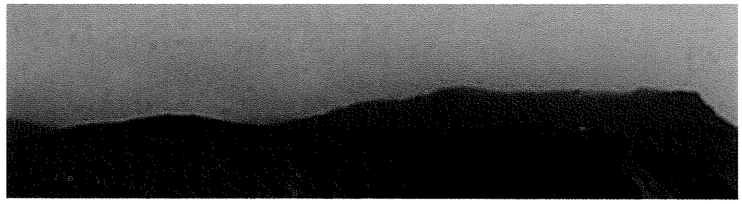

Integrated Ecological Monitoring in the Coastal Zone
Environmental Pollutants
Faroe Islands

Maria Dam

HEILSUFRØÐILIGA STARVSSTOVAN
Food and Environmental Agency

2000:2

Integrated Ecological Monitoring in the Coastal Zone: Environmental Pollutants

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The present report constitutes the Faroese part of a co-operative effort between Iceland, Norway and the Faroe Islands. The Faroese part of the project has been conducted by the Environmental Department of the Food and Environmental Agency. The initial part of the project was followed by a group consisting of :

Jacob Pauli Joensen, Head of the Environmental Department
Marita Poulsen, Head of the Chemical Laboratory Department., and
Maria Dam, Project Coordinator.

Layout: Heidi Gregersen

Several people have shared their experiences, time and resources in the course of the project.

Thanks are due to:

Marnar Gaard
Tróndur Patursson
Beinta Johannesen, Náttúruvísindadeildin
Eyðfinnur Stefansson, Náttúrugripasavnið
Grete Bruntze, Biofar
Bjarki Geyti, Biofar
Dagunn Olsen, Fiskirannsóknarstovan
Jákup Reinert, Fiskirannsóknarstovan
Arnold Henriksen, Fiskirannsóknarstovan
Karina Nattestad, Fiskirannsóknarstovan
Dorete Bloch, Náttúrugripasavnið
Jens-Kjeld Jensen, Nólsoy
Ailsa Reid, Sillyflatt, Angus, Scotland
Valur Bogasson, Fiskirannsoknarstofnun, Reykjavik

June 2000
ISBN 99918-940-3-9

Preface

In 1995 the Nordic Council of Ministers Working Group on Environment and Data decided to initiate the development of "Integrated ecological environmental monitoring in the coastal zone" as proposed by the Project Group for Integrated Coastal Monitoring *Projektgruppen for integrert kystovervåkning* (Nord 1992:39). Iceland acted as lead country for the project, and chose to put special emphasis on environmental pollutants such as heavy metals and persistent organochlorine compounds. The project was set up in co-operation with Norway and the Faroe Islands and the task of focussing the content of the project was begun.

It was decided to concentrate efforts on establishing "background" or reference data from the three countries, which in turn required the identification of clean-area reference stations of comparable biology, one in each country. It was further decided to analyse samples from the various tiers of the food web and preferably the components of one particular food chain. The species chosen were seen as indicator species and these were:

primary producer; kelp *Laminaria hyperborea*
filter feeder (microphag); blue mussels *Mytilus edulis*
grazer; limpets *Patella vulgata*, banded chink shells *Lacuna vincta (divericata),* and secondarily also sea-urchin *Echinus esculentus*
1 tier predator; dab *Limanda limanda* or (in Iceland) butterfish *Pholis gunellus*
2 tier predator; black guillemot *Cepphus grylle*

It later proved difficult to find locations which both met the full list of requirements and which were accessible with a reasonable expenditure of time and resources. In particular, the goal of mapping the year-round variations in the biological and chemical parameters required that sampling was preferably repeated once a month or at least "several times" during the year. Problems with locating a site where the above-mentioned indicator-species occurred side-by-side was the main obstacle to finding a suitable sampling station in the Faroe Islands at all, and led to a delay in the onset of the project. The solution became the assignment of two Faroese reference stations, one at Kirkjubø and one at Svínáir.

The results of the project were presented at a workshop, also sponsored by the Nordic Council of Ministers, in Reykjavik in 1998. In the present report the results of the Faroese part of the project are presented.

Contents

Summary

The project has focused on establishing the present level of certain pollutants in the coastal zone in the Faroe Islands. Special emphasis has been placed on pollutants that are man-made and transported over long distances via air, water or biomasses. Such pollutants include PCB, a synthetic oil used for example as an insulator in electrical installations, and *p,p´*-DDE, the latter being the degradation product of the pesticide DDT. In Figure I the concentrations of PCB are represented as the sum of the "seven Dutch" congeners *i.e.* the CBs 28, 52, 101, 118, 153, 138 and 180. The first two of these congeners, CB 28 and 52, are more easily biodegradable than the other five. In particular, the congener CB 153 seems to be resistant to metabolic degradation and thus tends to make up a large part of the total PCB burden. In Figure I the results have been lipid adjusted, meaning that they are shown with a basis in the lipid content of the specific tissue analysed. This is done to allow comparisons between different tissue types and between species, and can be done because research has shown that the distribution of these lipid soluble persistent compounds are mainly governed by equilibrium partitioning between tissue types according to lipid content.

The so-called heavy metals are also often seen as potentially long-range transported ones even though they are truly natural of origin and occur in the earth's crust and in the biosphere as naturally as iron, oxygen and nitrogen. In Table I the concentrations of these metals are given for the various species and tissues on a dry weight basis and this is done for the same reason as the lipid soluble organic pollutants were shown on a lipid basis above.

Mercury (Hg) is a major pollutant from coal-fired power plants and can be transported over wide distances in the gaseous state. It is thus possible that air-transport may play an important role in the distribution of this metal, although this is probably best studied in fish from lakes and not in marine species such as dab. Lead (Pb) from cars burning lead-enriched gasoline, is also transported in air. However, since lead-free alternatives became generally available in Northwestern Europe in the early eighties, the long-range transport of lead has decreased and there are generally low levels of this metal in the Faroese biota (Table I). The cadmium (Cd) concentrations, on the other hand, are rather puzzling. It appears from the results in this project, such as for limpets (Table I), that there may be quite high concentrations of cadmium, esspecially in the marine snails. It is known that for cadmium in particular, salinity is of decisive importance for the bioavailability of this metal. Research from Greenland on blue mussels sampled along a salinity gradient revealed that the uptake increased with salinity. The results of the present study do not allow a similar conclusion to be drawn because the study was not designed to elucidate this particular question. However, certain results, such as those from limpets sampled around the Faroes, may support the Greenland findings.

Figure I The figure gives an overview of the general level of PCB 7 and *p,p´*-DDE, in mg/kg l.w., in the species analysed in the project. The values are mean values calculated for the sum of the pooled samples. In total the values represent 54 sea-urchins (gonads), 91 common limpets from Kirkjubøur in June, Sep. and Dec. 1996 of mean shell diam. 4,6 cm (soft parts), 210 blue mussels in the size range 3 – 4 cm shell-length (soft parts), 25 starfish (whole body), 120 dab (liver), 11 adult female and 45 adult male black guillemots (liver).

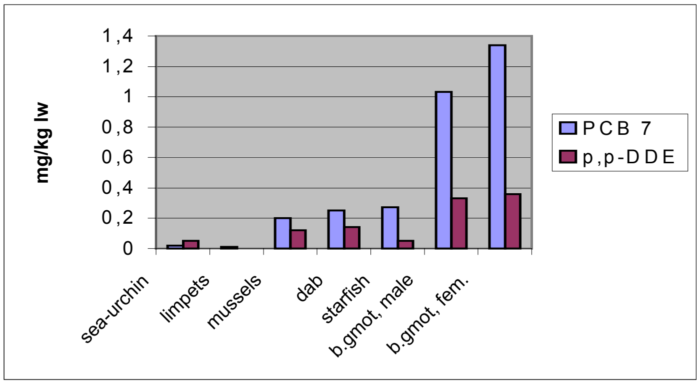


Table I Summary of metal results in mg/kg d.w. are given for mercury, cadmium and lead. The results represent year-round averages in those instances where such data were produced. The kelp samples were taken from the *lamina* in the growth zone. The banded chink shells were analysed with shell on. The results for the common limpets shown are those for individuals sampled in Kirkjubøur only, with an average shell base diameter of 4 to 6 cm. The results for the blue mussels refer to individuals in the size regime of shell length 3 - 4 cm.

species	tissue	no. indiv.	Hg	Cd	Pb
kelp	lamina	125	<0,20	5,3	0,28
sea-urchin	gonads	54	<0,15	0,76	0,15
b. chink shells	whole body	502	na	1,62	0,09
c. limpets	soft parts	361	<0,12	40,5	0,57
b. mussels	soft parts	210	0,11	1,47	0,82
starfish	whole body	25	0,12	1,37	7,03
dab	liver*	120	0,10	2,54	<0,4
black guillemot	liver	88	2,44	3,68	<0,06

na; not analysed.

* mercury in muscle.

1 Study areas / Sampling

1.1 Kirkjubøur

Kirkjubøur is a small village situated on the southernmost tip of Streymoy (Figure 1.1.1). There are approximately 50 inhabitants in the village, which comprises a green house, and in local terms, a large farm. The driving distance between Kirkjubøur and the capitol Tórshavn is about 12 km. Kirkjubøur is a historic site and receives many visitors to the remains of the medieval Magnus Cathedral, known as *Múrurin*.

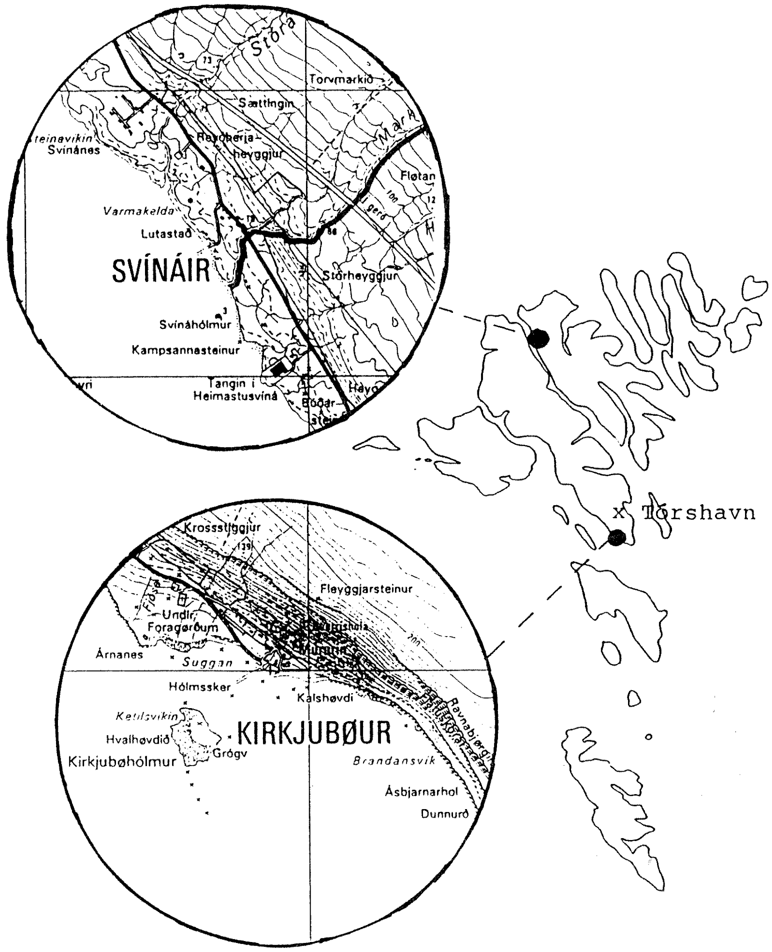
At the beach, south of the headland Árnanes, small horse mussels occur. Árnanes is a rocky headland with small semi-enclosed dams that are filled with seawater at intervals depending on tidal and wave actions. There are lots of *Ascophyllum nodosum, Corallina officinalis, Fucus sp*., some *Cladophora rupestris*, *Rhodymenia palmata* and *Halichondia panica.* Kelp (*Laminaria hyperborea)* is abundant below the tidal zone.

Near the church there is a breakwater extending towards the Kirkjubøholm. South of this breakwater large quantities of kelp are washed ashore and quite often sheep can be seen foraging on these. Nowadays dab is regularly caught off this area, and eel was taken here in earlier days. There are Acorn barnacles *(Balanus balanoides*) and common limpets (*Patella vulgata)* and dogwhelks *(Nucella lapillus)* are prominent on the headland. Grey topshell *(Gibbula cineraria)* are abundant, and sometimes periwinkles (probably mainly *Littorina obtusata*) are seen in large quantities on rocks and boulders in the bay.

Birds are present year round. Dominant species are common eiders, terns and gulls. Shags forage in the area and black guillemot breed in the vicinity, less than 2 km distance from the breakwater.

The site may be described as a part of an extremely exposed coast with regard to wave action, even though the breakwater offers some shelter to the bay area a little south of the headland where the main sampling was carried out. The tidal zone, that is the difference in height between the highest and the lowest tide, is somewhat less than 70 cm.

Figure 1.1.1 The Faroe Islands in scale 1:1000 000, with enlarged parts showing the sampling sites Svínáir and Kirkjubøur in scale 1: 20 000.



Svínáir

Svínáir is a small village with c. 20 households on the western shore of Eysturoy, see map (Figure 1.1.1). Svínáir is situated in the northern part of the sound between Streymoy and Eysturoy. This part of the sound is named Sundalagið Norð and it is restricted by two thresholds, one to the south and one to the north. The thresholds limit the exchange of water masses in the deeper parts of the sound whereas the water flux at the surface, especially at the southern threshold in the narrow Streymnes, can be very high. At Streymnes there is a bridge connecting the two islands, and the driving time between Svínáir and Tórshavn is c. 40 minutes.

The main attraction of Svínáir in the present project is a relatively large population of blue mussels at the outlet of the river Stórá. Here the mussels have shelter, fresh water and presumably an addition of nutrients from the nearby households. Originally the most desirable site for mussel sampling should be a remote area, but it appears that mussels will only thrive near people or a fish farm.

Until a few years ago there were substantial fish farming activities in the Sundalagið Norð. Nowadays the fish farming industry has moved out of the fjords or into areas where the exchange of water masses is more frequent. However, some fish farming is still carried out in the vicinity of Svínáir. Also of relevance in this respect is the growth-proofing facility for fish farming nets situated in Norðskáli, c.1 km south of Svínáir.

Common eiders occur in the area all year round; in the summer the oystercatcher is also commonly seen. Air bladder algae species dominate, especially the knotted wrack (*Ascophyllum nodosum)*. Kelp *(Laminaria hyperborea)* is rare, whereas the sugar kelp *(Laminaria saccarina* or *Laminaria faroensis)* does occur. Just south of the river outlet there are quite a few dogwhelks and some common limpets *(Patella vulgata)*.

1.2 Sea temperature

The Faroese Office of Public Works (*Landsverkfrøðingurin*) and the Faroese Fisheries Laboratory (*Fiskirannsóknarstovan*) monitor sea current and temperature at seven locations around the Faroese coast.

According to measurements in Mykines made by the Faroese Fisheries Laboratory, in the period 1914 - 1950, the sea temperature along the coast varied between c. 6°C during the coldest period (March) and nearly 10°C during the mildest (August), although in later years temperatures have been slightly lower, especially during late winter and spring.

During the period January 1993 to June 1994 the Faroese Office of Public Works measured the sea temperature at Kirkjubøur. The temperature was recorded with a six times per hour frequency, and the average monthly temperatures are shown in Table 1.2.1

When these measurements are compared to those made by the Faroese Fisheries Laboratory in the same sound (at Oyragjógv) but further west, (Table 1.2.2), we notice that the temperature fluctuations during the year are larger in Kirkjubøur than at Oyragjógv. The reason for this is that the Kirkjubøur site is a shallow water area, whereas Oyragjógv is at a deeper part of the sound near the neck where the water flux reaches its highest level. In addition to this are the allegedly higher temperatures reached in the Kirkjubøur area due to certain geographic/topographic circumstances.

Temperature recording in Kirkjubøur ended in June 1994, and since then a new monitoring station has been established c.1 km further north near the new ferry quay Gamlarætt.

There is no sea temperature monitoring in Svínáir, but c. 3.5 km north, in Eiði, there is a measurement site. The monitor is situated in a semi-enclosed harbour basin, and it is therefore not surprising that the temperature variations in Eiði are similar to those in Kirkjubøur (Figure 1.3.1).

Monthly averages for six stations are shown in Figure 1.3.2 [1]. There is a tendency to greater variations in sea temperatures at the sites with calmer water masses, but the overall picture is one of small variations in temperature between the different sites.

Table 1.2.1 Monthly averages in sea temperature at Kirkjubøur. Depth of measurements approx. 1.5 m, total depth at measurement site approx. 2 m. Source: Faroese Office of Public Works.

	Jan.	Feb.	Mar.	Apr.	Mai	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Des.
1993	5.7*		5.8	6.4	7.6	8.3	9.1*		9.4*	7.9	7.6*	5.7
1994	5.0	5.1	5.0*	6.0*	7.2	8.2*						

*: Based on less than 4000 separate readings.

Table 1.2.2 Monthly averages in sea temperature at Oyragjógv. Frequency of measurements:1 per hour. Depth of measurements approx. 1.5 m, total depth at measurement site approx. 5 m. Source: Faroese Fisheries Laboratory.

	Jan.	Feb.	Mar.	Apr.	Mai	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Des.
1993	6.2	5.9	5.9	6.2	6.9	7.7	8.4	9.0	9.2	8.6	8.0	6.8
1994	6.0	5.7	5.5	5.8	6.8							

Table 1.2.3 The differences between monthly sea temperature averages in Kirkjubøur compared to Oyragjógv. ($t_{diff} = t_{Kirkj.} - t_{Oyr.}$) Source: Faroese Office of Public Works and Faroese Fisheries Laboratory.

	Jan.	Feb.	Mar.	Apr.	Mai	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Des.
1993	-0.5	-	-0.1	0.2	0.7	0.6	0.7	-	0.2	-0.7	-0.4	-1.1
1994	-1.0	-0.6	-0.5	0.2	0.4							

[1] The measurements from Vágur on Suðuroy were irregular in this period and are therefore excluded.

Figure 1.2.1 Monthly averages in sea temperature, °C, at selected sites in the Faroe Islands. Source: Faroese Office of Public Works (Heinesen 1996) and Faroese Fisheries Laboratory (Hansen 1996).

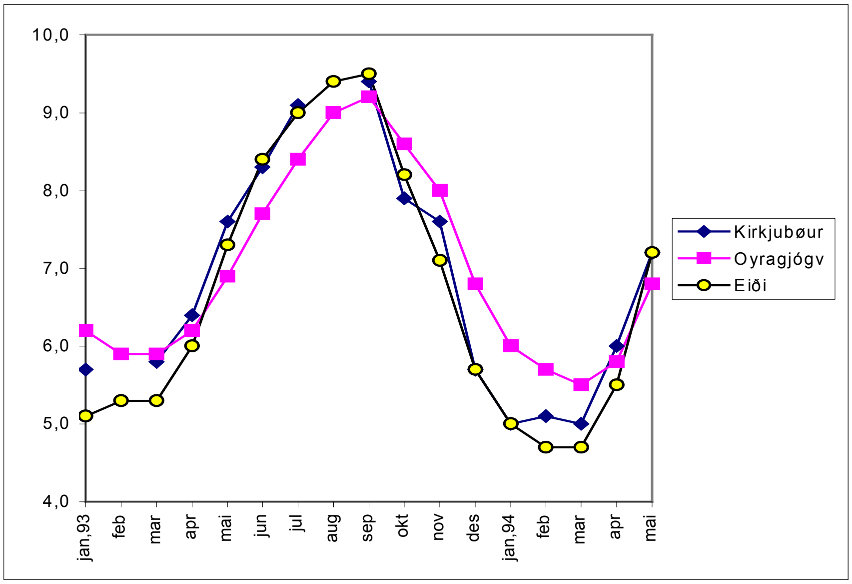
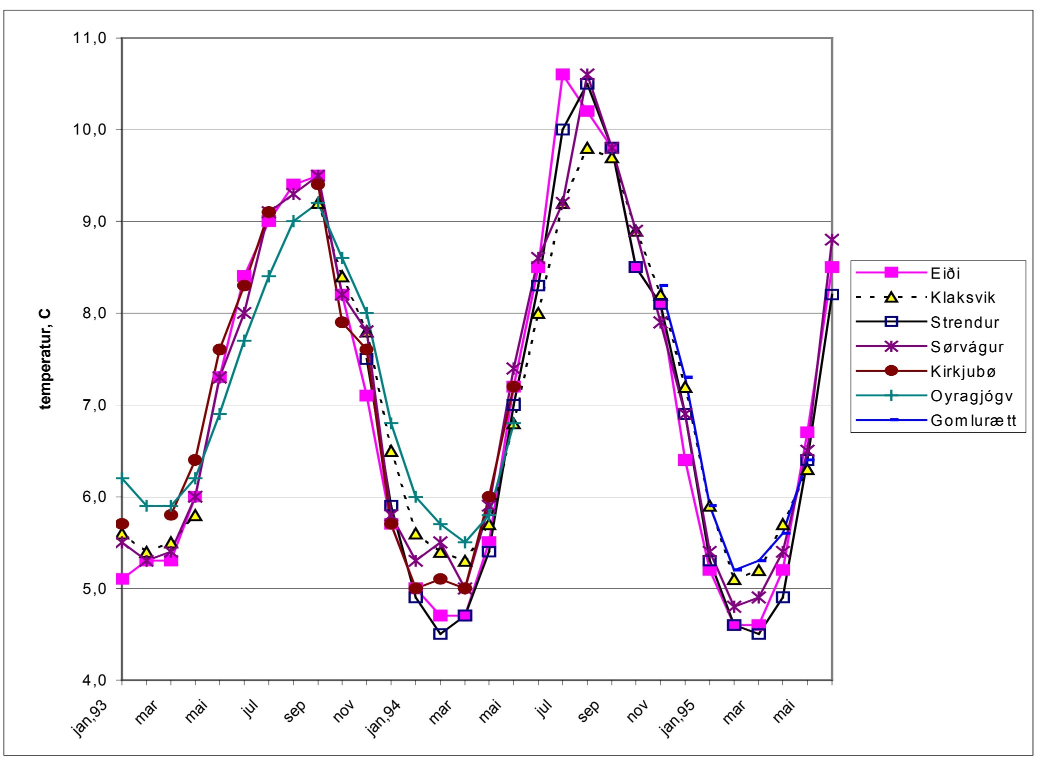


Figure 1.2.2 Monthly averages in sea temperature, °C, at coastal sites around the Faroe Islands. Source: Faroese Office of Public Works (Heinesen 1996) and Faroese Fisheries Laboratory (Hansen 1996).



2 Biological parameters

The selection of parameters that were recorded differed among species, and these are described in the beginning of each subsection dedicated to the various indicator species. However, in general terms attempts were always made to describe the parameters for all species, that is the lengths and sizes, that are either known to or are at least thought to affect the level of pollutants. The resources are never unlimited though, and sometimes some simplifications in sample treatment/ processing were found necessary. It must also be admitted that the species that were hardest to obtain, typically the protected species, were also those that received the greatest attention in the laboratory. However, there were also some very easily attainable species that were considered worthwhile to spend extra resources on. An example of the former is the black guillemot, which is protected from hunting all year round in the Faroe Islands, as in many other countries. The latter is represented by common limpets in the Faroes, which are not as common in Iceland.

One parameter which was always measured was the content of dry matter in the samples. This value, which may be inverted to describe the water content, is on the limits of what may be called a biological parameter. But because the dry matter percentage, like the fat content, gives an indication of the condition of the sample, it is included as a biological parameter here. The particular reason for measuring the dry weight in this project was primarily to ensure the compatability of the results of this study with those of other studies.

