	12°42'	2		54	0.178		23.5	40
- - -				29		51	0.190		25.3	39
Mean				Surface	16.2	70	0.21	3.7	18.1	62
S.D.					1.5	16	0.02	1.1	5.6	20
S.E.					1.0	5	0.01	0.6	1.6	6
Mean				Bottom	9.4	63	0.194	3.5	21.0	52
S.D.					3.7	19	0.02	1.6	6.8	22
S.E.					2.6	6	0.01	0.9	2.1	7

The error term is 1 S.E. of the mean of double determinations

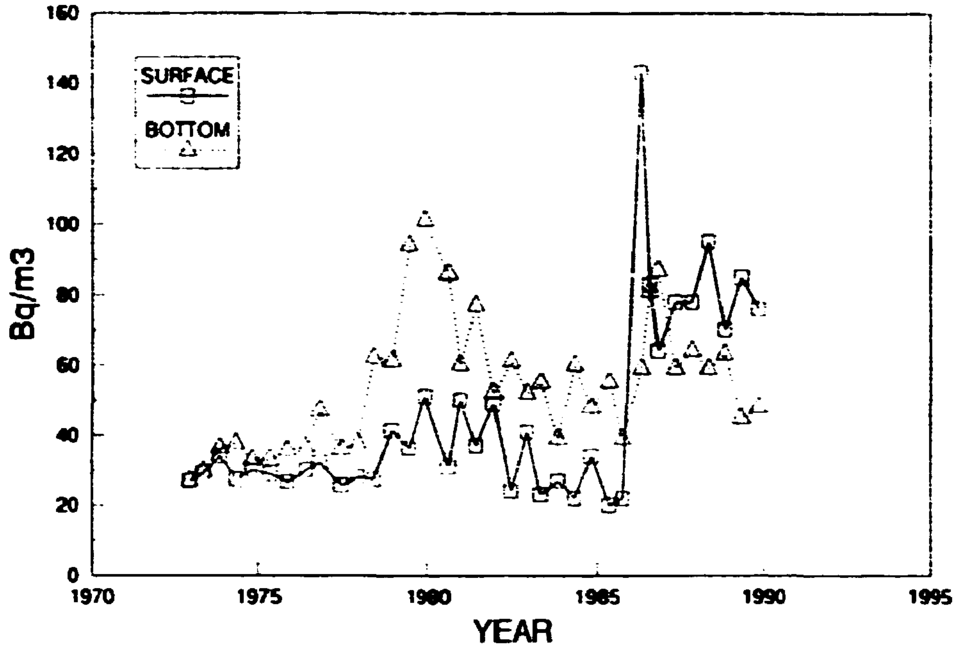


Fig. 4.4.2. Cesium-137 in surface and bottom water collected in inner Danish waters 1972-1989.

Table 4.4.2.B. Radionuclides in sea water collected around Zealand in November 1989

Location	Date in November	Position N	Position E	Depth in m	^{90}Sr Bq m^{-3}	^{137}Cs Bq m^{-3}	$^{134}Cs/^{137}Cs$	Salinity ‰	Chernobyl Bq ^{137}Cs m^{-3}
Kullen	17	56°15'	12°25'	2	14.5	66	0.178	17.7	65
-				20	10.9	42	0.153	25.2	36
Hesselø	13	56°10'	11°47'	2	55	0.149		21.4	45
-				22		22	0.022 B	33.2	2.6 B
Kattegat SW	13	56°07'	11°10'	2	74	0.165		17.5	67
-				34		23	0.119	32.8	15.0
Asnæs rev	13	55°39'	10°46'	2	67	0.172		17.6	63
- -				32		25	0.124 A	32.0	17.5 A
Halskov rev	13	55°23'	11°03'	2	15.9	70	0.187	15.4	72
- -				21		40	0.122	27.8	27
Langeland bælt	14	54°52'	10°50'	2		74	0.177	14.5	73
- -				29		37	0.131	28.4	27
Femern bælt	14	54°36'	11°04'	2	17.4	73	0.170	14.0	69
- -				22	13.0	51	0.155	22.4	44
Gedser odde	14	54°28'	11°59'	2	84	0.171		10.7	79
- -				16		71	0.182	13.9	71
Møen	14	54°57'	12°42'	2		100	0.178	8.8	98
-				21		93	0.171	8.9	88
The Sound - South	16	55°25'	12°37'	2		91	0.175	10.0	89
- - -				13		84	0.177	11.9	82
The Sound - North A	17	55°48'	12°44'	2	80	0.159		12.1	70
- - -				17		68	0.147	17.3	55
The Sound - North B	17	55°59'	12°42'	2		78	0.176	14.4	76
- - -				28		24	0.113	32.6	14.8
Mean				Surface	15.9	76	0.171	14.5	72
S.D.					1.5	12	0.010	3.7	13
S.E.					0.8	3	0.003	1.1	4
Mean				Bottom	12.0	48	0.135	23.9	40
S.D.					1.5	25	0.043	8.9	28
S.E.					1.1	7	0.012	2.6	8

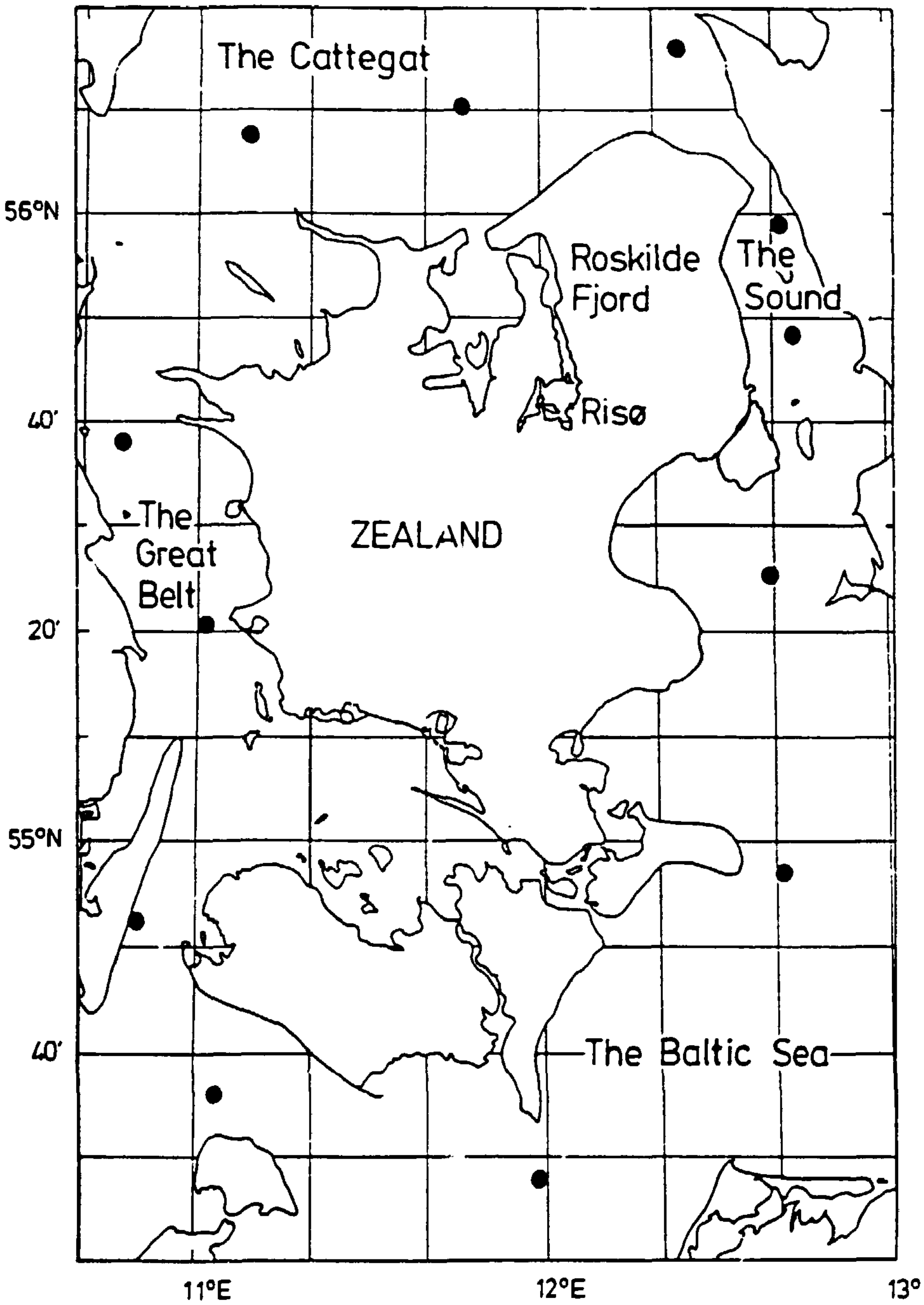


Fig. 4.4.3. Sea water locations around Zealand.

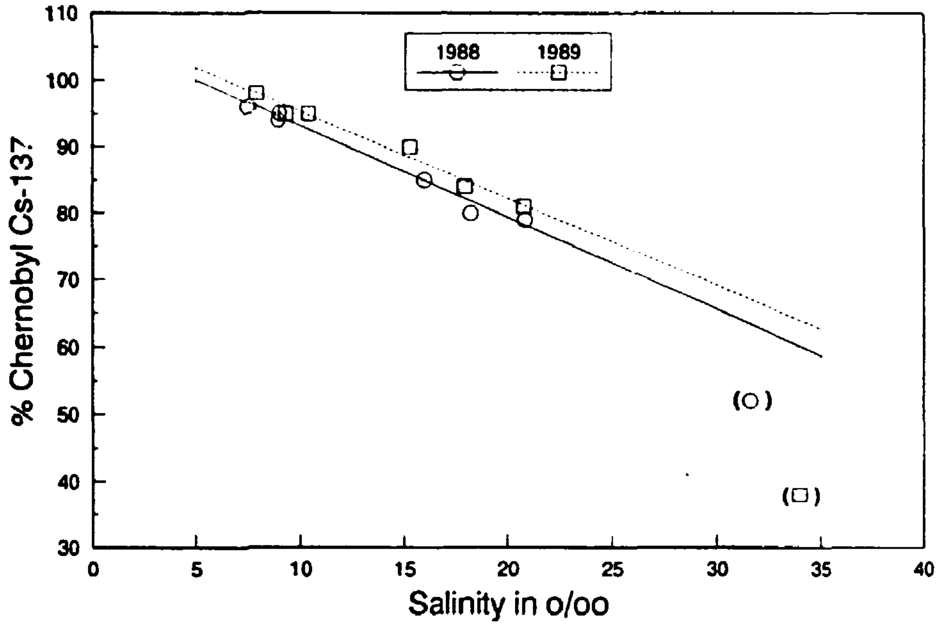


Fig. 4.4.4. Percentage of Cs-137 from Chernobyl related to salinity in sea water samples collected in inner Danish waters (figures in brackets collected in the North Sea) in 1988 and 1989 (monthly samples from 6 stations).

Table 4.4.3. Radionuclides in sea water collected in the Danish Straits, North Sea, and Baltic Sea in 1988 and 1989

Location/ cruise	Year	Date	Position N	Position E or W	Depth in m	^{90}Sr Bq m^{-3}	^{99}Tc Bq m^{-3}	^{137}Cs Bq m^{-3}	^{134}Cs/^{137}Cs	Chernobyl ^{137}Cs Bq m^{-3}	^{3}H kBq m^{-3}	Salinity ‰
Klintholm	1988	Jan 13	54°57'	12°28'E	0			85	0.31	82		9.5
"	"	Feb 15	"	"	0			91	0.29	86		9.9
"		March 14	"	"	0			92	0.30	91		9.0
"	"	Apr 14	"	"	0			104	0.30	104		8.3
"	"	May 17	"	"	0			104	0.26	95		7.8
"	"	June 13	"	"	0			93	0.27	89		8.0
"	"	July 14	"	"	0			97	0.26	91		7.8
"	"	Aug 16	"	"	0			97	0.25	91		9.4
"	"	Sep 19	"	"	0			95	0.24	89		9.0
"	"	Oct 14	"	"	0			95	0.26	98		9.2
"	"	Nov 17	"	"	0			89	0.16	60		9.6
"	"	Dec 17	"	"	0			91	0.22	85		9.9
% Chernobyl: 94 ± 9; n = 12 (± 1 S.D.)												
Klintholm	1989	Jan 13	54°57'	12°28'E	0			89	0.20	76		10.8
"	"	Feb 16	"	"	0			33	0.20	83		10.6
"	"	March 17	"	"	0			94	0.21	90		9.4
"	"	Apr 14	"	"	0			88	0.22	88		9.0
"	"	May 13	"	"	0			79	0.20	76		8.8
"	"	June 14	"	"	0			96	0.190	88		8.6
"	"	July 17	"	"	0			84	0.190	79		9.2
"	"	Aug 15	"	"	0			81	0.191	79		9.0
"	"	Sep 19	"	"	0			89	0.195	91		8.6
"	"	Oct 19	"	"	0			85	0.179	82		9.0
"	"	Nov 13	"	"	0			86	0.180	85		9.2
"	"	Dec 18	"	"	0			92	0.166	87		9.6
% Chernobyl: 95 ± 5; n = 12 (± 1 S.D.)												
Halskov	1988	Jan 14	55°21'	11°07'E	0			68	0.24	50	3.2 ± 0.5	17.0
"	"	Feb 16	"	"	0			78	0.25	63		13.3
"	"	March 15	"	"	0			71	0.23	53		19.7
"	"	Apr 13	"	"	0			73	0.24	59		16.9
"	"	May 17	"	"	0			95	0.27	88		8.2
"	"	June 14	"	"	0			86	0.26	80	4.8 ± 0.2	12.2
"	"	July 15	"	"	0			87	0.24	76	5.0 ± 0.0	11.8
"	"	Aug 15	"	"	0			82	0.25	77	3.5 ± 0.1	13.8
"	"	Sep 20	"	"	0			62	0.23	54		21.6
"	"	Oct 13	"	"	0			71	0.21	58		17.8
"	"	Nov 16	"	"	0			70	0.21	61	3.5 ± 0.1	19.2
"	"	Dec 21	"	"	0			66	0.20	56		19.8
% Chernobyl: 85 ± 7; n = 12 (± 1 S.D.)												

Table 4.4.3. (continued)

Location/ cruise	Year	Date	Position N	Position E or W	Depth in m	^{90}Sr Bq m^{-3}	^{99}Tc Bq m^{-3}	^{137}Cs Bq m^{-3}	$^{134}Cs/^{137}Cs$	Chernobyl ^{137}Cs Bq m^{-3}	^{3}H kBq m^{-3}	Salinity ‰
Halskov	1989	Jan 12	55°21'	11°07'E	0			65	0.20	56		19.8
"	"	Feb 15	"	"	0			64	0.196	55		17.6
"	"	March 16	"	"	0			81	0.22	79		11.1
"	"	Apr 13	"	"	0			72	0.196	65		10.3
"	"	May 13	"	"	0			68	0.180	58		16.3
"	"	June 13	"	"	0			80	0.191	74		11.0
"	"	July 18	"	"	0			66	0.185	61		(16.2)
"	"	Aug 14	"	"	0			75	0.181	70		14.9
"	"	Sep 18	"	"	0			75	0.186	73		12.9
"	"	Oct 18	"	"	0			64	0.132	45		19.8
"	"	Nov 13	"	"	0			72	0.173	68		15.9
"	"	Dec 19	"	"	0			64	0.161	58		17.4
% Chernobyl: 90 ± 7; n = 12 (± 1 S.D.)												
Klint	1988	Jan 14	55°58'	11°35'E	0		0.76	57	0.22	39		23.2
"	"	Feb 16	"	"	0		0.79	63	0.22	43		18.6
"	"	March 15	"	"	0		0.42	66	0.26	56		19.0
"	"	Apr 13	"	"	0		0.67	76	0.25	64		14.1
"	"	May 16	"	"	0		0.50	78	0.23	62		15.6
"	"	June 14	"	"	0		0.41	81	0.24	69		15.4
"	"	July 15	"	"	0		0.85	76	0.22	61		14.1
"	"	Aug 15	"	"	0			63	0.22	52		17.9
"	"	Sep 20	"	"	0		0.46	73	0.22	62		18.1
"	"	Oct 13	"	"	0		0.64 ± 0.04					
"	"	Nov 16	"	"	0		0.63	61	0.194	48		21.1
"	"	Dec 18	"	"	0		0.74	53	0.21	46		23.0
% Chernobyl: 80 ± 6; n = 11 (± 1 S.D.)												
Klint	1989	Jan 12	55°58'	11°35'E	0		1.00	45	0.171	33		24.3
"	"	Feb 15	"	"	0		0.69	46	0.154	31		23.9
"	"	March 16	"	"	0		1.00	64	0.194	56		14.8
"	"	Apr 13	"	"	0		0.51	73	0.169	57		14.1
"	"	May 12	"	"	0		0.65	75	0.191	67		15.4
"	"	June 13	"	"	0		0.77	68	0.192	63		15.7
"	"	July 18	"	"	0		1.00	79	0.191	75		8.8
"	"	Aug 14	"	"	0		0.66	63	0.170	55		17.4
"	"	Sep 18	"	"	0		0.39	63	0.168	56		17.4
"	"	Oct 18	"	"	0		0.51	58	0.154	48		20.0
"	"	Nov 13	"	"	0		0.48	61	0.157	53		19.6
"	"	Dec 19	"	"	0		0.44	47	0.136	36		23.8
% Chernobyl: 84 ± 8; n = 12 (± 1 S.D.)												

Table 4.4.3. (continued)

Location/ cruise	Year	Date	Position N	Position E or W	Depth in m	^{90}Sr Bq m^{-3}	^{99}Tc Bq m^{-3}	^{137}Cs Bq m^{-3}	^{134}Cs/^{137}Cs	Chernobyl ^{137}Cs Bq m^{-3}	^{3}H kBq m^{-3}	Salinity ‰
Lund	1988	Jan 13	55°15'	12°18'E	0			68	0.27	58		10.2
fishing	"	Feb 15	"	"	0			80	0.29	75		10.7
port	"	March 14	"	"	0			82	0.28	75		8.5
"	"	Apr 14	"	"	0		0.097 A	95	0.29	92		8.3
"	"	May 16	"	"	0			96	0.28	92		7.9
"	"	June 13	"	"	0			105	0.26	97		7.8
"	"	July 14	"	"	0			86	0.26	81		7.6
"	"	Aug 16	"	"	0			92	0.26	90		9.4
"	"	Sep 19	"	"	0			84	0.25	81		9.5
"	"	Oct 14	"	"	0			83	0.24	79		10.4
"	"	Nov 17	"	"	0			90	0.24	87		10.0
"	"	Dec 17	"	"	0			61	0.24	61		8.0
% Chernobyl: 95±4; n = 12 (±1 S.D.)												
Lund	1989	Jan 13	55°15'	12°18'E	0			75	0.20	65		10.4
fishing	"	Feb 16	"	"	0			76	0.20	67		13.2
port	"	March 17	"	"	0			79	0.20	71		10.2
"	"	Apr 14	"	"	0			69	0.20	64		16.2
"	"	May 13	"	"	0			76	0.21	75		8.9
"	"	June 14	"	"	0			84	0.20	82		8.5
"	"	July 17	"	"	0			82	0.196	80		9.4
"	"	Aug 15	"	"	0			85	0.167	72		10.0
"	"	Sep 19	"	"	0			79	0.20	83		9.0
"	"	Oct 19	"	"	0			89	0.180	86		9.2
"	"	Nov 13	"	"	0			86	0.182	87		10.5
"	"	Dec 18	"	"	0			77	0.168	74		9.2
% Chernobyl: 95±6; n = 12 (±1 S.D.)												
Svenskehavn	1988	Jan 17	55°05'	15°09'E	0			102	0.33	104		7.2
(Bornholm)	"	Feb 14	"	"	0			104	0.29	98		7.0
"	"	March 15	"	"	0			120	0.29	114		7.2
"	"	Apr 17	"	"	0			106	0.28	100		7.5
"	"	May 15	"	"	0			114	0.28	111		7.6
"	"	June 19	"	"	0	22		104	0.27	99		7.6
"	"	July 17	"	"	0			106	0.28	107		7.5
"	"	Aug 14	"	"	0			98	0.26	96		7.6
"	"	Sep 18	"	"	0			106	0.23	92		7.4
"	"	Oct 16	"	"	0			102	0.24	98		7.7
"	"	Nov 19	"	"	0			100	0.23	93		7.8
% Chernobyl: 96±4; n = 11 (±1 S.D.)												

Table 4.4.3. (continued)

Location/ cruise	Year	Date	Position N	E or W	Depth in m	^{90}Sr Bq m^{-3}	^{99}Tc Bq m^{-3}	^{137}Cs Bq m^{-3}	^{134}Cs/^{137}Cs	Chernobyl ^{137}Cs Bq m^{-3}	^{3}H kBq m^{-3}	Salinity ‰
Svenskehavn	1989	Jan 1	55°05'	15°09'E	0			96	0.22	91		7.9
(Bornholm)	″	Feb 4	″	″	0			103	0.22	100		7.5
″	″	March 5	″	″	0			97	0.22	95		7.9
″	″	Apr 2	″	″	0			92	0.23	95		8.1
″	″	May 1	″	″	0			98	0.21	97		7.8
″	″	June 4	″	″	0		0.178 A	92	0.21	94		8.0
″	″	July 2	″	″	0			95	0.20	95		8.0
″	″	Aug 1	″	″	0			98	0.179	88		7.9
″	″	Sep 3	″	″	0			91	0.189	85		7.9
″	″	Sep 30	″	″	0			90	0.174	83		7.9
″	″	Oct 31	″	″	0			100	0.189	103		7.8
″	″	Dec 2	″	″	0	19.0		91	0.179	91		7.7

% Chernobyl: 98 ± 4; n = 12 (± 1 S.D.)

Location/ cruise	Year	Date	Position N	E or W	Depth in m	^{90}Sr Bq m^{-3}	^{99}Tc Bq m^{-3}	^{137}Cs Bq m^{-3}	^{134}Cs/^{137}Cs	Chernobyl ^{137}Cs Bq m^{-3}	^{3}H kBq m^{-3}	Salinity ‰
Hesselo	1988	May 23	56°13'	12°05'E	2			77	0.25	67		14.5
″	″	May 23	″	″	24			37	0.120	15.5		33.6
″	″	Nov 30	″	″	2			54	0.185	41		24.2
″	″	Nov 30	″	″	24			47	0.177	34		26.0
″	″	June 7	56°12'	11°42'E	2	18.6		75	0.24	65	4.1 ± 0.1	15.7
″	1989	May 9	56°12'	11°43'E	2			71	0.187	62		16.8
″	″	Oct 30	″	″	2			51	0.146	41		23.1
″	″	May 20	56°13'	12°05'E	2		0.52	59	0.181	50		17.4
″	″	May 20	″	″	22			22	0.076 A	7.7 A		32.8
″	″	Nov 17	″	″	2			60	0.170	56		19.9
″	″	Nov 17	″	″	22			26	0.104	14.7		31.6
Læso	1988	June 8	57°18'	10°56'E	2			68	0.24	59		17.4
″	″	June 9	57°19'	11°07'E	2			71	0.22	56		18.2
″	″	Dec 16	″	″	2	8.8	0.22	34	0.151	21		30.4
″	1989	May 11	57°18'	10°56'E	0	13.6		50	0.164	40		24.0
″	″	Nov 1	″	″	0			35	0.125	24		31.9
″	″	May 11	57°19'	11°07'E	2		0.79	49	0.164	38		22.6
″	″	Nov 2	57°19'	11°08'E	2			37	0.126	25		27.2
Anholt	1988	June 9	56°43'	11°31'E	2	16.5		76	0.24	65		15.2
″	1989	Nov 3	″	″	2	12.8		52	0.150	43		22.8
Møn-Stevns	1988	May 26	55°11'	12°37'E	2			112	0.30	114	4.4 ± 0.4*	7.8
″	″	May 26	″	″	23			77	0.25	68	2.4 ± 0.5*	19.9
″	″	Dec 6	55°11'	12°36'E	2			99	0.23	96		8.8
″	″	Dec 6	″	″	23			90	0.22	83		10.8
″	1989	May 19	″	″	2	19.5		99	0.21	98		8.4
″	″	May 19	″	″	22			94	0.20	90		11.2
″	″	Nov 14	″	″	2	19.0		87	0.168	81		9.3
″	″	Nov 14	″	″	22	18.5		89	0.172	85		9.9
Gedser-Møn	1988	May 26	54°42'	12°21'E	2			104	0.28	100		8.5
″	″	May 26	″	″	16	18.6		86	0.26	76		13.5
″	″	Dec 6	″	″	2			96	0.22	89		10.1
″	″	Dec 6	″	″	16			88	0.22	82		11.4

Table 4.4.3. (continued)

Location/ cruise	Year	Date	Position N	E or W	Depth in m	^{90}Sr Bq m^{-3}	^{99}Tc Bq m^{-3}	^{137}Cs Bq m^{-3}	^{134}Cs / ^{137}Cs	Chernobyl ^{137}Cs Bq m^{-3}	^{3}H kBq m^{-3}	Salinity ‰
Gedser-Møn	1989	May 18	54°42'	12°21'E	2	17.5		96	0.21	94		9.7
"	"	May 18	"	"	15	19.7		84	0.177	70		13.5
"	"	Nov 14	"	"	2			95	0.173	91		9.4
"	"	Nov 14	"	"	16			86	0.177	84		9.4
Barsebäck	1988	May 25	55°43'	12°52'E	2			103	0.28	100		8.1
"	"	May 25	"	"	11			45	0.143	22	2.1±0.1*	30.8
"	"	Dec 1	"	"	2			90	0.22	82	4.1±0.4	12.4
"	"	Dec 1	"	"	22			54	0.188	41	3.5±0.1	24.2
"	1989	May 20	55°46'	12°53'E	2			96	0.20	92		9.3
"	"	May 20	"	"	18			28	0.084 A	11 A		31.5
"	"	Nov 17	"	"	2			78	0.172	74		11.8
"	"	Nov 17	"	"	22			33	0.118	22		31.9
Ringhals	1988	June 8	57°15'	12°04'E	2	20		60	0.24	52	7.0±0.1	19.2
"	"	June 8	"	"	14			41	0.179	26	2.7±0.4	29.6
"	"	Dec 15	57°15'	12°03'E	2			36	0.143	22		27.6
"	"	Dec 15	"	"	23			30	0.127	15.9		31.8
"	1989	May 12	57°15'	12°03'E	2			63	0.178	53		17.6
"	"	May 12	"	"	23			27	0.113 A	14.3 A		32.3
"	"	Oct 31	57°15'	12°04'E	2			49	0.154	41		22.6
"	"	Oct 31	"	"	24			43	0.135	31		25.0
Ringhals▲	1988	Jan 1	(57°16'	12°06'E)	0			55	0.23	40	2.2±0.4	24.0
(location 98)	"	Feb 1	"	"	0			58	0.23	42	2.2±0.1	19.0
"	"	March 1	"	"	0			48	0.21	33	2.7±0.2	26.5
"	"	March 21	"	"	0			62	0.24	50	6.4±0.4	18.4
"	"	May 2	"	"	0			61	0.24	49	3.6±0.1	19.8
"	"	June 1	"	"	0			70	0.27	66	4.2±0.3	17.1
"	"	June 30	"	"	0			69	0.24	61	2.2±0.5	17.1
"	"	Aug 1	"	"	0			69	0.21	54	3.8±0.3	18.4
"	"	Aug 31	"	"	0			63	0.21	50	4.2±0.4	19.0
"	"	Sep 29	"	"	0			56	0.188	41		23.1
"	"	Nov 1	"	"	0			61	0.22	54	4.0±0.3	20.9
"	"	Nov 30	"	"	0			42	0.181	31		26.8
% Chernobyl: 79±8; n = 12 (± 1 S.D.)												
Ringhals▲	1989	Jan 2	(57°16'	12°06'E)	0			44	0.170	31		23.6
(location 98)	"	Feb 1	"	"	0			56	0.191	46		20.6
"	"	March 1	"	"	0			52	0.172	40		20.9
"	"	March 30	"	"	0			49	0.190	43		17.3
"	"	May 1	"	"	0			57	0.181	48		18.2
"	"	June 1	"	"	0			63	0.169	51		17.9
"	"	June 29	"	"	0			64	0.186	58		18.1
"	"	July 31	"	"	0			62	0.157	49		17.3
"	"	Aug 31	"	"	0			56	0.173	50		22.1
"	"	Oct 2	"	"	0			52	0.151	42		22.9

Table 4.4.3. (continued)

Location/ cruise	Year	Date	Position N	E or W	Depth in m	^{90}Sr Bq m^{-3}	^{99}Tc Bq m^{-3}	^{137}Cs Bq m^{-3}	^{134}Cs/^{137}Cs	Chernobyl ^{137}Cs Bq m^{-3}	^{3}H kBq m^{-3}	Salinity ‰
Ringhals♣	1989	Nov 1	(57°16'	12°06'E)	0			46	0.149	38		22.8
(location 98)	"	Nov 30	"	"	0			35	0.119	24		27.6
% Chernobyl: 81 ± 7; n = 12 (± 1 S.D.)												
Skagerak/	1988	Jan 28	57°35'	09°25'E	0		2.1	23	0.159 A	11.3 A		30.6
Dana 1	"	Jan 28	57°30'	08°42'E	0		1.96	26	0.126	10.3		32.7
North Sea/	1988	Feb 1	54°14'	08°00'E	0		4.3	11.2	0.136 A	4.8 A		32.1
Dana 1	"	Feb 17	56°47'	07°08'E	0		0.59	41	0.155	20		34.3
North Sea/	1988	April 17	59°11'	04°07'E	0			44	0.134	19.9		32.0
Dana 4	"	April 18	62°06'	00°25'E	0	2.2		7.5				35.0
"	"	April 22	61°22'	06°33'W	0	3.4		7.4	0.22 A	5.3 A		34.6
"	"	April 24	59°27'	00°01'W	0		0.186					34.2
"	"	April 25	58°33'	04°00'E	0			30				33.6
"	"	April 25	58°21'	04°59'E	0		0.83					33.2
"	"	April 25	57°58'	06°32'E	0			36	0.166	20.0		32.8
"	"	April 25	57°39'	09°31'E	0		0.89					30.5
North Sea/	1988	May 15	55°22'	07°35'E	0		2.7	12.6	0.23	9.9		30.2
Dana 5	"	May 15	55°41'	07°33'E	0		1.33	25	0.106 B	9.1 B		33.8
"	"	May 15	56°42'	07°35'E	0		1.10	39	0.098 A	13.1 A		34.0
"	"	May 15	54°33'	07°42'E	0		2.7	15.7				31.4
"	"	May 15	54°16'	07°36'E	0			12.2	0.21	9.0		29.6
Skagerak/	1988	May 15	57°10'	08°25'E	0		2.6	9.8				32.7
Dana 5	"	May 15	57°47'	10°36'E	0		1.15	42	0.122 A	17.6 A		29.0
Cattegat/ Dana 5	1988	May 15	57°14'	11°18'E	0		1.47	28	0.134	13.1		32.4
Baltic Sea/	1989	Feb	55°38'	19°59'E	0			97	0.22	92		7.6
Dana	"	Feb	55°02'	13°42'E	0			96	0.22	90		8.7
North Sea/	1989	Feb 20	57°43'	05°12'E	0			11.5	0.122 A	6.1 A		29.9
Dana	"	Feb 2	56°57'	07°15'E	0			27	0.056 A	6.7 A		34.7
"	"	Feb 3	57°09'	06°14'E	0			13.4	0.105 A	6.1 A		35.0
"	"	Feb 3	56°33'	06°53'E	0			27	0.058 A	6.7 A		34.8
"	"	Feb 5	54°58'	08°03'E	0	12.7		10.6				30.3
"	"	Feb 7	54°52'	07°12'E	0			11.8	0.092 A	4.7 A		33.9
"	"	Feb 8	53°56'	05°21'E	0			28	0.067 A	8.1 A		34.6
"	"	Feb 8	54°14'	05°28'E	0			16.2	0.079 A	5.6 A		34.7
"	"	Feb 11	55°09'	00°17'E	0			21.5	0.054 B	5.1 B		34.9
"	"	Feb 17	55°16'	06°36'E	0	16.7		12.7	0.100 A	5.6 A		34.1
"	"	Feb 17	55°20'	07°13'E	0			10.7	0.132 A	6.1 A		33.0
North Sea/	1988	Jan 12	53°42'	06°00'E	0		5.3					34.0
Gauss	"	Jan 12	54°14'	08°23'E	0		3.1					26.4
"	"	Jan 12	54°15'	07°30'E	0		3.7					32.6
"	"	Jan 13	55°00'	08°00'E	0		2.6					31.3
"	"	Jan 13	55°00'	06°00'E	0		0.95					34.4

Table 4.4.3. (continued)

Location/ cruise	Year	Date	Position N	Position E or W	Depth in m	^{90}Sr $Bq\ m^{-3}$	^{99}Tc $Bq\ m^{-3}$	^{137}Cs $Bq\ m^{-3}$	$^{134}Cs/^{137}Cs$	Chernobyl ^{137}Cs $Bq\ m^{-3}$	^{3}H $kBq\ m^{-3}$	Salinity ‰
North Sea/	1988	Jan 15	51°31'	03°00'E	0		4.4					34.3
Gauss	″	Jan 15	52°01'	04°00'E	0		4.0					30.4
″	″	Jan 15	52°30'	04°00'E	0		5.3					33.8
″	″	Jan 16	53°00'	04°30'E	0		4.8					31.6
″	″	Jan 13	53°56'	07°24'E	0		5.1					30.9
Channel/	1988	Jan 16	51°02'	01°31'E	0		4.7					35.0
Gauss	″	Jan 16	50°30'	00°00'E	0		11.1					35.1
″	″	Jan 17	50°14'	01°29'W	0		0.38					35.3
″	″	Jan 17	50°04'	04°09'W	0		0.165					35.2
″	″	Jan 20	51°00'	06°00'W	0		0.094					35.2
Irish Sea/	1988	Jan 21	52°30'	06°00'W	0		0.122					34.7
Gauss	″	Jan 22	54°30'	05°10'W	0		3.0					33.8
″	″	Jan 23	54°24'	03°46'W	0		28 ± 1.5					31.2
″	″	Jan 23	54°00'	04°00'W	0		5.0					33.8
″	″	Jan 23	53°30'	04°00'W	0		2.2					33.7
″	″	Jan 27	55°30'	06°30'W	0		2.5					33.7
North Sea/	1988	Jan 28	58°00'	06°00'W	0		0.82					34.4
Gauss	″	Jan 30	58°45'	03°30'W	0		0.71 ± 0.1					34.6
″	″	Jan 31	58°00'	01°59'E	0		0.48					34.7
″	″	Feb 2	57°37'	01°24'E	0		0.46					34.6
Borkumriff	1988	Oct 2	53°48'	06°22'E	0		1.78					33.8
(Lightship)	″	Oct 30	″	″	0		3.3					33.4
″	″	Nov 26	″	″	0		4.0					33.5
″	″	Dec 30	″	″	0		4.4					33.6
″	1989	Jan 28	″	″	0		1.68					33.6
″	″	March 7	″	″	0		1.64					33.4
″	″	March 31	″	″	0		3.6					34.0
″	″	April 30	″	″	0		2.3					33.8
″	″	June 3	″	″	0		2.0					32.8
″	″	June 27	″	″	0		2.0					32.5
″	″	July 28	″	″	0		1.71					32.9
″	″	Aug 25	″	″	0		1.85					8.6
″	″	Oct 3	″	″	0		1.62					9.0
″	″	Nov 3	″	″	0		2.4					9.6
″	″	Dec 1	″	″	0		2.4					22.9
″	″	Dec 25	″	″	0		1.90					22.9
Elbe I	1988	Oct 31	(54°00'	08°07'E)	0		2.2					32.8
(Lightship)	″	Nov 29	″	″	0		1.97					32.0
″	1989	March 28	″	″	0		2.8					30.7
″	″	May 2	″	″	0		2.1					28.2
″	″	May 16	″	″	0		2.3					-
″	″	July 10	″	″	0		2.1					32.0
″	″	Sep 3	″	″	0		1.34					17.5
″	″	Sep 29	″	″	0		1.35					7.9
″	″	Oct 3	″	″	0		1.58					32.2
″	″	Nov 27	″	″	0		1.80					31.9

Table 4.4.3. (continued)

Location/ cruise	Year	Date	Position N	E or W	Depth in m	^{90}Sr Bq m^{-3}	^{99}Tc Bq m^{-3}	^{137}Cs Bq m^{-3}	^{134}Cs/^{137}Cs	Chernobyl ^{137}Cs Bq m^{-3}	^{3}H kBq m^{-3}	Salinity ‰
St 413/DMU	1989	Feb 7	56°40'	12°07'E	0		1.42					27.6
"	"	Feb 7	"	"	25		1.42					32.4
"	"	March 15	"	"	5		0.60					18.4
"	"	March 15	"	"	51		0.98					32.5
"	"	April 25	"	"	5		0.55					16.6
"	"	April 25	"	"	30		1.08					33.8
"	"	May 30	"	"	5		0.73					17.0
"	"	May 30	"	"	40		0.96					34.1
"	"	July 11	"	"	5		0.44					16.7
"	"	July 11	"	"	40		0.79					33.6
"	"	Aug 15	"	"	5		0.45					16.1
"	"	Aug 15	"	"	35		0.75					33.1
"	"	Sep 19	"	"	5		0.49					19.2
"	"	Sep 19	"	"	40		0.51					32.7
"	"	Oct 10	"	"	5		0.43					20.8
"	"	Oct 10	"	"	13		0.098					25.1
"	"	Nov 7	"	"	5		0.48					22.5
"	"	Nov 7	"	"	37		0.31					33.5
St 925/DMU	1989	Feb 14	56°08'	11°10'E	5		0.78					23.7
"	"	Feb 14	"	"	25		1.62					28.5
"	"	March 14	"	"	5		0.48					14.3
"	"	March 14	"	"	38		1.09					29.1
"	"	April 26	"	"	5		0.34					13.9
"	"	May 31	"	"	5		0.62					16.7
"	"	May 31	"	"	30		1.53					31.1
"	"	July 12	"	"	5		0.46					15.8
"	"	July 12	"	"	35		0.95					31.7
"	"	Aug 22	"	"	5		0.70					18.6
"	"	Aug 22	"	"	30		0.91					29.2
"	"	Oct 11	"	"	5		0.52					21.7
"	"	Oct 11	"	"	30		0.57					29.8
"	"	Nov 9	"	"	5		0.39					19.7
"	"	Nov 9	"	"	31		0.38					32.4
St 444/DMU	1989	Feb 16	55°00'	13°18'E	0		0.32					9.8
"	"	March 13	"	"	5		0.21					8.2
"	"	April 28	"	"	5		0.25					-
"	"	June 2	"	"	5		0.23					8.3
"	"	June 2	"	"	30		0.29					9.5
"	"	July 10	"	"	5		0.103					8.2
"	"	Aug 24	"	"	5		0.25					8.4
"	"	Sep 21	"	"	5		0.39					8.3
"	"	Oct 12	"	"			0.082 A					8.4
St 1013/DMU	1989	Feb 6	57°37'	09°55'E	5		2.1					32.3
St 1005/DMU	1989	Feb 8	57°48'	10°52'E	0		0.097 A					31.7
St 1004/DMU	1989	Feb 8	57°51'	09°34'E	5		0.60					34.0
St GF6/DMU	1989	Feb 8	57°32'	11°20'E	20		1.53					32.6

Table 4.4.3. (continued)

Location/ cruise	Year	Date	Position N	Position E or W	Depth in m	^{90}Sr Bq m^{-3}	^{99}Tc Bq m^{-3}	^{137}Cs Bq m^{-3}	^{134}Cs/^{137}Cs	Chernobyl ^{137}Cs Bq m^{-3}	^{3}H kBq m^{-3}	Salinity ‰
St. 905/DMU	1989	Feb 7	57°12'	11°40'E	4		1.04					31.0
"	"	Feb 7	"	"	40		1.11					33.2
St. 1019/DMU	1989	Feb 9	57°08'	08°35'E	5		2.1					30.7
St. 1022/DMU	1989	Feb 9	56°39'	08°08'E	5		2.3					29.9
St. 1024/DMU	1989	Feb 9	56°39'	07°24'E	5		0.94					34.5
St. 1027/DMU	1989	Feb 9	56°39'	06°18'E	5		0.56					34.8
St. 1041/DMU	1989	Feb 10	55°44'	08°00'E	5		2.5					29.2
St. 1043/DMU	1989	Feb 10	55°44'	07°24'E	5		2.4					31.8
St. 1046/DMU	1989	Feb 10	55°44'	06°18'E	5		2.6					34.7
St. 1059/DMU	1989	Feb 11	55°00'	08°16'E	5		0.79					27.9
St. 1061/DMU	1989	Feb 11	55°00'	07°36'E	5		3.0					33.3
St. 1064/DMU	1989	Feb 11	55°00'	06°27'E	5		1.47					34.6
St. 1131/DMU	1989	Feb 9	57°19'	08°30'E	5		0.86					34.6
St. 105/DMU	1989	March 7	55°15'	15°59'E	5		0.104					8.0
"	"	March 7	"	"	80		0.54					14.8
Bolund	1988	Aug 17	55°42'	12°05'E	0			49	0.193	35		11.8
"	1989	May 31	"	"	0			46	0.153	34		14.8
Risø	1989	Aug 1	55°42'	12°05'E	0			52	spiked			15.2

The error term is 1 S.E. of the mean of double determinationations

*Triple determinations.

▲Cf. Fig. 3.2.1.2

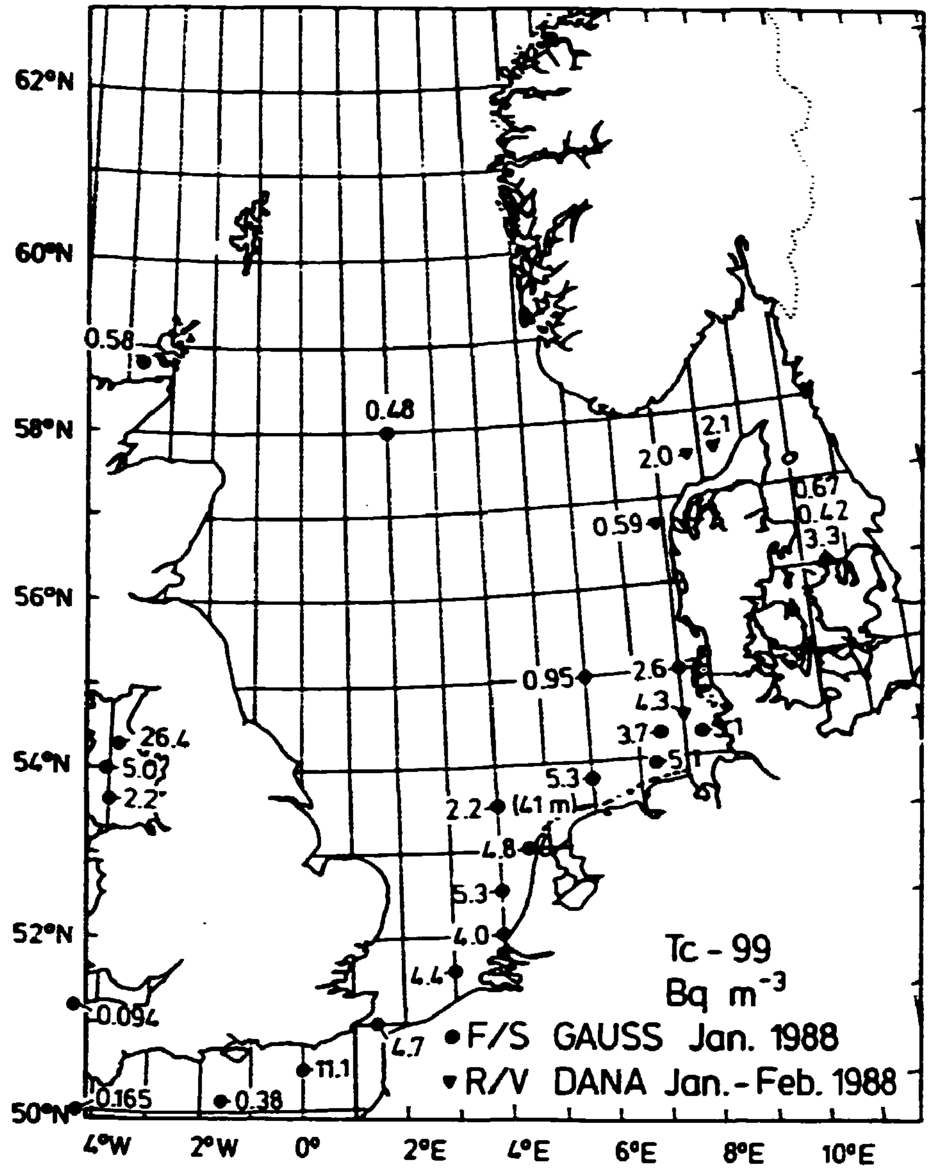


Fig. 4.4.5. Technetium-99 in surface sea water collected in January-February 1988. (Unit: Bq m^{-3}).

