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Research

Data report – sampling of sea water and marine organisms outside Ringhals NPP

2022:18

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Report number: 2022:18
ISSN: 2000-0456
Available at: www.ssm.se

SSM perspective

Background

The Radiation Safety Authority (SSM) funded the collection of marine biota over an annual cycle at the Ringhals nuclear power plant (NPP) to enable development of analytical methods for C-14. Methods for the C-14 analysis and results in the form of levels of C-14 in various marine organisms have been reported by the Swedish Defense Research Institute (FOI) in FOI report FOI-R--4861--SE - *Determination of 14C in marine biota during an annual cycle*. During the collection of the biota samples other parameters like for example; temperature, visibility depth, salinity, conductivity as well as data of the biota samples themselves were collected. These data reported here separately.

Objective

The project as a whole aimed to collect marine biota over an annual cycle along with marine chemical and physical parameters. The current report aims to report the data that is not covered in FOI's report (FOI-R--4861--SE) in order to make the data referable and possible to use in for example model calculations.

Summary by the author

Medins Havs och Vattenkonsulter AB was assigned by the Swedish Radiation Safety Authority (SSM) to perform sampling in marine environments in the coast area close to Ringhals NPP. This document reports the data gained when sampling water and biota from August 2018 to July 2019. The work was conducted according to an agreement between Medins and Swedish Radiation Safety Authority, dated 21 March 2018.

Project information

Contact person SSM: Karin Aquilonius
Reference: SSM2018-1476
Activitynumber: 7030239-00

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Summary

This is a data report done in order to make data referable. The sampling of data was done in connection to collection of seaweed, mussels and fish to be used in the development of methodology for analyses of C-14. The data covers sampling of seaweed, mussels, fish, physical and chemical parameters in the Swedish marine environment at a site close to Ringhals nuclear power plant on the Swedish west coast. The sampling was performed by Medins Havs och Vattenkonsulter AB assigned by the Swedish Radiation Safety Authority once a month from August 2018 to July 2019. Sampling was performed in two different areas, one reference area and one target area. Data for physical parameters were measured directly in respective areas using a multi-parameter probe. In this report all the data generated from sampling during 2018-2019 are presented in appendices.

Sammanfattning

Detta är en datarapport framtagen för att göra data refererbara. Insamlingen av data genomfördes i samband med insamling av tång, musslor och fisk för att användas vid utveckling av metodik för analyser av C-14. Uppgifterna omfattar provtagning av tång, musslor, fisk, fysikaliska och kemiska parametrar i den svenska marina miljön i närheten av Ringhals kärnkraftverk på den svenska västkusten. Provtagningen utfördes av Medins Havs och Vattenkonsulter AB på uppdrag av Strålsäkerhetsmyndigheten en gång i månaden från augusti 2018 till juli 2019. Provtagningen gjordes i två olika områden, ett referensområde och ett målområde. Data för fysiska parametrar mättes direkt i respektive områden med användning av en multiparametersond. I denna rapport presenteras all data som genererats från provtagningen under 2018-2019 i bilagor.

Content

1. Introduction

Medins Havs och Vattenkonsulter AB has been assigned by the Swedish Radiation Safety Authority to perform sampling in marine environments in the coast area close to Ringhals nuclear power plant. This document reports the data gained when sampling water and biota from August 2018 to July 2019. The work was conducted according to an agreement between Medins and Swedish Radiation Safety Authority, dated 21 March 2018.

Figure 1. View from the Båtafjorden situated south of Ringhals nuclear power plant.

2. Objective and scope

The purpose of the sampling was to collect sea water and different kinds of marine organisms in order to provide the client with material for further analysis. Overall, the project aims to produce environmental data regarding ^{14}C by collecting marine samples during an annual cycle and match the content of ^{14}C to emissions from Ringhals nuclear power plant. The results are thought to provide information of variance of ^{14}C in time and space as well as transmission and enrichment in marine ecosystems. The analysis of ^{14}C was performed by the Swedish Defence Research Agency (FOI).

Sampling was performed in two different areas, one reference area (R) and one target area (M) (Figure 2). Except for water, some marine organisms were sampled: seaweed, mussels and fish. Some physical parameters were measured directly in respective areas using a multi-parameter probe. Water samples were also taken for further analyses at the laboratory.

In this report all the data generated from sampling during 2018-2019 are presented.

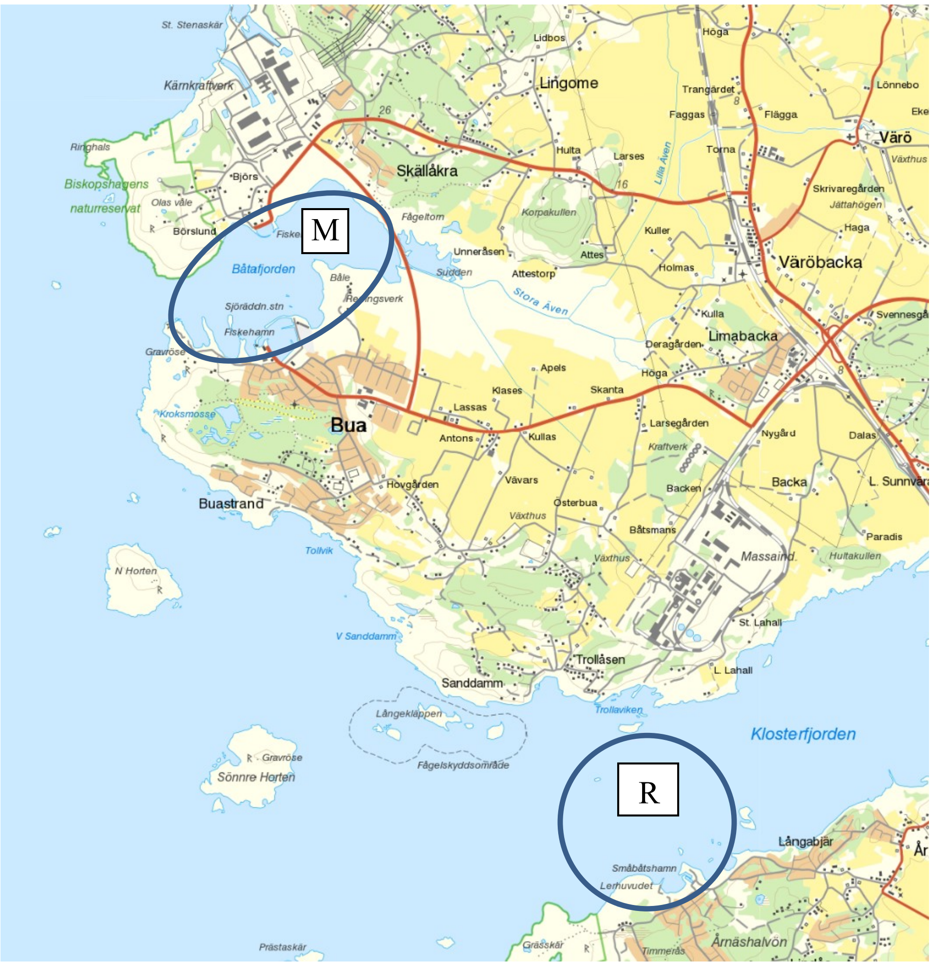


Figure 2. Overall view of the sampling areas where target area (M) and reference area (R) are circled. Ringhals nuclear power plant can be viewed in the northwest part of the figure.

3. Methods

3.1. Sites and sampling frequency

Sampling was performed monthly, in two different areas, one reference area (R) and one target area (M) (Figure 2). Initially the target area (M) was divided into two areas, where M1 constituted of the inner part of the Båtafjorden and M2 of the outer part (Figure 3). In Table 1 sampling occasions, sampling areas and sampled materials during 2018-2019 are presented. Only water and seaweed were sampled in the reference area (R). In the target area (M) water and seaweed were sampled, but also mussels and fish. The partition of target area (M) into M1 and M2 was interrupted as from November 2018 and constituted from November only of one larger target area (M) (Figure 2).

Figure 3. The target area (M) initially was divided into two areas M1 and M2.

Table 1. List showing sampling occasions, sampling areas and materials sampled during 2018-2019. M1=Target area 1, M2=Target area 2, R=Reference area.

Year	**Month**	**Water (liters)**		**Seaweed**			**Mussels**		**Fish**	
		M	**R**	**M1**	**M2**	**R**	**M1**	**M2**	**M1**	**M2**
2018	August	100	100	x	x	x	x	x	x	x
2018	September	100	100	x	x	x	x	x	x	x
2018	October	100	100	x	x	x	x	x	x	x
2018	November	100	100	x		x	x			x
2018	December			x		x	x			x
2019	January			x		x	x			x
2019	February			x		x	x			x
2019	March			x		x	x			x
2019	April			x		x	x			x
2019	May			x		x	x			x
2019	June			x		x	x			x
2019	July	50	50	x		x	x			x

Water sampling was performed at one site in both target area (M1) and reference area (R) respectively from the start in august 2018 to November 2018. Further water sampling was performed at one occasion in July 2019 (Table 1).

At the same sites physical parameters were measured directly in the field using a multi-parameter sonde and other equipment. At these sites water samples were also taken for analysis of carbon fractions. Measurements and sampling were performed every month from August 2018 to July 2019. The two sites were located centrally within the two areas and the positions are listed in Table 2.

Table 2. Positions of the two sites where field measurements were performed and water was sampled for analysis of different carbon fractions during August 2018 to July 2019.

Area	Code	X-coordinate RT90 2,5 gon v	Y-coordinate
Target area	M	6352835	1276754
Reference area	R	6348014	1279935

3.2. Equipment

In Table 3 used equipment can be viewed. Probes were used to measure different parameters in the water column at both areas. Transparency was measured with a Secchi disc. Plastic jars and bottles were used for sampling of water and plastic bags for storing biota. When sampling fish multi gill nets were used.

Table 3. Used equipment when sampling water and biota and measuring physical parameters in the field.

Instrument	Parameter	Unit
AML Minos X	Depth	m
AML Minos X	Temperature	°C
AML Minos X	Conductivity	mS/m
AML Minos X	Fluorescence	V
WTW instrument	Oxygen	mg/l
WTW instrument	Turbidity	FNU

Other equipment	Use
Limnos water sampler	Carbon fractions
Secchi disc	Transparancy
Aqua scope	
GPS/plotter	Position/depth
Plastic jars 25 liters	Storing water
Plastic bottles	Analysis of carbon fractions
Plastic bags	Storing biota
Mussel frame	Precollected mussels
Water pump and tube	
Multi gill nets Nordic coast	
Boat	

3.3. Execution of sampling in the field

Sampling of water, fish and measurements in the field were always performed by boat. Sampling seaweed and mussels were mostly performed by snorkeling and wading. To avoid contamination all sampling was conducted with protective rubber gloves and great care was taken not to contaminate containers or equipment.

3.3.1. Water sampling and field measurements

Surface water was sampled from the depth of 0.5 meter by filling plastic containers. The containers each contained 25 liters and were filled using a tube and a battery pump. The containers were transported to the shore where additives of different chemicals were put into the water samples according to instructions from the Swedish Defence Research Agency (FOI) (Table 4). During the period of August-November 100 liters (four containers) were sampled every month from both areas respectively. In July the water volume was 50 liters instead of 100 liters.

