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Analysis of radioisotopes in environmental samples

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Abstract

A number of environmental samples collected within the site investigation areas at Oskarshamn and Forsmark were analysed for several artificial and natural occurring radioisotopes. Samples included soil, sediment as well as plant and animal species from the terrestrial, limnic and marine environment. A total of 19 samples were analysed from the Oskarshamn area and 17 from the Forsmark area.

Results obtained all show concentrations and isotope signatures characteristic for normal environmental samples only contaminated by atmospheric nuclear bomb test fallout. However, two samples (humus and moss from a spruce forest in Forsmark, AFM001076-1-3 and AFM001076-7-4) showed significantly enhanced ^{238}Pu/$^{239+240}$Pu ratios (7.4 and 10% respectively) when analysed by alpha spectrometry. Replicate analysis of remaining 25% of the sample materials yielded 7.5 and 9.8% respectively. Process blank samples analysed in parallel showed no detectable Pu-activity. The ^{240}Pu/^{239}Pu activity ratio in these particular samples showed a slight increase over the fallout background but total concentrations were not abnormal. One potential candidate source could be the Chernobyl accident fallout, which possibly could be verified if ^{137}Cs data were available for the samples.

Sammanfattning

Omgivningsprov insamlade i platsundersökningsområdena vid Oskarshamn och Forsmark analyserades med avseende på ett antal naturliga och artificiella radioisotoper. Proven utgjordes av jord, sediment och olika växt- och djurarter från terrest, limnisk och marin miljö. Totalt analyserades 19 prov insamlade i Oskarshamnsområdet och 17 prov från Forsmarksområdet.

De erhållna resultaten visar på normalt förekommande koncentrationer och isotopsammansättning i samtliga prov. Isotopsignaturen för plutonium i analyserade prov anger atmosfärisk deponering från kärnvapentestperioden som enda källa. Undantaget var två prov (humus och mossa från en granskog i Forsmark, AFM001076-1-3 and AFM001076-7-4) som uppvisade signifikant förhöjda ^{238}Pu/$^{239+240}$Pu-kvoter vid analys med alfaspektrometri (7,4 och 10 % respektive). Replikatanalys utförd på kvarstående 25 % av materialet visade kvoter på 7,5 respektive 9,8 %. Processblankprov utförda parallellt uppvisade inga detekterbara plutoniumhalter. Aktivitetskvoterna av ^{240}Pu/^{239}Pu för de båda proven var svagt förhöjda men halterna av Pu var ej avikande. En tänkbar källa bidragande till den avvikande Pu isotopsignaturen är nedfall från Tjernobylolyckan. Analys av av ^{137}Cs-halter i de båda proven skulle eventuellt kunna ge vägledning om så är fallet.

Contents

1 Introduction

This document reports the data gained by the analysis of radioisotopes in materials collected at Oskarshamn and Forsmark, which is part of the activities performed within the site investigations at Forsmark and Oskarshamn. The work was carried out in accordance with activity plans AP PF 400-06-005 and AP PS 400-06-006. In Table 1-1, controlling documents for performing this activity are listed. Activity plans are SKB's internal controlling documents.

In order to characterise both deposits and biota with respect to the chemical composition, a number of different samples from the site investigation areas at Forsmark and Oskarshamn have been analysed for elements /Karlsson and Hannu 2006, Engdahl et al. 2006/. These analyses have now been complemented with the radioisotope analyses described in this report. The analyses were performed by Risö Forskningscenter, Roskilde, Denmark.

Original data from the reported activities are stored in the primary database SICADA. Data are traceable in SICADA by the Activity plan numbers (AP PF 400-06-005 and AP PS 400-06-006). Only data in databases are accepted for further interpretation and modelling. The data presented in this report are regarded as copies of the original data. Data in the databases may be revised, if needed. Such revisions will not necessarily result in a revision of the P-report, although the normal procedure is that major revisions entail a revision of the P-report. Minor revisions are normally presented as supplements, available at www.skb.se.

Table 1-1. Controlling documents for performance of the activity.

Activity plan	Number	Version
Analyser av isotoper i olika materia	AP PF 400-06-005	1.0
Analyser av isotoper i olika materia	AP PS 400-06-006	1.0

2 Objective and scope

Analyses of selected radioisotopes were performed on samples of deposits and biota. The analysed samples were collected from terrestrial, limnic and marine environments at the two investigation sites. The samples are further described in Chapter 3. The purpose was to generate information which will be used in different models of the surface (eco)systems at Forsmark and Oskarshamn. The information may also be used in an EIA (Environmental Impact Assessment) for a future repository for spent nuclear fuel. The parameters determined are shown in Table 2-1.

The main sources of the isotopes analysed in the current samples are either natural decay chain radioisotopes (^{226}Ra, ^{230}Th, ^{232}Th, ^{234}U, ^{235}U, ^{238}U) or atmospheric fallout from nuclear bomb tests conducted during the fifties and sixties (^{238}Pu, ^{239}Pu, ^{240}Pu, ^{242}Pu). The isotopes ^{229}Th, ^{233}U and ^{236}U are extremely rarely detected in environmental samples. The ^{236}U isotope can be an exception to this since it is usually present in reprocessed uranium, and therefore also in depleted uranium, which is commonly used in ordinary laboratory chemicals of uranium compounds.

Although produced in large amounts in nuclear reactors, the current main sources of ^{99}Tc and ^{129}I to the marine environment around Scandinavia are reprocessing plants in UK and France. For ^{129}I these sources also dominate the contribution to the terrestrial environment. Both these elements are highly enriched in brown seaweed, which therefore has been widely used as a bio-indicator for technetium and iodine. The enrichment factors (concentration in seaweed relative surrounding water) are in the order of 10^4–10^5. Even though technetium behaves conservatively in oxic seawater it may be enriched in sediments when anoxic conditions develop.

Table 2-1. Parameters measured.

Wet weight
Dry weight
^{238}Pu, ^{239}Pu, ^{240}Pu, ^{242}Pu, ^{226}Ra, ^{229}Th, ^{230}Th, ^{232}Th, ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{99}Tc, ^{129}I.

3 Samples

The samples analysed were collected from terrestrial, limnic, and marine environments and consisted of flora, fauna, soil and sediment. In Table 3-1 and 3-2 all samples are listed, including information of sampling sites, sampling dates or periods and further descriptions of the different samples. The sampling sites are presented in the maps in Figure 3-1 and 3-2.

3.1 Oskarshamn

Aquatic flora, fauna and sediment were sampled in August 2006 in connection with the activity "Chemical characterisation of deposits and biota" /Engdahl et al. 2006/. The aquatic samples are considered to represent the whole lake, sea bay or sea, where they were taken. The sediments were sampled with an Ekman grabber.

For terrestrial fauna, moose was sampled by local hunters during autumn and winter 2005/2006, and small rodents were sampled in summer and autumn 2003 /Cederlund et al. 2004/. The samples of moose and small rodents are considered to represent the whole investigation area.