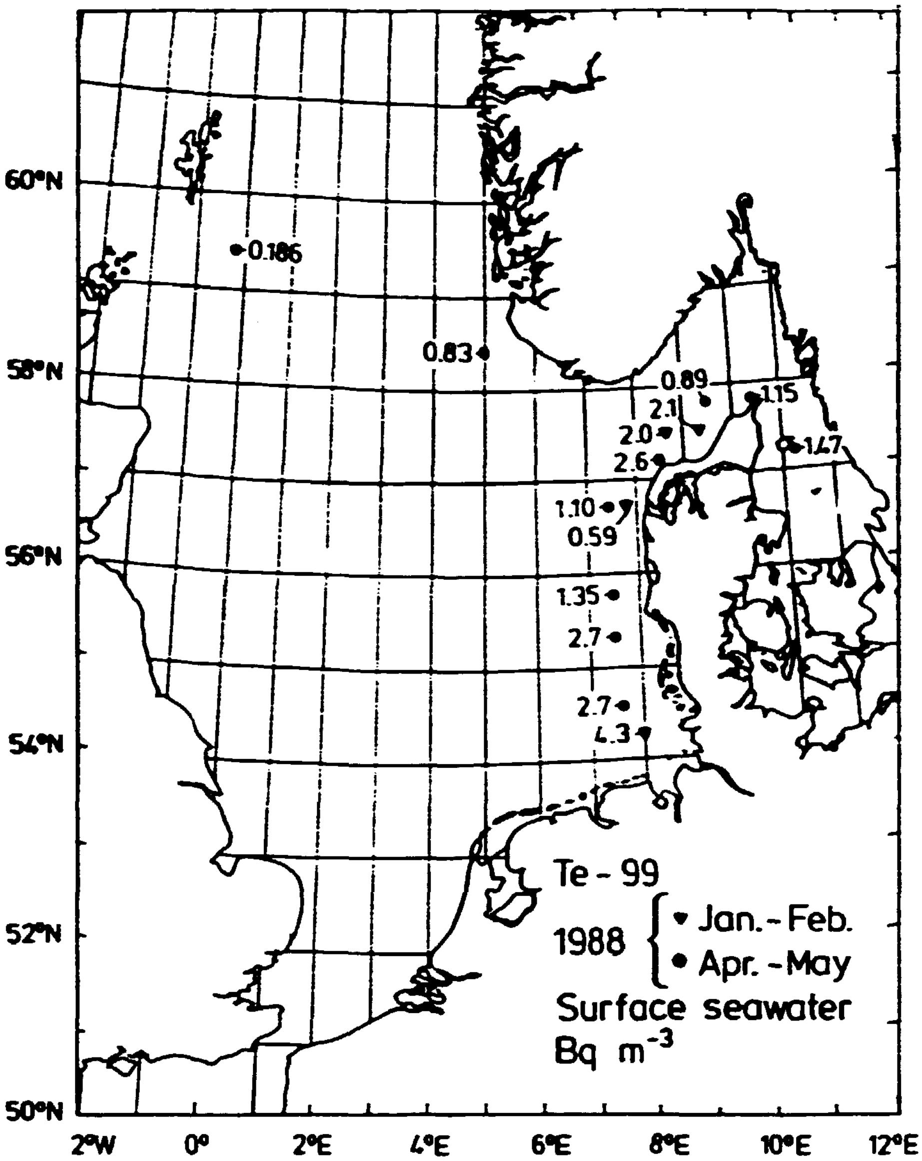


Fig. 4.4.6. Technetium-99 in surface sea water collected in 1988. (Unit: Bq m^{-3}).

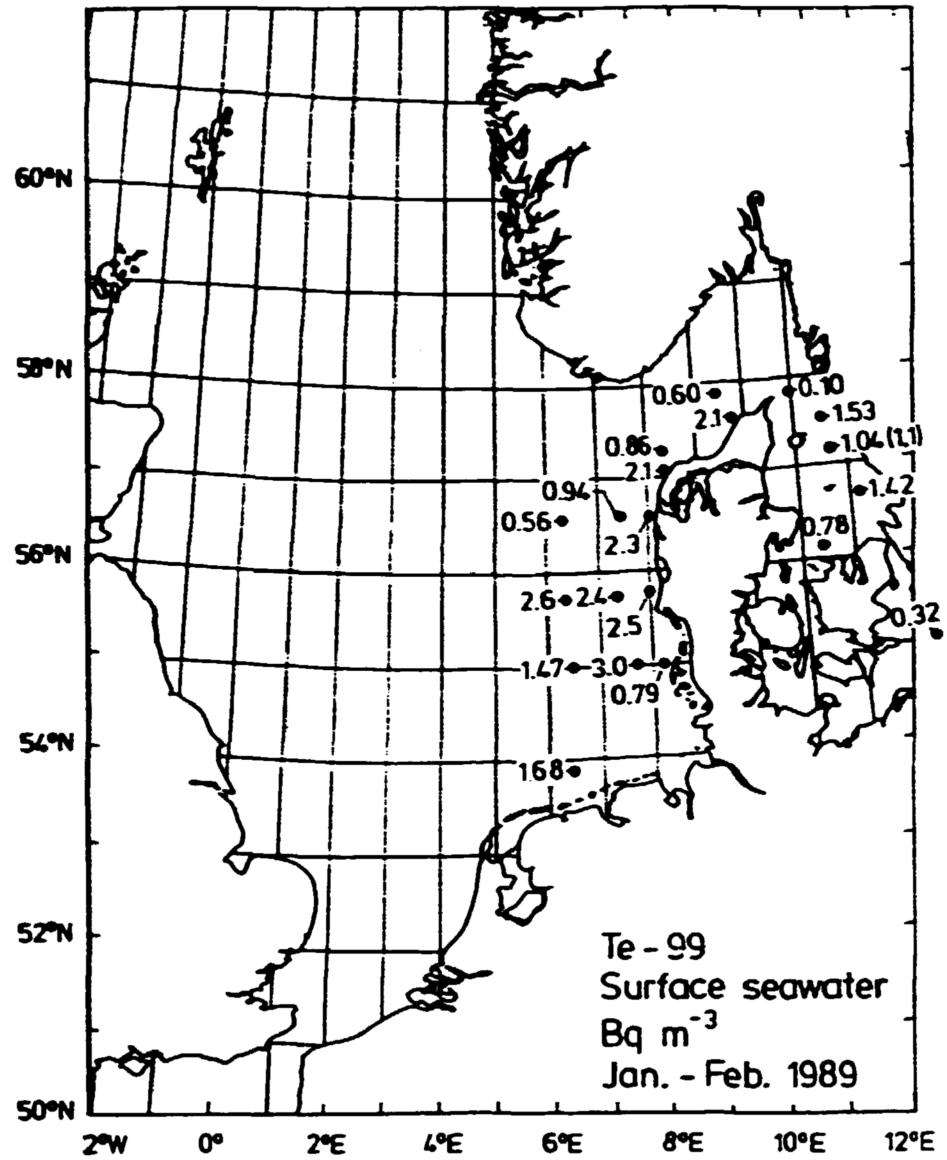


Fig. 4.4.7. Technetium-99 in surface sea water collected in January-February 1989. (Unit: Bq m^{-3}).

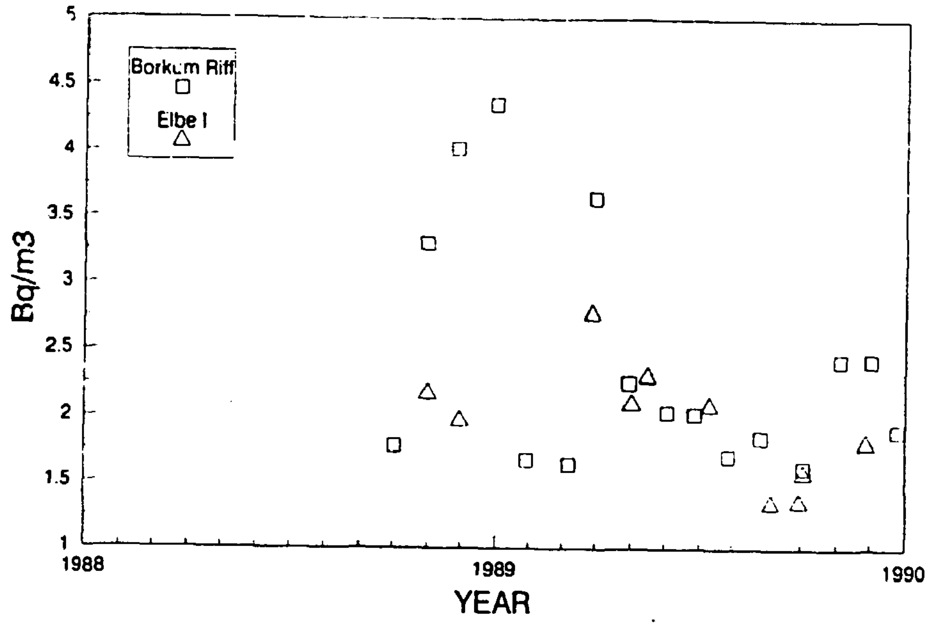
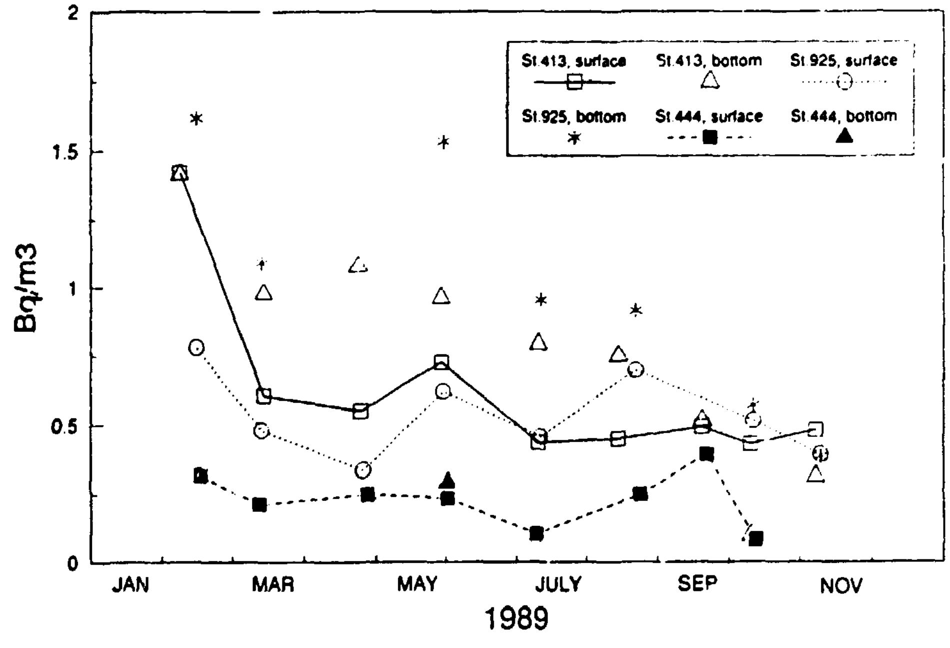


Fig. 4.4.8. Technetium-99 in surface sea water from the German Bight 1988-1989. (Unit: Bq m^{-3}).
Borkum Riff: 53°48'N, 06°22'E and Elbe I: 54°00'N, 08°07'E.

Fig. 4.4.9. Technetium-99 in sea water collected in 1989. (Unit: Bq m^{-3}).
St. 413/DMU: 56°40'N, 12°07'E
St. 925/DMU: 56°08'N, 11°10'E
St. 444/DMU: 55°00'N, 13°08'E



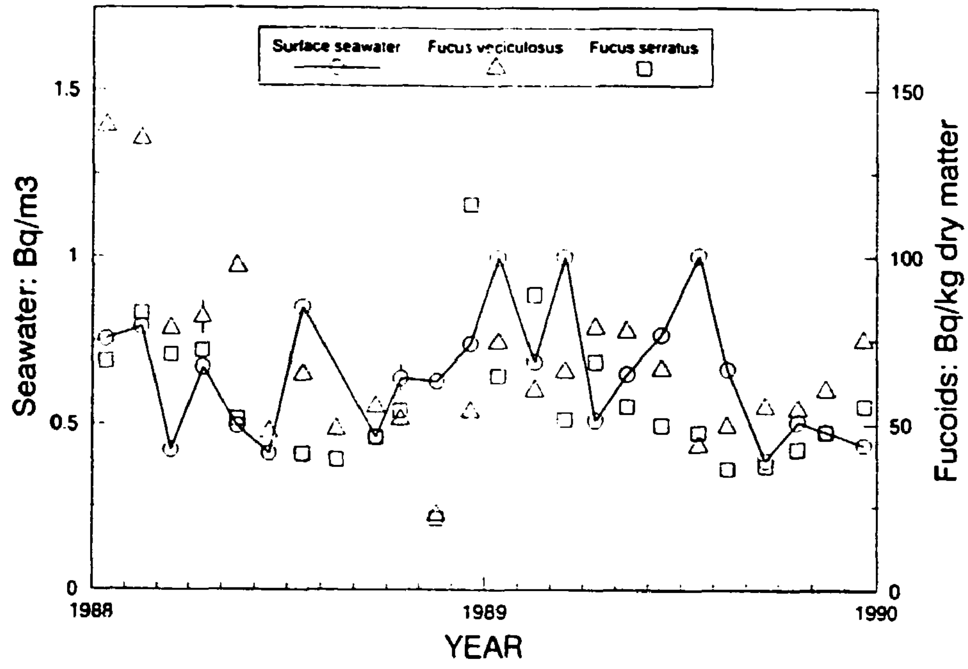


Fig. 4.4.10. Technetium-99 in sea water and Fucoids from the shore at Klint: 55°58'N, 11°35'E in 1988-1989.

Fig. 4.5.1. Mean ^{137}Cs deposition (global fallout only) (± 1 S.E.) in Danish uncultivated soils (0-30 cm layer) collected at Tylstrup, Askov, St. Jyndevad, Tystofte, Ledreborg and Abed in 1975, 1987 and 1989, compared with the theoretical decay of ^{137}Cs since 1975 ($t^{1/2}$ = 30.5 y).

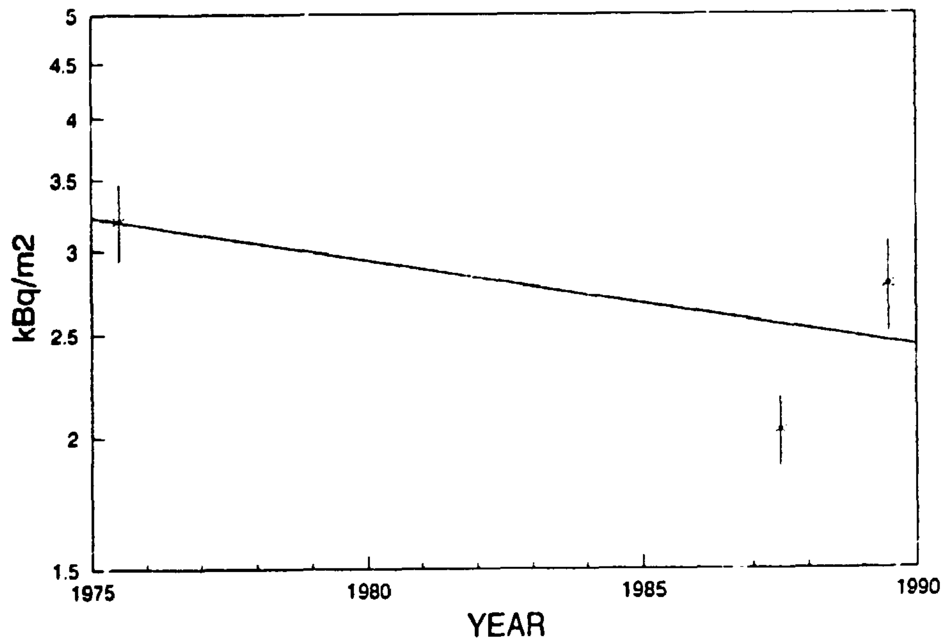


Table 4.5.1. Radiocesium in uncultivated soil collected in South-Jutland October, 18, 1988. (Unit: Bq m^{-2}). ($^{134}Cs/^{137}Cs$)

Location		I	II			Σ	Chernobyl ^{137}Cs*				
		0-5 cm	0-5 cm	0-10 cm	10-20 cm	0-20 cm	I 0-5 cm	II 0-5 cm	0-10 cm	10-20 cm	Σ 0-20 cm
Hokkerup	untreated	3816	2605	4023	1470	5473	3599	2255	3031	-	3031
		(0.239)	(0.220)	(0.191)							
"	treated	3825	2685	3588	1426	5014	3551	1628	2723	113	2836
		(0.236)	(0.154)	(0.193)	(0.020)						
Sønder Vilstrup	untreated	1507	1543	2135	745	2880	1052	1376	1439	-	1439
		(0.177)	(0.226)	(0.171)							
"	treated	1451	1501	2026	667	2693	1143	1243	1298	-	1298
		(0.200)	(0.210)	(0.163)							
Gabol	untreated	2162	1972	4909	1382	6291	1675	1596	3366	257 A	3623
		(0.197)	(0.205)	(0.174)	(0.047 A)						
"	treated	1894	1953	4604	1300	5904	1557	1475	3151	222	3373
		(0.209)	(0.192)	(0.174)	(0.043)						
Rangstrup	untreated	1088	775	1763	1850	3613	812	544 A	800	749	1549
		(0.189)	(0.178 A)	(0.115)	(0.103)						
"	treated	997	732	1842	1865	3707	626	279	848	808	1656
		(0.159)	(0.096)	(0.117)	(0.110)						
Styding	untreated	2226	2011	2941	960	3901	2018	1778	2286	-	2286
		(0.230)	(0.224)	(0.197)							
"	treated	2124	1905	2622	898	3520	1738	1549	1869	-	1869
		(0.208)	(0.206)	(0.181)							
Mean	untreated	2160	1781	3154	1281	4432	1831	1510	2184	201	2399
Relative S.D.	untreated	48%	38%	42%	34%	32%	60%	42%	49%	162%	40%
Mean	treated	2058	1755	2936	1231	4168	1723	1235	1978	229	2206
Relative S.D.	treated	52%	41%	39%	38%	31%	64%	45%	4[illegible]%	147%	39%

*Calculated from $^{134}Cs/^{137}Cs$ assuming that this ratio was 0.55 in pure Chernobyl debris on April 26, 1986.

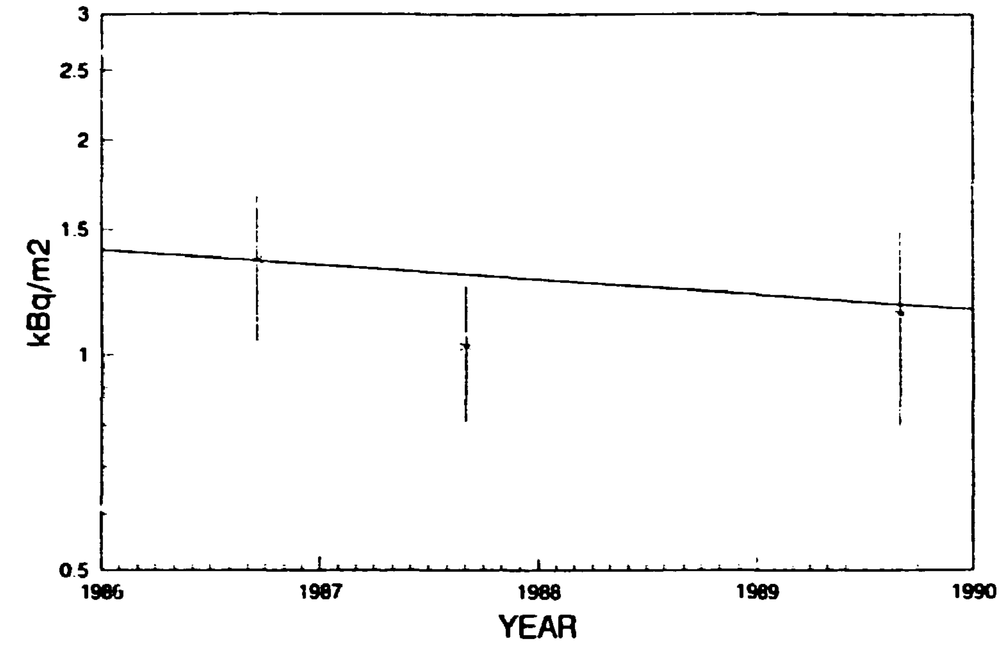
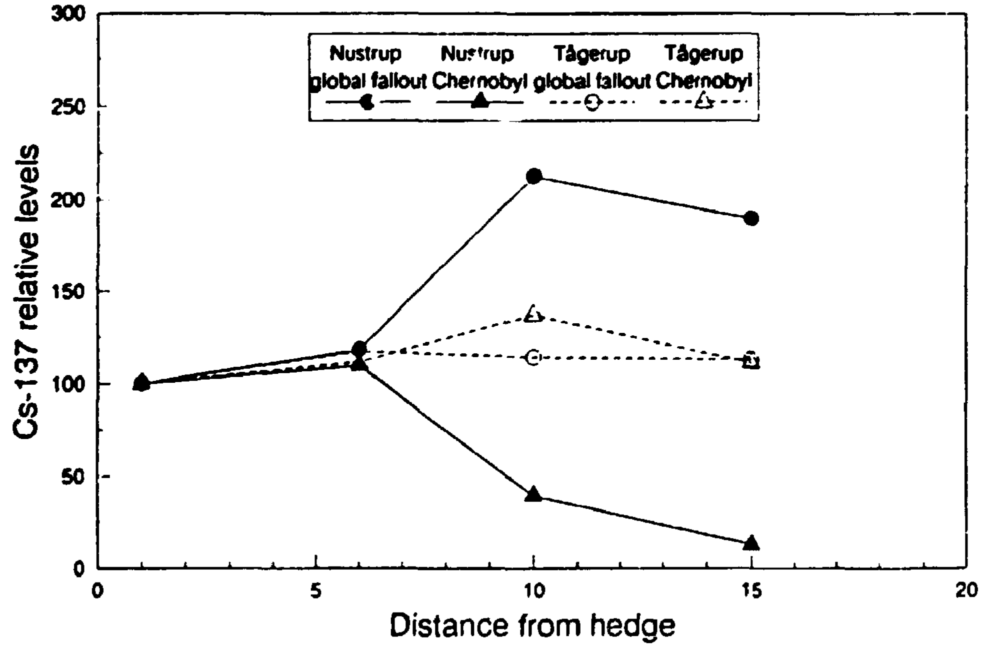


Fig. 4.5.2. Chernobyl ^{137}Cs (±1 S.E.) in Danish uncultivated soil collected at the 10 State experimental farms 1986, 1987 and 1989, compared with the theoretical decay of ^{137}Cs since September 1986 ($t\frac{1}{2}$ = 30.5 yr).

Fig. 4.5.3. The relative deposition of ^{137}Cs (Bq m^{-2}) in the 0-5 cm soil layer at Nustrup in S-Jutland and Tågerup in Zealand from global fallout and from Chernobyl in 1989, as a function of distance from the hedge. The distance is given in units of the height of the hedge.



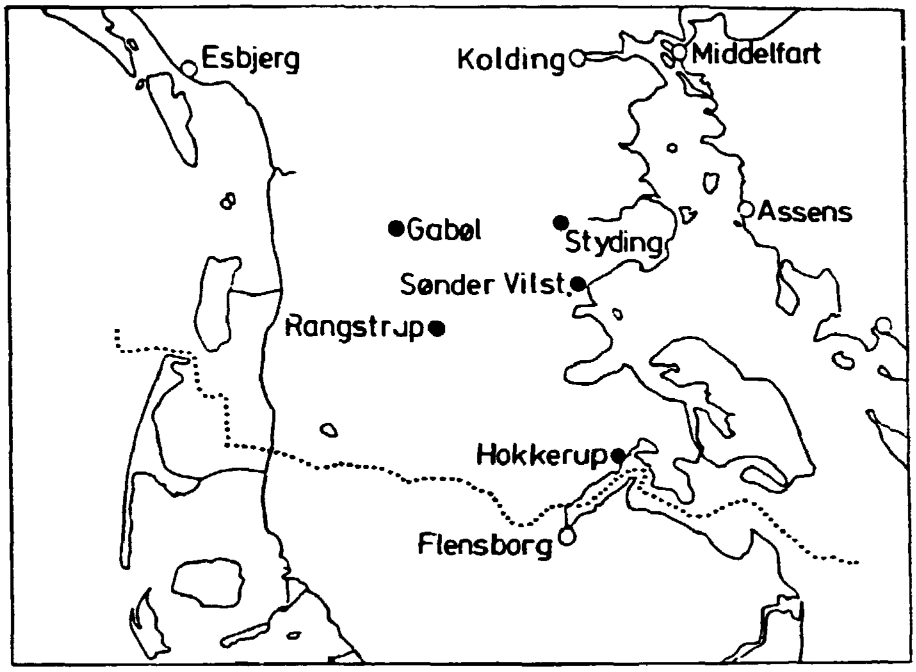


Fig. 4.5.4. Special soil sampling in South-Jutland in 1988.

Table 4.5.2. Radiocesium in uncultivated soil collected at the 10 State experimental farms in Denmark in September 1989. (Unit: Bq m^{-2}). ($^{134}Cs/^{137}Cs$)

Location	0-5 cm	5-10 cm	10-20 cm	20-30 cm	Σ 0-30 cm	Chernobyl ^{137}Cs* 0-5 cm	5-10 cm	10-20 cm	Σ 0-20 cm
Tyistrup	1200 (0.062)	1280	490	210	3180	388			388
Kalø	1800 (0.098)	1530 (0.007 B)	570	163	4050	921	60 B		981
Borris	1130 (0.104)	1090 (0.064)	1310	1290	4820	615	367		982
Askov	2100 (0.167)	2200 (0.138)	1920 (0.057)	1380	7650	1832	1632	579	4043
St. Jyndevad	1350 (0.124)	710	1130	720	3910	884			884
Årslev	1720 (0.154)	800 (0.100)	850	550	3920	1387	420		1807
Tystofte	1020 (0.128)	420	590	270	2290	685			685
Ledreborg	490 (0.142)	710 (0.081 A)	1260	790	3240	362	300 A		362
Abed	560 (0.112 A)	1200 (0.052)	1650	330	3740	328 A	329		657
Tornbygård	770 (0.086)	530	990	720	3010	346			346
Mean	1212	1051	1075	643	3981	775	311	58	1144
Relative S.D	44%	51%	[illegible]	67%	37%	65%	159%		96%

*Calculated from $^{134}Cs/^{137}Cs$ assuming that this ratio was 0.55 in pure Chernobyl debris on April 26, 1986

Table 4.5.3. Radiocesium in cultivated soil (0-5 cm) collected in 1989. (Unit: Bq m^{-2}) (^{134}Cs/^{137}Cs)

Location	Distance from hedge	Height of hedge	Date	^{137}Cs	^{134}Cs/^{137}Cs	Chernobyl ^{137}Cs	Global fallout
Nustrup	1 × height	6 m	April 13	4130	0.201	3825	305
(Zone IV)	6 × height	"	"	4560	0.200	4199	361
"	10 × height	"	"	2160	0.152	1511	649
"	15 × height	"	"	1065	0.099	486	579
Tågerup	1 × height	7 m	February 13	640	0.076	212	428
(Zone VI)	6 × height	"	"	740	0.074	237	503
"	10 × height	"	"	780	0.085	291	489
"	15 × height	"	"	720	0.075	236	484

Table 4.5.4. Strontium-90 in uncultivated soil from the 10 State experimental farms in Denmark in August-September 1987. (Area: 0.04314 m^2)

	0-5 cm		5-10 cm		10-20 cm		20-30 cm		Σ0-30 cm
	Bq kg^{-1} dry	Bq m^{-2}	Bq kg^{-1} dry	Bq m^{-2}	Bq kg^{-1} dry	Bq m^{-2}	Bq kg^{-1} dry	Bq m^{-2}	Bq m^{-2}
Tylstrup	4.1 ± 0.6	172 ± 26	5.4	279	4.0	412	1.37	122	1010
Kalø	4.5	178	4.8	256	3.1	300	1.72	222	956
Borris	1.87	110	1.81	81	2.3	257	2.3	283	[illegible]
Askov	3.8	248	2.9	133	3.4	183	2.6	172	736
St. Jyndevad	1.53*	82*	0.80*	43*	0.33*	36*	0.31*	32*	193
Årslev	3.9	190	3.1	166	3.5	270	3.1	157	783
Tystofte	2.8	141	2.5	170	3.0	356	1.7	173	840
Ledreborg	2.5	147	2.2	138	2.4	291	2.5	285	861
Abed	2.3 ± 0.2	90 ± 10	2.7	113	3.7	192	2.9	180	584
Tornbygård	1.56	105	1.62	83	2.2	208	2.1	179	575
Arithmetic mean	2.89	146	2.78	146	2.79	250	2.06	180	726
Relative S.D.	39%	36%	50%	52%	38%	43%	40%	43%	34%
Bolund	5.7	226	5.9	305	4.2	490	1.04	105	1126

*From Table 4.5.5.

Table 4.5.5. Strontium-90 in uncultivated soil from St. Jyndevad and Skydebanen in Denmark in April 1987

Depth in cm	St. Jyndevad Bq kg^{-1} dry	St. Jyndevad Bq m^{-2}	Skydebanen Bq kg^{-1} dry	Skydebanen Bq m^{-2}	Area m^2
0-5	1.53	82	2.8	121	0.0800
5-10	0.80	43	2.6	152	0.0800
10-15	0.33	17.5	3.2	195	0.0800
20	0.33	37	1.74	290	0.03456
30	0.29	28	3.5	610	0.03456
40	0.080	7.6	0.150	27	0.03456
50	0.050	4.6			0.03456
60	0.043 A	4.2			0.03456
70	0.054	5.4			0.03456
80	0.035	3.5			0.03456
90	0.022	2.3			0.03456
100	0.024	2.5			0.03456
		Σ 240		Σ 1400	

Table 4.6.1.A. Radiocesium in marine sediments collected in Roskilde Fjord on August 17, 1988 at Bolund (55°42'N 12°05'E). (Area: 0.0145 m^2)

Layer in cm	^{134}Cs Bq kg^{-1} dry	^{134}Cs Bq m^{-2}	^{137}Cs Bq kg^{-1} dry	^{137}Cs Bq m^{-2}	Chernobyl ^{137}Cs Bq m^{-2}	Chernobyl ^{137}Cs %
0-3	6.9	79	67	680	296	44
3-6	4.8	38	35	280	142	51
6-9	2.5	23	18.0	165	86	52
9-12	B.D.L.	B.D.L.	7.9	61	-	0
12-15	0.6 A	4.2 A	4.2 A	32 A	16 A	50
Σ 0-15		144		1220	540	44

Table 4.6.1.B. Radiocesium in marine sediments collected in Roskilde Fjord on May 31, 1989 at Bolund (55°42'N 12°05'E). (Area: 0.0145 m^2)

Layer in cm	^{134}Cs Bq kg^{-1} dry	^{134}Cs Bq m^{-2}	^{137}Cs Bq kg^{-1} dry	^{137}Cs Bq m^{-2}	Chernobyl ^{137}Cs Bq m^{-2}	Chernobyl ^{137}Cs %
0-3	5.1	31	55	330	148	45
3-6	2.4	19.1	38	300	91	30
6-9	1.36	7.3	27	140	35	25
9-12	B.D.L.	B.D.L.	13.5	136	-	0
12-15	B.D.L.	B.D.L.	2.6	44	-	0
Σ 0-15		57		950	274	29

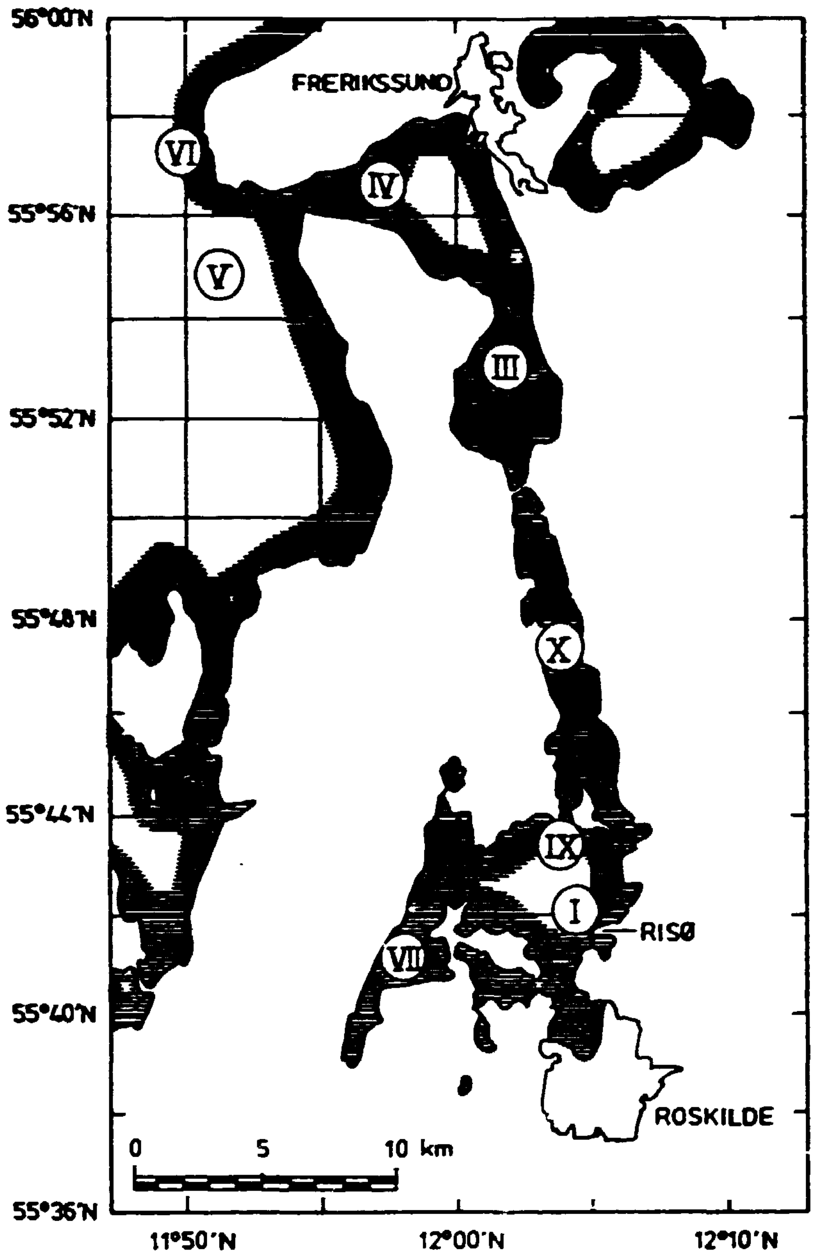


Fig. 4.6. Roskilde fjord.

Table 4.6.2. Strontium-90 in marine sediments collected in Roskilde Fjord on May 7, 1987 at Bolund (55°42'N 12°05'E). (Area: 0.0145 m^2)

Layer in cm	^{90}Sr Bq kg^{-1} dry	Bq m^{-2}
0-3	0.37	2.6
3-6	0.30	4.4
6-9	0.32	4.1
9-15	0.29	5.0
Σ 0-15		16.1

5. Danish Food and Various Vegetation

by A. Aarkrog

5.1. Cows Milk

Dried milk from seven locations (Figure 5.1.1) was collected monthly and analysed for ^{90}Sr (Tables 5.1.1.A & B) and for ^{137}Cs (Tables 5.1.3.A & B). Since 1983 the ^{90}Sr concentrations in Danish milk have decayed with a halflife of 10 years; the global fallout ^{137}Cs has shown a halflife of 6 years and that of Chernobyl ^{137}Cs of 1.1 years (1987-1989). Tables 5.1.5.A & B show that the contribution of Chernobyl ^{137}Cs in Danish milk decreased from 84% in 1988 to 74% in 1989 (in 1987 the percentage was 94).

Consumers milk was collected in June 1988, the mean ratio between ^{137}Cs in fresh milk and that in dried milk (Table 5.1.3.A) was 1.24 ± 0.81 (± 1 S.D.; n = 7). Jutland showed higher levels in dried milk than in consumers milk whereas it was opposite in the islands.

5.2. Other Milk Products

Cheese was collected in 1988 and in 1989 and analysed for ^{90}Sr and ^{137}Cs (Table 5.2.2). The cheese levels (in particular ^{137}Cs) were higher than the corresponding country means in dried milk, probably because the cheese was produced of older milk and of milk preferentially coming from the western part of the country.

5.3. Cereal Grain

Grain samples collected at the 10 State experimental farms were as previously analysed for ^{90}Sr and ^{137}Cs. Figures 5.3.1-5.3.4 show the ^{90}Sr levels since measurements began in 1959 and Figures 5.3.5-5.3.8 show the corresponding ^{137}Cs concentrations for the period 1962-89. The effective halflife of ^{90}Sr in Danish grain has been 10-15 years since 1983.

The $^{134}Cs/^{137}Cs$ in grain (Tables 5.3.5.A & B) shows the contribution of Chernobyl ^{137}Cs in 1987: 78% of the total ^{137}Cs in Danish grain came from Chernobyl, in 1988: 81% and in 1989: 67%. The effective halflife of global fallout of ^{137}Cs has since 1983 been 12 years (for oats 16 years) and that of Chernobyl ^{137}Cs has since 1987 been 5 years (shorter for barley and oats, longer for wheat and rye).

The predictions of the ^{137}Cs levels in grain from 1988 and 1989 based upon revised models, including root uptake are summarized in Appendix C, cf. also Appendix A. It appears that the observed values in 1988 in general were lower than those predicted while the opposite was the case in 1989.

As has been suggested earlier (*Aarkrog* 1989) this may reflect that the resuspended ^{137}Cs becomes increasingly more available as time goes by.

5.4. Bread

The bread levels in 1988 as well as in 1989 were in general higher than expected from Danish grain measurements (Tables 5.4.3.A & B). This may suggest import of grain from areas in Europe which was more contaminated by Chernobyl debris than Denmark.

5.5. Potatoes

The effective halflife of ^{90}Sr in potatoes in Denmark has since 1983 been about 20 years, somewhat longer in the Islands than in Jutland (cf. Figures 5.5.1-5.5.2). The ^{137}Cs concentrations have shown greater variability partly due to the Chernobyl accident (Figures 5.5.3-5.5.4).

5.6. Vegetables and Fruit

Peas show 3-4 times higher ^{137}Cs concentrations than cabbage and carrots. The ^{137}Cs levels in vegetables and fruit did not change significantly from 1988 to 1989.

5.7. Meat, Fish, Eggs and Various Vegetable Foodstuffs

5.7.1. Meat

During 1988 and 1989 82% of the ^{137}Cs in Danish beef came from Chernobyl, this activity decayed with an effective halflife of 3-4 years which is shorter than that of global fallout. The ^{137}Cs concentrations in pork were one third to one half of those in beef.

5.7.2. Fish

Fish from the inner Danish waters contained 2-4 times more ^{137}Cs than fish from the North Sea. Fish from the Baltic Sea showed 3-4 times higher levels than fish from the inner Danish waters. The ^{137}Cs concentrations in 1989 were lower than those in 1988 in fish from the North Sea, while no difference was observed for fish from the inner Danish waters.

The contribution from Chernobyl to the total ^{137}Cs concentration in fish was 72% in the inner waters and 46% in the North Sea in 1988 and 1989. Fish from the Baltic Sea showed a percentage of 91% in 1989.

Eels from a location in the Baltic Sea (Oscarshamn) has been meassured for ^{137}Cs since the Chernobyl accident (Figure 5.7.2). The maximum was reached at the beginning of 1988.

5.7.3. Eggs

The ^{90}Sr concentrations in eggs in 1988 and 1989 were similar to those in 1987, i.e. mean $\lessapprox$ 0.01 Bq kg^{-1}. The ^{137}Cs levels were an order of magnitude higher.

5.7.4. Various Vegetable Foods

The levels in rize, oats, banana, orange, coffee and tea in 1988 were similar (within a factor of 2-3) to those observed at the last sampling in 1986; but hazel nuts contained far less ^{137}Cs in 1988 (about two orders of magnitude less).

5.8. Total Diet (Consumption Data)

The ^{90}Sr intake with total Danish diet has since 1983 decreased with a halflife corresponding to the radiological halflife of ^{90}Sr, i.e. 28.5 years. The daily pro capite intake of Ca with the Danish diet is now 1.17 g Ca corresponding to 428 g per year.

The global fallout ^{137}Cs in the diet (23% of the total ^{137}Cs in 1988 and 1989) decayed with an effective halflife of approx. 5 years whereas Chernobyl ^{137}Cs (77%) decreased with 3 years halflife. The determination of the decay of the global fallout is encumbered with uncertainties due to the contribution of Sellafield radiocesium from fish consumption.

5.9. Total Diet (Production Data)

The ^{90}Sr intake with total diet calculated from the concentrations in the various diet constituents may be compared with the measured levels in total diet (consumption data). In 1988 the production data were 0.14 Bq ^{90}Sr day^{-1} cap^{-1} and the consumption figure was 0.16. In 1989 the data were 0.12 and 0.15, respectively. The corresponding figures for ^{137}Cs were in 1988 0.40 and 0.46, respectively, and in 1989 0.34 and 0.33 Bq ^{137}Cs day^{-1} cap^{-1}, respectively.

5.10. Grass

5.10.1. Grass from Zealand

Strontium-90 in grass collected around Risø has since 1987 decayed with an effective halflife of 5 years and ^{137}Cs with about 1.5 years halflife. These figures are based on monthly samples collected throughout the year.

5.10.2. Grass Collected Countrywide

Since September 1986 the ^{137}Cs levels in grass collected during the summer half year at the 10 State experimental farms has decayed with a halflife of a little less than 1 year.

5.11. Sea Plants

5.11.1. Sea Plants from Roskilde Fjord

The ^{90}Sr concentrations have since 1987 decayed with a halflife of about 2 years and ^{137}Cs with 2.5 years.

5.11.2. Sea Plants from Inner Danish Waters

An anova of the ^{137}Cs data on Fucus samples collected monthly 1987-1989 at Strøby Egede, Nysted, Mullerup/Reersø, Gilleleje/Nakkehoved and Klint show no significant interactions between year, month and location. But the main effects are all highly significant. The maximum levels are occurring in June. the levels in 1988 and 1989 are higher than those in 1987 and the concentrations are higher in Fucus from the southern stations close to the Baltic Sea (i.e. Strøby Egede and Nysted) than in the northern Cattegat stations (Gilleleje and Klint).

The observed mean ratios between Bq kg^{-1} d.w. Fucus and Bq l^{-1} sea water for ^{99}Tc were $1.05 \cdot 10^5$ for Fucus vesiculosus and $0.88 \cdot 10^5$ for Fucus serratus both sampled monthly at Klint in 1988 and 1989 (cf. also Fig. 4.4.10). In 1988 the relative variations of the ^{99}Tc concentrations in sea weed were two times higher in 1989 although the variation of the water concentrations was the same for the two years. This may indicate a recall by the Fucus of higher water concentrations of ^{99}Tc in 1987. The relative variation of the ^{60}Co concentrations in sea weed did not differ for the two years.

5.12. Lichen and Moss

In Fig. 5.12 five years observations of ^{137}Cs in Danish lichen are shown (1986-1990). It appears that the environmental halflife of ^{137}Cs varies between 1.5 and 4 years for the various locations. The halflife of the Chernobyl debris was shorter than that of global fallout ^{137}Cs.

5.13. Mushrooms from a Forest in NE-Zealand

In cooperation with the University of Roskilde a study of radiocesium in mushrooms was carried out in September-October 1989. The samples were collected from a spruce forest and a beech wood in Gribskov, NE-Zealand by three students from the University, and the samples were analysed at Risø. The results have been published in a Danish report from the University of Roskilde (*Roos* et al. 1990).

The report concludes that for the same mushroom species and the same deposition of fallout, the spruce forest showed higher levels than the beech wood. Common yellow mussula is well suited as a bioindicator for radiocesium. A significant part of the ^{137}Cs in mushrooms comes from global fallout, especially in the honey fugus where 35-85% was old fallout. In common yellow nussula about 45% was global fallout, but in clouded agaric nearly all ^{137}Cs was from Chernobyl. The environmental halflife of ^{137}Cs in most mushrooms is apparently long. The observed ratio between the ^{137}Cs concentrations in the mushrooms and those in the upper 10 cm soil layer varied between 3 and 35 depending upon mushroom species and forest type. Chernobyl radiocesium showed a higher (about 3 times) transfer than global fallout cesium.

Table 5. Geometric means of Strontium-90 and Cesium-137 levels in Danish environmental biological samples collected in 1988 and 1989

Sample type and unit	Strontium-90		Cesium-137	
	1988	1989	1988	1989
Countrywide dried milk, Bq l^{-1} fresh	0.060	0.056	0.196	0.133
Danish cheese, Bq kg^{-1}	0.41	0.44	0.135	0.153
Countrywide rye, Bq kg^{-1}	0.32	0.28	0.13	0.093
Countrywide barley, Bq kg^{-1}	0.33	0.34	0.082	0.052
Countrywide wheat, Bq kg^{-1}	0.29	0.26	0.066	0.051
Countrywide oats, Bq kg^{-1}	0.40	0.57	0.195	0.164
Countrywide rye bread, Bq kg^{-1}	0.27	0.20	0.24	0.25
Countrywide white bread, Bq kg^{-1}	0.125	0.109	0.088	0.036
Countrywide potatoes, Bq kg^{-1}	0.035	0.032	0.076	0.078
Countrywide cabbage, Bq kg^{-1}	0.23	0.21	0.034	0.027
Countrywide carrot, Bq kg^{-1}	0.28	0.17	0.026	0.033
Countrywide peas, Bq kg^{-1}	0.13	0.14	0.122	0.100
Countrywide apples, Bq kg^{-1}	0.037	0.017	0.053	0.058
Country intake† with diet, Bq day^{-1} cap^{-1}	0.161	0.150	0.46	0.33
Countrywide beef, Bq kg^{-1}	0.008	0.013	1.06	0.97
Countrywide pork, Bq kg^{-1}	0.007*	0.001*	0.41	0.42*
Countrywide° plaice, Bq kg^{-1}	0.018	0.020	2.6	1.3
Countrywide° herring, Bq kg^{-1}	0.0033	0.0040	2.2	1.6
Countrywide° cod, Bq kg^{-1}	0.018	0.0145	4.1	3.7
Countrywide grass, Bq kg^{-1} fresh	-	-	0.28	0.18

†Mean of June and December sampling

*Copenhagen samples only

°Mean of inner Danish water and North Sea samples.

