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Oskarshamn site investigation

Surface water sampling in Oskarshamn – Subreport October 2003 to February 2004

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September 2004

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Abstract

Within the site investigation area in Oskarshamn surface water has been sampled from October 2002. This report deals with the sampling period October 2003 to January 2004. Sampling has been conducted at 28 sites. Nineteen of these were sites in streams, four were sites in lakes and five were sites at sea in the coastal area. Sampling was performed on five occasions and the water was analysed for a large number of parameters. In the lakes and at sea vertical measurements were also taken by a sonde equipped with probes. All data collected has after an initial control been sent to SKB for storage in their database SICADA.

Most sites in streams and lakes can bee classified as mesotrophic and the water had a high content of humic substances. Most sites at sea had relatively low concentrations of nutrients but the more secluded sites close to the mainland had higher concentrations of nitrogen. In the lakes and at the sea the bottom water was relatively oxygen rich. Evidence of acidification with low values of pH was found in a two of the smaller streams. In the other streams and in the lakes the buffering capacity was high.

The data gathered are generally considered to be of high quality. The analysis of DIC (dissolved inorganic carbon) has a lower quality data set, probably due to a problem with storage of the sampling bottles prior to analysis.

The method used for determination of run-off is probably inexact resulting in lower quality of this data set.

The measurements of chlorophyll with the sonde in the lakes are disturbed by the high concentration of humus in the water. Since both humic substances and chlorophyll have similar fluorescence in the wavelength used by the sonde the concentration of chlorophyll is highly overestimated by these measurements.

The light sensor of the sonde is unable to give zero values even in a complete darkness. This results in readings which are 4.3 µmoles/second/m^2 to high which is not compensated for in the data set.

Sammanfattning

Provtagning av ytvatten inom platsundersökningsområdet i Oskarshamn startade i oktober 2002. Denna rapport redovisar provtagningsperioden oktober 2003 till januari 2004. Provtagning har skett vid 28 stationer. Nitton av dessa var i vattendrag, fyra var i sjöar och fem var platser i havet. Provtagning genomfördes vid fem tillfällen och ett stort antal parametrar analyserades. I sjöarna och i havet genomfördes även vertikala mätningar med en sond. Alla data som samlades in skickades efter en första kvalitetsgranskning till SKB för lagring i databasen SICADA.

De flesta stationerna i sjöarna och vattendragen kan klassificeras som mesotrofa. I flertalet fall var också halten av humus hög i vattnet. I havet var näringsämneshalten låg vid de flesta stationerna men vid de stationer som ligger mer skyddat var kvävehalten förhöjd. I sjöarna och i havet var syrehalten förhållandevis hög i bottenvattnet. Försurning och låga pH-värden förekom i två av de mindre vattendragen. I de övriga vattendragen och i sjöarna var buffertkapaciteten god.

De data som samlats in har en generellt hög kvalitet. Fyra typer av data har dock bedömts ha en lägre kvalitet.

Resultaten av analyserna av DIC (löst oorganiskt kol) har en lägre kvalitet, förmodligen beroende på problem med lagringen av proverna innan dessa analyserades.

Den metod som använts för bestämning av flödena i vattendragen är inte exakt. Detta har troligen resulterat i flödesdata av en något sämre kvalitet.

De mätningar av klorofyll som utförts med sonden i sjöarna har blivit störd av den höga halten av humus som förekommer i vattnet. Orsaken är att både humusämnen och klorofyll fluorescerar vid den våglängd som används av sonden för att mäta klorofyllhalten. Detta har resulterat i en kraftig övervärdering av klorofyllhalterna i sjöarna.

Sondens ljussensor ger inte nollvärden i totalt mörker. Detta har resulterat i värden som är 4,3 µmol/sekund/m^2 för höga. (I dataleveransen har det inte kompenserats för detta).

Contents

1 Introduction

This document reports the data gained in surface water sampling, which is one of the activities performed within the site investigation at Oskarshamn. The work was conducted according to activity plan AP PS 400-03-079 (SKB internal controlling document).

2 Objective and scope

The purpose of the surface water sampling is to characterise the surface water in the site investigation area. A number of streams, lakes and sites in the coastal area are sampled. This report deals with data from October 2003 to January 2004 (Figure 2-1 and Appendix 1). The sampling was divided into weekly working seasons, where every season included sampling from all the chosen places in the area of interest (Appendix 2).

The surface water sampling activity consisted of two different programmes, the chemical programme and the ecological programme. The chemistry programme included fewer sites and working seasons in comparison with the ecological programme (Appendix 2 and Appendix 3). The working seasons of the two programmes coincided and the sampling was co-ordinated.

The ecological programme as well as the chemical basically included the same parameters regardless of the type of water that was sampled (stream, lake or coastal area).

A number of physical and chemical parameters were measured directly on the spot using a multi-parameter sonde. Water samples were also taken for analysis of further parameters and the samples were later sent to different laboratories.

The large number of sites and parameters analysed have generated a large amount of data which will later be used for advanced analysis and modelling. In this report the evaluation aims to describe the quality of the data sampled from October 2003 to January 2004. These data are also compared with the results gained in the autumn and early winter of 2002 and 2003.