Figure 3-1. *Sampling sites for soil and terrestrial vegetation, sediment, limnic biota (Lake Frisksjön), marine biota (Borholmsfjärden and the shore outside Simpevarp-Kråkelund), and mammals (whole investigation area). All samples were analysed for radioisotopes.*

Figure 3-2. *Sampling sites in Forsmark.*

Terrestrial vegetation and soil was sampled at one site in August 2006 by personnel from SKB. Three replicates were put together to one pooled sample for each sample type (spruce needles, bilberry sprigs and soil). Each replicate consisted of spruce needles from one spruce (sampled at a height of 1–2 m), and bilberry sprigs and soil were sampled under that spruce.

For all fauna samples, i.e. moose, rodents, fish and mussels, muscle was prepared and analysed. For Common mussel (*Mytilus edulis*) shells were also analysed.

3.2 Forsmark

The limnic sediment, algal mat, vegetation and mussels were sampled in September 2006 by personnel from SKB, whereas freshwater fish was sampled in August 2003 /Borgiel 2004/. The marine samples were all collected in spring 2005 /Kumblad and Bradshaw 2007/. The aquatic samples are considered to represent the whole lake or sea bay, where they were taken. The sediments and algal mat were sampled with a core sampler.

For terrestrial fauna, moose was sampled by local hunters during October 2005, and small rodents were sampled in summer and autumn 2003 /Cederlund et al. 2004/. The samples of moose and small rodents are considered to represent the whole investigation area.

Terrestrial vegetation was sampled at one site in July 2005 by personnel from SKB. Two types of samples were collected; moss and *Rubus saxatilis*. Soil was sampled from the same site in November 2005 /Persson and Stadenberg 2007/.

For all fauna samples, i.e. moose, rodents, fish and mussels, muscle was prepared and analysed.

Table 3-1. Description of all Oskarshamn samples accounted for in this report. For species names in Latin, Swedish and English, see Appendix 2.

Sample type	Sampling site	Sample no	Description of sample	Individuals /sample	Sampling date/ period
Terrestrial environment					
Soil	ASM001440	326	Peat (from 10 cm depth, under three spruces, pooled sample)	–	2006-08-22
Flora	ASM001440	327	*Vaccinium myrtillus* (bilberry sprigs under three spruces, pooled sample)	–	2006-08-22
	ASM001440	328	*Picea abies* (needles from three spruces, pooled sample)	–	2006-08-22
Fauna	ASM000005	329	*Apodemus flavicollis* (muscle from Yellow-necked mouse, pooled sample)	32	June and October 2003
	ASM000005	330	*Alces alces* (muscle from Moose)	3	Autumn/winter 2005–2006
Limnic environment Lake Frisksjön					
Flora	ASM000192	320	*Phragmites australis* (standing crop from Reed). Pooled sample from 3 different parts of the lake.	–	2006-08-30
	ASM000192	321	*Nymphaeaceae* (leaf from Water lily). Pooled sample from 3 different parts of the lake.	–	2006-08-30
Fauna	ASM000192	322	*Anodonta anatina* (muscle from Duck mussel). Pooled sample from 3 different parts of the lake.	5	2006-08-30
	ASM000192	323	*Perca fluviatilis* (muscle from planctivorous Perch)	61	2006-08-30
	ASM000192	324	*Perca fluviatilis* (muscle from piscivorous Perch)	3	2006-08-30
Sediment	PSM002065	325	Sediment 0–5 cm (pooled sample from five separate samples)	–	2006-08-30
Marine environment Borholmsfjärden					
Flora	ASM000202	314	*Potamogeton perfoliatus* (Pondweed). Pooled sample from 3 different parts of the bay.	–	2006-08-29
	ASM000202	315	*Chara sp.* (Charophyte algae). Pooled sample from 3 different parts of the bay.	–	2006-08-29
Fauna	ASM000202	317	*Alburnus alburnus* (muscle from Bleak)	c. 30	2006-08-31
	ASM000202	318	*Perca fluviatilis* (muscle from piscivorous Perch)	3	2006-08-31
Sediment	PSM007097	319	Sediment 0–5 cm (pooled sample from five separate samples)	–	2006-08-29
Shore outside Simpevarp-Kråkelund					
Flora	ASM100000	313	*Fucus vesiculosus* (Seaweed)	–	2006-08-29
Fauna	ASM100000	316	*Mytilus edulis* (muscle from Common mussel)	c. 700	2006-08-29
	ASM100000	331	*Mytilus edulis* (shell from Common mussel)	c. 700	2006-08-29

Table 3-2. Description of all Forsmark samples accounted for in this report. For species names in Latin, Swedish and English, see Appendix 2.

Sample type	Sampling site	Sample no	Description of sample	Individuals/ sample	Sampling date/ period
Terrestrial environment; spruce forest					
Soil	AFM001076	1	Humus layer (pooled sample)	–	Nov 2005
Flora	AFM001076	7	Moss sample (pooled sample, different species)	–	July 2005
	AFM001076	8	*Rubus saxatilis* (whole plants except roots)	–	July 2005
Fauna	AFM100207	1	*Clethrionomys glareolus* (muscle from Bank vole, pooled sample)	c. 45	May/June and Sept/Oct 2003
	AFM000100	5	*Alces alces* (muscle from Moose)	5	Oct 2005
Limnic environment; Lake Bolundsfjärden					
Sediment	AFM000050	12	Sediment 0–5 cm (pooled sample)	–	Sept 2006
Algal mat	AFM000050	13	Algal mat 0–5 cm (pooled sample)		Sept 2006
Flora	AFM000050	14	Charophytes (*Chara sp.*). Pooled sample from different parts of the lake.	–	Sept 2006
	AFM000050	15	*Phragmites australis* (standing crop from Reed). Pooled sample from different parts of the lake.	–	Sept 2006
Fauna	AFM000050	16	*Anodonta sp.* (muscle from mussel). Pooled sample from different parts of the lake.	–	Sept 2006
	AFM000050	17	*Rutilus rutilus* (muscle from planctivorous roach)	–	Aug 2003
	AFM000050	18	*Esox lucius* (muscle from piscivorous pike)	–	Aug 2003
Marine environment; bay outside the islands Stortixlan and Lilltixlan					
Sediment	AFM001313	1	Sediment 0–3 cm	–	Spring 2005
Flora	AFM001313	2	*Fucus vesiculosus* (Bladder wrack)	–	Spring 2005
	AFM001313	3	*Potamogeton sp.*	–	Spring 2005
Fauna	AFM001313	4	*Rutilus rutilus* (muscle from planctivorous/ benthivorous roach)	1	Spring 2005
	AFM001313	5	*Osmerus eperlanus* (muscle from piscivorous smelt)	1	Spring 2005

4 Equipment

The equipment used in the analyses is specified in Table 4-1 and described in the text below.