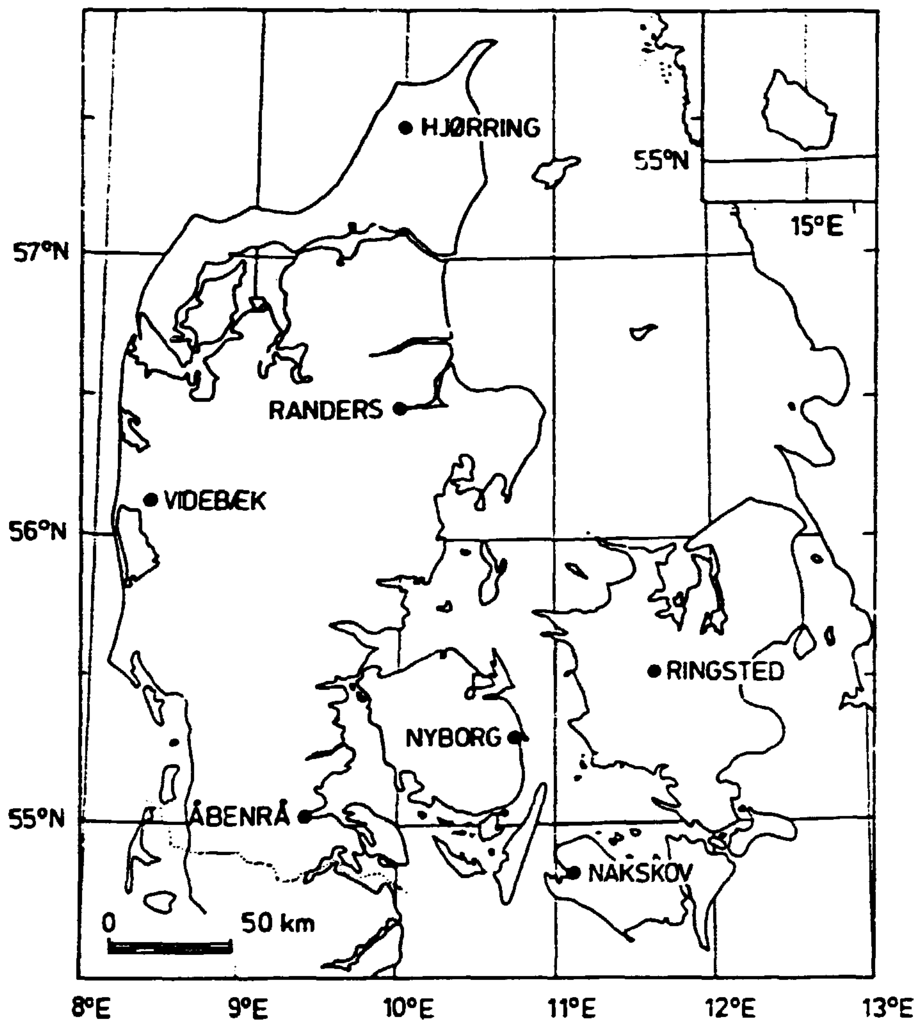


Fig. 5.1.1. Dried milk sampling locations in Denmark.

Table 5.1.1.A. Strontium-90 in dried milk in 1988. (Unit: Bq (kg Ca)$^{-1}$)

Month	Hjørring	Randers	Videbæk	Åbenrå	Nyborg	Ringsted	Nakskov	Geometric mean	Arithmetic mean
Jan-April	53	59 ± 1	66 ± 6	76 ± 1	35 ± 3	39 ± 4	58	53	55
May-June	41 ± 3	38	68	70	33	40	38	45	47
July-Oct	54 ± 2	52	59	68	36	39	35	48	49
Nov-Dec	54 ± 2	61 ± 0	63 ± 2	71 ± 3	57 ± 1	44 ± 2	38 ± 1	54	55
1988: Geometric mean*	51	53	64	71	38	40	43	50	
1988: Arithmetic mean*	51	53	64	71	39	40	44		52

*The data were weighted with the number of months when calculating the mean.

As 1 cubic meter of milk contains 1.2 kg Ca, the mean ^{90}Sr content in Danish milk produced in 1988 was 62 Bq m^{-3} (or 0.062 Bq ^{90}Sr l^{-1}).

Table 5.1.1.B. Strontium-90 in dried milk in 1989. (Unit: Bq (kg Ca)$^{-1}$)

Month	Hjørring	Randers	Videbæk	Åbenrå	Nyborg	Ringsted	Nakskov	Geometric mean	Arithmetic mean
Jan-April	56	56	62	62	31	45	37	48	50
May-June	51	51	63	63	34	48	32	47	49
July-Sep	52	57	64	58	42	40	34	48	50
Oct-Dec	46	46	52	48	33	42	34	42	43
1989: Geometric mean*	51	53	60	57	34	43	35	46	
1989: Arithmetic mean*	52	53	60	58	35	43	35		48

*The data were weighted with the number of months when calculating the mean.

As 1 cubic meter of milk contains 1.2 kg Ca, the mean ^{90}Sr content in Danish milk produced in 1989 was 58 Bq m^{-3} (or 0.058 Bq ^{90}Sr l^{-1}).

Table 5.1.2.A. Analysis of variance of ln Bq ^{90}Sr (kg Ca)$^{-1}$ in Danish dried milk in 1988 (from Table 5.1.1.A)

Variation	SSD	f	s^2	v^2	P
Between months*	0.226	3	0.075	2.332	-
Between locations	1.904	6	0.317	9.824	> 99.95%
Month × loc.	0.581	18	0.032	5.427	> 99.5 %
Remainder	0.083	14	0.006		

*Jan-April, May-June, July-Oct, Nov-Dec.

Table 5.1.2.B. Analysis of variance of ln Bq ^{90}Sr (kg Ca)$^{-1}$ in Danish dried milk in 1989 (from Table 5.1.1.B)

Variation	SSD	f	s^2	v^2	P
Between months*	0.083	3	0.028	3.785	-
Between locations	1.300	6	0.217	29.596	> 99.95%
Month × loc.	0.132	18	0.007		

*Jan-April, May-June, July-Sep, Oct-Dec.

Table 5.1.?A. Cesium-137 in Danish dried milk in 1988. (Unit: Bq ^{137}Cs (kg K)$^{-1}$)

Month	Hjørring	Randers	Videbæk	Åbenrå	Nyborg	Ringsted	Nakskov	Geometric mean	Arithmetic mean
Jan	210	196	450	190	69	74	27	125	174
Feb	260	260	290	590	168	38	29	155	230
March	115	211	(310)	230	88	63	33	118	151
April	91	600	560	240	89	89	31	151	240
May	138	177	380	230	99	87	27	126	163
June	136	140	430	290	82	53	42	123	168
July	210	145	310	320	73	41	32	116	161
Aug	174	195	340	380	74	36	27	118	175
Sep	137	230	310	320	59	30	44	114	161
Oct	220	164	154	210	69	32	40	100	126
Nov	117	154	230	330	98	60	18.5	106	145
Dec	89	128	193	179	67	37	21	80	102
1988: Geometric mean	149	197	310	280	83	50	30	118	
1988: Arithmetic mean	158	220	330	290	86	53	31		167

As 1 cubic meter of milk contains approx. 1.66 kg K, the mean ^{137}Cs content in Danish milk produced in 1988 was estimated at 280 Bq m^{-3} (or 0.28 Bq ^{137}Cs l^{-1}).

Figures in brackets were calculated from VAR3 (*Vestergaard* 1964).

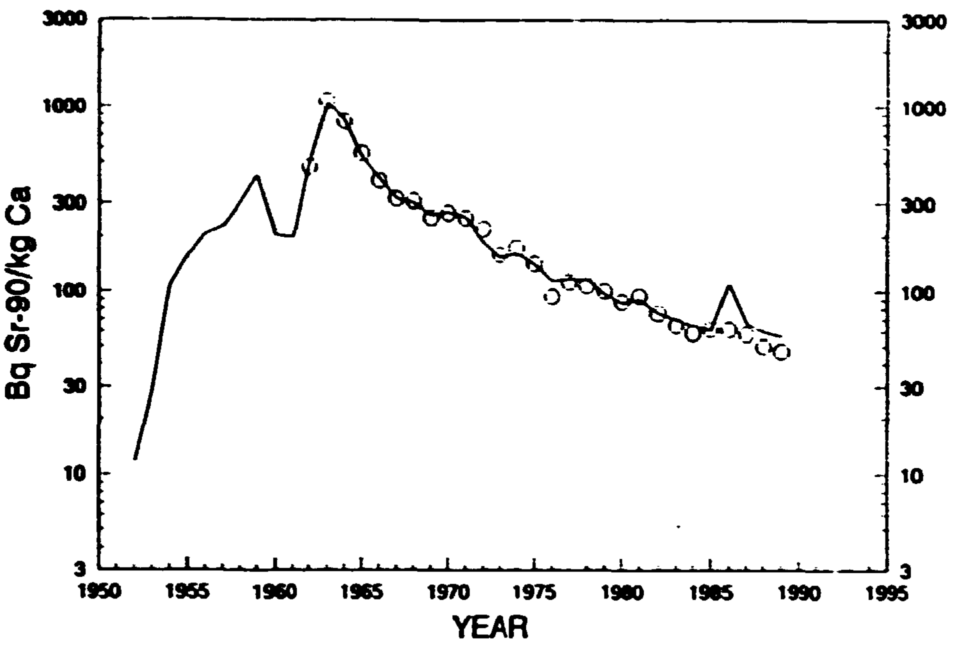


Fig. 5.1.2. Predicted (curve) and observed $^{90}Sr/Ca$ levels in dried milk from Denmark (May 1962 - April 1990) (milk year).

Fig. 5.1.3. Predicted (curve) and observed $^{137}Cs/K$ levels in dried milk from Denmark (May 1962 - April 1990) (milk year).

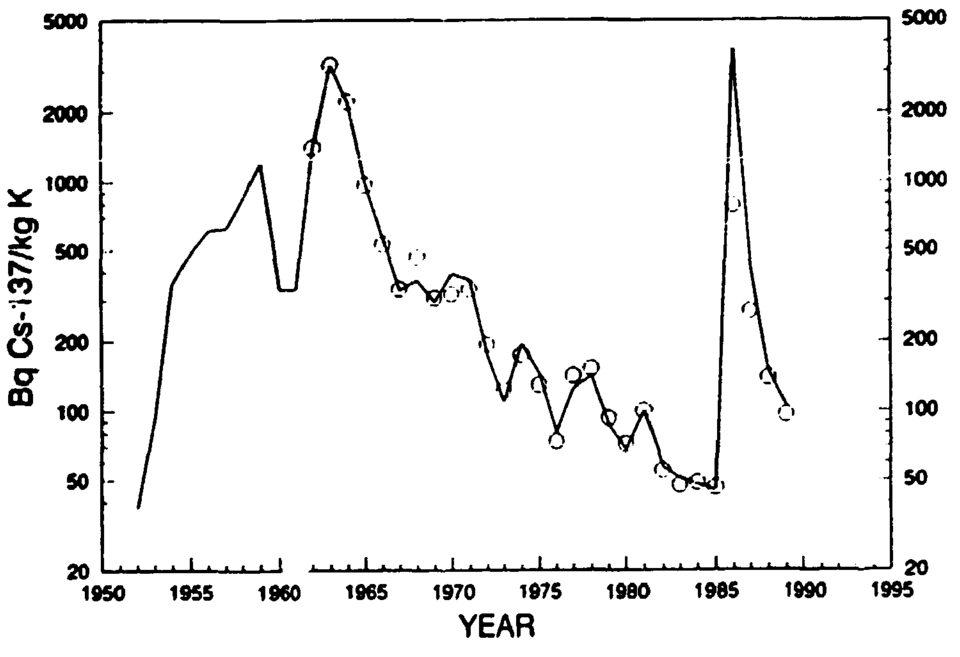


Table 5.1.3.B. Cesium-137 in Danish dried milk in 1989. (Unit: Bq ^{137}Cs (kg K)$^{-1}$)

Month	Hjørring	Randers	Videbæk	Åbenrå	Nyborg	Ringsted	Nakskov	Geometric mean	Arithmetic mean
Jan	140	151	300	149	54	37	23	88	121
Feb	113	151	182	196	44	95	22	92	115
March	67	240	230	230	38	40	21	83	123
April	73	113	155	250	42	51	25	78	101
May	99	90	190	179	59	39	24	77	97
June	86	197	240	191	57	56	22	92	121
July	137	290	290	173	59	64	28	111	148
Aug	153	194	176	130	66	76	31	101	118
Sep	93	230	270	144	51	38	24	87	121
Oct	71	96	156	(107)	59	27	18.3	61	76
Nov	79	79	167	73	51	31	19.2	58	71
Dec	59	76	164	43	73	34	18.5	55	67
1989: Geometric mean	93	144	200	141	54	46	23	80	
1989: Arithmetic mean	99	159	210	155	55	49	23		107

As 1 cubic meter of milk contains approx. 1.66 kg K, the mean ^{137}Cs content in Danish milk produced in 1989 was estimated at 178 Bq m^{-3} (or 0.178 Bq ^{137}Cs l^{-1}).

Figures in brackets were calculated from VAR3 (*Vestergaard* 1964).

Table 5.1.4.A. Analysis of variance of ln Bq ^{137}Cs (kg K)$^{-1}$ in Danish dried milk in 1988 (from Table 5.1.3.A) (milk year May 1988 - April 1989)

Variation	SSD	f	s^2	v^2	P
Between months	2.363	11	0.215	2.575	> 99%
Between locations	53.247	6	8.874	106.398	> 99.95%
Remainder	5.505	66	0.083		

Table 5.1.4.B. Analysis of variance of ln Bq ^{137}Cs (kg K)$^{-1}$ in Danish dried milk in 1989 (from Table 5.1.3.B) (milk year May 1989 - April 1990)

Variation	SSD	f	s^2	v^2	P
Between months	4.132	11	0.376	4.658	> 99.95%
Between locations	36.817	6	6.136	76.088	> 99.95%
Remainder	5.242	65	0.081		

Table 5.1.5.A. Radiocesium: $^{134}Cs/^{137}Cs$ in Danish dried milk in 1988

Month	Hjørring	Randers	Videbæk	Åbenrå	Nyborg	Ringsted	Nakskov	Mean ± 1 S.D.	Theoretical $^{134}Cs/^{137}Cs$
Jan	0.28	0.26	0.30	0.31	0.27	0.31		0.29 ± 0.02	0.32
Feb	0.30	0.30	0.27	0.30	0.26	0.25		0.28 ± 0.02	0.31
March	0.31	0.27	-	0.29	0.27	0.24	0.22	0.27 ± 0.03	0.30
April	0.25	0.26	0.29	0.28	0.22	0.20		0.25 ± 0.04	0.30
May	0.21	0.25	0.27	0.27	0.22	0.29		0.25 ± 0.03	0.29
June	0.21	0.24	0.25	0.26	0.27	0.25	0.25	0.25 ± 0.02	0.28
July	0.22	0.21	0.23	0.24	0.20	0.21	0.27	0.22 ± 0.02	0.27
Aug	0.23	0.21	0.24	0.23	0.188		0.197	0.22 ± 0.02	0.27
Sept	0.176	0.196	0.22	0.25	0.177	0.155	0.165	0.191 ± 0.03	0.26
Oct	0.22	0.27	0.20	0.25	0.188		0.152	0.21 ± 0.0[illegible]	0.25
Nov	0.22	0.23	0.22	0.24	0.193	0.185		0.22 ± 0.02	0.25
Dec	0.179	0.155	0.22	0.22	0.199	0.110		0.180 ± 0.04	0.24

$$\frac{\text{Observed } ^{134}Cs/^{137}Cs}{\text{Theoretical } ^{134}Cs/^{137}Cs} = 0.84 \pm 0.06 \text{ (1 S.D., N = 12)}$$

Table 5.1.5.B. Radiocesium: $^{134}Cs/^{137}Cs$ in Danish dried milk in 1989

Month	Hjørring	Randers	Videbæk	Åbenrå	Nyborg	Ringsted	Nakskov	Mean ± 1 S.D.	Theoretical $^{134}Cs/^{137}Cs$
Jan	0.190	0.20	0.192	0.183		0.171	0.147 B	0.181 ± 0.02	0.23
Feb	0.197	0.194	0.185	0.197	0.122 A	0.20		0.183 ± 0.03	0.23
March	0.173 A	0.22	0.189	0.178	0.24 A	0.148		0.190 ± 0.03	0.22
April	0.147 A	0.187	0.164	0.195	0.161 A	0.142 B	0.170 A	0.16[illegible] ± 0.02	0.22
May	0.147	0.172	0.171	0.185	0.195	0.161 A		0.172 ± 0.02	0.21
June	0.093 B	0.147	0.168	0.165	0.137 A	0.182 A		0.149 ± 0.03	0.21
July	0.150 A	0.167	0.149	0.192	0.098 B	0.137 A		0.149 ± 0.03	0.20
Aug	0.134	0.152 A	0.142	0.161	0.118	0.172		0.146 ± 0.02	0.196
Sept	0.089 A	0.150	0.142	0.125 A	0.122 A	0.127 B		0.126 ± 0.02	0.190
Oct	0.132 A	0.159 A	0.146 A		0.109 A	0.159 B		0.141 ± 0.02	0.186
Nov	0.120 B	0.119 A	0.134	0.115	0.177 A			0.133 ± 0.03	0.181
Dec	0.009 B	0.093 A	0.128	0.087 B	0.105 A	0.046 B	0.149 B	0.088 ± 0.05	0.176

$$\frac{\text{Observed } ^{134}Cs/^{137}Cs}{\text{Theoretical } ^{134}Cs/^{137}Cs} = 0.74 \pm 0.09 \text{ (1 S.D., N = 12)}$$

Table 5.2.1. Radiocesium in consumers milk collected in the 8 zones and Copenhagen in June 1988 (cf. Fig. 5.4.1). (Theoretical $^{134}Cs/^{137}Cs$: 0.28)

Location	Bq ^{137}Cs (kg K)$^{-1}$	Bq ^{137}Cs l^{-1}	^{134}Cs/^{137}Cs
I: North Jutland	108	0.164	-
II: East Jutland	113	0.168	0.26
III: West Jutland	260	0.39	0.25
IV: South Jutland	230	0.36	0.25
V: Funen	240	0.35	-
VI: Zealand	82	0.120	0.28
VII: Lolland-Falster	52	0.083	0.27
VIII: Bornholm	32	0.048	0.21
1988: Geometric mean	112	0.169	0.25
1988: Arithmetic mean	141	0.21	0.25
Copenhagen	70	0.109	0.25

Table 5.2.2. Strontium-90 and radiocesium in Danish cheese collected countrywide in the 8 zones in 1988 and 1989

Date	Bq ^{90}Sr kg^{-1}	Bq ^{90}Sr (kg Ca)$^{-1}$	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$	^{134}Cs/^{137}Cs	Theoretical $^{134}Cs/^{137}Cs$
Dec 1988	0.41	56	0.135	177	0.188 A	0.24
June 1989	0.44	58	0.153	198	-	0.21

Table 5.3.1.A. Strontium-90 in Danish grain in 1989. (Unit: Bq kg⁻¹)

Location	Rye Winter	Barley		Wheat		Oats Spring	Triticale
		Spring	Winter	Winter	Spring		
Tylstrup	0.36	0.43	0.42	0.90		0.51	
Kalø	0.21	0.35		0.27	0.30	0.44	
Borris	0.31	0.49	0.42	0.21	0.86	0.67	0.33
Askov	0.78	0.53		0.49			
St. Jyndevad	0.50	0.60		0.38		0.41	
Funen	0.32	0.24	0.83	0.32		0.52	
Tystofte	0.20	0.25	0.32	0.116	0.31	0.45	
Ledreborg	0.25	0.38	0.33	0.42	0.46	0.27	
Abed	0.184	0.115	0.114	0.154	0.162	0.168	
Bornholm	0.45	0.23	0.22	0.082	0.25		0.152
1988: Geometric mean	0.32	0.33	0.33	0.27	0.34	0.40	0.23
1988: Arithmetic mean	0.36	0.36	0.38	0.33	0.39	0.43	0.24

Table 5.3.1.B. Strontium-90 in Danish grain in 1989. (Unit: Bq kg⁻¹)

Location	Rye Winter	Barley		Wheat		Oats Spring
		Spring	Winter	Winter	Spring	
Jutland	0.40	0.46	0.43	0.27	0.86	0.60
The Islands	0.20	0.27	0.27	0.090	0.21	0.54
1989: Geometric mean	0.28	0.35	0.34	0.155	0.43	0.57
1989: Arithmetic mean	0.30	0.36	0.35	0.178	0.54	0.57

Table 5.3.2.A. Strontium-90 in Danish grain in 1988. (Unit: Bq (kg Ca)$^{-1}$)

Location	Rye	Barley		Wheat		Oats	Triticale
	Winter	Spring	Winter	Winter	Spring	Spring	
Tylstrup	1160	1400	900	1870		700	
Kalø	680	860		960	750	540	
Borris	990	1290	930	1030	2200	850	960
Askov	2100	1250		1380			
St. Jyndevad	1550	1350		1400		640	
Funen	710	660	1770	970		700	
Tystofte	600	630	800	440	1000	640	
Ledreborg	610	1000	670	1320	1120	320	
Abed	560	320	250	390	560	240	
Bornholm	1230	620	450	360	760		470
1988: Geometric mean	920	860	710	880	970	540	670
1988: Arithmetic mean	1020	940	830	1010	1070	580	720

Table 5.3.2.B. Strontium-90 in Danish grain in 1989. (Unit: Bq (kg Ca)$^{-1}$)

Location	Rye	Barley		Wheat		Oats
	Winter	Spring	Winter	Winter	Spring	Spring
Jutland	1150	1120	870	780	2100	760
The Islands	470	560	510	310	480	560
1989: Geometric mean	740	790	670	490	990	650
1989: Arithmetic mean	810	840	690	550	1270	660

Table 5.3.3.A. Analysis of variance of ln Bq ^{90}Sr kg^{-1} in grain in 1988 (from Table 5.3.1.A)

Variation	SSD	f	s^2	v^2	P
Between species	0.362	3	0.121	0.96	-
Between locations	8.12	9	0.902	7.16	> 99.95%
Spec. × loc.	3.15	25	0.126	0.57	-
Remainder	2.89	13	0.222		

Table 5.3.4.A. Analysis of variance of ln Bq ^{90}Sr (kg Ca)$^{-1}$ in grain in 1988 (from Table 5.3.2.A)

Variation	SSD	f	s^2	v^2	P
Between species	1.95	3	0.650	7.09	> 99.5%
Between locations	7.73	9	0.865	9.44	> 99.95%
Spec. × loc.	2.29	25	0.092	0.64	-
Remainder	1.857	13	0.143		

Table 5.3.3.B. Analysis of variance of ln Bq ^{90}Sr kg^{-1} in grain in 1989 (from Table 5.3.1.B)

Variation	SSD	f	s^2	v^2	P
Between species	0.916	3	0.305	1.368	-
Between locations	1.549	1	1.549	6.946	> 95%
Remainder + (spec × loc)	1.558	7	0.223		

Table 5.3.4.B. Analysis of variance of ln Bq ^{90}Sr (kg Ca)$^{-1}$ in grain in 1989 (from Table 5.3.2.B)

Variation	SSD	f	s^2	v^2	P
Between species	0.020	3	0.007	0.054	-
Between locations	1.935	1	1.935	15.000	> 99%
Remainder + (spec × loc)	0.905	7	0.129		

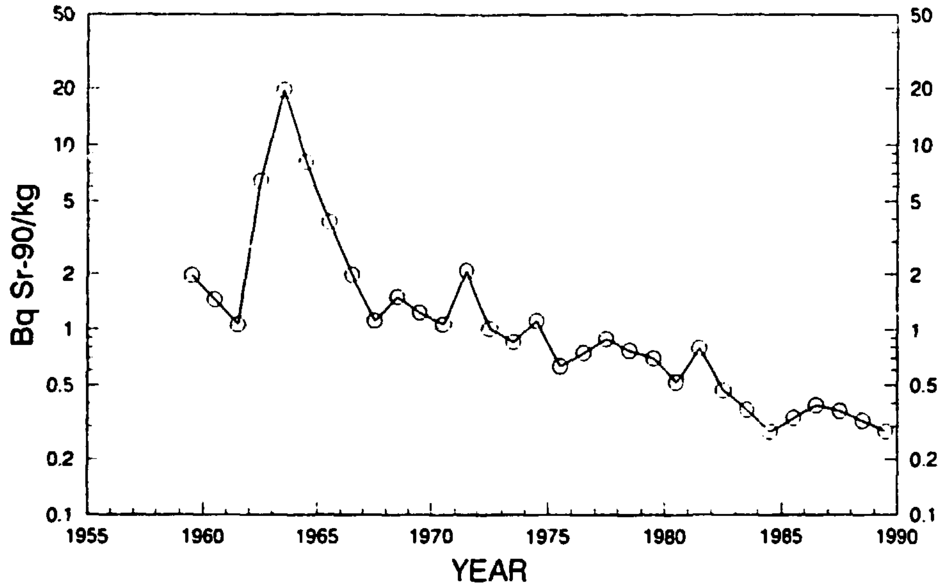
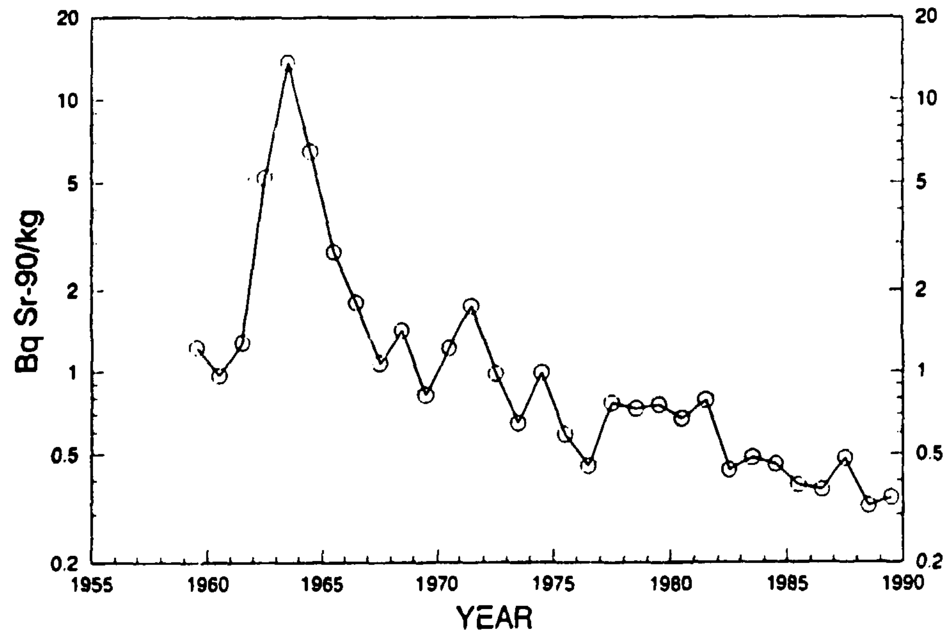


Fig. 5.3.1. Strontium-90 in :ye col!ᵉcted in Denmark in 1959-1989. (Unit: Bq kg $^{-1}$).

Fig. 5.3.2 Strontium-90 in barley collected in Denmark in 1959-1989. (Unit: Bq kg $^{-1}$).



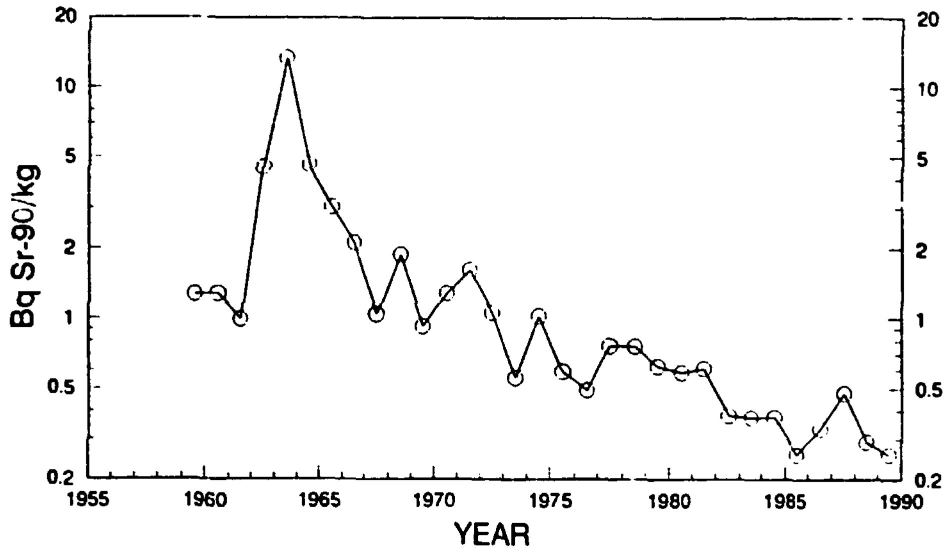


Fig. 5.3.3. Strontium-90 in wheat collected in Denmark in 1959-1989. (Unit: Bq kg⁻¹).

Fig. 5.3.4. Strontium-90 in oats collected in Denmark in 1959-1989. (Unit: Bq kg⁻¹).

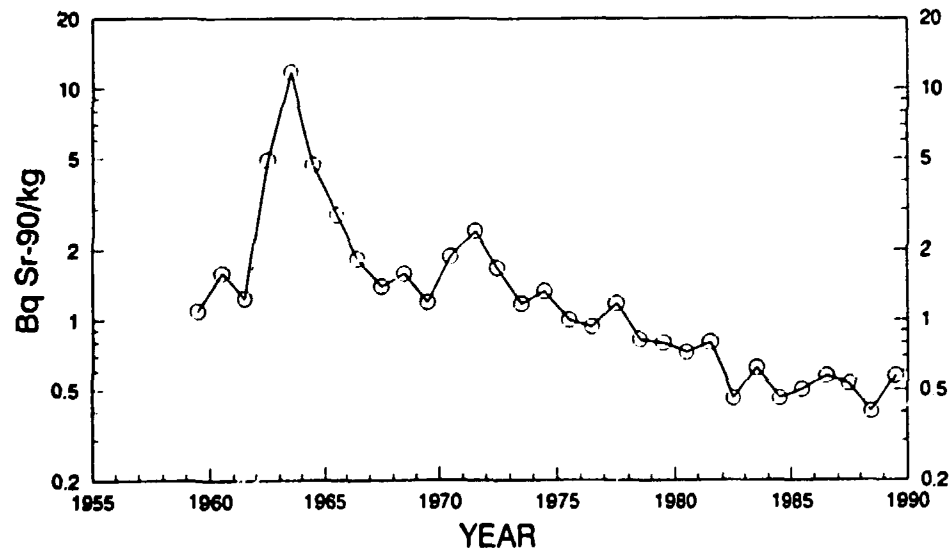


Table 5.3.5.A. Radiocesium in Danish grain in 1988. (Unit: Bq kg^{-1})

Location	Rye Winter	Barley Spring	Barley Winter	Wheat Winter	Wheat Spring	Oats Spring	Triticale
Tylstrup	0.116 (0.18 A)	0.057	0.080	0.131		0.24	
Kalo	0.143	0.29 (0.16 A)		0.080	0.063	0.49 (0.12 A)	
Borris	0.108 (0.28 A)	0.122	0.075	0.140 (0.21 B)	0.130 (0.38)	0.28 (0.14 B)	0.172 (0.19 A)
Askov	0.74 (0.22)	0.82 (0.22)		0.198 (0.23 A)			
St. Jyndevad	0.26 (0.25 A)	0.40		0.22 (0.25 A)		1.02 (0.11 A)	
Funen	0.073	0.049	0.28 (0.28)	0.080 (0.28 B)		0.24 (0.22)	
Tystofte	0.039 A	0.034 B	0.050	0.024 B	0.022 B	0.084	
Ledreborg	0.067 (0.22 B)	0.052	0.055	0.050 A	0.126	0.061	
Abed	0.092 (0.27 A)	0.034 B	0.033 A	0.025 A	0.027 A	0.051 A	
Bornholm	0.22 (0.13)	0.034 B	0.036 A	0.029 A	0.052		0.061 A
1988: Geometric mean	0.130	0.096	0.066	0.073	0.057	0.195	0.102
1988: Arithmetic mean	0.186	0.189	0.087	0.097	0.070	0.31	0.117

In brackets the $^{134}Cs/^{137}Cs$ are shown.

Table 5.3.5.B. Radiocesium in Danish grain in 1989. (Unit: Bq kg^{-1})

Location	Rye Winter	Barley		Wheat		Oats Spring	Triticale
		Spring	Winter	Winter	Spring		
Tylstrup	0.142	0.058	0.082			0.27	
	(0.135 A)					(0.112)	
Kalø	0.153	0.085	0.026 B	0.0195 B		0.136	
Borris	0.120	0.145	0.042 A	0.139	0.192	0.31	0.127
	(0.114 A)	(0.068 A)			(0.099 A)	(0.144 A)	
Askov	0.53	0.151	0.131	0.27	0.51	0.39	
	(0.156)	(0.555 A)		(0.080 B)	(0.196)	(0.151)	
St. Jyndevad	0.24	0.165	0.089	0.25		1.06	
	(0.125 A)			(0.165)		(0.118)	
Funen	0.087	0.50		0.040 A		0.30	
		(0.142)				(0.140)	
Tystofte	0.028 B	0.0131 B	0.0154 B	0.0111 B	0.027 A	0.060	
Ledreborg	0.026 B	0.027 A		0.021 B	0.039 A	0.084	
Abed		0.0150 B	0.024 A	0.021 A	0.036 A	0.031 A	
				(0.122 B)			
Bornholm	0.024 A	0.0181 A	0.025 B	0.0133 B	0.026 A	0.063	0.035 A
1989: Geometric mean	0.093	0.062	0.042	0.043	0.068	0.164	0.066
1989: Arithmetic mean	0.151	0.117	0.054	0.087	0.139	0.27	0.081

In brackets the $^{134}Cs/^{137}Cs$ are shown

Table 5.3.6.A. Cesium-137 in Danish grain in 1988. (Unit: Bq (kg K)$^{-1}$)

Location	Rye Winter	Barley		Wheat		Oats Spring	Triticale
		Spring	Winter	Winter	Spring		
Tylstrup	28	13.0	22	27		67	
Kalø	33	69		20	16.1	134	
Borris	26	31	23	40	34	85	36
Askov	189	198		52			
St. Jyndevad	60	93		57		270	
Funen	16.9	13.4	85	22		54	
Tystofte	8.8 A	8.5 B	13.2	6.4 B	5.5 B	19.0	
Ledreborg	17.3	12.5	13.5	14.2 A	35	14.9	
Abed	23	7.0 B	8.8 A	5.7 A	6.8 A	13.2 A	
Bornholm	44	6.0 B	9.3 A	7.3 A	11.5		12.1 A
1988: Geometric mean	31	22	18.0	18.7	14.2	50	21
1988: Arithmetic mean	45	45	25	25	18.0	82	24

Table 5.3.6.B. Cesium-137 in Danish grain in 1989. (Unit: Bq (kg K)$^{-1}$)

Location	Rye Winter	Barley		Wheat		Oats Spring	Triticale
		Spring	Winter	Winter	Spring		
Tylstrup	34	14.8	19.2			73	
Kalø	34	23	5.7 B	4.6 B		29	
Borris	27	47	10.5 A	37	57	93	27
Askov	127	40	35	74	114	95	
St. Jyndevad	60	45	25	77		300	
Funen	21	161		10.1 A		96	
Tystofte	7.0 B	3.8 B	3.8 B	4.6 B	9.0 A	10.9	
Ledreborg	6.2 B	7.6 A		6.3 B	13.4 A	27	
Abed		4.2 B	6.7 A	6.5 A	12.0 A	10.2 A	
Bornholm	6.3 A	5.1 A	7.9 B	4.0 B	7.0 A	18.1	7.6 A
1989: Geometric mean	22	17.6	10.9	12.5	20	44	14.2
1989: Arithmetic mean	36	35	14.2	25	35	75	17.1

Table 5.3.7.A. Analysis of variance of ln Bq ^{137}Cs kg^{-1} in grain in 1988 (from Table 5.3.5.A)

Variation	SSD	f	s^2	v^2	P
Between species	6.03	3	2.01	6.68	> 99.5%
Between locations	29.20	9	3.24	10.78	> 99.95%
Spec. × loc.	7.53	25	0.301	1.624	-
Remainder	2.41	13	0.185		

Table 5.3.8.A. A[illegible] of variance of ln Bq ^{137}Cs $(kg\ K)^{-1}$ in grain in 1988 (from Table 5.3.6.[illegible]

Variation	SSD	f	s^2	v^2	P
Between species	5.85	3	1.95	6.24	> 99.5%
Between locations	30.82	9	3.42	10.96	> 99.95%
Spec. × loc.	7.81	25	0.312	1.517	-
Remainder	2.68	13	0.206		

Table 5.3.7.B. Analysis of variance of ln Bq ^{137}Cs kg^{-1} in grain in 1989 (from Table 5.3.5.B)

Variation	SSD	f	s^2	v^2	P
Between species	9.296	3	3.099	8.708	> 99.95%
Between locations	47.186	9	5.243	14.733	> 99.95%
Spec. × loc.	8.896	25	0.356	1.595	-
Remainder	3.123	14	0.223		

Table 5.3.8.B. Analysis of variance of ln Bq ^{137}Cs $(kg\ K)^{-1}$ in grain in 1989 (from Table 5.3.6.B)

Variation	SSD	f	s^2	v^2	P
Between species	8.579	3	2.860	7.011	> 99.5%
Between locations	44.494	9	4.944	12.121	> 99.95%
Spec. × loc.	10.196	25	0.408	1.611	-
Remainder	3.544	14	0.253		

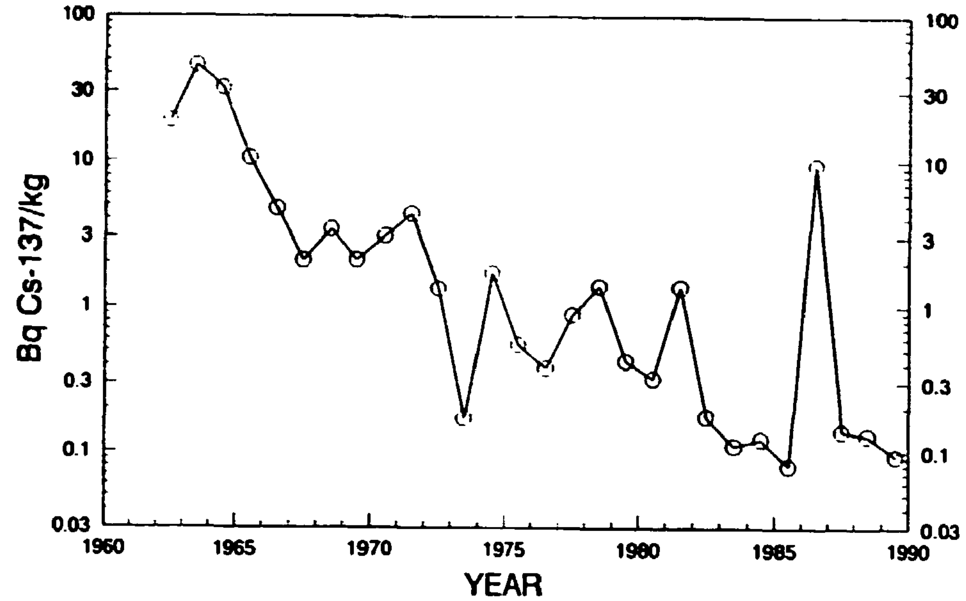
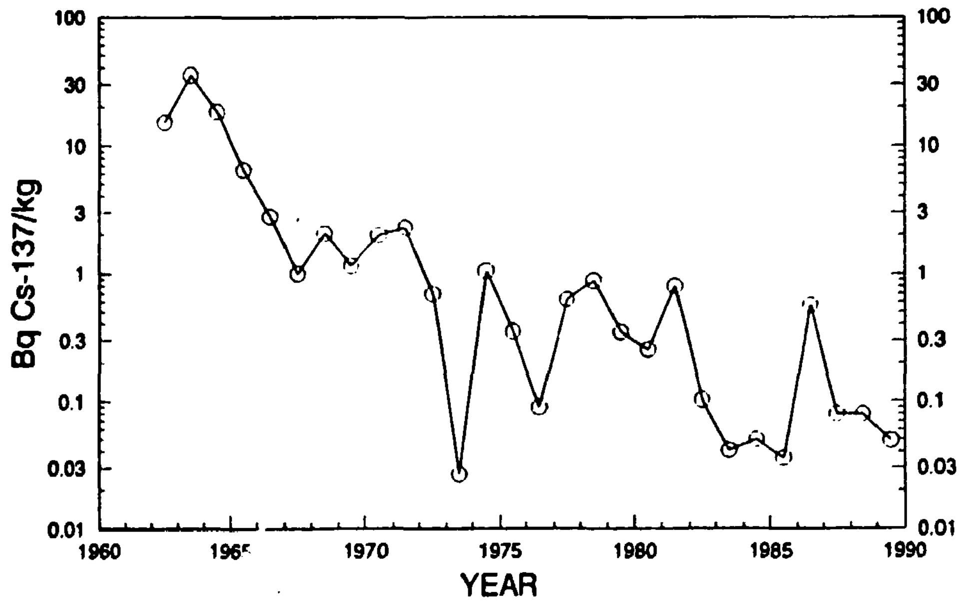


Fig. 5.3.5. Cesium-137 in rye collected in Denmark in 1962-1989. (Unit: Bg kg⁻¹).

Fig. 5.3.6. Cesium-137 in barley collected in Denmark in 1962-1989. (Unit: Bg kg⁻¹).



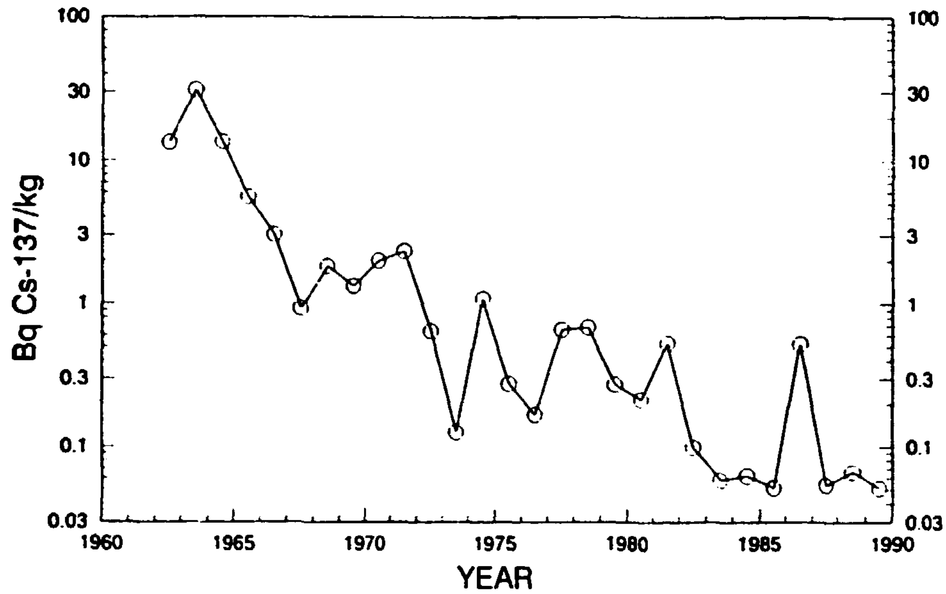
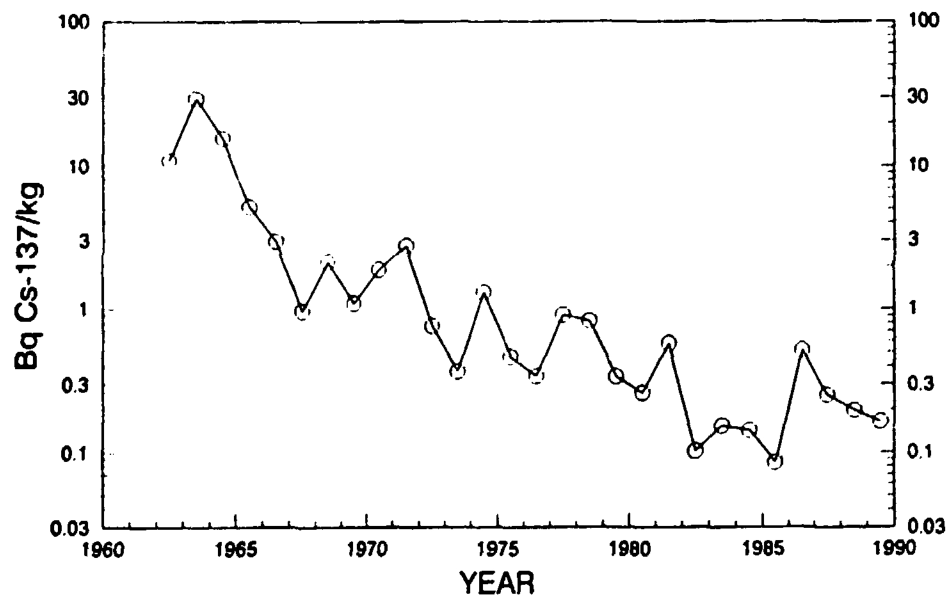


Fig. 5.3.7. Cesium-137 in wheat collected in Denmark in 1962-1989. (Unit: Bg kg^{-1}).

Fig. 5.3.8. Cesium-137 in oats collected in Denmark in 1962-1989. (Unit: Bg kg^{-1}).



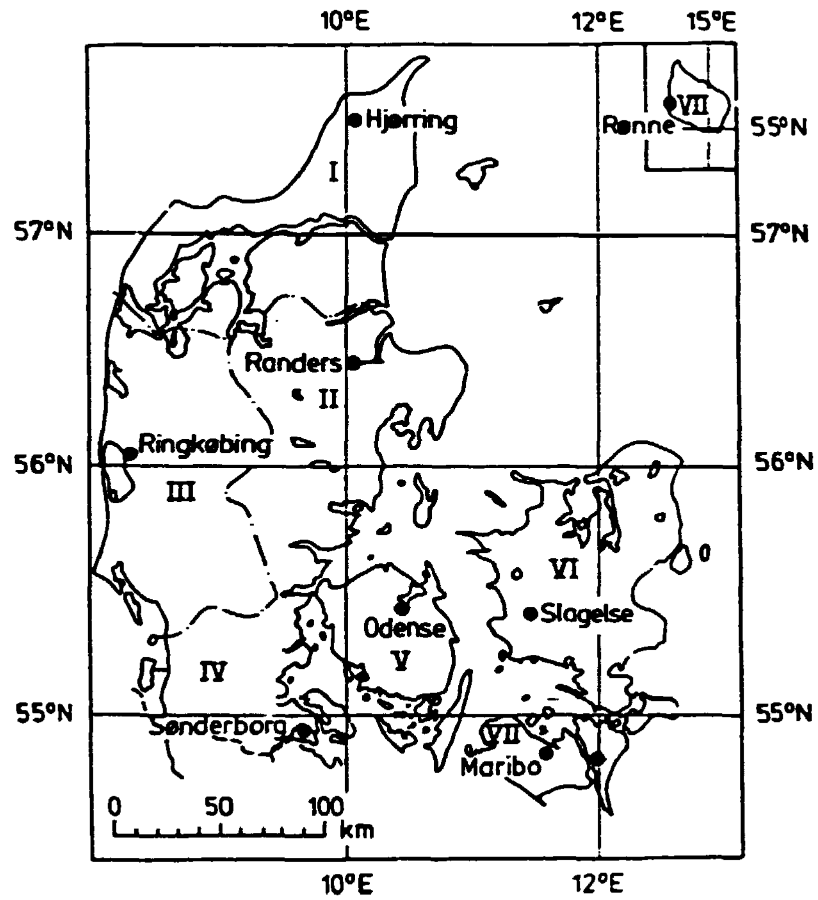


Fig. 5.4. Sample locations for bread and total diet.