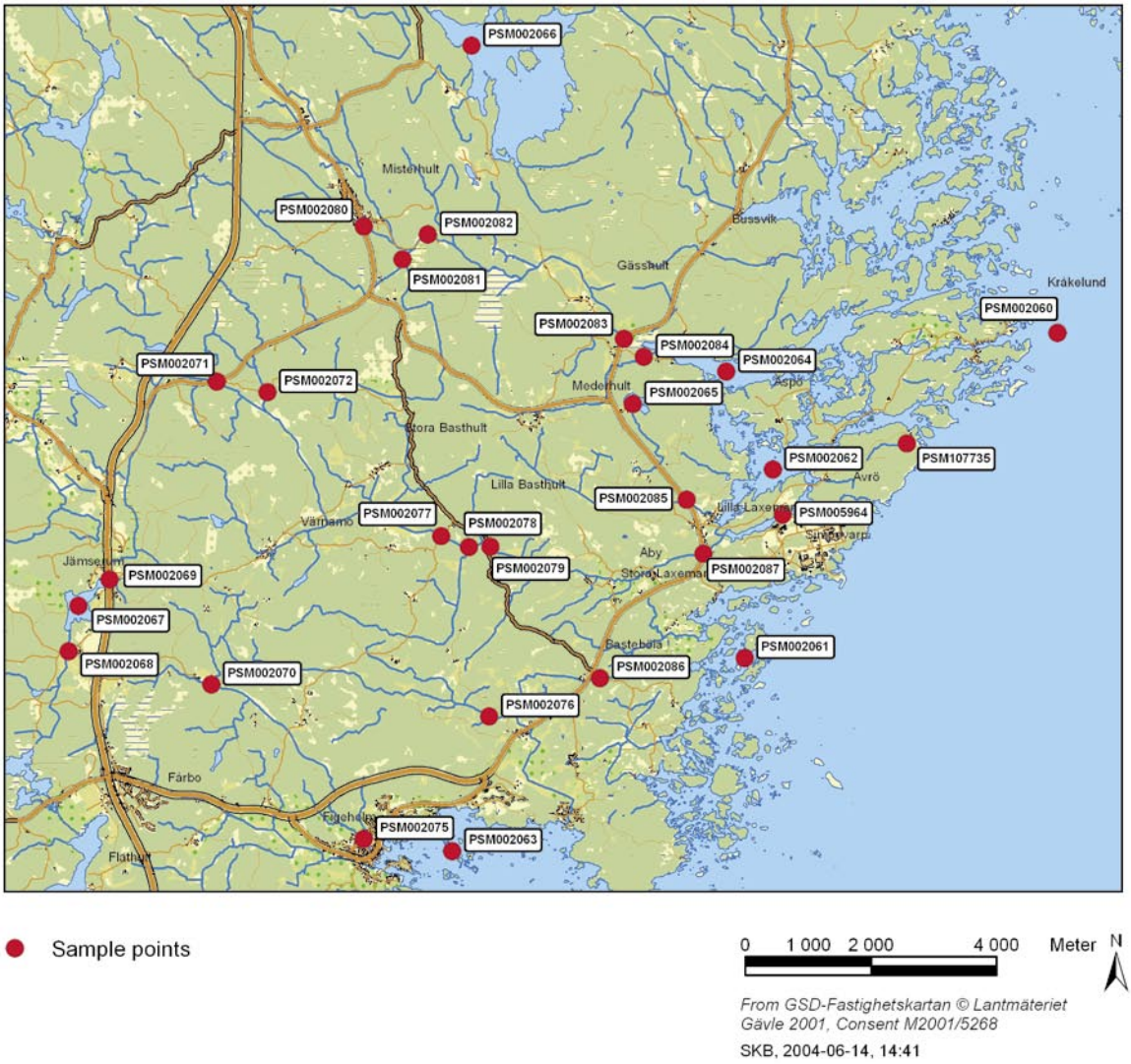

Figure 2-1. *The site investigation area and the sites sampled.*

3 Methods

3.1 Sites and sampling frequency

Sampling was performed on five occasions between October 2003 and January 2004 (Appendix 2). The number of sampled sites was 28 (19 streams, 4 lakes and 5 sites in the coastal area). The locations of the sites and the type of sampling programmes are shown in Figure 2-1 and in appendix 1 and 3. All sites were meant to be sampled on every occasion. This wasn't always possible due to stormy weather and dried up streams (Appendix 4). Due to changes in the sampling programme sampling at seven sites ceased in November 2003 (Appendix 4). In December sampling started at one new stream site (Appendix 4).

3.2 Execution of sampling and treatment of samples

Methods used when sampling in the field, treatments of samples before analysis and how samples was stored and transported to the analysing laboratories is described in the P-report written prior to this /Ericsson and Engdahl, 2004/. The controlling document for this activity has been AP PS 400-03-079 (SKB internal controlling document).

In this period only minor changes of the methods used have occurred. From January 2004, analysis of Carbon-13/PMC was not performed from sites where the alkalinity values were lower than 30 mg/l. The reason is that the amount of inorganic carbon is too low for the analysis in these waters.

3.3 Analysed parameters and Laboratories used

The analysed parameters and the laboratories used is shown in Table 3-1.

Table 3-1. Analysed parameters and laboratories used, October 2003 to January 2004.

Components	Analysing Laboratory
Alkalinity, pH, Conductivity, Anions (I-, Cl, Br, SO_4)	Äspö Laboratory
Standard elements (Na, K, Ca, Mg, Si, Fe, Mn, Li, Sr, TOT-S), ^{10}B, Iodine	Analytica, Luleå
TOC, DOC, DIC, TOT-NP, POP, PON, POC, $N0_3$, NO_2, NH_4, PO_4, Silicate, Chlorophyll, Oxygen	Department of Systems Ecology Stockholm University
Deuterium, ^{18}O, ^{87}Sr, ^{34}S	IFE, Norway
Tritium, ^{37}Cl, ^{13}C, PMC	EIL, Canada

4 Problems in the field and at the laboratories

It was not possible to sample some sample sites at all occasions (Appendix 4). During the autumn five stream sites were dried up on one ore more occasions. In January the open sea site PSM002060 was not sampled due to strong winds and high waves.

In January (2004-01-21) it was very cold (–10 to –13°C), which lead to various types of problems. At two sites (PSM002076 and PSM005964) the filtration had to be done indoors. At the same sites measurements of depth had to be mad manually when using the sonde. This was probably due to ice in the depth sensor. Another problem observed the same day was a tendency for the water to freeze in the bottles immediately after sampling. At least in some bottles ice crystals were noted. However these problems are not probable to affect the results.

During sampling in January (week four) the sonde had to be sent away to be repaired. Instead a similar sonde from the same manufacturer was used, with no light sensor. Therefore now values of light were obtained at this occasion.

The cold weather in January also lead to thick ice covers at many of the stream sites. This made it impossible to measure run-off at many of the sites.

In late autumn a poor relationship in some sample was discovered between the concentrations of HCO_3 and DIC (Figure 4-1). After discussions with the laboratories it was concluded that the problem probably was caused when the samples for DIC-analysis were frozen prior to sending them to the laboratory. The instruction which had been followed was to leave a one cm space in the bottle. This would allow the water to expand when the sample was put in the freezer. Probably this space wasn't enough in some bottles which caused leakage of water. Since February 2004 a new instruction has been followed. Now we leave two cm space in each bottle which hopefully will solve the problem.

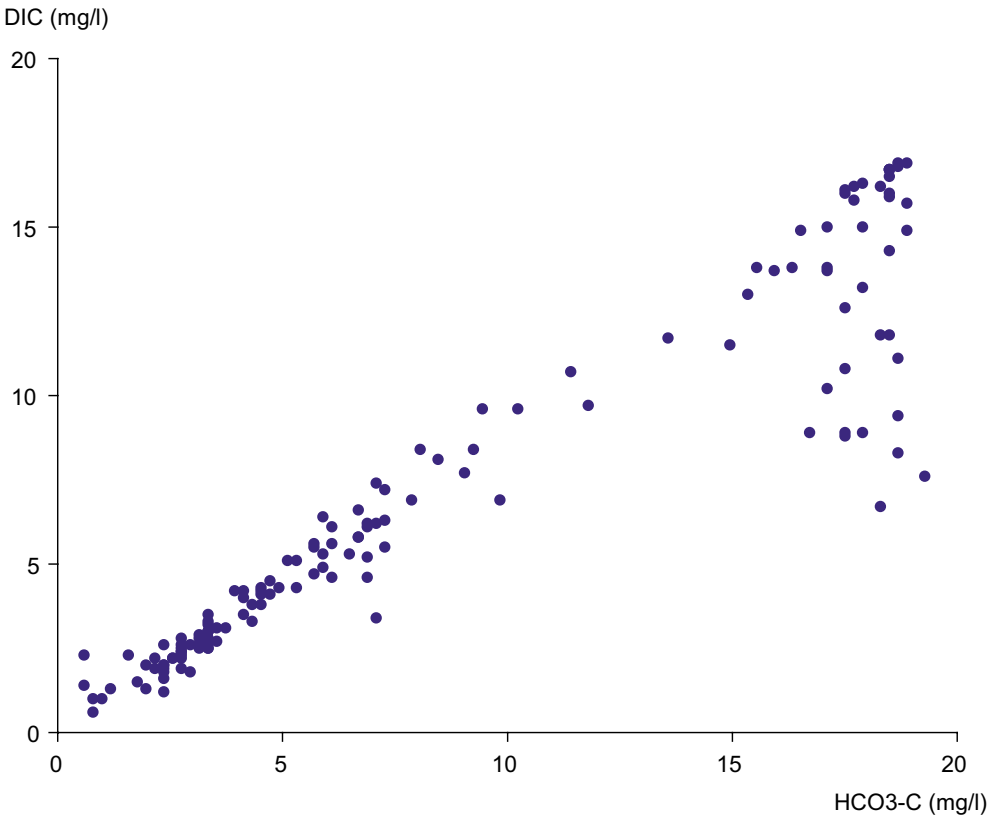

Figure 4-1. *Relation between the concentration of HCO3-C and DIC (Dissolved Inorganic Carbon). The figure shows data from all investigated sites, October 2003 to January 2004. Out layers indicating problems with DIC analysis is seen in the lower right side part of the graph.*

5 Documentation

All activities were continuously documented. Notes were taken on field conditions, time of sampling, marking of samples and so forth. Any deviations from the normal routines were also noted and commented in a report which was sent to SKB after each sampling occasion. These notes were later stored in the SKB database SICADA. Delivery notes with instructions on which components to analyse were always sent with the samples to the different laboratories. A new document, named Sample Comments, was introduced in January 2004. In this document, which are to be used from now on, notes from observations in the field and at the laboratory that possibly could affect the quality of a sample will be taken.