4.1 Description of equipment/interpretation tools

The Quantulus, Figure 4-1, is an ultra low level liquid scintillation spectrometer which enables measurements normally only possible in special underground installations. This is made possible by a combination of massive lead shielding as well as anti-coincidence shielding. The instrument was used for the measurement of ^{226}Ra. The data from the Quantulus LSC are normally corrected individually for each sample based on the so called quenching parameter which is determined internally by a standard gamma source irradiating the sample with a well known gamma ray fluence. Apart from the quenching parameter the cross-talk between the alpha and beta particle windows is adjusted by monitoring alpha/beta count rates for a standard source at various PSA-settings.

The Risø-type Geiger-Müller (GM) gas flow multicounter used is shielded both with a massive lead shield and a gas guard operating in anti-coincidence with the GM-detectors. The background of these detectors can therefore be kept at a very low level (around 0.2 counts per minute). This instrument was used for the analysis of ^{99}Tc. It is calibrated using standard ^{99}Tc sources.

The Canberra alpha spectrometry system (Figure 4-2) uses 450 mm^2 PIPS (Planar Implanted Passivated Silicon) connected to low-noise signal processing electronics and a Canberra Genie-2000 alpha spectrometry software. A total of 32 alpha detectors are installed and were used for the alpha spectrometry analysis of plutonium. Calibration and function checks for the solid state alpha spectrometry is done using electrodeposited or electrosprayed sources of ^{242}Pu and ^{243}Am with known activity.

Table 4-1. Overview of instrumentation used for the different isotopes analysed.

	Quantulus, LSC	GM gas flow counter	PIPS alpha detectors	ICP-MS	AMS
^{238}Pu			x		
^{239}Pu			x	x	
^{240}Pu			x	x	
^{242}Pu				x	
^{226}Ra	x				
^{229}Th				x	
^{230}Th				x	
^{232}Th				x	
^{233}U				x	
^{234}U				x	
^{235}U				x	
^{238}U				x	
^{99}Tc		x			
^{129}I					x

Figure 4-1. *The Quantulus LSC is the cabinet shown in the background behind a set-up of the ordinary anticoincidence shielded GM gas flow counters in a lead cave in the foreground.*

Figure 4-2. *The solid state alpha spectrometry system used for the alpha spectrometry of plutonium.*

The Thermo XII used for the analysis of Pu, U and Th isotopes is a quadrupole based ICP-MS equipped with a collision cell, see Figure 4-3. A low-flow concentric nebuliser and a CETAC U5000+ ultrasonic nebuliser were used for the sample introduction. Calibration and tuning of the ICP-MS was done using standard multi-element solutions as well as certified solutions for U-isotopes. The ICP-MS must be optimised daily to achieve maximum overall performance.

^{129}I was measured using accelerator mass spectrometry (AMS) with a National Electrostatic Model 15SDH-2 tandem Pelletron operating at maximum of 5 MV, (Figure 4-4). The instrument is situated at the Ångström Laboratory, Uppsala University.

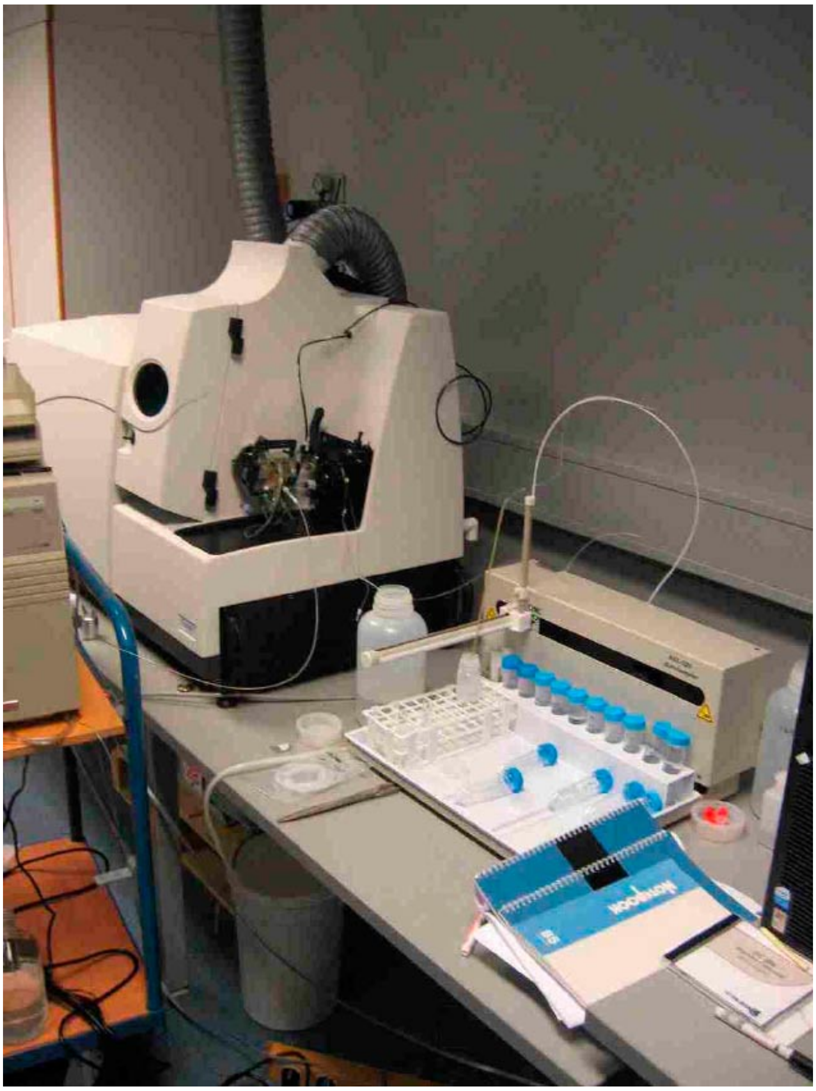

Figure 4-3. *The ICP-MS system used for the analysis of Pu, Th and U isotopes.*

Figure 4-4. *The accelerator mass spectrometer used for ^{129}I measurements.*

5 Execution

5.1 General

Upon delivery samples were weighed (fresh weight) and were then kept frozen until further treatment. All samples were freeze dried during 1–3 days and the dry weight was recorded. Following freeze drying, a subsample for iodine analysis was taken before ashing the remaining part of the sample. The ash weight of each sample was recorded. Following dissolution of the ashed samples in HNO3/HCl/HF aliquots of the dissolved sample were used for the separation of the various elements using ion exchange and extraction methods. A comprehensive description of the radiochemical separation methods used can be found at http://www.risoe.dk/rispubl/nuk/nukpdf/ris-r-1263.pdf.

The requested isotopes to be measured were analysed radiometrically using solid state alpha spectrometry, liquid scintillation counting, and GM-counters as well as non-radiometrically using ICP-MS.