3 Chemical analysis

3.1 Pretreatment

With few exceptions, all measurements are made on pooled samples. The pools were normally made up of 25 individuals. Blue mussel samples however, consisted of soft parts from 50 individuals.

For homogenising, only glass vessel blenders with steel cutters were used. For the fillets of dab and long rough dab, however, plastic vessel blenders were used.

For simplicity the tissue samples were often stored in polyethylene bags (Minigrip®, low density polyethylene).

Homogenised material was stored at c. -20 °C. Some of the homogenised samples were stored in heat-treated glass vessels with similarly treated aluminium foil under the screw cap until analysis.

The heat-treatment of glass jars and aluminium foil was done to evaporate traces of organic material that could otherwise contaminate the samples, and involved heating to c. 400 °C for about 4 hours.

Animal tissue was analysed without previous drying. However, in order to simplify comparisons to other analyses, the dry weight percent was routinely determined parallel to the heavy metal analysis.

The method and accuracy of the analysis is also described in Appendix B, where limits of detection as well as results for analysis of reference materials are specified.

3.2 Metal analyses

Metal analyses were done at the chemistry laboratory of the Food- and Environmental Agency of the Faroe Islands (*Heilsufrøðiliga Starvsstovan*). The laboratory is certified for most of the relevant analyses. In instances were non-certified methods were used, a simultaneous analysis of reference material was performed for quality control.

3.3 Organochlorines

Organochlorines, such as PCB, pesticides as *p,p´*-DDT and its metabolites, γ-HCH (Lindane) and HCB were analysed at NIVA (the Norwegian Institute for Water Research). NIVA participates in Quasimeme intercalibration exercises.

PCB-53 was added to the freeze dried, homogenised material as an internal standard. This material was then extracted twice with a cyclohexane/acetone mixture using ultrasound disintegration. The samples were then centrifuged and the total centrifugate was evaporated to dryness for determination of lipid content. For further analysis of biological samples, known aliquots of the fat are taken out and dissolved in cyclohexane and thereafter purified and saponified in concentrated sulphuric acid.

Prior to quantitative analysis the extract is evaporated to the specified volume in small, previously glowed sample tubes. Identification and quantification of the organochlorines are then performed with a gas chromatograph (GC) using a 50 m capillary column and electron capture detection (ECD). Quantification is based on an eight-point standard graph, and the concentrations of all the parameters to be quantified are adjusted to be within the linear part of the graph.

The quality assurance of the analysis includes the analysis of reference material for every 10th sample on the GC, as well as regularly repeated control of the full procedure by analysing internationally certified reference material, analysing blinds as well as frequent calibration of the instruments using 8 point standard graphs.

The laboratory states that an error interval equal to plus/minus 10% on PCB analysis is reasonable to assume, see also Appendix B.

3.4 PAH

A modified version of Grimmer and Bøhnkes method was used (Grimmer & Bøhnke 1975). After the homogenisation, the sample is dosed with internal standards and then saponified by heating with KOH/methanol. PAHs are then separated from the solution by extraction with cyclohexane. The extract is purified with methanol: water before further purification with DMF: water partitioning and chromatography on a silicagel column.

The analysis is done with gas chromatography using mass selective detection (GS/MSD).

Identification is based on retention times and/or significant ions. The quantification is based on the internal standards.

The quality control of the PAH analysis method includes analysis of certified reference material (blue mussels). The gas chromatograph is regularly calibrated and is frequently controlled by analysing standards.

4 Kelp

Kelp (*Laminaria hyperborea);* in Faroese *tonglatari*

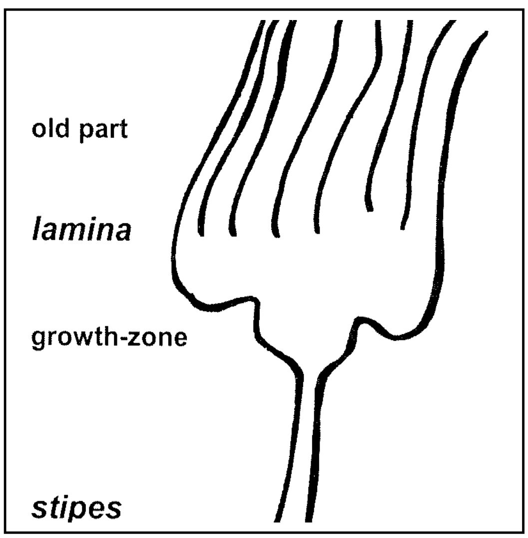
4.1 Sampling

Sampling was done by divers in Kirkjubøur in the area south of the Árnanes headland and north of the breakwater. When sampling, the *lamina* plus c. a half-meter of the *stipes* were taken of between 20 and 25 individuals. Sampling was done 4 times a year, once every season, first time in March 1996.

Subsampling in the laboratory was done by cutting a subsection of the *lamina* near the growth zone. *Stipes* were not included in the samples. The subsection consisted of a square of c.15 cm by 15 cm. This piece weighed from 35 to 55 grams depending on the season. The *lamina* from the early spring samples were thinner and lighter than those cut later in the growth cycle. In general, kelp which was severely damaged by wave action or covered in fungi was excluded from the samples taken for chemical analysis.

The samples were dried at 40°C for up to 3 days prior to analysis. This low-temperature drying was chosen to avoid excessive loss of mercury.

Figure 4.1.1



Frequently encountered in the laboratory as by-catch on *Laminaria hyperborea* were *Gibbula cineraria*, *Patina pellucidae*, *Lacuna divericata* and *Idotea sp*.

4.2 Growth cycle

Notes from the sample preparations:

March '96: Samples were taken from 29 individuals, the total delivered was 30, but one *lamina* was deemed to be too small and was excluded. Total wet weight of sample was 1305g. A square, approx. 15 x 15 cm, was cut from every *lamina* near the growth zone. *Lamina* was typically thin and soft, with a few exceptions only there were no remains of the old *lamina*. Mean fresh weight; 0,20 g/cm^2.

June '96: 19 individuals. Total wet weight of sample was 1152 g. Mean fresh weight; 0.27 g/cm^2.

Oct. '96: The algae appeared in general more worn and unhealthy. 23 individuals. Total wet weight of sample was 1265 g. Mean fresh weight; 0.24 g/cm^2.

Dec. '96: New, small sprigs had appeared on some individuals and, when present, these were included in the samples. 27 individuals. Total wet weight of sample was 1396 g. Mean fresh weight; 0.23 g/cm^2.

March '97: large, new sprouts had grown out. The smallest was c. 30 cm in width and 13 cm in length. 26 individuals were delivered, but one was excluded due to an unhealthy appearance. The sample is almost entirely made up of new *laminas*.

4.3 Pollutant concentrations

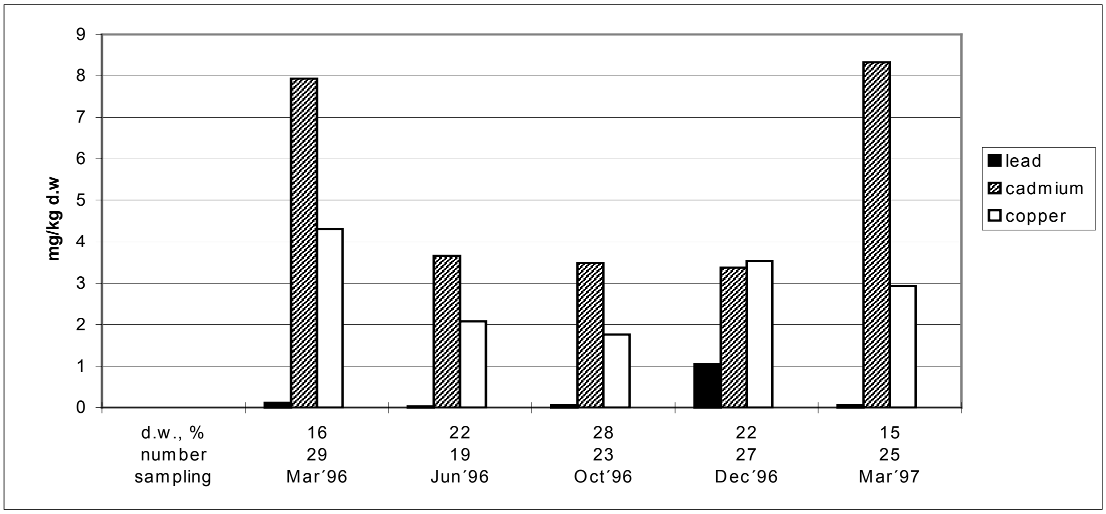
Heavy metals

Kelp from the four seasons was analysed for the concentrations of the metals lead, cadmium, copper and mercury (Figure 4.3.1).

Table 4.3.1 Kelp, pooled samples.

	March´96	June´96	Oct.t´96	Dec´96	March´97
No of individuals in samples	29	19	23	27	25
Dry mass, weight %	16	22	28	22	15
Mercury, mg/kg dry weight	<0,02	<0,02	<0,02	<0,02	<0,02

Figure 4.3.1 Kelp, concentrations of metals, in mg/kg d.w. Sample description in Table 4.3.1.



The results from the metal analysis in kelp were similar to those from Greenland, even though the results from the Greenland study referred to another algae species (Riget *et al.* 1995). Analysis of seasonal variations in metal concentrations in bladder wrack (*Fucus vesiculosus)* from Greenland showed a similar tendency to maximum concentrations of cadmium in early spring, in February, c. 5.5 mg/kg d.w., and minimum levels in August, c. 2.5 mg/kg d.w. The year-round mean value for copper in Greenland was in the range of 2 to 3 mg/kg d.w, and that of lead was c. 0.33 mg/kg d.w.

The results of an investigation of heavy metals in *Laminaria sp*. from a Faroese fjord, Skálafjørður, from May 1992 (*Skálafjordsundersøgelsen 1992*) are not comparable to those in the present study (Figure 4.3.1). The cadmium concentrations in the *Laminaria sp*. from Skálafjørður were significantly lower by a factor of 100, whereas the copper and lead concentrations were higher, copper between 4 and 8 mg/kg d. w and lead between 2 and 4 mg/kg d.w. In the present study the year-round mean lead concentration was 0.27 mg/kg and copper was 2.9 mg/kg.

5 Limpets / Banded chink shell

In Faroese, banded chink shells (*Lacuna divaricata)* are referred to with the common term used for small snails found in the littoral zone - *kúvingur*, while limpets (*Patella vulgata)* are known as *fliðir*.

5.1 Sampling

The common limpet is widespread around the coast of the Faroe Islands. This little animal of the subclass Prosobranchia of the Gastropoda is one of the few inhabitants of the partly extremely exposed coasts. The common limpet sucks itself fast to the rocks, feeding on a thin film of algae, and is known to stay at the same location more or less permanently (Hartnoll & Wright 1977; Küfner 1988). The limpet is however indeed able to move, but this seldom leads to it relocating.

In the Faroes, limpets are said to occasionally drown the oyster-catcher. This happens when the bird gets trapped between the limpet and the rock. These unfortunate birds have failed to hack off the limpet at the first attempt, and have been slow to retract their beaks, hence becoming caught in the strong grip of the limpet as it strengthens its hold on the substratum in response to disturbances.

Limpets for chemical analysis were collected in Kirkjubøur at the southwestern coast of the island Streymoy.

The banded chink shells, *Lacuna divaricata* or *L. vincta*, were taken only incidentally as a by-catch with the kelp, except for the sampling in March 1996. The March 1996 sampling of c. 200 individuals was found to be too laborious to be repeated with the appropriate frequency in the future, hence the snail was abandoned as an indicator species in favour of another grazer, the common limpet (*Patella vulgata)*. The substantial by-catch of chink shells was an unexpected bonus (Table 5.1.), and the snails were analysed for heavy metals.

Table 5.1.1 *Lacuna divaricata*, Kirkjubøur.

Date of sampling	28 Mar. 96	1 Oct. 96	18 Dec. 96	21 Mar. 97
Days until dry, spent in oven at 40^0 C	6	6	5	6
Number of individuals in samples	192	119	112	79
Wet weight, including shells	23,28	11,13	18,5	9,70
dry weight, including shells	9,28	5,52	8,32	4,04
dry weight, weight %	40%	50%	45%	42%
Mean individual wet weight of snail, g	0,12	0,09	0,16	0,12
Method of sampling	Collected by hand	by-catch on kelp	by-catch on kelp	by-catch on kelp

5.2 Reproduction cycle

For reproduction cycle analyses, samples from Kirkjubøur and from Velbastaður were used. The Velbastaður location is four kilometres to the northwest along the coast from Kirkjubø

The spawning period was determined as described in Orton *et al.* (1956). To spare the population at Kirkjubø, samples of about 50 individuals of various sizes were collected each month from Velbastaður, after the collection of limpets from Kirkjubø for chemical analyses was completed by March 1997. The material for reproduction cycle determination is shown in Table 5.2.2.

The sex was determined by visual inspection of the gonad color. This method is decribed in J.H.Orton *et al.* (1956), and was recommended to us by Dr Stephen Hawkins, Uni. of Southampton.

The colors of the gonads are:

Green to olive, granular gonads = female

Pink to cream, smooth gonads = male

Brown, small gonads, the color similar to that of a kidney bean = neutrum

The neutrum is the resting stage in the reproduction cycle. In this stage the sex of the limpet cannot be determined by the visual method used.

The actual maturity grades of the gonads are decribed by a series of developing and spawning stages in Orton *et al.* (1956). The developing and spawning stages are numbered from 1 to 5 for both male and female gonads. However, the distinction between the spawning and developing stages is difficult if not impossible to determine without extensive training and it was found to be sufficient for the present purpose to use a simplified version of the Orton gonad index scale (Table 5.2.1).

Table 5.2.1 Gonad index scale, modified, after Orton *et al.*1956

Gonad character-istica	**Gonad index**			
	1	**3**	**5**	**5+**
	Developing stages			***Spawning stage***
Female	Green to olive color emerges	The gonad fills about ¾ of the area of the visceral mass.	The gonads are large and bulging, and more than fillthe space between the foot and the visceral mass.	The eggs of the gonad are obviously mature as in stage 5, but the gonad appears more loose and tends to shrink.
Male	The male gonad cream to orange color emerges	The gonad fills about ¾ of the area of the visceral mass.	The gonads are large and bulging, and more than fill the space between the foot and the visceral mass.	The gonad is obviously mature as in stage 5, but does not appear as tense.
Neutrum	The gonad index 0 describes a neuter			

Analysis of the gonads revealed that the spawning period was mainly November (Figure 5.2.1), with a resting period in the neuter stage during spring.

Limpets in the UK become sexually mature at a size of about 15 mm in shell-base diameter (Blackmore 1969). They start out as males and turn to females when older (Orton 1946).

The spawning season is autumn and there are only small variations between years and locations. The event is triggered by storms. In Scotland the spawning season is mainly November (Hawkins, pers. comm.).

In another source we learn that the spawning season in Southeast Norway is late autumn (Kleppe 1981).

Figure 5.2.1 Seasonal variations in female and male gonad index.

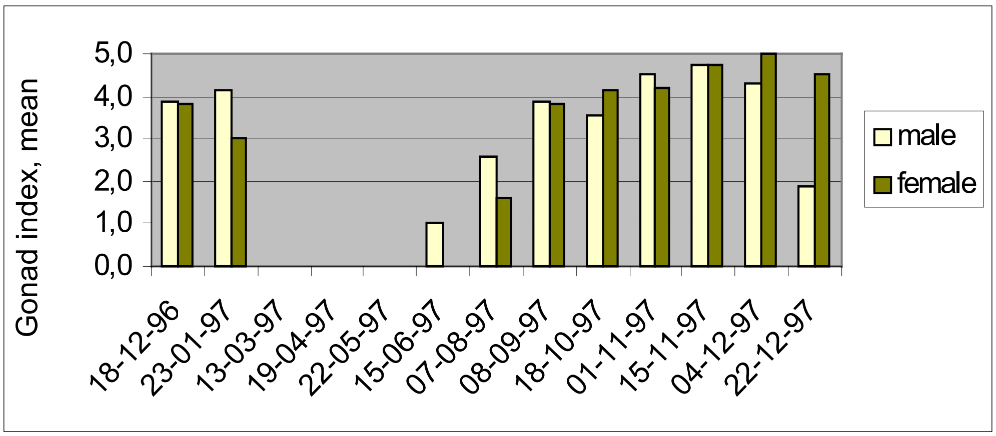


Table 5.2.2 *Patella vulgata* sampled for reproduction cycle analysis. All samples were taken at low tide in Kirkjubøur or in Velbastaður.

Sampling no.	1	2	3	4	5	6	7	8	9	10	11	12	13
Sampling date	181296	230197	130397	190497	220597	150697	070897	080997	181097	011197	151197	41297	221297
Location	Kirkjubø.	Kirkjubø.	Kirkjubø.	Velbast.	Velbast.	Velbast.	Velbast.	Velbast.	Velbast.	Velbast.	Velbast.	Velbast.	Velbast.
No. individuals	33	30	40	59	55	61	51	53	63	61	69	52	57
%Females	*30%*	*13%*	*0%*	*0%*	*0%*	*0%*	*10%*	*49%*	*37%*	*26%*	*20%*	*13%*	*14%*
% Males	*70%*	*27%*	*0%*	*2%*	*0%*	*10%*	*43%*	*51%*	*54%*	*72%*	*78%*	*54%*	*47%*
% Neutrum	*0%*	*60%*	*100%*	*98%*	*100%*	*90%*	*47%*	*0%*	*10%*	*2%*	*1%*	*33%*	*39%*
Shell diameter, cm													
all	4,0	4,6	4,6	3,9	4,0	4,2	4,1	4,4	3,8	4,2	4,0	3,8	3,9
Neutrum	*na*	*4,6*	4,6	*3,9*	*4,0*	*4,2*	*3,7*	*na*	*3,5*	*2,0*	*1,8*	*4,2*	*3,9*
Female	*4,2*	*4,4*	*na*	*na*	*na*	*na*	*4,8*	*4,5*	*4,2*	*4,4*	*4,5*	*4,3*	*4,4*
male	*3,9*	*4,9*	*na*	*4,5*	*na*	*4,4*	*4,3*	*4,3*	*3,6*	*4,1*	*3,9*	*3,5*	*4,6*
Gonad index													
Female, mean	3,8	3,0	na	na	na	na	1,6	3,8	4,1	4,2	4,7	5,0	4,5
min.	1	3	na	na	na	na	1	1	2	3	4	5	3
max.	5	3	na	na	na	na	2	5+	5	5	5	5	5+
Male, mean	3,9	4,1	na	na	na	1,0	2,6	3,9	3,5	4,5	4,8	4,3	1,9
min.	1	1	na	na	na	1	1	1	1	3	4	1	1
max.	5	5	na	na	na	1	4	5+	5+	5+	5+	5	5+

5.3 Sex and size distribution

There is an overabundance of males in relation to females in the material collected, both from Kirkjubøur and from Velbastaður, (Table 5.3.1). This is in agreement with observations in Scotland (Orton *et al*. 1956)

Table 5.3.1 The distribution of the sexes in the material used for reproduction cycle analysis.

Sampling period	Dec´96-mar´97	Apr´97-dec´97	all 1997
Location	Kirkjubøur	Velbastaður	Kirkjubøur/Velbastaður
No. individuals	103	581	684
%Females	14%	17%	17%
% Males	30%	42%	40%
% Neutrum	56%	41%	43%

Table 5.3.2 The size-related distribution of males and females in the limpets collected for gonad index analysis, all limpets were shown in Table 5.3.1.

		Kirkjubøur			Kirkjubøur Total	Velbastaður										Velbastaður Total	Main Total
Shell size	Data	18-12-96	23-01-97	13-03-97		19-04-97	22-05-97	15-06-97	07-08-97	08-09-97	18-10-97	01-11-97	15-11-97	04-12-97	22-12-97		
1,7	Number of Male																
	Number of Female																
1,8	Number of Male													1		1	1
	Number of Female																
1,9	Number of Male												1			1	1
	Number of Female																
2	Number of Male												3			3	3
	Number of Female																
2,1	Number of Male											1				1	1
	Number of Female																
2,2	Number of Male										1		1	1	2	5	5
	Number of Female																
2,3	Number of Male												1	1	1	3	3
	Number of Female																
2,4	Number of Male							1								1	1
	Number of Female																
2,5	Number of Male										1	2			1	4	4
	Number of Female																
2,6	Number of Male										3	1	1	1		6	6
	Number of Female																
2,7	Number of Male										1	1				2	2
	Number of Female																
2,8	Number of Male									1	1			1	1	4	4
	Number of Female										1					1	1
2,9	Number of Male									1	1		2	3	1	8	8
	Number of Female										1					1	1
3	Number of Male										1	1	1		2	5	5
	Number of Female																
3,1	Number of Male	1			1					2	2	3			1	8	9

cont. Table 5.3.2 The size related distribution of males and females in the limpets collected for gonad index analysis, all limpets were shown in Table 5.3.1.

		Kirkjubøur			Kirkjubøur Total	Velbastaður										Velbastaður Total	Main Total
	Number of Female										1		1			2	2
3,2	Number of Male	2			2				1		1		2	1		5	7
	Number of Female																
3,3	Number of Male	1			1						2	1	2	4		9	10
	Number of Female																
3,4	Number of Male										1		1	1		3	3
	Number of Female									1						1	1
3,5	Number of Male	1			1				2	1		1	6	2		12	13
	Number of Female	1			1					1		1				2	3
3,6	Number of Male	1			1				1	2	3	1		2	1	10	11
	Number of Female									1	1		1		1	4	4
3,7	Number of Male	1			1					3			2	1		6	7
	Number of Female										1	1	1			3	3
3,8	Number of Male	4		1	5				1		1	2	3	1	2	10	15
	Number of Female									2	2					4	4
3,9	Number of Male	2			2						1		1		3	5	7
	Number of Female	1	1		2					2	1	1				4	6
4	Number of Male	2			2				1	1	5	2	4	2		15	17
	Number of Female	1			1				1		3	2		2	1	9	10
4,1	Number of Male			2	2				2			4	3			9	11
	Number of Female	1			1						2		1			3	4
4,2	Number of Male	3		4	7				1	2	4	3	2	1	1	14	21
	Number of Female	2			2					1	1			1	1	4	6
4,3	Number of Male	1		4	5				1			1	2	2	3	9	14
	Number of Female	2	1		3					1		2	2		1	6	9
4,4	Number of Male	2		2	4			1	1	3	1	2	2		1	11	15
	Number of Female		1		1					1		1	1	1		4	5
4,5	Number of Male	1		3	4	1		1	2			4	3	1	1	13	17
	Number of Female									4	2	1		1	1	9	9
4,6	Number of Male		1	3	4				4	1		1	1	1		8	12
	Number of Female	1			1				1	1		2		2		6	7
4,7	Number of Male		2	7	9			2	1	2		3	1			9	18

cont. Table 5.3.2 .The size related distribution of males and females in the limpets collected for gonad index analysis, all limpets were shown in Table 5.3.1.