After analysis the data has continuously been reported from the laboratories. As a routine a first preliminary control of the data quality was performed before sending them for storage in the database SICADA. The data was reported to SICADA in field note numbers (Simpevarp) (Table 5-1). Data for this evaluation was delivered from SICADA 2004-03-18.

Table 5-1. Field note numbers (Simpevarp) for storage in SICADA.

Year	Week	Field note number
2003	40	144
2003	44	166
2003	47	184
2003	50	194
2004	4	223

6 Results and discussion

6.1 Run-off

The autumn 2003 was quite dry and some of the streams were completely dried up in the beginning of October (Appendix 4). After October the run-off increased in the streams due to increased precipitation (Figure 6-1 and 6-2). Compared to the autumn and early winter 2002 the run-off of year 2003 was much lower (Table 6-1 and 6-2).

Table 6-1. Average run-off from the stream water sites, October 2002 to January 2003.

Site number	Run-off (m^3/s)	Site number	Run-off (m^3/s)
PSM002068	0.080	PSM002080	0.084
PSM002069	0.115	PSM002081	0.330
PSM002070	0.071	PSM002082	0.826
PSM002071	0.195	PSM002083	0.644
PSM002072	0.037	PSM002084	0.062
PSM002075	0.233	PSM002085	0.077
PSM002076	0.062	PSM002086	0.039
PSM002077	0.660	PSM002087	1.254
PSM002078	0.130	PSM107735	
PSM002079	0.610		

Table 6-2. Average run-off from the stream water sites, October 2003 to January 2004.

Site number	Run-off (m^3/s)	Site number	Run-off (m^3/s)
PSM002068	0.014	PSM002080	0.001
PSM002069	0.040	PSM002081	0.008
PSM002070	0.006	PSM002082	0.080
PSM002071	0.044	PSM002083	0.079
PSM002072	0.009	PSM002084	0.009
PSM002075	0.008	PSM002085	0.006
PSM002076	0.001	PSM002086	0.001
PSM002077	0.032	PSM002087	0.109
PSM002078	0.017	PSM107735	0.003
PSM002079	0.068		

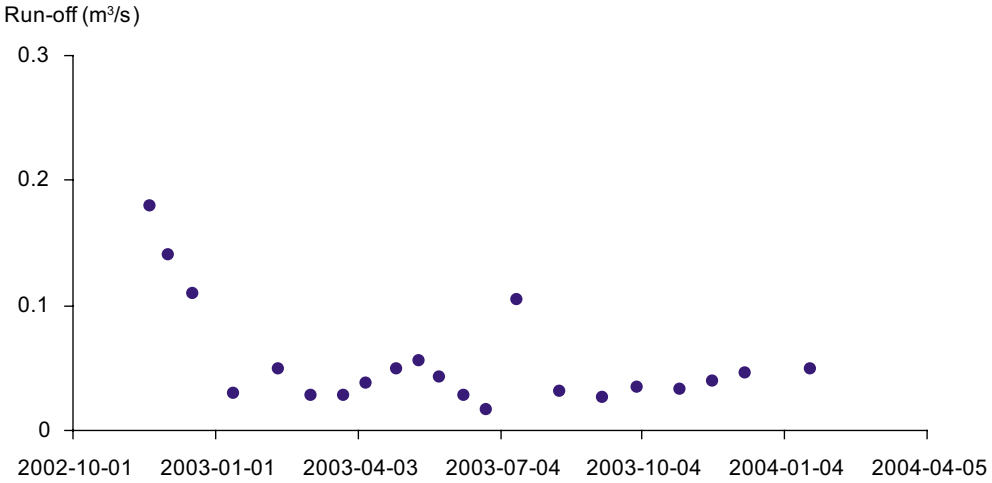

Figure 6-1. *Run-off from October 2002 to January 2004 at the site PSM002069 in the west of the investigation area.*

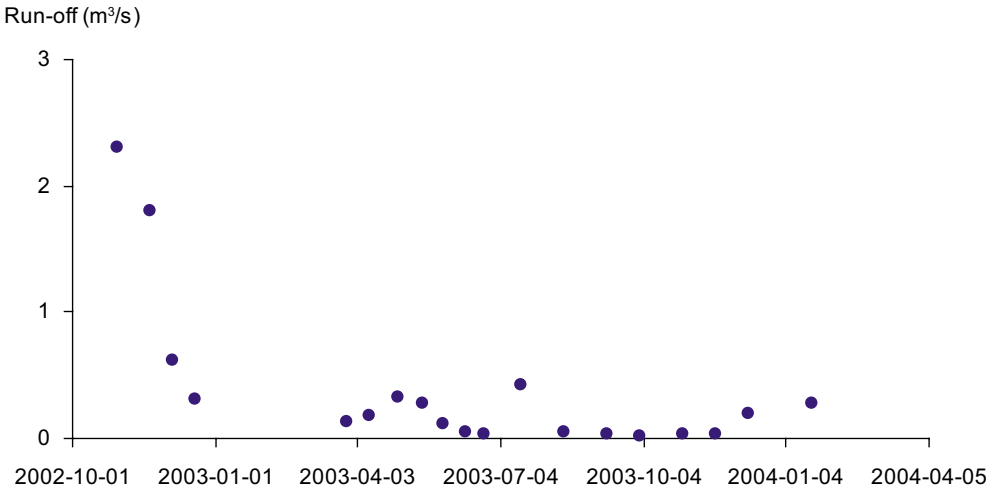

Figure 6-2. *Run-off from October 2002 to January 2004 at the site PSM002087 close to the sea in the east.*

6.2 Biochemical characterisation

6.2.1 Nutrients

Many of the streams had relatively high concentrations of nutrients (Table 6-3). Highest concentrations were generally measured downstream from farmland areas and in the larger tributaries. These results are similar to those measured in the autumn and early winter of 2002 (Table 6-4).

The three small lakes had generally higher concentration of nutrients than Lake Götemar (PSM002066) (Table 6-6). Similar results were measured also in the autumn and early winter of 2002 (Table 6-5).

At the sea sites the concentration of nutrients was generally lower in the last autumn than in the autumn and early winter of 2002 (Table 6-7 and 6-8). The difference is most evident at the more secluded sites. The probable reason for this is the considerably lower run-off this season.

Table 6-3. Average concentration of nutrients from the stream water sites, October 2002 to January 2003.