Table 5.4.1.A. Strontium-90 in Danish bread collected in June 1988

Location	Rye bread		White bread	
	Bq kg^{-1}	Bq (kg Ca)$^{-1}$	Bq kg^{-1}	Bq (kg Ca)$^{-1}$
Jutland	0.25 ± 0.02	470	0.138 ± 0.001	400
The Islands	0.30 ± 0.01	860	0.114 ± 0.004	240
1988: Geometric mean	0.27	630	0.125	310
1988: Arithmetic mean	0.27	660	0.126	320
Copenhagen	0.28 ± 0.03	550	0.122 ± 0.010	240
Population weighted mean	0.27	600	0.127	310

The error term is 1 S.E. of the mean of double determinations.

Table 5.4.1.B. Strontium-90 in Danish bread collected in June 1989

Location	Rye bread		White bread	
	Bq kg^{-1}	Bq (kg Ca)$^{-1}$	Bq kg^{-1}	Bq (kg Ca)$^{-1}$
Jutland	0.21	730	0.113	270
The Islands	0.20	340	0.104	210
1989: Geometric mean	0.20	500	0.109	240
1989: Arithmetic mean	0.20	540	0.109	240
Copenhagen	0.176	360	0.191	300
Population weighted mean	0.199	520	0.132	260

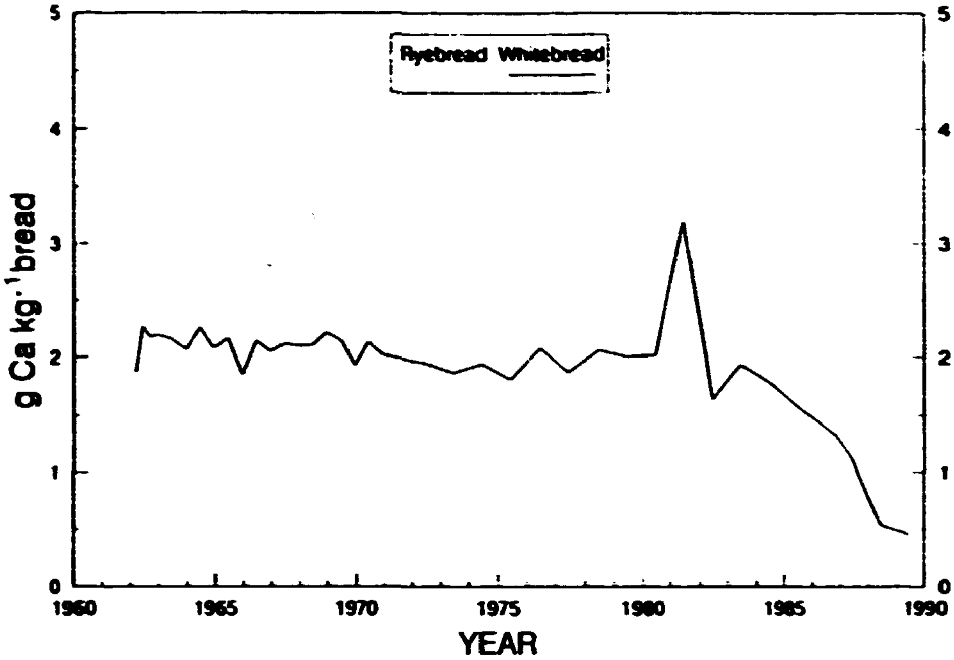


Fig. 5.4.3. Calcium in Danish bread 1962-1989. (Unit: g Ca kg^{-1} bread).

Table 5.4.2.A. Radiocesium in Danish bread collected in June 1988

Location		Rye bread Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$	^{134}Cs/^{137}Cs	White bread Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$	^{134}Cs/^{137}Cs
I	North Jutland	0.25	95	0.175	0.074	67	0.29
II	East Jutland	0.178	56	0.096 A	0.075	56	0.27 A
III	West Jutland	0.165	61	-	0.186	118	0.26
IV	South Jutland	0.25	96	-	0.082	67	0.199 A
V	Funen	0.58	196	0.25	0.136	110	0.35
VI	Zealand	0.27	75	0.111 A	0.046	32	0.25
VII	Lolland-Falster	0.33	115	0.174	0.37	300	0.28
VIII	Bornholm	0.105	27	-	0.0176 A	17.4 A	-
1988: Geometric mean		0.24	78	0.152	0.088	69	0.27
1988: Arithmetic mean		0.27	90	0.161	0.123	95	0.27
Copenhagen		0.45	152	0.27	0.058	42	-
Population-weighted mean		0.31	105	-	0.093	69	-

Table 5.4.2.B. Radiocesium in Danish bread collected in June 1989

Location		Rye bread Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$	^{134}Cs/^{137}Cs	White bread Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$	^{134}Cs/^{137}Cs
I	North Jutland	0.28	112	0.161	0.029	22	-
II	East Jutland	0.45	170	0.171	0.030	23	-
III	West Jutland	0.48	175	0.157	0.022	16.6	-
IV	South Jutland	0.40	154	0.148	0.047	35	-
V	Funen	0.38	139	0.168	0.068	47	0.21 A
VI	Zealand	0.22	84	0.172	0.028	21	-
VII	Lolland-Falster	0.120	44	0.26	0.057	37	0.22 A
VIII	Bornholm	0.057	17.2	0.34	0.027	21	-
1989: Geometric mean		0.25	91	0.189	0.036	26	0.22
1989: Arithmetic mean		0.30	112	0.197	0.039	28	0.22
Copenhagen		0.100	41	0.148 B	0.027	19.3	-
Population-weighted mean		0.29	109	-	0.033	24	-

Table 5.4.3.A. A comparison between ^{90}Sr and ^{137}Cs levels in bread (June) and grain 1988

Nuclides	Species	△Bread activity in June 1988 calculated as grain in Bq kg^{-1}	△Activity in grain from harvest 1987 Bq kg^{-1}	Bread/grain ratio
^{90}Sr	Wheat	0.85	0.59	1.44
	Rye	0.36	0.44	0.82
^{137}Cs	Wheat	0.33	0.078	4.2
	Rye	0.36	0.17	2.1

△(Risø Reports 1957-1989).

Table 5.4.3.B. A comparison between ^{90}Sr and ^{137}Cs levels in bread (June) and grain 1989

Nuclides	Species	△Bread activity in June 1989 calculated as grain in Bq kg^{-1}	△Activity in grain from harvest 1988 Bq kg^{-1}	Bread/grain ratio
^{90}Sr	Wheat	0.74	0.36	2.1
	Rye	0.27	0.36	0.75
^{137}Cs	Wheat	0.105	0.087	1.21
	Rye	0.40	0.186	2.2

△(Risø Reports 1957-1989).

Table 5.5.1.A. Strontium-90 and radiocesium in Danish potatoes in 1988

Location	Bq ^{90}Sr kg^{-1}	Bq ^{90}Sr (kg Ca)$^{-1}$	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$	$\frac{^{134}Cs}{^{137}Cs}$
Tylstrup	0.037	600	0.126	30	0.168 A
Kalø	0.0155	890	0.089	24	0.28 A
Borris	0.047	1020	0.26	65	0.174
Askov	0.036	1110	0.127	29	0.22 A
St. Jyndevad	0.047	700	0.116	28	0.161 A
Årslev	0.047	810	0.113	24	0.23
Tystofte	0.027	620	0.023 B	5.0 B	-
Ledreborg	0.040	610	0.034	8.2	-
Abed	0.034	450	0.025 B	5.4 B	-
Bornholm	0.036	660	0.030 A	7.3 A	-
1988: Geometric mean	0.035	720	0.070	16.5	0.20
1988: Arithmetic mean	0.037	750	0.094	23	0.21

Table 5.5.1.B. Strontium-90 and radiocesium in Danish potatoes in 1989

Location	Bq ^{90}Sr kg^{-1}	Bq ^{90}Sr (kg Ca)$^{-1}$	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$	$\frac{^{134}Cs}{^{137}Cs}$
Tylstrup	0.029	710	0.081	19.4	
Kalø	0.025	520	0.037 A	7.6 A	
Borris	0.024	530	0.182	35	0.136 A
Askov	0.080	1020	0.39	88	0.20
St. Jyndevad	0.025	370	0.129	28	
Årslev	0.025	360	0.108	23	0.179 B
Tystofte	0.048	570	< 0.022	< 4.9	
Ledreborg	0.030	670	0.024 B	5.7 B	
Abed	0.058	680	0.132	29	0.24 A
Bornholm	0.0179	240	0.039 A	6.4 A	
1989: Geometric mean	0.032	530	0.078	16.6	0.18
1989: Arithmetic mean	0.036	570	0.114	25	0.19

Table 5.6.1.A. Strontium-90 in vegetables and fruit collected in 1988

	Cabbage		Carrot		Peas		Apples	
Location	Bq kg^{-1}	Bq (kg Ca)$^{-1}$	Bq kg^{-1}	Bq (kg Ca)$^{-1}$	Bq kg^{-1}	Bq (kg Ca)$^{-1}$	Bq kg^{-1}	Bq (kg Ca)$^{-1}$
Jutland	0.28	640	0.41	1370	0.162	810	0.036	440
The islands	0.187	420	0.190	630	0.106	470	0.037	450
1988 Geometric mean	0.23	520	0.28	930	0.131	620	0.037	450
1988 Arithmetic mean	0.23	530	0.30	1000	0.134	640	0.037	450

Table 5.6.1.B. Strontium-90 in vegetables and fruit collected in 1989

	Cabbage		Carrot		Peas		Apples	
Location	Bq kg^{-1}	Bq (kg Ca)$^{-1}$	Bq kg^{-1}	Bq (kg Ca)$^{-1}$	Bq kg^{-1}	Bq (kg Ca)$^{-1}$	Bq kg^{-1}	Bq (kg Ca)$^{-1}$
Jutland	0.28	640	0.28	950	0.145	440	0.0193	340
The islands	0.152	270	0.099	360	0.132	510	0.0155	370
1989 Geometric mean	0.21	420	0.166	580	0.138	480	0.0173	360
1989 Arithmetic mean	0.22	460	0.189	650	0.139	480	0.0174	360

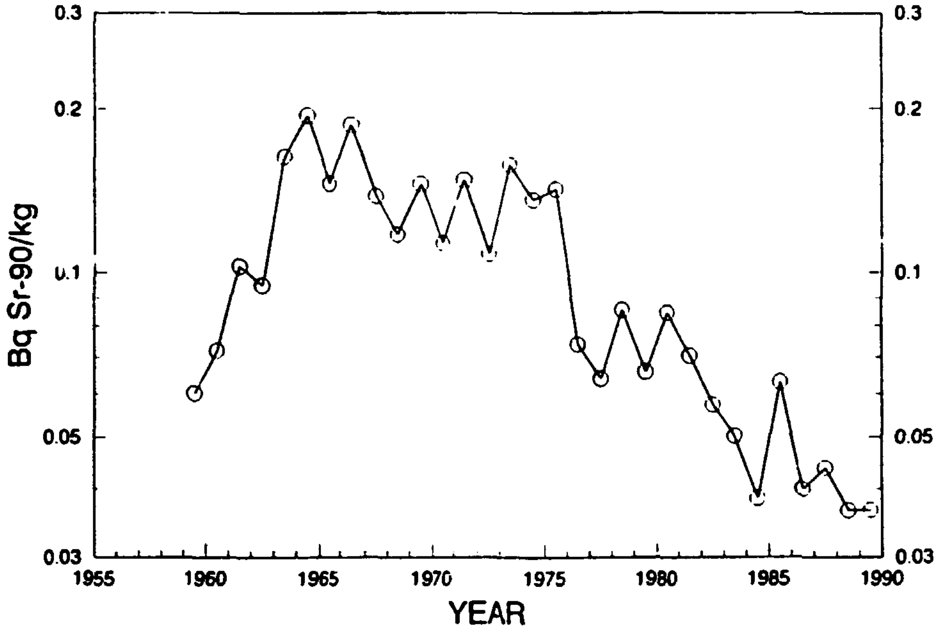
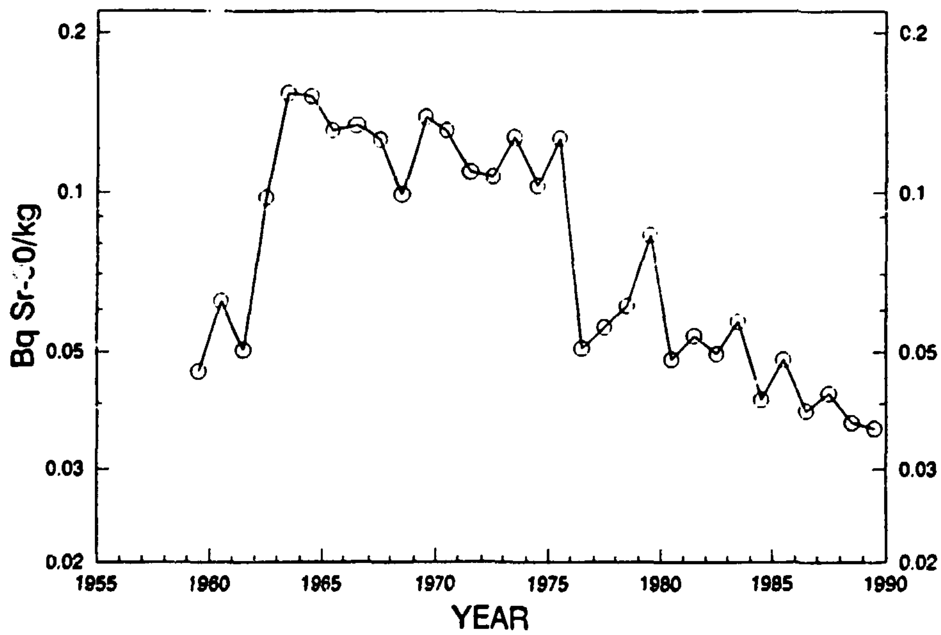


Fig. 5.5.1. Strontium-90 in potatoes collected in Jutland in 1959-1989. (Unit: Bq kg^{-1}).

Fig. 5.5.2. Stronuium-90 in potatoes collected in the Islands in 1959-1989. (Unit: Bq kg^{-1}).



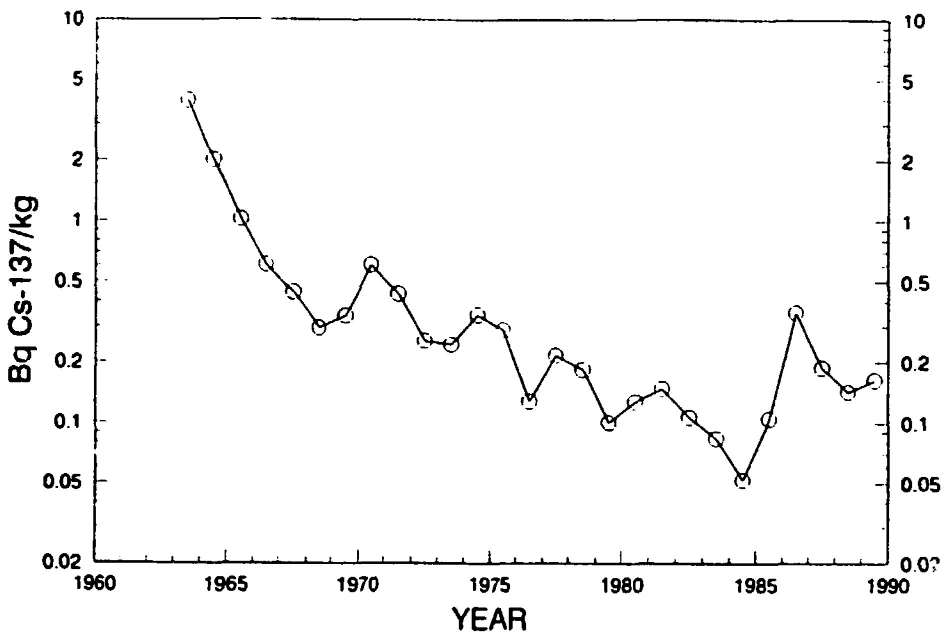


Fig. 5.5.3. Cesium-137 in potatoes collected in Jutland in 1963-1989. (Unit: Bq kg⁻¹).

Fig. 5.5.4. Cesium-137 in potatoes collected in the Islands in 1963-1989. (Unit: Bq kg⁻¹).

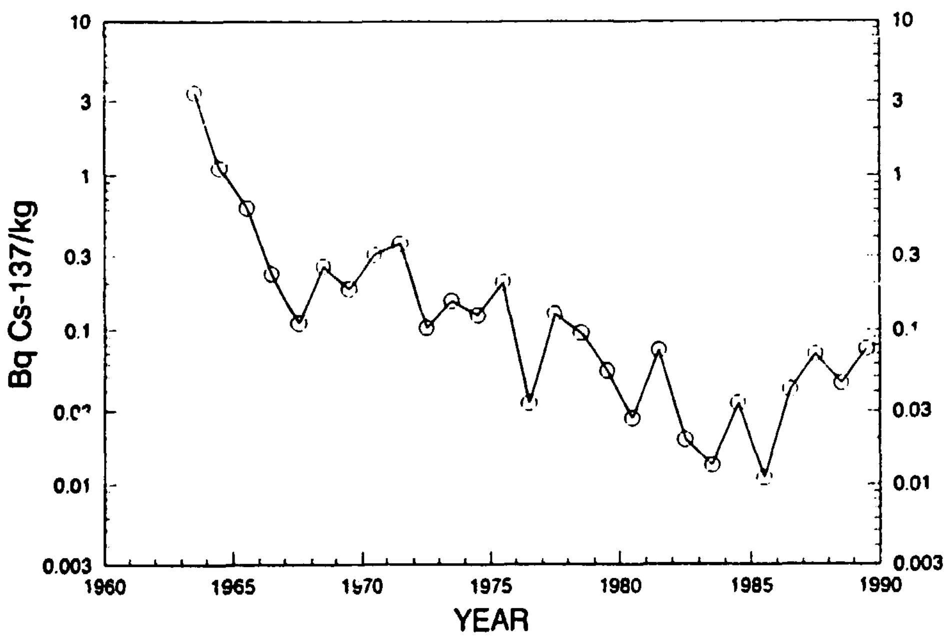


Table 5.6.2.A. Radiocesium in vegetables and fruit collected in 1988

Location		Cabbage			Carrots			Peas			Apples		
		^{137}Cs Bq kg^{-1}	^{137}Cs Bq (kg K)$^{-1}$	^{134}Cs / ^{137}Cs	^{137}Cs Bq kg^{-1}	^{137}Cs Bq (kg K)$^{-1}$	^{134}Cs / ^{137}Cs	^{137}Cs Bq kg^{-1}	^{137}Cs Bq (kg K)$^{-1}$	^{134}Cs / ^{137}Cs	^{137}Cs Bq kg^{-1}	^{137}Cs Bq (kg K)$^{-1}$	^{134}Cs / ^{137}Cs
I	North Jutland	0.055	26		0.032	18.2		0.23	67		0.066	73	0.24
II	East Jutland	0.035	51		0.0104 A	3.8 A		0.060	21		0.088	78	0.31
III	West Jutland	0.049	20		0.124	65	0.20	0.73	230	0.25	0.149	172	0.30
IV	South Jutland	0.130	77	0.102 A	0.107	61	0.143 A	0.22	77	0.28 B	0.041	39	[illegible] A
V	Funen	0.04[illegible]	26		0.044 A	21 A		0.146	54	0.28 A	0.034	33	0.50 A
VI	Zealand	0.0181	7.5		0.0123 A	4.9 A		0.107	27		0.104	145	0.23
VII	Lolland-Falster	0.0143 A	5.3 A		0.0070 B	2.5 B		0.050	16.0		0.025	21	
VIII	Bornholm	0.0119 A	5.0 A		0.011 B	3.0 B		0.028 A	6.7 A		0.0193 A	18.9	
1988:	Geometric mean	0.034	17.9		0.026	10.9	0.17	0.122	38	0.27	0.053	54	0.30
1988:	Arithmetic mean	0.045	27		0.043	22	0.17	0.196	63	0.27	0.066	72	0.31

Table 5.6.2.B. Radiocesium in vegetables and fruit collected in 1989

Location		Cabbage			Carrots			Peas			Apples		
		^{137}Cs Bq kg^{-1}	^{137}Cs Bq (kg K)$^{-1}$	^{134}Cs / ^{137}Cs	^{137}Cs Bq kg^{-1}	^{137}Cs Bq (kg K)$^{-1}$	^{134}Cs / ^{137}Cs	^{137}Cs Bq kg^{-1}	^{137}Cs Bq (kg K)$^{-1}$	^{134}Cs / ^{137}Cs	^{137}Cs Bq kg^{-1}	^{137}Cs Bq (kg K)$^{-1}$	^{134}Cs / ^{137}Cs
I	North Jutland	0.185	88	0.04 B	0.054	23		0.051	17.5		0.029	36	
II	East Jutland	0.0109 A	6.7 A		0.049	29		0.073	21		0.044	42	0.27
III	West Jutland	0.056	29	0.16 A	0.068	50	0.163 A	0.59	142	0.119	0.101	127	0.170
IV	South Jutland	0.039	14.9		0.21	84	0.103	0.132	47	0.21 A	0.141	170	0.20
V	Funen	0.0172 A	7.7 A		0.0113 B	7.7 B		0.37	127	0.155	0.079	86	0.161 A
VI	Zealand	0.0184 B	8.2 B		0.041	25		0.042	12.8		0.076	100	0.186
VII	Lolland-Falster	0.0093 B	3.6 B		0.031	14.0	0.146 B	0.049 A	17.2 A		0.069	51	0.193 A
VIII	Bornholm	0.022 A	9.7 A		0.0024 B	0.98 B		0.046	14.1		0.0168 A	11.8 A	
1989:	Geometric mean	0.027	12.4	0.082	0.033	17.1	0.135	0.100	32	0.156	0.058	60	0.194
1989:	Arithmetic mean	0.045	21	0.100	0.058	29	0.137	0.168	50	0.160	0.069	78	0.196

Table 5.6.3.A. Calculated ^{90}Sr and ^{137}Cs mean levels in vegetables in 1988

Daily intake in g		Bq ^{90}Sr kg^{-1}	Bq ^{90}Sr (kg Ca)$^{-1}$	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$
50	leaf vegetables (cabbage)	0.23	530	0.045	27
30	root vegetables (carrot)	0.30	1000	0.043	22
40	peas and beans	0.134	640	0.196	63
120 g		0.22	680	0.095	38

Table 5.6.3.B. Calculated ^{90}Sr and ^{137}Cs mean levels in vegetables in 1989

Daily intake in g		Bq ^{90}Sr kg^{-1}	Bq ^{90}Sr (kg Ca)$^{-1}$	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$
50	leaf vegetables (cabbage)	0.22	460	0.045	21
30	root vegetables (carrot)	0.189	650	0.058	29
40	peas and beans	0.139	480	0.168	50
120 g		0.185	510	0.089	33

Table 5.7.1.1. Strontium-90 in beef and pork collected in Denmark in June 1988 and June 1989

Year	Location	Species	Bq kg^{-1}	Bq (kg Ca)$^{-1}$
1988	Denmark	Beef	0.0081	120
1989	"	"	0.0131	119
1988	Copenhagen	Pork	0.0067 A	67 A
1989	"	"	< 0.001	< 14

Table 5.7.1.2.A. Radiocesium in beef and pork collected countrywide in Denmark in June 1988

Zone		Beef			Pork		
		Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs $(kg\ K)^{-1}$	$\frac{^{134}Cs}{^{137}Cs}$	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs $(kg\ K)^{-1}$	$\frac{^{134}Cs}{^{137}Cs}$
I.	North Jutland	0.92	410	0.29	0.32	109	0.177
II.	East Jutland	0.98	420	0.24	0.47	181	0.24
III.	West Jutland	0.32	111	0.179	0.65	196	0.26
IV.	South Jutland	2.1	830	0.28	0.52	210	0.24
V.	Funen	2.6	900	0.28	0.34	145	0.24
VI.	Zealand	0.74	220	0.26	0.128	47	-
VII.	Lolland-Falster	0.23	83	0.25	0.24	89	0.180
VIII.	Bornholm	2.4	870	0.27	0.194	64	-
Geometric mean		0.94	350	0.25	0.32	115	0.22
Arithmetic mean		1.27	480	0.26	0.36	130	0.22
Copenhagen		1.14	350	0.29	0.64	230	0.27
Population-weighted mean		1.08	390	-	0.46	163	-

Table 5.7.1.2.B. Radiocesium in beef collected countrywide in Denmark in June 1989

Zone		Beef		
		Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs $(kg\ K)^{-1}$	$\frac{^{134}Cs}{^{137}Cs}$
I.	North Jutland	0.66	230	0.152
II.	East Jutland	1.09	360	0.162
III.	West Jutland	1.43	500	0.174
IV.	South Jutland	1.28	460	0.177
V.	Funen	1.33	460	0.153
VI.	Zealand	0.73	250	0.189
VII.	Lolland-Falster	0.48	131	0.152
VIII.	Bornholm	0.44	184	0.138
Geometric mean		0.85	290	0.161
Arithmetic mean		0.93	320	0.162
Copenhagen		2.4	690	0.163
Population-weighted mean		1.40	450	-

Table 5.7.1.3.A. Radiocesium in beef and pork collected countrywide in Denmark in December 1988

Zone		Beef Bq ^{137}Cs kg^{-1}	Beef Bq^{137}Cs $(kg\ K)^{-1}$	Beef $^{134}Cs/^{137}Cs$	Pork Bq ^{137}Cs kg^{-1}	Pork Bq^{137}Cs $(kg\ K)^{-1}$	Pork $^{134}Cs/^{137}Cs$
I.	North Jutland	0.42	134	0.151	0.58	193	0.130 A
II.	East Jutland	0.47	177	0.196	0.36	138	0.137 A
III.	West Jutland	2.5	850	0.21	0.76	280	0.196
IV.	South Jutland	2.2	630	0.185	1.27	350	0.195
V.	Funen	1.08	400	0.176	0.52	181	0.21
VI.	Zealand	1.18	360	0.20	0.51	167	0.151
VII.	Lolland-Falster	1.17 ± 0.00	400 ± 13	0.24	0.31 ± 0.04	97 ± 18	0.172 A
VIII.	Bornholm	2.5	1000	0.25	0.31	104	0.197 A
Geometric mean		1.20	410	0.196	0.52	173	0.171
Arithmetic mean		1.45	490	0.198	0.58	189	0.173
Copenhagen		1.59	490	0.163	0.44	136	0.21
Population-weighted mean		1.33	430	-	0.54	180	-

Table 5.7.1.3.B. Radiocesium in beef collected countrywide in Denmark in December 1989

Zone		Beef Bq ^{137}Cs kg^{-1}	Beef Bq^{137}Cs $(kg\ K)^{-1}$	Beef $^{134}Cs/^{137}Cs$
I.	North Jutland	3.3	1250	0.134
II.	East Jutland	0.57	210	0.145
III.	West Jutland	0.68	220	0.157
IV.	South Jutland	0.90	310	0.182
V.	Funen	1.81	630	0.123
VI.	Zealand	0.74	260	0.124
VII.	Lolland-Falster	0.70	260	0.158
VIII.	Bornholm	2.2	740	0.131
Geometric mean		1.11	390	0.143
Arithmetic mean		1.36	480	0.144
Copenhagen		1.20	420	0.108
Population-weighted mean		1.19	420	-

Table 5.7.1.4.A. Radiocesium in beef and pork collected in Copenhagen in 1988

Month	Species	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$	$\frac{^{134}Cs}{^{137}Cs}$
March	Beef	1.29	420	0.31
"	Pork	0.46	165	0.27
Sept	Beef	0.92	290	0.18
"	Pork	0.30	97	0.22

Table 5.7.1.4.B. Radiocesium in pork collected in Copenhagen in March and September 1989

Month	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$	$\frac{^{134}Cs}{^{137}Cs}$
March	0.82	240	0.18
September	0.22	65	-

Table 5.7.1.5. Radiocesium in beef collected at Nyborg (Zone V) in 1988 and 1989

Month	Year	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$	$\frac{^{134}Cs}{^{137}Cs}$
Dec	1988	1.28	440	0.24
Jan	1989	0.26	86	0.22
Feb	"	0.133	49	0.21 A
March	"	0.169	64	0.152 B
April	"	0.129	48	-
May	"	0.191	66	0.158 A
June	"	2.4	690	0.163

Table 5.7.2.1.A. Strontium-90 in fish collected in Danish waters in 1988 (samples were obtained from Hundested (Cattegat) and Ringkøbing (North Sea))
(Cf. Table 5.7.2.2.A)

Species	Flesh Bq ^{90}Sr kg^{-1}	Flesh Bq ^{90}Sr (kg Ca)$^{-1}$	Bone Bq ^{90}Sr (kg Ca)$^{-1}$
Cod	0.0179	24	18.9
Plaice	0.0180	23	16.2
Herring	0.0033	6.2	4.0
1988: Geometric mean	0.0102	15.1	10.7
1988: Arithmetic mean	0.0131	17.8	13.0

Table 5.7.2.1.B. Strontium-90 in fish collected in Danish waters in 1989 (samples were obtained from Hundested (Cattegat) and Ringkøbing (North Sea))
(Cf. Table 5.7.2.2.B)

Species	Flesh Bq ^{90}Sr kg^{-1}	Flesh Bq ^{90}Sr (kg Ca)$^{-1}$	Bone Bq ^{90}Sr (kg Ca)$^{-1}$
Cod	0.0145	17.5	16.8
Plaice	0.0199	24.6	16.0
Herring	0.0040	7.5	4.0
1989: Geometric mean	0.0105	14.8	10.6
1989: Arithmetic mean	0.0128	16.5	12.4

Table 5.7.2.2.A. Radiocesium in fish (flesh) from Danish waters in 1988

Location	Month	Species	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs $(kg\ K)^{-1}$	$\frac{^{134}Cs}{^{137}Cs}$
Hundested	March	Cod	9.1	2800	0.22
(Cattegat)	March	Plaice	5.3	2000	0.25
- " -	March	Herring	2.7	810	0.142
- " -	Sept	Cod	5.9	2700	0.24
- " -	Sept	Plaice	5.8	1630	0.20
- " -	Sept	Herring*	2.2	630	0.147
1988: Geometric mean			4.6	1520	
1988: Arithmetic mean			5.2	1760	
Ringkøbing	March	Cod	2.8	1210	0.121
(North Sea)	March	Plaice	1.30	490	0.149
- " -	March	Herring	2.0	750	0.169
- " -	Sept	Cod	1.92	610	0.084
- " -	Sept	Plaice	1.11	390	0.146
- " -	Sept	Herring	2.1	680	0.142
1988: Geometric mean			1.79	640	
1988: Arithmetic mean			1.87	690	
1988: Total Geometric mean			2.9	990	
1988: Total Arithmetic mean			3.5	1220	

*The sample contained 3.7 Bq ^{110m}Ag kg^{-1}

Table 5.7.2.2.B. Radiocesium in fish (flesh) from Danish waters in 1989

Location	Month	Species	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs $(kg\ K)^{-1}$	^{134}Cs / ^{137}Cs
Hundested	March	Cod	33	10500	0.23
(Cattegat)	March	Plaice	1.61	650	0.123
-"-	March	Herring	1.83	590	0.132
-"-	Sept	Cod	6.9	2000	0.151
-"-	Sept	Plaice	6.0	1730	0.163
-"-	Sept	Herring	1.48	470	0.115
1989: Geometric mean			4.3	1370	
1989: Arithmetic mean			8.5	2700	
Ringkøbing	March	Cod	0.72	250	0.061 A
(North Sea)	March	Plaice	0.54	220	0.127 A
-"-	March	Herring	1.91	750	0.163
-"-	Sept	Cod	1.10	330	0.052 A
-"-	Sept	Plaice	0.56	230	0.077 A
-"-	Sept	Herring	1.18	440	0.090
1989: Geometric mean			0.90	330	
1989: Arithmetic mean			1.00	370	
Bornholm	Jan	Cod	24	6000	0.23
(Baltic Sea)	May	Cod	14.0	4300	0.195
-"-	May	Plaice	11.8	3900	0.180
-"-	May	Herring	10.8	3300	0.192
1989: Geometric mean			14.4	4300	
1989: Arithmetic mean			15.2	4400	
Skagen	Jan	Sole	1.26	440	0.152
-"-	Feb	Mackerel	0.24	82	0.076
1989: Geometric mean			0.55	190	
1989: Arithmetic mean			0.75	260	
1989: Total Geometric mean			2.6	880	
1989: Total Arithmetic mean			6.6	2000	

*The sample contained 0.44 Bq ^{210}Po kg^{-1}

Table 5.7.2.3. Radiocesium in marine fish (eel) from various locations in 1987 and 1988

Location	Date	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs $(kg\ K)^{-1}$	$^{134}Cs/^{137}Cs$
Oscarshamn Baltic Sea. Sweden	March 1988	11.7	5400	0.30
"	April 1988	10.0	4200	0.30
"	July 1988	9.8	4100	0.26
Biotest lake Forsmark.Sweden	1987	183	76000	0.48
"	1988	128	60000	0.35

Table 5.7.3. Strontium-90 and radiocesium in eggs collected in Copenhagen in 1988 and 1989

Year	Month	Bq ^{90}Sr kg^{-1}	Bq ^{90}Sr $(kg\ Ca)^{-1}$	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs $(kg\ K)^{-1}$	^{134}Cs kg^{-1}
1988	June	0.024	46	0.102	78	0.023
1989	June	0.0121	22	0.042	33	-

Fig. 5.7.2. Cesium-137 in eels from the Baltic Sea (Oscarshamn, Sweden) 1986-1988. (Unit: Bq ^{137}Cs kg^{-1}).

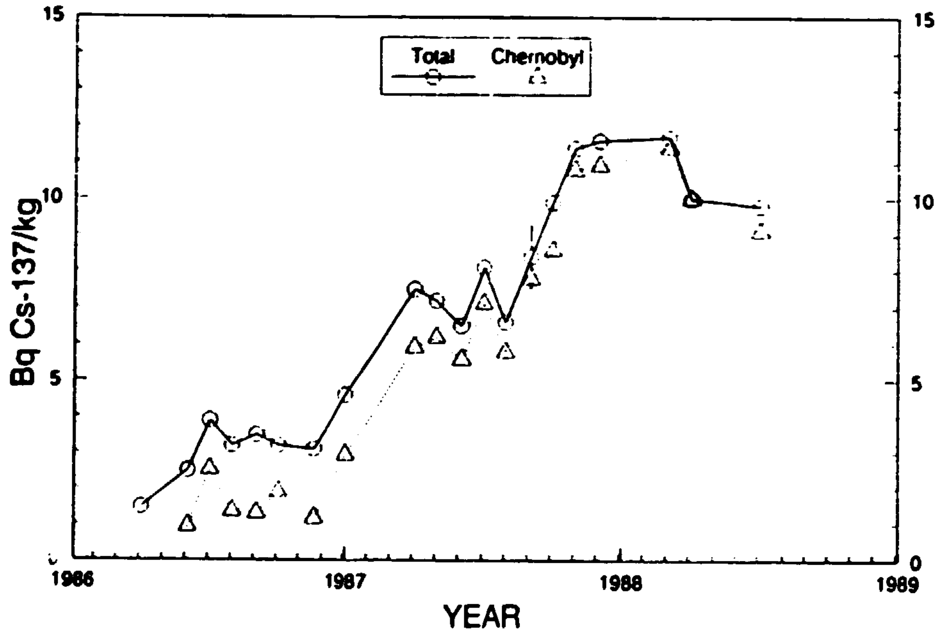


Table 5.7.4. Strontium-90 and radiocesium in various imported vegetable food purchased in Copenhagen in November 1988

Sample	Bq ^{90}Sr kg^{-1}	Bq ^{90}Sr $(kg\ Ca)^{-1}$	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs $(kg\ K)^{-1}$	$\frac{^{134}Cs}{^{137}Cs}$
Rize	0.167	220	0.054	43	
Oats	0.57	540	1.19	350	0.18
Hazel nuts	3.3	2000	1.75	320	0.22
Banana	0.0039	75	< 0.017	< 4.5	
Orange	0.046	170	0.013 B	8.8 B	
Coffee	0.191	330	0.56	31	
Tea	0.38	2200	1.34	98	0.08 A
Rize*	-	-	0.030 A	29 A	

*Collected in February 1989.

Table 5.8.1.A. Strontium-90 in Danish total diet collected in June 1988

Zone		Bq $(kg\ Ca)^{-1}$	Bq day^{-1} cap^{-1}	g Ca day^{-1}
I.	North Jutland	162	0.162	1.01
II.	East Jutland	147	0.165	1.12
III.	West Jutland	164	0.173	1.05
IV.	South Jutland	180	0.191	1.06
V.	Funen	151	0.189	1.25
VI.	Zealand	136	0.154	1.14
VII.	Lolland-Falster	152	0.160	1.05
VIII.	Bornholm	144	0.150	1.04
Geometric mean		154	0.168	1.09
Arithmetic mean		155	0.168	1.09
Copenhagen		126	0.155	1.23
Population-weighted mean		146	0.165	1.14

Table 5.8.1.B. Strontium-90 in Danish total diet collected in June 1989

Zone		Bq $(kg\ Ca)^{-1}$	Bq day^{-1} cap^{-1}	g Ca day^{-1}
I.	North Jutland	121	0.135	1.11
II.	East Jutland	122	0.141	1.16
III.	West Jutland	137	0.154	1.12
IV.	South Jutland	147	0.160	1.09
V.	Funen	130	0.155	1.19
VI.	Zealand	131	0.145	1.11
VII.	Lolland-Falster	118	0.146	1.24
VIII.	Bornholm	140	0.162	1.15
Geometric mean		131	0.150	1.15
Arithmetic mean		131	0.150	1.15
Copenhagen		113	0.151	1.34
Population-weighted mean		125	0.149	1.20

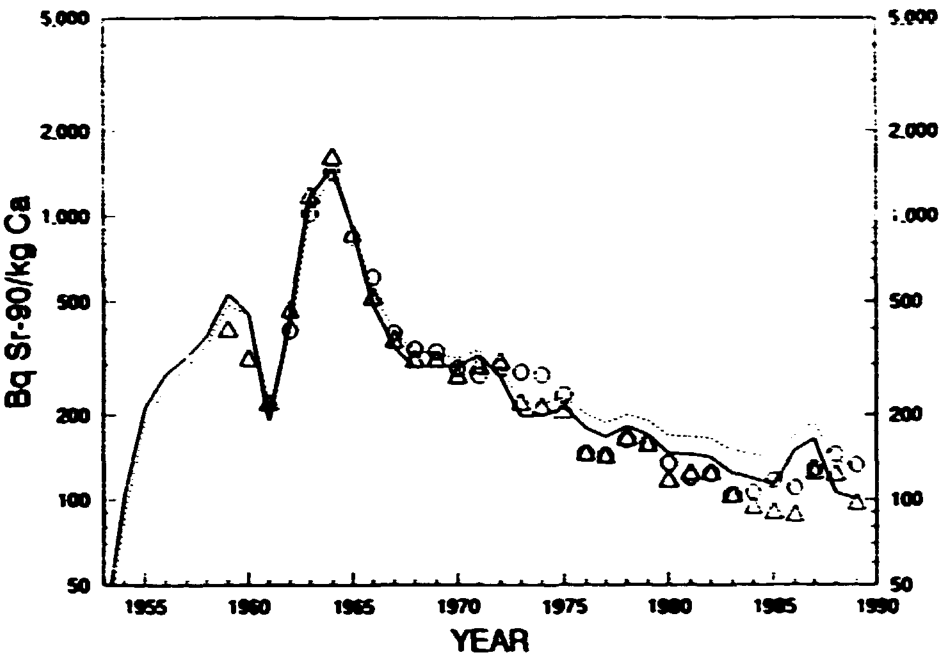


Fig. 5.8.1. Predicted and observed ^{90}Sr levels in the Danish total diet. The dotted curve represents the predicted values for »Diet C« (cf. Tables 5.7.1 and 5.7.2) and the circles are the corresponding observed values. The unbroken curve represents the predicted values for »Diet P« (cf. Table 5.9.3), and the triangles the corresponding observed values.

Fig. 5.8.2. Calcium in Danish average diet 1962-1989. (Unit: g Ca day^{-1}).

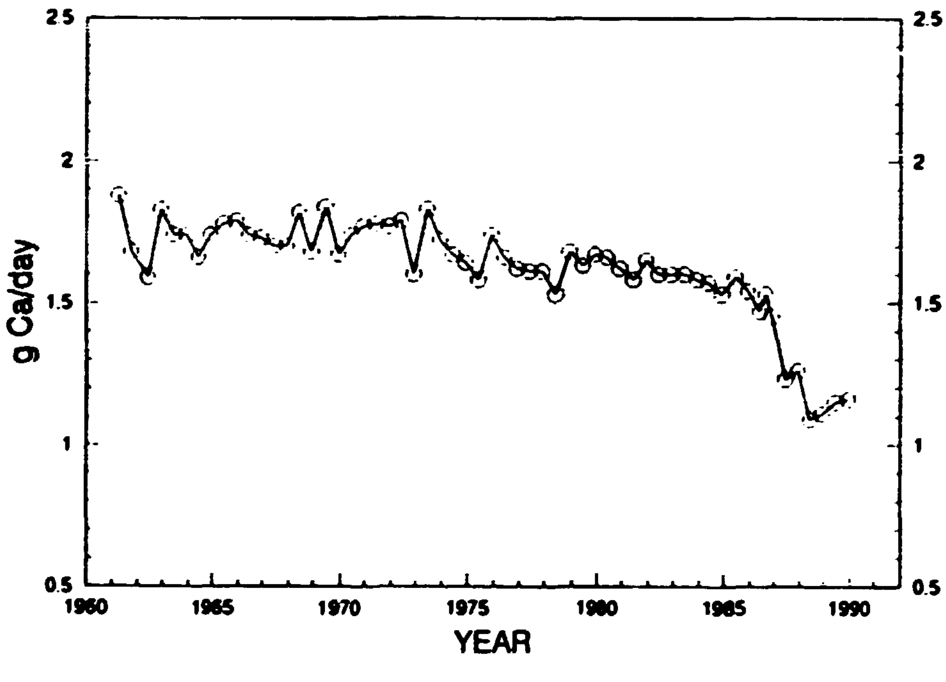


Table 5.8.2.A. Strontium-90 in Danish total diet collected in December 1988

Zone		Bq (kg Ca)$^{-1}$	Bq day^{-1} cap^{-1}	g Ca day^{-1}
I.	North Jutland	153	0.154	1.01
II.	East Jutland	151	0.157	1.04
III.	West Jutland	140	0.148	1.06
IV.	South Jutland	151	0.165	1.09
V.	Funen	149	0.168	1.13
VI.	Zealand	122	0.142	1.16
VII.	Lolland-Falster	124	0.145	1.17
VIII.	Bornholm	127	0.150	1.18
Geometric mean		140	0.153	1.10
Arithmetic mean		140	0.154	1.11
Copenhagen		100 ± 0	0.127 ± 0.004	1.27 ± 0.04
Population-weighted mean		131	0.146	1.14

The error term is 1 S.E. of the mean of double determinations.

Table 5.8.2.B. Strontium-90 in Danish total diet collected in December 1989

Zone		Bq (kg Ca)$^{-1}$	Bq day^{-1} cap^{-1}	g Ca day^{-1}
I.	North Jutland	159	0.173	1.09
II.	East Jutland	146	0.156	1.07
III.	West Jutland	164	0.173	1.06
IV.	South Jutland	153	0.171	1.11
V.	Funen	118	0.133	1.13
VI.	Zealand	117	0.161	1.38
VII.	Lolland-Falster	103	0.123	1.20
VIII.	Bornholm	90	0.112	1.25
Geometric mean		129	0.149	1.16
Arithmetic mean		131	0.150	1.16
Copenhagen		85	0.113	1.33
Population-weighted mean		125	0.147	1.21

Table 5.8.3.A. Radiocesium in Danish total diet collected in June 1988

Zone		Bq ^{137}Cs (kg K)$^{-1}$	Bq ^{137}Cs day^{-1} cap^{-1}	g K day^{-1}	$\frac{^{134}Cs}{^{137}Cs}$
I.	North Jutland	111	0.37	3.3	0.21
II.	East Jutland	104	0.36	3.4	0.20
III.	West Jutland	124	0.45	3.6	0.199
IV.	South Jutland	154	0.49	3.2	0.23
V.	Funen	175	0.55	3.1	0.25
VI.	Zealand	102	0.35	3.4	0.23
VII.	Lolland-Falster	174	0.61	3.5	0.24
VIII.	Bornholm	158	0.56	3.5	0.21
Geometric mean		135	0.46	3.4	0.22
Arithmetic mean		138	0.47	3.4	0.22±0.02
Copenhagen		164	0.49	3.0	0.24
Population-weighted mean		135	0.44	3.3	-

The error term is 1 S.D. of the mean.

Table 5.8.3.B. Radiocesium in Danish total diet collected in June 1989

Zone		Bq ^{137}Cs (kg K)$^{-1}$	Bq ^{137}Cs day^{-1} cap^{-1}	g K day^{-1}	$\frac{^{134}Cs}{^{137}Cs}$
I.	North Jutland	79	0.25	3.2	0.191 A
II.	East Jutland	103	0.33	3.2	0.151 A
III.	West Jutland	123	0.37	3.0	0.146
IV.	South Jutland	102	0.34	3.3	0.191
V.	Funen	79	0.27	3.4	0.165
VI.	Zealand	94	0.34	3.6	0.150
VII.	Lolland-Falster	45	0.177	3.9	0.145 A
VIII.	Bornholm	138	0.49	3.5	0.185
Geometric mean		91	0.31	3.4	0.164
Arithmetic mean		95	0.32	3.4	0.165±0.020
Copenhagen		75	0.26	3.5	0.146
Population-weighted mean		91	0.30	3.4	-

The error term is 1 S.D. of the mean.

Table 5.8.4.A. Radiocesium in Danish total diet collected in December 1988

Zone		Bq ^{137}Cs (kg K)$^{-1}$	Bq ^{137}Cs day^{-1} cap^{-1}	g K day^{-1}	^{134}Cs / ^{137}Cs
I.	North Jutland	123	0.45	3.6	0.142 A
II.	East Jutland	137	0.48	3.5	0.170
III.	West Jutland	147	0.50	3.4	0.170
IV.	South Jutland	136	0.45	3.3	0.173 A
V.	Funen	104	0.36	3.5	0.168 A
VI.	Zealand	92	0.31	3.4	0.154 B
VII.	Lolland-Falster	133	0.48	3.6	0.25
VIII.	Bornholm	159	0.62	3.9	0.20
Geometric mean		127	0.45	3.5	0.176
Arithmetic mean		129	0.46	3.5	0.178 ± 0.033
Copenhagen*		220 ± 111	0.77 ± 0.39	3.4 ± 0.1	0.20 ± 0.03
Population-weighted mean		150	0.52	3.5	-

The error term is 1 S.D. of the mean.