Surface water sampling for analysis of carbon fractions was performed at the same time. Samples were taken with a Limnos water sampler in both areas at every sampling occasion.

At every sampling occasion field measurements were performed with a probe and other probes. Parameters such as water temperature, oxygen concentration, conductivity (salinity), turbidity and fluorescence were measured in profile from the surface down to 0.5 meters above the sediment surface. Transparency was also measured with a secchi disc. Measurements were performed in both areas.

Table 4. Instructions of treating sampled water (from FOI). The sample names were used every time but adjusted for actual sampling month.

Sample	Carbon additive	NH_3	$CaCl_2*2H_2O$	Area
V-18-"month"-1a	Yes	Yes	Yes	Reference
V-18-"month"-1b	Yes	Yes	Yes	Reference
V-18-"month"-2a	No	Yes	Yes	Reference
V-18-"month"-2b	No	Yes	Yes	Reference
V-18-"month"-3a	Yes	Yes	Yes	Target
V-18-"month"-3b	Yes	Yes	Yes	Target
V-18-"month"-4a	No	Yes	Yes	Target
V-18-"month"-4b	No	Yes[1]	Yes[1]	Target

[1]Not added when sampling in november 2018

3.3.2. Seaweed and mussels

Seaweed as well as mussels from the target area (M) were mainly collected at the north side of the Båtafjorden, outside “Videbergs harbour”. In the reference area (R) seaweed was sampled in the south part, close to the harbour “Lerhuvudet”.

The top 30-centimeter parts of the seaweed plants were sampled. At least 50 grams (wet weight) were sampled at each occasion. Every collected mussel was measured to estimate the age of the mussel. The soft parts of the mussels were then separated from the shell and placed in a plastic bag. At least 50 grams (wet weight) were sampled at each occasion. Mussels and seaweed were sampled in the depth interval of 0,5-1,5 meters.

In November mussels were "precollected" in order to make it possible to get samples during wintertime when ice conditions could obstruct sampling. Single individuals of Common mussels were placed in nets in a frame that was placed in the water within the sampling area and anchored wit grapnels and buoys. Mussels from the frame were sampled in December 2018 and January-February 2019. In March and April both mussels from the frame and the shore were sampled.

3.3.3. Fish

Before sampling start, exception of fishing regulations at the Swedish Agency for Marine and Water Management was applied for.

When collecting fish in the target area (M) multi-mesh gillnets were used. The net effort was depending of expected catch that varied between months and seasons. When the catch during daytime was poor, the gillnets were set for the night and lifted next morning. Sampling of fish was mainly located to the north west part of the target area (M), where the water depth amounted approximately five meters. During the wintertime sampling was performed in somewhat deeper water within the target area (M).

The gillnets were rinsed, and the catch was registered as number and length of individuals and weight for each specimen. The catch was then stored in a cooling box.

Figure 4. Sampling of fish in the Båtafjorden January 2019.

3.4. Storing of samples and transport to analysing laboratory

When sampling was completed the material was stored at Medins laboratory. The plastic containers with seawater were stored in room temperature. All sampled biota were deep frozen. The week after sampling, water and biota were sent to the Swedish Defence Research Agency (FOI) for analysis.

Water samples for analysis of carbon fractions were sent to Synlab in Linköping the same day as sampling was performed. The bottles were kept dark and cool.

3.5. Analysis at the laboratory

Four different carbon fractions were analysed every month from the target area and reference area respectively. The fractions consisted of total organic carbon (TOC), particular organic carbon (POC), dissolved organic carbon (DOC) and bicarbonate/alkalinity. The parameter bicarbonate/alkalinity is here thought to represent the amount of dissolved inorganic carbon (DIC).

Alkalinity was analysed by titration of hydrochloric acid during evaporation of carbon dioxide. The endpoint for the titration was set to pH 5,4. It is assumed that alkalinity solely is determined by the carbonate system i.e. the concentration of HCO_3. In sea water with normal occurring values of pH 100% of the carbonate exists as HCO_3. Molecules that can be protolyzed at higher values of pH than the endpoint increase the value of the alkalinity, for example ions of phosphate and organic acids. However, these concentrations are normally negligible compared to the concentration of HCO_3.

3.6. Documentation

All activities were continuously documented. Notes were taken of field conditions, marking of samples and so forth. Any deviations from the normal routines were also noted. Delivery notes were sent with the samples to the laboratories.

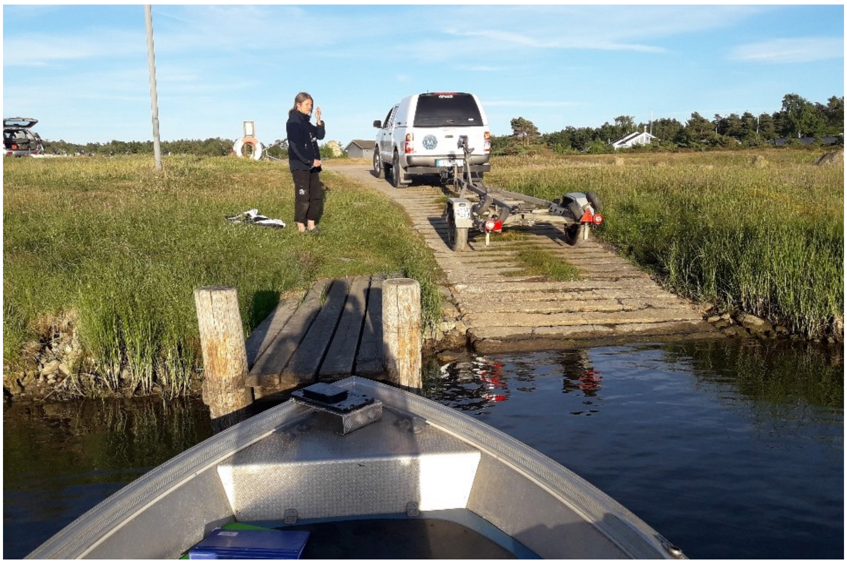


Figure 5. Place for launching the boat.

4. Nonconformities

Sampling was performed every month from August 2018 to July 2019. At some occasions malfunction of the multi parameter sonde or other probes occurred. In September 2018 the fluorescence meter was out of order. Of the same reason fluorescence data is lacking in May-July 2019. Oxygen data and turbidity are lacking in October 2018 due to electronic malfunction in the hand unit. Salinity (conductivity) was only measured in the surface water in September 2018.

5. Results

Below some of the results and data gained from sampling during August 2018 to July 2019 are presented in tables and graphs. All data can be viewed in Appendix 1-Appendix 5. The evaluation is defined to comprise only a compilation of sampling data.

5.1. Physical and chemical measurements in the field

5.1.1. Water transparency

Values for measured water transparency for the whole sampling period are presented in Table 5. Based on averages for the two areas, transparency was almost the same. Transparency in the reference area however showed a greater variation and very low values are noted for example in February and March (Figure 6). The reference area is a more open bay compared to the target area and thus more exposed for wind and waves. Water transparency depends for instance of the colour of the water, turbidity caused by inorganic and organic particles and plankton production.

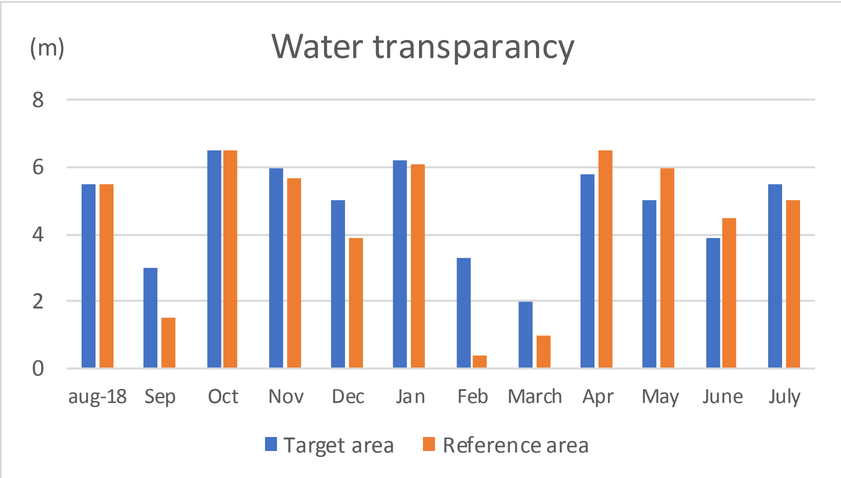


Figure 6. Water transparency without use of aqua scope, measured in the target area and reference area every month from August 2018-July 2019.

Table 5. Water transparency measured every month from August 2018-July 2019 with and without use of aqua scope. M=Target area, R=Reference area.

Area	Date	Secchi depth (m) with aqua scope	Secchi depth (m) without aqua scope
M	2018-08-15	6,0	5,5
M	2018-09-18	3,5	3,0
M	2018-10-16	6,5	6,5
M	2018-11-13	6,4	6,0
M	2018-12-12	5,5	5,0
M	2019-01-24	>6,2	>6,2
M	2019-02-20	3,6	3,3
M	2019-03-19	2,0	2,0
M	2019-04-16	>5,8	5,8
M	2019-05-09	5,4	5,0
M	2019-06-11	4,4	3,9
M	2019-07-08	6,2	5,5
M	Average	>5,1	>4,8
R	2018-08-16	6,1	5,5
R	2018-09-17	1,5	1,5
R	2018-10-15	6,5	6,5
R	2018-11-13	5,7	5,7
R	2018-12-12	4,5	3,9
R	2019-01-24	7,0	6,1
R	2019-02-20	0,45	0,40
R	2019-03-19	1,5	1,0
R	2019-04-16	7,2	6,5
R	2019-05-09	6,5	6,0
R	2019-06-11	5,0	4,5
R	2019-07-08	5,5	5,0
R	Average	4,8	4,4

5.1.2. Turbidity

Turbidity measurements generally showed low values, below 1 NTU in both areas (Appendix 4). Some months however, the turbidity was significantly higher, especially in the surface water at the reference area (Figure 7). As mentioned before the reference area is a more open bay compared to the target area and thus exposed for wind and waves.

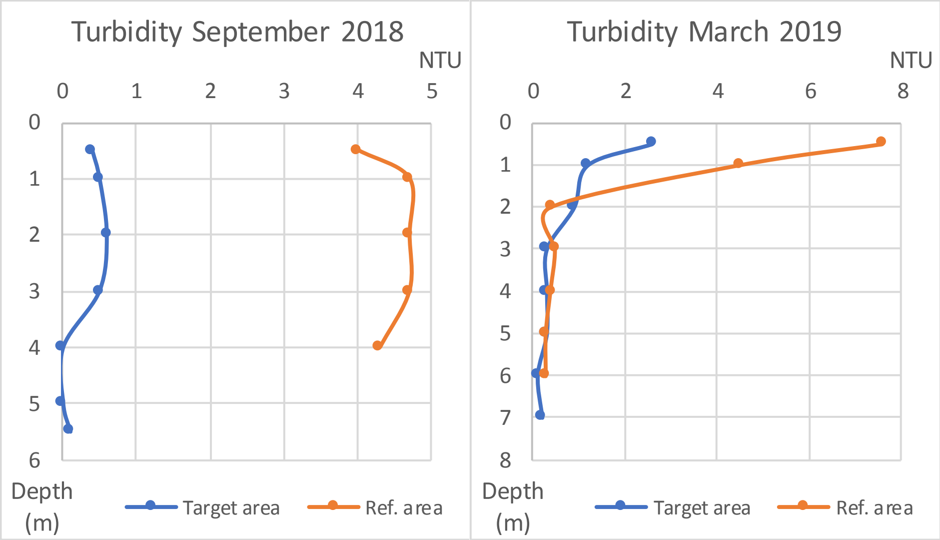


Figure 7. Turbidity measurements in profile at the target area and reference area in September 2018 and March 2019.