Site number	NH_4 (mg/l)	NO_2+NO_3 (mg/l)	PON (mg/l)	N-tot (mg/l)	PO_4 (mg/l)	POP (mg/l)	P-tot (mg/l)
PSM002068	0.039	0.195	0.057	1.098	0.004	0.006	0.016
PSM002069	0.057	0.115	0.042	0.944	0.002	0.005	0.015
PSM002070	0.051	0.187	0.063	1.110	0.006	0.012	0.028
PSM002071	0.039	0.182	0.045	0.901	0.003	0.006	0.018
PSM002072	0.031	0.058	0.021	0.995	0.003	0.003	0.018
PSM002075	0.036	0.271	0.050	1.210	0.007	0.009	0.028
PSM002076	0.111	0.132	0.085	1.470	0.008	0.012	0.038
PSM002077	0.063	0.177	0.058	0.786	0.007	0.010	0.029
PSM002078	0.025	0.149	0.046	0.896	0.005	0.007	0.017
PSM002079	0.061	0.187	0.058	1.028	0.007	0.011	0.029
PSM002080	0.050	0.287	0.056	1.148	0.002	0.008	0.018
PSM002081	0.058	0.116	0.053	1.089	0.007	0.011	0.030
PSM002082	0.055	0.433	0.074	1.333	0.006	0.009	0.027
PSM002083	0.095	0.291	0.076	1.322	0.008	0.014	0.038
PSM002084	0.076	0.629	0.071	1.790	0.013	0.014	0.042
PSM002085	0.091	1.859	0.066	3.006	0.007	0.010	0.038
PSM002086	0.058	1.324	0.074	2.600	0.016	0.015	0.047
PSM002087	0.048	0.241	0.056	1.102	0.007	0.010	0.028
PSM107735							

Table 6-4. K Average concentration of nutrients from the stream water sites, October 2003 to January 2004. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	NH_4 (mg/l)	NO_2+NO_3 (mg/l)	PON (mg/l)	N-tot (mg/l)	PO_4 (mg/l)	POP (mg/l)	P-tot (mg/l)
PSM002068	0.092	0.441	0.120	1.338	0.004	0.013	0.025
PSM002069	0.055	0.137	0.044	0.964	0.001	0.006	0.015
PSM002070	0.104	0.113	0.086	0.939	0.005	0.014	0.021
PSM002071	0.057	0.194	0.076	0.819	0.003	0.009	0.019
PSM002072	0.002	0.008	0.169	0.683	0.006	0.026	0.041
PSM002075	0.234	0.053	0.213	1.865	0.006	0.029	0.048
PSM002076	0.403	0.163	0.308	2.660	0.024	0.054	0.098
PSM002077	0.125	0.119	0.108	0.881	0.004	0.018	0.027
PSM002078	0.015	0.170	0.059	0.884	0.001	0.009	0.017
PSM002079	0.097	0.208	0.085	1.012	0.004	0.014	0.028
PSM002080	0.081	0.034	0.376	1.189	0.010	0.055	0.084
PSM002081	*0.014*	0.081	0.132	1.067	0.004	0.019	0.036
PSM002082	0.102	0.468	0.130	1.516	0.006	0.017	0.035
PSM002083	0.063	0.207	0.105	1.228	0.009	0.020	0.042
PSM002084	0.026	0.488	0.130	1.752	0.012	0.024	0.050
PSM002085	0.044	0.585	0.069	1.778	0.007	0.013	0.039
PSM002086	0.162	1.489	0.090	3.000	0.017	0.018	0.055
PSM002087	0.056	0.263	0.108	1.146	0.005	0.018	0.033
PSM107735	0.191	0.136	0.058	1.315	0.003	0.008	0.023

Table 6-5. Average concentration of nutrients and chlorophyll in the surface water of the investigated lakes, October 2002 to January 2003. Note that sampling didn't start at PSM005964 until August 2003. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	NH_4 (mg/l)	NO_2+NO_3 (mg/l)	PON (mg/l)	N-tot (mg/l)	PO_4 (mg/l)	POP (mg/l)	P-tot (mg/l)	Chlorophyll a (µg/l)
PSM002065	0.145	0.223	0.053	1.138	0.002	0.009	0.021	1.4
PSM002066	0.042	0.109	0.023	0.617	*0.001*	0.003	0.009	1.0
PSM002067	0.054	0.112	0.043	0.923	0.003	0.006	0.015	1.3
PSM005964								

Table 6-6. Average concentration of nutrients and chlorophyll in the surface water of the investigated lakes, October 2003 to January 2004. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	NH_4 (mg/l)	NO_2+NO_3 (mg/l)	PON (mg/l)	N-tot (mg/l)	PO_4 (mg/l)	POP (mg/l)	P-tot (mg/l)	Chlorophyll a (µg/l)
PSM002065	0.147	0.123	0.055	1.102	0.002	0.007	0.023	3.3
PSM002066	0.023	0.039	0.040	0.532	*0.001*	0.005	0.008	2.4
PSM002067	0.064	0.134	0.075	0.966	0.001	0.009	0.016	1.9
PSM005964	0.054	0.062	0.075	0.854	0.001	0.008	0.018	4.4

Table 6-7. Average concentration of nutrients and chlorophyll in the surface water of the investigated sites in the sea, October 2002 to January 2003. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	NH_4 (mg/l)	NO_2+NO_3 (mg/l)	PON (mg/l)	N-tot (mg/l)	PO_4 (mg/l)	POP (mg/l)	P-tot (mg/l)	Chlorophyll a (µg/l)
PSM002060	0.011	0.045	0.011	0.306	0.014	0.001	0.021	*0.6*
PSM002061	0.020	0.050	0.012	0.334	0.013	0.001	0.022	*0.7*
PSM002062	0.095	0.236	0.046	0.984	0.004	0.008	0.022	*0.9*
PSM002063	0.026	0.062	0.018	0.380	0.012	0.003	0.021	*1.2*
PSM002064	0.077	0.152	0.046	0.889	0.004	0.008	0.023	1.8

Table 6-8. Average concentration of nutrients and chlorophyll in the surface water of the investigated sites in the sea, October 2003 to January 2004. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	NH4 (mg/l)	NO2+NO3 (mg/l)	PON (mg/l)	N-tot (mg/l)	PO4 (mg/l)	POP (mg/l)	P-tot (mg/l)	Chlorophyll a (µg/l)
PSM002060	0.004	0.010	0.016	0.270	0.011	0.003	0.019	1.0
PSM002061	0.006	0.018	0.017	0.285	0.012	0.002	0.022	*0.6*
PSM002062	0.108	0.084	0.084	0.646	0.002	0.010	0.020	4.9
PSM002063	0.002	0.002	0.056	0.311	0.011	0.007	0.025	3.1
PSM002064	0.074	0.075	0.054	0.570	0.002	0.008	0.018	3.7

6.2.2 Carbon fractions

In many of the streams the concentrations of organic carbons were similar this autumn to those measured in the autumn and early winter of 2002 (Table 6-9 and 6-10). Dissolved inorganic carbon (DIC) was much higher during 2003. This is probably due to the much lower run-off this year.

As in the streams the water in the small lakes were coloured with humus. The concentration of TOC (total organic carbon) and DOC (dissolved organic carbon) were also high (Table 6-12). In Lake Götemar (PSM002066) the water was less coloured with lower concentration of organic carbons. These results are similar to those measured in the autumn and early winter of 2002 (Table 6-11). The concentration of DIC (dissolved organic carbon) had a tendency to be higher as in the streams. Probably due to the lower run-off during 2003.