*The error term is 1 S.E. of the mean of double collections.

Table 5.8.4.B. Radiocesium in Danish total diet collected in December 1989

Zone		Bq ^{137}Cs (kg K)$^{-1}$	Bq ^{137}Cs day^{-1} cap^{-1}	g K day^{-1}	^{134}Cs / ^{137}Cs
I.	North Jutland	121	0.42	3.5	0.135 A
II.	East Jutland	93	0.33	3.6	0.100 A
III.	West Jutland	100	0.34	3.4	0.126 A
IV.	South Jutland	108	0.39	3.6	0.162 A
V.	Funen	96	0.35	3.6	0.141 A
VI.	Zealand	81	0.29	3.6	0.163 A
VII.	Lolland-Falster	42	0.144	3.4	0.072 B
VIII.	Bornholm	240	0.91	3.8	0.153 A
Geometric mean		99	0.35	3.6	0.128
Arithmetic mean		109	0.40	3.6	0.132 ± 0.032
Copenhagen		63	0.21	3.3	0.104 A
Population-weighted mean		88	0.31	3.5	-

Table 5.9.1.A. Estimate of the ^{90}Sr content in grain products consumed pro capite in 1988

Type	Fraction from harvest 1987			Fraction from harvest 1988			Total
	kg flour	Bq kg^{-1}	Bq	kg flour	Bq kg^{-1}	Bq	Bq
Rye flour 100% extraction	21.9	0.44	9.64	7.3	0.36	2.63	12.27
Wheat flour 75% extraction	32.9	0.129	4.24	10.9	0.072	0.78	5.02
Grits	5.5	0.20	1.10	1.8	0.14	0.25	1.35
Total	60.3	0.25	14.98	20.0	0.18	3.66	18.64

Table 5.9.1.B. Estimate of the ^{90}Sr content in grain products consumed pro capite in 1989

Type	Fraction from harvest 1988			Fraction from harvest 1989			Total
	kg flour	Bq kg^{-1}	Bq	kg flour	Bq kg^{-1}	Bq	Bq
Rye flour 100% extraction	21.9	0.36	7.8	7.3	0.30	2.2	10.0
Wheat flour 75% extraction	32.9	0.072	2.4	10.9	0.072	0.78	3.18
Grits	5.5	0.172	0.95	1.8	0.23	0.41	1.36
Total	60.3	0.18	11.2	20.0	0.170	3.4	14.54

Table 5.9.2.A. Estimate of the ^{137}Cs content in grain products consumed pro capite in 1988

Type	Fraction from harvest 1987			Fraction from harvest 1988			Total
	kg flour	Bq kg^{-1}	Bq	kg flour	Bq kg^{-1}	Bq	Bq
Rye flour 100% extraction	21.9	0.17	3.72	7.3	0.19	1.39	5.11
Wheat flour 75% extraction	32.9	0.04	1.32	10.9	0.04	0.44	1.76
Grits	5.5	0.25	1.38	1.8	0.15	0.27	1.65
Total	60.3	0.11	6.42	20.0	0.11	2.10	8.52

Table 5.9.2.B. Estimate of the ^{137}Cs content in grain products consumed pro capite in 1989

Type	Fraction from harvest 1988			Fraction from harvest 1989			Total
	kg flour	Bq kg^{-1}	Bq	kg flour	Bq kg^{-1}	Bq	Bq
Rye flour 100% extraction	21.9	0.186	4.1	7.3	0.151	1.10	5.2
Wheat flour 75% extraction	32.9	0.042	1.38	10.9	0.056	0.61	1.99
Grits	5.5	0.23	1.26	1.8	0.20	0.36	1.62
Total	60.3	0.11	6.7	20.0	0.10	2.1	8.8

Table 5.9.3.A. Estimate of the mean content of ^{90}Sr in the human diet in 1988

Type of food	Annual quantity in kg	Bq ^{90}Sr per kg	Total Bq ^{90}Sr	Percentage of total Bq ^{90}Sr in food	References
Milk and cream	164.0	0.062	10.17	20.4	(Table 5.1.1.A)
Cheese	9.1	0.41	3.73	7.5	(Table 5.2.2)
Grain products	80.3	0.232	18.64	37.4	(Table 5.9.1.A)
Potatoes	73.0	0.037	2.70	5.4	(Table 5.5.1.A)
Vegetables	43.8	0.22	9.64	19.3	(Table 5.6.3.A)
Fruit	51.1	0.034	1.74	3.5	1)
Meat	54.7	0.022	1.20	2.4	2)
Eggs	10.9	0.024	0.26	0.5	(Table 5.7.3)
Fish	10.9	0.013	0.14	0.3	(Table 5.7.2.1.A)
Coffee and tea	5.5	0.25	1.38	2.8	3)
• Drinking water	548	0.0005	0.27	0.5	(Table 4.3.3.1.A)
Total			49.87		

The mean Ca intake was estimated at 0.41 kg y^{-1} (approx. 0.1 kg creta praeparata). Hence the ^{90}Sr/Ca ratio in total diet was 122 Bq ^{90}Sr (kg Ca)$^{-1}$ (3.3 S.U.) in 1988.

• No collections in 1988. 1987 data used.

Table 5.9.4.A. Estimate of the mean content of ^{137}Cs in the human diet in 1988

Type of food	Annual quantity in kg	Bq ^{137}Cs per kg	Total Bq ^{137}Cs	Percentage of total Bq ^{137}Cs in food	References
Milk and cream	164.0	0.28	45.92	29.9	(Table 5.1.3.A)
Cheese	9.1	0.135	1.23	0.8	(Table 5.2.2)
Grain products	80.3	0.106	8.52	5.6	(Table 5.9.2.A)
Potatoes	73.0	0.094	6.86	4.5	(Table 5.5.1.A)
Vegetables	43.8	0.095	4.16	2.7	(Table 5.6.3.A)
Fruit	51.1	0.049	2.50	1.6	1)
Meat	54.7	0.72	39.38	25.7	2)
Eggs	10.9	0.10	1.09	0.7	(Table 5.7.3)
Fish	10.9	3.6	39.24	25.6	(Table 5.7.2.2.A)
Coffee and tea	5.5	0.82	4.51	2.9	3)
• Drinking water	548	0.00006	0.03	0.0	(Table 4.3.3.1.A)
Total			153.44		

As the approximate intake of potassium was 1.365 kg y^{-1} the ^{137}Cs/K ratios were 112 Bq ^{137}Cs (kg K)$^{-1}$ or 3.0 M.U. in 1988.

• No collections in 1988. 1987 data used.

Notes to Tables 5.9.3 and 5.9.4.

1) Calculated from apples in Tables 5.6.1.B and 5.6.2.B and from banana and orange in Table 5.7.4 with the relative weighting factors 0.714, 0.143, 0.143, respectively.

2) Calculated from the mean of the June and December sampling for ^{137}Cs in beef (Tables 5.7.1.2.B and 5.7.1.3.B) and from Table 5.7.1.4.B (^{137}Cs in pork). Table 5.7.1.1 gives ^{90}Sr data for beef and pork. In the calculation beef is weighted by 0.33 and pork by 0.67.

3) One third of the total consumption consists of tea and two-thirds of coffee. The data from Table 5.7.4. are used for the calculation.

Arithmetic means are used all through.

Table 5.9.3.B. Estimate of the mean content of ^{90}Sr in the human diet in 1989 (cf. notes to A tables)

Type of food	Annual quantity in kg	Bq ^{90}Sr per kg	Total Bq ^{90}Sr	Percentage of total Bq ^{90}Sr in food
Milk and cream	164.0	0.058	9.51	22.6
Cheese	9.1	0.44	4.00	9.5
Grain products	80.3	0.181	14.54	34.5
Potatoes	73.0	0.036	2.63	6.3
Vegetables	43.8	0.185	8.10	19.2
Fruit	51.1	0.020	1.02	2.4
Meat	54.7	0.009	0.49	1.2
Eggs	10.9	0.012	0.13	0.3
Fish	10.9	0.013	0.14	0.3
Coffee and tea	5.5	0.254	1.40	3.3
Drinking water	548	0.33×10^{-3}	0.18	0.4
Total			42.14	

The mean Ca intake was estimated at 0.44 kg y^{-1} (approx. 0.1 kg creta praeparata). Hence the $^{90}Sr/Ca$ ratio in total diet was 96 Bq ^{90}Sr (kg Ca)$^{-1}$ (2.6 S.U.) in 1989.

Table 5.9.4.B. Estimate of the mean content of ^{137}Cs in the human diet in 1989 (cf. notes to A tables)

Type of food	Annual quantity in kg	Bq ^{137}Cs per kg	Total Bq ^{137}Cs	Percentage of total Bq ^{137}Cs in food
Milk and cream	164.0	0.178	29.19	17.1
Cheese	9.1	0.153	1.39	0.8
Grain products	80.3	0.110	8.80	5.1
Potatoes	73.0	0.114	8.32	4.9
Vegetables	43.8	0.089	3.90	2.3
Fruit	51.1	0.054	2.76	1.6
Meat	54.7	0.728	39.82	23.3
Eggs	10.9	0.042	0.46	0.3
Fish	10.9	6.6	71.94	42.0
Coffee and tea	5.5	0.819	4.50	2.6
Drinking water	548	0.105×10^{-3}	0.06	0.0
Total			171.14	

As the approximate intake of potassium was 1.365 kg y^{-1} the $^{137}Cs/K$ ratios were 125 Bq ^{137}Cs (kg K)$^{-1}$ or 3.4 M.U. in 1989.

Table 5.10.1.1.A. Strontium-90 and radiocesium in grass from Zealand, 1988

Periods	Bq ^{90}Sr (kg ash)$^{-1}$	Bq ^{90}Sr (kg Ca)$^{-1}$	Bq ^{137}Cs kg^{-1} dry	Bq^{137}Cs (kg K)$^{-1}$	g K kg^{-1} dry	$\frac{^{134}Cs}{^{137}Cs}$
Jan-March	11.8	290				
April-June	13.9	300				
July-Sept	20.3	420				
Oct-Dec	26.0	420	1.06	39	26.9	0.26
1988: Geometric mean	17.2	350				
1988: Arithmetic mean	18.0	360				

Table 5.10.1.1.B. Strontium-90 and radiocesium in grass from Zealand, 1989

Periods	Bq ^{90}Sr (kg ash)$^{-1}$	Bq ^{90}Sr (kg Ca)$^{-1}$	Bq ^{137}Cs kg^{-1} dry	Bq^{137}Cs (kg K)$^{-1}$	g K kg^{-1} dry	$\frac{^{134}Cs}{^{137}Cs}$
Jan-March	17.2	350	1.82	184	9.9	0.17 A
April-June	15.8	330	1.12 A	37	29.9	-
July-Sept	24.2	320	1.03	46	22.1	0.17 A
Oct-Dec	16.7	230	1.73	74	23.2	0.20 A
1989: Geometric mean	18.2	300	1.38	69	19.7	0.18
1989: Arithmetic mean	18.4	310	1.42	85	21.3	0.18

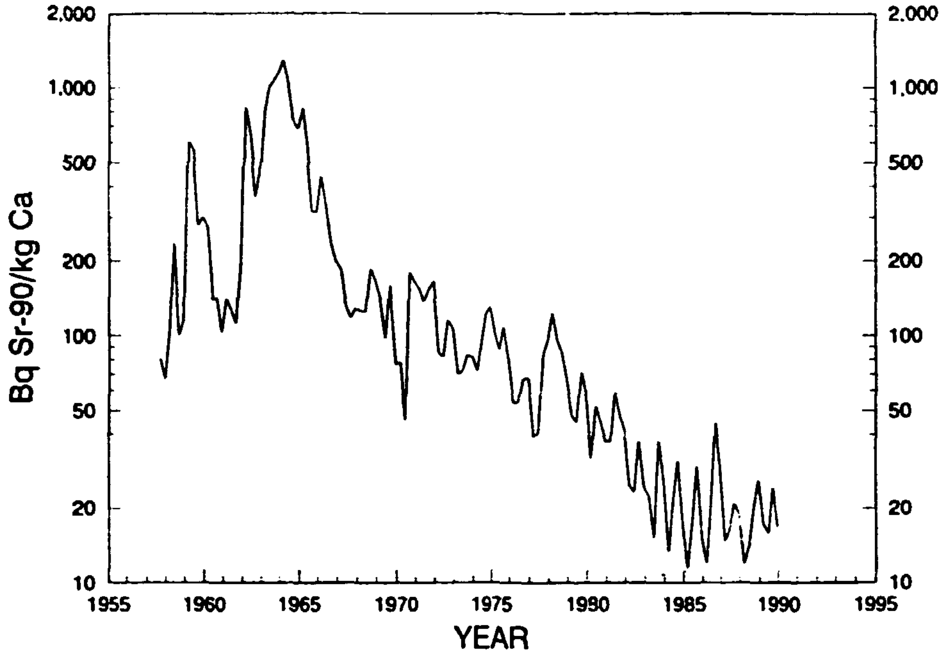


Fig. 5.10.1. Quarterly ^{90}Sr levels in grass, 1957-1989.

Fig. 5.10.2. Cesium-137 in grass samples collected at Risø, Denmark in the period April 1986 - December 1989.

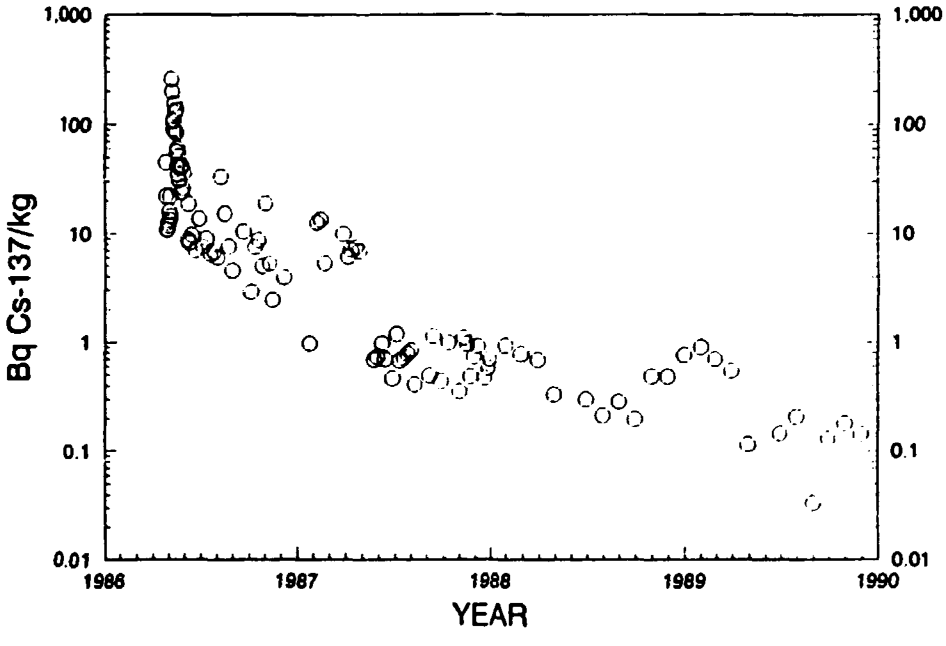


Table 5.10.1.2.A. Radiocesium in grass collected at Risø weekly in 1988

Month	Bq ^{137}Cs kg^{-1} fresh weight	Bq ^{137}Cs m^{-2}	g K kg^{-1} fresh	^{134}Cs/^{137}Cs
Jan	0.69	0.29	1.47	0.32
Feb	0.92	0.33	4.68	0.28
March	0.77	0.24	0.87	0.17 B
April	0.69	0.160	5.94	0.27 A
May	0.33	0.129	7.25	0.36 A
June	-	-	8.32	-
July	0.30	0.108	6.79	0.24 A
Aug	0.21 A	0.078 A	7.12	-
Sept	0.28	0.100	6.25	0.38 A
Oct	0.197 A	0.082 A	4.88	0.34 B
Nov	0.49	0.111	5.73	-
Dec	0.48	0.148	2.24	0.28 A
1988: Geometric mean	0.43	0.144	4.3	0.29
1988: Arithmetic mean	0.49	0.161	5.1	0.29

Table 5.10.1.2.B. Radiocesium in grass collected at Risø weekly in 1989

Month	Bq ^{137}Cs kg^{-1} fresh weight	Bq ^{137}Cs m^{-2}	g K kg^{-1} fresh	^{134}Cs/^{137}Cs
Jan	0.76	0.134	2.76	0.25 A
Feb	0.90	0.144	2.95	0.27
March	0.69	0.149	2.52	0.21 A
April	0.55	0.137	3.55	0.25 A
May	0.115 A	0.043 A	6.54	
June	-	-	5.98	
July	0.145	0.055	5.95	
Aug	0.21 A	0.078 A	5.75	
Sept	0.03 B	0.014 B	5.60	
Oct	0.130	0.065	4.77	
Nov	0.181 A	0.052 A	6.45	
Dec	0.144 A	0.043 A	3.23	
1989: Geometric mean	0.23	0.068	4.4	0.24
1989: Arithmetic mean	0.35	0.083	4.7	0.24

Table 5.10.2.A. Radiocesium in grass collected at the state experimental farms in 1988 (fresh weight samples)

	May-June				August-September			
Location	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs m^{-2}	$\frac{^{134}Cs}{^{137}Cs}$	g K kg^{-1}	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs m^{-2}	$\frac{^{134}Cs}{^{137}Cs}$	g K kg^{-1}
Tylstrup	0.73	0.70	0.25	5.3	0.32	0.49		5.3
Kalø	0.90	0.83	0.29	7.4	0.57	0.36	0.24	8.3
Borris	0.22	0.41		7.3	0.62	0.50	0.22	5.3
Askov	0.56	0.54	0.194 A	6.3	0.159	0.166	0.37	5.0
St. Jyndevad	0.195	0.38		5.3	0.88	1.09	0.091	5.0
Årslev	0.148 A	0.22 A		8.1	0.27	0.172	0.30	4.9
Tystofte	1.00±0.26*	1.85±0.48*	0.25±0.01**	7.9±2.3*	0.101 B	0.080 B		4.7
Ledreborg	0.31	0.33		4.0	0.116	0.107		5.0
Abed	0.079	0.127	0.31	3.8	0.073 B	0.043 B		3.6
Tornbygård	0.147	0.093		6.1	-	-		-
1988: Geometric mean	0.31	0.39	0.26	6.0	0.25	0.22	0.22	5.1
S.D. factor	2.40	2.43	1.20	1.31	2.43	2.80	1.71	1.24
1988: Arithmetic mean	0.43	0.55	0.26	6.2	0.35	0.33	0.24	5.2
S.D.	0.34	0.52	0.04	1.55	0.28	0.33	0.10	1.27
N	10	10	5	10	9	9	5	9

* The error term is 1 S.E. of the mean of triple determinations.

**The error term is 1 S.E. of the mean of double determinations.

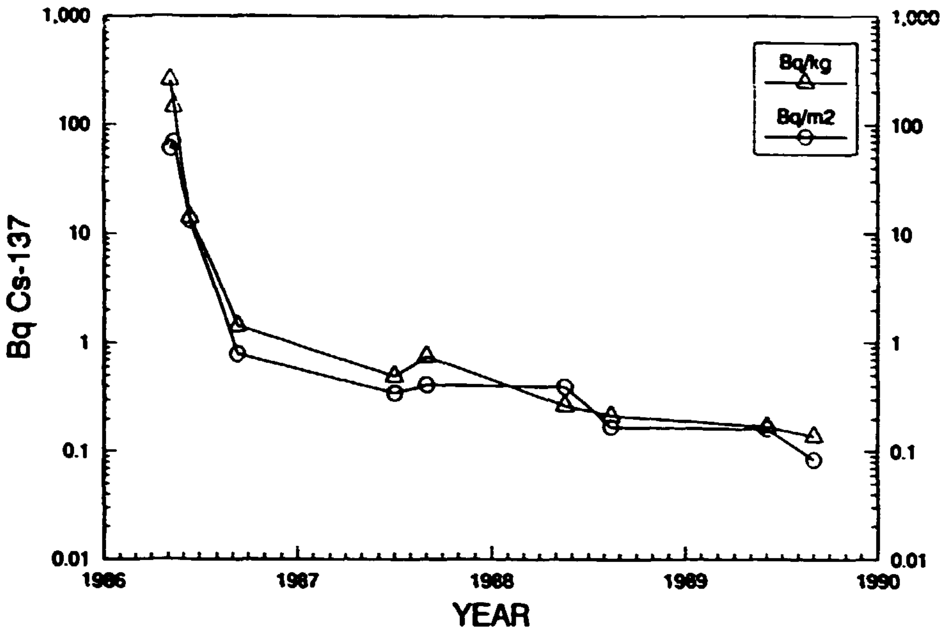


Fig. 5.10.3. Cesium-137 median values in grass from the 10 Danish State experimental farms 1986-1989.

Fig. 5.11.1. Strontium-90 in sea plants from Roskilde Fjord, 1959-1989.

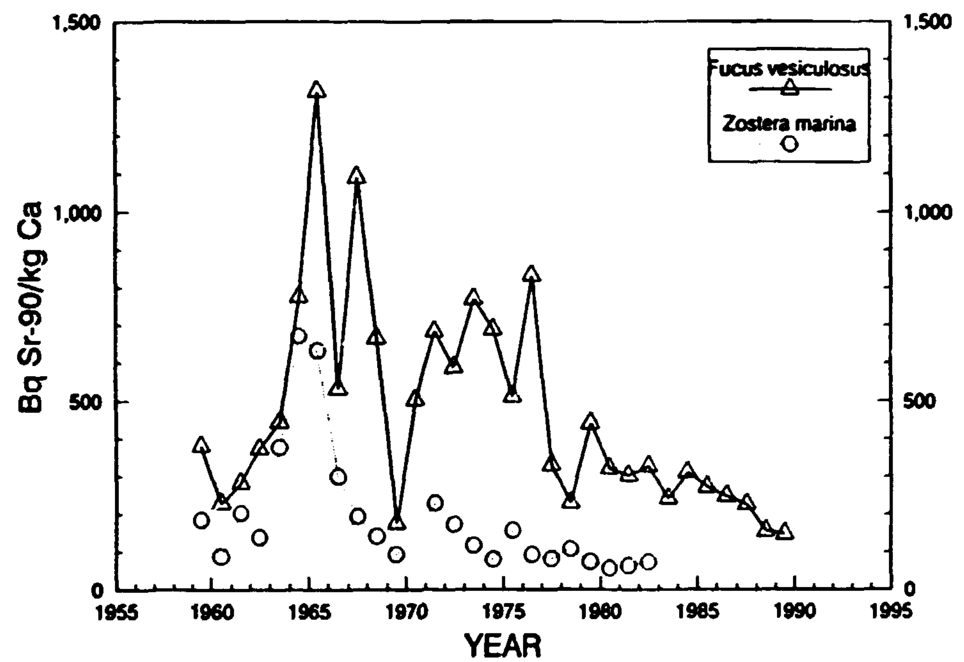


Table 5.10.2.B. Radiocesium in grass collected at the state experimental farms in 1989 (fresh weight samples)

Location	June				September			
	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs m^{-2}	$\frac{^{134}Cs}{^{137}Cs}$	g K kg^{-1}	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs m^{-2}	$\frac{^{134}Cs}{^{137}Cs}$	g K kg^{-1}
Tylstrup	0.91	0.48	0.14 A	6.4	0.199	0.090		8.2
Kale	0.145 A	0.083 A		8.5	0.109 A	0.071 A		7.4
Borris	0.22	0.175		6.0	0.41	0.200		5.4
Askov	0.68	0.77	0.23	4.4	0.33	0.133	0.186 B	7.4
St. Jyndevad	2.2	1.66	0.137	4.6	0.172	0.108	0.22 A	8.9
Årslev	0.193	0.181	0.16 B	5.1	0.166	0.113		6.4
Tystofte	0.072 A	0.146		6.4	0.080 B	0.031 B		7.1
Ledreborg	0.116	0.092	0.21 B	4.9	0.024 B	0.020 B		5.6
Abed	0.101 A	0.100 A		7.8	0.092 A	0.077 A		7.2
Tornbygård	0.043 B	0.034 B		7.2	-	-		-
1989: Geometric mean	0.22	0.194	0.173	6.0	0.135	0.077	0.20	7.0
S.D. factor	3.51	3.19	1.26	1.25	2.33	2.05	1.14	1.18
1989: Arithmetic mean	0.47	0.37	0.176	6.1	0.176	0.094	0.21	7.1
S.D.	0.69	0.51	0.054	1.38	0.125	0.054	0.03	1.13
N	10	10	5	10	9	9	2	9

Table 5.11.1.1. Strontium-90 in Fucus vesiculosus from Roskilde Fjord in 1988 and 1989

Location (cf. Fig. 4.6.1)	Date	Bq ^{90}Sr (kg Ca)$^{-1}$	Bq ^{90}Sr kg^{-1} dry weight
I: 55°42'N 12°06'E	Jan-June 1988	180	3.4
I: 55°42'N 12°06'E	June-Nov 1988	125	3.7
IX: 55°45'N 12°04'E	June 2, 1988	155	2.9
X: 55°51'N 12°02'E	June 2, 1988	158	3.6
I: 55°42'N 12°06'E	Jan-June 1989	171	2.8
I: 55°42'N 12°06'E	July-Dec 1989	200	2.9
IX: 55°45'N 12°04'E	May 23, 1989	107	2.9
X: 55°51'N 12°02'E	May 23, 1989	108	2.9

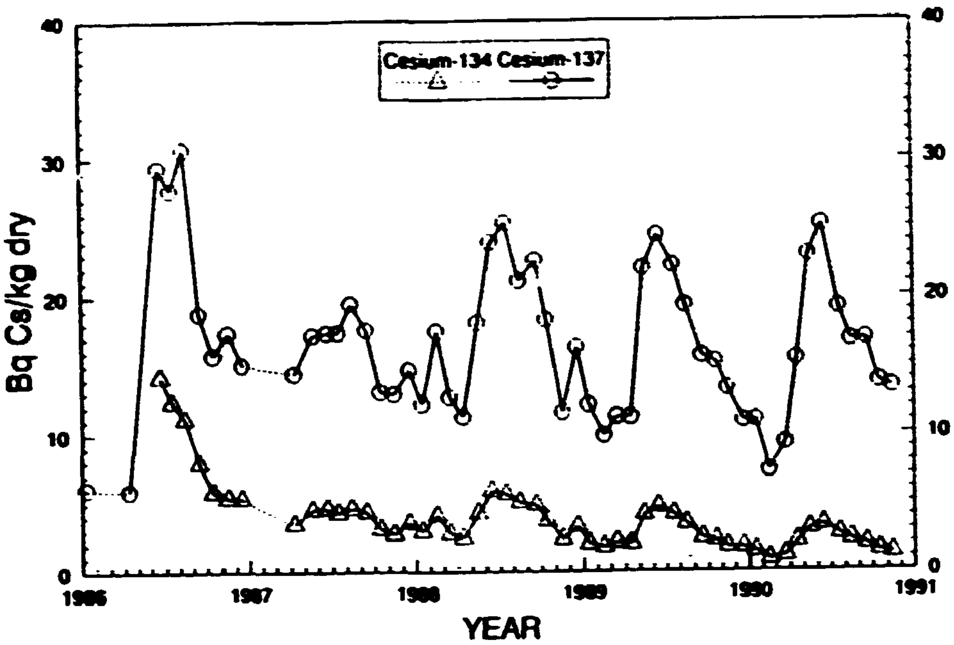


Fig. 5.II.2. Cesium-137 and cesium-134 (lower curve) in Fucus vesiculosus and Fucus serratus from April 1986 to November 1990 collected at Klint, Zealand (55°58'N, 11°35'E).

Fig. 5.II.3. Cesium-137 and cesium-134 (lower curve) in surface sea water from April 1986 to November 1990 collected at Klint, Zealand (55°58'N, 11°35'E).

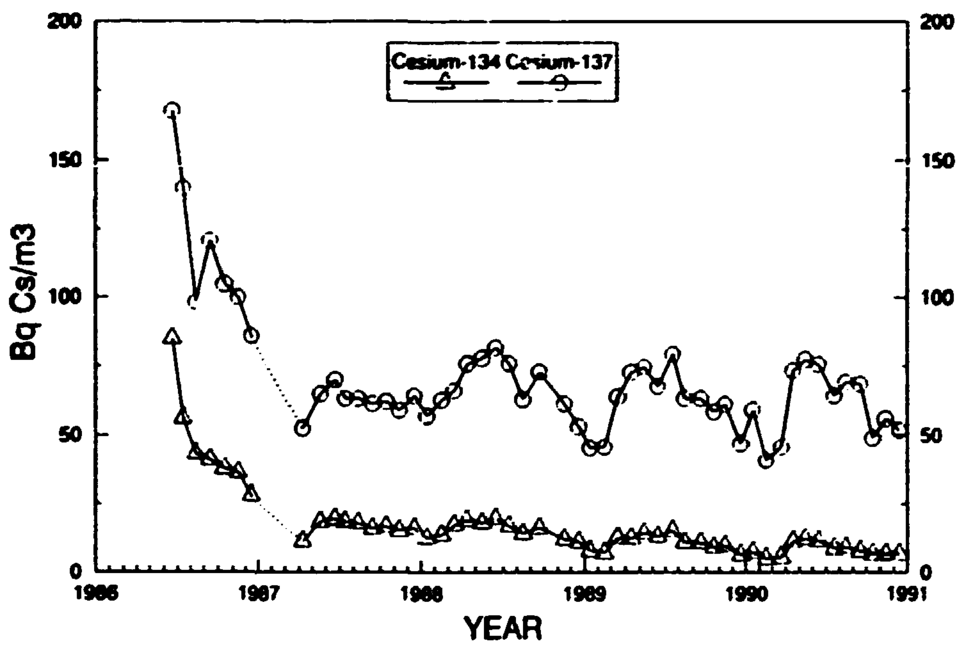


Table 5.11.1.2. Radiocesium in Fucus vesiculosus from Roskilde Fjord in 1988 and 1989

Location (cf. Fig. 4.6.1)	Date	% dry matter	Bq ^{137}Cs (kg K)$^{-1}$	Bq ^{137}Cs kg^{-1} dry weight	^{134}Cs / ^{137}Cs	Salinity in ‰
I: 55°42'N 12°06'E	Jan 21, 1988	17.3	540	18.8	0.21	11.0
I: 55°42'N 12°06'E	April 19, 1988	17.2	680	13.2	0.198	9.9
I: 55°42'N 12°06'E	Aug 22, 1988	17.1	650	20.4	0.134	11.9
I: 55°42'N 12°06'E	Oct 18, 1988	17.5	560	18.1	0.20	10.9
IX: 55°45'N 12°04'E	June 2, 1988	18.1	630	19.2	0.186	13.5
X: 55°51'N 12°02'E	June 2, 1988	14.6	580	21.4	0.184	15.7
I: 55°42'N 12°06'E	Jan 10, 1989	17.7	460	13.5	0.171	12.0
I: 55°42'N 12°06'E	April 19, 1989	13.4	420	12.2	0.154	14.2
I: 55°42'N 12°06'E*	July 19, 1989	22.8**	510	13.7	0.126	15.4
I: 55°42'N 12°06'E	Oct 19, 1989	21.7	450	14.8	0.100	14.3
IX: 55°45'N 12°04'E	May 23, 1989	14.4	560	20.6	0.133	14.8
X: 55°51'N 12°02'E	May 23, 1989	14.9	500	16.4	0.149	16.1

* Measured on fresh

**Freeze drying.

Table 5.11.2. Radionuclides in Fucus vesiculosus (Fu.ve.) and Fucus serratus (Fu.se.) collected at Klint (55°58'N, 11°35'E) in 1987. (Unit: Bq kg^{-1} dry matter) (corrected 1987-data from Risø-R-563)

Species	Date	^{60}Co	^{137}Cs	^{106}Ru / ^{137}Cs	^{110m}Ag / ^{137}Cs	^{125}Sb / ^{137}Cs	^{134}Cs / ^{137}Cs	% dry matter	Salinity in ‰
Fu.ve.	April 10	4.0	14.9		0.23		0.27	17.8	
Fu.se.	April 10	4.1	14.0	1.31	0.41	0.14	0.21	16.0	
Fu.ve.	May 21	4.0	13.5		0.24		0.25	17.8	
Fu.se.	May 21	4.7	21				0.27	19.0	
Fu.ve.	June 22	3.0	14.9				0.25	16.8	16.7
Fu.se.	June 22	2.6	19.9				0.27	17.4	
Fu.ve.	July 15	2.7	18.1		0.06 B		0.25	13.0	
Fu.se.	July 15	3.4	16.8				0.24	21.4	
Fu.ve.	Aug 13	2.8	18.1				0.25	14.6	
Fu.se.	Aug 13	2.0	21				0.22	20.2	
Fu.ve.	Sept 15	2.6	17.6				0.25	17.0	18.4
Fu.se.	Sept 15	2.5	17.6				0.25	21.3	
Fu.ve.	Oct 15	3.0	15.0				0.25	17.4	18.2
Fu.se.	Oct 15	1.79	11.3			0.12	0.22	22.1	
Fu.ve.	Nov 13	2.0 A	12.6				0.22	19.6	20.8
Fu.se.	Nov 13	2.3	13.3				0.21	19.0	
Fu.ve.	Dec 17	2.4	14.2				0.24	19.2	
Fu.se.	Dec 17	3.0	15.2			0.22	0.25	19.3	

Table 5.11.2.A. Radionuclides in Fucus vesiculosus (Fu.ve.) and Fucus serratus (Fu.se.) collected at Klint (55°58'N, 11°35'E) in 1988. (Unit: Bq kg⁻¹ dry matter)

Species	Date	^{60}Co	^{137}Cs	^{125}Sb / ^{137}Cs	^{134}Cs / ^{137}Cs	^{99}Tc	% dry matter	Salinity in ‰
Fu.ve.	Jan 14	1.90	11.1		0.24	139	18.2	23.1
Fu.se.*	Jan 14	2.4	13.3	0.085	0.24	69	20.1	
Fu.ve.	Feb 16	2.1	16.1		0.20	135	16.0	18.8
Fu.se.	Feb 16	3.4	19.0		0.26	83	16.2	
Fu.ve.	March 15	2.5	11.5		0.25	78	18.8	19.0
Fu.se.	March 15	2.7	14.0		0.195	71	21.6	
Fu.ve.	April 13	2.2	12.1		0.22	82±5	18.9	14.1
Fu.se.	April 13	2.1	10.5		0.22	72	22.7	
Fu.ve.	May 16	0.86	13.8		0.23	97	16.1	15.6
Fu.se.	May 16	1.76	22		0.24	52	18.6	
Fu.ve.	June 14	1.45	19.8		0.26	48	17.8	15.4
Fu.se.	June 14	B.D.L.	28		0.24		18.4	
Fu.ve.	July 15	1.64	25		0.22	65	16.5	13.9
Fu.se.	July 15	1.86	25		0.23	41	22.0	
Fu.ve.	Aug 15	1.37	21		0.24	48	15.4	17.8
Fu.se.	Aug 15	1.71	22		0.24	39	24.5	
Fu.ve.	Sep 20	1.84	23		0.20	55	20.6	18.2
Fu.se.**	Sep 20	2.6	23		0.23	46	20.0	
Fu.ve.	Oct 13	2.3	17.1		0.192	52	20.7	21.4
Fu.se.	Oct 13	3.0	19.5	0.124 A	0.21	54	21.8	
Fu.ve.	Nov 16	2.1	12.4		0.189	22	21.7	21.1
Fu.se.	Nov 16	2.0	10.8		0.22	21	22.4	
Fu.ve.	Dec 18	2.5	15.9		0.20	54	21.0	22.7
Fu.se.	Dec 18	2.7	16.7	0.206 A	0.20	116	20.0	

*^{54}Mn: 0.49 A; **^{58}Co: 0.9 B.

Table 5.11.2.B. Radionuclides in Fucus vesiculosus (Fu.ve.) and Fucus serratus (Fu.se.) collected at Klint (55°58'N, 11°35'E) in 1989. (Unit: Bq kg^{-1} dry matter)

Species	Date	^{60}Co	^{137}Cs	^{54}Mn	^{125}Sb / ^{137}Cs	^{134}Cs / ^{137}Cs	^{99}Tc	% dry matter	Salinity in ‰
Fu.ve.	Jan 12	2.1	10.0			0.139	74	21.5	24.3
Fu.se.	Jan 12	2.7	14.1			0.184	64	21.2	
Fu.ve.	Feb 15	2.2	7.3			0.182	60	20.9	23.9
Fu.se.	Feb 15	2.7	12.5			0.175	89	23.2	
Fu.ve.	March 15	1.55	8.1			0.167	66	22.5	15.2
Fu.se.	March 15	2.1	14.5	0.48 A	0.171	0.199	51	22.3	
Fu.ve.	April 13	1.11	13.4	0.21 A		0.172	79	17.1	14.2
Fu.se.	April 13	1.63	9.2	0.61 A	0.24	0.182	69	24.2	
Fu.ve.	May 12	1.77	22			0.179	78	14.8	15.4
Fu.se.	May 12	1.58	22	0.39 A	0.070	0.195	55	18.6	
Fu.ve.	June 13	B.D.L.	23			0.182	66	15.6	15.7
Fu.se.	June 13	1.52	26			0.186	50	18.4	
Fu.ve.	July 18	1.65	25			0.192	43	15.6	16.2
Fu.se.	July 18	1.15	19.0			0.177	48	21.9	
Fu.ve.	Aug 14	1.73	22			0.166	49	18.0	17.4
Fu.se.	Aug 14	1.70	17.0			0.192	37	21.9	
Fu.ve.	Sep 18	1.86	16.0		0.107	0.154	55	19.3	17.5
Fu.se.	Sep 18	1.19	15.3		0.099	0.148	37	23.0	
Fu.ve.	Oct 18	1.74	14.4			0.169	54	22.9	19.8
Fu.se.	Oct 18	1.82	16.0		0.150	0.122	42	26.1	
Fu.ve.	Nov 13	B.D.L.	11.3			0.106	60	16.3	19.8
Fu.se.	Nov 13	2.1	15.2			0.150	48	20.3	
Fu.ve.	Dec 19	1.8 A	9.7			0.190	75	15.4	23.8
Fu.se.	Dec 19	2.0	12.2			0.129	56	23.9	

Table 5.11.3. Radionuclides in Fucus vesiculosus (Fu.ve.) and Fucus serratus (Fu.se.) collected in Danish waters in 1988 and 1989. (Unit: Bq kg^{-1} dry matter)

Location	Position N E	Date	^{60}Co	^{137}Cs	^{54}Mn	^{125}Sb/^{137}Cs	^{134}Cs/^{137}Cs	^{99}Tc	% dry matter	Salinity in ‰	Species
Nysted	54°40' 11°44'	Jan 13, 1988		25			0.25		18.5	12.3	Fu.ve.
-"-	-"-	Feb 15, 1988		27			0.24		16.8	9.2	Fu.ve.
-"-	-"-	March 14, 1988		26			0.26		16.8	7.8	Fu.ve.
-"-	-"-	April 14, 1988		32			0.25	17.8 ± 1.7	14.2	11.4	Fu.ve.
-"-	-"-	May 18, 1988		45			0.25		15.7	9.6	Fu.ve.
-"-	-"-	June 13, 1988		61			0.24	13.8	16.5	8.8	Fu.ve.
-"-	-"-	July 14, 1988		54			0.24		17.8	9.4	Fu.ve.
-"-	-"-	Aug 16, 1988		48			0.25	16.3	18.1	11.1	Fu.ve.
-"-	-"-	Sep 19, 1988		40			0.23		16.3	10.7	Fu.ve.
-"-	-"-	Oct 14, 1988		44			0.22	10.7	16.3	13.9	Fu.ve.
-"-	-"-	Nov 17, 1988		39			0.22		18.5	13.4	Fu.ve.
-"-	-"-	Dec 17, 1988		31	0.5 B		0.22		20.5	14.0	Fu.ve.
-"-	-"-	Jan 13, 1989*		25			0.20	16.2	20.5	16.1	Fu.ve.
-"-	-"-	Feb 16, 1989		21			0.193		21.7	15.1	Fu.ve.
-"-	-"-	March 17, 1989		26			0.20		18.4	11.1	Fu.ve.
-"-	-"-	April 14, 1989		36		0.029 A	0.194	18.0	16.9	10.3	Fu.ve.
-"-	-"-	May 13, 1989		37	0.46	0.041	0.196		17.8	10.8	Fu.ve.
-"-	-"-	June 14, 1989		41			0.184		20.8	10.4	Fu.ve.
-"-	-"-	July 17, 1989		51			0.186	17.1	19.1	10.4	Fu.ve.
-"-	-"-	Aug 15, 1989		41			0.183		17.2	12.7	Fu.ve.
-"-	-"-	Sep 19, 1989		37			0.174		17.3	10.7	Fu.ve.
-"-	-"-	Oct 19, 1989		39			0.186	12.5	16.3	10.9	Fu.ve.
-"-	-"-	Nov 13, 1989		28			0.157		19.3	13.3	Fu.ve.
-"-	-"-	Dec 18, 1989		24			0.161		21.2	11.6	Fu.ve.
Strøby											
Egede	55°25' 12°15'	Jan 13, 1988	2.8	32			0.29		19.8	11.5	Fu.ve.
-"-	-"-	March 14, 1988		34			0.31		11.7	9.0	Fu.ve.
-"-	-"-	April 14, 1988		47			0.28	18.4	16.1	10.5	Fu.ve.
-"-	-"-	May 16, 1988	1.31	59			0.27		13.3	8.2	Fu.ve.
-"-	-"-	June 13, 1988		72			0.28	14.9	14.4	7.8	Fu.ve.
-"-	-"-	July 14, 1988	1.37	61			0.25		18.6	7.9	Fu.ve.
-"-	-"-	Aug 16, 1988		51			0.26	13.1	18.1	9.9	Fu.ve.
-"-	-"-	Sep 19, 1988	1.37	42	0.6 B		0.25		17.4	10.2	Fu.ve.
-"-	-"-	Oct 13, 1988	2.1 A	35			0.23	19.1	16.7	12.1	Fu.ve.
-"-	-"-	Nov 17, 1988	1.92	29			0.23		17.1	10.5	Fu.ve.
-"-	-"-	Dec 18, 1988**	1.83	29			0.21		17.8	10.6	Fu.ve.
-"-	-"-	Jan 13, 1989	1.60	26			0.22	23	17.5	12.5	Fu.ve.
-"-	-"-	Feb 16, 1989	1.60	29			0.199		15.1	11.8	Fu.ve.
-"-	-"-	March 17, 1989		34			0.20		14.1	9.9	Fu.ve.
-"-	-"-	April 14, 1989	1.10	41	0.45		0.20	34	13.6	9.6	Fu.ve.
-"-	-"-	May 13, 1989	0.85	44	0.34 A		0.199		15.7	10.2	Fu.ve.
-"-	-"-	June 14, 1989		56			0.197		12.7	9.1	Fu.ve.
-"-	-"-	July 17, 1989		54			0.198	25	21.7	9.4	Fu.ve.
-"-	-"-	Aug 15, 1989	1.06	38			0.184		19.5	10.2	Fu.ve.
-"-	-"-	Sep 19, 1989	1.01 A	37			0.180		17.9	9.6	Fu.ve.
-"-	-"-	Oct 19, 1989		44			0.167	11.4	17.8	13.3	Fu.ve.
-"-	-"-	Nov 13, 1989	1.09	40			0.171		17.3	10.2	Fu.ve.
-"-	-"-	Dec 18, 1989	0.73 A	30			0.159		21.3	11.8	Fu.ve.