5.1.3. Salinity

Salinity varied generally to a low extent in both areas during the sampling period. Mostly the salinity values amounted between 16-22 PSU. Lower and higher values occurred, and the results showed as expected lower values in the surface water compared to the bottom water due to saltwater being heavier (Figure 8). Overall variation in salinity in both areas is dependent on water exchange with the open sea.

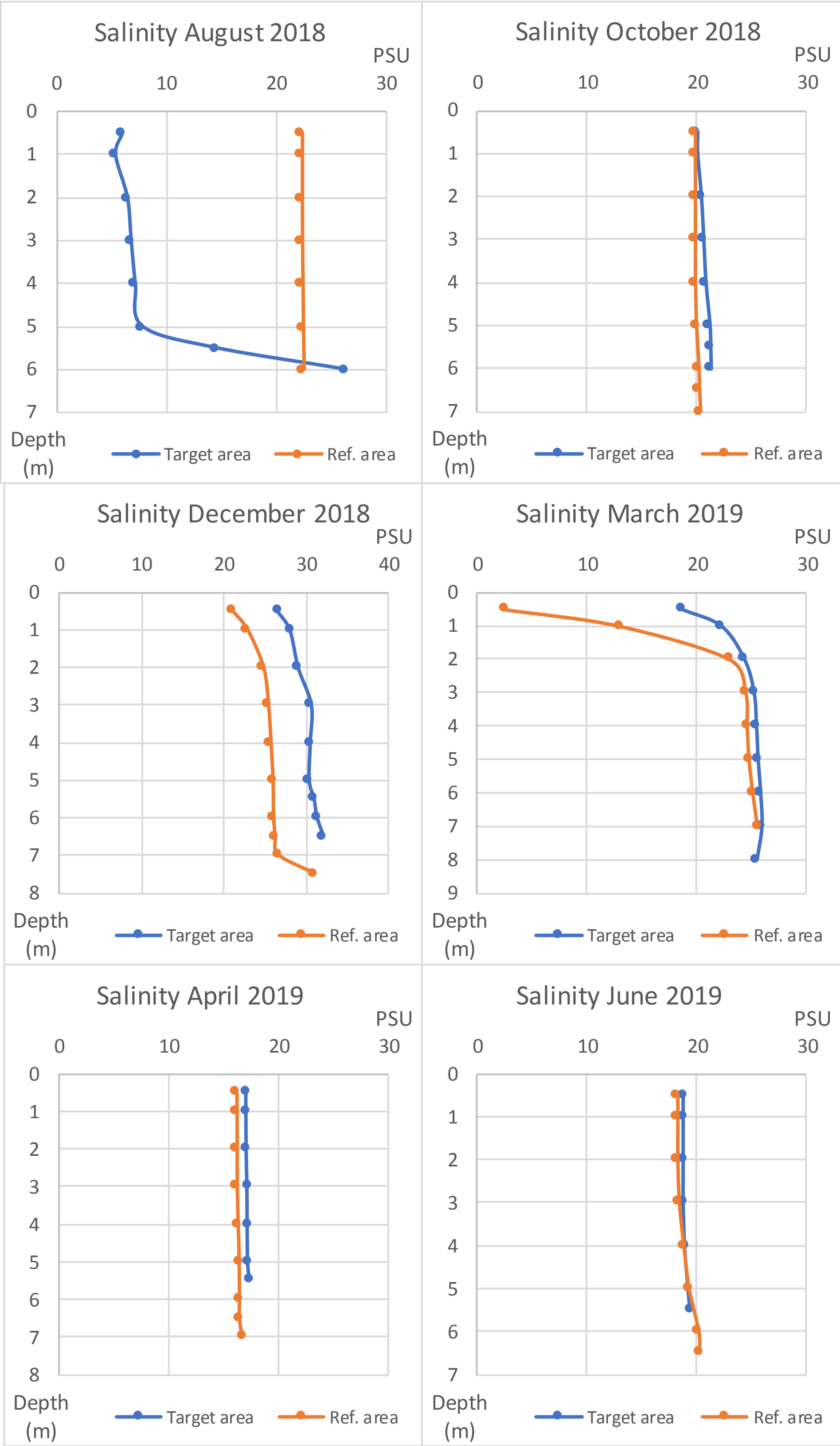


Figure 8. Salinity profiles in the target and reference areas for six different sampling occasions 2018-2019.

5.1.4. Fluorescence

Measurements of fluorescens were performed as profiles in the water column. Fluorescence can be used to detect the presence of phytoplankton since there is a connection between fluorescence and concentrations of chlorophyll. In Figure 9, some results are presented. The values were generally low with the highest values in February in both areas.

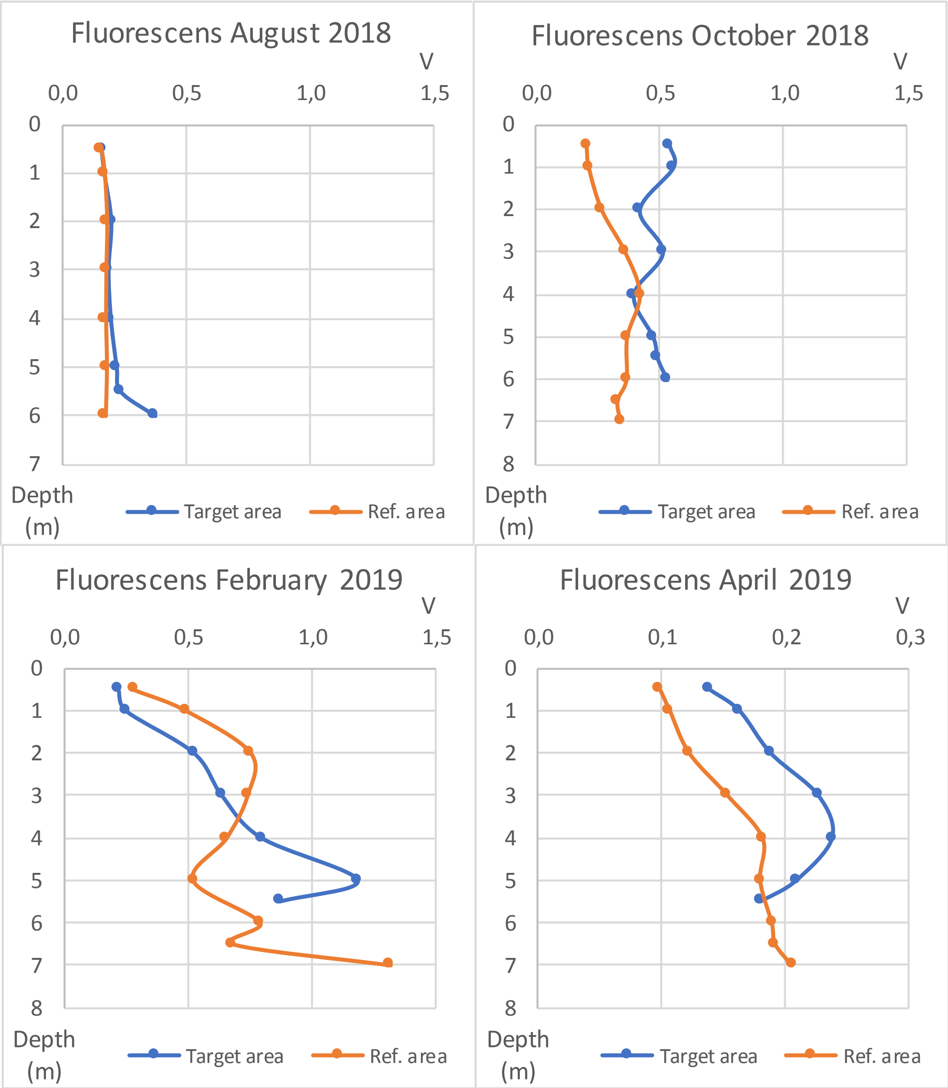


Figure 9. Fluorescence profiles in the target and reference areas in August and October 2018 and February and April 2019.

5.1.5. Temperature and oxygen

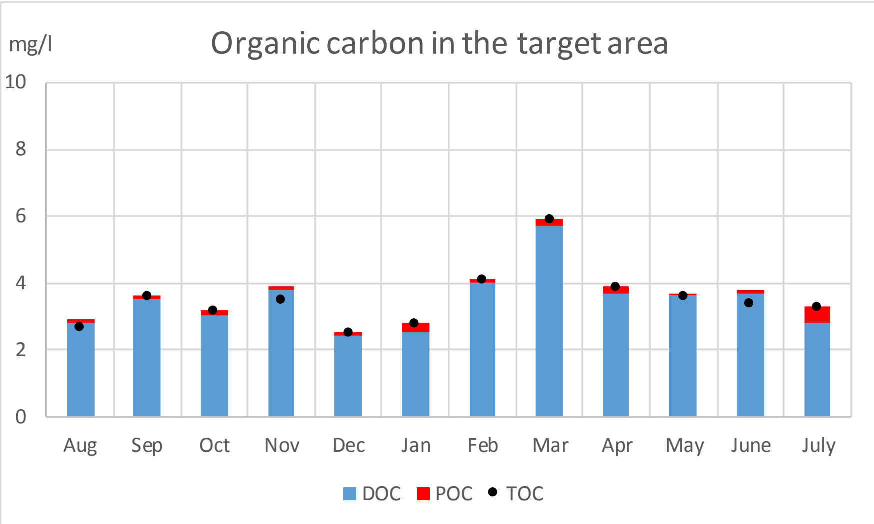
The water temperature varied with seasons and no pronounced thermoclines could be observed. The oxygen concentrations were high and satisfactory. The minimum concentration of oxygen during the whole period amounted 7,8 mg/litre and was measured in the bottom water in the target area in July 2019.

5.2. Analysis of carbon fractions

Four different carbon fractions were analysed every month from the target area and reference area respectively. The fractions consisted of total organic carbon (TOC), particular organic carbon (POC), dissolved organic carbon (DOC) and bicarbonate/alkalinity. The parameter bicarbonate/alkalinity is here thought to represent the amount of dissolved inorganic carbon (DIC) (See section 3.5). All results are presented in Table 6.

The amount of organic carbon varied a lot especially at the reference area. The highest levels of organic carbon were registered in March 2019, in both areas (Figure 10 and Figure 11). Considerably lower concentrations of organic carbon were measured in January 2019. Overall, DOC was the dominating fraction. The results indicate slightly higher concentrations of organic carbon in the reference area, but the differences were small.