Similar to previous years results the concentrations of organic carbon fractions were higher at the two most secluded sites in the sea (PSM002062 and PSM002064) (Table 6-13 and 6-14). Due to the lower run-off the concentration was lower at these sites 2003 compared to the autumn and early winter of 2002. As a consequence the transparency at the more secluded sites was higher in the autumn 2003. The lower run-off also manifested itself with comparatively higher concentrations of DIC (dissolved organic carbon) at the two most secluded sites.

Table 6-9. Average concentration of carbon fractions from the stream water sites, October 2002 to January 2003.

Site number	POC (mg/l)	DOC (mg/l)	DIC (mg/l)	TOC (mg/l)
PSM002068	0.854	22.6	1.7	23.5
PSM002069	0.511	17.7	2.2	17.9
PSM002070	0.830	20.2	4.9	20.1
PSM002071	0.637	15.5	2.2	16.3
PSM002072	0.255	30.9	0.9	31.2
PSM002075	0.613	20.5	2.7	20.9
PSM002076	1.066	24.5	2.7	22.5
PSM002077	0.694	17.8	1.7	18.1
PSM002078	0.531	18.0	1.0	18.2
PSM002079	0.658	17.9	1.5	18.1
PSM002080	0.703	21.1	2.1	21.7
PSM002081	0.595	21.2	3.0	20.9
PSM002082	0.741	20.5	2.2	20.7
PSM002083	0.881	21.3	1.8	21.8
PSM002084	0.851	19.4	3.0	20.0
PSM002085	0.643	18.7	8.4	19.1
PSM002086	0.737	23.1	1.4	24.0
PSM002087	0.699	18.1	1.3	18.6
PSM107735				

Table 6-10. Average concentration of carbon fractions from the stream water sites, October 2003 to January 2004.

Site number	POC (mg/l)	DOC (mg/l)	DIC (mg/l)	TOC (mg/l)
PSM002068	1.984	17.5	4.1	18.2
PSM002069	0.458	18.0	2.8	18.7
PSM002070	1.476	16.8	6.8	17.3
PSM002071	0.827	12.8	3.6	13.2
PSM002072	2.280	14.0	1.3	14.2
PSM002075	3.380	27.7	8.2	29.7
PSM002076	3.608	33.2	4.9	34.5
PSM002077	1.730	12.7	4.1	13.6
PSM002078	0.707	16.0	1.3	16.1
PSM002079	1.312	15.0	3.2	15.8
PSM002080	2.815	17.9	7.9	18.5
PSM002081	1.491	21.5	3.5	22.1
PSM002082	1.416	18.9	6.0	19.5
PSM002083	1.433	20.5	3.1	20.5
PSM002084	2.098	21.2	5.5	21.9
PSM002085	0.802	19.6	12.4	20.1
PSM002086	1.112	25.5	2.3	26.1
PSM002087	1.647	16.1	4.2	17.2
PSM107735	0.708	30.4	1.2	30.7

Table 6-11. Average concentration of carbon fractions and transparency in the investigated lakes, October 2002 to January 2003. Note that sampling didn't start at PSM005964 until August 2003.

Site number	POC (mg/l)	DOC (mg/l)	DIC (mg/l)	TOC (mg/l)	Transparency (m)
PSM002065	0.463	16.1	2.0	16.4	2.1
PSM002066	0.150	9.2	1.8	9.2	4.5
PSM002067	0.478	17.7	2.3	18.2	1.3
PSM005964					

Table 6-12. Average concentration of carbon fractions and transparency in the investigated lakes, October 2003 to January 2004. Note that PSM005964 only has been sampled twice, in August and in September.

Site number	POC (mg/l)	DOC (mg/l)	DIC (mg/l)	TOC (mg/l)	Transparency (m)
PSM002065	0.398	17.3	2.4	17.3	1.6
PSM002066	0.306	9.2	2.0	9.2	4.1
PSM002067	0.850	18.2	2.8	18.6	1.1
PSM005964	0.643	12.2	5.4	12.2	2.1

Table 6-13. Average concentrations of carbon fractions and transparency at the investigated sea sites, October 2002 to January 2003.

Site number	POC (mg/l)	DOC (mg/l)	DIC (mg/l)	TOC (mg/l)	Transparency (m)
PSM002060	0.059	3.9	15.1	3.9	12.8
PSM002061	0.068	4.0	15.5	4.0	8.0
PSM002062	0.438	13.1	6.7	13.8	1.8
PSM002063	0.106	4.6	15.2	4.6	5.1
PSM002064	0.372	11.6	8.9	11.3	2.6

Table 6-14. Average concentrations of carbon fractions and transparency at the investigated sea sites, October 2003 to January 2004.

Site number	POC (mg/l)	DOC (mg/l)	DIC (mg/l)	TOC (mg/l)	Transparency (m)
PSM002060	0.112	3.8	11.5	3.8	16.2
PSM002061	0.100	4.0	15.5	4.0	8.5
PSM002062	0.542	7.3	13.3	7.4	2.7
PSM002063	0.370	4.1	12.4	4.2	5.6
PSM002064	0.354	6.6	12.5	6.8	4.4

6.2.3 Acidification

The high run-off in the autumn 2002 resulted in low concentrations of HCO_3 and low values of pH in many of the smaller streams (Table 6-15). These results indicate acidification to be a problem in the smaller streams of the area. In the autumn 2003, with considerably lower run-off the situation seemed better with higher pH in most streams (Table 6-16).

Similar to the results from the autumn 2002 the lakes had relatively high concentrations of HCO_3 and relatively high pH values during the autumn 2003 (Table 6-17 and 6-18).

Table 6-15. Minimum concentration of HCO_3, and minimum pH from the stream water sites, October 2002 to January 2003.

Site number	HCO_3 (mg/l)	pH	Site number	HCO_3 (mg/l)	pH
PSM002068	5	5.97	PSM002080	5	5.83
PSM002069	12	6.36	PSM002081	10	6.29
PSM002070	15	6.14	PSM002082	5	6.08
PSM002071	8	6.04	PSM002083	3	5.85
PSM002072	0	5.07	PSM002084	6	5.97
PSM002075	7	6.24	PSM002085	20	6.59
PSM002076	10	5.88	PSM002086	1	5.59
PSM002077	4	5.95	PSM002087	2	5.95
PSM002078	1	5.46	PSM107735		
PSM002079	3	5.85			

Table 6-16. Minimum concentration of HCO_3, and minimum pH from the stream water sites, October 2003 to January 2004.

Site number	HCO_3 (mg/l)	pH	Site number	HCO_3 (mg/l)	pH
PSM002068	12	6.03	PSM002080	31	6.31
PSM002069	15	6.56	PSM002081	16	6.06
PSM002070	28	6.58	PSM002082	10	6.15
PSM002071	13	6.47	PSM002083	10	6.08
PSM002072	6	6.16	PSM002084	21	6.49
PSM002075	28	6.38	PSM002085	59	7.30
PSM002076	16	6.04	PSM002086	8	6.00
PSM002077	22	6.51	PSM002087	9	6.28
PSM002078	2	5.41	PSM107735	3	5.47
PSM002079	9	6.01			

Table 6-17. Minimum concentration of HCO_3, and minimum pH in the surface water of the lakes, October 2002 to January 2003.

Site number	HCO_3 (mg/l)	pH
PSM002065	11	6.43
PSM002066	11	6.79
PSM002067	12	6.49
PSM005964		

Table 6-18. Minimum concentration of HCO_3, and minimum pH in the surface water of the lakes, October 2003 to January 2004.