Table 5.II.3. continued

Location	Position N E	Date	^{60}Co	^{137}Cs	^{54}Mn	$\frac{^{125}Sb}{^{137}Cs}$	$\frac{^{134}Cs}{^{137}Cs}$	^{99}Tc	% dry matter	Salinity in ‰	Species
Mullerup	55°30' 11°10'	Jan 14, 1988		13.6			0.25		18.0	17.9	Fu.ve.
-"-	-"-	Feb 16, 1988		17.2			0.24		16.9	13.9	Fu.ve.
-"-	-"-	April 13, 1988		25			0.27	48 ± 4.9	15.0	16.7	Fu.ve.
-"-	-"-	May 17, 1988		25			0.26		18.7	10.4	Fu.ve.
-"-	-"-	June 14, 1988		27			0.24	34	20.1	13.0	Fu.ve.
-"-	-"-	July 15, 1988		29		0.140	0.25			11.2	Fu.se.
-"-	-"-	Sep 20, 1988		17.5			0.24		24.2	20.5	Fu.ve.
-"-	-"-	Oct 13, 1988		11.8		0.22 A	0.192	30	24.7	18.2	Fu.ve.
Reersø	55°31' 11°07'	Jan 12, 1989		14.3			0.196	43	18.4	19.9	Fu.ve.
-"-	-"-	Feb 15, 1989		14.3			0.21		18.3	18.6	Fu.ve.
-"-	-"-	March 16, 1989		22			0.20		16.1	11.3	Fu.ve.
-"-	-"-	April 13, 1989		25			0.182	48	17.1	11.1	Fu.ve.
-"-	-"-	May 12, 1989		17.0			0.173		12.7	15.1	Fu.ve.
-"-	-"-	June 13, 1989	1.06 A	28			0.190		17.1	13.0	Fu.ve.
-"-	-"-	July 18, 1989		30			0.196	27	20.6	16.9	Fu.ve.
-"-	-"-	Aug 14, 1989		25			0.175		19.3	16.4	Fu.ve.
-"-	-"-	Sep 18, 1989		30			0.156		16.2	12.4	Fu.ve.
-"-	-"-	Oct 18, 1989		21			0.175	28	22.0	18.9	Fu.ve.
-"-	-"-	Dec 19, 1989		14.0			0.099		18.8	18.7	Fu.ve.
Gilleleje	56°07' 12°19'	Jan 15, 1988	4.3	15.9			0.191		21.4	20.4	Fu.se.
Nakkehoved	56°07' 12°21'	Feb 19, 1988	1.39	11.8			0.26		16.7	18.8	Fu.ve.
-"-	-"-	March 15, 1988	2.1	13.3			0.22		19.7	18.1	Fu.ve.
-"-	-"-	April 13, 1988	3.7	17.6			0.24	104 ± 1.8	19.4	11.4	Fu.se.
-"-	-"-	May 16, 1988	2.1	20			0.25		13.4	15.8	Fu.ve.
-"-	-"-	June 14, 1988		21			0.25		16.9	13.7	Fu.ve.
-"-	-"-	July 13, 1988		24			0.23		16.1	13.7	Fu.ve.
-"-	-"-	Aug 15, 1988	2.2	19.1			0.22	53	18.6	18.4	Fu.ve.
-"-	-"-	Oct 13, 1988	2.3	15.4			0.20	102	19.1	22.4	Fu.ve.
-"-	-"-	Nov 16, 1988	2.1	12.2		0.22	0.22		20.4	21.7	Fu.ve.
-"-	-"-	Dec 21, 1988	2.1	13.5			0.182		18.7	22.1	Fu.ve.
-"-	-"-	Dec 21, 1988△	3.6	19.6			0.190		21.9		Fu.se.
-"-	-"-	Jan 12, 1989		12.3			0.180	200	20.8	21.6	Fu.ve.
-"-	-"-	March 15, 1989	1.55	10.4			0.193		18.6	15.4	Fu.ve.
-"-	-"-	April 13, 1989	0.99	12.0			0.191	141	15.1	12.2	Fu.ve.
-"-	-"-	May 12, 1989		16.9			0.21		14.6	15.2	Fu.ve.
-"-	-"-	June 13, 1989		24			0.188		13.7	11.7	Fu.ve.
-"-	-"-	Aug 14, 1989	1.41	18.9			0.160		18.1	19.0	Fu.ve.
-"-	-"-	Sep 19, 1989		17.7			0.168		18.1	19.6	Fu.ve.
-"-	-"-	Oct 18, 1989	1.60	12.2			0.169	82	23.2	19.0	Fu.ve.
-"-	-"-	Nov 15, 1989	2.4	14.1			0.148		17.6	17.6	Fu.ve.
-"-	-"-	Dec 19, 1989	1.58	10.5			0.162		23.6	21.0	Fu.ve.
Svenske Havn	55°05' 15°09'	May 25, 1988		45			0.28	6.3	12.2		Fu.ve.
-"-	-"-	May 30, 1989		51			0.199		14.2		Fu.ve.
Hesselø	55°12' 11°43'	June 7, 1988	1.38	25			0.24		19.6		Fu.ve.
-"-	-"-	June 7, 1988	2.1	25			0.23		22.7		Fu.se.
-"-	-"-	May 9, 1989	1.46	24			0.185		17.0		Fu.ve.
-"-	-"-	May 9, 1989	1.62	22			0.175		19.1		Fu.se.
-"-	-"-	Oct 30, 1989	1.58	16.7		0.11 B	0.135		19.9		Fu.ve.
-"-	-"-	Oct 30, 1989	1.39	13.9			0.140		21.5		Fu.se.

Table 5.11.3. continued

Location	Position N E	Date	^{60}Co	^{137}Cs	^{54}Mn	^{125}Sb / ^{137}Cs	^{134}Cs / ^{137}Cs	^{99}Tc	% dry matter	Salinity in ‰	Species
Anholt	56°43' 11°31'	June 9, 1988	0.88 A	18.7			0.23		19.4		Fu.ve.
-"-	-"-	Nov 3, 1989		15.3			0.131		15.6		Fu.ve.
Læsø											
Vesterøby	57°18' 10°56'	June 8, 1988		14.6			0.23		22.7		Fu.ve.
-"-	-"-	May 11, 1989	1.66	10.1			0.152		17.2		Fu.ve.
-"-	-"-	Nov 1, 1989	1.68	8.6			0.105 A		20.3		Fu.ve.
Læsø											
Østerby	57°19' 11°08'	June 9, 1988		16.6			0.21		14.9		Fu.ve.
-"-	-"-	Dec 16, 1988	1.96	10.8			0.182		17.0		Fu.ve.
-"-	-"-	May 11, 1989		16.2			0.194		14.6		Fu.ve.
-"-	-"-	Nov 2, 1989	1.65	10.7			0.111 A		16.6		Fu.ve.

*^{95}Nb: 0.9 A Bq kg^{-1} dry weight

**^{131}I: 4.4 A Bq kg^{-1} dry weight

Δ ^{106}Ru: 13.2 A Bq kg^{-1} dry weight

Table 5.II.3.C. Radionuclides in Fucus vesiculosus (Fu.ve.) and Fucus serratus (Fu.se.) collected in Danish waters in 1987 (corrected 1987 data from Risø-R-563)

Location	Position N	Position E	Date	Bq ^{60}Co kg^{-1} d.w.	Bq ^{137}Cs kg^{-1} d.w.	^{110m}Ag/^{137}Cs	^{106}Ru/^{137}Cs	^{134}Cs/^{137}Cs	% dry matter	Species	Salinity in ‰
Nysted	54°40'	11°44'	April 29		18.0			0.30		Fu.ve.	9.5
-"-	-"-		May 20		36			0.28	13.3	Fu.ve.	10.4
-"-	-"-		June 23		37			0.29	17.9	Fu.ve.	10.6
-"-	-"-		July 16		34			0.31	19.8	Fu.ve.	11.0
-"-	-"-		Aug 12		29			0.29	20.8	Fu.ve.	13.6
-"-	-"-		Sept 14		35			0.31	17.2	Fu.ve.	10.5
-"-	-"-		Oct 14		34			0.25	16.5	Fu.ve.	10.8
-"-	-"-		Nov 11		32			0.28	17.6	Fu.ve.	9.9
-"-	-"-		Dec 18		30			0.26	17.7	Fu.ve.	11.3
Strøby Egede	55°25'	12°15'	April 29		43			0.33	16.5	Fu.ve.	8.5
-"-	-"-		May 20		37			0.36	14.1	Fu.ve.	9.1
-"-	-"-		June 17	2.1	60			0.32	10.2	Fu.ve.	8.1
-"-	-"-		July 16		42			0.32	17.2	Fu.ve.	10.6
-"-	-"-		Aug 12	2.0	40			0.34	20.8	Fu.ve.	9.8
-"-	-"-		Sept 14		44			0.29	19.1	Fu.ve.	11.8
-"-	-"-		Oct 14		36			0.28	18.1	Fu.ve.	9.6
-"-	-"-		Nov 11		36			0.29	18.2	Fu.ve.	11.1
-"-	-"-		Dec 16	2.0	33			0.30	18.8	Fu.ve.	12.8
Gilleleje	56°07'	12°19'	April 24	9.2	14.8	0.22		0.30		Fu.ve.	17.3
-"-	-"-		May 20	6.4	19.4	0.25	0.97	0.29	21.9	Fu.se.	17.2
-"-	-"-		June 22	2.0	18.6			0.28	17.3	Fu.ve.	16.8
-"-	-"-		July 17	4.6	21			0.24	19.5	Fu.se.	20.2
-"-	-"-		Aug 14	3.7	12.3			0.29	26.2	Fu.se.	19.8
-"-	-"-		Sept 14	5.9	17.7			0.23		Fu.se.	16.7
-"-	-"-		Oct 16	3.3	18.5			0.27	21.5	Fu.se	24.4
-"-	-"-		Nov 12	3.9	11.5		0.58	0.31	20.7	Fu.se.	20.8
Hesselø	56°12'	11°43'	May 25	3.2	13.1	0.23		0.28	22.1	Fu.ve.	
-"-	-"-		May 25	3.2	15.3			0.26	21.8	Fu.se.	
-"-	-"-		Dec 14	2.8	14.7			0.25	34.3	Fu.se.	
Anholt	56°43'	11°31'	May 13	2.0	22	0.13	0.56	0.25	21.6	Fu.ve.	
-"-	-"-		Dec 14	1.4 A	16.8			0.24	17.9	Fu.ve.	
Mullerup	55°30'	11°10'	April 30	1.6	20[a]	0.13		0.33	13.5	Fu.ve.	15.3
-"-	-"-		May 21	1.86	22			0.33	12.7	Fu.ve.	17.8
-"-	-"-		June 22		31			0.33	14.5	Fu.ve.	18.7
-"-	-"-		July 15	1.5	17.8[b]			0.31	25.3	Fu.ve.	16.7
-"-	-"-		Aug 13	1.0 A	16.3			0.30	21.3	Fu.ve.	17.3
-"-	-"-		Sept 15		19.7			0.27	20.5	Fu.ve.	13.4
-"-	-"-		Oct 15		19.5			0.32	22.0	Fu.se.	12.6
-"-	-"-		Oct 15		20.4			0.28	19.4	Fu.ve.	
-"-	-"-		Dec 17		19.3			0.26	21.2	Fu.ve.	16.6
Læsø	57°18'	10°56'	May 13	2.4	14.6			0.24	25.4	Fu.se.	
-"-	57°19'	11°08'	May 13	2.5	13.7			0.22	13.6	Fu.ve.	
Svenske Havn	55°05'	15°09'	May 19		41	0.21		0.35	21.4	Fu.ve.	

a) $^{125}Sb/^{137}Cs$ = 0.35
b) $^{125}Sb/^{137}Cs$ = 0.25

Table 5.12.1.A. Radionuclides in lichen collected in Denmark in 1988

Sample	Location	Date	^{137}Cs Bq m^{-2}	^{106}Ru / ^{137}Cs	^{110m}Ag / ^{137}Cs	^{125}Sb / ^{137}Cs	^{134}Cs / ^{137}Cs	^{144}Ce / ^{137}Cs	kg d.w. m^{-2}
Lichen	Bornholm	May 25	198	0.070 A			0.23		0.88
Lichen	Asserbo	June 14	790	0.079	0.0019 B	0.014 A	0.28		1.28
Lichen	Hvide Sande	June 27	3200	0.072		0.0174	0.28	0.016 A	1.14
Lichen	Skagen 1	Sep 29	200	0.059 B			0.24		0.56
Lichen	Skagen 2	Sep 29	310				0.24		0.94
Lichen	Skagen 3	Sep 29	220				0.22		0.62
Lichen (Pseudevernia furfuracea)	Skagen	Sep 29	124				0.21		0.38
Lichen (Pseudevernia furfuracea)	Skagen	Sep 29	206				0.25		1.19
Lichen (Mypogymnia physodes)	Skagen	Sep 29	64				0.26		0.40

Table 5.12.1.B. Radionuclides in lichen and moss collected in Denmark in 1989

Sample	Location	Date	^{137}Cs Bq m^{-2}	^{106}Ru / ^{137}Cs	^{125}Sb / ^{137}Cs	^{134}Cs / ^{137}Cs	kg d.w. m^{-2}
Moss	Arnager, Bornholm	May 30	660			0.154	3.90
Lichen	Dueodde, Bornholm	May 30	63			0.138	0.43
Lichen	Hvide Sande	June 6	1600	0.050 A	0.015 A	0.21	0.98
Lichen	Skagen 1	Sep 24	310			0.179	0.96
Lichen	Skagen 2	Sep 24	220			0.174	0.76

Table 5.12.2. Radiocesium in lichen (Cladina portentosa) collected at Oustrup Heather October 3, 1989, by Ulrik Søchting, Institute of Sporeplants, University of Copenhagen

Sample	^{137}Cs Bq kg^{-1} d.w.	^{137}Cs Bq m^{-2}	^{134}Cs Bq kg^{-1} d.w.	^{134}Cs Bq m^{-2}	^{134}Cs / ^{137}Cs	% Chernobyl ^{137}Cs
Top layer No. 1	390	560	68	97	0.174	
Top layer No. 2	430	610	76	107	0.175	
Top layer No. 3	440	540	70	86	0.158	
Top layer No. 4	360	400	59	67	0.167	
Top layer No. 5	490	710	70	103	0.144	
Bottom layer No. 1	16.4	820	1.0 A	51 A	0.06	
Bottom layer No. 2	41	125	1.2 B	4 B	0.03	
Bottom layer No. 3	15.6	470	1.1 B	33 B	0.07	
Bottom layer No. 4	35	730	0.8 B	16 B	0.02	
Bottom layer No. 5	22	900	0.8 A	30 A	0.04	
$\bar{x}$ Top ±1 S.D.	420±50	560±113	69±6.1	92±16	0.164±0.01	90
$\bar{x}$ Bottom ±1 S.D.	26±11	610±315	1.0±0.2	27±18	0.04±0.02	22
Top + Bottom ±1 S.D.		1170±337		119±24	0.102	55

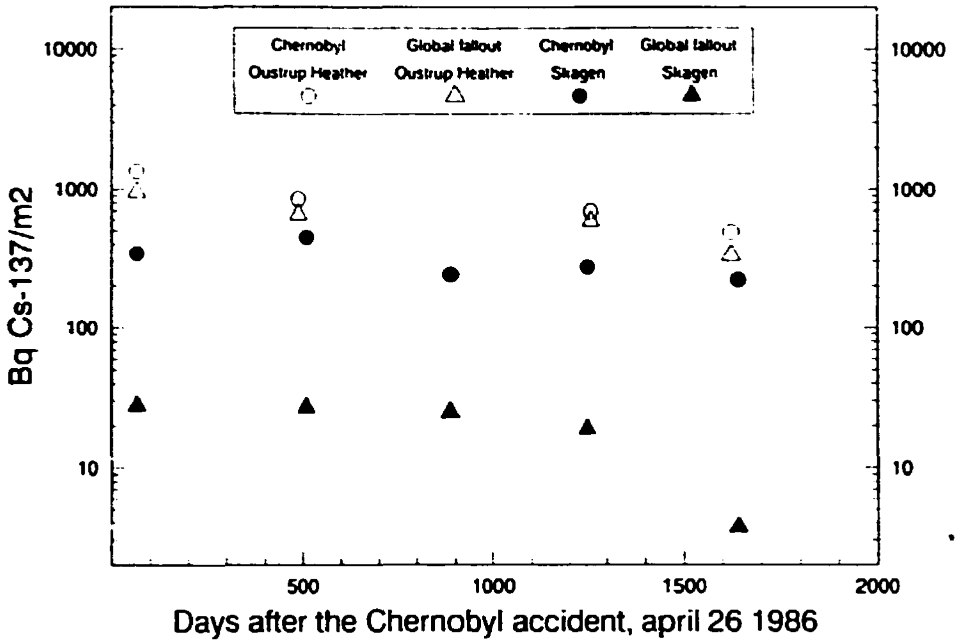


Fig. 5.12. The ecological decay of ^{137}Cs from Chernobyl and from global fallout (all ^{137}Cs data corrected to April 26, 1986) in Danish lichen collected at Oustrup Heather and Skagen 1986-1990.

Table 5.13.1.1. Radiocesium in mushrooms collected in spruce-forest in Gribskov in the north-east part of Zealand in Denmark in September-October 1989. (The error term is ±1 S.E.) collected by University of Roskilde

Species	Date	^{137}Cs Bq kg^{-1} d.w.	^{134}Cs Bq kg^{-1} d.w.	^{134}Cs / ^{137}Cs	g K kg^{-1} d.w.	% dry matter
Honey fungus	Sept 29	268 ± 14 (n = 2)	32.5 ± 1.6 (n = 2)	0.121 ± 0.000 (n = 2)	52.8 ± 1.1 (n = 2)	7.12 ± 0.26 (n = 2)
(Armillaria	Oct 17	278 ± 9 (n = 2)	35.1 ± 3.5 (n = 2)	0.127 ± 0.017 (n = 2)	48.7 ± 0.1 (n = 2)	5.47 ± 1.47 (n = 2)
mellea)	Oct 19	142	14.9	0.105	69.4	4.56
Clouded agaric	Sept 29	113	19.7	0.174	72.6	6.23
(Clitocybe	Oct 4	626	116	0.185	28.0	9.62
nebularis)						
Common yellow	Oct 4	640 ± 49 (n = 2)	76 ± 5.2 (n = 2)	0.118 ± 0.001 (n = 2)	42.2 ± 0.1 (n = 2)	11.73 ± 3.07 (n = 2)
russula	Oct 11	360	42	0.117	43.2	5.14
(Russula	Oct 17	580 ± 92 (n = 4)	69 ± 10 (n = 4)	0.120 ± 0.002 (n = 4)	42.7 ± 2.1 (n = 4)	5.55 ± 0.44 (n = 4)
ochroleuca)	Oct 19	570 ± 41 (n = 2)	48 ± 1 (n = 2)	0.084 ± 0.008 (n = 2)	54.3 ± 2.9 (n = 2)	3.83 ± 0.29 (n = 2)
	Oct 30	950 ± 134 (n = 2)	74 ± 16 (n = 2)	0.077 ± 0.006 (n = 2)	51.0 ± 0.6 (n = 2)	4.19 ± 0.29 (n = 2)
The blusher	Oct 11	445	46	0.103	46.0	-
(Amanita	Oct 17	300	34	0.113	44.4	5.42
rubescens)	Oct 19	126	13.2	0.104	58.8	3.39
Wood blewit	Oct 4	108	17.7	0.164	52.4	5.62
(Lepista nuda)	Oct 30	7			58.7	5.26
Field blewit	Oct 30	25	3.9 A	0.155 A	77.6	3.52
(Lapista personata)						
Geometric mean:						
Honey fungus	Sept 29-Oct 19	240 ± 1.14 (n = 5)	29 ± 1.18 (n = 5)	0.120 ± 1.06 (n = 5)	54.0 ± 1.07 (n = 5)	
Clouded agaric	Sept 29-Oct 4	270 ± 2.35 (n = 2)	48 ± 2.43 (n = 2)	0.179 ± 1.03 (n = 2)	45.1 ± 1.61 (n = 2)	
Common yellow russula	Oct 4-Oct 30	600 ± 1.11 (n = 11)	62 ± 1.10 (n = 11)	0.103 ± 1.06 (n = 11)	46.0 ± 1.04 (n = 11)	
The blusher	Oct 11-Oct 19	260 ± 1.45 (n = 3)	27 ± 1.46 (n = 3)	0.107 ± 1.03 (n = 3)	49.3 ± 1.09 (n = 3)	
Wood blewit	Oct 11-Oct 19	28 ± 3.92 (n = 2)	17.7	0.164	55.5 ± 1.06 (n = 2)	
Field blewit	Oct 30	25	3.9 A	0.155 A	77.6	
Arithmetic mean:						
Honey fungus	Sept 29-Oct 19	247 ± 27 (n = 5)	30 ± 4 (n = 5)	0.120 ± 0.007 (n = 5)	54.5 ± 3.9 (n = 5)	
Clouded agaric	Sept 29-Oct 4	370 ± 257 (n = 2)	68 ± 48 (n = 5)	0.180 ± 0.006 (n = 2)	50 ± 22 (n = 2)	
Common yellow russula	Oct 4-Oct 30	640 ± 63 (n = 11)	65 ± 6 (n = 11)	0.105 ± 0.006 (n = 11)	46.3 ± 1.8 (n = 11)	
The blusher	Oct 11-Oct 19	292 ± 93 (n = 3)	31 ± 10 (n = 3)	0.107 ± 0.003 (n = 3)	49.7 ± 4.5 (n = 3)	
Wood blewit	Oct 11-Oct 19	57 ± 50 (n = 2)	17.7	0.164	55.5 ± 3.1 (n = 2)	
Field blewit	Oct 30	25	3.9 A	0.155 A	77.6	

Table 5.13.1.2. Radiocesium in mushrooms collected in beech wood in Gribskov in the north-east part of Zealand in Denmark in September-October 1989. (The error term is ±1 S.E.) collected by University of Roskilde

Species	Date	^{137}Cs Bq kg^{-1} d.w.	^{134}Cs Bq kg^{-1} d.w.	^{134}Cs/^{137}Cs	g K kg^{-1} d.w.	% dry matter
Honey fungus	Sept 29	65 ± 10 (n = 4)	2.01 ± 0.39 (n = 4)	0.030 ± 0.002 (n = 4)	45.1 ± 1.9 (n = 4)	9.23 ± 0.34 (n = 4)
(Armillaria	Oct 11	142	3.4 B	0.024 B	41.1	-
mellea)						
Clouded agaric	Oct 4	210	25	0.118	44.3	18.32
(Clitocybe	Oct 11	221 ± 167 (n = 2)	28 ± 21 (n = 2)		40.6 ± 7.5 (n = 2)	6.48 ± 1.04 (n = 2)
nebularis)	Oct 14	97	11	0.118	35.6	6.70
Common yellow	Oct 4	980	116	0.119	43.3	18.62
russula	Oct 11	250	27	0.110	41.9	5.52
(Russula	Oct 14	820 ± 133 (n = 3)	90 ± 15 (n = 3)	0.110 ± 0.006 (n = 3)	42.9 ± 1.6 (n = 3)	5.32 ± 0.62 (n = 3)
ochroleuca)	Oct 17	910	110	0.121	42.4	5.20
	Oct 19	1200 ± 270(n = 3)	123 ± 27 (n = 3)	0.104 ± 0.008 (n = 3)	48.7 ± 0.2 (n = 3)	4.39 ± 0.24 (n = 3)
	Oct 30	690 ± 280 (n = 2)	73 ± 33 (n = 2)	0.103 ± 0.006 (n = 2)	46.3 ± 2.3 (n = 2)	5.46 ± 0.98 (n = 2)
The blusher	Oct 4	81	3.7 B	0.046 B	41.1	9.14
(Amanita	Oct 11	64	1.6 B	0.024 B	48.1	4.26
rubescens)	Oct 17	560	49	0.087	37.8	5.40
	Oct 19	43 A			58.7	3.93
Wood blewit	Oct 20	13.4			58.9	5.51
(Lepista nuda)						
Geometric mean:						
Honey fungus	Sept 29-Oct 11	72 ± 1.26(n = 5)	2.1 ± 1.26 (n = 5)	0.029 ± 1.07 (n = 5)	44.2 ± 1.04 (n = 5)	
Clouded agaric	Oct 4-Oct 14	*143 ± 1.54(n = 4)*	*18 ± 1.51 (n = 4)*	*0.126 ± 1.05 (n = 4)*	39.8 ± 1.09 (n = 4)	
Common yellow russula	Oct 4-Oct 30	780 ± 1.17(n = 11)	85 ± 1.17 (n = 11)	0.108 ± 1.03 (n = 11)	44.9 ± 1.02 (n = 11)	
The blusher	Oct 4-Oct 19	106 ± 1.77 (n = 4)	6.6 ± 2.81 (n = 3)	0.046 ± 1.44 (n = 3)	45.8 ± 1.10 (n = 4)	
Wood blewit	Oct 20	13.4			58.9	
Arithmetic mean:						
Honey fungus	Sept 29-Oct 11	80 ± 17.4 (n = 5)	2.3 ± 0.4 (n = 5)	0.029 ± 0.002 (n = 5)	44.3 ± 1.7 (n = 5)	
Clouded agaric	Oct 4-Oct 14	187 ± 75 (n = 4)	23 ± 9.3 (n = 4)	0.126 ± 0.006 (n = 4)	40.3 ± 3.6 (n = 4)	
Common yellow russula	Oct 4-Oct 30	870 ± 117(n = 11)	95 ± 12.4 (n = 11)	0.109 ± 0.003 (n = 11)	45.0 ± 1.0 (n = 11)	
The blusher	Oct 4-Oct 19	188 ± 125 (n = 4)	18 ± 15 (n = 3)	0.052 ± 0.018 (n = 3)	46.4 ± 4.6 (n = 4)	
Wood blewit	Oct 20	13.4			58.9	

Table 5.13.2.1. Radiocesium in soil samples (0-5 cm layer) collected in spruce-forest in Gribskov in the north-east part of Zealand in Denmark October 26, 1989 collected by University of Roskilde

		^{137}Cs		^{134}Cs		$\frac{^{134}Cs}{^{137}Cs}$	g K
Territory	No.	Bq kg^{-1} fresh	Bq m^{-2}	Bq kg^{-1} fresh	Bq m^{-2}		kg^{-1} fresh
1	4	43	1140	4.8	128	0.112	2.63
1	5	48	1610	5.2	176	0.109	1.79
1	6	36	830	3.0	71	0.085	2.48
1 Arithmetic mean		42	1190	4.4	125	0.102	2.30
(n = 3)	S.E.	4	230	0.7	30	0.009	0.26
2	10	45	1080	4.9	117	0.108	2.10
2	11	42	1070	5.5	141	0.131	0.92
2	12	69	2900	5.2	220	0.075	11.2
2 Arithmetic mean		52	1690	5.2	159	0.105	4.7
(n = 3)	S.E.	8	620	0.2	31	0.016	3.2
Geometric mean of 1 and 2		46	1310	4.7	134	0.102	2.5
(n = 6)S.E.(factor)		1.09	1.20	1.09	1.17	1.09	1.40
Arithmetic mean of 1 and 2		47	1440	4.8	142	0.104	3.5
(n = 6) S.E.		5	310	0.4	21	0.008	1.6

Table 5.13.2.2. Radiocesium in soil samples (0-5 cm layer) collected in beech wood in Gribskov in the north-east part of Zealand in Denmark October 26, 1989 collected by University of Roskilde

Territory	No.	^{137}Cs Bq kg^{-1} fresh	^{137}Cs Bq m^{-2}	^{134}Cs Bq kg^{-1} fresh	^{134}Cs Bq m^{-2}	$^{134}Cs/^{137}Cs$	g K kg^{-1} fresh
1	1	53	2100	2.9	113	0.055	8.85
1	2	45	1980	2.8	121	0.062	10.46
1	3	47	1800	3.8	145	0.081	5.70
1 Arithmetic mean		48	1940	3.1	127	0.066	8.3
(n=3)	S.E.	2	76	0.3	10	0.008	1.4
2	7	34	1190	3.6	124	0.104	1.52
2	8	65	1310	8.4	170	0.129	0.93
2	9	65	2600	5.8	230	0.089	8.32
2 Arithmetic mean		55	1690	5.9	174	0.107	3.6
(n=3)	S.E.	10	440	1.4	30	0.012	2.4
Geometric mean of 1 and 2		50	1760	4.2	146	0.083	4.3
(n=6) S.E. (factor)		1.10	1.12	1.19	1.11	1.14	1.52
Arithmetic mean of 1 and 2		51	1820	4.5	150	0.086	6.0
(n=6) S.E.		5	210	0.9	18	0.011	1.6

Table 5.13.2.3. Radiocesium in soil samples collected in spruce-forest in Gribskov in the north-east part of Zealand in Denmark November 1, 1989 collected by University of Roskilde

Layer	^{137}Cs Bq kg^{-1} fresh	^{137}Cs Bq m^{-2}	^{134}Cs Bq kg^{-1} fresh	^{134}Cs Bq m^{-2}	$^{134}Cs/^{137}Cs$	g K kg^{-1} fresh
0-10 cm	27	1800	2.0	136	0.076	13.8
10-20 cm	5.9	680	0.051	5.9	0.0086	14.4
20-30 cm	2.0	300	B.D.L.	B.D.L.		15.7
0-30 cm		Σ 2780		Σ 142		

Table 5.13.2.4. Radiocesium in soil samples collected in beech wood in Gribskov in the north-east part of Zealand in Denmark November 1, 1989 collected by University of Roskilde

Layer	^{137}Cs Bq kg^{-1} fresh	^{137}Cs Bq m^{-2}	^{134}Cs Bq kg^{-1} fresh	^{134}Cs Bq m^{-2}	$^{134}Cs/^{137}Cs$	g K kg^{-1} fresh
0-10 cm	22	2600	1.3 A	149 A	0.058	13.3
10-20 cm	0.97	161	B.D.L.	B.D.L.		16.0
20-30 cm	0.47	79	B.D.L.	B.D.L.		16.6
0-30 cm		Σ 2800		Σ 149		

6. Strontium-90 and Radiocesium in Humans

6.1. Strontium-90 in Human Bone

(by A. Aarkrog)

Tables 6.1.1-6.1.6 A & B summarize the results from 1988 and 1989. The levels are decreasing for all age groups with an effective halflife of about 4 years (1985-1989).

6.2. Radiocesium in the Human Body

by B. Lauridsen and J. Søgaard-Hansen

Whole-body measurements of radiocesium were initiated at Risø in July 1963 (cf. 2.3 in Risø Report No. 85). The initial program stopped in 1977 due to very low body contents. The Chernobyl accident resulted in elevated radiocesium levels in foodstuff and the whole-body measurements were resumed in September 1986.

The new control group comprises a large fraction of the old supplemented with a few newcomers. In total there are about 20 persons in the group including 2 children.

Results from the early whole-body measurements are shown in Fig. 6.2.1. The figure shows the average yearly Bq ^{137}Cs (kg K)$^{-1}$ contents (± 1 S.E.) in the period 1963 to 1977. The measurements are compared with calculated values based on foodstuff data. For comparison the average values for 1986, 1987, 1988 and 1989 are given.

In Fig. 6.2.2 the measured mean values of ^{134}Cs + ^{137}Cs body content are shown for men, women and children. The figure, furthermore, shows the calculated levels based upon estimated intake of radiocesium with food. In Fig. 6.2.2 persons in the control group were omitted if they have been on official travel to countries with relatively high contamination levels. The measured body contents in 1989 are now well below the 1987 peak values and are approaching the pre-Chernobyl level. The calculated levels appear to be in good agreement with the observed values. The mean concentration in 1988 was 1250 Bq ^{134}Cs + ^{137}Cs/(kg K) (rel. S.D.: 27%). The mean concentration in 1989 was 555 Bq ^{134}Cs + ^{137}Cs/(kg K) (rel. S.D.: 12%).

6.3. Radionuclides in Human Milk

(by A. Aarkrog)

The mean concentrations in human milk were 0.099 ± 0.017 Bq ^{137}Cs l^{-1} and 0.0020 ± 0.0004 Bq ^{90}Sr l^{-1}, 84% of the ^{137}Cs was from Chernobyl. Compared with the diet levels measured in Zealand in June and December 1988, we found that 29% of the daily intake of ^{137}Cs and 1.4% of the ^{90}Sr were excreted in 1 l of human milk. These observations are compatible with those made earlier for global fallout (*Aarkrog* 1979).

6.4. Human Urine

Since the last quarter of 1987, when the maximum ^{137}Cs level in human urine from Risø occurred (660 Bq ^{137}Cs (kg K)$^{-1}$) the concentrations have decreased with an effective halflife of 0.75 years. This decrease is in agreement with that observed for wholebody measurements (cf. 6.2).

The ratio between the annual mean values of Bq ^{137}Cs (kg K)$^{-1}$ in body and urine was 3.1 in 1988 and 2.9 in 1989. The maximum of ^{137}Cs in urine and body occurred approximately 0.5-1 year after the maximum in diet.

Table 6.1.1.A. Strontium-90 in vertebrae from newborn children (< 1 month old) in 1988

Zone	Age in days	Month of death	Sex	Bq (kg Ca)$^{-1}$
II	27	4	M	19,6

Table 6.1.1.B. Strontium-90 in vertebrae from newborn children (< 1 month old) in 1989

No samples

Table 6.1.2.A. Strontium-90 in bone from infants (≤ 4 years) in 1988

Zone	Age in months	Month of death	Sex	Bq (kg Ca)$^{-1}$
I	8	4	F	28
III	3	4	F	23
III	1	4	M	18.0
IV	8	4	M	33 B

Table 6.1.2.B. Strontium-90 in bone from infants (≤ 4 years) in 1989

Zone (Location)	Age in months	Month of death	Sex	Bq (kg Ca)$^{-1}$
Jutland	3	8	F	11.5 B

Table 6.1.3.A. Strontium-90 in bone from children and teenagers (≤ 19 years) in 1988

No samples.

Table 6.1.3.B. Strontium-90 in bone from children and teenagers (≤ 19 years) in 1989

Zone	Age in years	Month of death	Sex	Bq (kg Ca)$^{-1}$
II	15	5	M	17.0
VI	6	6	F	18.0

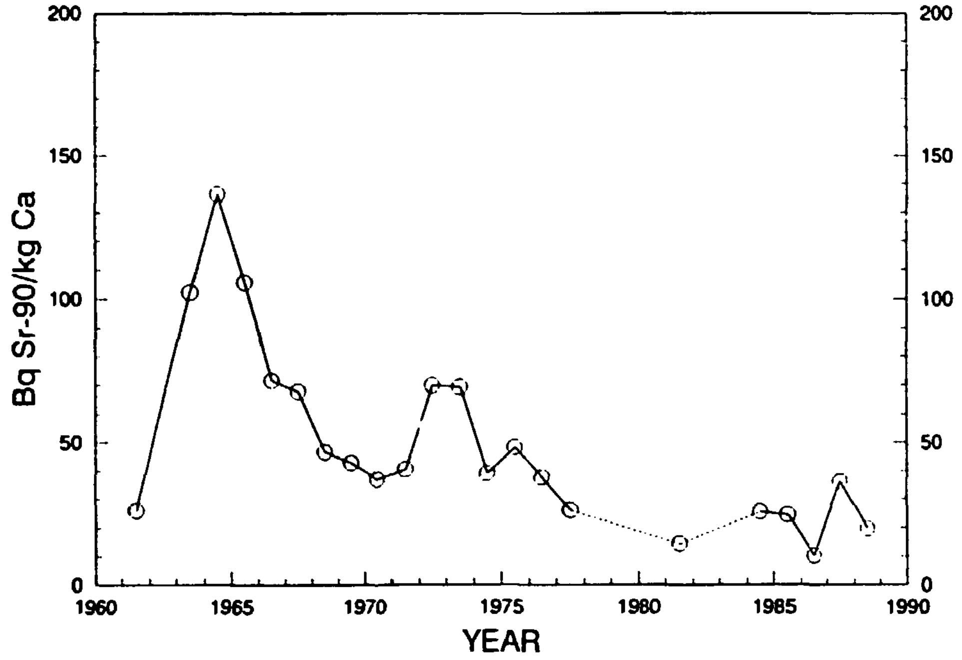


Fig. 6.1.1. Strontium-90 levels in bone from new-born (< 1 month) 1961-1989.

Fig. 6.1.2. Strontium-90 levels in bone from infants (> 1 month ≤ 4 years) 1961-1989.

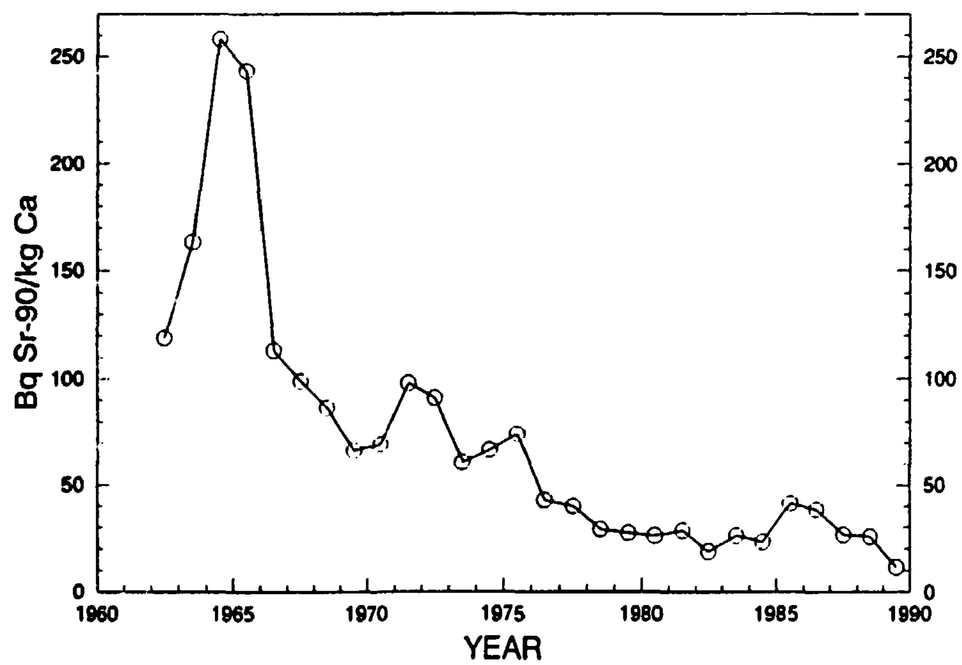


Table 6.1.4.A. Strontium-90 in vertebrae from adults (≤ 29 years) in 1988

Zone	Age in years	Month of death	Sex	Bq (kg Ca)$^{-1}$
II	28	9	F	16.6
II	23	9	M	12.4
II	23	9	M	11.6
VI	20	5	M	23
VI	29	5	M	15.8

Table 6.1.4.B. Strontium-90 in vertebrae from adults (≤ 29 years) in 1989

Zone (Location)	Age in years	Month of death	Sex	Bq (kg Ca)$^{-1}$
II	20	6	M	12.0
II	21	6	M	11.3
VI	24	1	M	11.1
Jutland	23	5	M	14.1

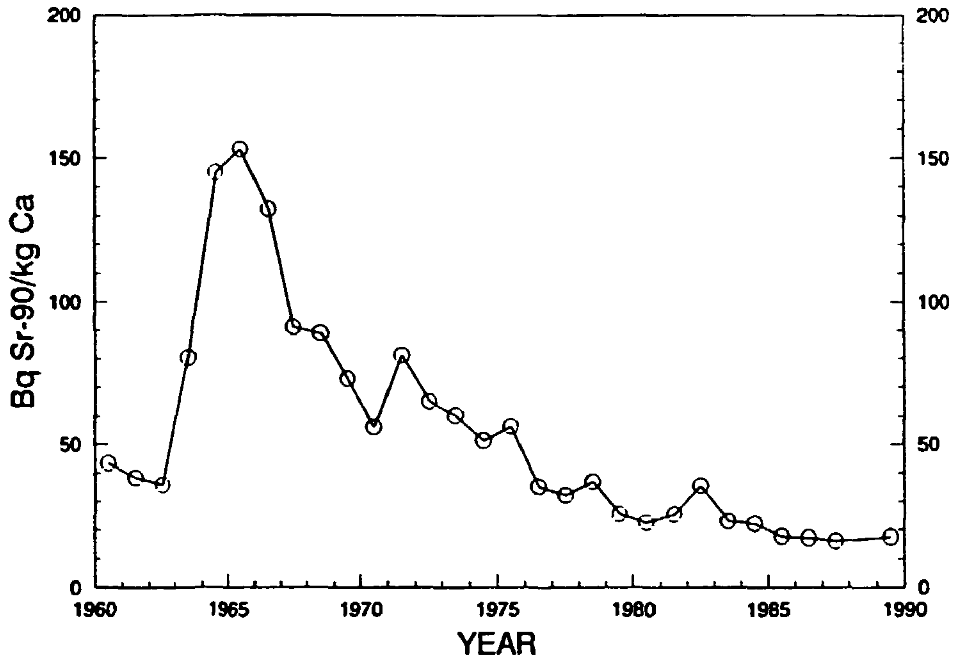


Fig. 6.1.3. Strontium-90 levels in bone from children (> 4 years ≤19 years) 1960-1989.

Fig. 6.1.4. Strontium-90 levels in bone from adults (> 19 years ≤29 years) 1960-1989.

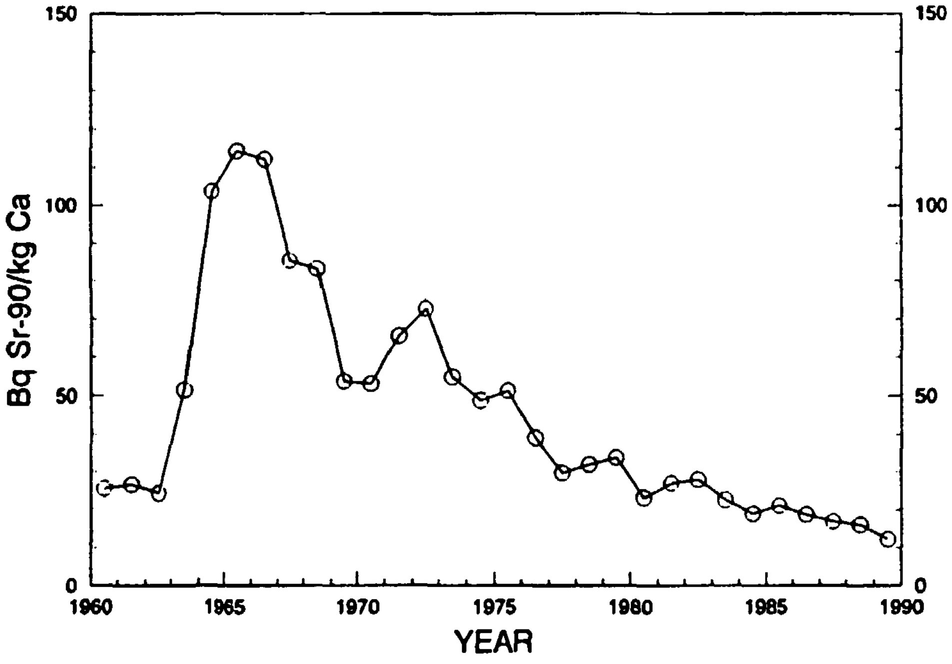


Table 6.1.5.A. Strontium-90 in vertebrae from adults (> 29 years) in 1988

Zone	Age in years	Month of death	Sex	Bq (kg Ca)$^{-1}$
I	32	4	M	16.5
I	60	9	M	20
I	73	4	M	24
I	74	9	M	31
I	81	4	M	24
II	36	9	F	22
II	38	4	F	34
II	46	4	F	17.6
II	49	4	F	25
II	51	4	F	24
II	63	4	F	14.4
II	32	4	M	14.3
II	37	9	M	20
II	53	10	M	19.6
II	57	9	M	18.3
II	67	4	M	10.6
III	57	10	M	19.5
IV	75	4	M	33
VI	47	4	F	21
VI	50	5	F	19.9
VI	53	4	F	21
VI	56	4	F	20
VI	58	12	F	10.1
VI	65	4	F	22
VI	35	4	M	14.8
VI	49	4	M	14.7
VI	54	12	M	11.3
VI	56	4	M	13.3 A
VI	63	4	M	15.0
VI	66	4	M	20

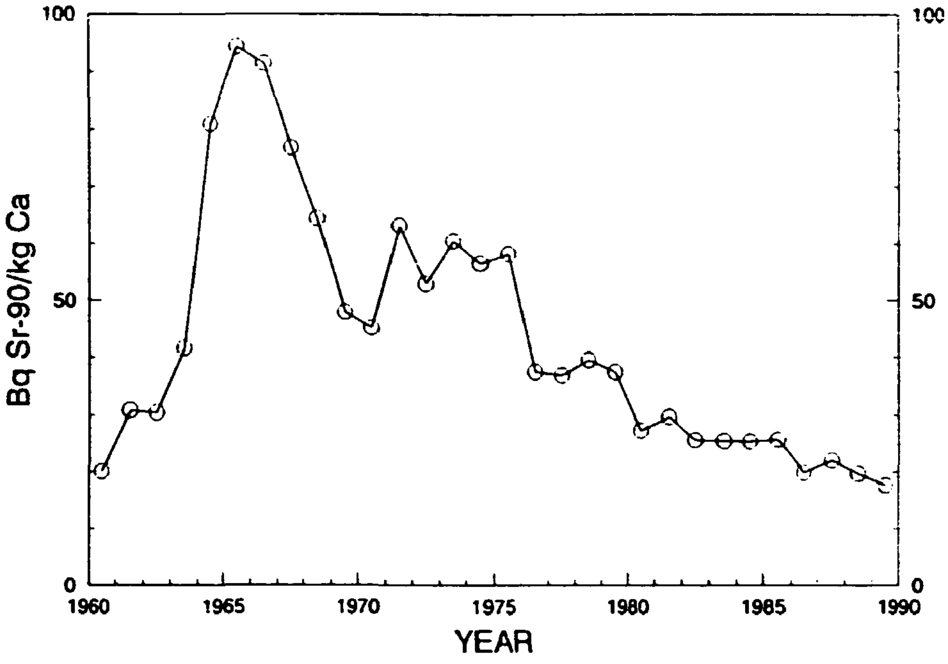


Fig. 6.1.5. Strontium-90 levels in bone from adults (> 29 years) 1960-1989).