5.2 Analysis

5.2.1 ^{238}Pu, $^{239+240}$Pu

The isolated plutonium, including the isotopic yield determinant ^{242}Pu which was added to the sample in a known amount prior so separation, was first measured for 3–5 days by solid state alpha spectrometry and the net intensity (brutto minus blank background) of the ^{238}Pu and $^{239+240}$Pu alpha peaks were related to the intensity of the ^{242}Pu peak. Concentration of the ^{238}Pu and $^{239+240}$Pu in the sample was calculated as:

(X counts/[^{242}Pu counts] · added ^{242}Pu activity)/sample mass; where X represents the actual Pu-isotope.

Note that with solid state alpha spectrometry, the ^{239}Pu and ^{240}Pu isotopes are not resolvable and are therefore reported as the sum $^{239+240}$Pu. The electrodeposited source used for alpha spectrometry was thereafter dissolved and the Pu further purified for ICP-MS of ^{239}Pu and ^{240}Pu. Due to the relatively short half life and the ^{238}U background, the ^{238}Pu cannot be measured accurately by ICP-MS. The intensity of the mass 239 and 240 ion beams was corrected for background, blank contribution, and the 239 mass was corrected for the influence of $^{238}UH^+$. Mass bias was corrected for by using a uranium solution with certified ^{234}U/^{235}U/^{238}U isotope ratios (NIST SRM U112a) and applying a linear interpolation. Detection limits were calculated as 3 sigma above blank background.

5.2.2 ^{242}Pu

A separate aliquot of the sample (about 25%) was used for the analysis of Pu-242. After chemical isolation of Pu it was analysed for ^{239}Pu, ^{240}Pu and ^{242}Pu by ICP-MS. In no cases a significant signal above the blank background could be detected. Detection limits were calculated from 3 sigma above blank background.

5.2.3 ^{232}Th, ^{235}U, ^{238}U

A small (1–5% of total sample weight) aliquot was used for the direct analysis by ICP-MS and quantified by a combined internal ^{233}U standard and an external ^{238}U-^{232}Th calibration. The ^{238}U concentration was determined by dividing the net m/z 238 ion signal with the m/z 233 signal and multiplying with the added amount of ^{233}U. Correction for mass bias was done using U112a with certified $^{234}U/^{235}U/^{238}U$ ratios. Th-232 was determined from the ratio of the ^{232}Th signal to the ^{238}U signal and the known U/Th sensitivity obtained from a U-Th standard solution. For some samples the concentration was sufficiently high to determine ^{235}U directly, otherwise they were determined from the concentrated aliquots together with ^{233}U, ^{234}U, and ^{236}U.

5.2.4 ^{229}Th, ^{230}Th

Thorium isotopes in a large fraction (around 75%) of the sample were analysed by ICP-MS following chemical purification. The raw ion beam ratios of $^{229}Th/^{232}Th$ and $^{230}Th/^{232}Th$ were corrected for background and mass fractionation. Concentrations of ^{229}Th and ^{230}Th were calculated from the ratios by multiplying with the previously determined ^{232}Th concentration. Investigation of dead-time corrections were performed by analysing a natural $^{235}U/^{238}U$ standard at concentrations similar to the samples. It was found that no dead-time correction was necessary.

5.2.5 ^{233}U, ^{234}U, ^{235}U, ^{236}U

Uranium isotopes in a large fraction (around 75%) of the sample were analysed by ICP-MS following chemical purification. The raw ion beam ratios of $^{235}U/^{238}U$, $^{234}U/^{238}U$, $^{233}U/^{238}U$ and $^{236}U/^{238}U$ were corrected for background and mass fractionation. Investigation of dead-time corrections were performed by analysing a natural $^{235}U/^{238}U$ standard at concentrations similar to the samples. It was found that no dead-time correction was necessary.

5.2.6 ^{129}I

Iodine was extracted from a subsample by evaporating iodine in a quartz oven and collecting in alkaline solution. A fraction of the sample was kept for ^{127}I analysis by ICP-MS and the remaining iodine liquid-liquid extracted. The back-extracted iodide was precipitated as AgI and mixed with niobium powder. When dry the AgI powder was pressed in a copper holder for analysis by accelerator mass spectrometry to determine the $^{129}I/^{127}I$ ratio. The ^{129}I concentration was obtained by multiplying with the determined ^{127}I concentration.

5.2.7 ^{99}Tc

Technetium was analysed by beta counting on a Geiger-Muller anticoincidence shielded gas flow counter. The counter was calibrated using standard ^{99}Tc sources. The radiochemical yield was determined by using $^{99}Tc^m$ obtained from a ^{99}Mo-$^{99}Tc^m$ generator.

5.3 Nonconformities

The marine mussel sample from Forsmark could not be included in the analyses as too few individuals were found at the selected location.

In several cases the concentration of the isotopes measured was below the detection limit of the method used. Instrumental changes in order to decrease the detection limits would only have minimal effect, and because separation methods were used to extract the elements, the main improvement would be by increasing the sample mass. One exception to this is ^{236}U which only can be detected down to about 10^{-5} (by atom) of the ^{235}U present in the sample due to spectrometric interferences from the ^{235}U isotope.

6 Results

Data are listed in Appendix 1; Radioisotope data.

In conclusion, the samples analysed all show isotope signatures and isotope (element) concentrations which are to be expected in environmental samples. Sources of U and Th decay chain isotopes are of natural origin as judged from $^{235}U/^{238}U$ ratios and from absence of ^{233}U and ^{236}U. Similarly, $^{230}Th/^{232}Th$ ratios and concentrations of the two Th-isotopes are typical of environmental samples. No ^{229}Th (daughter product of ^{233}U) could be found in the samples. For Pu the major part of the samples (where it could be detected) had a $^{238}Pu/^{239+240}Pu$ ratio typical of the 3–5% observed in nuclear bomb test fallout in the fifties and sixties in the north hemisphere. Similarly, the $^{240}Pu/^{239}Pu$ atom ratio, when measurable, showed a signature indicative of nuclear bomb test fallout.

However, two samples (humus and moss from a spruce forest in Forsmark, AFM001076-1-3 and AFM001076-7-4) showed significantly enhanced $^{238}Pu/^{239+240}Pu$ ratios (7.4 and 10% respectively) when analysed by alpha spectrometry. Replicate analysis of remaining 25% of the sample materials yielded 7.5 and 9.8% respectively. Process blank samples analysed in parallel showed no detectable Pu-activity. The $^{240}Pu/^{239}Pu$ activity ratio in these particular samples showed a slight increase over the fallout background but total concentrations were not abnormal. One potential candidate source could be the Chernobyl accident fallout, which possibly could be verified if ^{137}Cs data were available for the samples.

Levels of ^{99}Tc and ^{129}I were all within the range of what can be expected. The sources of these isotopes are mainly European reprocessing plants (La Hague and Sellafield). The transport route of ^{99}Tc to the Baltic Sea is therefore through sea currents and total concentrations observed in the Baltic Sea reflect both the water exchange with the North Sea as well as the oxygen status of the Baltic Sea. The latter is due to that Tc is a redox sensitive element which, during anoxic or suboxic conditions, becomes attached to particulate matter and ends up in the sediments. The transport routes of ^{129}I are more “sluggish” since it can be transported both through air and by water ways, which explains why it can be detected in several of the terrestrial samples analysed.