Site number	HCO_3 (mg/l)	pH
PSM002065	13	6.58
PSM002066	12	7.07
PSM002067	15	6.64
PSM005964	34	7.08

6.2.4 Oxygen

The lakes and the more secluded sites at sea were covered with ice in January 2004. In the lakes the oxygen levels were lower at the bottom water but none of the lakes had oxygen deficiency in the bottom water (Figure 6-3).

There was no stratification at the open sea site Kråkelund (PSM002060) and the oxygen levels were similar at the surface and at the bottom. The bottom water had high oxygen levels also at the more secluded sites (Figure 6-4).

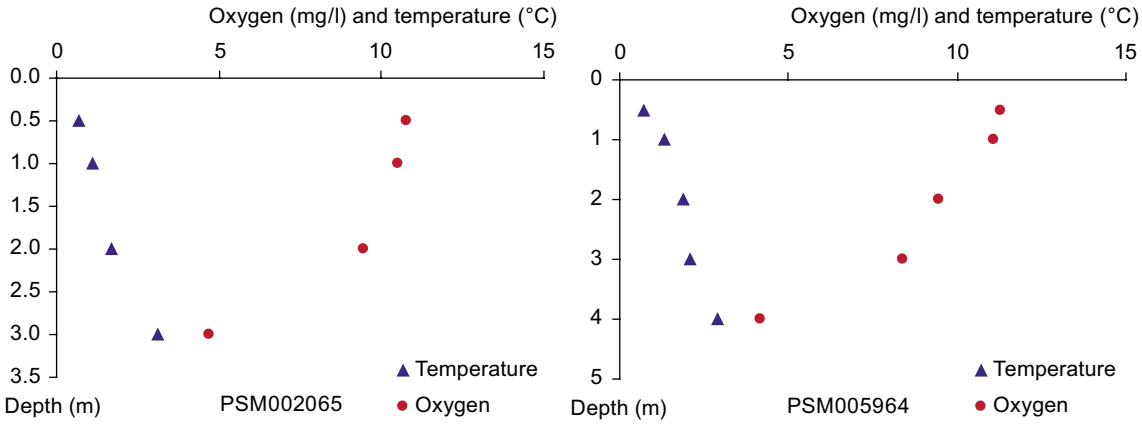

Figure 6-3. *Profiles of temperature and oxygen measured by the sonde in January 2004 in Lake Frisksjön (PSM002065) and Lake Söråmagasinet (PSM0055964).*

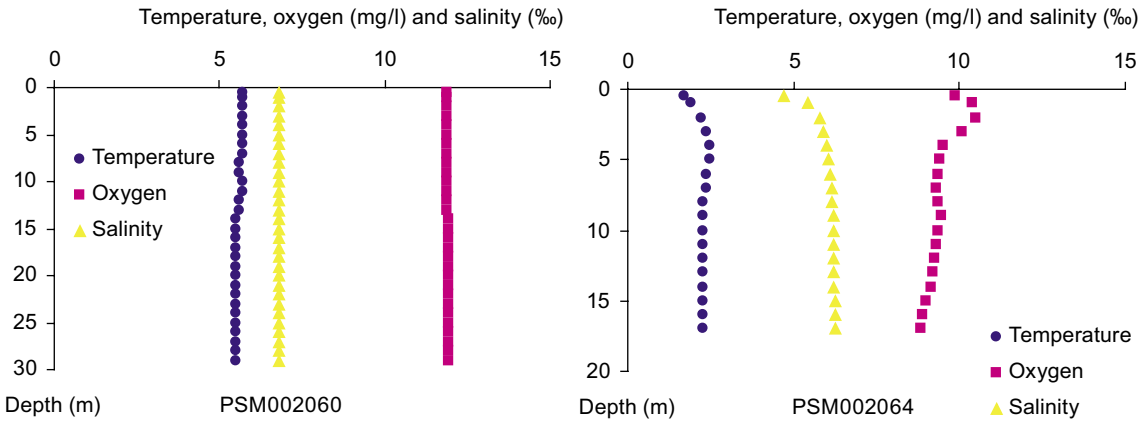

Figure 6-4. *Profiles of temperature, oxygen and salinity measured by the sonde in December 2003 and January 2004 at the sea sites Kråkelund (PSM002060) and Granholmsfjärden (PSM002064).*

6.3 Chemical characterisation

6.3.1 Major ions and conductivity

The concentration of major ions and the conductivity was generally higher in the streams this autumn than in the autumn and early winter of 2002 (Table 6-19 and 6-20). The reason for this is most probable the considerably lower run-off this year.

In the lakes the difference in ion concentrations between the two years were small and no general difference could be seen (Table 6-21 and 6-22).

At the sea sites the concentration of ions and the conductivity was generally higher this autumn than in the autumn and early winter of 2002 (Table 6-23 and 6-24). The highest difference was seen at the two more secluded sites (PSM002062 and PSM002064). This shows a smaller outflow of fresh water into the sea in the autumn 2003 than in the autumn and early winter of 2002.

Table 6-19. Average concentrations of major ions and conductivity at the investigated sites in the streams, October 2002 to January 2003. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Fe (mg/l)	Si (mg/l)	Sr (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Br (mg/l)	Conductivity (mS/m)
PSM002068	4.45	0.923	7.03	1.80	1.36	5.75	0.040	9	3.90	8.32	*0.20*	7.70
PSM002069	9.15	1.67	8.68	2.28	1.47	4.58	0.043	13	11.3	9.40	*0.20*	12.5
PSM002070	10.4	1.34	13.1	2.93	1.34	8.27	0.067	29	13.0	8.66	*0.20*	14.7
PSM002071	10.3	1.50	8.70	2.37	1.30	5.73	0.043	11	13.7	11.88	*0.20*	14.4
PSM002072	8.40	0.255	4.50	1.10	1.35	5.80	0.025	3	9.90	3.36	*0.20*	8.20
PSM002075	9.00	1.43	10.7	2.60	0.818	8.58	0.055	17	10.1	12.59	*0.18*	12.9
PSM002076	6.17	1.12	12.3	2.10	1.31	11.33	0.053	12	5.70	18.19	*0.15*	12.1
PSM002077	8.10	1.43	8.13	2.08	1.14	7.45	0.040	8	10.2	13.92	*0.20*	11.2
PSM002078	4.20	0.560	6.30	1.53	0.769	10.48	0.030	2	4.00	12.64	*0.19*	7.30
PSM002079	7.68	1.36	8.15	2.05	1.11	7.85	0.040	7	9.60	14.32	*0.20*	11.5
PSM002080	6.90	1.25	7.67	1.43	1.17	8.07	0.033	10	7.40	8.28	*0.20*	9.10
PSM002081	4.43	0.99	10.6	1.60	0.970	8.60	0.035	19	4.20	8.68	*0.20*	9.10
PSM002082	5.58	1.16	8.95	1.58	0.947	8.30	0.035	13	5.60	8.48	*0.20*	9.00
PSM002083	6.56	1.26	8.76	1.80	1.21	8.86	0.040	10	7.00	12.30	*0.19*	10.0
PSM002084	8.76	2.57	16.5	3.44	0.900	10.10	0.068	17	8.40	32.04	*0.16*	16.4
PSM002085	6.74	1.26	29.9	3.52	0.41	10.88	0.086	46	6.40	35.35	*0.17*	20.3
PSM002086	11.9	3.08	18.2	4.06	0.682	13.08	0.076	5	11.0	47.37	0.64	19.0
PSM002087	7.34	1.41	8.64	2.16	0.957	8.50	0.042	7	8.80	15.94	*0.17*	11.0
PSM107735												