The amount of inorganic carbon measured as HCO_3 was as expected to be much higher than concentrations of organic carbon (Table 6). Results from the target area shows relatively equal values during the investigation period (Figure 11). Considerably lower values were registered in February and March in the reference area.



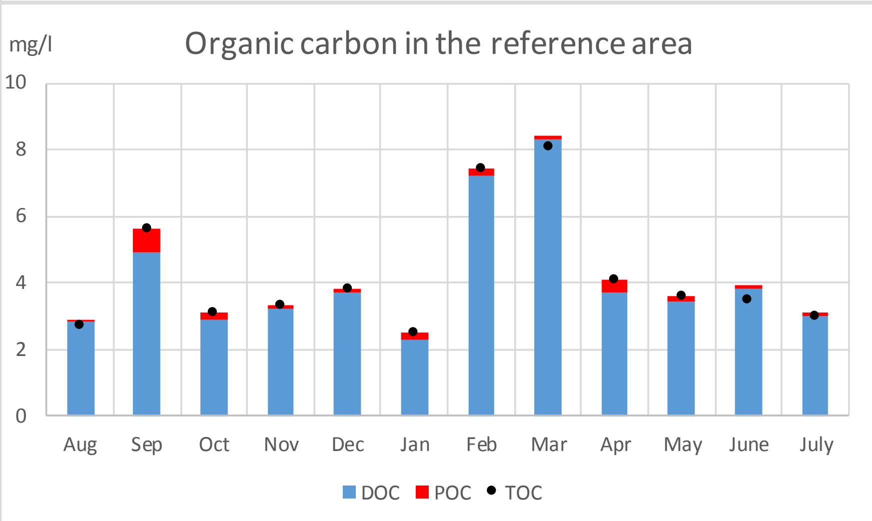


Figure 10. Analysed organic carbon fractions in target area and reference area.

Table 6. Results from the analysis of carbon fractions from monthly water samples at target area (M) and Reference area (R) from August 2018 to July 2019.

Area	**Code**	**Date**	**Temp.** °C	**TOC*** mg/l	**DOC** mg/l	**POC** mg/l	**HCO_3** mg/l
Target	M	2018-08-15	22,3	2,7	2,8	*0,096*	110
Target	M	2018-09-18	16,5	3,6	3,5	0,096	100
Target	M	2018-10-16	13,9	3,2	3,0	0,20	110
Target	M	2018-11-13	10,5	3,5	3,8	*0,096*	100
Target	M	2018-12-12	6,1	2,5	2,4	0,096	110
Target	M	2019-01-24	4,2	2,8	2,5	0,30	110
Target	M	2019-02-20	4,7	4,1	4,0	0,11	90
Target	M	2019-03-19	5,3	5,9	5,7	0,20	85
Target	M	2019-04-16	8,2	3,9	3,7	0,20	96
Target	M	2019-05-09	10,0	3,6	3,6	*0,096*	100
Target	M	2019-06-11	16,7	3,4	3,7	*0,096*	70
Target	M	2019-07-08	19,6	3,3	2,8	0,50	110
Average	**M**	**12 month**		**3,5**	**3,5**	**0,18**	**99**
Reference	R	2018-08-16	19,5	2,7	2,8	*0,096*	110
Reference	R	2018-09-17	14,0	5,6	4,9	0,71	83
Reference	R	2018-10-15	12,6	3,1	2,9	0,19	110
Reference	R	2018-11-13	9,2	3,3	3,2	0,096	110
Reference	R	2018-12-12	5,3	3,8	3,7	0,11	97
Reference	R	2019-01-24	2,8	2,5	2,3	0,19	110
Reference	R	2019-02-20	3,3	7,4	7,2	0,20	18
Reference	R	2019-03-19	4,5	8,1	8,3	*0,096*	23
Reference	R	2019-04-16	6,9	4,1	3,7	0,41	97
Reference	R	2019-05-09	9,3	3,6	3,4	0,20	100
Reference	R	2019-06-11	16,1	3,5	3,8	*0,096*	110
Reference	R	2019-07-08	17,1	3,0	3,0	*0,096*	110
Average	**R**	**12 month**		**4,2**	**4,1**	**0,21**	**90**

*For TOC values lower than DOC, the difference is within the measurement uncertainty.

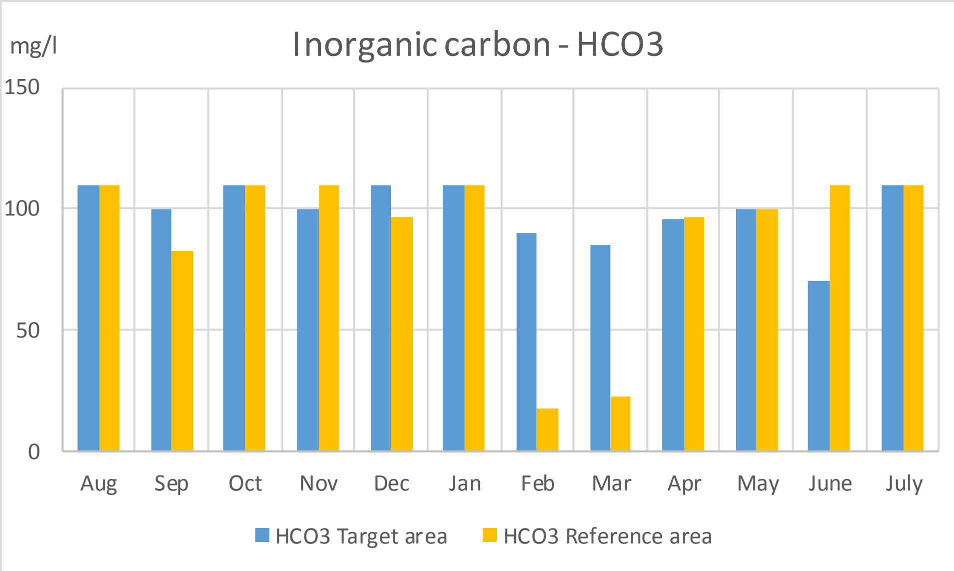


Figure 11. Inorganic carbon in the target area and the reference area

5.3. Water sampling

Sea water was sampled in containers and delivered to the Swedish Defence Research Agency (FOI). Sampling of water was performed August-November 2018 and in July 2019 according to earlier presentation (Section 3.3.1).

5.4. Biological sampling

Sampling of seaweed, mussels and fish was performed in the target area. In the reference area only seaweed was sampled. In Table 7 the different sampled organisms are listed and named in Latin, English and Swedish.

Table 7. Sampled marine organism and their names in Latin, English and Swedish.

Organism	**Species**		
	Latin	**English**	**Swedish**
Seaweed	*Fucus vesiculosus*	Bladder wrack	Blåstång
Mussel	*Mytilus edulis*	Common mussel	Blåmussla
Fish	*Symphodus melops*	Corkwing wrasse	Skärsnultra
Fish	*Ctenolabrus rupestris*	Goldsinny wrasse	Stensnultra
Fish	*Myoxocephalus scorpius*	Shorthorn sculpin	Rötsimpa
Fish	*Agonus cataphractus*	Armed Bullhead	Skäggsimpa
Fish	*Taurulus bubalis*	Longspined bullhead	Oxsimpa
Fish	*Platichthys flesus*	European flounder	Skrubbskädda
Fish	*Hyperoplus lanceolatus*	Great sandeel	Tobiskung
Fish	*Trachinus draco*	Greater weaver	Fjärsing
Fish	*Merlangius merlangus*	Whiting	Vitling

5.4.1. Seaweed

Bladder wrack (*Fucus vesiculosus*), was sampled at all occasions in both areas (Figure 12). Sampled biomass for each month and area are presented in Table 8.

Table 8.

Area	Year	Month	Day	Species	Total biomass (g)
M1	2018	08	15	Bladder wrack	75
M1	2018	09	18	Bladder wrack	75
M1	2018	10	16	Bladder wrack	85
M1	2018	11	13	Bladder wrack	95
M1	2018	12	12	Bladder wrack	70
M1	2019	01	24	Bladder wrack	140
M1	2019	02	20	Bladder wrack	135
M1	2019	03	19	Bladder wrack	93
M1	2019	04	16	Bladder wrack	100
M1	2019	05	09	Bladder wrack	96
M1	2019	06	11	Bladder wrack	102
M1	2019	07	08	Bladder wrack	134
M2	2018	08	15	Bladder wrack	88
M2	2018	09	18	Bladder wrack	57
M2	2018	10	15	Bladder wrack	90
R	2018	08	16	Bladder wrack	54
R	2018	09	17	Bladder wrack	63
R	2018	10	15	Bladder wrack	61
R	2018	11	13	Bladder wrack	99
R	2018	12	12	Bladder wrack	82
R	2019	01	24	Bladder wrack	85
R	2019	02	20	Bladder wrack	106
R	2019	03	19	Bladder wrack	87
R	2019	04	16	Bladder wrack	106
R	2019	05	09	Bladder wrack	105
R	2019	06	11	Bladder wrack	272
R	2019	07	08	Bladder wrack	215

Figure 12. Sampled seaweed.

5.4.2. Mussels

Common mussel (*Mytilus edulis*) was sampled every month in the target area. In Table 9 data from the sampling is presented, as number of individuals, average length and total net biomass (except the shells). The column “Habitat” refers to where the mussels where sampled and/or stored in the sea water during wintertime. As mentioned in section 3.3.2 mussels were “precollected” and single individuals were placed in nets in a frame in the water within the sampling area Mussels from the frame were sampled in December 2018 and January-February 2019. In March and April both mussels from the frame and the shore were sampled. All data for every single individual are presented in Appendix 2.

Figure 13. Common mussel from the target area.

Table 9.

Year	Month	Area	Number of individuals	Average length (mm)	Total net biomass (g)	Habitat
2018	08	M1	13	57	53	Shore
2018	08	M2	8	66	53	Shore
2018	09	M1	11	59	55	Shore
2018	09	M2	10	54	51	Shore
2018	10	M1	11	51	76	Shore
2018	10	M2	7	61	88	Shore
2018	11	M1	9	61	92	Shore
2018	12	M1	7	59	104	Frame
2019	01	M1	8	62	94	Frame
2019	02	M1	12	60	103	Frame
2019	03	M1	10	57	70	Frame
2019	03	M1	4	63	40	Shore
2019	04	M1	7	59	55	Frame
2019	04	M1	6	66	68	Shore
2019	05	M1	7	65	80	Shore
2019	06	M1	8	56	61	Shore
2019	07	M1	8	61	66	Shore
Total			146	60	1 209	

5.4.3. Fish

Sampling of fish was performed in the target area every month. Mainly two species were caught in such a number and biomass in order to provide material for further analysis. The species were Corkwing wrasse, (*Symphodus melops)* and Goldsinny wrasse *(Ctenolabrus rupestris)* (Table 10). Both species are common in shallow water at the shore during spring, summer and autumn. In the winter they often reside at greater depths. The diet consists of small animals such as mussels, shells, crustaceans and worms. It is known that corkwing wrasse forms smaller schools which stay in minor areas.