		Kirkjubøur			Kirkjubøur Total	Velbastaður										Velbastaður Total	Main Total
	Number of Female									3		1	2			6	6
4,8	Number of Male	1	1	4	6				1		1	1			2	5	11
	Number of Female									1	2	2			2	7	7
4,9	Number of Male		2		2				1	1	1		1		1	5	7
	Number of Female								1	1	3		1		1	7	7
5	Number of Male		1	7	8					1	2	4	2		2	11	19
	Number of Female									1	1		1			3	3
5,1	Number of Male			1	1				1	1		3	2			7	8
	Number of Female		1		1							1	1			2	3
5,2	Number of Male		1	1	2					2				1	1	4	6
	Number of Female									2						2	2
5,3	Number of Male												1			1	1
	Number of Female	1			1				1	1	1	1				4	5
5,4	Number of Male								1	1						2	2
	Number of Female								1	1			1			3	3
5,5	Number of Male									2		1	1			4	4
	Number of Female									1			1			2	2
5,6	Number of Male							1								1	1
	Number of Female																
5,7	Number of Male												1			1	1
	Number of Female																
5,8	Number of Male											1	1			2	2
	Number of Female																
5,9	Number of Male			1	1												1
	Number of Female																
Total Number of Male		23	8	40	71	1		6	22	27	34	44	54	28	27	243	314
Total Number of Female		10	4		14				5	26	23	16	14	7	8	99	113

5.4 Pollutants

Limpets

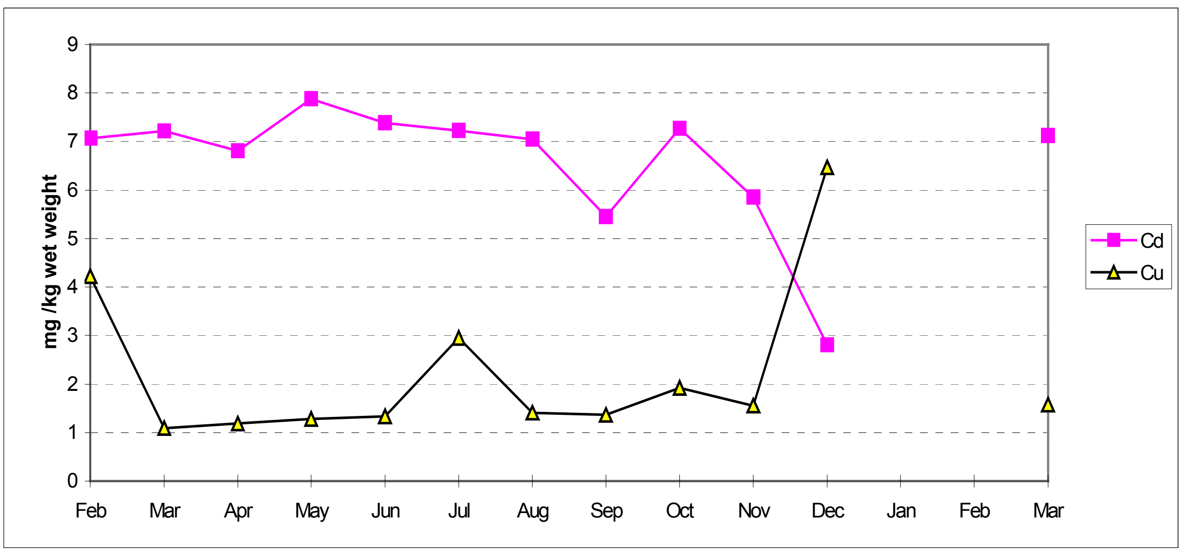
Limpets of medium size were collected monthly starting in February 1996 and continuing to March 1997, so as to span a full year. Limpets were stored in double PE-bags at about -18°C until analysis.

Metals

Table 5.4.1. Characteristics of pooled samples of limpets collected in Kirkjubøur. Only soft parts were analysed. The size equals the largest diameter of the base of the shell. Concentrations of mercury are given in mg/kg wet weight.

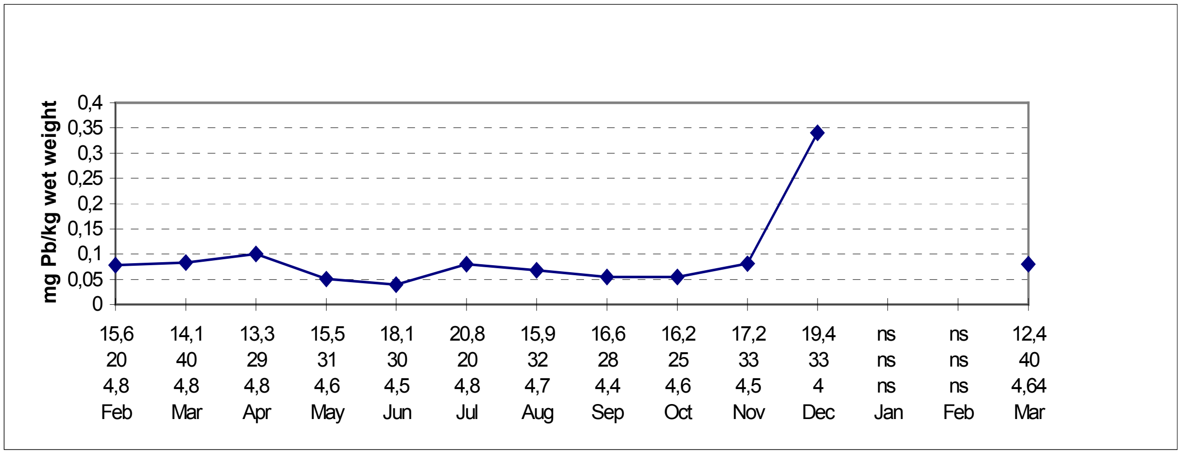
	Feb´96	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mar´97
Size, cm	4,8	4,8	4,8	4,6	4,5	4,8	4,7	4,4	4,6	4,5	4,0	4,64
Number	20	40	29	31	30	20	32	28	25	33	33	40
Dry weight, %	15,6	14,1	13,3	15,5	18,1	20,8	15,9	16,6	16,2	17,2	19,4	12,4
Mercury	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02

Figure 5.4.1 Copper and cadmium in soft parts of limpets collected in Kirkjubøur. More data for these limpets are shown in Table 5.4.1.



The December 1996 sample appears to be different from the others, both because the copper and in particular the lead concentrations are remarkably high, but also in that the cadmium concentration is much lower than at other times during the year. The average size of the December ´96 limpets were smaller than in the other samples; the size-related variations are shown in Figure 5.4.3 and Figure 5.4.4. It appears that the natural variations are inverse to what is observed from Kirkjubøur, so the extraordinary results for the December sample (Figure 5.4.1 and Figure 5.4.2) cannot be explained as size-dependent.

Figure 5.4.2 Lead in soft parts of limpets collected in Kirkjubøur. More data for these limpets are shown in Table 5.4.1. Concentrations are in mg/kg wet weight. The following data for the samples are shown under the graph (from top):, dry weight % of sample, number of individuals in sample, mean diameter of shell base and month of collection. ns: no samples taken.



Calibration curve

A number of limpets were collected at Velbastaður during August 1996. This material consisted of limpets in all sizes. The shell-lengths were measured, the largest diameter of the base of the limpet, and the individuals were pooled according to size, from 2 cm up to 6 cm, in groups of 0.5 cm intervals (except the group with the smallest animals, which comprised all limpets whose shell-lengths were larger than or equal to 2 cm, but shorter than 3 cm). These pools were analysed with respect to heavy metals, and a "calibration curve" was constructed, showing the heavy metal concentration as a function of size.

Figure 5.4.3 Calibration-curve. Copper and cadmium in soft parts of limpets collected in Velbastaður, 27 August 1996. Units are mg/kg wet weight. The concentrations are shown as functions of the diameter of the limpet shell base.

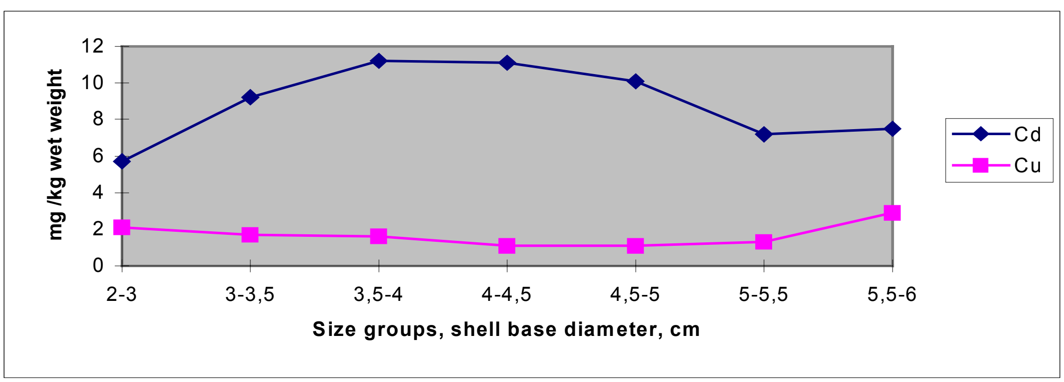


Figure 5.4.4 Calibration-curve. Lead in soft parts of limpets collected in Velbastaður, 27 August 1996. Units are mg/kg wet weight. The concentrations are shown as functions of the diameter of the limpet shell base.

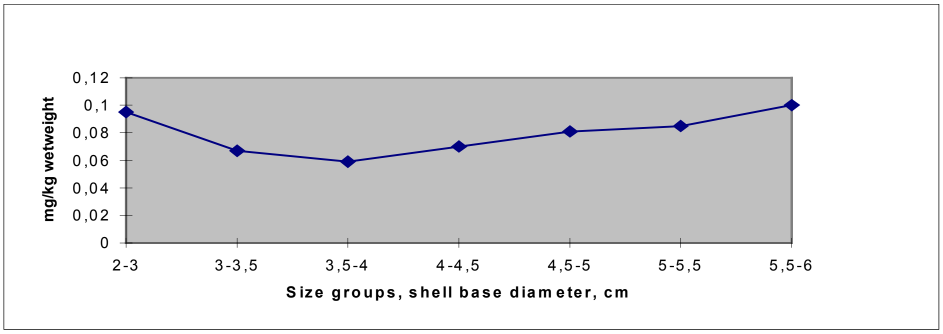
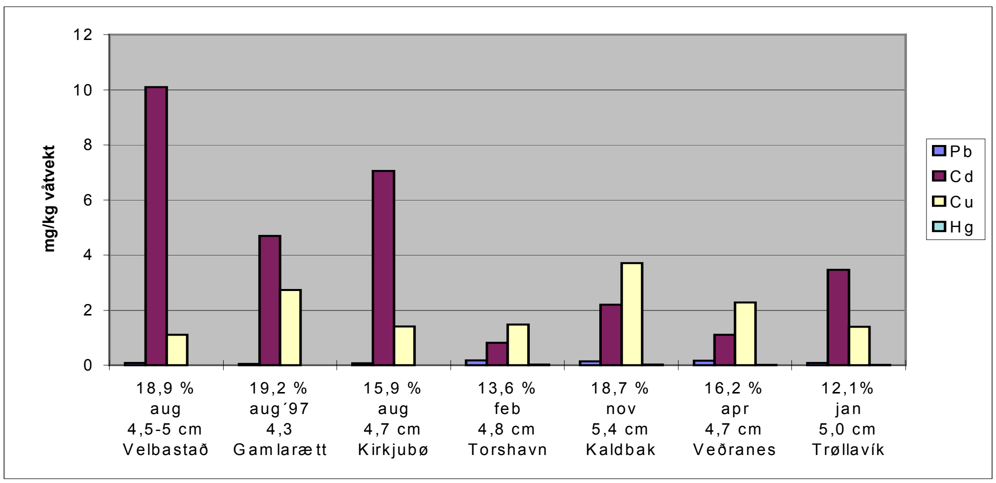


Figure 5.4.5 Metal concentrations, mg/kg wet weight soft parts, in limpets collected from various localities around the Faroe Islands, when not otherwise stated, the sampling was done in 1996.



Organochlorines

Limpets collected in March, June, September and December 1996, as well as in March 1997, were analysed for PCB and pesticides. The results are given in Appendix B.

The analysis results were, with a few exceptions, lower than the detection limit at 0.05 µg/kg w.w., for PCB as well as for the pesticides. The PCB congeners that were found in quantifiable amounts were CB 153, though not in the March 1996 nor in the March 1997 samples. In the December 1996 sample, measurable amounts of CB 138 as well as the pesticides HCB, α-HCH, *p,p*-DDE and *p,p*-DDD were found, but in concentrations at or very close to the detection limit.

When the fat content in the December sample is taken into account, it appears that the reason for the measurable amounts of pesticides is not that the actual concentration is higher, but rather that the amount of fat and therefore fat-soluble substances is highest in this batch.

Table 5.4.2 The sum of the “seven Dutch” PCB congeners in limpets, see also Table 5.4.1.

	March´96	June´96	Sept´96	Dec´96	March´97
PCB 7, µg/kg lipid	nd	11	9	12	nd
% lipid	0,36	0,53	0,56	1,38	0,46

PAH

Four samples of limpets from 1996 were analysed for PAH. The results are shown in Appendix B. As a rule, the PAH level was very low, and not detectable at 0.2 µg/kg w.w. Exceptions were naphthalene and the methylated derivatives 2-M and 1-M naphthalene, as well as 2,6-dimethyl-naphthalene and acenaphtene. However, the concentrations were at most a factor 10 higher than the detection limit.

"Periwinkles (*Littorina littorea*) and limpets (*Patella vulgata*) tend to underestimate CPAH (that is group 1 and 2A + 2B of the IARC) and accumulate relatively more of the fraction with low molecular weight and relatively high solubility (than blue mussels)." (Cited from Naes *et al*. 1995)

Table 5.4.3 Total PAH in limpets, see also Table 5.4.1.

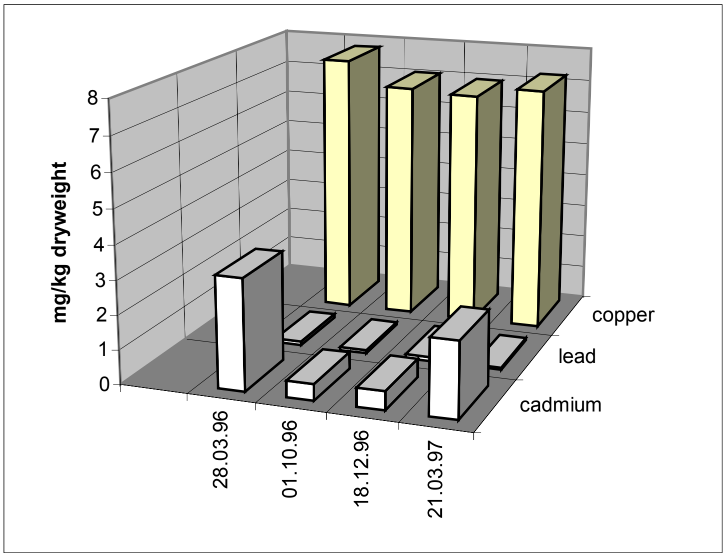
	march´96	june´96	sept´96	dec´96
Total PAH, µg/kg w.w.	0,6	5,7	3,9	2,7
Total PAH, mg/kg lipid	0,17	1,08	0,70	0,20

Banded chink shells

In the Faroes, the banded chink shells were only analysed for the heavy metals lead, cadmium and copper. The results are shown in Figure 5.4.6.

The cadmium and copper concentrations are highest in the March samples. However, due to the limited number of samples, and the lack of a summer sample for instance, conclusions on eventual seasonal variations are not possible. The results do not, however, follow the same pattern as the heavy metals in limpets collected at the same site. The largest difference is found for copper and lead which reach the highest levels in limpets in mid-winter.

Figure 5.4.6 Concentration of selected metals in banded chink shells collected in Kirkjubøur in the period March 1996 to March 1997.



In Table 5.4.4 metal results for banded chink shells and limpets are shown along with those for two other marine snail species, dogwhelk (*Nucella lapillus*) and grey topshell (*Gibbula cineraria*). These four species are sampled at what may be considered the same locations - Gamlarætt is c. 2 km north of Kirkjubøur. Two of these are analysed with the shell on and two as soft parts only, which is manifested in the high dry-weight percentages of these species. But the most remarkable feature, which does not appear to be related to shell or no- shell, is the very high concentration of cadmium and copper in the dogwhelk. Figure 5.4.5 allows the exclusion of particulary high cadmium levels at Gamlarætt as a factor, and it can therfore be concluded that dogwhelk do contain extraordinarily high concentrations of these metals.

Table 5.4.4 Heavy metals in four marine snail species, in mg/kg d.w.
Source for *Gibbula c.* results: Dam 1999.

	*Lacuna d.**	*Nucella*	*Gibbula c.**	*Patella v.*
sampling site	Kirkjubøur	Gamlarætt	Kirkjubøur	Gamlarætt
date of sampling	Mar´96-Mar´ 97	12. Aug´97	Jun´96-Mar´97	12. Aug´97
number of ind.	502	38	297	28
dry weight, %	44%	18%	69%	19,2%
cadmium	1,62	157,8	0,7	24,5
lead	0,09	0,4	0,2	0,3
copper	7,24	265,0	16,4	14,2
mercury	na	0,1	na	<0,1

*: shell included in sample

na: not analysed

6 Blue Mussels

Blue Mussels (*Mytilus edulis)* - in Faroese *kræklingur*.

Mussels were collected on the beach where they lay exposed during exceptionally low tide. The area is flat so the periods of immersion and exposure are the same for all the individuals in the population sampled. It can therefore be assumed that the relation between age and size is quite similar throughout the population.

Blue mussels were kept alive for 16 hours in seawater taken at the sampling site prior to sample preparation. This cleansing period is especially advisable if the mussels are sampled from a muddy bottom, allowing time for the intestines to be emptied of sediments.

After the cleansing period the length and height of the mussels were recorded (Figure 6.2.1), and mussels with shell-lengths in the range 3 to 4 cm were set apart to be prepared for analyses of environmental pollutant concentrations. For this the mussels were cut open and left to drain for at least 5 minutes before the soft parts were scraped out with a stainless steal knife. Pooled samples consisting of soft parts from approx. 50 individuals were prepared at this stage.

Blue mussels to be analysed for environmental toxins were sampled four times a year. Samples for reproduction cycle studies were taken monthly from the same population.

6.1 Reproduction cycle

Figure 6.1.1 Gonad index in *M. edulis* from the Faroe Islands.

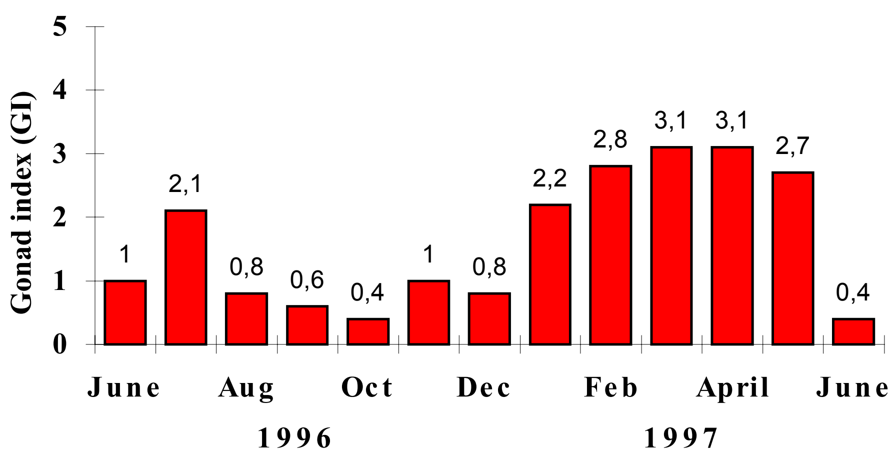


Table 6.1.1 Distribution of gonad stages in samples of *M. edulis* from the Faroe Islands.

Date	No.	Male									Spent	Female									Index
		Developing					Spawning					Developing					Spawning				GI
		I	II	III	IV	V	IV	III	II	I	0	I	II	III	IV	V	IV	III	II	I	
1996																					
18. June	30							2	3	4	13	1						2	2	3	1
26. June	29						5	3	3	3	7					1	3	4			2,1
14. Aug.	29						1	1	3	6	13	1								4	0,8
19. Sep.	28								6	4	16	1								1	0,6
14. Oct.	30								3	6	21										0,4
28. Nov.	18	5	1	2							4	6									1
19. Dec.	30	7	2						2	3	11	5									0,8
1997																					
23. Januar	31		2	1	3						3	8	4	6	4						2,2
19. Feb.	29	1	5	3	3	1							8	3	5						2,8
20. March	31			5	2	2						6	4	2	7	3					3,1
13. April	28			2	4	5					1	4	6	2	2	2					3,1
20. May	21	1					1	2			2	1	2	3	1		3	4	4		2,7
15. June	29							1	1	5	20	0								2	0,4

6.2 Size distribution

The size of all the sampled mussels was usually measured, including those that would not be subject to further analysis of gonad maturity or concentration of pollutants.

Figure 6.2.1 The height and length are measured.

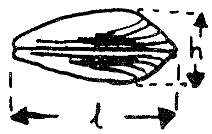


Table 6.2.1 The number of mussels whose lengths and height was measured

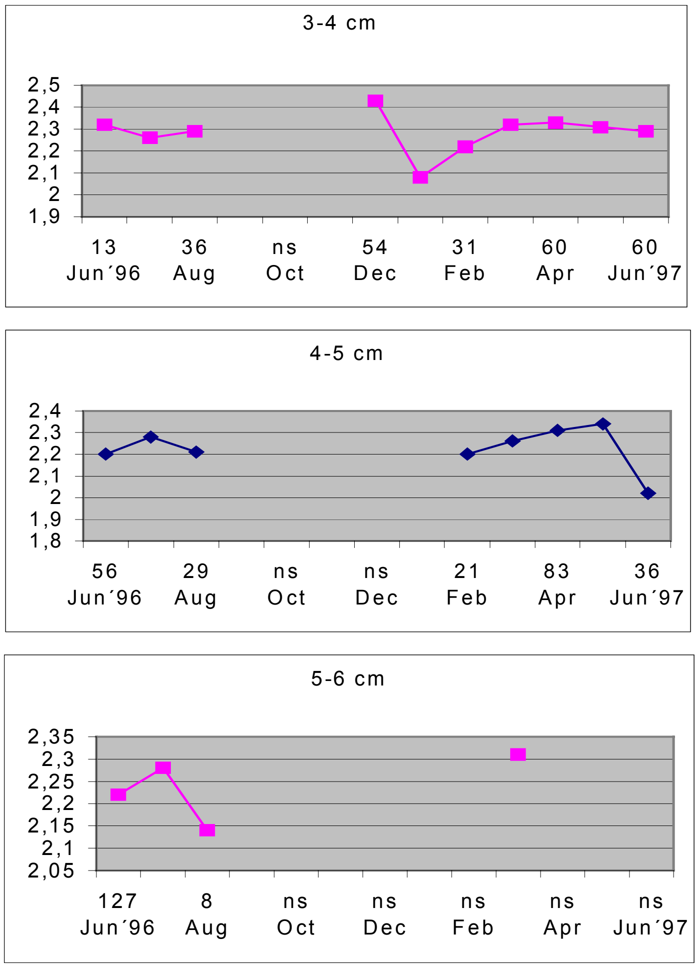
N	Jun.´96	Jul.	Aug.	Dec.	Jan.´97	Feb.	Mar.	Apr.	May	Jun.´97
3-4 cm	13	35	36	54	32	31	68	60	19	60
4-5 cm	56	27	29			21	79	83	31	36
5-6 cm	127	13	8				56			

Table 6.2.2 The shell-index, i.e. the ratio between the shell length and the height.

size-groups (shell length)	Jun.´96	Jul.	Aug.	Dec.	Jan.´97	Feb.	Mar.	Apr.	May	Jun.´97
3-4 cm	2,32	2,26	2,29	2,43	2,08	2,22	2,32	2,33	2,31	2,29
4-5 cm	2,2	2,28	2,21			2,2	2,26	2,31	2,34	2,02
5-6 cm	2,22	2,28	2,14				2,31			

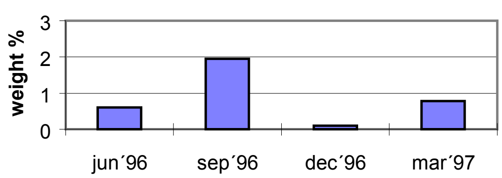
The individual shell lengths of mussels analysed for environmental pollutants are given in Table A.2.1, Appendix.A.