Information on environmental radioactivity in several types of samples in the Baltic Sea may be obtained through the Helcom/Mors group operating under the Helsinki convention. For further information:

http://sea.helcom.fi/dps/docs/folders/Monitoring%20and%20Assessment%20Group%20(MONAS)/MORS%20PRO%2011,%202006.html.

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Appendix 1

Radioisotope data

Uncertainties from radiometric measurements were calculated from brutto counts, background and tracer uncertainties. For mass spectrometric measurements uncertainties were calculated from the relative standard deviation (RSD) of the repeated measurements (n=10) and uncertainties in isotopic standard and external standard. All uncertainties refer to one sigma.

Forsmark ID code	Risø code	Sample name	Wet weight (g)	Dry weight (g)	[^{238}U] (Bq/kg dw)	[^{238}U] Uncertainty calc from RSD and 5% tracer uncertainty	[^{235}U] (mBq/kg dw)	[^{235}U] Uncertainty calc from RSD and 5% tracer uncertainty	[^{234}U] (Bq/kg dw)	[^{234}U] Uncertainty calc from RSD and 5% tracer uncertainty
AFM100207	2006-8150	Ängssork	–	8.127	0.05	7	3	9	0.06	11
AFM001076	2006-8151	Humuslager 0–2.5 cm	–	16.714	38	9	1,769	10	46.4	9
AFM001076	2006-8152	Mossa	–	62.8	58	9	2,672	11	69.2	10
AFM001076	2006-8153	Stenbär	–	48.3	0.13	7	6	9	0.15	10
AFM000100	2006-8154	Älg	1,989	887	0.01	8	0.3	9	0.01	11
AFM000050	2006-8155	Sediment 0–5 cm	910	73.8	164	9	7,731	10	187.7	9
AFM000050	2006-8156	Algmatta 0–5 cm	1,101	22.5	59	9	2,781	10	68.9	9
AFM000050	2006-8157	Chara	–	111.6	9.0	5	423	7	10.1	6
AFM000050	2006-8158	Vass	530.1	177.4	0.22	6	11	8	0.3	7
AFM000050	2006-8159	Dammussla	1,373	65.8	4.3	5	200	7	5.0	6
AFM000050	2006-8160	Mört	182.4	42.8	0.38	6	19	9	0.5	7
AFM000050	2006-8161	Gädda	33.5	5.6	0.13	7	6	10	0.16	10
AFM001313	2006-8162	Sediment 0–3 cm	20	15.4	8.0	11	382	12	8.5	11
AFM001313	2006-8163	Fucus	16.8	3.7	15	7	720	8	18.1	8
AFM001313	2006-8164	Potamogeton	18.7	1.6	9.0	16	431	17	10.4	17
AFM001313	2006-8165	Mört	10.2	2.6	0.15	12	7	16	0.20	13
AFM001313	2006-8166	Nors	21	4.9	0.02	7	1	12	0.03	22

Forsmark ID code	Risø code	Sample name	[^{233}U] (mBq/kg dw)	[^{236}U] (mBq/kg dw)	[^{232}Th] (Bq/kg dw)	[^{232}Th] Uncertainty calc from RSD and 5% tracer uncertainty Including a 5% uncertainty in the U/Th ratio calibration	[^{230}Th] (mBq/kg dw)	[^{230}Th] Uncertainty (%)	[^{229}Th] (mBq/kg)
AFM100207	2006-8150	Ängssork	BDL (<35.6 mBq/kg)	BDL (<1.2 mBq/kg)	0.01	8	29	28	BDL (<133 mBq/kg)
AFM001076	2006-8151	Humuslager 0–2.5 cm	BDL (<41.1 mBq/kg)	BDL (<1.4 mBq/kg)	9.15	9	8,926	11	BDL (<153 mBq/kg)
AFM001076	2006-8152	Mossa	BDL (<5.2 mBq/kg)	BDL (<0.2 mBq/kg)	0.98	10	1,200	11	BDL (<19 mBq/kg)
AFM001076	2006-8153	Stenbär	BDL (<6.6 mBq/kg)	BDL (<0.2 mBq/kg)	0.02	7	21	21	BDL (<25 mBq/kg)
AFM000100	2006-8154	Älg	BDL (<0.9 mBq/kg)	BDL (<0.03 mBq/kg)	0.002	8	3.6	15	BDL (<3 mBq/kg)
AFM000050	2006-8155	Sediment 0–5 cm	BDL (<18.5 mBq/kg)	BDL (<0.6 mBq/kg)	21.91	9	28,766	11	BDL (<69 mBq/kg)
AFM000050	2006-8156	Algmatta 0–5 cm	BDL (<35.2 mBq/kg)	BDL (<1.2 mBq/kg)	17.13	9	29,471	11	BDL (<131 mBq/kg)
AFM000050	2006-8157	Chara	BDL (<7.5 mBq/kg)	BDL (<0.3 mBq/kg)	0.13	6	264	10	BDL (<28 mBq/kg)
AFM000050	2006-8158	Vass	BDL (<2.3 mBq/kg)	BDL (<0.08 mBq/kg)	0.02	7	28	12	BDL (<9 mBq/kg)
AFM000050	2006-8159	Dammussla	BDL (<5.3 mBq/kg)	BDL (<0.2 mBq/kg)	0.12	6	245	13	BDL (<20 mBq/kg)
AFM000050	2006-8160	Mört	BDL (<8.0 mBq/kg)	BDL (<0.3 mBq/kg)	0.01	7	BDL (<3 mBq/kg)	–	BDL (<30 mBq/kg)
AFM000050	2006-8161	Gädda	BDL (<54.4 mBq/kg)	BDL (<1.9 mBq/kg)	0.01	8	BDL (<20 mBq/kg)	–	BDL (<203 mBq/kg)
AFM001313	2006-8162	Sediment 0–3 cm	BDL (<19.7 mBq/kg)	BDL (<0.7 mBq/kg)	5.82	11	5,560	13	BDL (<74 mBq/kg)
AFM001313	2006-8163	Fucus	BDL (<75.4 mBq/kg)	BDL (<2.6 mBq/kg)	0.57	8	842	11	BDL (<281 mBq/kg)
AFM001313	2006-8164	Potamogeton	BDL (<188.8 mBq/kg)	BDL (<6.4 mBq/kg)	1.51	17	2,139	19	BDL (<705 mBq/kg)
AFM001313	2006-8165	Mört	BDL (<104.8 mBq/kg)	BDL (<3.6 mBq/kg)	0.0016	18	BDL (<38 mBq/kg)	–	BDL (<391 mBq/kg)
AFM001313	2006-8166	Nors	BDL (<57.1 mBq/kg)	BDL (<1.9 mBq/kg)	0.0010	9	BDL (<21 mBq/kg)	–	BDL (<213 mBq/kg)