The species were sampled from August to December 2018 and from March to July 2019. In January and February 2019 other species were caught, for example Longspined bullhead (Figure 14 and Table 10).

Some other species were also caught in August and November 2018, but not delivered to FOI for analysis. This material was stored in a freezer until further notice (Table 11).

Table 10. Sampled fish species sent for analysis, number of individuals, average length and biomass of fish from the target area (M) and the reference area (R).

Year	Month	Area	Species	Number of individuals	Average length (mm)	Total biomass (g)
2018	08	M	Corkwing wrasse	7	105	137
2018	08	M	Goldsinny wrasse	4	81	25
2018	09	M	Corkwing wrasse	5	114	120
2018	09	M	Goldsinny wrasse	11	95	139
2018	10	M	Corkwing wrasse	4	128	116
2018	10	M	Goldsinny wrasse	17	90	185
2018	11	M	Corkwing wrasse	5	75	28
2018	11	M	Goldsinny wrasse	1	89	10
2018	12	M	Corkwing wrasse	1	82	7,7
2018	12	M	Goldsinny wrasse	7	83	55
2019	01	M	Shorthorn sculpin	4	188	369
2019	01	M	Armed Bullhead	1	147	22
2019	02	M	Longspined bullhead	1	119	37
2019	02	M	Shorthorn sculpin	7	168	566
2019	02	M	European flounder	1	154	141
2019	03	M	Corkwing wrasse	1	-	7,2
2019	04	M	Corkwing wrasse	1	89	6,7
2019	04	M	Goldsinny wrasse	3	85	23
2019	05	M	Corkwing wrasse	13	102	191
2019	05	M	Goldsinny wrasse	4	86	30
2019	05	M	Great sandeel	2	240	85
2019	06	M	Corkwing wrasse	14	90	140
2019	06	M	Goldsinny wrasse	15	86	115
2019	07	M	Corkwing wrasse	16	89	169
2019	07	M	Goldsinny wrasse	7	97	61
Total				152		2 785

Table 11. Other caught fish species stored in freezer.

Area	Year	Month	Day	Species	Length (mm)	Weight (g)
M2	2018	08	15	Greater weaver	230	
M2	2018	08	15	Greater weaver	253	
M2	2018	08	15	Greater weaver		199
M2	2018	11	14	Whiting	146	21
M2	2018	11	14	Great sandeel	227	33
M2	2018	11	14	Bullhead	172	75
M2	2018	11	14	Bullhead	155	63
M2	2018	11	14	Bullhead	165	88

Figure 14. Longspined bullhead (*Taurulus bubalis*)

Appendix 1 Seaweed

Sampling date, site and biomass of seaweed samples.

Area	Year	Month	Day	Species	Total biomass (g)
M1	2018	08	15	Bladder wrack	75
M1	2018	09	18	Bladder wrack	75
M1	2018	10	16	Bladder wrack	85
M1	2018	11	13	Bladder wrack	95
M1	2018	12	12	Bladder wrack	70
M1	2019	01	24	Bladder wrack	140
M1	2019	02	20	Bladder wrack	135
M1	2019	03	19	Bladder wrack	93
M1	2019	04	16	Bladder wrack	100
M1	2019	05	09	Bladder wrack	96
M1	2019	06	11	Bladder wrack	102
M1	2019	07	08	Bladder wrack	134
M2	2018	08	15	Bladder wrack	88
M2	2018	09	18	Bladder wrack	57
M2	2018	10	15	Bladder wrack	90
R	2018	08	16	Bladder wrack	54
R	2018	09	17	Bladder wrack	63
R	2018	10	15	Bladder wrack	61
R	2018	11	13	Bladder wrack	99
R	2018	12	12	Bladder wrack	82
R	2019	01	24	Bladder wrack	85
R	2019	02	20	Bladder wrack	106
R	2019	03	19	Bladder wrack	87
R	2019	04	16	Bladder wrack	106
R	2019	05	09	Bladder wrack	105
R	2019	06	11	Bladder wrack	272
R	2019	07	08	Bladder wrack	215

Appendix 2 Mussels

Sampling date, site, length and biomass of mussel samples.

Area	Year	Month	Day	Species	Length (mm)	Total net biomass (g)	Habitat
M1	2018	08	15	Common mussel	66		Shore
M1	2018	08	15	Common mussel	60		Shore
M1	2018	08	15	Common mussel	58		Shore
M1	2018	08	15	Common mussel	56		Shore
M1	2018	08	15	Common mussel	65		Shore
M1	2018	08	15	Common mussel	55		Shore
M1	2018	08	15	Common mussel	53		Shore
M1	2018	08	15	Common mussel	58		Shore
M1	2018	08	15	Common mussel	56		Shore
M1	2018	08	15	Common mussel	55		Shore
M1	2018	08	15	Common mussel	55		Shore
M1	2018	08	15	Common mussel	48		Shore
M1	2018	08	15	Common mussel	50	53	Shore
M2	2018	08	15	Common mussel	74		Shore
M2	2018	08	15	Common mussel	72		Shore
M2	2018	08	15	Common mussel	70		Shore
M2	2018	08	15	Common mussel	63		Shore
M2	2018	08	15	Common mussel	66		Shore
M2	2018	08	15	Common mussel	68		Shore
M2	2018	08	15	Common mussel	63		Shore
M2	2018	08	15	Common mussel	52	53	Shore
M1	2018	09	18	Common mussel	60		Shore
M1	2018	09	18	Common mussel	52		Shore
M1	2018	09	18	Common mussel	73		Shore
M1	2018	09	18	Common mussel	55		Shore
M1	2018	09	18	Common mussel	65		Shore
M1	2018	09	18	Common mussel	70		Shore
M1	2018	09	18	Common mussel	62		Shore
M1	2018	09	18	Common mussel	55		Shore
M1	2018	09	18	Common mussel	58		Shore
M1	2018	09	18	Common mussel	45		Shore
M1	2018	09	18	Common mussel	55	55	Shore
M2	2018	09	18	Common mussel	55		Shore
M2	2018	09	18	Common mussel	65		Shore
M2	2018	09	18	Common mussel	70		Shore
M2	2018	09	18	Common mussel	58		Shore
M2	2018	09	18	Common mussel	48		Shore
M2	2018	09	18	Common mussel	50		Shore
M2	2018	09	18	Common mussel	48		Shore
M2	2018	09	18	Common mussel	53		Shore
M2	2018	09	18	Common mussel	48		Shore
M2	2018	09	18	Common mussel	46	51	Shore
M1	2018	10	16	Common mussel	56		Shore
M1	2018	10	16	Common mussel	46		Shore
M1	2018	10	16	Common mussel	55		Shore
M1	2018	10	16	Common mussel	54		Shore
M1	2018	10	16	Common mussel	55		Shore
M1	2018	10	16	Common mussel	56		Shore

Area	Year	Month	Day	Species	Length (mm)	Total net biomass (g)	Habitat
M1	2018	10	16	Common mussel	48		Shore
M1	2018	10	16	Common mussel	50		Shore
M1	2018	10	16	Common mussel	48		Shore
M1	2018	10	16	Common mussel	50		Shore
M1	2018	10	16	Common mussel	45	76	Shore
M2	2018	10	15	Common mussel	65		Shore
M2	2018	10	15	Common mussel	64		Shore
M2	2018	10	15	Common mussel	64		Shore
M2	2018	10	15	Common mussel	58		Shore
M2	2018	10	15	Common mussel	64		Shore
M2	2018	10	15	Common mussel	60		Shore
M2	2018	10	15	Common mussel	50	88	Shore
M1	2018	11	13	Common mussel	61		Shore
M1	2018	11	13	Common mussel	70		Shore
M1	2018	11	13	Common mussel	59		Shore
M1	2018	11	13	Common mussel	59		Shore
M1	2018	11	13	Common mussel	60		Shore
M1	2018	11	13	Common mussel	63		Shore
M1	2018	11	13	Common mussel	59		Shore
M1	2018	11	13	Common mussel	61		Shore
M1	2018	11	13	Common mussel	60	92	Shore
M1	2018	12	12	Common mussel	65		Frame
M1	2018	12	12	Common mussel	68		Frame
M1	2018	12	12	Common mussel	54		Frame
M1	2018	12	12	Common mussel	52		Frame
M1	2018	12	12	Common mussel	60		Frame
M1	2018	12	12	Common mussel	56		Frame
M1	2018	12	12	Common mussel	56	104	Frame
M1	2019	1	24	Common mussel	67		Frame
M1	2019	1	24	Common mussel	62		Frame
M1	2019	1	24	Common mussel	64		Frame
M1	2019	1	24	Common mussel	56		Frame
M1	2019	1	24	Common mussel	62		Frame
M1	2019	1	24	Common mussel	60		Frame
M1	2019	1	24	Common mussel	62		Frame
M1	2019	1	24	Common mussel	61	94	Frame
M1	2019	2	20	Common mussel	70		Frame
M1	2019	2	20	Common mussel	57		Frame
M1	2019	2	20	Common mussel	73		Frame
M1	2019	2	20	Common mussel	56		Frame
M1	2019	2	20	Common mussel	64		Frame
M1	2019	2	20	Common mussel	67		Frame
M1	2019	2	20	Common mussel	56		Frame
M1	2019	2	20	Common mussel	60		Frame
M1	2019	2	20	Common mussel	55		Frame
M1	2019	2	20	Common mussel	55		Frame
M1	2019	2	20	Common mussel	59		Frame
M1	2019	2	20	Common mussel	49	103	Frame
M1	2019	3	19	Common mussel	56		Frame
M1	2019	3	19	Common mussel	58		Frame
M1	2019	3	19	Common mussel	59		Frame
M1	2019	3	19	Common mussel	50		Frame

Area	Year	Month	Day	Species	Length (mm)	Total net biomass (g)	Habitat
M1	2019	3	19	Common mussel	56		Frame
M1	2019	3	19	Common mussel	52		Frame
M1	2019	3	19	Common mussel	51		Frame
M1	2019	3	19	Common mussel	52		Frame
M1	2019	3	19	Common mussel	64		Frame
M1	2019	3	19	Common mussel	68	70	Frame
M1	2019	3	19	Common mussel	63		Shore
M1	2019	3	19	Common mussel	53		Shore
M1	2019	3	19	Common mussel	72		Shore
M1	2019	3	19	Common mussel	65	40	Shore
M1	2019	4	16	Common mussel	58		Frame
M1	2019	4	16	Common mussel	59		Frame
M1	2019	4	16	Common mussel	62		Frame
M1	2019	4	16	Common mussel	60		Frame
M1	2019	4	16	Common mussel	63		Frame
M1	2019	4	16	Common mussel	63		Frame
M1	2019	4	16	Common mussel	50	55	Frame
M1	2019	4	16	Common mussel	80		Shore
M1	2019	4	16	Common mussel	75		Shore
M1	2019	4	16	Common mussel	57		Shore
M1	2019	4	16	Common mussel	63		Shore
M1	2019	4	16	Common mussel	66		Shore
M1	2019	4	16	Common mussel	57	68	Shore
M1	2019	5	9	Common mussel	60		Shore
M1	2019	5	9	Common mussel	77		Shore
M1	2019	5	9	Common mussel	60		Shore
M1	2019	5	9	Common mussel	68		Shore
M1	2019	5	9	Common mussel	65		Shore
M1	2019	5	9	Common mussel	60		Shore
M1	2019	5	9	Common mussel	63	80	Shore
M1	2019	6	11	Common mussel	57		Shore
M1	2019	6	11	Common mussel	64		Shore
M1	2019	6	11	Common mussel	57		Shore
M1	2019	6	11	Common mussel	55		Shore
M1	2019	6	11	Common mussel	60		Shore
M1	2019	6	11	Common mussel	55		Shore
M1	2019	6	11	Common mussel	55		Shore
M1	2019	6	11	Common mussel	46	61	Shore
M1	2019	7	8	Common mussel	64		Shore
M1	2019	7	8	Common mussel	68		Shore
M1	2019	7	8	Common mussel	65		Shore
M1	2019	7	8	Common mussel	64		Shore
M1	2019	7	8	Common mussel	56		Shore
M1	2019	7	8	Common mussel	58		Shore
M1	2019	7	8	Common mussel	55		Shore
M1	2019	7	8	Common mussel	55	66	Shore

Appendix 3 Fish

Sampling date, site, length and biomass of fish samples.