Table 6-20. Average concentrations of major ions and conductivity at the investigated sites in the streams, October 2003 to January 2004. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Fe (mg/l)	Si (mg/l)	Sr (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Br (mg/l)	Conductivity (mS/m)
PSM002068	5.54	1.30	9.54	2.38	2.00	5.76	0.180	21	7.10	7.92	*0.20*	11.4
PSM002069	9.06	1.26	8.84	2.30	1.55	4.10	0.050	16	13.0	8.57	*0.20*	12.1
PSM002070	13.6	0.850	13.7	3.25	1.32	5.85	0.415	35	23.9	6.06	*0.20*	18.4
PSM002071	13.6	1.92	10.9	2.96	1.11	5.70	0.062	19	22.9	14.90	*0.20*	17.2
PSM002072	10.4	0.730	5.30	1.50	0.476	5.20	0.030	6	15.7	8.32	*0.20*	11.3
PSM002075	11.9	1.69	16.2	4.00	4.24	9.60	0.085	43	18.6	9.03	*0.35*	18.7
PSM002076	9.63	1.31	15.9	3.05	3.84	12.50	0.078	25	10.3	23.21	*0.36*	16.6
PSM002077	15.0	2.03	12.0	3.35	1.01	6.75	0.065	23	26.0	16.59	*0.20*	19.2
PSM002078	4.60	0.583	8.40	2.07	0.658	11.83	0.040	3	4.30	22.99	*0.23*	9.70
PSM002079	12.5	1.95	11.3	3.00	1.07	7.64	0.064	18	19.9	18.14	*0.20*	16.8
PSM002080	9.70	3.49	14.4	2.95	0.918	7.60	0.060	40	12.1	14.30	*0.20*	16.8
PSM002081	5.25	1.41	13.3	2.23	0.935	9.40	0.048	19	5.80	20.63	*0.20*	12.6
PSM002082	9.58	2.84	14.1	2.74	1.22	8.80	0.060	32	12.5	15.38	*0.20*	16.2
PSM002083	14.2	1.49	12.1	2.82	1.23	8.54	0.066	20	19.6	17.89	*0.24*	17.1
PSM002084	11.3	3.93	18.1	3.94	1.87	9.22	0.072	33	11.8	29.93	*0.21*	19.5
PSM002085	8.84	1.93	30.1	3.86	1.11	10.18	0.090	75	6.90	27.62	*0.22*	22.8

Site number	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Fe (mg/l)	Si (mg/l)	Sr (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Br (mg/l)	Conductivity (mS/m)
PSM002086	11.4	2.95	16.2	3.70	1.69	13.05	0.070	10	12.3	40.19	0.72	19.2
PSM002087	13.0	2.26	13.2	3.40	1.14	8.26	0.070	23	20.0	20.00	*0.19*	18.0
PSM107735	5.75	1.84	16.0	4.85	1.69	9.75	0.075	4	6.00	50.16	*0.29*	16.9

Table 6-21. Average concentrations of major ions and conductivity at the investigated sites in the lakes, October 2002 to January 2003. Results from surface water. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Fe (mg/l)	Si (mg/l)	Sr (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Br (mg/l)	Conductivity (mS/m)
PSM002065	8.53	1.77	7.90	2.48	0.729	4.45	0.040	13	11.4	14.30	*0.11*	13.0
PSM002066	11.0	1.73	10.1	2.93	0.053	2.20	0.060	11	14.4	22.30	*0.20*	15.3
PSM002067	8.80	1.49	8.62	2.28	1.50	4.48	0.044	13	11.6	9.48	*0.20*	12.1
PSM005964												

Table 6-22. Average concentrations of major ions and conductivity at the investigated sites in the lakes, October 2003 to January 2004. Results from surface water. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Fe (mg/l)	Si (mg/l)	Sr (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Br (mg/l)	Conductivity (mS/m)
PSM002065	9.72	1.80	6.92	2.20	1.24	3.92	0.040	14	9.4	10.53	*0.20*	10.8
PSM002066	10.9	1.44	9.55	2.80	0.052	1.60	0.060	12	13.9	20.68	*0.20*	15.2
PSM002067	9.00	1.30	8.76	2.28	1.61	4.20	0.050	16	12.9	8.54	*0.20*	11.8
PSM005964	14.4	2.64	10.9	3.58	0.917	0.92	0.054	34	18.3	14.79	*0.18*	17.6

Table 6-23. Average concentrations of major ions and conductivity at the investigated sites in the sea, October 2002 to January 2003. Results from surface water. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Fe (mg/l)	Si (mg/l)	Sr (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Br (mg/l)	Conductivity (mS/m)
PSM002060	1935	72.0	89.6	225	*0.02*	0.38	1.34	85	3025	507.8	12.20	1045
PSM002061	1946	71.5	89.5	224	*0.02*	0.46	1.33	87	3271	472.5	11.42	1053
PSM002062	776	30.0	41.8	93.3	0.367	5.00	0.580	41	1620	229.1	4.75	450
PSM002063	1880	67.8	86.7	217	*0.02*	0.75	1.29	83	3211	454.6	10.40	1011
PSM002064	896	34.1	47.1	109	*0.379*	4.40	0.658	48	1627	229.8	5.15	554

Table 6-24. Average concentrations of major ions and conductivity at the investigated sites in the sea, October 2003 to January 2004. Results from surface water. Figures in italic indicate that some individual values in the calculation were below the detection limit of the analysis.

Site number	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Fe (mg/l)	Si (mg/l)	Sr (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Br (mg/l)	Conductivity (mS/m)
PSM002060	1993	74.6	96.8	239	*0.02*	0.30	1.49	94	3757	534.2	14.85	1159
PSM002061	2028	75.3	98.0	240	*0.02*	0.38	1.49	94	3744	537.5	15.12	1160
PSM002062	1602	60.2	80.7	192	0.099	1.13	1.21	78	2829	402.5	11.09	892
PSM002063	1955	72.7	93.7	235	*0.02*	0.35	1.43	92	3665	537.8	13.37	1137
PSM002064	1670	62.7	82.9	201	*0.093*	1.30	1.25	85	3253	467.4	12.85	1017

6.3.2 Isotopes

Data on isotopes from the period October 2003 to January 2004 hadn't been delivered from the analysing laboratories when this report was written.

6.4 Effect on the results of methodological changes

No major change of methods that could effect on the results occurred between October 2003 and January 2004.

6.5 Accuracy of data

Data has continuously been assessed after analysis and before storage into SICADA. Generally very few analysing errors or contaminations have been detected and it is our opinion that the data is of high quality. The problems with storing and analysing dissolved inorganic carbon (DIC) which was discussed above caused lower quality of this dataset and some of these values have to be treated as false.

Two more sets of data are of lower quality. The first is the measurements of the run-off at the stream sites. These measurements have been performed with a float method (BIN HR 013) (see methods) which, for many reasons, has been the only possible way to perform measurements of the run-off. The accuracy of this method is quite low compared to measurements with discharge weirs and gauges. The difficulties with measurement of run-off when the stream sites are covered with ice during winter also causes loss of data which are important to have when calculating transports. The second data set with lower quality is the measurements of chlorophyll performed in the lakes by the sonde. The problem seems to be that both humic substances and chlorophyll have similar fluorescence in the wavelength used by the sonde. Since the inland waters contains high concentrations of humic substances the sonde to large proportion measure humus as chlorophyll.