Table 6.1.5.B. Strontium-90 in vertebrae from adults (> 29 years) in 1989

Zone (Location)	Age in years	Month of death	Sex	Bq (kg Ca)$^{-1}$
I	55	10	F	14.2
I	70	10	F	29
I	85	10	F	25
I	60	6	M	11.4
II	56	1	F	32
II	73	6	F	24
II	85	10	F	19.6
II	39	10	M	17.6
II	60	10	M	10.8
II	70	10	M	13.8
II	79	9	M	36
III	52	5	F	17.7
III	80	5	F	25
III	70	10	M	14.5
IV	84	5	F	26
VI	30	1	F	15.8
VI	42	6	F	18.4
VI	43	6	F	7.4 A
VI	44	6	F	21
VI	52	6	F	12.4
VI	67	6	F	11.8
VI	34	6	M	11.7
VI	43	6	M	19.8
VI	43	6	M	26
VI	45	1	M	12.4 A
VI	54	1	M	10.7 A
VI	54	6	M	14.4
VI	56	6	M	17.0
VI	66	6	M	23
VI	66	6	M	14.6
VI	67	1	M	8.1
VI	71	1	M	21
VI	77	1	M	21
VI	78	1	M	6.9 B
Jutland	35	6	F	15.2
"	39	10	F	17.3
"	42	6	F	19.8
"	43	10	F	13.1
"	40	10	M	19.7
"	47	10	M	24
"	52	5	M	9.2
"	57	10	M	16.6
"	59	5	M	15.7
"	65	6	M	19.0

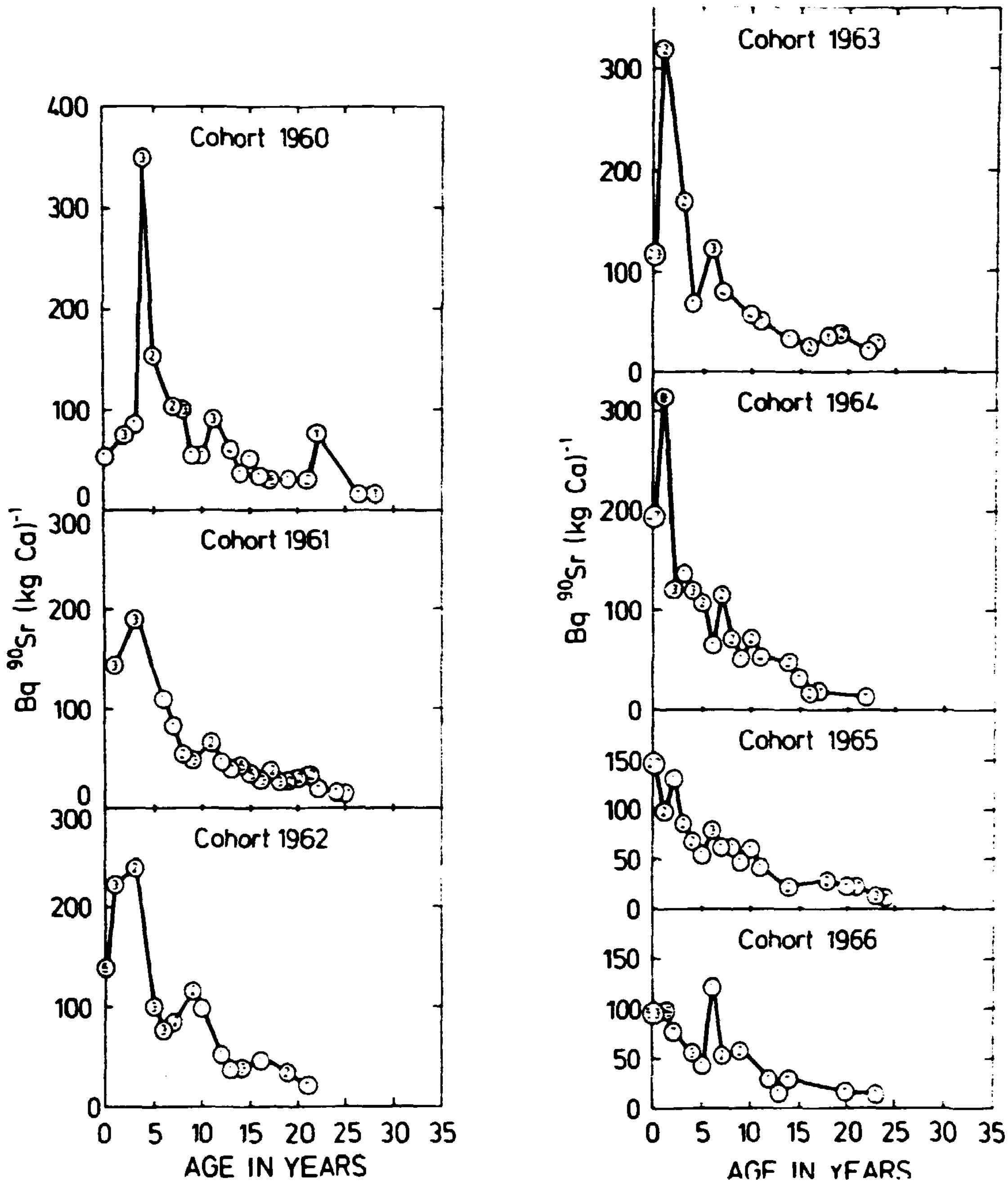


Fig. 6.1.6. Strontium-90 in human bone from Danish cohorts 1960-1966. Abscissa: age in years. Ordinate: bone level in Bq ^{90}Sr (kg Ca)$^{-1}$.

Table 6.1.6.A. Strontium-90 in human vertebrae collected in Denmark in 1988. (Unit: Bq (kg Ca)$^{-1}$)

Age group	Number of samples	Min.	Max.	Median	Arithmetic mean	Geometric mean
New-born (< 1 month)	1	19.6	19.6	19.6	19.6	19.6
Infants (≤ 4 years)	4	18.0	33	26	26	25
Children (≤ 19 years)	0	-	-	-	-	-
Adults (≤ 29 years)	5	11.6	23	15.8	16.0	15.5
Adults (> 29 years)	30	10.1	34	20.0	19.7	18.9

Table 6.1.6.B. Strontium-90 in human vertebrae collected in Denmark in 1989. (Unit: Bq (kg Ca)$^{-1}$)

Age group	Number of samples	Min.	Max.	Median	Arithmetic mean	Geometric mean
New-born (< 1 month)	0	-	-	-	-	-
Infants (≤ 4 years)	1	11.5	11.5	11.5	11.5	11.5
Children (≤ 19 years)	2	17.0	18.0	17.5	17.5	17.5
Adults (≤ 29 years)	4	11.1	14.1	11.6	12.1	12.0
Adults (> 29 years)	44	6.9	36	17.2	17.7	16.6

Table 6.2.A. Radiocesium ($^{134+137}Cs$) in humans from Risø and environment measured in 1988

No.	Date	Sex	Age	Bq Cs (kg K)$^{-1}$	g K (kg)$^{-1}$
2	February 2	F	44	3172	2.21
2	March 21	F	44	1834	2.04
2	April 18	F	44	1679	2.14
2	May 9	F	44	1505	1.87
2	June 15	F	45	1673	1.88
2	July 13	F	45	1387	1.82
2	October 10	F	45	1000	2.11
2	November 11	F	45	1089	1.89
2	December 12	F	45	730	2.01
3	February 11	F	55	1817	1.56
3	March 21	F	55	1003	1.87
3	April 13	F	55	932	1.94
3	May 16	F	55	1184	1.78
3	June 20	F	55	1036	1.84
3	July 19	F	55	1577	1.91
3	August 11	F	55	1850	1.82
3	October 11	F	55	2821	1.94
3	November 22	F	55	2473	2.02
3	December 13	F	56	2551	1.88
4	February 8	M	55	2787	1.78
4	March 15	M	55	2322	1.80
4	April 14	M	55	2027	1.80
4	May 16	M	55	1829	1.69
4	June 15	M	55	1691	1.65
4	July 19	M	55	1448	1.85
4	August 16	M	55	1351	1.84
4	November 14	M	56	1405	2.11
4	December 15	M	56	915	2.05
6	May 11	M	56	1486	1.79
6	June 15	M	56	1366	1.73
6	July 18	M	56	1133	1.86
6	August 10	M	56	909	1.87
6	October 6	M	56	1125	2.04
6	November 15	M	56	890	1.96
6	December 12	M	57	709	1.99
7	February 16	F	48	2197	1.66
7	March 16	F	48	1316	1.56
7	April 13	F	48	1458	1.59
7	June 14	F	48	1140	1.70
7	July 13	F	49	1091	1.70
7	August 12	F	49	1343	1.68
7	October 12	F	49	901	1.81
7	November 11	F	49	1109	1.83
7	December 12	F	49	878	1.94
9	February 9	F	59	1788	1.74
9	April 12	F	59	1207	1.65
9	May 13	F	59	886	1.64

Table 6.2.A. (continued)

No.	Date	Sex	Age	Bq Cs (kg K)$^{-1}$	g K (kg)$^{-1}$
9	June 17	F	60	918	1.74
9	July 15	F	60	791	1.59
9	October 7	F	60	718	1.85
9	November 10	F	60	524	1.75
9	December 12	F	60	493	2.05
11	February 10	F	51	2097	1.56
11	March 23	F	51	1877	1.61
11	April 12	F	51	1574	1.36
11	May 9	F	51	1507	1.48
11	June 22	F	51	1530	1.39
11	August 11	F	51	869	1.64
11	October 11	F	51	956	1.67
11	November 14	F	51	621	1.60
11	December 13	F	51	556	1.76
13	December 19	M	41	496	2.69
14	February 9	M	45	1468	2.36
14	March 18	M	45	1045	2.09
14	April 13	M	45	1026	2.13
14	May 9	M	45	1042	2.16
14	June 15	M	45	924	2.24
14	August 16	M	45	823	2.26
14	October 13	M	45	644	2.52
14	November 15	M	46	609	2.61
14	December 12	M	46	534	1.99
15	February 10	F	46	2311	1.70
15	March 25	F	46	2223	1.64
15	April 12	F	46	1530	1.48
15	May 11	F	47	1527	1.61
15	June 16	F	47	1543	1.56
15	July 18	F	47	1352	1.52
15	October 10	F	47	1281	1.63
15	November 16	F	47	1185	1.67
15	December 15	F	47	917	1.71
17	February 16	M	28	1406	2.36
17	April 22	M	29	995	2.07
17	May 17	M	29	991	2.18
17	June 21	M	29	946	2.42
17	July 18	M	29	964	2.31
17	August 9	M	29	890	2.43
17	October 11	M	29	748	2.65
17	November 7	M	29	615	2.61
17	December 19	M	29	261	2.50
18	February 11	F	52	1250	1.55
18	March 18	F	52	792	1.44
18	April 20	F	52	1091	1.52
18	May 10	F	52	1340	1.46
18	June 16	F	52	881	1.67
18	July 15	F	52	960	1.62

Table 6.2.A. (continued)

No.	Date	Sex	Age	Bq Cs (kg K)$^{-1}$	g K (kg)$^{-1}$
18	August 11	F	52	765	1.72
18	October 11	F	52	723	1.84
18	December 18	F	52	357	1.96
19	February 16	F	49	1674	1.66
19	March 23	F	49	1198	1.80
19	April 11	F	49	893	1.61
19	May 10	F	49	953	1.55
19	June 21	F	49	1124	1.79
19	August 10	F	49	883	1.71
19	October 12	F	49	664	2.07
19	November 16	F	49	672	1.85
19	December 9	F	49	561	1.85
20	February 5	M	45	1413	2.13
20	March 18	M	45	1110	1.85
20	April 13	M	45	1304	1.89
20	May 10	M	45	1327	1.72
20	June 14	M	45	1105	1.82
20	August 16	M	45	1168	1.89
20	October 13	M	45	1025	2.06
20	November 9	M	45	841	2.27
20	December 8	M	46	1274	2.23
22	February 11	F	6	2282	3.35
22	March 22	F	6	1911	2.99
22	April 20	F	6	803	2.28
22	May 11	F	6	761	2.51
22	June 24	F	7	736	2.47
22	August 15	F	7	858	2.47
22	October 14	F	7	857	2.70
22	November 24	F	7	651	2.49
22	December 19	F	7	751	2.92
24	February 22	F	13	2462	1.91
24	March 23	F	13	1850	1.97
24	May 10	F	13	1553	1.65
24	June 14	F	13	924	1.90
24	August 12	F	13	916	1.74
24	October 7	F	13	731	2.09
24	November 22	F	13	538	1.85
24	December 13	F	13	425	2.16
25	February 10	M	11	2553	2.20
25	March 16	M	11	1150	1.69
25	April 13	M	11	1172	1.76
25	May 10	M	11	1265	1.56
25	June 13	M	12	981	1.74
25	August 12	M	12	844	1.84
25	October 11	M	12	977	2.06
25	November 24	M	12	512	2.00
25	December 7	M	12	551	2.13

Table 6.2.A. (continued)

No.	Date	Sex	Age	Bq Cs (kg K)$^{-1}$	g K (kg)$^{-1}$
27	February 8	M	46	2842	1.77
27	March 15	M	46	2082	1.76
27	April 18	M	46	1807	1.67
27	May 13	M	46	1463	1.62
27	June 14	M	46	1383	1.75
27	July 14	M	46	1198	1.68
27	October 13	M	47	914	1.91
27	November 18	M	47	767	1.89
27	December 9	M	47	577	2.00
31	May 17	M	73	1353	1.57
31	June 14	M	73	1118	1.98
31	July 21	M	73	988	1.79
31	August 9	M	73	1106	1.86
31	October 11	M	73	1187	2.04
31	November 24	M	73	856	1.92
38	March 21	M	9	1289	2.33
38	April 18	M	9	1283	2.17
38	May 9	M	10	917	2.62
38	June 14	M	10	930	2.31
38	August 15	M	10	826	2.35
36	October 10	M	10	749	2.54
38	November 11	M	10	661	2.52
38	December 12	M	10	521	2.77

Mean*	February 1988	2015 ± 170
	March 1988	1530 ± 165
	April 1988	1350 ± 100
	May 1988	1315 ± 70
	June 1988	1225 ± 75
	July 1988	1170 ± 75
	August 1988	1090 ± 100
	September 1988	-
	October 1988	1050 ± 40
	November 1988	975 ± 135
	December 1988	785 ± 140

*Monthly mean values (adults only) $^{134+137}Cs$ Bq (kg K)$^{-1}$ ± 1 S.E.

An approximate estimate of the ^{137}Cs content may be obtained by multiplying the Bq Cs (kg K)$^{-1}$ with 0.78

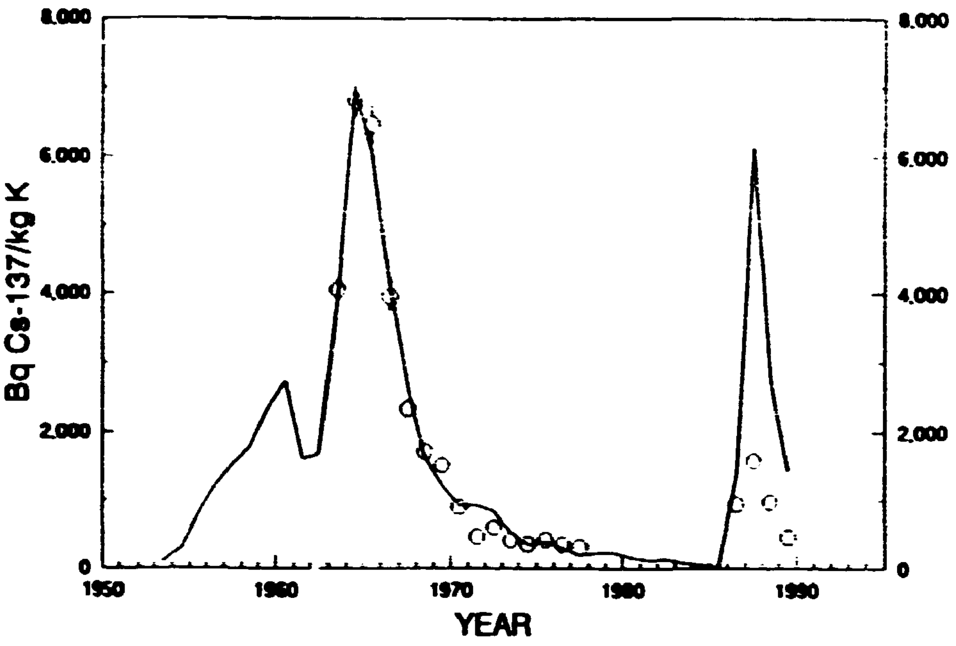


Fig. 6.2.1. A comparison between observed (±1 S.E.) and calculated (Aarkrog 1979) Bq ^{137}Cs (kg K)$^{-1}$ levels in persons from Zealand.

Fig. 6.2.2. Radiocesium in Danish men, women and children from Zealand in 1986-1989. The curves represent the calculated levels based upon calculated diet measurements.

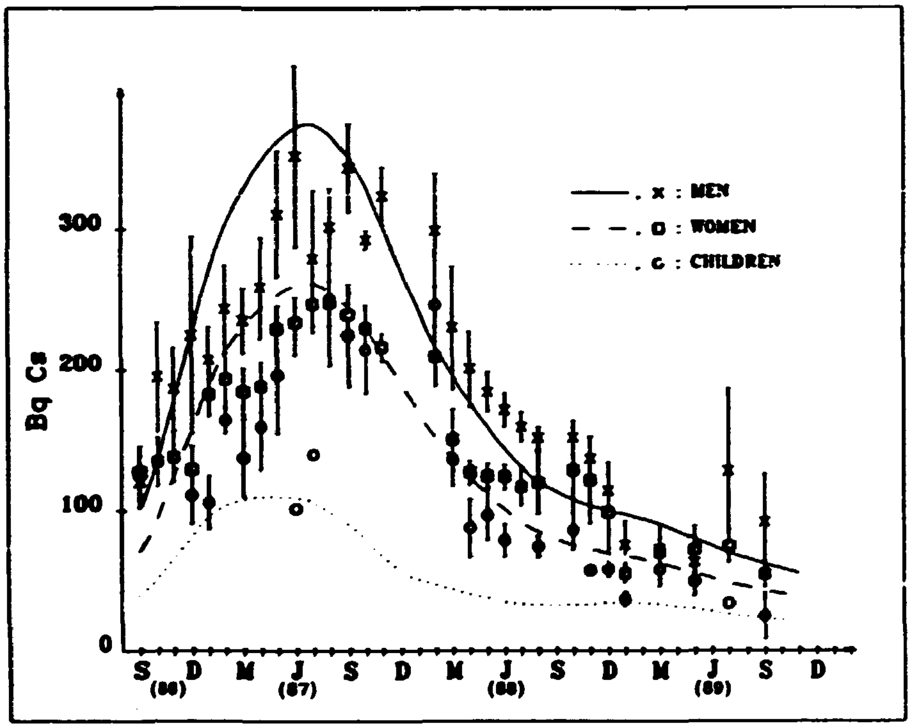


Table 6.2.B. Radiocesium ($^{134+137}Cs$) in humans from Risø and environment measured in 1989

No.	Date	Sex	Age	Bq Cs (kg K)$^{-1}$	g K (kg)$^{-1}$
2	January 20	F	45	619	2.19
2	March 3	F	45	655	2.04
2	May 22	F	45	557	2.03
2	July 11	F	46	488	2.05
2	September 21	F	46	368	2.58
3	March 20	F	56	1747	1.91
3	May 23	F	56	1554	1.95
3	July 19	F	56	1183	1.78
4	January 18	M	56	1138	1.63
4	March 14	M	56	744	1.93
4	July 18	M	56	706	1.78
4	September 26	M	56	657	2.02
6	January 19	M	57	484	1.44
6	March 16	M	57	457	1.97
6	May 19	M	57	409	1.87
6	July 18	M	57	470	1.82
6	September 21	M	58	419	2.14
7	January 20	F	49	752	1.47
7	March 13	F	49	349	2.03
7	May 19	F	49	472	1.90
7	July 26	F	50	832	2.33
7	September 27	F	50	320	1.91
9	January 17	F	60	644	1.25
9	March 15	F	60	438	1.82
9	May 25	F	60	582	1.84
9	July 19	F	61	522	1.80
9	September 27	F	61	694	1.92
11	January 19	F	52	524	1.42
11	March 14	F	52	556	1.70
11	May 30	F	52	497	1.66
11	July 26	F	52	504	1.75
14	January 18	M	46	524	1.99
14	March 14	M	46	366	2.40
14	May 24	M	46	509	2.53
14	July 19	M	46	355	2.36
14	September 22	M	46	341	2.53
15	January 19	F	47	955	1.29
15	March 13	F	47	583	1.65
15	May 29	F	48	749	1.52
15	July 17	F	48	651	1.64
15	September 29	F	48	644	1.53
17	January 23	M	29	376	2.13
17	March 28	M	30	420	2.61
17	May 22	M	30	282	2.62
17	July 11	M	30	254	2.65

Table 6.2.B. (continued)

No.	Date	Sex	Age	Bq Cs (kg K)$^{-1}$	g K (kg)$^{-1}$
17	September 25	M	30	116	2.78
18	January 18	F	52	311	1.60
18	March 15	F	53	375	1.78
18	May 22	F	53	348	1.80
19	January 20	F	50	477	1.53
19	March 15	F	50	350	1.83
19	May 24	F	50	521	1.73
19	July 26	F	50	445	1.81
19	September 22	F	50	298	2.06
20	March 21	M	46	393	1.96
20	July 17	M	46	635	1.88
20	September 25	M	46	438	2.00
22	January 19	F	7	346	2.36
22	March 21	F	7	599	2.39
22	May 25	F	7	498	2.73
22	July 26	F	8	396	2.84
22	September 27	F	8	86	3.21
24	February 2	F	14	442	1.68
24	March 16	F	14	758	1.87
24	June 1	F	14	502	2.01
24	September 26	F	14	335	2.06
25	January 17	M	12	448	1.51
25	March 15	M	12	592	1.94
25	May 30	M	12	517	1.78
25	September 25	M	13	319	1.85
27	January 17	M	47	570	1.25
27	March 16	M	47	359	1.86
27	May 29	M	47	365	1.86
31	March 20	M	74	564	2.14
31	September 21	M	74	546	1.94
38	January 30	M	10	488	2.25
38	March 13	M	10	351	2.52
38	May 1	M	11	450	2.25
38	September 22	M	11	294	2.49
Mean*	January 1989			615 ± 70	
	March 1989			557 ± 90	
	May 1989			575 ± 95	
	July 1989			587 ± 170	
	September 1989			440 ± 55	

*Monthly mean values (adults only) $^{134+137}Cs$ Bq (kg K)$^{-1}$ ± 1 S.E.

An approximate estimate of the ^{137}Cs content may be obtained by multiplying the Bq Cs (kg K)$^{-1}$ with 0.83

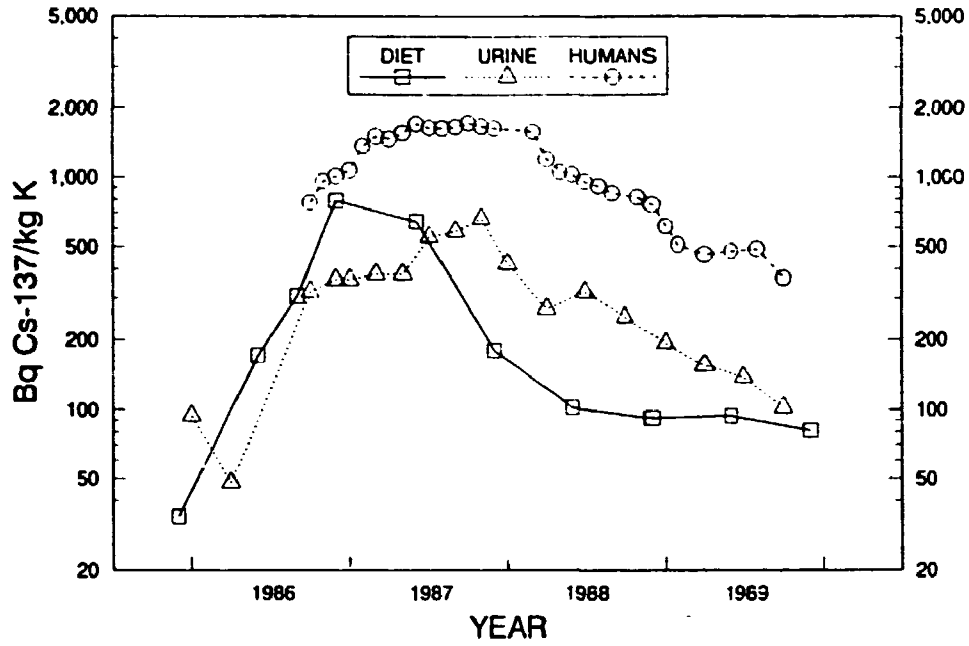


Fig. 6.4. Radiocesium (Bq ^{137}Cs (kg K)$^{-1}$ in diet, urine, and humans from Zealand in 1986-1987. (The human data were calculated from whole-body measurements of (^{134}Cs + ^{137}Cs) by multiplication with 0.67 in 1986, 0.72 in 1987, 0.78 in 198? and 0.83 in 1989.

Table 6.3. Radiocesium and ^{90}Sr in human milk collected in Himmelev near Roskilde in 1988-1989. Donor born in 1945, child born December 24, 1987

Period	Bq ^{137}Cs l^{-1}	Bq ^{137}Cs $(kg\ K)^{-1}$	$\frac{^{134}Cs}{^{137}Cs}$	Bq ^{90}Sr l^{-1}	Bq ^{90}Sr $(kg\ Ca)^{-1}$
Aug 10-Sep 7 1988	0.121	280	0.21	0.00177	6.4
Sep 7-Oct 6 1988	0.110	260	0.23	0.00180 A	7.0 A
Oct 7-Nov 6 1988	0.093	220	0.23	0.00185	7.3
Nov 7-Dec 2 1988	0.094	220	0.183	0.0027 A	10.3 A
Dec 6-Jan 12 1989	0.076	183	0.21	0.00178	6.9

Table 6.4. Radiocesium in urine samples from a control group at Risø. 1988-1989

Date	^{40}K $g\ l^{-1}$	Bq ^{137}Cs $(kg\ K)^{-1}$	$\frac{^{134}Cs}{^{137}Cs}$
January 1988	2.20	420	0.29
April 1988	0.89	270	0.33
July 1988	1.46	320	0.16
October 1988	1.59	250	-
January 1989	1.43	193	-
April 1989	1.83	155	-
July 1989	0.79	138	-
October 1989	1.29	102	-

7. Tritium in the Environment

by Heinz Hansen

7.1. Introduction

Tritium is produced naturally in the atmosphere by the interaction of cosmic-ray protons and neutrons with nitrogen, oxygen or argon. Surface waters contain about 0.4 kBq m^{-3} from this source (UNSCEAR 1982). Tritium is also produced and injected into the stratosphere as the result of thermonuclear explosions. At present, this latter source has enhanced the natural inventory by about a factor of ten (UNSCEAR 1982). Finally, tritium is produced as a by-product of the peaceful uses of atomic energy: it is released both during reactor operation and fuel reprocessing.

7.2. Assay of Tritium in Low-Level Amounts

The present assays of tritium levels in water are based on a relative enrichment of ^3H_2O by electrolysis and subsequent liquid scintillation counting as previously described (Risø Reports Nos. 386 etc. (Risø Reports 1957-1989)).

We have found that the tritium background in the air in our laboratory makes it impossible to produce reliable results if the concentrations are below 2 kBq m^{-3}. (Personal Communication *G. Östlund*, 1984). Previously we have applied a constant background correction by subtraction of 1.2 kBq ^3H m^{-3} from our measured values (cf. Appendix in Risø-R-527) (Risø Reports 1957-1989). This is not done any longer. Instead a blank is following the samples analysed and the ^3H level in this blank is used for the correction.

7.3. Summary of Results

The tritium results are shown in detail in the chapters where the samples belong.

Tables 4.2.3 and 4.2.4 give the results for precipitation. The annual mean concentrations in rain in 1988 were: 4.4 kBq m^{-3} at Risø, 2.5 at Tylstrup, 2.3 at Jyndevad, and 3.2 at Bornholm. In 1989 the levels were 6.8, 2.3, 2.2, and 2.6, respectively. The enhanced tritium levels at Risø were due to discharges of the DR 3 reactor at the site. The median concentration of tritium in Danish ground water (cf. Table 4.3.1) was 1.4 kBq ^3H m^{-3} in 1988 and 1989.

The tritium concentrations in Danish streams and lakes were 2.4 and 2.4 kBq m^{-3}, respectively (Tables 4.3.2.1 and 4.3.2.2). Danish drinking water contained 1.8 kBq ^3H m^{-3} in 1989 (Table 4.3.3.1).

8. Measurements of Background Radiation in 1988 and 1989

by L. Bøtter-Jensen and S.P. Nielsen

8.1. Instrumentation

Measurements of the background radiation were made with thermoluminescence dosimeters (TLD's), and a NaI(Tl) detector.

8.2. State Experimental Farms

The State experimental farms are situated as shown in Fig. 4.2. The results of the TLD measurements are shown in Table 8.2.1.A and B. The results of the NaI(Tl) detector measurements are shown in Table 8.2.2.A and B.

The γ-background measured with the NaI(Tl) detector in four groups of sampling stations is shown in Fig. 8.2.1 from 1962 to 1989.

8.3. Risø Environment

The five zones around Risø are located as shown in Fig. 8.3.1. The results of the TLD measurements are shown in Table 8.3.1.A and B, and the results of the NaI(Tl) detector measurements are shown in Table 8.3.2.A and B.

8.4. Gylling Næs Environment

The Gylling Næs environment is routinely monitored with TLDs, and the results from the site are given in Table 8.4.1.A and B. The locations are shown in Fig. 8.4.1.

8.5. Great Belt and Langeland Belt Areas

Locations on both shores of the Great Belt and the Langeland Belt (an international shipping route) are routinely monitored with TLDs; the results and locations are shown in Table 8.5.1.A and B and Fig. 8.5.1, respectively.

8.6. The Baltic Island of Bornholm

Locations on the island of Bornholm have been monitored with TLDs in the period May 1987 - April 1988 and May 1988 - May 1989. The results and locations are shown in Table 8.6.1.A and B and Fig. 8.6.1, respectively.

Table 8.2.1.A. TLD-measurements of the background radiation (integrated over 12 months and normalized to μR h⁻¹) at the State experimental farms in 1987/88

Location	Oct 1987 - Oct 1988 $\mu R\ h^{-1}$
Tylstrup	7.3
Borris	7.1
Ødum	6.5
Askov	7.8
St. Jyndevad	6.2
Blangstedgård	8.2
Tystofte	8.3
Abed	8.9
Mean	7.5

Table 8.2.1.B. TLD-measurements of the background radiation (integrated over 12 months and normalized to μR h⁻¹) at the State experimental farms in 1988/89

Location	Sept 1988 - Sept 1989 $\mu R\ h^{-1}$
Tylstrup	7.5
Borris	7.1
Ødum	6.7
Askov	7.9
St. Jyndevad	6.2
Blangstedgård	8.1
Tystofte	8.4
Abed	8.7
Mean	7.6

Table 8.2.2.A. Terrestrial exposure rates at the state experimental farms measured with the NaI(Tl) detector in 1988 ($\mu R\ h^{-1}$)

Location	March	August	December	Mean
Tylstrup	3.1	3.0	2.9	3.0
Borris	3.0	3.0	3.1	3.0
Kalø	4.1	3.8	3.7	3.9
Askov	3.7	3.6	3.6	3.6
St. Jyndevad	2.5	1.8	1.8	2.0
Årslev	4.8	4.8	4.8	4.8
Ledreborg	4.5	4.9	4.8	4.7
Tystofte	4.8	5.3	5.2	5.1
Abed	4.9	5.7	5.5	5.4
Mean	3.9	4.0	3.9	4.0

No measurements at Tornbygård in 1988

Table 8.2.2.B. Terrestrial exposure rates at the state experimental farms measured with the NaI(Tl) detector in 1989 ($\mu R\ h^{-1}$)

Location	March	July	October	Mean
Tylstrup	2.8	3.3	3.3	3.2
Borris	3.3	3.4	3.4	3.4
Kalø	3.5	3.7	3.8	3.7
Askov	3.6	3.8	3.7	3.7
St. Jyndevad	2.4	2.2	2.3	2.3
Årslev	4.5	4.7	4.5	4.6
Ledreborg	4.8	4.6	5.2	4.8
Tystofte	5.1	4.6	4.9	4.9
Abed	5.4	4.9	5.0	5.1
Tornbygård	(6.0)	6.0*	(6.1)	6.0
Mean	4.1	4.1	4.2	4.2

Figures in brackets were calculated from VAR3 (*Vestergaard* 1964).

*Measured May 30.

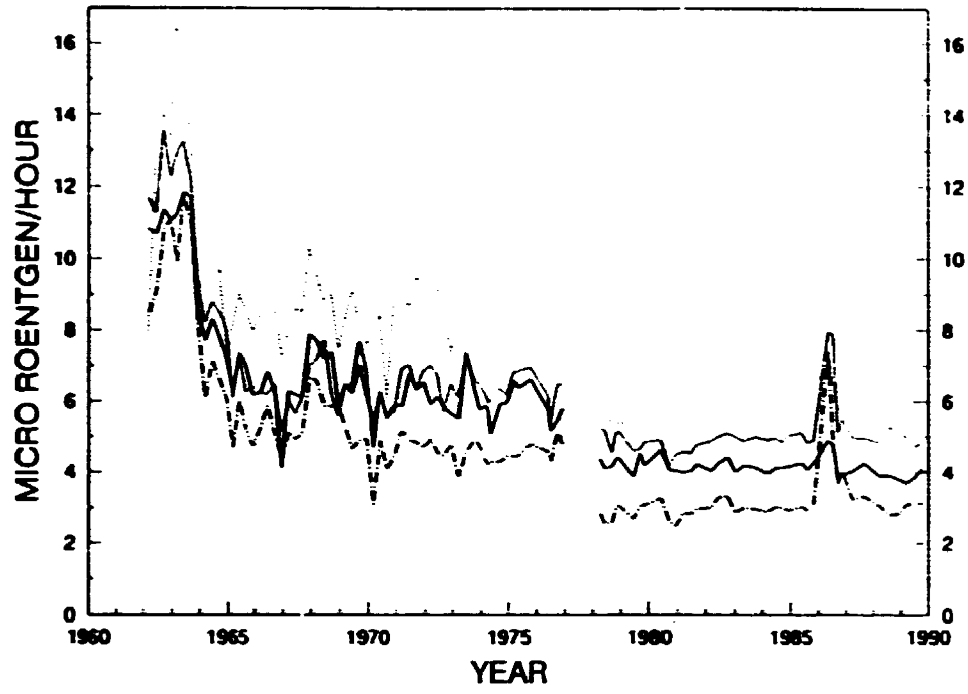


Fig. 8.2.1. Terrestrial exposure rates at the State experimental farms in 1962-1976 and 1978-1989 measured with the NaI(Tl) detector (μR h⁻¹).

......	*Åkirkeby/Tornbygård*
———	*Abed, Blangstedgård/Årslev, Tystofte*
▬▬▬	*Virumgård/Ledreborg, Ødum/Kalø, Tylstrup*
—·—	*Jyndevad, Askov, Studsgård/Borris*

Fig. 8.3.1. The environment of Risø. Locations for measurements of the background radiation.

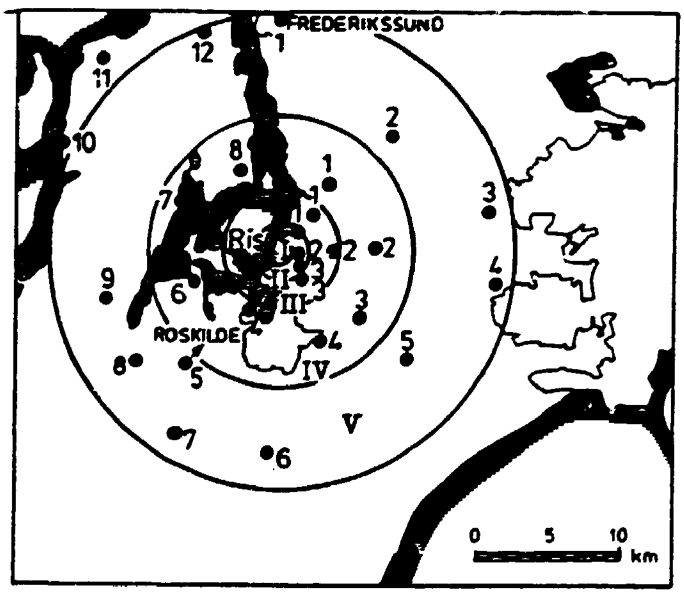


Table 8.3.1A. TLD-measurements of the background radiation (mean of 2 × 6 months integration periods and normalized to μR h⁻¹) in five zones (I-V) around Risø in 1987/88

Riso zone	Location	Oct 87 - Oct 88 μR h⁻¹
I	1	8.2
I	2	9.3
I	3	22.4
I	4	8.6
I	5	11.7
Mean		12.0
II	1	7.5
II	2	8.2
II	3	7.5
II	4	8.0
Mean		7.8
III	1	8.7
III	2	8.3
III	3	8.0
Mean		8.3
IV	1	7.5
IV	2	8.6
IV	3	8.2
IV	4	7.2
IV	5	6.9
IV	6	7.9
IV	7	9.1
Mean		7.9
V	1	8.1
V	2	9.4
V	3	9.0
V	4	7.5
V	5	8.3
V	6	8.1
V	7	9.1
V	8	9.6
V	9	9.2
V	10	8.1
Mean		8.6

Table 8.3.1.B. TLD-measurements of the background radiation (12-month integration period and normalized to μR h-1) in five zones (I-V) around Risø in 1988/89

Riso zone	Location	Oct 88 - Oct 89 μR h-1
I	1	7.8
I	2	9.0
I	3	20.9
I	4	8.5
I	5	10.7
Mean		11.4
II	1	7.7
II	2	8.3
II	3	7.4
II	4	7.8
Mean		7.8
III	1	8.2
III	2	8.0
III	3	7.7
Mean		7.9
IV	1	7.1
IV	2	8.2
IV	3	8.9
IV	4	7.1
IV	5	6.5
IV	6	7.6
IV	7	8.9
Mean		7.8
V	1	7.8
V	2	8.7
V	3	8.7
V	4	7.8
V	5	8.2
V	6	8.1
V	7	8.5
V	8	9.2
V	9	9.0
V	10	7.6
Mean		8.4

Table 8.3.2.A. Terrestrial exposure rates at the Risø zones in 1988 measured with the NaI(Tl) detector ($\mu R\ h^{-1}$)

Risø zone	Location	January	April	August	October
I	1	5.4	5.3	5.5	5.8
I	2	6.5	6.9	7.5	7.4
I	3	70	78	70	73
I	4	5.4	5.4	6.0	5.9
I	5	11.2	10.8	11.0	11.2
Mean		19.7	21	20	21
II	1	4.4	4.2	4.6	4.4
II	2	5.0	5.0	5.4	5.2
II	3	4.2	4.3	4.5	4.6
II	4	4.2	4.4	4.8	4.5
Mean		4.4	4.5	4.8	4.7
III	1		5.3		5.2
III	2		4.7		5.4
III	3		4.1		4.2
Mean			4.7		4.9
IV	1		4.3		4.3
IV	2		4.7		4.7
IV	3		4.8		4.8
IV	4		4.5		4.5
IV	5		3.8		3.4
IV	6		3.9		3.8
IV	7		4.7		4.4
Mean			4.4		4.3
V	1		4.6		4.4
V	2		5.6		5.8
V	3		4.7		5.2
V	4		4.7		5.2
V	5		5.2		5.5
V	6		5.6		5.4
V	7		4.4		4.2
V	8		4.4		4.2
V	9		5.0		4.9
V	10		4.3		3.8
Mean			4.8		4.9

Table 8.3.2.B. Terrestrial exposure rates at the Risø zones in 1989 measured with the NaI(Tl) detector ($\mu R\ h^{-1}$)

Risø zone	Location	January	April	July	October
I	1	5.3	5.9	6.0	5.4
I	2	6.8	7.4	7.2	7.1
I	3	72	68	70	74
I	4	5.5	5.8	5.9	5.3
I	5	10.8	11.1	11.0	11.4
Mean		20	19.6	20	21
II	1	4.2	4.3	4.6	4.6
II	2	5.2	5.1	5.2	5.0
II	3	4.8	4.7	4.2	4.1
II	4	4.4	4.6	4.7	4.3
Mean		4.6	4.7	4.7	4.5
III	1		5.2		5.7
III	2		5.0		5.1
III	3		4.3		4.0
Mean			4.8		4.9
IV	1		4.4		4.4
IV	2		4.6		4.8
IV	3		5.0		4.6
IV	4		4.5		4.2
IV	5		3.1		4.2
IV	6		3.9		3.9
IV	7		4.6		4.5
Mean			4.3		4.4
V	1		4.4		4.6
V	2		5.4		4.9
V	3		4.9		5.2
V	4		5.0		5.3
V	5		5.5		5.4
V	6		5.2		4.9
V	7		4.3		5.7
V	8		4.1		4.3
V	9		4.4		4.3
V	10		4.1		3.7
Mean			4.7		4.8

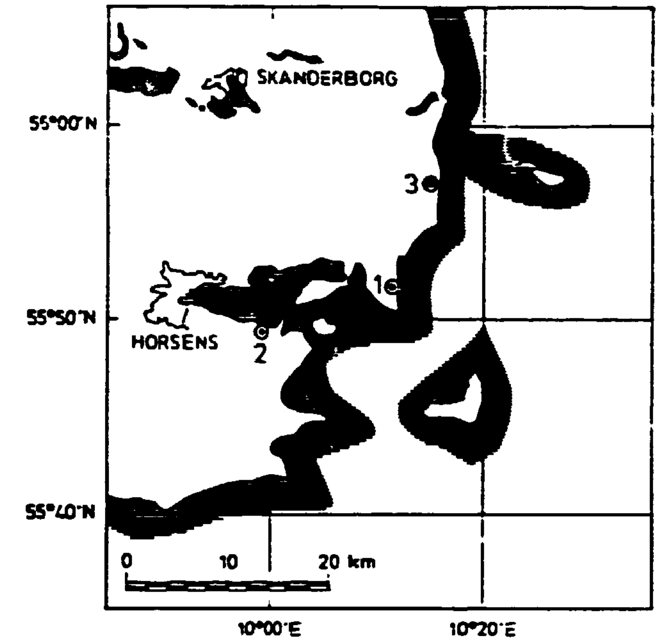


Fig. 8.4.1. The environment of Gylling Næs. Locations for measurements of the background radiation.

Fig. 8.5.1. The coasts of the Great Belt. Locations for measurements of the background radiation.

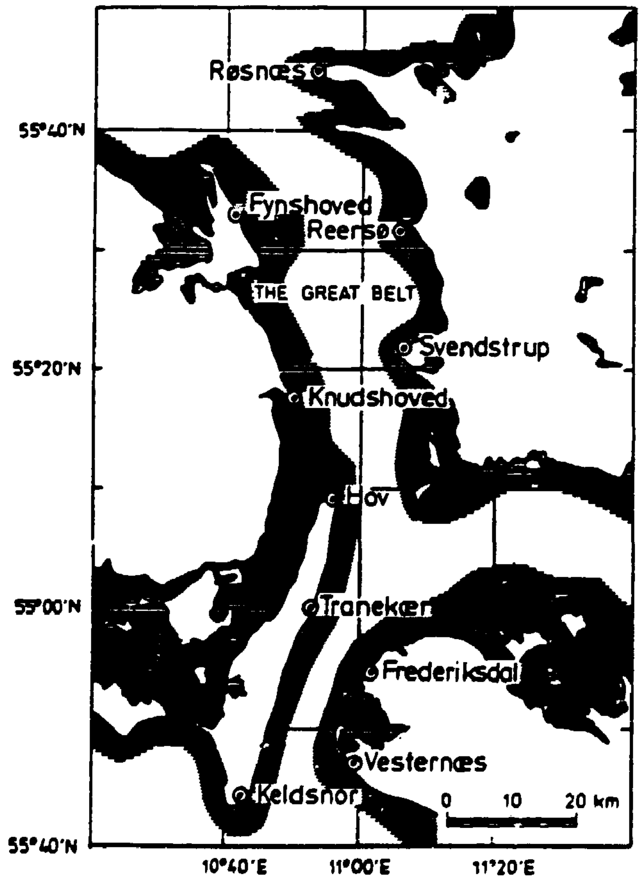


Table 8.4.1.A. TLD-measurements of the background radiation (integrated over 12 months and normalized to μR h⁻¹) at the Gylling Næs site in 1987/88

Location	Oct 1987 - Oct 1988 μR h^{-1}
1	8.5
2	-
3	8.9
Mean	8.7

Table 8.4.1.B. TLD-measurements of the background radiation (integrated over 12 months and normalized to μR h^{-1}) at the Gylling Næs site in 1988/89

Location	Oct 1988 - Oct 1989 μR h^{-1}
1	8.5
2	-
3	8.6
Mean	8.6

Table 8.5.1.A. TLD-measurements of the background radiation (integrated over 12 months and normalized to μR h^{-1}) along the coasts of the Great Belt and Langeland Belt in 1987/88

Location	Oct 1987 - Oct 1988 μR h^{-1}
Røsnæs	8.0
Reersø	9.1
Svendstrup	7.8
Vesternæs	8.6
Frederiksdal	8.9
Kelds Nor	10.2
Tranekær	8.4
Hov	9.0
Fyns Hoved	8.3
Knuds Hoved	10.7
Mean	8.9

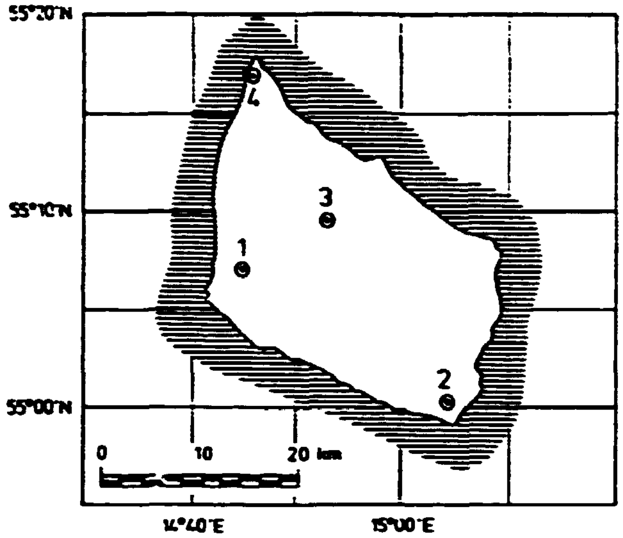


Fig. 8.6.1. Locations for measurements on Bornholm.

Table 8.5.1.B. TLD-measurements of the background radiation (integrated over 12 months and normalized to μR h⁻¹) along the coasts of the Great Belt and Langeland Belt in 1988/89

Location	Oct 1988 - Oct 1989 μR h^{-1}
Røsnæs	7.5
Reersø	8.5
Svendstrup	7.4
Vesternæs	8.1
Frederiksdal	8.2
Kelds Nor	9.5
Tranekær	8.2
Hov	8.5
Fyns Hoved	8.1
Knuds Hoved	10.0
Mean	8.4

Table 8.6.1.A. TLD-measurements of the background radiation (integrated over 12 months and normalized to μR h^{-1}) on the island of Bornholm in 1987/88

Location	May 1987 - April 1988 μR h^{-1}
1	9.7
2	9.7
3	8.6
4	17.1
Mean	11.3

Table 8.6.1.B. TLD-measurements of the background radiation (integrated over 13 months and normalized to μR h^{-1}) on the island of Bornholm in 1988/89

Location	May 1988 - May 1989 μR h^{-1}
1	9.5
2	9.4
3	9.7
4	15.1
Mean	10.9

9. Conclusion

9.1. Environmental Monitoring at Risø, Barsebäck, and Ringhals

No radioactive contamination of the environment originating from the operation of Risø National Laboratory was ascertained outside its boundaries in 1988 and 1989.

Benthic brown algae, mussels, and fish collected at the Swedish nuclear plants at Barsebäck and Ringhals were analysed for radioactive pollution. Transfer factors from releases of various radionuclides to Fucus were calculated. The radioactive contamination of the marine environment due to the operation of the Swedish nuclear power plants resulted in doses of less than 1% of the background radiation to any individual eating 20 kg mussel and 100 kg fish per year.

9.2. Fallout in the Abiotic Environment

The mean content of ^{90}Sr in air collected in 1988 and 1989 were 0.15 and 0.1 $\mu Bq\ m^{-3}$, respectively. This corresponds to an effective halflife since 1987 of a little less than 1 year.

The mean concentrations of ^{137}Cs in air from 1988 and 1989 were 2.5 and 1.6 $\mu Bq\ m^{-3}$, respectively, also corresponding to an effective halflife since 1987 of about 1 year.