Area	Year	Month	Day	Species	Length (mm)	Total biomass (g)
M	2018	08	15	Corkwing wrasse	120	
M	2018	08	15	Corkwing wrasse	125	
M	2018	08	15	Corkwing wrasse	145	
M	2018	08	15	Corkwing wrasse	105	
M	2018	08	15	Corkwing wrasse	65	
M	2018	08	15	Corkwing wrasse	105	
M	2018	08	15	Corkwing wrasse	70	137
M	2018	08	15	Goldsinny wrasse	84	
M	2018	08	15	Goldsinny wrasse	87	
M	2018	08	15	Goldsinny wrasse	77	
M	2018	08	15	Goldsinny wrasse	77	25
M	2018	09	18	Corkwing wrasse	120	
M	2018	09	18	Corkwing wrasse	120	
M	2018	09	18	Corkwing wrasse	125	
M	2018	09	18	Corkwing wrasse	90	
M	2018	09	18	Corkwing wrasse	115	120
M	2018	09	18	Goldsinny wrasse	95	
M	2018	09	18	Goldsinny wrasse	100	
M	2018	09	18	Goldsinny wrasse	80	
M	2018	09	18	Goldsinny wrasse	100	
M	2018	09	18	Goldsinny wrasse	105	
M	2018	09	18	Goldsinny wrasse	80	
M	2018	09	18	Goldsinny wrasse	100	
M	2018	09	18	Goldsinny wrasse	100	
M	2018	09	18	Goldsinny wrasse	95	
M	2018	09	18	Goldsinny wrasse	95	
M	2018	09	18	Goldsinny wrasse	100	139
M	2018	10	15	Corkwing wrasse	135	
M	2018	10	15	Corkwing wrasse	132	
M	2018	10	15	Corkwing wrasse	128	
M	2018	10	15	Corkwing wrasse	115	116
M	2018	10	15	Goldsinny wrasse	91	
M	2018	10	15	Goldsinny wrasse	89	
M	2018	10	15	Goldsinny wrasse	103	
M	2018	10	15	Goldsinny wrasse	95	
M	2018	10	15	Goldsinny wrasse	106	
M	2018	10	15	Goldsinny wrasse	104	
M	2018	10	15	Goldsinny wrasse	103	
M	2018	10	16	Goldsinny wrasse	87	
M	2018	10	16	Goldsinny wrasse	82	
M	2018	10	16	Goldsinny wrasse	81	
M	2018	10	16	Goldsinny wrasse	92	
M	2018	10	16	Goldsinny wrasse	92	
M	2018	10	16	Goldsinny wrasse	83	
M	2018	10	16	Goldsinny wrasse	82	
M	2018	10	16	Goldsinny wrasse	79	
M	2018	10	16	Goldsinny wrasse	78	
M	2018	10	16	Goldsinny wrasse	76	185

Area	Year	Month	Day	Species	Length (mm)	Total biomass (g)
M	2018	11	14	Corkwing wrasse	78	
M	2018	11	14	Corkwing wrasse	71	
M	2018	11	14	Corkwing wrasse	72	
M	2018	11	14	Corkwing wrasse	79	
M	2018	11	14	Corkwing wrasse	73	28
M	2018	11	14	Goldsinny wrasse	89	10
M	2018	12	12	Corkwing wrasse	82	7,7
M	2018	12	12	Goldsinny wrasse	82	
M	2018	12	12	Goldsinny wrasse	75	
M	2018	12	12	Goldsinny wrasse	93	
M	2018	12	12	Goldsinny wrasse	85	
M	2018	12	12	Goldsinny wrasse	85	
M	2018	12	12	Goldsinny wrasse	80	
M	2018	12	12	Goldsinny wrasse	82	55
M	2019	01	24	Shorthorn sculpin	180	
M	2019	01	24	Shorthorn sculpin	156	
M	2019	01	24	Shorthorn sculpin	232	
M	2019	01	24	Shorthorn sculpin	183	369
M	2019	01	24	Armed Bullhead	147	22
M	2019	02	20	Longspined bull-head	119	37
M	2019	02	20	Shorthorn sculpin	169	
M	2019	02	20	Shorthorn sculpin	134	
M	2019	02	20	Shorthorn sculpin	177	
M	2019	02	20	Shorthorn sculpin	176	
M	2019	02	20	Shorthorn sculpin	173	
M	2019	02	20	Shorthorn sculpin	172	
M	2019	02	20	Shorthorn sculpin	172	566
M	2019	02	20	European flounder	154	141
M	2019	03	19	Corkwing wrasse	-	7,2
M	2019	04	16	Corkwing wrasse	89	6,7
M	2019	04	16	Goldsinny wrasse	80	
M	2019	04	16	Goldsinny wrasse	91	
M	2019	04	16	Goldsinny wrasse	83	23
M	2019	05	9	Corkwing wrasse	110	
M	2019	05	9	Corkwing wrasse	74	
M	2019	05	9	Corkwing wrasse	107	
M	2019	05	9	Corkwing wrasse	123	
M	2019	05	9	Corkwing wrasse	115	
M	2019	05	9	Corkwing wrasse	108	
M	2019	05	9	Corkwing wrasse	110	
M	2019	05	9	Corkwing wrasse	117	
M	2019	05	9	Corkwing wrasse	100	
M	2019	05	9	Corkwing wrasse	116	
M	2019	05	9	Corkwing wrasse	80	
M	2019	05	9	Corkwing wrasse	74	
M	2019	05	9	Corkwing wrasse	87	191
M	2019	05	9	Goldsinny wrasse	84	
M	2019	05	9	Goldsinny wrasse	88	
M	2019	05	9	Goldsinny wrasse	76	
M	2019	05	9	Goldsinny wrasse	96	30
M	2019	05	9	Great sandeel	255	

Area	Year	Month	Day	Species	Length (mm)	Total biomass (g)
M	2019	05	9	Great sandeel	225	85
M	2019	06	11	Corkwing wrasse	112	
M	2019	06	11	Corkwing wrasse	121	
M	2019	06	11	Corkwing wrasse	122	
M	2019	06	11	Corkwing wrasse	100	
M	2019	06	11	Corkwing wrasse	72	
M	2019	06	11	Corkwing wrasse	118	
M	2019	06	11	Corkwing wrasse	100	
M	2019	06	11	Corkwing wrasse	78	
M	2019	06	11	Corkwing wrasse	75	
M	2019	06	11	Corkwing wrasse	70	
M	2019	06	11	Corkwing wrasse	79	
M	2019	06	11	Corkwing wrasse	67	
M	2019	06	11	Corkwing wrasse	77	
M	2019	06	11	Corkwing wrasse	72	140
M	2019	06	11	Goldsinny wrasse	90	
M	2019	06	11	Goldsinny wrasse	105	
M	2019	06	11	Goldsinny wrasse	85	
M	2019	06	11	Goldsinny wrasse	100	
M	2019	06	11	Goldsinny wrasse	92	
M	2019	06	11	Goldsinny wrasse	90	
M	2019	06	11	Goldsinny wrasse	83	
M	2019	06	11	Goldsinny wrasse	83	
M	2019	06	11	Goldsinny wrasse	82	
M	2019	06	11	Goldsinny wrasse	82	
M	2019	06	11	Goldsinny wrasse	80	
M	2019	06	11	Goldsinny wrasse	82	
M	2019	06	11	Goldsinny wrasse	77	
M	2019	06	11	Goldsinny wrasse	83	
M	2019	06	11	Goldsinny wrasse	78	115
M	2019	07	8	Corkwing wrasse	115	
M	2019	07	8	Corkwing wrasse	116	
M	2019	07	8	Corkwing wrasse	107	
M	2019	07	8	Corkwing wrasse	103	
M	2019	07	8	Corkwing wrasse	105	
M	2019	07	8	Corkwing wrasse	90	
M	2019	07	8	Corkwing wrasse	73	
M	2019	07	8	Corkwing wrasse	75	
M	2019	07	8	Corkwing wrasse	84	
M	2019	07	8	Corkwing wrasse	72	
M	2019	07	8	Corkwing wrasse	70	
M	2019	07	8	Corkwing wrasse	73	
M	2019	07	8	Corkwing wrasse	105	
M	2019	07	8	Corkwing wrasse	74	
M	2019	07	8	Corkwing wrasse	87	
M	2019	07	8	Corkwing wrasse	68	169
M	2019	07	8	Goldsinny wrasse	100	
M	2019	07	8	Goldsinny wrasse	85	
M	2019	07	8	Goldsinny wrasse	105	
M	2019	07	8	Goldsinny wrasse	100	
M	2019	07	8	Goldsinny wrasse	84	
M	2019	07	8	Goldsinny wrasse	105	

Area	Year	Month	Day	Species	Length (mm)	Total biomass (g)
M	2019	07	8	Goldsinny wrasse	97	61

Appendix 4 Field measurements

Sampling date, site and marine parameter values of the sea water.