Another problem with the sonde data is that the sensor measuring photosynthetically active radiation (PAR) is unable to give a zero value, when it is completely dark. The lowest PAR value that the sensor can show seems to be 4.3 µmoles/second/m^2. The manufacturer says that this error is due to an electronic mismatch between the sonde port and the light sensor and suggests that the offset could be subtracted.

7 References

Ericsson U, Engdahl A, 2004. Oskarshamn site investigation. Surface water sampling in Simpevarp 2002–2003. SKB P-04-13. Svensk Kärnbränslehantering AB.

Appendix 1

Sites, co-ordinates and sampling depth

Sites, depth and co-ordinates Oct 2003–Jan 2004

ID-code	Name	Type of water	Co-ordinate X	Co-ordinate Y	Sampling depth (m)
PSM002060	Kråkelund	Sea	636924	155580	0.5–29
PSM002061	Ekö	Sea	636405	155081	0.5–8
PSM002062	Borholmsfjärden	Sea	636706	155126	0.5–3
PSM002063	Fågelöfjärden	Sea	636097	154615	0.5–5
PSM002064	Granholmsfjärden	Sea	636862	155052	0.5–17
PSM002065	Frisksjön	Lake	636810	154901	0.5–3
PSM002066	Götemar	Lake	637382	154646	0.5–16
PSM002067	Jämsen	Lake	636490	154019	0.5–11
PSM005964	Söråmagasinet	Lake	636634	155143	0.5–4
PSM002068	Köksmåla	Stream	636416	154002	0.1
PSM002069	Jämserum	Stream	636531	154066	0.1
PSM002070	Flohult	Stream	636362	154229	0.1
PSM002071	Plittorp	Stream	636845	154238	0.1
PSM002072	Lillekvarn	Stream	636829	154319	0.1
PSM002075	Figeholm	Stream	636117	154473	0.1
PSM002076	Övrahammar	Stream	636312	154673	0.1
PSM002077	Brolund	Stream	636599	154596	0.1
PSM002078	Sillebäcken	Stream	636575	154642	0.1
PSM002079	Kvarnstugan	Stream	636583	154674	0.1
PSM002080	Misterhult	Stream	637093	154472	0.1
PSM002081	Perstorpet	Stream	637046	154535	0.1
PSM002082	Misterhultsbäcken Ö	Stream	637079	154574	0.1
PSM002083	Smedtorpet	Stream	636912	154888	0.1
PSM002084	Kärrsvik	Stream	636884	154919	0.1
PSM002085	Ekerum	Stream	636656	154986	0.1
PSM002086	Basteböla	Stream	636373	154848	0.1
PSM002087	Ekhyddan	Stream	636570	155012	0.1
PSM107735	Grönaslätt	Stream	636747	155338	0.1

Appendix 2

Schedule – Surface water sampling, weekly working seasons October 2003–January 2004

Sampling occations and programme Oct 2003–Jan 2004

Year	2003	2003	2003	2003	2004
Month	Oct	Oct	Nov	Dec	Jan
Week nr	40	44	47	50	4
Ecological programme	X	X	X	X	X
Chemical programme (class 3)		X		X	

Appendix 3

Programmes performed at the different sites

Sites and programme Oct 2003–Jan 2004

ID-code	Name	Type of water	Ecological programme	Chemical programme
PSM002060	Kråkelund	Sea	X	X
PSM002061	Ekö	Sea	X	X
PSM002062	Borholmsfjärden	Sea	X	X
PSM002063	Fågelöfjärden	Sea	X	
PSM002064	Granholmsfjärden	Sea	X	X
PSM002065	Frisksjön	Lake	X	X
PSM002066	Götemar	Lake	X	
PSM002067	Jämsen	Lake	X	
PSM005964	Söråmagasinet	Lake	X	
PSM002068	Köksmåla	Stream	X	
PSM002069	Jämserum	Stream	X	
PSM002070	Flohult	Stream	X	
PSM002071	Plittorp	Stream	X	X
PSM002072	Lillekvarn	Stream	X	X
PSM002075	Figeholm	Stream	X	
PSM002076	Övrahammar	Stream	X	X
PSM002077	Brolund	Stream	X	
PSM002078	Sillebäcken	Stream	X	
PSM002079	Kvarnstugan	Stream	X	X
PSM002080	Misterhult	Stream	X	
PSM002081	Perstorpet	Stream	X	
PSM002082	Misterhultsbäcken Ö	Stream	X	X
PSM002083	Smedtorpet	Stream	X	X
PSM002084	Kärrsvik	Stream	X	X
PSM002085	Ekerum	Stream	X	X
PSM002086	Basteböla	Stream	X	X
PSM002087	Ekhyddan	Stream	X	X
PSM107735	Grönaslätt	Stream	X	X

Appendix 4

Sampling sites and weeks when not sampled

Sites and sampling occations Oct 2003–Jan 2004

ID-code	Name	Type of water	Programme	2003 Week 40	2003 Week 44	2003 Week 47	2003 Week 50	2004 Week 4
PSM002060	Kråkelund	Sea	Eco +Chem	X	X	X	X	W
PSM002061	Ekö	Sea	Eco + Chem	X	X	X	X	X
PSM002062	Borholmsfjärden	Sea	Eco + Chem	X	X	X	X	X
PSM002063	Fågelöfjärden	Sea	Eco	X	X	O	O	O
PSM002064	Granholmsfjärden	Sea	Eco + Chem	X	X	X	X	X
PSM002065	Frisksjön	Lake	Eco + Chem	X	X	X	X	X
PSM002066	Götemar	Lake	Eco	X	X	O	O	O
PSM002067	Jämsen	Lake	Eco	X	X	X	X	X
PSM005964	Söråmagasinet	Lake	Eco	X	X	X	X	X
PSM002068	Köksmåla	Stream	Eco	X	X	X	X	X
PSM002069	Jämserum	Stream	Eco	X	X	X	X	X
PSM002070	Flohult	Stream	Eco	X	X	O	O	O
PSM002071	Plittorp	Stream	Eco + Chem	X	X	X	X	X
PSM002072	Lillekvarn	Stream	Eco + Chem	D	X	O	O	O
PSM002075	Figeholm	Stream	Eco	X	X	O	O	O
PSM002076	Övrahammar	Stream	Eco + Chem	D	X	X	X	X
PSM002077	Brolund	Stream	Eco	X	X	O	O	O
PSM002078	Sillebäcken	Stream	Eko	D	D	X	X	X
PSM002079	Kvarnstugan	Stream	Eco + Chem	X	X	X	X	X
PSM002080	Misterhult	Stream	Eco	X	X	O	O	O
PSM002081	Perstorpet	Stream	Eco	D	X	X	X	X
PSM002082	Misterhultsb. Ö	Stream	Eco + Chem	X	X	X	X	X
PSM002083	Smedtorpet	Stream	Eco + Chem	X	X	X	X	X
PSM002084	Kärrsvik	Stream	Eco + Chem	X	X	X	X	X
PSM002085	Ekerum	Stream	Eco + Chem	X	X	X	X	X
PSM002086	Basteböla	Stream	Eco + Chem	D	D	D	X	X
PSM002087	Ekhyddan	Stream	Eco + Chem	X	X	X	X	X
PSM107735	Grönaslätt	Stream	Eco + Chem	O	O	O	X	X

Sampled sites in each week is marked with an X.
Reason for not sampling: W = strong wind, D = stream was dried up, O = out of programme.