Forsmark ID code	Risø code	Sample name	[^{226}Ra] (Bq/kg dw)	[^{226}Ra] Uncertainty (%)	[^{129}I] (mBq/kg dw)	[^{129}I] Uncertainty (%)	[^{242}Pu] (mBq/kg dw)	[^{238}Pu] (mBq/kg dw)	[^{238}Pu] Uncertainty (%)	[^{239}Pu] (mBq/kg dw)	[^{239}Pu] Uncertainty (%)
AFM100207	2006-8150	Ängssork	0.5	21	–	–	BDL (<3.1 mBq/kg)	BDL (<20 mBq/kg)		BDL (<15 mBq/kg)	–
AFM001076	2006-8151	Humuslager 0–2.5 cm	14	13	4.359	4	BDL (<3.5 mBq/kg)	210	13	1,510	12
AFM001076	2006-8152	Mossa	4.8	12	6.618	33	BDL (<0.4 mBq/kg)	40	10	210	13
AFM001076	2006-8153	Stenbär	0.4	15	0.159	0.6	BDL (<0.6 mBq/kg)	BDL (<4 mBq/kg)	–	BDL (<10 mBq/kg)	–
AFM000100	2006-8154	Älg	0.1	14	0.242	0.4	BDL (<0.1 mBq/kg)	BDL (<0.2 mBq/kg)	–	BDL (<1 mBq/kg)	–
AFM000050	2006-8155	Sediment 0–5 cm	30	11	0.332	2	BDL (<1.6 mBq/kg)	73	11	1,120	12
AFM000050	2006-8156	Algmatta 0–5 cm	42	11	2.070	2	BDL <3.0 mBq/kg)	237	8	2,528	8
AFM000050	2006-8157	Chara	32	11	1.430	7	BDL (<0.6 mBq/kg)	4	23	78	20
AFM000050	2006-8158	Vass	3.8	11	0.451	3	BDL (<0.2 mBq/kg)	BDL (<1 mBq/kg)	–	BDL (<2 mBq/kg)	–
AFM000050	2006-8159	Dammussla	20	12	0.275	3	BDL (<0.5 mBq/kg)	BDL (<3 mBq/kg)	–	23	27
AFM000050	2006-8160	Mört	2	17	–	–	BDL (<0.7 mBq/kg)	BDL (<4 mBq/kg)	–	BDL (<7 mBq/kg)	–
AFM000050	2006-8161	Gädda	0.4	25	–	–	BDL (<4.7 mBq/kg)	BDL (<70 mBq/kg)	–	BDL (<4 mBq/kg)	–
AFM001313	2006-8162	Sediment 0–3 cm	8.5	12	0.487	3	BDL (<1.7 mBq/kg)	BDL (<20 mBq/kg)	–	102	31
AFM001313	2006-8163	Fucus	42.2	12	–	–	BDL (<6.5 mBq/kg)	8	77	BDL (<10 mBq/kg)	
AFM001313	2006-8164	Potamogeton	11	16	–	–	BDL (<16.2 mBq/kg)	BDL (<60 mBq/kg)	–	BDL (<5 mBq/kg)	–
AFM001313	2006-8165	Mört	1	25	–	–	BDL (<9.0 mBq/kg)	BDL (<100 mBq/kg)	–	BDL (<10 mBq/kg)	–
AFM001313	2006-8166	Nors	0.3	26	–	–	BDL (<4.9 mBq/kg)	BDL (<50 mBq/kg)	–	BDL (<5 mBq/kg)	–

Forsmark ID code	Risø code	Sample name	[^{240}Pu] (mBq/kg dw)	[^{240}Pu] Uncertainty (%)	[$^{239+240}$Pu] (mBq/kg dw)	[$^{239+240}$Pu] Uncertainty (%)	[^{99}Tc] (Bq/kg dw)	[^{99}Tc] Uncertainty (%)	[^{238}Pu]/[$^{239+240}$Pu] (%)	[^{238}Pu]/[$^{239+240}$Pu] Uncertainty (%)
AFM100207	2006-8150	Ängssork	BDL (<20 mBq/kg)	–	BDL (<20 mBq/kg)	–	–	–		
AFM001076	2006-8151	Humuslager 0–2.5 cm	1,290	13	2,785	7	–	–	7.5; 7.5	15; 15
AFM001076	2006-8152	Mossa	150	14	364	7	–	–	10.0; 9.8	12; 16
AFM001076	2006-8153	Stenbär	BDL (<10 mBq/kg)	–	BDL (<4 mBq/kg)	–	–	–		
AFM000100	2006-8154	Älg	BDL (<1 mBq/kg)	–	0.16	50	–	–		
AFM000050	2006-8155	Sediment 0–5 cm	685	11	1,800	6	–	–	4.1	13
AFM000050	2006-8156	Algmatta 0–5 cm	1,760	8	4,290	6	–	–	5.5	10
AFM000050	2006-8157	Chara	71	17	149	7	–	–	2.7	24
AFM000050	2006-8158	Vass	BDL (<2 mBq/kg)	–	3.6	29	–	–		
AFM000050	2006-8159	Dammussla	10	29	37	11	–	–		
AFM000050	2006-8160	Mört	BDL (<5 mBq/kg)	–	BDL (<4 mBq/kg)	–	–	–		
AFM000050	2006-8161	Gädda	BDL (<4 mBq/kg)	–	BDL (<70 mBq/kg)	–	–	–		
AFM001313	2006-8162	Sediment 0–3 cm	48	22	148	13	BDL (<0.6 Bq/kg)	45		
AFM001313	2006-8163	Fucus	BDL (<10 mBq/kg)	–	131	15	1.5	17	6.1	78
AFM001313	2006-8164	Potamogeton	BDL (<5 mBq/kg)	–	75	37	–	–		
AFM001313	2006-8165	Mört	BDL (<10 mBq/kg)	–	BDL (<100 mBq/kg)	–	–	–		
AFM001313	2006-8166	Nors	BDL (<5 mBq/kg)	–	BDL (<50 mBq/kg)	–	–	–		