Figure 6.2.2 Shell index in three size groups of *Mytilus edulis*, see also Figure 6.2.1. The numbers under the graphs refer to the number of individuals in the samples. ns: no samples taken.



6.3 Fat content

Figure 6.3.1 Fat content in blue mussels, in % of wet weight of soft parts.



Other data such as number of individuals in the samples, shell size and dry weight are shown in Table 6.4.1.

6.4 Pollutants

Blue mussels were collected in the summer, autumn, winter and spring (Table 6.4.1). Except for the pooled sample from June 1996, only mussels in the range 3 to 4 cm shell length were analysed for heavy metals, persistent organic pollutants and poly-aromatic hydrocarbons.

Metals

Table 6.4.1 Blue mussels- some data describing the pooled samples.

	Jun´96	Sept´96	Dec´96	Mar´97	Average
Number of individuals in samples	69	54	51	36	53
Mean shell length, cm	4,82	3,68	3,42	3,52	3,9
Minimum "	3,45	3,05	2,9	2,95	3,1
Maximum "	5,70	4,00	4,05	4,00	4,4
Dry weight, %	18,1	20	18,7	16,7	18,4
Mercury, mg/kg w.w.	0,02	0,02	0,02	0,03	0,02

Figure 6.4.1 Lead and cadmium in mussels. Concentrations are in mg/kg w.w. soft parts. Pooled samples were described in Table 6.4.1

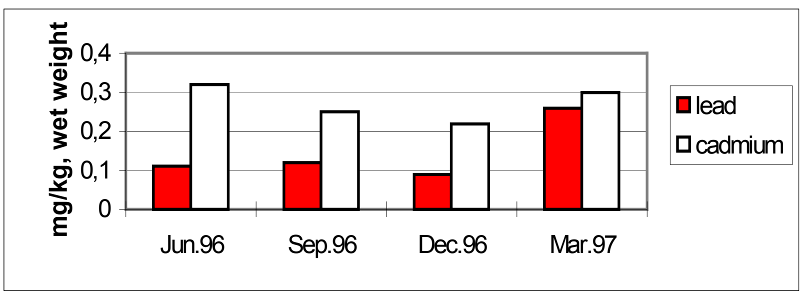
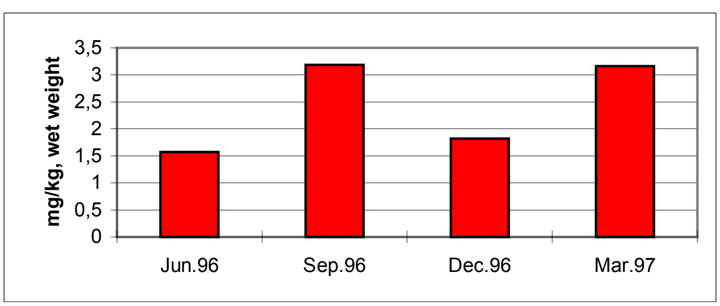


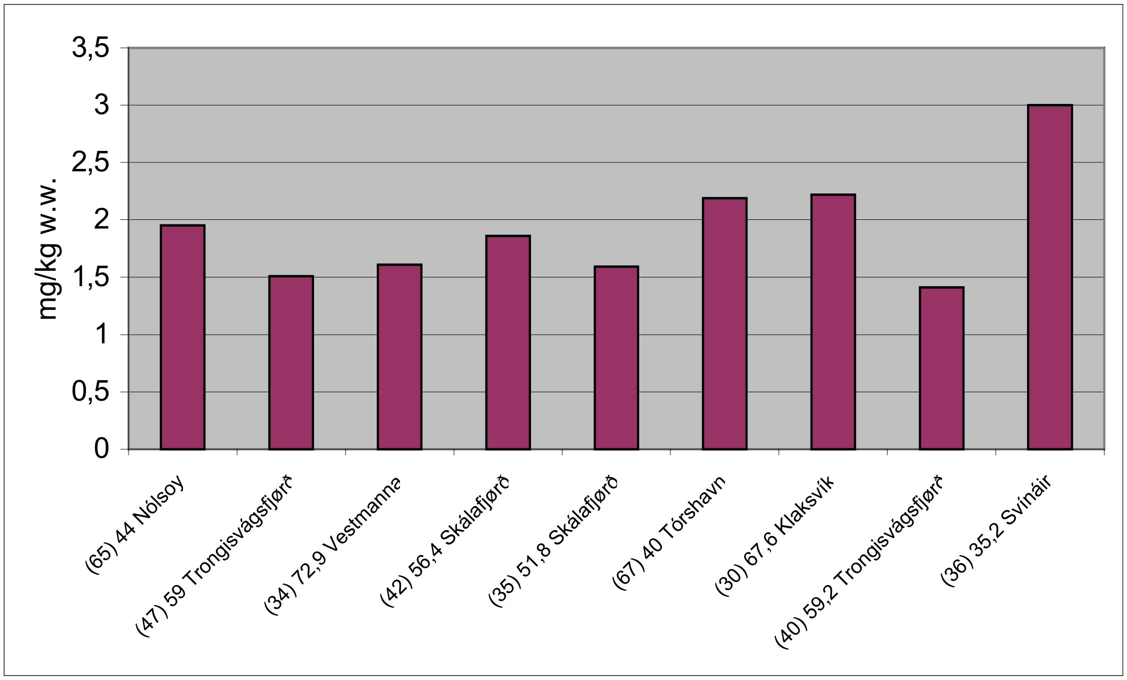
Figure 6.4.2 Copper in blue mussels. Concentrations are in mg/kg w.w. soft parts. Pooled samples were described in Table 6.4.1



The averages for the 210 mussels that were analysed were 0.02 mg/kg of mercury, 0.15 mg/kg of lead, 0.27 mg/kg of cadmium and 2.44 mg/kg copper, all values in wet weight of soft parts. Expressed on a dry mass basis equal to 18% of the wet weight, the concentrations are 0.11 mg/kg of mercury, 0.83 mg/kg of lead, 1.5 mg/kg of cadmium and 13.6 mg/kg of copper.

Values from Greenland on blue mussels of 3 cm shell length were 0,078 mg/kg of mercury, 1,73 mg/kg of lead, 1,75 mg/kg of cadmium and 8,64 mg/kg of copper. All values refer to the dry weight of the samples. (Riget *et al*. 1996).

Figure 6.4.3 Copper in blue mussels collected at several locations along the Faroese coast in February and March 1996.Source: Food and Environmental Agency, Faroe Islands, unpublished results. The number of mussels in each pooled sample is given in brackets followed by the mean shell length (in mm).



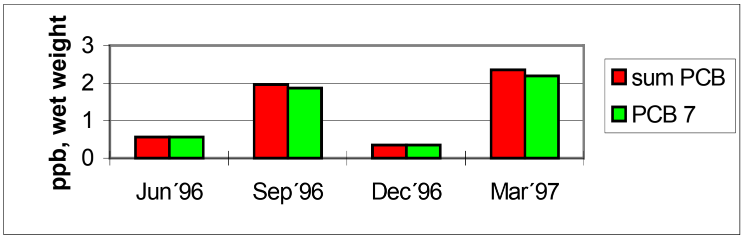
Size dependent variations in metal concentrations?

Table 6.4.2 Metals in blue mussels in three size groups, sampling date March 20th, 1997. Total number of individuals analysed in the three pooled samples was 137.

Shell length category	3<x<4	4 <x< 5	5 <x< 6	mean
Number of ind.	36	48	53	
Shell length, mean, cm	3,52	4,43	5,47	4,5
min	2,95	4,05	5,05	4,0
max	4,00	4,95	6,05	5,0
Dry weight, %	16,7	15,7	16,7	16,4
Mercury	0,03	0,02	0,02	0,02
Lead, mg/kg w.w.	0,26	0,25	0,23	0,25
Cadmium, mg/kg w.w.	0,30	0,27	0,23	0,27
Copper, mg/kg w.w.	3,16	3,17	2,69	3,01

Organochlorines

Figure 6.4.4 PCB in blue mussels, in µg/kg wet weight of soft parts. Data on the conditions of the mussels are given in Figure 6.3.1 and in Table 6.4.1.
PCB 7: CB 28, CB 52, CB 101, CB 118, CB 153, CB 138 and CB 180.



If the concentrations are expressed on a lipid weight basis, the picture changes significantly, with the PCB in the lean December mussels suddenly peaking to concentrations above those in March (Table 6.4.3).

Table 6.4.3 PCB 7 in blue mussels, in mg/kg lipid.
PCB 7: CB 28, CB 52, CB 101, CB 118, CB 153, CB 138 and CB 180.

	Jun´96	Sep´96	Dec´96	Mar´97
lipid, weight %	0,61	1,95	0,1	0,78
PCB 7	0,092	0,096	0,350	0,281

The dominating congenes were CB 153 and CB 138, together amounting on average to 66% of PCB 7. Third highest was congener CB 118. These three total more than 80% of the total PCB 7 load if expressed solely as concentrations.

The concentrations of PCB found in this study are of similar magnitude to those found in mussels from Tangafjørður in 1993 (Förlin *et al*. 1996). The congener profile is similar though not exactly the same. For example, the percentage of PCB 7 constituted by CB 153 is a little higher in the presently analysed mussels than in the those from Tangafjørður, 40% and 33% respectively, see also Figure 6.4.5 . However, this is rather high compared to the relative contribution of CB 153 in blue mussels in Kattegat and Storebelt (Granby & Spliid 1995).

Figure 6.4.5 The percentage contributions for three congenes to the PCB 7.

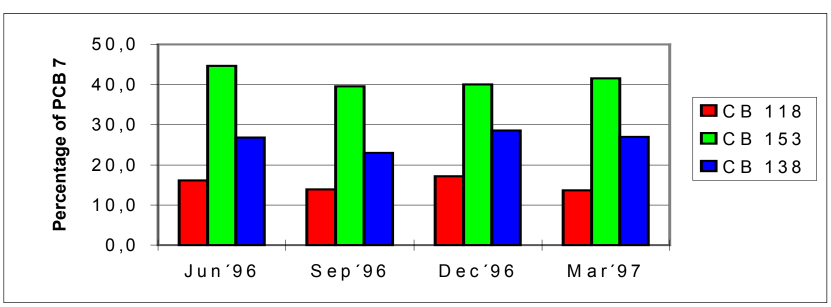


Table 6.4.4 Organochlorine pesticides in blue mussels, in µg/kg w.w.

	June ´96	**September ´96**	**December ´96**	**March ´97**
Lipids, weight %	0,61	1,95	0,10	0,78
Pentachlorobenzene	<0,05	<0,05	<0,05	<0,05
Hexachlorobenzene	<0,05	<0,05	<0,05	<0,05
α-hexachlorohexane	<0,05	0,06	<0,05	<0,05
γ-hexachlorohexane	<0,05	0,10	<0,05	<0,05
Octachlorostyrene	<0,05	<0,05	<0,05	<0,05
p,p´-DDT	0,14	<0,05	<0,05	0,26
p,p´-DDE	0,31	0,75	0,27	0,91
p,p´-DDD	0,09	0,24	0,08	0,22
Σ DDT*, mg/kg lipid	0,09	0,05	0,35 - 0,40	0,18

* values reported as less than the detection limit are used in the calculation in the following way; first the sum is calculated assuming that the result was 0, then the other sum is found by assuming the correct result was just equal to the detection limit, hence an interval formed by the low and the high sum is reported.

The sum DDT is comparable to that found in mussels from Tangafjørður in 1993, which was 0.14 mg/kg lipid (Förlin *et al.* 1996), and this is approximately a quarter of the concentration found in mussels from the Kattegat and Storebelt (Granby & Spliid 1995).

Size dependent variations in organochlorine concentrations?

Table 6.4.5 PCB in blue mussels, grouped in three size categories, in µg/kg wet weight. Sampled in March 1997.

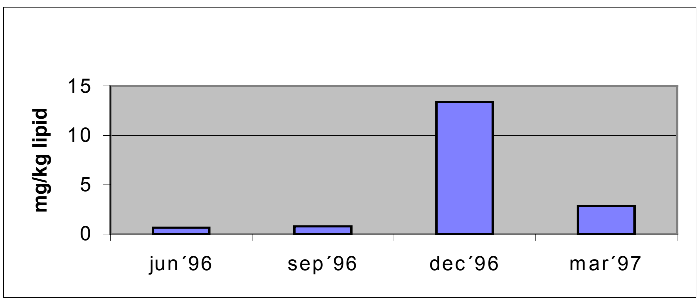
Shell length, cm	3 < x < 4	4 < x < 5	5 < x < 6
Lipids, weight %	0,78	1,17	1,45
CB 28	<0,05	<0,05	0,06
CB 52	0,07	0,08	0,08
CB 101	0,21	0,28	0,37
CB 118	0,3	0,47	0,49
CB 153	0,91	1,20	1,28
CB 105	0,11	0,16	0,17
CB 138	0,59	0,86	0,88
CB 156	0,05	0,09	0,07
CB 180	0,11	0,21	0,17
CB 209	<0,05	<0,05	<0,05
Σ PCB	2,35	3,35	3,57
PCB 7	2,19	3,1	3,33
PCB 7, mg/kg lipid	0,28	0,26	0,23

Table 6.4.6 Pesticides in mussels of three size categories, µg/kg w.w. Sampled in March 97.

Shell length, cm	3<x<4	4 <x< 5	5 <x< 6
Lipids, weight %	0,78	1,17	1,45
Pentachlorobenzene	<0,05	<0,05	0,06
Hexachlorobenzene	<0,05	<0,05	<0,05
α-hexachlorohexane	<0,05	0,06	0,05
γ-hexachlorohexane	<0,05	0,06	0,14
Octachlorostyrene	<0,05	<0,05	<0,05
p,p´-DDT	0,26	0,39	0,6
p,p´-DDE	0,91	1,59	2,02
p,p´-DDD	0,22	0,30	0,41
Σ DDT, mg/kg lipid	0,18	0,19	0,21

PAH

Figure 6.4.6 Sum PAH in blue mussels in the four seasons.



On a wet weight basis the sum of PAH including the naphthalenes was found to be in the range 4 – 22 µg/kg in soft parts of blue mussels, all in the size group 3 to 4 cm shell length (Table 6.4.7).

Table 6.4.7 PAH in blue mussels, µg/kg w.w.

Month of sampling	June ´96	September ´96	December ´96	March ´97
Lipids, weight %	0,61	1,95	0,1	0,78
Naphthalene	<0,2	<0,2	3,3	0,5
2-Methyl-Naphthalene	<0,2	0,5	3,8	2,9
1-Methyl-Naphthalene	<0,2	<0,2	2,9	2,1
Biphenyl	0,2	0,5	0,5	0,4
2,6-Dimethylnaphthalene	<0,2	1	<0,2	0,7
Acenaphthylene	<0,2	<0,2	<0,2	<0,2
Acenaphthene	<0,2	<0,2	<0,2	<0,2
2,3,5-Trimethylnaphthalene	<0,2	0,6	<0,2	<0,2
Fluorene	0,2	0,5	0,2	0,5
Phenanthrene	<0,2	1	<0,2	0,8
Antracene	<0,2	<0,2	<0,2	<0,2
1-Metylphenanthrene	0,2	1,1	0,3	0,8
Fluoranthene	0,6	1,6	0,3	1,2
Pyrene	0,3	1,6	0,4	0,9
Benz(a)anthracene	<0,2	0,6	<0,2	0,5
Chrysene/Triphenylene	0,8	2,1	0,5	2,5
Benzo(b)fluoranthene	0,7	1,8	0,7	3,8
Benzo(j,k)fluoranthene	<0,2	<0,2	<0,2	x
Benzo(e)pyrene	0,6	1,2	0,5	2,5
Benzo(a)pyrene	<0,2	<0,2	<0,2	0,3
Perylene	<0,2	0,2	<0,2	0,7
Indeno(1,2,3-cd)pyrene	<0,2	0,2	<0,2	0,5
Dibenzo(a,h)anthracene	<0,2	<0,2	<0,2	<0,2
Benzo(ghi)perylene	0,2	0,3	<0,2	0,7
Σ PAH	**3,8**	**14,8**	**13,4**	**22,3**
Σ KPAH	0,7	2,6	0,7	5,1
Σ KPAH as % of Sum PAH	18,4	17,6	5,2	22,9
Σ PAH, in mg/kg dry weight	0,02	0,07	0,07	0,13

x: included in benzo(b)fluoranthene.

7 Dab

Dab (*Limanda limanda);* in Faroese *sandsprøka* or *skrubba*.

Attempts to collect butterfish/ rock gunnel were unsuccessful, and instead the dab, which is also commonly used in monitoring programmes, was chosen as an indicator species in the Faroes.

Dab was sampled monthly throughout one year, first in March 1996. The fishing gear was a 60 fathom line with 60 hooks and herring as bait. The line was set in Brandansvík, which is just south of the breakwater in Kirkjubøur, and was left over night. The outcome varied between 17 and 35 individuals of dab and in between these a small by-catch of *Pleuronectes platessa* and *Platichthys flesus*.

The fish were usually alive when delivered by the fisherman. They were killed by a firm blow to the head region. The fish were then registered, weighed and measured prior to dissection. The whole length of the fish was taken as shown in Figure 7.1.1.

Liver, stomach, gonads and muscles, the latter sorted into dark and light side fillets respectively, as well as otoliths were taken and kept separate in polyethylene bags at < - 20°C. However, for the catches from July to September 1996, the gonads were set in formaldehyde (16 % in 0.9 % NaCl/water).

The length, age and other parameters for the fish are shown in Table 7.1.1.

Only fish whose whole length was in the interval larger than or equal to 20 cm and less than or equal to 30 cm were included in the samples to be analysed for pollutants, and therefore only data for these fish are included in Table 7.1.1. Only the diet analysis included the individuals that were either larger or smaller than the target size.

7.1 Size and age distribution.

Figure 7.1.1 Measuring the length of the fish

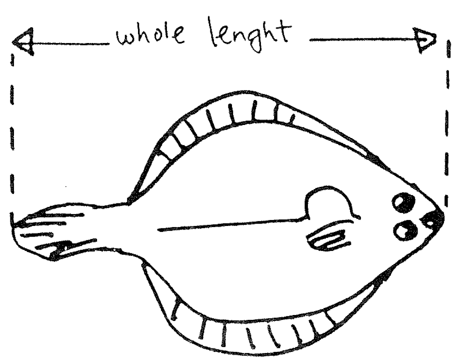


Table 7.1.1 *Limanda limanda*

Number	**Mar´96**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan´97**	**Feb**	**Mar´97**
Total	21	15		18	17	17	22	21	24	17		20	17
female, %	67	93		89	88	76	73	57	75	65		60	71
male, %	33	7		11	12	24	27	43	25	35		40	29
length, mean	**26,55**	**26,2**		**25,7**	**26,7**	**27,1**	**26,8**	**25,9**	**26**	**26**		**28,6**	**27,3**
Min	20,6	21		22	21,5	24,2	21	21,5	20,1	21,3		26,2	21,8
Max	30	29,5		29,8	30	29,6	30	29,5	30	30		29,8	30
weight, mean	206,6	181,1		190,9	207,4	224,6	210,4	184,5	179	178,7		240,2	207,2
Min	111	81		100	99	152	102	98	77	87		155	94
Max	310	264		350	307	312	313	279	277	312		315	292
age, mean	3,4	4,1		3,4	3,7	3,8	4,3	3,8	4,3	4,2		4,7	4,5
Min	2	4		3	3	3	3	3	3	3		4	3
Max	*5*	5		4	6	5	6	5	5	5		6	6
repro.cycle	**Mar´96**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan´97**	**Feb**	**Mar´97**
female, degree of maturity	1,6	1,1		1	1	1	1	1,3	1,4	1,5		1,8	1,4
female gonad index	6	0,8		0,6	0,4	0,8	0,6	1	1,2	1,2		3,4	1,7
male gonad index	0,6			0,1	0,1	0,1	0,1	0,8	1,3	0,8		0,9	0,6

7.2 Sex ratio and reproduction cycle

The sex and degree of gonad maturity was noted, Figures 7.2.1, 7.2.2 and 7.2.3.

Figure 7.2.1 *Limanda limanda*, the total number of individuals in each month is shown under the bars.

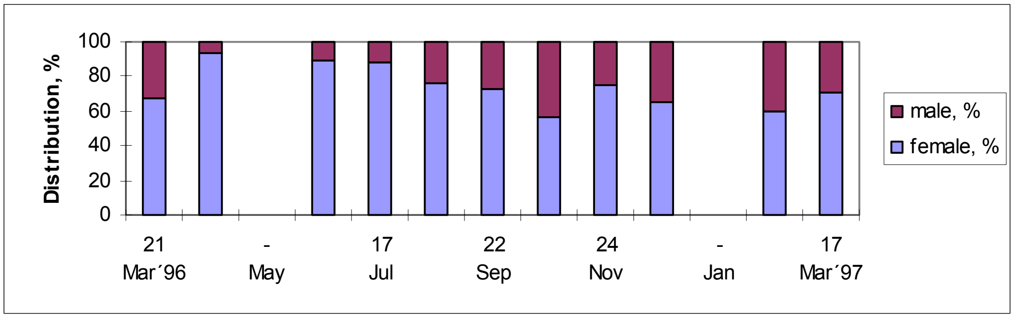


Figure 7.2.2 *Limanda limanda* .

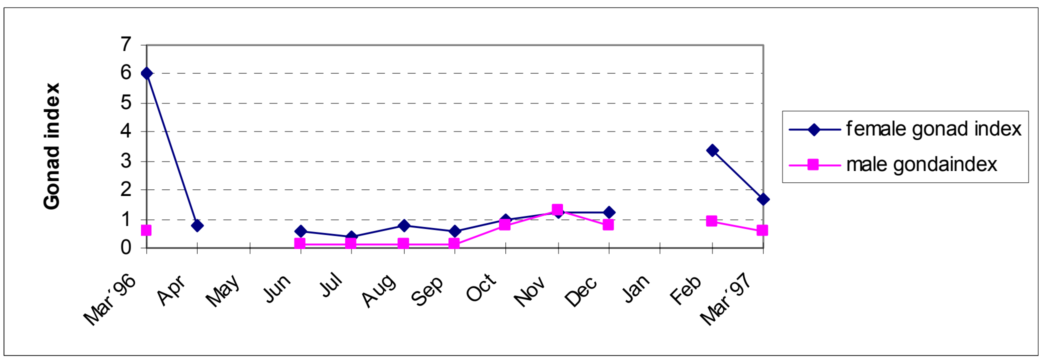
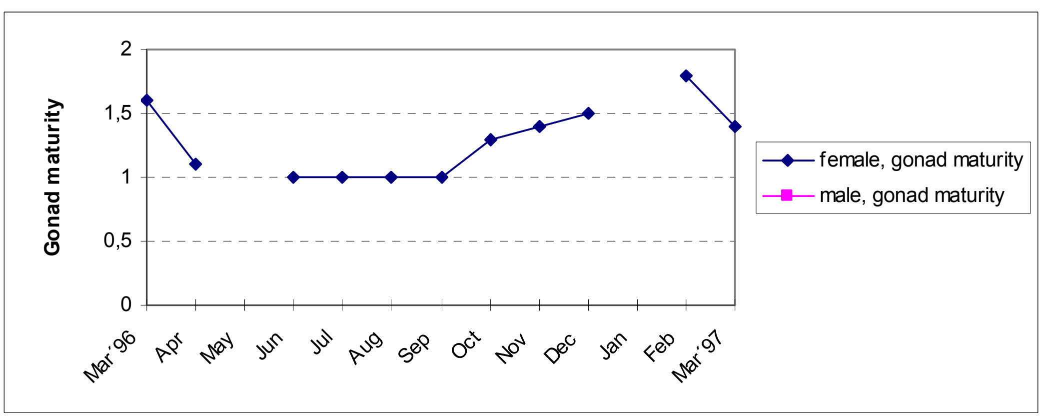


Figure 7.2.3 *Limanda limanda*



7.3 Food

Table 7.3.1 The number and percentage of occurance of prey items in stomachs of dab from Kirkjubøur, Faroe Islands. The samples were taken in the period March 1996 to March 1997.