Area	X Coordinate	Y Coordinate	Date	Depth	Temp.	Sali-nity	Fluore-scence	Oxy-gen	Oxy-gen	Tur-bidity
	RT90 2,5 gon v			(m)	°C	PSU	(V)	(mg/l)	(%)	NTU
M	6352835	1276754	2018-08-15	0,5	22,1	6,0	0,16	9,1	105	0,0
M	6352835	1276754	2018-08-15	1,0	22,1	5,4	0,17	9,1	105	0,0
M	6352835	1276754	2018-08-15	2,0	22,0	6,5	0,20	9,2	104	0,0
M	6352835	1276754	2018-08-15	3,0	21,5	6,8	0,19	9,2	104	0,0
M	6352835	1276754	2018-08-15	4,0	20,6	7,2	0,20	9,3	104	0,0
M	6352835	1276754	2018-08-15	5,0	20,1	7,8	0,22	9,3	103	0,10
M	6352835	1276754	2018-08-15	5,5	20,1	14	0,23	8,0	87	0,40
M	6352835	1276754	2018-08-15	6,0	20,1	26	0,37			
R	6348014	1279935	2018-08-16	0,5	19,6	22	0,15	9,2	100	0,0
R	6348014	1279935	2018-08-16	1,0	19,6	22	0,17	9,1	100	0,10
R	6348014	1279935	2018-08-16	2,0	19,6	22	0,18	9,2	100	0,0
R	6348014	1279935	2018-08-16	3,0	19,6	22	0,17	9,1	100	0,0
R	6348014	1279935	2018-08-16	4,0	19,6	22	0,17	9,1	99	0,40
R	6348014	1279935	2018-08-16	5,0	19,6	22	0,17	9,1	99	0,60
R	6348014	1279935	2018-08-16	6,0	19,6	22	0,17	9,1	99	1,3
M	6352835	1276754	2018-09-18	0,5	16,5	20		10,1	103	0,40
M	6352835	1276754	2018-09-18	1,0	16,5			10,1	104	0,50
M	6352835	1276754	2018-09-18	2,0	16,5			10,1	103	0,60
M	6352835	1276754	2018-09-18	3,0	16,9			9,7	102	0,50
M	6352835	1276754	2018-09-18	4,0	16,6			9,5	98	0,0
M	6352835	1276754	2018-09-18	5,0	16,2			9,4	98	0,0
M	6352835	1276754	2018-09-18	5,5	16,4			7,8	80	0,10
R	6348014	1279935	2018-09-17	0,5	14,7	13		10,1	99	4,0
R	6348014	1279935	2018-09-17	1,0	14,7			10,0	99	4,7
R	6348014	1279935	2018-09-17	2,0	14,7			10,0	99	4,7
R	6348014	1279935	2018-09-17	3,0	14,9			9,8	98	4,7
R	6348014	1279935	2018-09-17	4,0	15,2			9,3	93	4,3
M	6352835	1276754	2018-10-16	0,5	13,8	20	0,54			
M	6352835	1276754	2018-10-16	1,0	13,8	20	0,55			
M	6352835	1276754	2018-10-16	2,0	13,8	20	0,42			
M	6352835	1276754	2018-10-16	3,0	13,7	21	0,51			
M	6352835	1276754	2018-10-16	4,0	13,5	21	0,40			
M	6352835	1276754	2018-10-16	5,0	13,3	21	0,47			
M	6352835	1276754	2018-10-16	5,5	13,2	21	0,49			
M	6352835	1276754	2018-10-16	6,0	13,2	21	0,53			
R	6348014	1279935	2018-10-15	0,5	12,9	20	0,21			
R	6348014	1279935	2018-10-15	1,0	12,9	20	0,21			
R	6348014	1279935	2018-10-15	2,0	12,9	20	0,27			
R	6348014	1279935	2018-10-15	3,0	12,9	20	0,36			
R	6348014	1279935	2018-10-15	4,0	12,9	20	0,42			
R	6348014	1279935	2018-10-15	5,0	12,9	20	0,37			
R	6348014	1279935	2018-10-15	6,0	12,9	20	0,37			
R	6348014	1279935	2018-10-15	6,5	12,9	20	0,33			
R	6348014	1279935	2018-10-15	7,0	12,9	20	0,34			
M	6352835	1276754	2018-11-13	0,5	9,3	17	0,51	11,3	101	1,7
M	6352835	1276754	2018-11-13	1,0	9,3	17	0,56	11,3	101	1,2
M	6352835	1276754	2018-11-13	2,0	9,3	17	0,54	11,3	101	1,2
M	6352835	1276754	2018-11-13	3,0	9,4	18	0,63	11,3	101	1,2

Area	X Coordinate	Y Coordinate	Date	Depth	Temp.	Sali-nity	Fluore-scence	Oxy-gen	Oxy-gen	Tur-bidity
	RT90 2,5 gon v			(m)	°C	PSU	(V)	(mg/l)	(%)	NTU
M	6352835	1276754	2018-11-13	4,0	9,4	18	0,60	11,3	101	1,2
M	6352835	1276754	2018-11-13	5,0	9,4	18	0,54	11,1	100	1,0
M	6352835	1276754	2018-11-13	5,5	9,4	18	0,54			
R	6348014	1279935	2018-11-13	0,5	10,7	18	0,51	11,4	99	1,9
R	6348014	1279935	2018-11-13	1,0	10,7	18	0,52	11,4	99	
R	6348014	1279935	2018-11-13	2,0	10,7	18	0,54	11,4	99	
R	6348014	1279935	2018-11-13	3,0	10,7	18	0,52	11,4	99	
R	6348014	1279935	2018-11-13	4,0	10,7	18	0,53	11,4	99	
R	6348014	1279935	2018-11-13	5,0	10,3	18	0,36	11,3	99	
R	6348014	1279935	2018-11-13	6,0	10,1	21	0,37	11,3	98	
M	6352835	1276754	2018-12-12	0,5	7,2	27	0,31	12,3	97	0,10
M	6352835	1276754	2018-12-12	1,0	8,4	28	0,29	11,9	98	0,20
M	6352835	1276754	2018-12-12	2,0	9,1	29	0,26	11,6	98	0,30
M	6352835	1276754	2018-12-12	3,0	11,3	31	0,19	11,6	98	0,40
M	6352835	1276754	2018-12-12	4,0	8,4	30	0,19	11,1	100	0,40
M	6352835	1276754	2018-12-12	5,0	7,6	30	0,19	11,3	98	0,30
M	6352835	1276754	2018-12-12	5,5	7,3	31	0,18	11,4	95	0,40
M	6352835	1276754	2018-12-12	6,0	7,3	31	0,19	11,4	94	0,40
M	6352835	1276754	2018-12-12	6,5	7,5	32	0,14			
R	6348014	1279935	2018-12-12	0,5	5,4	21	0,33	12,4	96	1,4
R	6348014	1279935	2018-12-12	1,0	5,8	23	0,48	12,2	96	0,50
R	6348014	1279935	2018-12-12	2,0	6,0	25	0,40	12,2	97	0,30
R	6348014	1279935	2018-12-12	3,0	6,2	25	0,43	12,1	96	0,20
R	6348014	1279935	2018-12-12	4,0	6,3	26	0,38	12,1	96	0,30
R	6348014	1279935	2018-12-12	5,0	6,3	26	0,42	12,0	96	0,20
R	6348014	1279935	2018-12-12	6,0	6,4	26	0,39	11,9	95	0,20
R	6348014	1279935	2018-12-12	6,5	6,4	26	0,42	11,9	95	0,20
R	6348014	1279935	2018-12-12	7,0	6,5	27	0,34	11,9	94	0,30
R	6348014	1279935	2018-12-12	7,5	7,0	31	0,41			
M	6352835	1276754	2019-01-24	0,5	4,4	25	0,27	13,3	102	0,10
M	6352835	1276754	2019-01-24	1,0	4,4	25	0,29	13,3	102	0,10
M	6352835	1276754	2019-01-24	2,0	3,6	25	0,25	13,3	100	0,0
M	6352835	1276754	2019-01-24	3,0	3,5	25	0,25	13,3	100	0,10
M	6352835	1276754	2019-01-24	4,0	3,4	25	0,24	13,3	99	0,0
M	6352835	1276754	2019-01-24	5,0	3,1	26	0,20	13,3	99	0,0
M	6352835	1276754	2019-01-24	5,5	3,1	26	0,20	13,2	98	0,0
M	6352835	1276754	2019-01-24	6,0	3,6	26	0,19			
R	6348014	1279935	2019-01-24	0,5	3,0	19	0,37	13,3	99	0,20
R	6348014	1279935	2019-01-24	1,0	3,0	19	0,33	13,3	98	0,20
R	6348014	1279935	2019-01-24	2,0	3,0	19	0,33	13,3	98	0,20
R	6348014	1279935	2019-01-24	3,0	3,0	19	0,35	13,3	98	0,20
R	6348014	1279935	2019-01-24	4,0	3,1	25	0,34	13,3	98	0,20
R	6348014	1279935	2019-01-24	5,0	3,1	25	0,37	13,3	98	0,10
R	6348014	1279935	2019-01-24	6,0	3,2	25	0,35	13,2	98	0,10
R	6348014	1279935	2019-01-24	6,5	3,2	25	0,34	13,2	98	0,10
R	6348014	1279935	2019-01-24	7,0	3,2	25	0,56			
M	6352835	1276754	2019-02-20	0,5	4,8	16	0,22	13,2	102	1,5
M	6352835	1276754	2019-02-20	1,0	4,8	16	0,25	13,4	103	1,9
M	6352835	1276754	2019-02-20	2,0	4,2	20	0,52	13,5	104	1,4
M	6352835	1276754	2019-02-20	3,0	4,0	20	0,63	13,8	104	1,6
M	6352835	1276754	2019-02-20	4,0	3,5	21	0,79	13,8	104	1,0