The depositions of ^{90}Sr at the ten State experimental farms in Denmark were 1 $Bq\ m^{-2}$ in 1988 and 0.5 $Bq\ m^{-2}$ in 1989 corresponding to an effective halflife since 1987 of 1.5 year. The corresponding depositions for ^{137}Cs were 12 and 3.5 $Bq\ m^{-2}$ and the halflife was 0.7 year.

Since 1987 the ^{137}Cs concentrations in Danish streams and lakes have decayed with effective halflives of 1.8 and 2.7 years, respectively.

The concentrations of ^{90}Sr and ^{137}Cs in the surface sea water of inner Danish waters have been nearly unchanged since 1987, i.e. about 17 Bq ^{90}Sr m^{-3} and 81 Bq ^{137}Cs m^{-3}.

9.3. Fallout Nuclides in the Human Diet

The mean concentrations in Danish milk were 0.06 Bq ^{90}Sr l^{-1} and 0.20 Bq ^{137}Cs l^{-1} in 1988 and in 1989 the levels were 0.056 and 0.13, respectively. The effective halflife of ^{90}Sr in Danish milk was 10 years and of Chernobyl ^{137}Cs it was 1 year, while for global fallout ^{137}Cs it was 6 years.

Danish grain from 1988 contained 0.34 Bq ^{90}Sr kg^{-1} and 0.12 Bq ^{137}Cs kg^{-1} the corresponding figures for 1989 were 0.34 and 0.09, respectively. The effective halflife of ^{90}Sr in Danish grain is 10-15 years. Global fallout ^{137}Cs in Danish grain has decayed with a halflife of 12 years and Chernobyl ^{137}Cs with about 5 years halflife.

Danish vegetables (cabbage and carrots) contained 0.2-0.3 Bq ^{90}Sr kg^{-1} and 0.03 Bq ^{137}Cs kg^{-1} in 1988 and 1989. Potatoes showed mean concentrations of 0.03 Bq ^{90}Sr kg^{-1} and 0.07 Bq ^{137}Cs kg^{-1}.

The intakes of ^{90}Sr with total diet were 0.16 and 0.15 Bq d^{-1} in 1988 and 1989, respectively and the corresponding ^{137}Cs intakes were 0.46 and 0.33. The effective halflife of Chernobyl ^{137}Cs in Danish total diet is 3 years, while global fallout ^{137}Cs decays with approx. 5 years halflife. Strontium-90 has decayed with an effective halflife similar to the radiological halflife.

9.4. Strontium-90 and Cesium-137 in Humans

The ^{90}Sr mean content in adult human bone (vertebrae) collected in 1988 was 20 Bq (kg Ca)$^{-1}$ and in 1989 the level was 17.

Whole-body measurements of ^{137}Cs were resumed after the Chernobyl accident. The measured mean level in 1988 was 980 Bq ^{137}Cs (kg K)$^{-1}$ and in 1989 the mean was 460, i.e. the effective halflife of Chernobyl ^{137}Cs in humans was 1 year.

9.5. Tritium in Environmental Samples

The tritium mean concentrations in 1988 and 1989 in ground, stream, lake, and drinking water were around 2 kBq m^{-3}. The mean content of precipitation in 1988 and 1989 was 2.4 kBq m^{-3}. Sea water from the inner Danish waters contained 3-5 kBq tritium per m^3.

9.6. Background Radiation

The average total background exposure rate measured with TLDs at the State experimental farms was 7.6 μR h^{-1}. The mean of the terrestrial exposure rates at the State experimental farms measured with the NaI(Tl) detector was 4.1 μR h^{-1}. The annual means in 1988-1989 are not different from the levels prior to the Chernobyl accident.

Acknowledgements

The authors wish to thank the staff of the former Health Physics Department for their conscientious performance of their work of this report.

We are specially indebted to the staffs of the ten State experimental farms at Tylstrup, Kalø, Borris, Askov, St. Jyndevad, Årslev, Tystofte, Ledreborg, Abed, and Tornbygård, who have continued to supply us with a number of the most important samples dealt with in this report.

R/V DANA belonging to the Ministry of Fisheries have collected surface water samples from the North Sea, the Danish Straits, and the Baltic Sea in 1988 and 1989.

R/V GAUSS from the German Hydrografic Institute in Hamburg, the German lightships: Borkumriff and Elbe I and R/V Gunnar Thorsen from the National Environmental Research Institute, Denmark, collected a substantial number of the sea water samples in this report.

Part of this work was supported by the CEC Radiation Protection Programme.

Appendix A

Calculation of Revised Models for ^{137}Cs in Danish Grain

Until 1983 the ^{137}Cs concentrations in Danish grain were nearly proportional to the fallout rates of ^{137}Cs in May-August of the harvest year (Risø-R-437) (*Aarkrog* 1979).

After 1984, however, an increasing discrepancy between observed and predicted ^{137}Cs concentrations in grain was noticed. This was a result of the growing importance of root uptake relative to direct contamination, which was dominating as long as fresh ^{137}Cs still was present in the atmosphere.

In order to estimate the soil factor b in the prediction model:

Bq ^{137}Cs kg^{-1} grain (year i) = a·Bq ^{137}Cs m^{-2} (May-Aug (i)) + b·Bq ^{137}Cs m^{-2} (accumulated by (i))

we made the following calculations for Danish grain from 1985:

1. From the old prediction models (Table C.2.2.4 in Risø-R-437) (*Aarkrog* 1979), which includes the rate factor a only, and from the fallout rates in May-August 1985 the predicted ^{137}Cs levels in Danish grain from 1985 were calculated.

2. The differences between observed and predicted levels were calculated.

3. The differences were divided by the accumulated ^{137}Cs fallout in 1985 obtained from Appendix D.3 (Jutland: 2894 Bq ^{137}Cs m^{-2} and the Islands: 2312 Bq ^{137}Cs m^{-2}). This gave the b values in the revised prediction models shown below:

Rye	Jutland	:	$Bq\ kg_{(i)} = 0.074\ d_{i(May\text{-}Aug)} + 0.032 \cdot 10^{-3}\ A_i$
Rye	Islands	:	$Bq\ kg_{(i)} = 0.078\ d_{i(May\text{-}Aug)} + 0.005 \cdot 10^{-3}\ A_i$
Barley	Jutland	:	$Bq\ kg_{(i)} = 0.063\ d_{i(May\text{-}Aug)} + 0.017 \cdot 10^{-3}\ A_i$
Barley	Islands	:	$Bq\ kg_{(i)} = 0.052\ d_{i(May\text{-}Aug)} + 0.001 \cdot 10^{-3}\ A_i$
Wheat	Jutland	:	$Bq\ kg_{(i)} = 0.063\ d_{i(May\text{-}Aug)} + 0.017 \cdot 10^{-3}\ A_i$
Wheat	Islands	:	$Bq\ kg_{(i)} = 0.045\ d_{i(May\text{-}Aug)} + 0.006 \cdot 10^{-3}\ A_i$
Oats	Jutland	:	$Bq\ kg_{(i)} = 0.052\ d_{i(May\text{-}Aug)} + 0.064 \cdot 10^{-3}\ A_i$
Oats	Islands	:	$Bq\ kg_{(i)} = 0.049\ d_{i(May\text{-}Aug)} + 0.005 \cdot 10^{-3}\ A_i$

where $d_{i(May\text{-}Aug)}$ is the fallout rate in Bq ^{137}Cs m^{-2} in May-Aug in year (i) and A_i is the accumulated fallout by year (i) in Bq ^{137}Cs m^{-2} according to Appendix D.3.

4. In order to check whether the contribution of ^{137}Cs from root uptake seems reasonable, we made a calculation of the observed ratios between the ^{137}Cs concentrations in grain and in the ploughing layer (0-20 cm).

The soil concentrations were based on two sets of measurements of ^{137}Cs in countrywide collected Danish soils: One in 1975 (Table 4.2.8 in Risø-R-345) (Risø-Reports 1957-1989) and another in 1983 (Table 4.5.3 in Risø-R-563) (Risø Reports 1957-1989).The effective halflife of ^{137}Cs in cultivated soil in

Denmark has been measured to 13 years (Risø-R-563) (Risø Reports 1957-1989). The soil data from 1975 and 1983 were decay corrected with this halflife to 1985 and the mean concentrations in the 0-20 cm ploughing layer became: 6.7 ± 0.9 Bq ^{137}Cs per kg dry soil in Jutland and 6 ± 0.1 Bq ^{137}Cs kg^{-1} in the Islands (the error term was $\pm$ 1 S.E. of the means of the two determinations).

The differences calculated under 2. were divided by the respective soil concentrations of ^{137}Cs and the observed mean ration between grain and soil (dry matter) ^{137}Cs activities was $(0.9 \pm 0.35) \cdot 10^{-2}$ ($\pm$ 1 S.E.; n = 8). This was compatible with the values expected for Danish soils (sandy clay) according to IAEA's »Handbook of parameter values for prediction of radionuclide transfer in the terrestrial and fresh water environments« (2nd draft March 1987). According to this publication the expected values for sand vary between $1 \cdot 10^{-2}$ and $3.4 \cdot 10^{-2}$ and for clay between $0.8 \cdot 10^{-2}$ and $2.8 \cdot 10^{-2}$ according to pH of the soil.

Appendix B

Statistical information

Zone		ΔΔΔ Area in km^2	ΔΔ Population in thousands	Δ Annual milk production in mega-kg	Δ Annual wheat production in mega-kg	Δ Annual rye production in mega-kg	Δ Annual potato production in mega-kg	Δ Grass and green fodder production in mega-kg
I:	North Jutland	6,171	482	893	980	425	980	17,649
II:	East Jutland	7,561	909	1,427				
III:	West Jutland	12,104	711	1,326				
IV:	South Jutland	3,929	250	663				
V:	Funen	3,486	455	357				
VI:	Zealand	7,435	2,115*	306	992	140	120	2,536
VII:	Lolland-Falster	1,795	141	76				
VIII:	Bornholm	588	47	51				
Total		43,069	5,110	5,099	1,972	565	1,100	20,185

*1,170,000 people were living in Greater Copenhagen and 945,000 in the remaining part of Zealand.

Δ (ref. Danmarks Statistik 1986)
ΔΔ (ref. Danmarks Statistik 1988)
ΔΔΔ (ref. Danmarks Statistik 1972)

Appendix C

A Comparison Between Observed and Predicted Levels in the Human Food Chain in Denmark in 1988 and 1962

Table C.1. A Comparison between observed and predicted ^{90}Sr levels in environmental samples collected in 1988

Sample	Location	Unit	Number observations in mean	Observed ± 1 S.E. (Arithmetic mean)	Predicted	Obs./pred.	Model in reference (*Aarkrog* 1979)
Dried milk	Jutland	Bq ^{90}Sr (kg Ca)$^{-1}$	4	60 ± 5	110	0.55	C 3.2.1 No 1
-"-	Islands	-"-	3	41 ± 2	37	1.11	C 3.2.1 No 3
Rye	Jutland	Bq ^{90}Sr kg^{-1}	5	0.43 ± 0.10	0.42	1.02	C 2.2.1 No 1
"	Islands	-"-	5	0.28 ± 0.05	0.12	2.33	C 2.2.1 No 3
Barley	Jutland	-"-	7	0.46 ± 0.03	0.59	0.78	C 2.2.1 No 4
"	Islands	-"-	10	0.30 ± 0.06	0.22	1.36	C 2.2.1 No 6
Wheat	Jutland	-"-	7	0.49 ± 0.11	0.44	1.11	C 2.2.1 No 8
"	Islands	-"-	9	0.25 ± 0.04	0.19	1.32	C 2.2.1 No 10
Oats	Jutland	-"-	4	0.51 ± 0.06	1.28	0.40	C 2.2.1 No 12
"	Islands	-"-	4	0.35 ± 0.08	0.61	0.57	C 2.2.1 No 13
Potatoes	Jutland	-"-	5	0.036 ± 0.006	0.097	0.37	C 2.5.1 No 8
"	Islands	-"-	5	0.037 ± 0.003	0.087	0.43	C 2.5.1 No 10
Cabbage	Jutland	-"-		0.28	0.30	0.93	C 2.5.1 No 1
"	Islands	-"-		0.187	0.26	0.72	C 2.5.1 No 3
Carrot	Jutland	-"-		0.41	0.51	0.80	C 2.5.1 No 5
"	Islands	-"-		0.190	0.15	1.27	C 2.5.1 No 6
Apples	Denmark	-"-	2	0.036 ± 0.0065	0.012	3.00	C 2.5.1 No 13
Pork	"	-"-		0.0067	0.023	0.29	C 3.4.1 No 3
Beef	"	-"-		0.0081	0.033	0.25	C 3.4.1 No 1
Eggs	"	-"-		0.024	0.012	2.00	C 3.6.1 No 6
Total diet C	"	Bq ^{90}Sr (kg Ca)$^{-1}$		145	137	1.06	C 4.2.1 No 1
Total diet P	"	-"-		122	106	1.15	C 4.2.1 No 7
Human bone > 29 yr	"	-"-	30	19.7 ± 1.1	38	0.52	C 4.3.1 No 13
Whole year grass	Islands	-"-	4	360 ± 36	425	0.85	C 2.4.1 No 1
Fucus vesiculosus	"	-"-	4	154 ± 11	442	0.35	C 2.7.1 No 3
Ground water**	Denmark	Bq ^{90}Sr m^{-3}	10	0.38 ± 0.19	0.23	1.65	C 1.4.1 No 1
Stream water*	"	-"-			6.20		C 1.4.1 No 3
Lake water*	"	-"-			34		C 1.4.1 No 6

**Mean of all ground water samples except Feldbak (cf. 4.3.1)

* No samples in 1988

Table C.1.B. Comparison between observed and predicted ^{90}Sr levels in environmental samples collected in 1989

Sample	Location	Unit	Number observations in mean	Observed ±1 S.E. (Arithmetic mean)		Predicted	Obs./pred.	Model in reference (Aarkrog 1979)
Dried milk	Jutland	Bq ^{90}Sr (kg Ca)$^{-1}$	4	56	±2	104	0.54	C.3.2.1 No. 1
-"-	Islands	-"-	3	38	±3	34	1.12	C.3.2.1 No. 3
Rye	Jutland	Bq ^{90}Sr kg^{-1}		0.40		0.38	1.05	C.2.2.1 No. 1
-	Islands	-"-	-	0.20		0.11	1.82	C.2.2.1 No. 3
Barley	Jutland	-"-	2	0.44	±0.02	0.56	0.79	C.2.2.1 No. 4
-	Islands	-"-	2	0.27	±0.00	0.21	1.29	C.2.2.1 No. 6
Wheat	Jutland	-"-	2	0.56	±0.30	0.40	1.40	C.2.2.1 No. 8
-	Islands	-"-	2	0.15	±0.06	0.175	0.86	C.2.2.1 No. 10
Oats	Jutland	-"-		0.60		1.25	0.48	C.2.2.1 No. 12
-	Islands	-"-		0.54		0.59	0.92	C.2.2.1 No. 13
Potatoes	Jutland	-"-	5	0.037	±0.011	0.094	0.39	C.2.5.1 No. 8
-	Islands	-"-	5	0.036	±0.007	0.085	0.42	C.2.5.1 No. 10
Cabbage	Jutland	-"-		0.28		0.30	0.93	C.2.5.1 No. 1
-	Islands	-"-		0.152		0.25	0.61	C.2.5.1 No. 3
Carrot	Jutland	-"-		0.28		0.50	0.56	C.2.5.1 No. 5
-	Islands	-"-		0.099		0.14	0.71	C.2.5.1 No. 6
Apples	Denmark	-"-	2	0.0174	±0.0019	0.012	1.45	C.2.5.1 No. 13
Pork	-	-"-		< 0.001		0.022	-	C.3.4.1 No. 3
Beef	-	-"-		0.0131		0.032	0.41	C.3.4.1 No. 1
Eggs	-	-"-		0.0121		0.010	1.21	C.3.6.1 No. 6
Total diet C	-	Bq ^{90}Sr (kg Ca)$^{-1}$		133		132	1.01	C.4.2.1 No. 1
Total diet P	-	-"-		96		101	0.95	C.4.2.1 No. 7
Human bone > 29 yr	-	-"-	44	17.7	±0.98	37	0.48	C.4.3.1 No. 13
Whole year grass	Islands	-"-	4	310	±27	365	0.85	C.2.4.1 No. 1
Fucus vesiculosus	-	-"-	4	146	±43	418	0.35	C.2.7.1 No. 3
Ground water**	Denmark	Bq ^{90}Sr m^{-3}	10	0.24	±0.13	0.21	1.14	C.1.4.1 No. 1
Stream water	-	-"-	8	6.8	±0.95	5.9	1.15	C.1.4.1 No. 3
Lake water	-	-"-	8	14.0	±2.7	34	0.41	C.1.4.1 No. 6

**Mean of all ground water samples except Feldbak (cf. 4.3.1)

Table C.2.A. Comparison between observed and predicted ^{137}Cs levels in environmental samples collected in 1988

Sample	Location	Unit	Number observations in mean	Observed ± 1 S.E. (Arithmetic mean)	Predicted	Obs./pred.	Model in reference (*Aarkrog* 1979)
Dried milk	Jutland	Bq ^{137}Cs (kg K)$^{-1}$	48	250 ± 18	211	1.18	C.3.2.2 No. 1
-"-	Islands	-"-	36	57 ± 5	66	0.86	C.3.2.2 No. 3
Rye	Jutland	Bq ^{137}Cs kg^{-1}	5	0.27 ± 0.12	0.52	0.52	Appendix A
"	Islands	-"-	5	0.098 ± 0.032	0.34	0.29	Appendix A
Barley	Jutland	-"-	7	0.26 ± 0.105	0.40	0.65	Appendix A
"	Islands	-"-	10	0.066 ± 0.024	0.22	0.30	Appendix A
Wheat	Jutland	-"-	7	0.137 ± 0.022	0.40	0.34	Appendix A
"	Islands	-"-	9	0.048 ± 0.012	0.21	0.23	Appendix A
Oats	Jutland	-"-	4	0.51 ± 0.25	0.53	0.96	Appendix A
"	Islands	-"-	4	0.109 ± 0.044	0.22	0.50	Appendix A
Potatoes	Jutland	-"-	5	0.144 ± 0.030	0.199	0.72	C.2.5.3 No. 5
"	Islands	-"-	5	0.045 ± 0.017	0.034	1.32	C.2.5.3 No. 7
Cabbage	Denmark	-"-	8	0.045 ± 0.014	0.078	0.058	C.2.5.3 No. 1
Carrot	"	-"-	8	0.043 ± 0.016	0.071	0.61	C.2.5.3 No. 3
Apples	"	-"-	8	0.066 ± 0.016	0.60	0.11	C.2.5.3 No. 11
Pork	"	-"-		0.47	1.38	0.34	C.3.4.2 No. 3
Beef	"	-"-		1.36	1.32	1.03	C.3.4.2 No. 1
Eggs	"	-"-		0.102	0.091	1.12	C.3.6.2 No. 6
Total diet C	"	Bq ^{137}Cs (kg K)$^{-1}$		165	1140	0.14	C.4.2.2 No. 1
Total diet P	"	-"-		112	580	0.19	C.4.2.2 No. 6

Table C.2.B Comparison between observed and predicted ^{137}Cs levels in environmental samples collected in 1988

Sample	Location	Unit	Number observations in mean	Observed ± 1 S.E. (Arithmetic mean)	Predicted	Obs./pred.	Model in reference (*Aarkrog* 1979)
Dried milk	Jutland	Bq ^{137}Cs (kg K)$^{-1}$	48	155 ± 10	142	1.09	C.3.2.2 No. 1
-"-	Islands	-"-	36	42 ± 3	41	1.02	C.3.2.2 No. 3
Rye	Jutland	Bq ^{137}Cs kg^{-1}	5	0.24 ± 0.076	0.24	1.00	Appendix A
"	Islands	-"-	4	0.041 ± 0.015	0.073	0.56	Appendix A
Barley	Jutland	-"-	10	0.097 ± 0.015	0.160	0.61	Appendix A
"	Islands	-"-	8	0.080 ± 0.060	0.042	1.91	Appendix A
Wheat	Jutland	-"-	6	0.23 ± 0.067	0.160	1.44	Appendix A
"	Islands	-"-	9	0.026 ± 0.004	0.052	0.50	Appendix A
Oats	Jutland	-"-	5	0.43 ± 0.162	0.33	1.30	Appendix A
"	Islands	-"-	5	0.108 ± 0.049	0.052	2.08	Appendix A
Potatoes	Jutland	-"-	5	0.164 ± 0.061	0.167	0.98	C.2.5.3 No. 5
"	Islands	-"-	5	0.065 ± 0.023	0.008	8.1	C.2.5.3 No. 7
Cabbage	Denmark	-"-	8	0.045 ± 0.021	0.066	0.68	C.2.5.3 No. 1
Carrot	"	-"-	8	0.058 ± 0.023	0.048	1.21	C.2.5.3 No. 3
Apples	"	-"-	8	0.069 ± 0.014	0.30	0.23	C.2.5.3 No. 11
Pork	"	-"-		0.52	0.62	0.84	C.3.4.2 No. 3
Beef	"	-"-		1.14	0.83	1.37	C.3.4.2 No. 1
Eggs	"	-"-		0.042	0.059	0.71	C.3.6.2 No. 6
Total diet C	"	Bq ^{137}Cs (kg K)$^{-1}$		105	52	2.02	C.4.2.2 No. 1
Total diet P	"	-"-		125	480	0.26	C.4.2.2 No. 6

Appendix D

Fallout Rates and Accumulated Fallout (mCi ^{90}Sr km^{-2}) in Denmark 1950-1989

d_i

Annual fallout rate in mCi ^{90}Sr km^{-2} y^{-1} or Bq ^{90}Sr m^{-2} y^{-1}. Accumulated fallout by the end of the year (i) assuming effective half-lives of ^{90}Sr of 28.8 y. Unit: mCi ^{90}Sr km^{-2} or Bq ^{90}Sr m^{-2}.

$d_{i(May\text{-}Aug)}$ and $d_{i(July\text{-}Aug)}$:

The fallout rates in the periods: May-Aug and July-Aug, respectively. Unit: mCi ^{90}Sr km^{-2} $period^{-1}$ or Bq ^{90}Sr m^{-2} $period^{-1}$. The fallout rate (d_i) was based on precipitation data collected for all Denmark in the period 1962-1984 (cf. Table 4.2.1) (Risø Reports 1957-1989). Before 1962 the levels in the tables were estimated from the HASL data for New York (HASL Appendix 291, 1975) (HASL 1958-1978) considering that the mean ratio between ^{90}Sr fallout in Denmark and New York was 0.7 in the period 1962-1974.

The $d_{i(May\text{-}Aug)}$ and $d_{i(July\text{-}Aug)}$ values were also obtained from 4.2 (Risø Reports 1957-1989) for the period 1962-1984. For the years 1959-1961 the values were calculated from data obtained from ^{90}Sr analysis of air (1959) and precipitation samples (1962 and 1961) collected at Risø. Before 1959, the values were estimated from the corresponding d_i values assuming that the ratios $d_{i(May\text{-}Aug)}/d_i$ and $d_{i(July\text{-}Aug)}/d_i$ were constant in time and equal to the means found for the period 1962-1974, which were 0.54 (1 S.D.: 0.09) and 0.24 (1 S.D.: 0.06), respectively.

Table D.1 shows the mCi ^{90}Sr km^{-2} figures and Table D.2 gives the Bq m^{-2} values.

Appendix D.1. Fallout rates and accumulated fallout (mCi ^{90}Sr km^{-2}) in Denmark 1950-1989

	Denmark		Jutland		Islands	
Year	di	$Ai_{(28.82)}$	di	$Ai_{(28.82)}$	di	$Ai_{(28.82)}$
1950	0.021	0.020	0.022	0.021	0.020	0.020
1951	0.101	0.118	0.114	0.132	0.088	0.105
1952	0.198	0.309	0.224	0.347	0.172	0.270
1953	0.500	0.789	0.566	0.891	0.434	0.687
1954	1.901	2.623	2.152	2.967	1.650	2.279
1955	2.501	4.997	2.831	5.655	2.171	4.340
1956	3.101	7.898	3.510	8.939	2.692	6.858
1957	3.101	10.728	3.510	12.142	2.692	9.313
1958	4.302	14.658	4.869	16.591	3.734	12.725
1959	6.102	20.247	6.908	22.918	5.297	17.576
1960	1.140	20.859	1.291	23.610	0.990	18.107
1961	1.481	21.787	1.676	24.661	1.285	18.913
1962	7.428	28.493	7.976	31.830	6.880	25.155
1963	16.695	44.071	18.453	49.041	14.937	39.101
1964	10.412	53.136	11.685	59.225	9.139	47.048
1965	3.954	55.679	4.204	61.861	3.704	49.497
1966	2.145	56.395	2.166	62.445	2.124	50.345
1967	1.047	56.023	1.176	62.048	0.918	49.997
1968	1.403	56.006	1.568	62.045	1.237	49.968
1969	1.035	55.632	1.241	61.721	0.829	49.542
1970	1.647	55.863	1.993	62.140	1.301	49.586
1971	1.506	55.951	1.726	62.288	1.286	49.615
1972	0.435	54.993	0.457	61.194	0.413	48.792
1973	0.192	53.821	0.215	59.891	0.168	47.750
1974	0.710	53.183	0.779	59.171	0.643	47.197
1975	0.414	52.272	0.452	58.150	0.376	46.397
1976	0.103	51.082	0.116	56.826	0.090	45.339
1977	0.384	50.204	0.405	55.827	0.362	44.581
1978	0.463	49.426	0.538	54.985	0.388	43.867
1979	0.166	48.379	0.174	53.810	0.156	42.947
1980	0.095	47.244	0.114	52.556	0.078	41.932
1981	0.451	46.358	0.309	51.559	0.269	41.159
1982	0.046	45.257	0.048	50.332	0.043	40.184
1983	0.036	44.174	0.036	49.123	0.037	39.227
1984	0.029	43.110	0.033	47.941	0.026	38.283
1985	0.022	42.067	0.020	46.776	0.023	37.360
1986	1.041	42.042	1.081	46.674	1.000	37.412
1987	0.039	42.022	0.038	46.649	0.040	37.396
1988	0.027	41.049	0.024	45.564	0.030	36.537
1989	0.0147	40.088	0.0112	44.492	0.0183	35.687

Denmark		Jutland		Islands	
$d_{i(May-Aug)}$	$d_{i(July-Aug)}$	$d_{i(May-Aug)}$	$d_{i(July-Aug)}$	$d_{i(May-Aug)}$	$d_{i(July-Aug)}$
0.01	0.01	0.01	0.01	0.01	0.01
0.05	0.02	0.06	0.03	0.05	0.02
0.11	0.05	0.12	0.05	0.09	0.04
0.27	0.12	0.31	0.14	0.23	0.10
1.03	0.46	1.16	0.52	0.89	0.40
1.35	0.60	1.53	0.68	1.17	0.52
1.67	0.74	1.90	0.84	1.45	0.65
1.67	0.74	1.90	0.84	1.45	0.65
2.32	1.03	2.63	1.17	2.01	0.90
2.50	0.68	2.76	0.75	2.24	0.61
0.47	0.31	0.52	0.34	0.42	0.28
0.66	0.47	0.73	0.52	0.590	0.42
4.223	1.857	4.566	2.052	3.880	1.662
9.965	5.629	10.753	5.932	9.177	5.327
6.235	2.568	7.170	2.910	5.299	2.226
2.029	0.850	2.094	0.852	1.964	0.848
1.049	0.418	0.984	0.496	1.114	0.340
0.367	0.141	0.380	0.134	0.354	0.148
0.848	0.426	0.910	0.460	0.786	0.392
0.614	0.276	0.723	0.319	0.505	0.233
0.908	0.547	1.076	0.632	0.740	0.462
0.992	0.405	1.154	0.516	0.830	0.294
0.253	0.084	0.262	0.084	0.244	0.084
0.075	0.033	0.093	0.039	0.057	0.027
0.421	0.190	0.463	0.219	0.378	0.162
0.159	0.075	0.179	0.091	0.157	0.060
0.032	0.010	0.032	0.011	0.032	0.009
0.178	0.107	0.164	0.085	0.190	0.129
0.232	0.096	0.275	0.098	0.188	0.093
0.086	0.030	0.087	0.031	0.084	0.029
0.051	0.022	0.064	0.025	0.038	0.0180
0.175	0.060	0.176	0.058	0.174	0.061
0.022	0.0071	0.024	0.0085	0.020	0.0058
0.013	0.0048	0.015	0.0055	0.0114	0.0043
0.013	0.0075	0.016	0.0090	0.0106	0.0059
0.0086	0.0054	0.0075	0.0046	0.0088	0.0062
0.74	0.052	0.78	0.055	0.70	0.048
0.0159	0.0068	0.0178	0.0068	0.0141	0.0070
0.0121	0.0075	0.0125	0.0074	0.0117	0.0076
0.0077	0.0042	0.0059	0.0025	0.0095	0.0060

Appendix D.2. Fallout rates and accumulated fallout (Bq ^{90}Sr m^{-2}) in Denmark 1950-1989

	Denmark		Jutland		Islands	
Year	di	$Ai_{(28.82)}$	di	$Ai_{(28.82)}$	di	$Ai_{(28.82)}$
1950	0.777	0.759	0.814	0.795	0.740	0.722
1951	3.737	4.389	4.218	4.894	3.256	3.884
1952	7.326	11.436	8.288	12.868	6.364	10.004
1953	18.500	29.225	20.942	33.007	16.058	25.443
1954	70.337	97.196	79.624	109.954	61.050	84.438
1955	92.537	185.224	104.747	209.599	80.327	160.849
1956	114.737	292.833	129.870	331.402	99.604	254.264
1957	114.737	397.884	129.870	450.310	99.604	345.458
1958	159.17[illegible]	543.820	180.153	615.481	138.158	472.124
1959	225.774	751.306	255.596	850.377	195.989	652.236
1960	42.180	774.629	47.767	876.800	36.630	672.495
1961	54.797	809.716	62.012	916.502	47.[illegible]45	702.929
1962	274.836	1058.779	295.112	1182.821	254.560	934.736
1963	617.715	1636.653	682.761	1821.249	552.669	1452.058
1964	385.244	1973.849	432.345	2200.039	338.143	1747.659
1965	146.298	2069.764	155.548	2299.609	137.048	1839.918
1966	79.365	2098.057	80.142	2323.199	78.588	1872.915
1967	38.739	2086.017	43.512	2310.468	33.966	1861.566
1968	51.911	2087.122	58.016	2312.200	45.769	1862.009
1969	38.295	2074.909	45.917	2302.078	30.673	1847.704
1970	60.939	2085.092	73.741	2319.360	48.137	1850.789
1971	55.722	2089.939	63.862	2326.587	47.582	1853.258
1972	16.095	2055.987	16.909	2287.806	15.281	1824.135
1973	7.104	2014.063	7.955	2241.204	6.216	1786.854
1974	26.270	1991.847	28.823	2216.082	23.791	1767.617
1975	15.318	1959.467	16.724	2179.746	13.912	1739.193
1976	3.811	1916.622	4.292	2132.136	3.330	1701.114
1977	14.208	1884.946	14.985	2096.097	13.394	1673.764
1978	17.131	1856.876	19.906	2065.718	14.356	1648.004
1979	6.142	1818.745	6.438	2022.914	5.772	1614.475
1980	3.504	1778.945	4.229	1979.966	2.869	1577.924
1981	10.662	1747.079	11.447	1944.499	9.967	1549.659
1982	1.691	1707.212	1.782	1900.127	1.601	1514.297
1983	1.344	1667.954	1.329	1856.433	1.359	1479.475
1984	1.094	1629.385	1.209	1813.506	0.980	1445.264
1985	0.806	1591.452	0.744	1771.286	0.868	1411.618
1986	38.5	1591.218	40	1766.622	37	1415.882
1987	1.44	1554.810	1.41	1726.017	1.47	1383.670
1988	0.989	1518.827	0.874	1685.853	1.105	1351.867
1989	0.544	1483.265	0.413	1646.193	0.677	1320.402

	Denmark		Jutland		Islands	
Year	$di_{(May-Aug)}$	$di_{(July-Aug)}$	$di_{(May-Aug)}$	$di_{(July-Aug)}$	$di_{(May-Aug)}$	$di_{(July-Aug)}$
1950	0.370	0.370	0.370	0.370	0.370	0.370
1951	1.850	0.740	2.220	1.110	1.850	0.740
1952	4.070	1.850	4.440	1.850	3.330	1.480
1953	9.990	4.440	11.470	5.180	8.510	3.700
1954	38.110	17.020	42.920	19.240	32.930	14.800
1955	49.950	22.200	56.610	25.160	43.290	19.240
1956	61.790	27.380	70.300	31.080	53.650	24.050
1957	61.790	27.380	70.300	31.080	53.650	24.050
1958	85.840	38.110	97.310	43.290	74.740	33.300
1959	92.500	25.160	102.120	27.750	82.880	22.570
1960	17.390	11.470	19.240	12.580	15.540	10.360
1961	24.420	17.390	27.010	19.240	21.830	15.540
1962	156.251	68.709	168.942	75.924	143.560	61.494
1963	368.705	208.273	397.861	219.484	339.549	197.099
1964	230.695	95.016	265.290	107.670	196.063	82.362
1965	75.073	31.450	77.478	31.524	72.668	31.376
1966	38.813	15.466	36.408	18.352	41.218	12.580
1967	13.579	5.217	14.060	4.958	13.098	5.476
1968	31.376	15.762	33.670	17.020	29.082	14.504
1969	22.718	10.212	26.751	11.803	18.685	8.621
1970	33.596	20.239	39.812	23.384	27.380	17.094
1971	36.704	14.985	42.698	19.092	30.710	10.878
1972	9.361	3.108	9.694	3.108	9.028	3.108
1973	2.775	1.221	3.441	1.443	2.109	0.999
1974	15.577	7.030	17.131	8.103	13.986	5.994
1975	5.883	2.775	6.623	3.367	5.809	2.220
1976	1.184	0.370	1.184	0.407	1.184	0.333
1977	6.586	3.959	6.068	3.145	7.030	4.773
1978	8.584	3.552	10.175	3.626	6.956	3.441
1979	3.182	1.110	3.219	1.147	3.108	1.073
1980	1.903	0.816	2.386	0.936	1.420	0.664
1981	6.464	2.205	6.494	2.144	6.433	2.265
1982	0.816	0.263	0.876	0.314	0.755	0.215
1983	0.483	0.178	0.544	0.202	0.423	0.160
1984	0.488	0.277	0.581	0.336	0.395	0.216
1985	0.318	0.200	0.276	0.169	0.326	0.230
1986	27.4	1.91	28.8	2.05	26.0	1.76
1987	0.59	0.25	0.66	0.25	0.52	0.26
1988	0.447	0.276	0.462	0.272	0.432	0.280
1989	0.285	0.157	0.219	0.093	0.351	0.221

Appendix D.3. Fallout rates and accumulated fallout (Bq ^{137}Cs m^{-2}) in Denmark 1950-1989

	Denmark		Jutland		Islands	
Year	di	$Ai_{(30.02)}$	di	$Ai_{(30.02)}$	di	$Ai_{(30.02)}$
1950	1.243	1.215	1.302	1.273	1.184	1.157
1951	5.979	7.030	6.749	7.838	5.210	6.221
1952	11.722	18.323	13.261	20.618	10.182	16.029
1953	29.600	46.830	33.507	52.889	25.693	40.770
1954	112.539	155.731	127.398	176.173	97.680	135.290
1955	148.059	296.857	167.595	335.922	128.523	257.792
1956	183.579	469.471	207.792	531.304	159.366	407.637
1957	183.579	638.145	207.792	722.227	159.366	554.062
1958	254.678	872.445	288.245	987.409	221.053	757.424
1959	361.238	1205.526	408.954	1364.492	313.582	1046.561
1960	67.488	1243.959	76.427	1408.032	58.608	1079.940
1961	87.675	1301.241	99.219	1472.849	76.072	1129.632
1962	439.738	1701.242	472.179	1900.635	407.296	1501.949
1963	988.344	2628.199	1092.418	2924.739	884.270	1331.659
1964	616.390	3170.535	691.752	3533.949	541.029	2807.121
1965	234.077	3326.905	248.877	3696.486	219.277	2957.324
1966	126.984	3375.057	128.227	3737.418	125.741	3012.697
1967	61.982	3358.593	69.619	3720.145	54.346	2997.040
1968	83.058	3363.098	92.826	3725.944	73.230	3000.195
1969	61.272	3346.212	73.467	3712.693	49.077	2979.675
1970	97.502	3365.115	117.986	3743.247	77.019	2986.928
1971	89.155	3375.430	102.179	3757.659	76.131	2993.148
1972	25.752	3323.554	27.054	3698.331	24.450	2948.724
1973	11.366	3258.804	12.728	3626.358	9.946	2891.141
1974	42.032	3225.498	46.117	3588.654	38.066	2862.350
1975	24.509	3175.828	26.758	3532.894	22.259	2818.771
1976	6.098	3109.302	6.867	3458.970	5.328	2759.642
1977	22.733	3060.549	23.976	3403.451	21.430	2717.597
1978	27.410	3017.479	31.850	3356.893	22.970	2678.016
1979	9.827	2958.211	10.301	3290.341	9.235	2625.917
1980	5.606	2896.171	6.766	3221.854	4.591	2570.470
1981	17.059	2846.738	18.316	3166.216	15.948	2527.385
1982	2.706	2784.409	2.851	3096.736	2.561	2472.203
1983	2.151	2722.959	2.126	3028.134	2.175	2417.902
1984	1.751	2662.521	1.935	2960.911	1.567	2364.247
1985	1.290	2603.012	1.191	2894.495	1.388	2311.642
1986	1210.000	3725.984	1340.000	4137.847	1080.000	3314.232
1987	29.000	3669.280	32.000	4074.674	26.000	3263.994
1988	11.900	3597.161	13.400	3994.768	10.300	3199.562
1989	3.500	3518.480	4.510	3907.998	2.530	3129.007

Year	Denmark di(May-Aug)	Denmark di(July-Aug)	Jutland di(May-Aug)	Jutland di(July-Aug)	Islands di(May-Aug)	Islands di(July-Aug)
1950	0.592	0.592	0.592	0.592	0.592	0.592
1951	2.960	1.184	3.552	1.776	2.960	1.184
1952	6.512	2.960	7.104	2.960	5.328	2.368
1953	15.984	7.104	18.352	8.288	13.616	5.920
1954	60.976	27.232	68.672	30.784	52.688	23.680
1955	79.920	35.520	90.576	40.256	69.264	30.784
1956	98.864	43.808	112.480	49.728	85.840	38.480
1957	98.864	43.808	112.480	49.728	85.840	38.480
1958	137.344	60.976	155.696	69.264	119.584	53.280
1959	148.000	40.256	163.392	44.400	132.608	36.112
1960	27.824	18.352	30.784	20.128	24.864	16.576
1961	39.072	27.824	43.216	30.784	34.928	24.864
1962	250.002	109.934	270.307	121.478	229.696	98.390
1963	589.928	333.237	636.578	351.174	543.278	315.358
1964	369.112	152.026	424.464	172.272	313.701	131.779
1965	120.117	50.320	123.965	50.438	116.269	50.202
1966	62.101	24.746	58.253	29.363	65.949	20.129
1967	21.726	8.347	22.496	7.933	20.957	8.762
1968	50.202	25.219	53.872	27.232	46.531	23.206
1969	36.349	16.339	42.802	18.885	29.896	13.794
1970	53.754	32.382	63.699	37.414	43.808	27.350
1971	58.726	23.976	68.317	30.547	49.136	17.405
1972	14.9[illegible]3	4.973	15.510	4.973	14.445	4.973
1973	4.440	1.954	5.506	2.309	3.374	1.598
1974	24.923	11.248	27.410	12.965	22.378	9.590
1975	9.413	4.440	10.597	5.387	9.294	3.552
1976	1.894	0.592	1.894	0.651	1.894	0.533
1977	10.538	6.334	9.709	5.032	11.248	7.637
1978	13.734	5.683	16.280	5.802	11.130	5.506
1979	[illegible].091	1.776	5.150	1.835	4.973	1.717
1980	3.045	1.305	3.818	1.498	2.271	1.063
1981	10.342	3.528	10.390	3.431	10.294	3.624
1982	1.305	0.420	1.401	0.503	1.208	0.343
1983	0.773	0.285	0.870	0.324	0.677	0.256
1984	0.781	0.443	0.929	0.538	0.632	0.347
1985	0.508	0.320	0.441	0.270	0.522	0.368
1986	772.000	78.000	790.000	94.000	754.000	63.000
1987	12.000	5.400	12.500	5.500	11.400	5.300
1988	4.800	2.400	5.310	2.620	4.160	2.080
1989	1.110	0.570	1.490	0.730	0.740	0.410

References

Aarkrog, A. (1979). Environmental Studies on Radioecological Sensitivity and Variability with Special Emphasis on the Fallout Nuclides ^{90}Sr and ^{137}Cs. Risø-R-437.

Aarkrog, A. (1988). Studies of Chernobyl Debris in Denmark, Environment International 14, 149-155.

Aarkrog, A. (1989). Radioecological Lessons Learned from Chernobyl, Proceeding of the XVeth Regional Congress of IPRA, Visby, Gotland, Sweden, 10-14 Sept., 1989, 129-134.

Bryant, F.J., Morgan,A. and Spicer, G.S. (1959). The Determination of Radiostrontium in Biological Materials. AERE-R 3030.

Danmarks statistik. Statistisk årbog 1972 (Statistical Yearbook) (Copenhagen, 1972).

Danmarks statistik, Landbrugsstatistik 1985. (Statistical Yearbook) (Copenhagen, 1986).

Danmarks statistik. Statistisk årbog 1987 (Statistical Yearbook) (Copenhagen 1988).

Hald, A. (1958). Private communication.

Harley, John H. (1972). Manual of Standard Procedures. HASL-300.

HASL (1958-1978). General reference to: Environmental quarterly. Quarterly reports from Health and Safety Laboratory, U.S. Atomic Energy Commission, later U.S. Energy Research and Development Administration and latest Environmental Measurements Laboratory, Department of Energy (New York).

Lippert, J. (1975). Statdata, Risø-M-1780.

Osmond, R.G., Owers, M.J., Healy, C. and Mead, A.P. (1959). The Determination of Radioactivity due to Caesium, Strontium, Barium and Cerium in Waters and Filters. AERE-R 2899.

Quittner, P. (1969). Nucl. Instr. and Methods 76, 115-124.

Risø Reports Nos. 1, 3, 9, 14, 23, 41, 63, 85, 107, 130, 154, 180, 201, 220, 245, 265, 291, 305, 323, 345, 361, 386, 403, 421, 447, 469, 487,509, 527, 540, 549 and 563 (1957-89).

Roos, N., Nørby Jensen, M., Lundmark Jensen, N. (1990). Radioaktivt Cesium i Svampeundersøgelse af 6 arter i Gribskov (in Danish) 58 pp. University of Roskilde.

Sydkraft: Barsebäckverket-Månadsrapport; Vattenfall: Ringhalsverket. Månadsrapport ..., and Vattenfall: Forsmarkverket - Miljörapport. (Monthly reports to the Swedish authorities on discharges from Barsebäck, Ringhals and Forsmark, respectively) (in Swedish).

UNSCEAR. (1982). United Nations Scientific Committee on the Effects of Atomic Radiation.. Ionizing Radiation: Sources and biological effects. (New York) 773 pp.

Vestergaard, J. (1964). Analysis of Variance with Unequal Numbers in Group. GIER System Library No. 211 (A/S Regnecentralen, Copenhagen, 1964).

Bibliographic Data Sheet **Risø-R-570**

Title and author(s)

Environmental Radioactivity in Denmark in 1988 and 1989

A. Aarkrog, L. Bøtter-Jensen, Chen Qing Jiang, H. Dahlgaard, Heinz Hansen, Elis Holm, Bente Lauridsen, S.P. Nielsen and J. Søgaard-Hansen

ISBN	ISSN
87-550-1720-7	0106-2840
	0106-407X

Dept. or group	Date
Health Physics Department	July 1991

Groups own reg. number(s)	Project/contract no.

Pages	Tables	Illustrations	References
213	212	76	51

Abstract (Max. 2000 characters)

Strontium-90, radiocesium, and other radionuclides were determined in samples from all over the country of air, precipitation, stream water, lake water, ground water, drinking water, sea water, soil, sediments, dried milk, fresh milk, meat, fish, cheese, eggs, grain, bread, potatoes, vegetables, fruit, grass, moss, lichen, sea plants, total diet, and humans. Estimates are given of the mean contents of radiostrontium and radiocesium in the human diet in Denmark during 1988 and 1989. Tritium was determined in precipitation, ground water, other fresh waters, and sea water. The γ-background was measured regularly by TLD's and a NaI detector. The marine environments at Barsebäck and Ringhals were monitored for ^{137}Cs and corrosion products (^{58}Co, ^{60}Co, ^{65}Zn, ^{54}Mn).

During 1988 and 1989 the expanded programme initiated after the Chernobyl accident in 1986 was brought back to the pre-Chernobyl level.

Descriptors INIS/EDB

AIR; ANTIMONY ISOTOPES; AQUATIC ECOSYSTEMS; ATMOSPHERIC PRECIPITATIONS; BACKGROUND RADIATION; BARSEBAECK-1 REACTOR; BARSEBAECK-2 REACTOR; BONE TISSUES; CERIUM ISOTOPES; CESIUM 134; CESIUM 137; CHERNOBYLSK-4 REACTOR; CHROMIUM 51; COBALT ISOTOPES; DENMARK; DIET; ENVIRONMENT; FALLOUT DEPOSITS; FISHES; FOOD; FOOD CHAINS; GLOBAL FALLOUT; GROUND WATER; IODINE 131; IRON 59; LOCAL FALLOUT; MAN; MANGANESE 54; MILK; NIOBIUM 95; NUMERICAL DATA; PLANTS; RADIOACTIVITY; REACTOR ACCIDENTS; RINGHALS-1 REACTOR; RINGHALS-2 REACTOR; RINGHALS-3 REACTOR; RISOE NATIONAL LABORATORY; RUTHENIUM ISOTOPES; SEAWATER; SEAWEEDS; SEDIMENTS; SILVER 110; STRONTIUM 90; TECHNETIUM 99; TRITIUM; VEGETABLES; ZINC 65; ZIRCONIUM 95;

Available on request from Risø Library, Risø National Laboratory, (Risø Bibliotek, Forskningscenter Risø), P.O.Box 49, DK-4000 Roskilde, Denmark.
Telephone +45 42 37 12 12, ext. 2268/2269
Telex 43 116. Telefax +45 46 75 56 27.