		Mar´96 - Apr´96		Jun´96 - Oct´96		Nov´96 - Mar´97	
	Total no. of stomachs	47		124		115	
	Stomachs containing prey*	29		84		69	
Prey Code	**Taxon/ Species**	**#**	**%**	**#**	**%**	**#**	**%**
5100000000	**Gastropoda**	**9**	**19**	**25**	**20**	**15**	**13**
5100000000	Remains	4		2		6	
5102060101	*Patina pellucida*					1	
5102100801	*Gibbula cineraria*					1	
5103090000	*Lacunaidae*			1			
5103090300	*Lacuna diverticata*			8		10	
5103100000	*Littorina sp.*	1				1	
5105040145	*Buccinum undatum*			1			
5500000000	Bivalvia					2	
5515250106	*Spisula eliptica*	6		20		2	
6100000000	**Crustacea**	**7**	**15**	**7**	**6**	**16**	**14**
6100000000	Remains	6		3		11	
6130000000	Cirripedia					1	
6158000000	Isopod	6				3	
6168000000	Unident. Amphipod			1		5	
6183100300	*Galathea spp.*	1		2			
6183010000	*Paguroidae*	3		3		10	
8700000000	**Pisces**	**13**	**28**	**28**	**23**	**18**	**16**
8700000000	Remains	17		25		16	
8791031703	*Gadus esmarki*			2			
8845010105	*Ammodytes spp.*	4		4		2	
	Miscellaneous						
3	Bone not marine animal			3			
8	Trash (not living mat.)			2			
9	Stone/sand	30		47		33	
222	Bait	9		31		20	
3700000000	Hydrozoa					1	
333	Turbellaria			1			
4700000000	Nematoda	2		29		4	
5001000000	Polychaeta	1				1	
111111	*Pycnogonium littorale*	1					
11	**Algae**	**34**	**72**	**55**	**44**	**38**	**33**
1	**Empty**	**12**	**26**	**34**	**27**	**45**	**39**

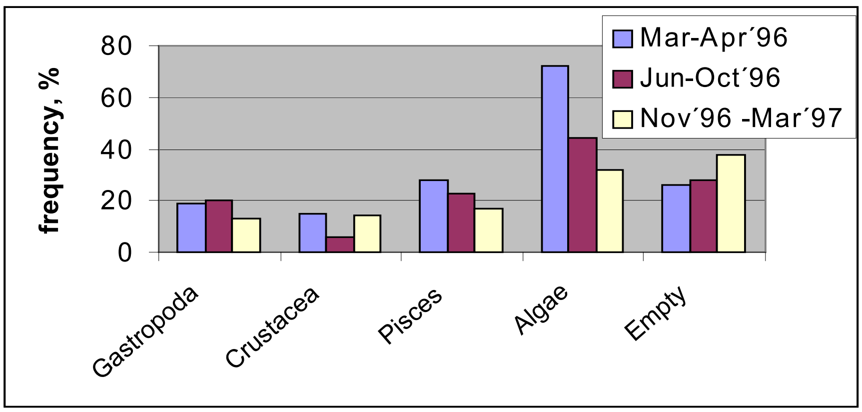
*Stomachs containing sand and/or bait and/or parasitic worms only, are regarded as empty.

The number and percentage of occurance of prey items in stomachs of dab is shown in Table 7.3.2.

Table 7.3.2 Percentage of occurrence of the major prey groups in stomachs of dab from Kirkjubøur, Faroe Islands caught in the period March ´96 to March ´97.

		Mar´96	Apr	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Feb	Mar´97
	Total no. of stomachs	28	19	18	24	25	33	24	35	26	30	24
	Stomachs containing prey	16	13	9	18	21	20	16	19	14	22	14
Prey Code	**Taxon/ Species**						%					
5100000000	Gastropoda	21	16	11	29	24	15	4	17	8	10	21
6100000000	Crustacea	11	21	11		4	3	13	3	4	20	33
8700000000	Pisces	18	42	17	38	20	21	17	11	8	27	17
11	Algae	36	68	56	21	64	33	46	43	38	37	13
0	Empty	43	32	50	25	16	39	33	46	46	27	42

Figure 7.3.17.3.1 Percentage frequency of main food groups and algae in dab from Kirkjubøur, Faroe Islands, caught in the period March´96 to March´97.



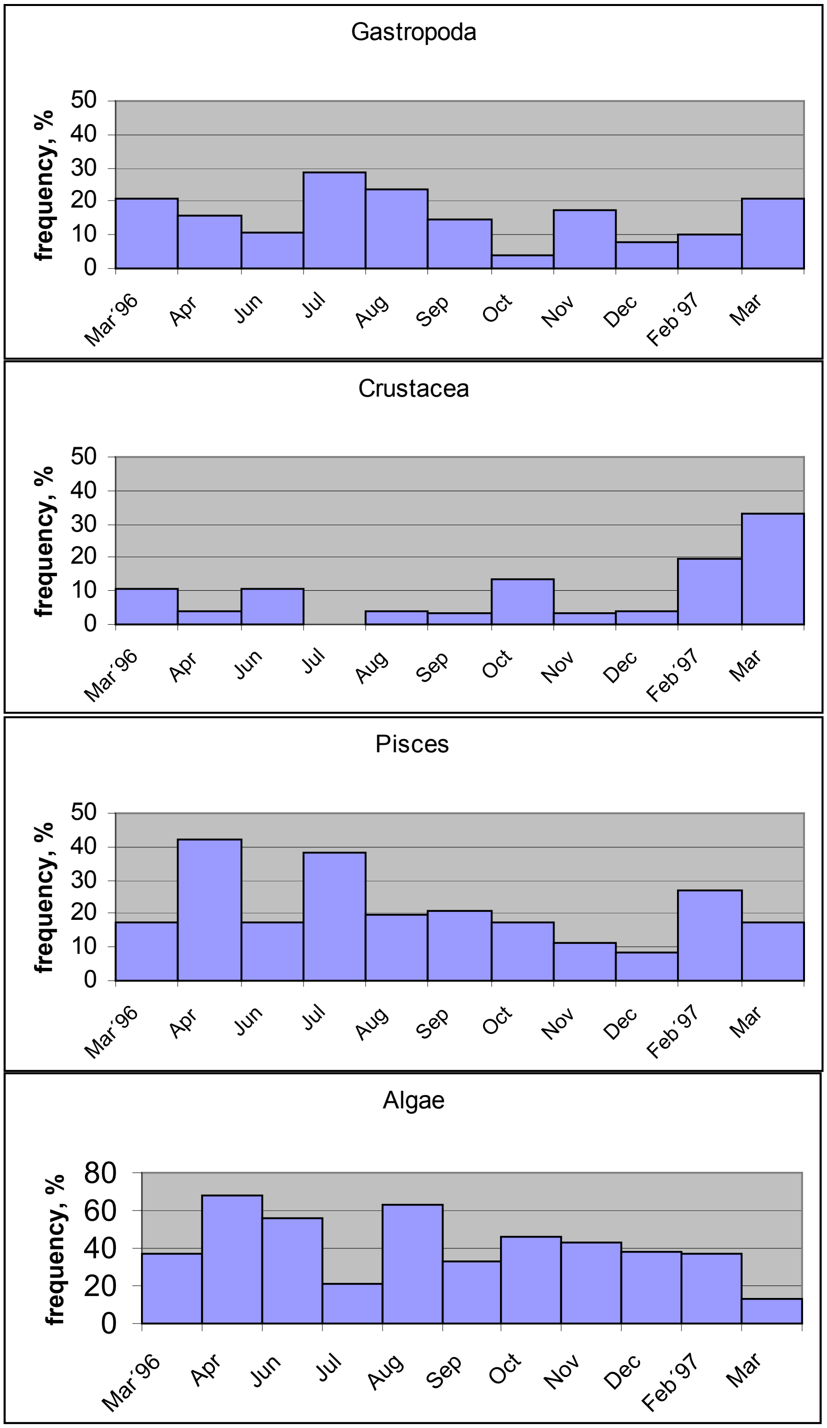
An example of the stomach content details from one month is given in Table 7.3.3

Table 7.3.3 Occurence of prey in stomach from dab caught in March 1996 in Kirkjubøur, Faroe Islands. Total number of stomachs were 28, of these were 12 empty*.

Prey code	Prey species	frequency	%frequency	weight,mg
9	sand/ gravel	14	50	4590
11	algae	10	36	10340
222	bait	5	18	3600
1111	Euparagus sp.	1	6	300
11111	Pycnogonida	1	6	180
5001000000	Polychaeta	1	6	
5103100000	Littorina sp.	1	6	40
5515250106	Spisula eliptica	4	25	1620
6100000000	Crustacea remains	2	13	900
6183100300	Galathea spp.	1	6	3030
8700000000	Pisces remains	3	19	3250
8845010105	Ammodytes sp.	2	13	4660
	Total $	16		13980

The percentage frequency is related to the stomachs containing prey except for the items sand, bait and algae.
*Stomachs containing sand and/or bait and or parasitic worms only, are regarded as empty.
n.a. not applicable.
$: Sand, algae and bait are excluded from the total weight.

Figure 7.3.3 Frequency of occurence of main prey groups and algae in stomachs of dab from Kirkjubøur, Faroe Islands, through the study period.



7.4 Fat content

Figure 7.4.1 *Limanda limanda*, fillet (muscle) contents of protein and lipids in percent of wet weight.

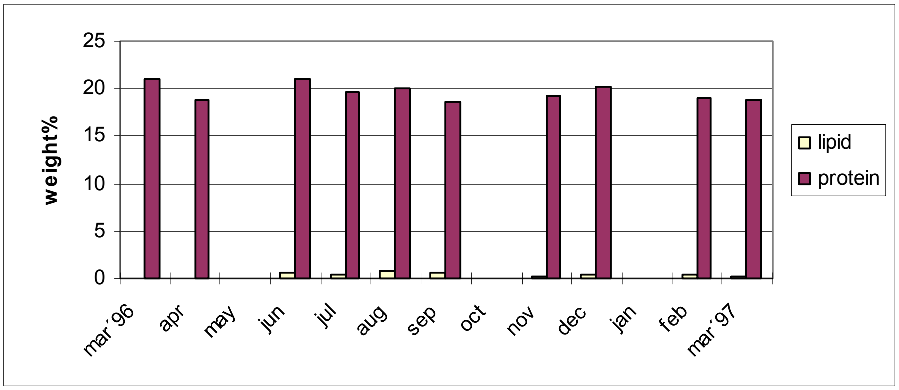
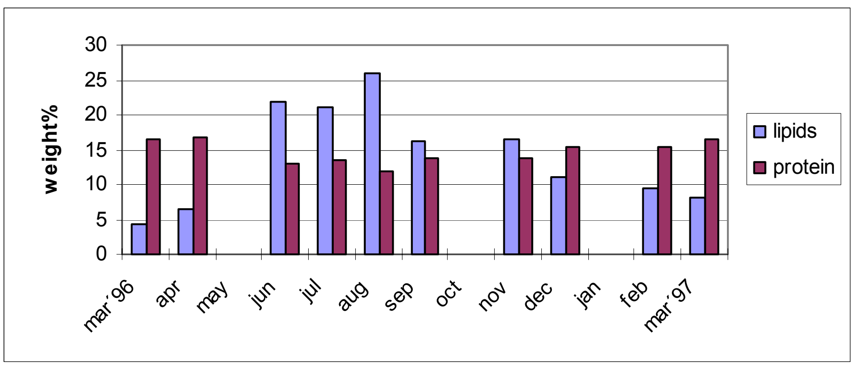


Figure 7.4.2 *Limanda limanda*, liver, contents of fat and protein in % w.w.



There are substantial variations in liver fat concentration during the year. The highest fat content is found during the summer months: June, July and August. The protein content on the other hand is more constant with a slight increment in the winter and early spring when the fatcontent is at its lowest. This may be an artefact stemming from the fact that the total liver mass is at its minimum (Figure 7.4.5). There is however a rather high mean liver mass for the dab taken in Feb´97. The reason for this is presumably that this sample has a higher mean full weight and age than any of the other samples (Table 7.3.1).

Figure 7.4.3 Fat content in dab muscle.

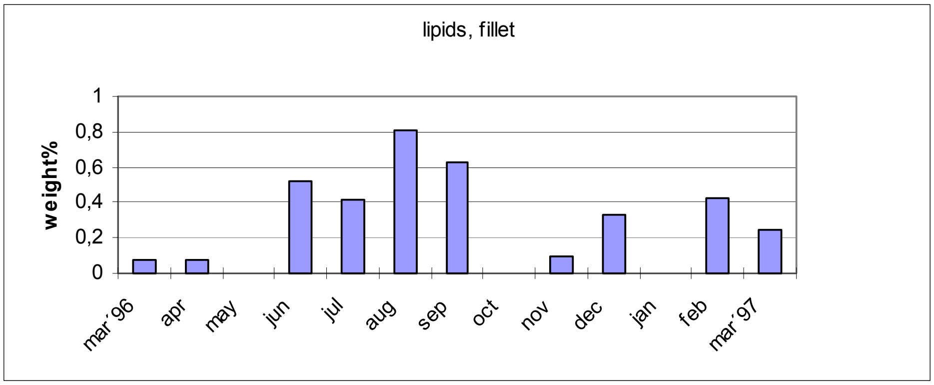


Figure 7.4.4 Fat content in dab liver.

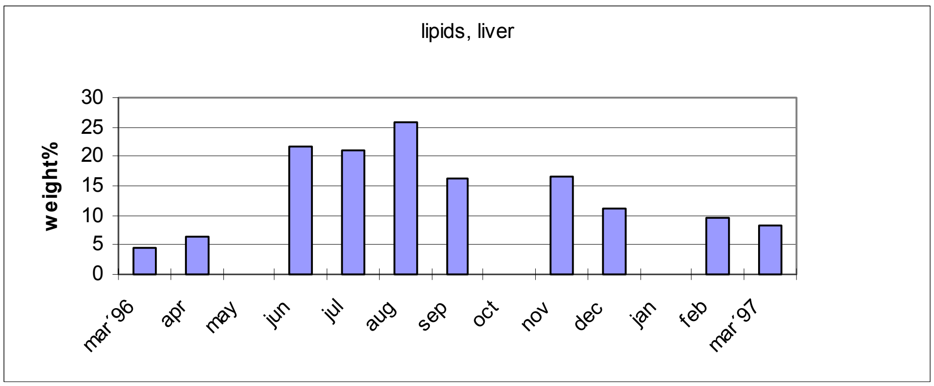
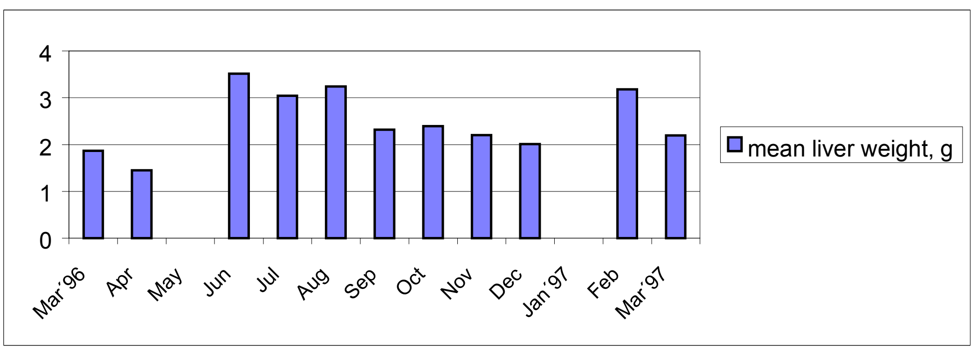


Figure 7.4.5 Mean liver weight of dab.



7.5 Pollutants

Metals

Table 7.5.1 Dab, *Limanda limanda*, muscle.

Fillet, Hg	**Mar´96**	**Jun/Jul**	**Aug/Sep**	**Nov/Dec**	**Mar´97**	**mean**
Dry weight, %	21,5	20,7	21	20	19,5	**20,54**
length, cm	26,55	26,2	26,9	26,0	27,3	**26,59**
age*	3,4	3,6	4,1	4,2	4,5	**3,96**
Number	21	35	39	41	17	
lipids, weight %		0,47	0,72	0,215	0,25	**0,41**
Hg, mg/kg	0,028	0,02	0,02	0,03	0,021	**0,02**

*: The age for the March 1996 batch was determined for half of the sample only, the middle length and weight of which was somewhat lower than for the other half.

Table 7.5.2 Dab, *Limanda limanda*, liver.

Liver, Metal	**Jun/Jul**	**Aug/Sep**	**Nov/Dec**	**mean**
Dry weight, %	38,5	39,1	32,6	**36,73**
lipids, weight %	21,45	21,1	14	**18,9**
Pb, mg/kg	<0,15	<0,15	<0,15	**<0,15**
Cd, mg/kg	0,7	0,83	1,27	**0,93**
Cu, mg/kg	5,29	8,54	8,01	**7,28**

Organochlorines

Some of the results are given in Table 7.5.3 and Table 7.5.4, others are included in Appendix B.

Table 7.5.3 PCB in dab, *Limanda limanda*, µg/kg wet weight liver.

	Mar´96	**Jun/Jul´96**	**Aug/Sep´96**	**Nov/Dec´96**	**Mar´97**	**mean**
Id	SK1 - 28	SK48 - 89	SK90-147	SK172-233	SK265-289	
lipids, %	5,56	21,1	21,5	15,1	8,79	**14,41**
sum PCB	14	44	38	52	30	**35,6**
PCB 7	13	41	35	49	28	**33,2**
PCB 7, µg/kg lipid	234	194	163	325	319	**247**
CB 118	2	5	5	7	4	**4,6**
CB 153	5	16	13	19	10	**12,6**
CB 138	3	9	8	12	6	**7,6**

Figure 7.5.1 PCB 7 in *Limanda limanda*, the percentage contribution from the three dominating congeners are shown.

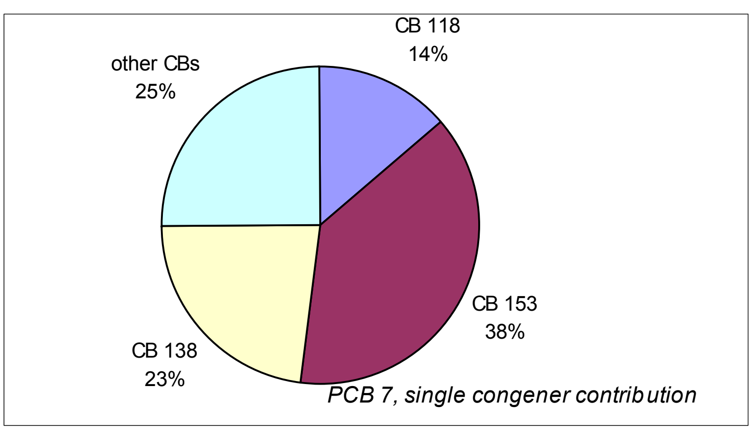


Table 7.5.4 Pesticides in *Limanda limanda*, µg/kg wet weight liver

	Mar´96	Jun/Jul´96	Aug/Sep´96	Nov/Dec´96	Mar´97	**Mar´96-Mar´97**
Id	SK1 - 28	SK48 - 89	SK90-147	SK172-233	SK265-289	**mean**
Lipids, weight %	5,56	21,1	21,5	15,1	8,79	**14,41**
Pentachlorobenzene	<1	<1	<1	<1	mar´97	
Hexachlorobenzene	1	3	2	3	2	
α-hexachlorohexane	<1	1	1	1	1	
γ-hexachlorohexane	m	1	<1	m	<1	
Octachlorostyrene	<1	<1	<1	<1	<1	
p,p´-DDT	m	6	5	7	3	**5**
p,p´-DDE	7	24	16	32	16	**19**
p,p´-DDD	1	3	3	4	2	**3**
Σ DDT, mg/kg lipid	0,14	0,16	0,11	0,28	0,24	**0,19**
DDE, mg/kg lipid	0,13	0,11	0,07	0,21	0,18	**0,14**

m: missing result

PAH

Table 7.5.5 PAH *Limanda limanda*, µg/kg wet weight liver.

	Mar´96	Aug/Sep´96
Naphthalene	1	2,7
2-Methyl-Naphthalene	1,4	1,8
1-Methyl-Naphthalene	1,7	2,3
Biphenyl	0,9	0,7
2,6-Dimethylnaphthalene	1,6	0,8
Acenaphthylene	<0,2	<0,2
Acenaphthene	2,2	1,4
2,3,5-Trimethylnaphtalene	1,2	<0,2
Fluorene	1,8	1
Phenanthrene	3,3	1,7
Antracene	<0,2	<0,2
1-Metylphenanthrene	0,7	0,2
Fluoranthene	0,7	0,6
Pyrene	0,6	<0,2
Benz(a)anthracene	<0,2	0,2
Chrysene/Triphenylene	0,2	0,5
Benzo(b)fluoranthene	0,3	0,9
Benzo(j,k)fluoranthene	<0,2	<0,2
Benzo(e)pyrene	0,2	0,4
Benzo(a)pyrene	0,2	0,3
Perylene	<0,2	<0,2
Ind(1,2,3cd)pyrene	<0,2	<0,2
Dibenzo(a,h)anthracene	<0,2	<0,2
Benzo(ghi)perylene	<0,2	0,4
Sum PAH	**18**	**15,9**
Σ KPAH	0,5	1,4
Σ KPAH, %	2,8	8,8

8 Black guillemots

Black guillemots (*Cepphus grylle):* in Faroese *teisti*. There is a separate Faroese sub-species of this species named *Cepphus grylle faroensis.*

As with the other species chosen as indicators for pollution in this study, the sampling of black guillemots in the Faroe Islands was to take place from a certain area, limited in size. The sampling site chosen initially was therefore Sveipur, the southernmost tip of Streymoy, which is within a few kilometres distance from the main sampling site at Kirkjubøur.

This study comprises in all 142 black guillemot, shot in the period November 1995 to February 1997. Approximately 25 individuals were shot during a few hours hunting time every second month in this period. An exception was the period between November 1995 and April 1996 in which no birds were taken. During the summer of 1996, early in June, there were only a few numbers of black guillemots observed and collected at Sveipur. After consulting with people with a thorough knowledge of the area and its surroundings, it was decided to widen the area for sampling. A counting expedition took place in June 1996 around the island Hestoy, which is in the sound where Kirkjubøur is situated. From August 1996 it was decided also to incorporate the area on the southwesterly end of Hestoy in the sampling site for black guillemots. Subsequent hunting took place both at Sveipur and near Hestoy.

Immediately after the hunt, the birds were registered and visually inspected. The lice in the birds plumage were then collected and the birds were stored frozen until further treatment.

Sample preparation of black guillemots with an overview of all birds, according to year of sampling, sex and degree of maturity is givin in Appendix A.1.

An overview of black guillemots taken in the Faroe Islands is given in Table 8.1.1.

Composition of pooled samples of black guillemot is givin in Appendix A.1.