Area	X Coordinate	Y Coordinate	Date	Depth	Temp.	Sali-nity	Fluore-scence	Oxy-gen	Oxy-gen	Tur-bidity
	RT90 2,5 gon v			(m)	°C	PSU	(V)	(mg/l)	(%)	NTU
M	6352835	1276754	2019-02-20	5,0	3,4	22	1,2	13,9	104	1,1
M	6352835	1276754	2019-02-20	5,5	3,4	23	0,87			
R	6348014	1279935	2019-02-20	0,5	3,2	16	0,28	13,1	98	7,9
R	6348014	1279935	2019-02-20	1,0	3,3	18	0,49	13,4	101	4,0
R	6348014	1279935	2019-02-20	2,0	4,3	17	0,75	13,5	103	2,0
R	6348014	1279935	2019-02-20	3,0	3,8	17	0,74	13,7	102	3,5
R	6348014	1279935	2019-02-20	4,0	3,3	18	0,65	13,7	102	1,9
R	6348014	1279935	2019-02-20	5,0	3,3	17	0,52	13,8	103	0,90
R	6348014	1279935	2019-02-20	6,0	3,4	17	0,79	13,9	104	0,70
R	6348014	1279935	2019-02-20	6,5	3,4	17	0,68	13,8	103	4,7
R	6348014	1279935	2019-02-20	7,0	3,4	23	1,3			
M	6352835	1276754	2019-03-19	0,5	5,0	19	0,21	12,6	100	2,6
M	6352835	1276754	2019-03-19	1,0	6,1	22	0,17	12,7	99	1,2
M	6352835	1276754	2019-03-19	2,0	5,4	24	0,24	12,8	99	0,90
M	6352835	1276754	2019-03-19	3,0	5,0	25	0,24	12,8	100	0,30
M	6352835	1276754	2019-03-19	4,0	5,1	25	0,28	12,8	99	0,30
M	6352835	1276754	2019-03-19	5,0	4,7	26	0,25	12,8	99	0,30
M	6352835	1276754	2019-03-19	6,0	4,7	26	0,20	12,8	98	0,10
M	6352835	1276754	2019-03-19	7,0	4,7	26	0,37	12,8	98	0,20
M	6352835	1276754	2019-03-19	8,0	4,6	26	0,46			
R	6348014	1279935	2019-03-19	0,5	5,3	2,5	0,23	12,6	98	7,6
R	6348014	1279935	2019-03-19	1,0	5,2	13	0,28	12,5	97	4,5
R	6348014	1279935	2019-03-19	2,0	4,6	23	0,22	12,6	97	0,40
R	6348014	1279935	2019-03-19	3,0	4,6	25	0,25	12,8	97	0,50
R	6348014	1279935	2019-03-19	4,0	4,6	25	0,19	12,8	98	0,40
R	6348014	1279935	2019-03-19	5,0	4,6	25	0,26	12,8	98	0,30
R	6348014	1279935	2019-03-19	6,0	4,6	25	0,18	12,7	97	0,30
R	6348014	1279935	2019-03-19	7,0	4,6	26	0,22			
M	6352835	1276754	2019-04-16	0,5	9,1	17	0,14	12,5	104	0,0
M	6352835	1276754	2019-04-16	1,0	9,0	17	0,16	12,5	104	0,0
M	6352835	1276754	2019-04-16	2,0	8,9	17	0,19	12,6	105	0,0
M	6352835	1276754	2019-04-16	3,0	8,6	17	0,23	12,6	105	0,0
M	6352835	1276754	2019-04-16	4,0	8,4	17	0,24	12,6	105	0,0
M	6352835	1276754	2019-04-16	5,0	7,9	17	0,21	12,7	105	0,0
M	6352835	1276754	2019-04-16	5,5	7,8	17	0,18	12,7	105	0,0
R	6348014	1279935	2019-04-16	0,5	7,0	16	0,098	12,7	103	0,0
R	6348014	1279935	2019-04-16	1,0	7,0	16	0,11	12,7	102	0,0
R	6348014	1279935	2019-04-16	2,0	7,0	16	0,12	12,6	102	0,0
R	6348014	1279935	2019-04-16	3,0	7,0	16	0,15	12,7	103	0,0
R	6348014	1279935	2019-04-16	4,0	7,0	16	0,18	12,7	103	0,0
R	6348014	1279935	2019-04-16	5,0	6,9	16	0,18	12,7	103	0,0
R	6348014	1279935	2019-04-16	6,0	6,9	16	0,19	12,7	103	0,0
R	6348014	1279935	2019-04-16	6,5	6,9	16	0,19	12,8	103	0,0
R	6348014	1279935	2019-04-16	7,0	6,7	17	0,21			
M	6352835	1276754	2019-05-09	0,5	10,0	18		11,3	102	0,0
M	6352835	1276754	2019-05-09	1,0	10,0	18		11,3	102	0,0
M	6352835	1276754	2019-05-09	2,0	10,1	18		11,4	103	0,0
M	6352835	1276754	2019-05-09	3,0	10,1	18		11,8	103	0,0
M	6352835	1276754	2019-05-09	4,0	10,5	18		11,2	103	0,10
M	6352835	1276754	2019-05-09	5,0	11,2	19		11,8	101	0,40
M	6352835	1276754	2019-05-09	5,5	12,0	20		10,8	102	0,40

Area	X Coordinate	Y Coordinate	Date	Depth	Temp.	Sali-nity	Fluore-scence	Oxy-gen	Oxy-gen	Tur-bidity
	RT90 2,5 gon v			(m)	°C	PSU	(V)	(mg/l)	(%)	NTU
R	6348014	1279935	2019-05-09	0,5	9,3	18		11,5	102	0,0
R	6348014	1279935	2019-05-09	1,0	9,3	18		11,5	102	0,0
R	6348014	1279935	2019-05-09	2,0	9,3	18		11,5	102	0,0
R	6348014	1279935	2019-05-09	3,0	9,3	18		11,5	102	0,0
R	6348014	1279935	2019-05-09	4,0	9,3	18		11,5	102	0,0
R	6348014	1279935	2019-05-09	5,0	9,3	18		11,5	102	0,0
R	6348014	1279935	2019-05-09	6,0	9,3	18		11,4	101	0,0
R	6348014	1279935	2019-05-09	7,0	9,3	18		11,4	101	0,0
M	6352835	1276754	2019-06-11	0,5	16,7	19		9,7	100	0,40
M	6352835	1276754	2019-06-11	1,0	16,7	19		9,7	100	0,40
M	6352835	1276754	2019-06-11	2,0	16,7	19		9,7	100	0,40
M	6352835	1276754	2019-06-11	3,0	16,7	19		9,7	100	0,40
M	6352835	1276754	2019-06-11	4,0	16,3	19		9,8	100	0,30
M	6352835	1276754	2019-06-11	5,0	15,5	19		9,9	99	0,10
M	6352835	1276754	2019-06-11	5,5	15,3	19		9,8	98	0,0
R	6348014	1279935	2019-06-11	0,5	16,1	18		9,8	100	0,30
R	6348014	1279935	2019-06-11	1,0	16,1	18		9,8	100	0,40
R	6348014	1279935	2019-06-11	2,0	16,1	18		9,8	100	0,40
R	6348014	1279935	2019-06-11	3,0	15,9	18		9,8	100	0,40
R	6348014	1279935	2019-06-11	4,0	15,6	19		9,9	100	0,40
R	6348014	1279935	2019-06-11	5,0	14,9	19		10,2	101	0,20
R	6348014	1279935	2019-06-11	6,0	14,9	20		10,2	101	0,10
R	6348014	1279935	2019-06-11	6,5	14,9	20		10,2	101	0,10
M	6352835	1276754	2019-07-08	0,5	19,6	23		9,6	105	0,0
M	6352835	1276754	2019-07-08	1,0	19,6	23		9,6	105	0,0
M	6352835	1276754	2019-07-08	2,0	19,6	22		9,6	105	0,0
M	6352835	1276754	2019-07-08	3,0	19,5	23		9,5	105	0,0
M	6352835	1276754	2019-07-08	4,0	18,8	23		9,9	107	0,10
M	6352835	1276754	2019-07-08	5,0	18,1	23		9,0	106	0,30
M	6352835	1276754	2019-07-08	5,5	17,3	23		7,8	81	0,40
R	6348014	1279935	2019-07-08	0,5	17,1	21		9,7	101	0,20
R	6348014	1279935	2019-07-08	1,0	17,1	21		9,8	102	0,10
R	6348014	1279935	2019-07-08	2,0	17,1	21		9,8	102	0,10
R	6348014	1279935	2019-07-08	3,0	17,1	21		9,8	102	0,20
R	6348014	1279935	2019-07-08	4,0	17,0	21		9,8	102	0,20
R	6348014	1279935	2019-07-08	5,0	17,0	21		9,8	102	0,20
R	6348014	1279935	2019-07-08	6,0	17,0	21		9,8	102	0,20
R	6348014	1279935	2019-07-08	6,5	17,0	22		9,8	102	0,20

Area	Date	Secchi depth (m) with aqua scope	Secchi depth (m) without aqua scope
M	2018-08-15	6,0	5,5
M	2018-09-18	3,5	3,0
M	2018-10-16	6,5	6,5
M	2018-11-13	6,4	6,0
M	2018-12-12	5,5	5,0
M	2019-01-24	>6,2	>6,2
M	2019-02-20	3,6	3,3
M	2019-03-19	2,0	2,0
M	2019-04-16	>5,8	5,8
M	2019-05-09	5,4	5,0
M	2019-06-11	4,4	3,9
M	2019-07-08	6,2	5,5
M	Average	>5,1	>4,8
R	2018-08-16	6,1	5,5
R	2018-09-17	1,5	1,5
R	2018-10-15	6,5	6,5
R	2018-11-13	5,7	5,7
R	2018-12-12	4,5	3,9
R	2019-01-24	7,0	6,1
R	2019-02-20	0,45	0,40
R	2019-03-19	1,5	1,0
R	2019-04-16	7,2	6,5
R	2019-05-09	6,5	6,0
R	2019-06-11	5,0	4,5
R	2019-07-08	5,5	5,0
R	Average	4,8	4,4

Appendix 5 Carbon fractions

Sampling date, site and data for carbon fractions in the sea water.

Area	Code	Date	Temp. °C	TOC* mg/l	DOC mg/l	POC mg/l	HCO_3 mg/l
Target	M	2018-08-15	22,3	2,7	2,8	*0,096*	110
Target	M	2018-09-18	16,5	3,6	3,5	0,096	100
Target	M	2018-10-16	13,9	3,2	3,0	0,20	110
Target	M	2018-11-13	10,5	3,5	3,8	*0,096*	100
Target	M	2018-12-12	6,1	2,5	2,4	0,096	110
Target	M	2019-01-24	4,2	2,8	2,5	0,30	110
Target	M	2019-02-20	4,7	4,1	4,0	0,11	90
Target	M	2019-03-19	5,3	5,9	5,7	0,20	85
Target	M	2019-04-16	8,2	3,9	3,7	0,20	96
Target	M	2019-05-09	10,0	3,6	3,6	*0,096*	100
Target	M	2019-06-11	16,7	3,4	3,7	*0,096*	70
Target	M	2019-07-08	19,6	3,3	2,8	0,50	110
Average	**M**	**12 month**		**3,54**	**3,46**	**0,18**	**99**
Reference	R	2018-08-16	19,5	2,7	2,8	*0,096*	110
Reference	R	2018-09-17	14,0	5,6	4,9	0,71	83
Reference	R	2018-10-15	12,6	3,1	2,9	0,19	110
Reference	R	2018-11-13	9,2	3,3	3,2	0,096	110
Reference	R	2018-12-12	5,3	3,8	3,7	0,11	97
Reference	R	2019-01-24	2,8	2,5	2,3	0,19	110
Reference	R	2019-02-20	3,3	7,4	7,2	0,20	18
Reference	R	2019-03-19	4,5	8,1	8,3	*0,096*	23
Reference	R	2019-04-16	6,9	4,1	3,7	0,41	97
Reference	R	2019-05-09	9,3	3,6	3,4	0,20	100
Reference	R	2019-06-11	16,1	3,5	3,8	*0,096*	110
Reference	R	2019-07-08	17,1	3,0	3,0	*0,096*	110
Average	**R**	**12 month**		**4,23**	**4,10**	**0,21**	**90**

*For TOC values lower than DOC, the difference is within the measurement uncertainty.

The Swedish Radiation Safety Authority has a comprehensive responsibility to ensure that society is safe from the effects of radiation. The Authority works from the effects of radiation. The Authority works to achieve radiation safety in a number of areas: nuclear power, medical care as well as commercial products and services. The Authority also works to achieve protection from natural radiation an to increase the level of ratiation safety internationally.

The Swedish Radiation Safety Authority works proactively and presentively to protect people and the environment from the harmful effects of radiation, now and in the future.
The Authority issues regulations and supervises compliance, while also supporting research, providing training and information, and issuing advice. Often, activities involving radiation require licences issued by the Authority. The Swedish Radiation Safety Authority maintains emergency preparedness around the clock with the aim of limiting the aftermath of radiation accidents and the unintentional spreading of radioactive substances. The Authority participates in international co-operation in order to promote radiation safety and finances projects aiming to raise the level of radiation safety in certain Eastern European countries.

The Authority reports to the Ministry of the Environment and has around 300 employees with competencies in the fields of engineering, natural and behavioral sciences, law, economics and communications. We have recieved quality, environmental and working environment certification.

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E-print AB, 2022