Oskarshamn ID code	Risø code	Sample name	Wet weight (g)	Dry weight (g)	[^{238}U] (Bq/kg dw)	[^{238}U] Uncertainty calc from RSD and 5% tracer uncertainty	[^{235}U] (mBq/kg dw)	[^{235}U] Uncertainty calc from RSD and 5% tracer uncertainty	[^{234}U] (Bq/kg dw)	[^{234}U] Uncertainty calc from RSD and 5% tracer uncertainty
ASM100000	2006-8167	Fucus	332.9	55.7	8.8	5	434	7	10.9	16
ASM000202	2006-8168	Nate	462.1	47.1	7.8	6	381	8	9.6	17
ASM000202	2006-8169	Chara	203.1	32.9	6.5	6	323	7	8.6	18
ASM100000	2006-8170A (Flesh)	Mytilus muskel	79.3	8.788	6.2	6	305	8	6.3	7
ASM100000	2006-8170B (Shells)	Mytilus skal	265.5	117.7	1.4	8	70	9	1.5	9
ASM000202	2006-8171	Löja	538.3	159.2	0.11	7	5.0	9	0.11	8
ASM000202	2006-8172	Abborre piscivor	365	103.9	0.04	6	2.1	9	0.05	7
PSM007097	2006-8173	Sediment 0–5 cm	636.6	68.6	81	6	4,006	8	99	18
ASM000192	2006-8174	Vass ovanveg	275.4	98	0.11	6	5.4	8	0.11	7
ASM000192	2006-8175	Näckros blad	421	45.8	2.2	5	109	7	2.9	18
ASM000192	2006-8176	Anodonta muskel	177.30	12.40	9.5	6	461	8	12	18
ASM000192	2006-8177	Abborre piscivor	189.6	54.5	0.06	5	3.0	7	0.072	6
PSM002065	2006-8178	Sediment 0–5 cm	643.5	50.4	127	5	6,204	7	160	17
ASM001440	2006-8179	Jord 10 cm	905.4	348.7	34	5	1,806	7	48	16
ASM001440	2006-8180	Blåbärsris	415	178.9	0.080	6	3.94	8	0.077	7
ASM001440	2006-8181	Granbarr	442.8	184.7	0.023	6	1.1	7	0.020	7
ASM000005	2006-8182	Större skogsmus	–	15	0.004	67	0.2	67	0.004	67
ASM000005	2006-8183	Älg	1,934	603.2	0.009	6	0.47	7	0.010	8
ASM000192	2006-8184	Abborre planktivor	–	12.5	0.009	55	0.5	55	0.012	56

Oskarshamn ID code	Risø code	Sample name	[^{233}U] (mBq/kg dw)	[^{236}U] (mBq/kg dw)	[^{232}Th] (Bq/kg dw)	[^{232}Th] Uncertainty calc from RSD and 5% tracer uncertainty Including a 11% uncertainty in the U/Th ratio calibration	[^{230}Th] (mBq/kg dw)	[^{230}Th] Uncertainty (%)	[^{229}Th] (mBq/kg dw)
ASM100000	2006-8167	Fucus	BDL (<5.0 mBq/kg)	BDL (<0.2 mBq/kg)	0.02	11	17	14	BDL (<21 mBq/kg)
ASM000202	2006-8168	Nate	BDL (<8.4 mBq/kg)	BDL (<0.3 mBq/kg)	1.07	12	1,142	13	BDL (<17 mBq/kg)
ASM000202	2006-8169	Chara	BDL (<9.1 mBq/kg)	BDL (<0.3 mBq/kg)	0.66	11	735	18	BDL (<26 mBq/kg)
ASM100000	2006-8170A (Flesh)	Mytilus muskel	BDL (<28.9 mBq/kg)	BDL (<1.0 mBq/kg)	0.045	12	66	25	BDL (<116 mBq/kg)
ASM100000	2006-8170B (Shells)	Mytilus skal	BDL (<3.1 mBq/kg)	BDL (<0.1 mBq/kg)	0.004	47	3.2	49	BDL (<11 mBq/kg)
ASM000202	2006-8171	Löja	BDL (<2.0 mBq/kg)	BDL (<0.1 mBq/kg)	0.009	12	6.6	32	BDL (<8 mBq/kg)
ASM000202	2006-8172	Abborre piscivor	BDL (<4.1 mBq/kg)	BDL (<0.1 mBq/kg)	0.002	16	1.3	32	BDL (<8 mBq/kg)
PSM007097	2006-8173	Sediment 0–5 cm	BDL (<23.3 mBq/kg)	BDL (<0.8 mBq/kg)	26	12	27,186	16	BDL (<40 mBq/kg)
ASM000192	2006-8174	Vass ovanveg	BDL (<3.4 mBq/kg)	BDL (<0.1 mBq/kg)	0.048	11	51	13	BDL (<9 mBq/kg)
ASM000192	2006-8175	Näckros blad	BDL (<7.3 mBq/kg)	BDL (<0.2 mBq/kg)	0.190	11	217	13	BDL (<21 mBq/kg)
ASM000192	2006-8176	Anodonta muskel	BDL (<23.2 mBq/kg)	BDL (<0.8 mBq/kg)	0.430	11	528	13	BDL (<76 mBq/kg)
ASM000192	2006-8177	Abborre piscivor	BDL (<6.0 mBq/kg)	BDL (<0.2 mBq/kg)	0.001	11	0.8	20	BDL (<10 mBq/kg)
PSM002065	2006-8178	Sediment 0–5 cm	BDL (<23.3 mBq/kg)	BDL (<0.8 mBq/kg)	24	11	27,750	15	BDL (<44 mBq/kg)
ASM001440	2006-8179	Jord 10 cm	BDL (<7.0 mBq/kg)	BDL (<0.2 mBq/kg)	4.5	11	5,605	15	BDL (<10 mBq/kg)
ASM001440	2006-8180	Blåbärsris	BDL (<1.6 mBq/kg)	BDL (<0.1 mBq/kg)	0.020	11	18	13	BDL (<5 mBq/kg)
ASM001440	2006-8181	Granbarr	BDL (<1.7 mBq/kg)	BDL (<0.1 mBq/kg)	0.013	11	11	14	BDL (<4 mBq/kg)
ASM000005	2006-8182	Större skogsmus	BDL (<16.3 mBq/kg)	BDL (<0.6 mBq/kg)	0.002	44	2.1	47	BDL (<17 mBq/kg)
ASM000005	2006-8183	Älg	BDL (<2.3 mBq/kg)	BDL (<0.1 mBq/kg)	0.008	12	5.4	17	BDL (<3 mBq/kg)
ASM000192	2006-8184	Abborre planktivor	BDL (<18.2 mBq/kg)	BDL (<0.6 mBq/kg)	0.002	47	2.6	65	BDL (<37 mBq/kg)