8.1 Sex and age distribution

The most decisive element for determining the body burden of pollutants, which are not easily excreted, is the intake via food. Also important for the resultant concentration of these pollutants are the routes available for elimination. It is well known that mammals do excrete quite significant amounts of lipid soluble pollutants via the milk. Whether the excretion via eggs on the other hand could be of any significance compared to that which is transferred through the “normal” excretory organs such as the livers in birds and fish is more uncertain but needs to be elucidated.

The ideal categories would therefore divide the individuals according to whether the birds were or had been breeding or not. This distinction is rather straightforward to make for the female species if the bird is killed in the process, and the question is then reduced to a diagnostic of the oviduct. For the males, the sexual activity does not leave obvious traces, and with the resources available, only a crude distinction based on an examination of the plumage could be made that separated the juvenile males, that is those 3 years of age and younger from the older ones. Given that breeding normally begins at an advanced age for species in the arctic or sub-arctic regions, it is possible that the group of birds termed as juvenile males are generally younger than the class of birds termed juvenile females.

The four groups were:

Females with a history of breeding; females, adult

Females with no sign of sexual activity; females, juvenile

Males showing the characteristic feathers of adult male birds, and/or having marks in the feathers from the nursing of youngsters: males, adult

Males in the juvenile plumage: males, juvenile

Table 8.1.1 Overview of black guillemots in the study, grouped in four categories as males and females, juvenile and adults.

Date and site of hunt	females, adult	Females juvenile	uncertain sex and/ or sexual maturity	males, adult	males, juvenile
20-11-95, 23-11-95,¤ Sveipur		6	4 (of which 1 female of unknown maturity)	5	1
17-04-96, 26-04-96, Sveipur	6	3	1 (male, unknown maturity)	12	3
07-06-96, Sveipur	3	1		2	2
12-08-96, Hestoy	5	1	2 (of which 1 female of unknown maturity)	8	4
09-11-96, Hestoy	0	3	1	8	5
28-12-96, Sveipur	1	2		3	3
09-01-97, Hestoy Sveipur	1 1	1 2		7 6	3 1
26-02-97, Hestoy Sveipur	2 10	 5		2 5	1
Total number	29	24	8	58	23
Percentage distribution , %	20	17	6	41	16

¤: not deloused.

There has for some time been speculation that some of the Faroese black guillemots might be winter migrating (Jensen 1996). The number of adult females especially in wintertime (Table 8.1.1), is rather low, and could be interpreted as an indication that the idea of winter-migration is plausible. In the period November 1996 to January 1997, in all 48 black guillemots were taken, of these only 3 adult females. In November 1995 16 birds were shot, of which only one was an adult female. During February and March a total of 18 adult females and 19 adult males were identified in the bulk of 50 birds. Also in June and August the distribution of the sexes was more even.

8.2 Reproduction cycle

It is normally assumed that black guillemots lay their eggs in the days around June 10th (Olsen 1995). This is also the time when the egg-laying takes place at the more southerly latitudes, in the Shetlands (Ewins 1989).

8.3 Food

Some say that black guillemots eat rock gunnels (butterfish) -*Pholis gunnelus*-, other that Black guillemots eat small fish (-fry) like sculpins - *Myoxocephalus scorpius*- or sandeel - *Ammodytes sp*. says others.

This latter belief is indeed more than hinted at in the Swedish name for this species *tobisgrissla*, and also by H.C. Müller in *Færøernes Fiskefauna* (The Fish Fauna of the Faroe Islands), who wrote that the rock gunnel is "the most favoured and nearly only food of the black guillemot"(cited in Joensen & Tåning 1970).

Late in November 1995 a pilot study of the black guillemot diet in the area around Sveipur was carried out (Table 8.3.1). Surprisingly, stomach contents consisted mainly of the small crustacea *Galathea sp*. This little crab-like animal was found in 14 out of the total 16 stomachs. In every second stomach were banded chink shells, whereas fish were only found in two.

Table 8.3.1 Pilot study of black guillemot stomach content. Birds shot in November 1995 near Sveipur.

Bird. no.	Galathea sp.	Lacuna d.	Isopoda	shrimp	fish	other
1	7	1				
2	9					
3	7					
4	5	16				
5		1	9			1 Trophonopsis truncatus*
6	4					
7	5	1		2		
8	6					
9	6	3				
10					1	
11	5					
12	1			1	1	
13	6	1		2		
14	4	1				1 unidentified snail
15	2	2				
16	7					
Frequency	14	8	1	3	2	2

* this is a small snail.

In the period from April 1996 to February 1997 a larger number of black guillemots were hunted (Table 8.1.1).

When the stomach contents had been sorted and analysed (Table 8.3.2 to Table 8.3.4), it appeared that this bird species operates with separate summer and winter diets. That is, in the summer the main prey is fish, whereas during wintertime the dominant food items are crustacea. Small marine snails are taken throughout the year (Figure 8.3.1).

This foraging behaviour is also seen in the relatives in Shetland (Ewins 1990); in Shetland, the *Galathea sp*. and the banded chink shell are frequently eaten during winter. In the summer, black guillemots in Shetland most frequently forage on fish, and then most often rock gunnels. Rock gunnels were the fish species most frequently identified when birds were observed during feeding in Shetland, also during summer (Ewins 1990).

Figure 8.3.1 The summer and winter diet as weight percentages of food groups taken by black guillemot from the Faroe Islands. The figure is based on data from Table 8.3.2 .
Gastropoda = snails, Crustacea = small crab-like animals, Pisces = fish.

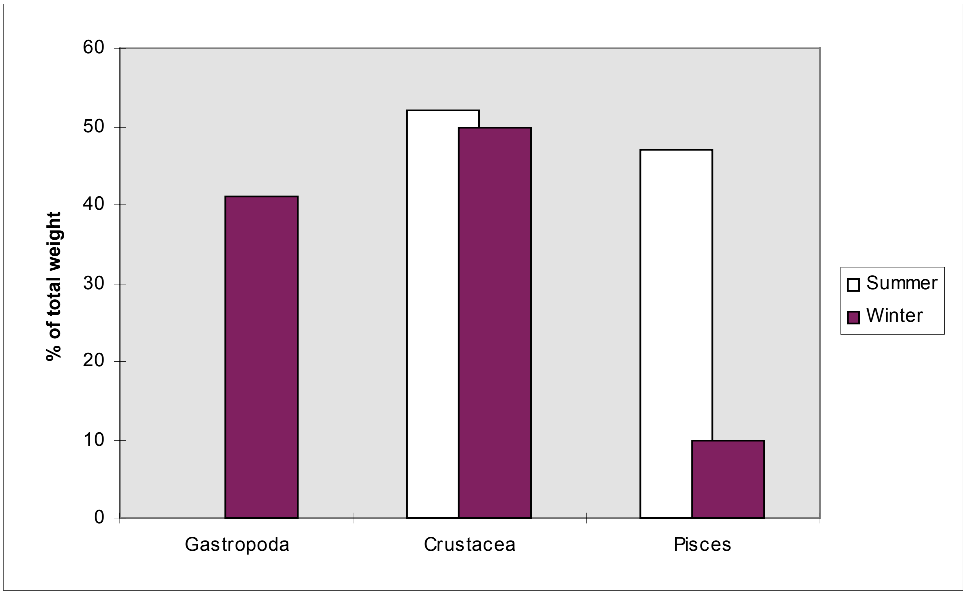
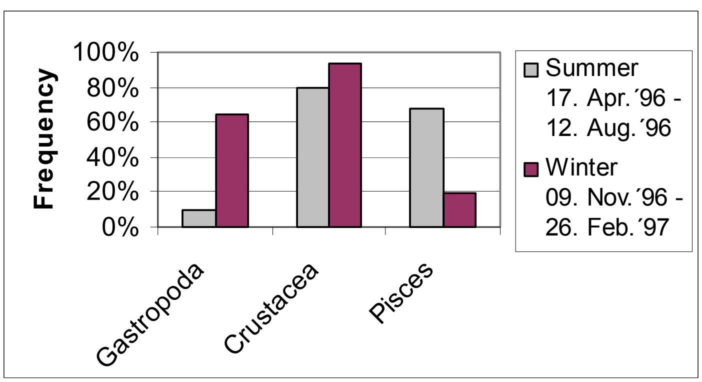


Figure 8.3.2 The summer and winter diet as frequency percentages of food groups taken by black guillemot from the Faroe Islands. The figure is based on data from Table 8.3.2 .
Gastropoda = snails, Crustacea = small crab-like animals, Pisces = fish.



Contrary to their cousins in Shetland, the black guillemots in the Faroes take mainly *Ammodytidae* when foraging on fish (Table 8.3.4). The season for fish is actually only during the spring and early summer. Already in August the number of stomachs containing remains of fish has decreased to less than 50%. In fact it appears that the peak in the fish season occurs in April. Then, at the height of the fish season, the sandeels are most frequently taken, whereas later on in August, the fish species taken are cod and sculpins. This may be due to the biology of the sandeel, which is known to hibernate during the dark periods, and only emerge from the sand in the light summer days (Popp Madsen 1994). There is no commercial sandeel fishery in the fishing grounds off the Faroe Islands, and therefore not much effort has been spent on studying the stock size, migration-pattern and other aspects of their biology here.

Some information is however available at the Faroese Fisheries Laboratory, which periodically catch large amounts of sandeel fry when they are out doing the cod stock size estimates (Reinert 1990). One assumes that the sandeel species found around the Faroes Islands are *Ammodytes tobianus* and *Ammodytes marinus*, where the latter is thought to be the dominant species in the offshore area, as the name also implies (Joensen & Tåning, 1970).

Figure 8.3.3 The frequency of occurrence of fish in stomachs of black guillemots from the Faroe Islands through the study period.

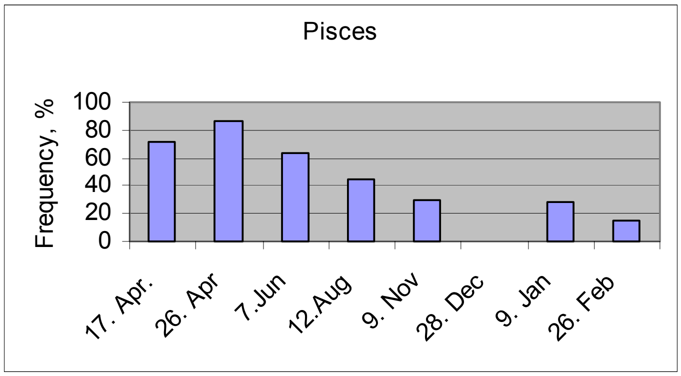


Figure 8.3.4 The frequency of occurrence of Crustacea in stomachs of black guillemots from the Faroe Islands through the study period.

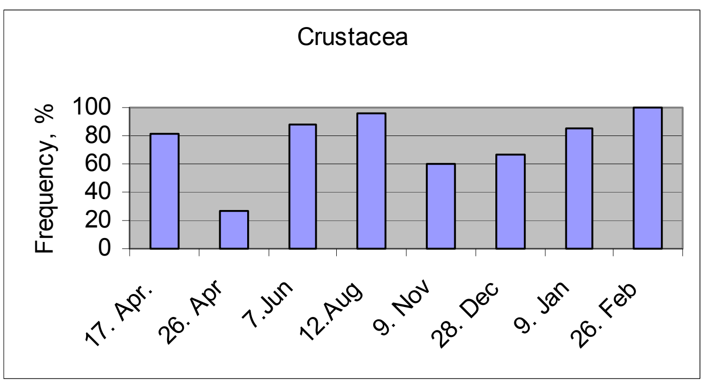


Figure 8.3.5 The frequency of occurrence of Mollusca in stomachs of black guillemots from the Faroe Islands through the study period.

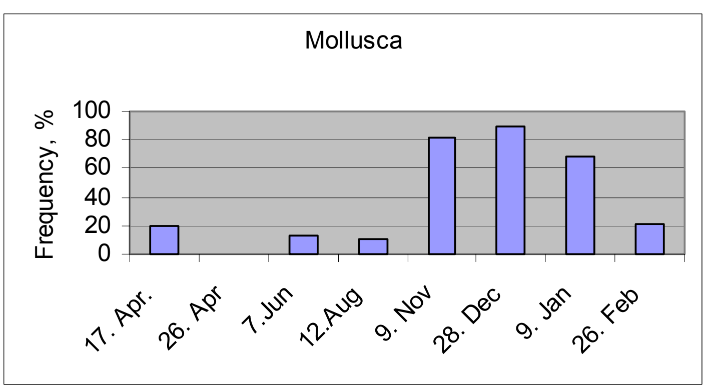


Table 8.3.2 The number and frequency of occurrence of prey items in stomachs of black guillemots.

			Summer			**Winter**	
			170496-120896			091196-260297	
	Total no. of stomachs		53			73	
	No. with prey remains		53			73	
Prey Code	Taxon/species	No.*	Weight in mg #	% of tot.weight	No.*	Weight in mg #	% of tot. weight
5100000000	**Gastropoda**	**5**	**836**	**0**	**47**	**296620**	**40**
5102100800	*Gibbula spp.*	1	539	64	-	-	-
5102100801	*Gibbula cineraria*	-	-	-	1	86	0
5103090000	*Lacunaidae*	-	-	-	1	297	0
5103090300	*Lacuna divericata*	4	297	36	39	294281	99
5103660401	*Velutina velutina*	-	-	-	5	1859	1
5104000000	Neogastropoda	-	-	-	1	97	0
6100000000	**Crustacea**	**42**	**103882**	**52**	**68**	**370719**	**50**
6100000000	remains	15	31442	30	10	39672	11
6162020300	*Idothea spp.*	1	122	-	2	3731	1
6162020308	*Idotea baltica*	-	-	-	1	357	0
6168000000	unidentified Amphipod	1	122	-	3	8642	2
6169210000	*Gammaridae*	-	-	-	1	180	0
6170011000	*Parathemisto spp.*	1	1290	1	-	-	-
6179180100	*Pandalus*	-	-	-	3	2476	1
6183000000	Anomura	3	180	-	10	34530	9
6183100300	*Galathea spp.*	19	60322	58	27	151026	41
6183100301	*Galathea intermedia*	2	10526	10	12	130105	35
8700000000	**Pisces**	**36**	**93749**	**47**	**14**	**70445**	**10**
8700000000	remains	36	93749	-	14	70445	100
	Miscellaneous						
3700000000	Hydrozoa	-	-		1	4	
4700000000	Nematoda	1	-		-	-	
2	Grit	11	1261		2	570	
Total			198467	100		737784	100
* Number of stomachs containing prey.							
# Total weight of prey-group eaten, in mg.							

Table 8.3.3 Occurrence of fish remains in black guillemot stomachs during the sampling period.

	apr´96	jun´96	aug´96	nov´96	dec´96	Jan´97	feb´97
total no. stomachs	25	8	20	17	9	22	25
no. stomachs cont. otoliths	17	4	4	1	0	0	1
no. stomachs cont. fish	21	6	9	5	0	6	3
% stomachs cont. fish	84	75	45	29	0	27	12

Not surprisingly to those who are familiar with otoliths from small fish species such as *Ammodytes sp.*[2], other remains from fish were more frequently found than otoliths, for instance pieces of muscle. In only one instance were otoliths the only fish remains in a stomach.

Table 8.3.4 Fish eaten by black guillemot, species identified from otoliths in Table 8.3.3

		Apr ´96		**Jun´96**		**Aug´96**		**Nov´96**		**Feb´97**	
Number of stomachs containing otoliths		17		4		4		1		1	
Number of stomachs analysed		25		8		20		17		25	
Prey code	**Prey species**	**freq. (%)**	**no (%)**	**freq. (%)**	**no (%)**	**freq. (%)**	**no (%)**	**freq. (%)**	**no (%)**	**freq. (%)**	**no (%)**
8700000000	Pisces			1 (25)	1 (6)						
8791030000	Gadidae					3 (75)	5 (71)				
8791030901	*Pollachius virens*							1 (100)	1 (100)		
8791031801	*Merlangius merlangus*	1 (6)	1 (1)								
8831022207	*Myoxocephalus scorpius*					2 (50)	2 (29)				
8845010000	Ammodytidae	17 (100)	68 (99)	4 (100)	16 (94)					1 (100)	1 (100)

[2] Otoliths from *Ammodytea* are typically 2 mm in length and about half as wide

8.4 Pollutants

Metals

When metal concentrations of black guillemots are compared to what has been found in those in Greenland (Nielsen & Dietz 1989), it appears that the levels in the Faroese birds are somewhat lower. In the black guillemots from Greenland, the cadmium concentrations were in the range 2 to 4 mg/kg, whereas in the Faroese birds the concentrations were in the range 1 to 2 mg/kg wet weight liver. Mercury in the Greenland birds were between 0.5 and 0.64 mg/kg wet weight liver. In the birds from the Faroe Islands the mercury concentrations varied between 0.5 and 1 mg/kg.

Lead was not detected, at 0.02 mg/kg w.w., in all except three out of fourteen black guillemot pooled liver samples from the Faroe Islands. The highest lead concentration found was 0.21 mg/kg w.w. in a pooled sample of livers from 5 young male birds taken in January and February 1997.

Figure 8.4.1 Metals in black guillemot, adult males, in mg/kg w.w.
Error-bars were calculated on the basis of the standard deviations between the three parallel pooled samples from January and February 1997. Dry weight percent and number of individuals in the samples are shown under the bars.

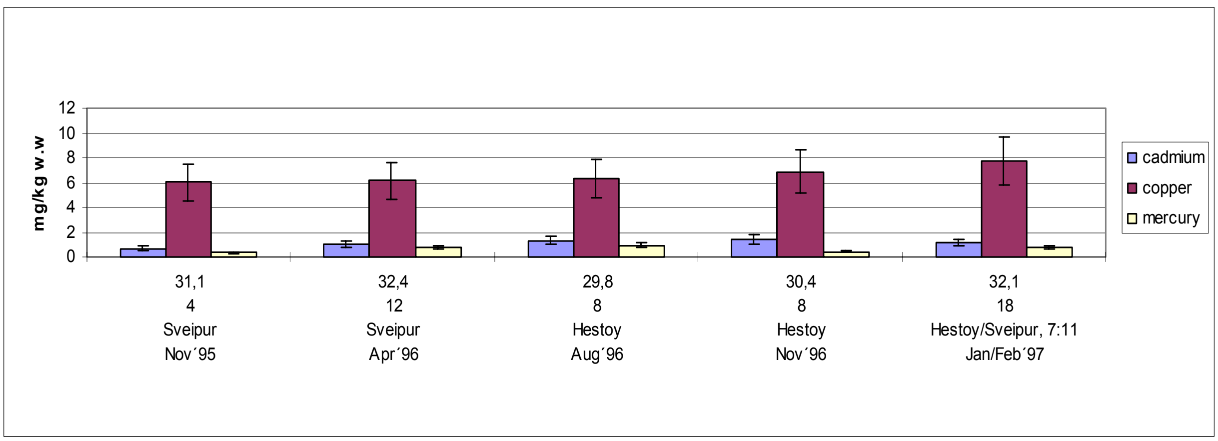


Figure 8.4.2 Metals in black guillemot, adult females, in mg/kg w.w. Error-bars were calculated as in Figure 8.4.1.

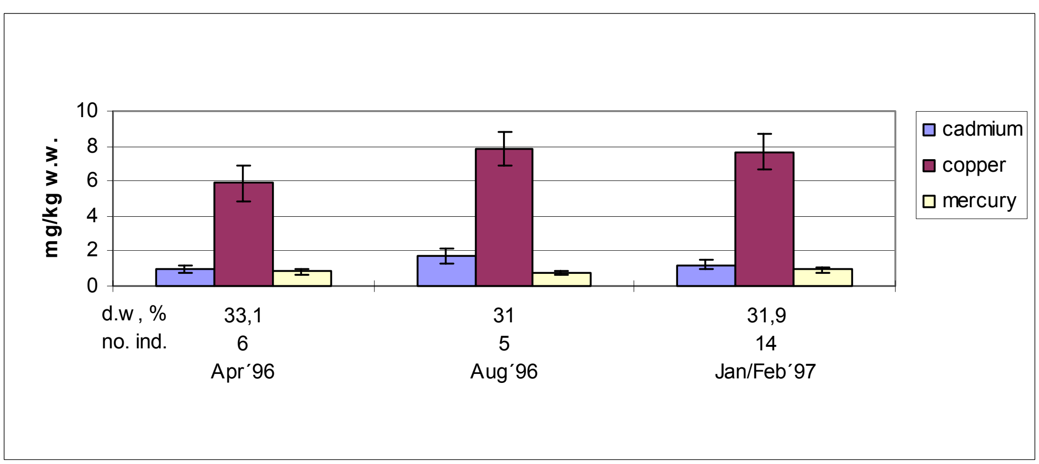


Figure 8.4.3 Cadmium and mercury in mg/kg w.w. liver of black guillemots collected in January and February 1997. The birds were separated in pooled samples of females and males, young and adults, see also Appendix A.1. and B.2.

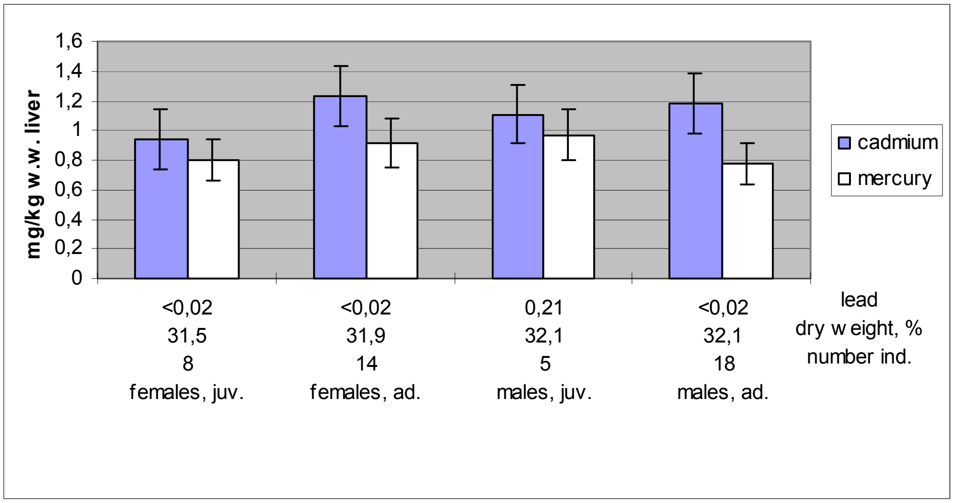
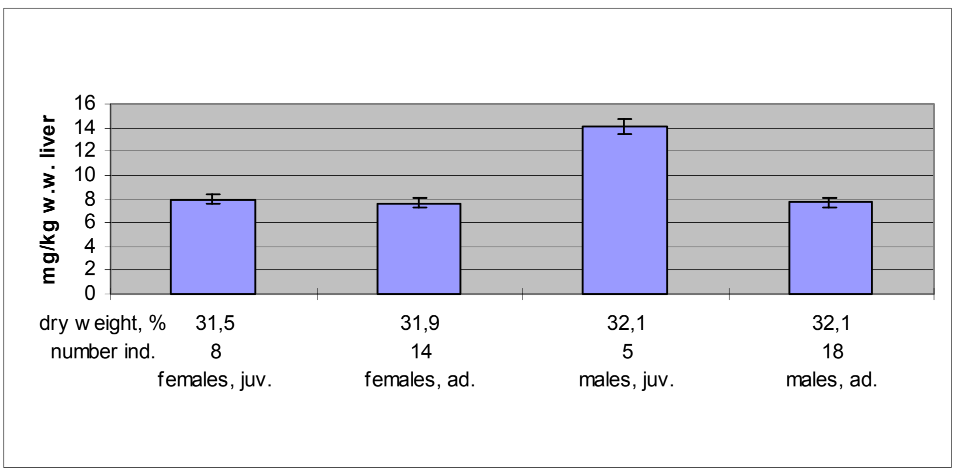


Figure 8.4.4 Copper in black guillemot in mg/kg w.w. liver, in January/February 1997. The birds were separated in pooled samples of females and males, young and adults, see also Appendix A.1. and B.2.



Organochlorines

It appears that the concentrations of PCB and DDE are higher in the spring than in the autumn and winter for both females and males (Figures 8.4.5- 8.4.6, Table 8.4.1). The lipid content in the sample does not vary accordingly and thus the apparent decrease cannot be ascribed to changes in lipid content. Without knowledge of the individual variation, it is impossible to state whether this difference is significant or not. However, it is interesting to note that the build up of these organochlorines occurs during the "fish-eating" period *i.e.* in the spring and early summer.

Figure 8.4.5 PCB 7 and DDE as µg/kg w.w. liver in adult black guillemot males in the four seasons. Adult in this context equals 3K+.
PCB 7 = CB 28, CB 52, CB 101, CB 118, CB 153, CB 138 and CB 180. DDE = 4,4-DDE.

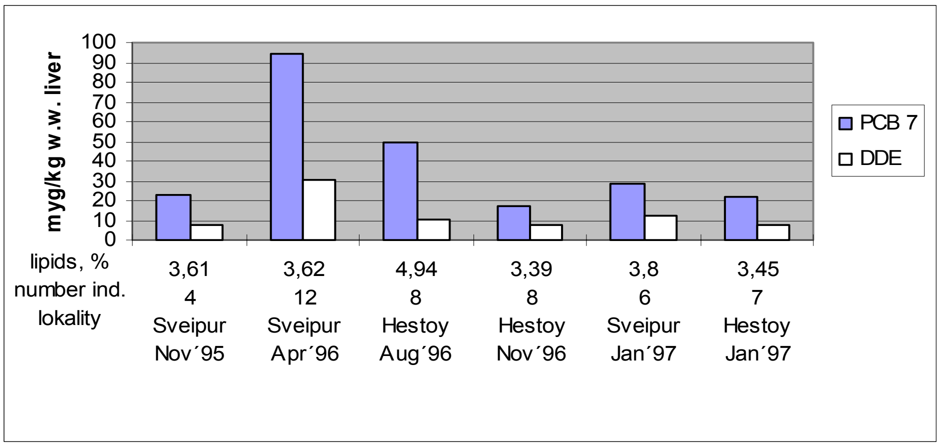


Figure 8.4.6 PCB 7 and DDE as µg/kg w.w. liver in adult black guillemot females sampled spring and autumn.
PCB 7 = CB 28, CB 52, CB 101, CB 118, CB 153, CB 138 and CB 180. DDE = 4,4-DDE.

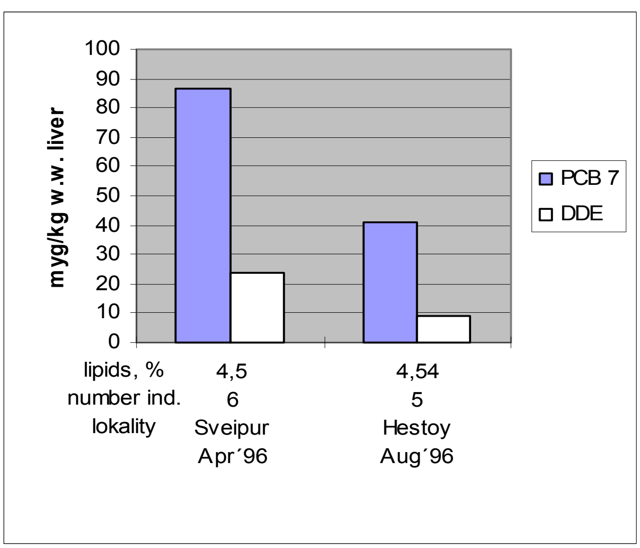


Figure 8.4.7 Percentage distribution of the three dominant PCB congeners in black guillemot livers from the Faroe Islands. The figures represent means of 11 adult females and 32 adult males.

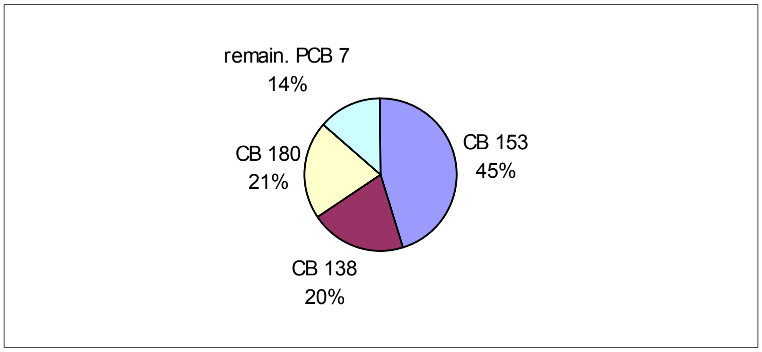


Table 8.4.1Pesticides in black guillemot adults, in µg/kg w.w. liver.

	male, ad.	**female, ad.**	**male, ad.**	**female, ad.**	**male, ad.**	**male, ad.**
Date of sampling	**Nov´95**	**Apr´96**	**Apr´96**	**Aug´96**	**Aug´96**	**Nov´96**
Locality	Sveipur	Sveipur	Sveipur	Hestoy	Hestoy	Hestoy
Number of ind.	4	6	12	5	8	8
fat, %	3,61	4,50	3,62	4,54	4,94	3,39
Pentachlorobenzene	0,2	0,3	<0,2	<0,2	<0,2	<0,2
Hexachlorobenzene	2,6	7,9	4,2	1,7	2	1,7
α-hexachlorohexane	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2
γ-hexachlorohexane	0,8	0,6	m	0,2	0,3	0,5
Octachlorostyrene	<0,2	0,2	0,2	<0,2	<0,2	<0,2
p,p´-DDE	7,7	23,7	30,6	8,9	10,2	7,4
p,p´-DDD	<0,2	0,4	0,4	<0,2	m	<0,2

m; missing result due to possible interference.

9 Starfish and Sea-urchin

9.1 Starfish *Asteria rubens*

In Faroese *krossfiskur*.

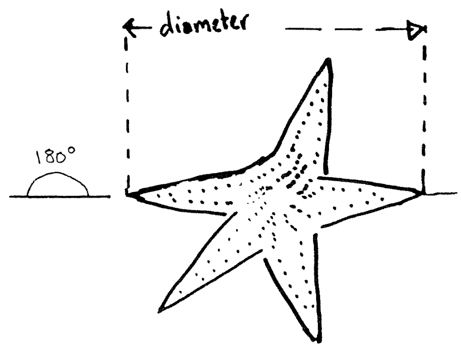
Starfish were collected off Svínáir by divers in June and December 1996. The starfish were frozen to c. -20°C within a few hours. When samples at a later stage where taken out, the thawed starfish were weighed and measured individually (Table 9.1.1 and Figure 9.1.1).

The whole individuals that were to be used for analysis were blended into pooled samples to a consistence that can be described as paste with calcareous-grit.

Table 9.1.1 Starfish pooled samples, see also Appendix A.2, Table A.2.2 and A.2.3.

Sample-ID.	June´96	19.Dec´96 ”small”	19.Dec´96 ”large”
Number	24	22	20
Diameter, cm, mean	17,08	7,4	15,3
(min.-max.)	(11,5 – 21,0)	(5,4 – 12,0)	(8,4 – 20,5)
Weight, g, mean	40,5	6,9	42,0
(min.-max.)	(15,4 – 76,9)	(2,6 – 21,5)	(9,6 – 82,0)

Figure 9.1.1 The diameter of starfish is measured.

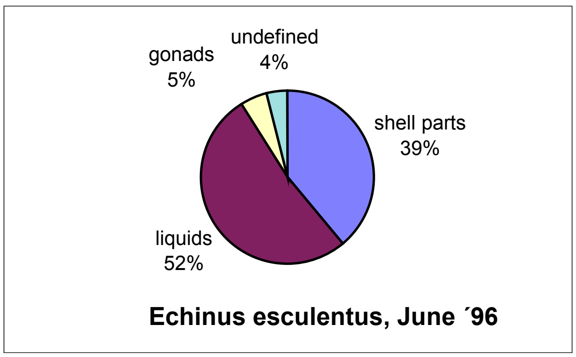


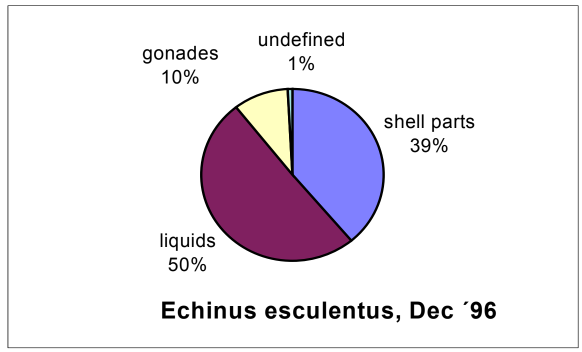
9.2 Sea-urchin *Echinus esculentus*

In Faroese *igulker*.

The sea-urchin of first choice, *Strongylocentrotus droebachensis,* was not abundant in the Svínáir area. The attempt to collect this species gave only 3 individuals and hence the sea-urchin that was common in this area, *Echinus esculentus*, was taken instead.

Figure 9.2.1 The composition of sea-urchins in terms of weight percentages. Individual data are shown in Appendix A2, Table A.2.4 and A.2.5.





9.3 Pollutants

Comparison between these species should be done with the fact in mind that the exoskeleton of the starfish was included in the sample whereas it was not for the blue mussels, and it is well known that lead is enriched in calcareous structures.

Results in this section refer to the whole body of starfish but only to the gonads of sea-urchins.

Metals

It is said that starfish eat blue mussels. Bio-magnification of cadmium and mercury from mussels to starfish is, however, not indicated in the results (Table 9.3.2). The concentration of lead in starfish is the highest found in this study.

Table 9.3.1 Starfish. Metal concentrations are in mg/kg w.w.
Starfish from June are comparable to the “large” sample from December.

Date of sampling	dry weight %	lead	cadmium	copper	mercury
June´96	30,6	2,15	0,42	54,7	0,037
Dec´96, large	25,2	0,13	0,39	3,31	
Dec´96, small	30,2	0,28	0,36	14,00	

Table 9.3.2 The relation between metal concentrations in starfish to those in blue mussels.

Metal concentrations were expressed in mg/kg d.w. Both species were collected in the same month at the same site. The data for blue mussels were also given in chapter 6.4.

	Date of sampling	lead	cadmium	Copper	mercury
Starfish	June´96	7,03	1,37	178,76	0,12
Blue mussels	June´96	0,61	1,77	8,67	0,11
Ratio		11,6	0,8	20,6	1,1

Table 9.3.3 Metal concentrations in sea-urchin gonads.

Dec´96,	lead	cadmium	copper	mercury
mg/kg, w.w.	0,02	0,1	0,41	<0,02
mg/kg, d.w.	0,15	0,76	3,13	<0,15

Organochlorines

Table 9.3.4 Pesticides in Echinodermata.

µg/kg w.w.

	Asteria rubens	Echinus esculentus	Echinus esculentus
date of sampling	18-jun-96	18-jun-96	19-dec-96
lipids, weight%	1,61	2,79	2,69
pentachloro-benzen	<0,1	<0,1	<0,05
hexachloro-benzen	<0,05	<0,1	<0,05
a-hexachloro-hexan	0,08	0,2	0,13
g-hexachloro-hexan	0,11	ia	0,07
octachlor-styren	<0,1	<0,1	<0,05
p,p´-DDT	ia	ia	<0,05
p,p´-DDE	0,84	1,9	0,71
p,p´-DDD	0,1	0,1	0,12

ia: not analysed.

Table 9.3.5 PCB in Echinodermata.

µg/kg w.w.

	Asteria rubens	Echinus esculentus	Echinus esculentus
date of sampling	18-jun-96	18-jun-96	19-dec-96
CB 28	0,08	0,1	<0,05
CB 52	0,11	<0,1	0,05
CB 101	0,38	0,2	0,13
CB 118	0,86	0,2	0,12
CB 153	1,8	0,2	0,14
CB 105	0,25	<0,1	<0,05
CB 138	0,95	0,1	0,07
CB 156	0,07	<0,1	<0,05
CB 180	0,1	<0,1	<0,05
CB 209	0,07	<0,1	<0,05

PAH

Starfish sampled off Svínáir in June 1996 were analysed for PAH. The concentrations of every compound in this group (Table 9.3.6) were less than the limit of detection. It is plausible that the concentration of PAH in starfish is at a minimum in June, such as it is in blue mussels, and that the present data thus represent the minimum concentrations in the year. Whether this is the case must be confirmed by further analyses. The results available do show that the concentration of PAH in starfish is less than or of a similar magnitude to that in blue mussels.

Table 9.3.6 PAH in starfish, *Asteria rubens* and sea-urchin, *Echinus esculentus*. µg/kg w.w.

	Asteria	Echinus	Echinus
sampling	June´96	June´96	Dec.´96
lipids, weight %	1,61	2,79	2,69
Naphthalene	<0,5	<0,5	<0,2
2-M-Naf	<0,5	<0,5	<0,2
1-M-Naf	<0,5	<0,5	<0,2
Biphenyl	<0,5	<0,5	0,3
2,6-Dimethylnaphtalene	<0,5	<0,5	0,4
Acenaphtylene	<0,5	<0,5	<0,2
Acenaphtene	<0,5	<0,5	0,5
2,3,5-Trimethylnaphtalene	<0,5	<0,5	<0,2
Fluorene	<0,5	<0,5	0,2
Phenanthrene	<0,5	<0,5	<0,2
Antracene	<0,5	<0,5	<0,2
1-Metylphenanthrene	<0,5	<0,5	<0,2
Fluoranthene	<0,5	<0,5	0,4
Pyrene	<0,5	<0,5	0,4
Benz(a)anthracene	<0,5	<0,5	<0,2
Chrysene/triphenylene	<0,5	<0,5	0,5
Benzo(b)fluoranthene	<0,5	<0,5	<0,2
Benzo(j,k)fluoranthene	<0,5	<0,5	<0,2
Benzo(e)pyrene	<0,5	<0,5	0,3
Benzo(a)pyrene	<0,5	<0,5	<0,2
Perylene	<0,5	<0,5	<0,2
Ind(1,2,3cd)pyrene	<0,5	<0,5	<0,2
Dibenzo(a,h)antracene	<0,5	<0,5	<0,2
Benzo(ghi)perylene	<0,5	<0,5	<0,2

10 Phytoplankton

10.1 Species composition

Two 1-hour phytoplankton fisheries were conducted, one in June and one in September 1996. A 10 µm mesh bag was used, and phytoplancton was collected during slow steeming, in the uppermost 20 cm surface level. The species were analysed by Karina Nattestad, Faroese Fisheries Laboratory (Table 10.1.1).

Table 10.1.1 Main species composition in uppermost 20 cm in Sundalagið Norð, off Svínaáir. The sampling took place at c. 5 pm.

Date of sampling	29. Jun. ´96	28. Sep. ´96
Diatoms	*Nitzschia sp.* *Thallasiosira nordenskioldii* *Thalassiosira ssp* *Rhizosolenia fragilissima* *Rhizosolenia ssp* *Chaetoceros debilis* *Chaetoceros decipiens* *Chatoceros ssp* *Thalassionema nitzschioides*	*Nitzschia sp.* *Rhizosolenia delicatula* *Eucampia zoodiacus* plus other diatoms
Dinoflaggelates	*Peridinium depressum* *Ceratium fucus* *Ceratium lineatum* *Dinophysis norvegica*	*Dinophysis norvegica* *Peridinium depressum* *Ceratium fucus* *Ceratium longipes* *Ceratium lineatum* plus other dinoflaggelates
Other algae	*Dictyocha speculum* various larger naked flaggelates various smaller naked flaggelates	*Dictyocha speculum* various larger naked flaggelates various smaller naked flaggelates

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Appendix A

A.1

Sample preparation of Black guillemots with overview of all birds, according to year of sampling, sex and degree of maturity. Table A.1.1 - A.1.3

composition of pooled samples of Black guillemots

A.2

Individual shell length of blue mussels Table A.2.1

Starfish Table A.2.2 – A.2.3

Sea-urchins Table A.2.4 – A.2.5

Sample preparation of Black guillemots with overview of all birds, according to year of sampling, sex and degree of maturity.

The birds were kept frozen at –20^{0}C until sample preparations. For subsampling, the plumage of the semi-thawed birds was removed, and subcutaneous fat was collected. For the birds shot in 1995 however, only intestinal fat was sampled. A muscle sample consisting of the entire left breast muscle was taken. The bird was opened by cutting open the abdomen and chest and the sex and sexual status were recorded. Parameters such as appearance of oviduct, size of largest egg, size of testicles etc. were recorded. Thereafter the liver was taken and the stomach sampled for later analyses of food remains. The plumage was later stored at the Museum of Natural History and the carcass and the other tissues were kept in storage at the Food and Environmental Agency until analysis. The remains after the analyses were left in the Environmental Specimen Bank of the Food and Environmental Agency.

The chemical analyses were in general done on pooled liver samples combining for instance 5 - 7 birds. In general the whole liver from each bird was taken into the pools.

In the Tables A.1.1 to A.1.3 the weight of the birds and some of the samples taken are given. The bird ID is composed of a two-digit number followed by the date of the hunt (day-month-year). The suffix –BF is added to individuals in which a *bursus fabriosus* was found.

Table A.1.1 Black guillemots 1995, all weights are in grams.

Bird ID	Female/male, adults/ juvenile	Liver	Bird, full weight	Muscle, left breast	Intestinal fat
02-201195-BF	F. Juv.	26,72	411	31,65	
04-201195-BF	F. Juv.	33,45	451	33,57	1,19
07-231195-BF	F. juv.	29,61	440	36,16	0,40
14-201195-BF	F. juv.	26,46	486	25,79	0,40
15-231195-BF	F. juv.	27,76	453	34,78	0,56
16-231195-BF	F. juv.	32,46	432	32,36	0,88
03-201195	M. ad.	34,29	470	37,65	1,23
09-231195-BF	M. ad.	30,09	450	34,70	1,40
10-231195	M. ad.	30,46	488	41,25	2,45
11-201195	M. ad.	28,24	464	39,01	0,66
12-231195	M. ad.	36,71	508	37,60	1,02
08-201195-BF	M. juv.	28,97	453	32,35	1,49
01-201195-BF	F.?, juv.	25,41	408	26,61	0,97
05-201195-BF	F.?, juv.	28,76	405	30,14	1,28
06-201195-BF	F.?, juv.	35,77	500	33,63	2,60
13-231195-BF	F.?, juv.	30,23	428	34,29	1,20

Table A.1.2 Black guillemots 1996, all weights are in grams.

Bird ID	Female/male, adults/ juvenile	Liver	Bird, full weight	Muscle, left breast	Subcut. fat
11-170496-BF	F. ad.	25,36	448	33,10	2,14
16-260496	F. ad.	28,85	439	31,36	0,08
18-260496	F. ad.	26,60	434	40,70	2,57
22-260496	F. ad.	25,95	437	37,07	2,40
24-260496	F. ad.	26,72	457	46,22	2,41
25-260496	F. ad.	24,92	444	44,43	2,43
03-070696	F. ad.	24,94	439	36,47	2,70
05-070696	F. ad.	26,21	413	38,12	1,95
08-070696	F. ad.	22,01	393	31,44	1,91
02-120896	F. ad.	22,88	423	39,19	1,76
03-120896	F. ad.	27,38	426	36,51	1,59
04-120896	F. ad.	29,21	437	34,18	2,16
17-120896-BF	F. ad.	29,82	414	34,37	2,50
05-281296*	F. ad.	25,96	420	39,28	3,00
14-170496	F. juv.	31,62	471	40,84	4,30
20-170496-BF	F. juv.	22,93	385	32,56	1,56
23-260496-BF	F. juv.	29,81	455	37,78	3,63
02-070696-BF	F. juv.	25,60	382	33,01	2,34
18-120896-BF	F. juv.	24,98	402	33,10	5,60
11-091196-BF	F. juv.	29,74	387	31,01	2,87
12-091196-BF	F. juv.	30,10	449	37,13	3,16
13-091196-BF	F. juv.	30,04	424	35,12	1,95
01-281296-BF*	F. juv.	25,42	435	31,15	4,00
09-281296*	F. juv.	23,92	379	31,88	3,42
12-170496-BF?	M. ad.	25,21	395	31,66	1,78
13-170496-BF	M. ad.	33,73	508	37,89	3,09
15-170496	M. ad.	23,84	429	34,93	3,43
17-170496	M. ad.	26,07	426	33,82	2,39
18-170496	M. ad.	24,24	434	39,83	3,32
17-260496	M. ad.	24,01	421	36,00	2,21
19-260496	M. ad.	24,77	433	39,97	1,88
20-260496	M. ad.	21,12	387	35,84	2,15
21-260496	M. ad.	24,67	444	38,13	2,13

26-260496	M. ad.	26,10	429	37,88	2,30
27-260496	M. ad.	28,13	464	42,14	3,01
28-260496	M. ad.	25,98	455	40,79	2,74
29-260496	M. ad.	25,60	439	39,39	4,84
30-260496	M. ad.	22,24	433	36,86	3,58
01-070696-BF	M. ad.	19,31	336	26,89	1,74
04-070696	M. ad.	22,12	383	30,60	1,99
01-120896-BF	M. ad.	22,69	409	33,89	1,34
05-120896	M. ad.	20,50	384	35,75	1,93
06-120896	M. ad.	23,30	399	33,18	2,22
07-120896	M. ad.	29,86	469	39,42	2,03
08-120896-BF	M. ad.	23,28	392	35,48	2,89
09-120896-BF	M. ad.	25,12	420	36,38	4,60
10-120896	M. ad.	24,03	431	37,60	2,86
11-120996	M. ad.	26,26	430	39,61	1,36
13-120896	M. ad.	25,56	398	34,92	5,11
14-120896	M. ad.	25,90	422	32,68	1,47
15-120896	M. ad.	24,14	397	31,52	4,37
01-091196	M. ad.	29,14	466	37,48	3,85
02-091196	M. ad.	25,05	453	39,03	3,91
03-091196	M. ad.	23,31	433	34,92	2,46
04-091196	M. ad.	29,76	470	31,45	4,30
05-091196	M. ad.	24,49	462	38,00	2,28
06-091196	M. ad.	24,03	423	30,07	2,51
07-091196	M. ad.	28,42	500	41,84	5,49
09-091196	M. ad.	26,85	441	36,97	1,50
06-281296	M. ad.	17,39¤ 11,33"	502	38,97	5,94
07-281296	M. ad.	10,66¤ 16,81"	479	37,44	3,61
08-281296	M. ad.	9,67¤ 13,41"	430	36,05	5,39
16-170496	M. juv.	28,20	474	37,54	3,27
19-170496-BF	M. juv.	25,51	420	28,42	3,34
06-070696-BF	M. juv.	22,60	370	31,58	1,63
07-070696-BF	M. juv.	24,59	341	25,20	1,24
19-120896	M. juv.	28,58	423	32,22	4,10
08-091196-BF	M. juv.	23,19	373	31,08	1,29
10-091196-BF	M. juv.	25,57	463	35,47	3,99
14-091196-BF	M. juv.	30,25	438	33,42	2,73
16-091196-BF	M. juv.	27,08	445	29,55	5,46
17-091196-BF	M. juv.	21,38	350	28,25	
02-281296-BF*	M. juv.	25,46	467	34,35	4,79
03-281296-BF*	M. juv.	27,02	443	33,27	3,89
04-281296-BF*	M. juv.	23,02	445	34,97	3,95
12-120896, hun	F.?, juv.	22,41	382	30,27	2,76
16-120896-BF	F.?, juv.	29,59	448	38,88	5,93
20-120896-BF	F.?, juv.	28,23	412	30,91	4,18
15-091196-BF	F.?, juv.	20,34	370	26,49	2,16

*Liver in glass jar.
¤ ½ liver in polyethylene bag.
" ½ liver in glass jar.