Oskarshamn ID code	Risø code	Sample name	[^{226}Ra] (Bq/kg dw)	[^{226}Ra] Uncertainty (%)	[^{129}I] (mBq/kg dw)	[^{129}I] Uncertainty (%)	[^{242}Pu] (mBq/kg dw)	[^{238}Pu] (mBq/kg dw)	[^{238}Pu] Uncertainty (%)
ASM100000	2006-8167	Fucus	8.7	11	22.9	8.1	BDL (<0.4 mBq/kg)	BDL (<3.1 mBq/kg)	–
ASM000202	2006-8168	Nate	4.1	11	5.0	2.7	BDL (<0.6 mBq/kg)	1.4	56
ASM000202	2006-8169	Chara	5.5	11	7.2	0.3	BDL (<0.7 mBq/kg)	1.0	110
ASM100000	2006-8170A (Flesh)	Mytilus muskel	1.0	33	10.5	1.2	BDL (<2.1 mBq/kg)	BDL (<23 mBq/kg)	–
ASM100000	2006-8170B (Shells)	Mytilus skal	3.7	12	4.5	1.4	BDL (<0.2 mBq/kg)	BDL (<1.9 mBq/kg)	–
ASM000202	2006-8171	Löja	0.20	18	0.40	2.7	BDL (<0.1 mBq/kg)	BDL (<1.6 mBq/kg)	–
ASM000202	2006-8172	Abborre piscivor	0.01	95	0.41	3.3	BDL (<0.3 mBq/kg)	BDL (<1.1 mBq/kg)	–
PSM007097	2006-8173	Sediment 0–5 cm	8.5	11	0.84	0.9	BDL (<1.7 mBq/kg)	33	16.6
ASM000192	2006-8174	Vass ovanveg	2.9	11	0.23	2.1	BDL (<0.2 mBq/kg)	BDL (<2.1 mBq/kg)	–
ASM000192	2006-8175	Näckros blad	5.3	11	0.64	3.8	BDL (<0.5 mBq/kg)	BDL (<3.8 mBq/kg)	–
ASM000192	2006-8176	Anodonta muskel	29.2	10	0.36	5.2	BDL (<1.7 mBq/kg)	BDL (<12.6 mBq/kg)	–
ASM000192	2006-8177	Abborre piscivor	0.35	19	0.37	4.1	BDL (<0.4 mBq/kg)	BDL (<3.8 mBq/kg)	–
PSM002065	2006-8178	Sediment 0–5 cm	69.8	10	0.55	5.2	BDL (<1.7 mBq/kg)	82	14.9
ASM001440	2006-8179	Jord 10 cm	15.6	10	3.03	4.1	BDL (<0.5 mBq/kg)	77	7
ASM001440	2006-8180	Blåbärsris	16.2	10	0.30	4.4	BDL (<0.1 mBq/kg)	BDL (<1.0 mBq/kg)	–
ASM001440	2006-8181	Granbarr	1.8	11	0.41	3.3	BDL (<0.1 mBq/kg)	BDL (<1.0 mBq/kg)	–
ASM000005	2006-8182	Större skogsmus	0.10	45	0.071	4.3	BDL (<1.2 mBq/kg)	BDL (<19 mBq/kg)	–
ASM000005	2006-8183	Älg	0.04	17	0.083	4.7	BDL (<0.2 mBq/kg)	BDL (<0.4 mBq/kg)	–
ASM000192	2006-8184	Abborre planktivor	0.20	36	1.24	5.5	BDL (<1.3 mBq/kg)	BDL (<18 mBq/kg)	–

Oskarshamn			[^{239}Pu]	[^{239}Pu]	[^{240}Pu]	[^{240}Pu]	[$^{239+240}$Pu]	[$^{239+240}$Pu]	[^{99}Tc]	[^{99}Tc]	[^{238}Pu]/[$^{239+240}$Pu]	[^{238}Pu]/[$^{239+240}$Pu]
ID code	Risø code	Sample name	(mBq/kg dw)	Uncertainty (%)	(mBq/kg dw)	Uncertainty (%)	(mBq/kg dw)	Uncertainty (%)	(Bq/kg dw)	Uncertainty (%)	(%)	Uncertainty (%)
ASM100000	2006-8167	Fucus	9.6	34	5.2	34	15	16	4.3	8		
ASM000202	2006-8168	Nate	38	19	28	19	66	9	–	–	2.2	57
ASM000202	2006-8169	Chara	26	20	17	20	44	12	–	–	2.2	111
ASM100000	2006-8170A (Flesh)	Mytilus muskel	BDL (10 mBq/kg)	–	BDL (10 mBq/kg)	–	9	84	0.89	25		
ASM100000	2006-8170B (Shells)	Mytilus skal	BDL (2 mBq/kg)	–	BDL (2 mBq/kg)	–	2	50	0.08	23		
ASM000202	2006-8171	Löja	BDL (1 mBq/kg)	–	BDL (1 mBq/kg)	–	1	84	–	–		
ASM000202	2006-8172	Abborre piscivor	BDL (2 mBq/kg)	–	BDL (2 mBq/kg)	–	1	41	–	–		
PSM007097	2006-8173	Sediment 0–5 cm	527	44	491	44	1,018	7	0.19	19	3.2	18
ASM000192	2006-8174	Vass ovanveg	BDL (5 mBq/kg)	–	BDL (5 mBq/kg)		2	43				
ASM000192	2006-8175	Näckros blad	18	22	10	22	28	13				
ASM000192	2006-8176	Anodonta muskel	35	26	20	26	55	17				
ASM000192	2006-8177	Abborre piscivor	BDL (1 mBq/kg)	–	BDL (1 mBq/kg)		1	110				
PSM002065	2006-8178	Sediment 0–5 cm	1,782	12	1,135	12	2,917	7			2.8	17
ASM001440	2006-8179	Jord 10 cm	1,475	7	991	7	2,467	6			3.1	9
ASM001440	2006-8180	Blåbärsris	BDL (1 mBq/kg)	–	BDL (1 mBq/kg)	–	BDL (<1 mBq/kg)	–				
ASM001440	2006-8181	Granbarr	BDL (5 mBq/kg)	–	BDL (5 mBq/kg)	–	2.0	35				
ASM000005	2006-8182	Större skogsmus	BDL (20 mBq/kg)	–	BDL (20 mBq/kg)	–	BDL (<19 mBq/kg)	–				
ASM000005	2006-8183	Älg	BDL (1 mBq/kg)	–	BDL (1 mBq/kg)	–	0.3	40				
ASM000192	2006-8184	Abborre planktivor	BDL (20 mBq/kg)	–	BDL (20 mBq/kg)	–	BDL (<18 mBq/kg)	–				

Appendix 2

Species names in Latin, English and Swedish

Latin	English	Swedish
Alburnus alburnus	Bleak	Löja
Alces Alces	Moose	Älg
Anodonta anatina	Freshwater mussel	Dammussla
Apodemus flavicollis	Yellow-necked mouse	Större skogsmus
Chara sp.	Charophyte	Kransalg
Clethrionomys glareolus	Bank vole	Ängssork
Fucus vesiculosus	Bladder wrack	Blåstång
Mytilus edulis	Common mussel	Blåmussla
Nymphaeaceae	Water lily	Näckros
Perca fluviatilis	Perch	Abborre
Phragmites australis	Reed	Bladvass
Picea abies	Spruce	Gran
Potamogeton perfoliatus	Pondweed	Ålnate
Vaccinium myrtillus	Bilberry sprigs	Blåbärsris
Esox lucius	Pike	Gädda
Osmerus eperlanus	Smelt	Nors
Rutilus rutilus	Roach	Mört
Rubus saxatilis	Stone bramble	Stenbär