Table A.1.3 Black guillemots 1997, all weights are in grams.
Suffix - H: Bird was shot near Hestoy, -S: Bird shot near Sveipur

Bird ID	Female/male, adults/ juvenile	Liver	Bird, full weight	Muscle $, left breast	Subcut. fat
06-090197	F. ad.	31	476	42,22	5,8
18-090197	F. ad.	29,82	479	39,7	6,9
12-260297	F. ad.	31,4	444	23,6	4,1
13-260297	F. ad.	29,06	478	30,8	2,8
14-260297	F. ad.	30,75	438	30,7	2,5
15-260297	F. ad.	30,76	443	32,2	4,8
17-260297	F. ad.	30,2	448	24,9	2,9
20-260297	F. ad.	30,7	459	30,1	3,5
22-260297	F. ad.	33,13	473	27,6	4,8
23-260297	F. ad.	32,58	458	20,5	3,8
26-260297	F. ad.	27,43	455	22,1	4,1
32-260297	F. ad.	34,03	510	28,3	4,9
34-260297	F. ad.	29,99	462	20,2	3,4
36-260297	F. ad.	30,38	458	25,6	2,9
01-090197-H	M. ad	29,46	467	38,97	3,8
02-090197-H	M. ad	28,56	514	42,77	6,6
03-090197-H	M. ad	27,23	445	38,31	5,4
04-090197-H	M. ad	32,58	551	45,06	4,9
05-090197-H	M. ad	27,70	445	34,69	3,7
08-090197-H	M. ad	29,50	513	38,65	7,1
10-090197-H	M. ad	24,24	458	38,25	7,0
16-090197-S	M. ad	24,59	421	38,27	3,6
17-090197-S	M. ad	30,27	472	37,69	7,2
19-090197-S	M. ad	23,06	395	31,26	3,2
20-090197-S	M. ad	28,14	467	41,68	9,4
21-090197-S	M. ad	26,40	492	42,21	5,4
23-090197-S	M. ad	28,77	492	40,00	7,1
16-260297-S	M. ad	34,88	478	30,6	4,7
19-260297-S	M. ad	30,37	435	18,1	3,0
25-260297-S	M. ad	26,16	432	17,2	2,2
27-260297-S	M. ad	25,30	427	21,1	3,3
29-260297-S	M. ad	27,82	433	24,1	3,2
33-260297-H	M. ad	28,06	389	17,1	3,4
35-260297-H	M. ad	30,51	431	23,8	5,5
09-090197	F. juv	28,61	417	36,31	2,4
24-090197-BF	F. juv	30,13	478	39,17	10,1
25-090197-BF	F. juv	28,58	468	41,09	7,24
18-260297	F. juv	28,19	402	27,2	2,4
21-260297	F. juv	31,49	432	21,5	3,2
24-260297-BF	F. juv	30,34	428	24,4	2,9
28-260297-BF	F. juv	31,91	464	24,3	4,2
31-260297	F. juv	29,18	416	21,2	3,9
07-090197-BF	M. juv.	24,77	423	36,3	5,6
11-090197-BF	M. juv.	25,45	422	36,78	7,2
12-090197-BF	M. juv.	29,45	459	34,55	4,7
22-090197-BF	M. juv.	26,74	432	34,24	5,1
30-260297-BF	M. juv.	31,75	437	17,4	4,2

$ For birds shot in February´97 the weight given refers to a part of the left breast muscle only.

Composition of pooled samples of Black guillemot

The following tables gives the composition of the pooled samples in terms of bird ID and the weight of the liver that was combined into the pools, see also Table A.1.1-A.1.3. The bird ID is composed of a two-digit number followed by the date of the hunt (day-month-year). The suffix –BF is added to individuals in which a *bursus fabriosus* was found. Suffix – H is given to birds shot near Hestoy, and –S to those shot near Sveipur in 1997.

Adult females

HU-Ad-apr96 all Sveipur	Liver, g
11-170496-BF	25,36
16-260496	28,85
18-260496	26,60
22-260496	25,95
24-260496	26,72
25-260496	24,92

HU-Ad-aug96 all Hestoy	Liver, g
02-120896	22,88
03-120896	27,38
04-120896	29,21
12-120896	22,41
17-120896-BF	29,82

HU-Ad-97	Liver, g
06-090197-H	31
18-090197-S	29,82
12-260297-S	31,4
13-260297-S	29,06
14-260297-S	30,75
15-260297-S	30,76
17-260297-S	30,2
20-260297-S	30,7
22-260297-S	33,13
23-260297-S	32,58
26-260297-S	27,43
32-260297-S	34,03
34-260297-H	29,99
36-260297-H	30,38

Juvenile females

HU-JUV-97	Liver, g
09-090197-H	28,61
24-090197-BF-S	30,13
25-090197-BF-S	28,58
18-260297-S	28,19
21-260297-S	31,49
24-260297-BF-S	30,34
28-260297-BF-S	31,91
31-260297-S	29,18

Juvenile males

Males younger than or equal to 3 K	Liver, g
07-090197-BF-H	24,77
11-090197-BF-H	25,45
12-090197-BF-H	29,45
22-090197-BF-S	26,74
30-260297-BF-S	31,75

Adult males

HA-Ad-nov95 all Sveipur	Liver, g
03-201195	34,29
10-231195	30,46
11-201195	28,24
12-231195	36,71

HA-Ad-apr96 all Sveipur	Liver, g
15-170496	23,84
17-170496	26,07
18-170496	24,24
17-260496	24,01
19-260496	24,77
20-260496	21,12
21-260496	24,67
26-260496	26,10
27-260496	28,13
28-260496	25,98
29-260496	25,60
30-260496	22,24

HA-Ad-aug96 all Hestoy	Liver, g
05-120896	20,50
06-120896	23,30
07-120896	29,86
10-120896	24,03
11-120996	26,26
13-120896	25,56
14-120896	25,90
15-120896	24,14

HA-Ad-nov96 all Hestoy	Liver, g
01-091196	29,14
02-091196	25,05
03-091196	23,31
04-091196	29,76
05-091196	24,49
06-091196	24,03
07-091196	28,42
09-091196	26,85

HA-Ad-jan97-H	Liver, g
01-090197-H	29,46
02-090197-H	28,56
03-090197-H	27,23
04-090197-H	32,58
05-090197-H	27,7
08-090197-H	29,5
10-090197-H	24,24

HA-Ad-jan97-S	Liver, g
16-090197-S	24,59
17-090197-S	30,27
19-090197-S	23,06
20-090197-S	28,14
21-090197-S	26,4
23-090197-S	28,77

HA-Ad-feb97	Liver, g
16-260297-S	34,88
19-260297-S	30,37
25-260297-S	26,16
27-260297-S	25,3
29-260297-S	27,82

Table A.2.1 Individual shell length of blue mussels.

Date of sampling:	20.jun-96	cont. 20.jun-96	19.sep-96	19.dec-96	20.mar-97
	4,8	4,8	3,9	4	3,65
	5,1	4,35	3,9	3	3,65
	5,3	4,75	3,95	3,5	3,35
	5,25	5,35	4	4	3,35
	4,6	5,3	3,55	3,5	3,75
	5,35	4,95	3,6	3,35	3,8
	4,55	4,95	3,9	3,1	3,6
	5,35	4,3	3,9	3,45	3,35
	3,75	5,3	3,8	3,1	3,4
	3,85	4,7	3,7	3,4	3,25
	4,6	5,7	3,65	3,7	3,75
	4,55	4,25	3,6	3,4	3,7
	4,9	3,6	3,6	3,25	3,7
	4,7	5,15	3,7	3	3,65
	5,1	4,45	3,7	2,9	3,7
	4,6		3,45	3,65	3,7
	5,4		3,9	3,45	3,05
	5,5		3,7	3,05	4
	5,15		3,75	3,15	3,45
	4,75		3,6	3,4	3,05
	5,1		3,55	3,15	3,2
	5,35		4	3,65	4
	5,65		3,95	3,2	3,35
	5,15		3,85	3,8	3,3
	4,2		3,05	4,05	3,85
	4,8		3,2	3,4	3,75
	5,1		3,75	3,55	3,5
	4,2		3,7	3,2	3,6
	4,7		3,2	3,75	4
	5,1		3,85	3,5	3,45
	3,6		3,4	3,25	3,35
	4,4		3,45	3,35	3,35
	4,45		3,7	3,45	3,45
	4,85		3,8	3,7	3,7
	4,65		3,5	3,6	3,75
	4,8		3,8	3	2,95
	4,5		4	3,6	
	5,45		4	3	
	5,4		3,7	3,4	
	5		3,45	3	
	5,25		3,8	3,5	
	5,3		3,8	3,3	
	4,95		3,7	3,3	
	4,5		3,95	3,35	
	3,45		3,85	3,5	
	4,55		3,5	3,95	
	4,5		4	3,05	
	5,45		3,4	3,75	
	5,6		3,45	3,95	
	4,5		3,65	3	
	4,15		3,45	3,5	
	5,1		3,7	4	
	5,6		3,05	3,45	
	4,2		3,65	3,2	

Table A.2.2 Starfish pooled sample “Large”.

N = 20	Sampling : Svínáir, 19. Dec´96	
No.	diameter, cm	weight, g
1	14,5	26,3
2	13	26,3
3	14	31,8
4	13	28,6
5	12,5	19,6
6	11,5	16,4
7	10,5	19,2
8	14	21,9
9	8,4	9,6
10	10	12,2
14	20	80
15	16,5	41
16	15,5	51
17	16,5	47
18	17,5	50
19	20,5	69
20	19,5	67
21	18	62
22	20,5	82
23	19,5	79
mean	**15,3**	**42,0**
min	**8,4**	**9,6**
max	**20,5**	**82**
Total weight		**839,9**

Table A.2.3 Starfish pooled sample “Small”.

N = 22	Sampling : Svínáir, 19. Dec´96	
No.	diameter, cm	weight, g
30	8,7	9,3
31	6,5	5,4
32	6	4,6
33	7,2	4,4
34	8,7	9,7
35	12	21,5
36	9,5	9,7
37	8,3	9,9
38	8,7	11,3
39	6,7	5,5
40	6,5	5
41	5,6	3,8
42	6,8	4,3
43	5,4	2,9
44*	8,6	9,7
45	6,4	4,5
46	5,5	2,7
47	7,2	5,3
48	5,5	2,6
11	7,4	6,5
12**	8,8	6,8
13	7,3	6
mean	**7,4**	**6,9**
min	**5,4**	**2,6**
max	**12**	**21,5**
Total weight		**151,4**

*; four arms
**: three arms

Table A.2.4 *Echinus esculentus*. Date of sampling 18. June 1996 of Svínáir.

no.	whole weight, g	gonads weight, g	shell weight, g	diameter, cm (excl. the spines)	height, cm (excl. the spines)	fluids, g
jun-01	87,24	**2,51**	30	5,9		44,5
jun-02	110,85	**3,74**	38,7	6,7	4,2	57,88
jun-03	84,52	**3,7**	36	6,6	3,8	36,7
jun-04	74	**7,39**	31,2	6,3	3,9	30,1
jun-05	83,22	**1,71**	34,8	6,1	3,8	37,57
jun-06	81,22	**3,37**	40,6	6,3	3,9	32,26
jun-07	124,3	**11,41**	49,7	6,9	4,6	61,3
jun-08	93,3	**3,65**	40,5	6,6	3,2	43,1
jun-09	93,8	**4,55**	40,9	6,4	4,1	48,7
jun-10	101,5	**8,18**	42	6,4	3,8	51,1
jun-11	180,3	**9,12**	70,4	7,6	4,8	91,3
jun-12	111,8	**5,49**	42,8	6,9	4,3	61,7
jun-13	133,7	**10,82**	51,9	7	4,5	67,2
jun-14	127,1	**11,76**	49,9	6,8	4,3	63,4
jun-15	121,2	**4,89**	48,5	6,8	4,7	61,6
jun-16		**8,28**	67,4	7,5	4,3	78,2
jun-17	170,4	**9,5**	62	7,7	4,7	92,5
jun-18	140,5	**6,16**	59,9	7,1	4,8	74
jun-19	202,7	**2,74**	58,6	8,4	5,8	136,2
jun-20	187,9	**6,99**	68,4	7,8	5,6	110,5
jun-21	206,5	**13,12**	79,1	8,5	5,3	111,9
jun-22	215,5	**0,82**	70,4	8,2	6,3	137,5
jun-23	230,3	**14,97**	79	8,4	6	134
jun-24	234,5	**6,84**	79,1	8,2	5,4	146,1
jun-25	191,1	**5,04**	78,7	8,1	5,2	101,7
jun-26	256,2	**18,06**	99,1	9,5	5,3	134,9
sum	*3643,65*	**184,81**	1449,6			2045,91
mean	**145,7**	**7,1**	**55,8**	**7,3**	**4,7**	**78,7**
range	74 – 256,2	**0,82 - 18,06**	30 - 99,1	5,9 – 9,5	3,2 – 6,3	30,1 – 146,1

Table A.2.5 *Echinus esculentus*. Date of sampling 19. Dec. 1996 off Svínáir.

No.	**whole weight, g**	**gonads weight, g**	**shell weight, g**	**diameter, cm** (excl. the spines)	**height, cm** (excl. the spines)	**fluids, g**
Dec-01	131,9	15,1	43,1	6,8	4,2	43,6
Dec-02	122,6	9,1	53,9	7	4,3	57,3
Dec-03	100,8	9,5	47,9	6,35	3,7	42
Dec-04	111,7	12,6	45,7	6,6	4,2	54,4
Dec-05	126,8	11,6	56,4	7	4,3	57
Dec-06	147,2	18,2	60,8	7,2	4,7	64,3
Dec-07	168	11	58,8	7,5	4,9	97,6
Dec-08	168,5	14,1	72,1	7,5	4,8	88,4
Dec-09	144,3	14,7	60	7,1	4,4	62,4
Dec-10	123,1	18	52,9	6,8	4,5	50,7
Dec-11	166,5	16,3	61	7,7	5	86,3
Dec-12	171,8	12,5	71,5	7,8	4,8	89,1
Dec-13	203,3	27,4	73,2	7,6	5,8	96,8
Dec-14	206,9	19,1	85	8,1	5,2	99,9
Dec-15	156,6	19,8	66,7	7,4	5,1	83,5
Dec-16	202,9	27,8	65,1	7,8	5,6	121,1
Dec-17	217,3	13,1	67,6	8	5,5	136,4
Dec-18	165,3	15,2	67,6	7,6	4,5	81,5
Dec-19	198,1	39,7	81	8,1	5,3	88,6
Dec-20	206,5	12,8	71,8	8,1	5,3	116
Dec-21	*106,5**	*21,7*	*67,5*	*7,5*	*4,8*	*74*
Dec-22	152,6	16,2	65,4	7,7	5,6	70,6
Dec-23	220,1	10,9	77,8	8,2	5,1	131,4
Dec-24	197,4	15,2	68,9	7,9	5,3	112,2
Dec-25	202,3	16,1	78,1	8	5,2	107,5
Dec-26	204,5	9,9	81	8,1	5,6	110,5
Dec-27	293	32,8	95,3	8,9	5,9	162,8
Dec-28	270	11,7	86	8,7	5,8	169,7
Sum	4780	450,4	1814,6			2481,6
Mean	**177,0**	16,7	**67,2**	**7,6**	**5,0**	**91,9**
Min.	100,8	9,1	43,1	6,4	3,7	42,0
Max.	293,0	39,7	95,3	8,9	5,9	169,7

* probably erroneous value, not included in the mean.

12 Appendix B

B.1 Analysis reports from laboratories on PCB, pesticides and PAH in sea-urchins, mussels, common limpets etc.

B.2 Results of heavy metals in Black guillemots, in mg/kg w.w. liver

NIVA

Norsk Institutt for Vannforskning

Postboks 173 Kjelsås
0411 Oslo
Tel: 22 18 51 00
Fax: 22 18 52 00

ANALYSE RAPPORT

NORSK AKKREDITERING Nr. P009

Navn: **Miljø- og Levnedsmiddelstyrelsen, Attn.: Maria Dam**
Adresse: **Debesartrød, FR-100 Torshavn, Færøyene**

Deres referanse:	**Vår referanse:**	***Dato***
Maria Dam	Rekv.nr. 1997-1019 O.nr. O 97025 02	07/10/97

Prøvene ble levert ved NIVAs laboratorium av oppdragsgiver, og merket slik som gjengitt i tabellen nedenfor.
Prøvene ble analysert med følgende resultater (analyseusikkerhet er gitt i eget dokument):

Prøvenr	**Prøve merket**	**Prøvetakings-dato**	**Mottatt NIVA**	**Analyseperiode**
1	Sjøpindsvin 1-27	19 dec 96	970530	970723-970820
2	Blåmusling (613-1) 5<x<6cm		970530	970723-970812
3	Blåmusling (613-2) 4<x<5cm		970530	970916-970917
4	Blåmusling (613-3) 3<x<4cm		970530	970723-970820
5	Blåmusling juni 96 587-1		970530	970723-970820
6	Blåmusl. sept.96 Svinari 587-1		970530	970723-970820
7	Blåmusling des. 96 587-3		970530	970723-970820

Analysevariabel	Enhet	Prøvenr Metode	1	2	3	4	5	6	7
Fett	%	H 3-4	2,69	1,45	1,17	0,78	0,61	1,95	0,10
Penta-klorbenzen	µg/kg v.v.	H 3-4	<0,05	0,06	<0,05	<0,05	<0,05	<0,05	<0,05
Hexa-klorbenzen	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05
Alfa-hexakl.cyclohex.	µg/kg v.v.	H 3-4	0,13	0,05	0,06	<0,05	<0,05	0,06	<0,05
Gamma-hexakl.cyclohex	µg/kg v.v.	H 3-4	0,07	s0,14	0,06	<0,05	<0,05	0,10	<0,05
Polyklorertbifenyl 28	µg/kg v.v.	H 3-4	<0,05	0,06	<0,05	<0,05	<0,05	0,05	<0,05
Polyklorertbifenyl 52	µg/kg v.v.	H 3-4	0,05	0,08	0,08	0,07	<0,05	0,07	<0,05
Oktaklorstyren	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05
Polyklorertbifenyl101	µg/kg v.v.	H 3-4	0,13	0,37	0,28	0,21	0,07	0,22	0,05
4,4-DDE	µg/kg v.v.	H 3-4	0,71	2,02	1,59	0,91	0,31	0,75	0,27
Polyklorertbifenyl118	µg/kg v.v.	H 3-4	0,12	0,49	0,47	0,30	0,09	0,26	0,06
Polyklorertbifenyl153	µg/kg v.v.	H 3-4	0,14	1,28	1,20	0,91	0,25	0,74	0,14
4,4-DDD	µg/kg v.v.	H 3-4	0,12	0,41	0,30	0,22	0,09	0,24	0,08
Polyklorertbifenyl105	µg/kg v.v.	H 3-4	<0,05	0,17	0,16	0,11	<0,05	0,09	<0,05
Polyklorertbifenyl138	µg/kg v.v.	H 3-4	0,07	0,88	0,86	0,59	0,15	0,43	0,10
Polyklorertbifenyl156	µg/kg v.v.	H 3-4	<0,05	0,07	0,09	0,05	<0,05	<0,05	<0,05
Polyklorertbifenyl180	µg/kg v.v.	H 3-4	<0,05	0,17	0,21	0,11	<0,05	0,10	<0,05
Polyklorertbifenyl209	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05
4,4-DDT	µg/kg v.v.	H 3-4	<0,05	0,60	s0,39	0,26	0,14	<0,05	<0,05
Sum PCB	µg/kg v.v.	Beregnet*	.51	3.57	3.35	2.35	.56	1.96	.35
Seven Dutch	µg/kg v.v.	Beregnet*	.51	3.33	3.1	2.19	.56	1.87	.35
PAH i biol. matr.	µg/kg v.v.	H 2-3	u			u	u	u	u

u: Analyseresultat er vedlagt i egen analyserapport., s: Analyseresultat er suspekt., *: Analysemetoden er ikke akkreditert.

Kommentarer

3 1019 3 er reanalyset p.g.a. feil ved første opparbeidelse.

NIVA

ANALYSE RAPPORT

NORSK AKKREDITERING Nr. P009

Rekv.nr. 1997-1019

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings-dato	Mottatt NIVA	Analyseperiode
8	Patella vulgata Kirkjubø	960318	970530	970723-970915
9	Patella vulgata Kirkjubø	960618	970530	970723-970915
10	Patella vulgata Kirkjubø	960911	970530	970723-970915
11	Patella vulg. des.96 Kirkjubø		970530	970723-970915
12	Patella vulgata Kirkjubø	970313	970530	970723-970915
13	Sandfl.lever Mar.96 SK2-SK28	mar 96	970530	970728-970820
14	Sandfl.lever jul.96 SK48-SK 89	jun /jul 96	970530	970728-970813

Analysevariabel	Enhet	Prøvenr Metode	8	9	10	11	12	13	14
Fett	%	H 3-4	0,36	0,53	0,56	1,38	0,46	5,56	21,1
Penta-klorbenzen	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	<1	<1
Hexa-klorbenzen	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	0,05	<0,05	1	3
Alfa-hexakl.cyclohex.	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	0,05	<0,05	<1	1
Gamma-hexakl.cyclohex	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	s0,05	<0,05	m	1
Polyklorertbifenyl 28	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	<1	1
Polyklorertbifenyl 52	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	<1	1
Oktaklorstyren	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	<1	<1
Polyklorertbifenyl101	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	1	4
4,4-DDE	µg/kg v.v.	H 3-4	<0,05	s0,05	<0,05	0,05	<0,05	7	24
Polyklorertbifenyl118	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	2	5
Polyklorertbifenyl153	µg/kg v.v.	H 3-4	<0,05	0,06	0,05	0,12	<0,05	5	16
4,4-DDD	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	0,08	<0,05	1	3
Polyklorertbifenyl105	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	1	2
Polyklorertbifenyl138	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	0,05	<0,05	3	9
Polyklorertbifenyl156	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	<1	1
Polyklorertbifenyl180	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	2	5
Polyklorertbifenyl209	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	<1	<1
4,4-DDT	µg/kg v.v.	H 3-4	<0,05	<0,05	<0,05	<0,05	<0,05	m	6
Sum PCB	µg/kg v.v.	Beregnet*	0	.06	.05	.17	0	14	44
Seven Dutch	µg/kg v.v.	Beregnet*	0	.06	.05	.17	0	13	41
PAH i biol. matr.	µg/kg v.v.	H 2-3	u	u	u	u	u	u	

m: Analyseresultat mangler pga maskert topp

u: Analyseresultat er vedlagt i egen analyserapport.

s: Analyseresultat er suspekt.

* : Analysemetoden er ikke akkreditert.

NIVA

Side nr. 3/6

ANALYSE RAPPORT

NORSK AKKREDITERING Nr. P009

Rekv.nr. 1997-1019

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings-dato	Mottatt NIVA	Analyseperiode
15	Sandflyndrelever SK90-SK147	aug / sep 96	970530	970728-970820
16	Sandflyndrelever SK172-SK233	nov / dec 96	970530	970728-970813
17	Sandflyndrelever SK265-SK289	mar 97	970530	970728-970813
			970530	970728-970820
			970530	970728-970820
			970530	970728-970813
			970530	970728-970813

Analysevariabel	Enhet	Prøvenr Metode	15	16	17	18	19	20	21
Fett	%	H 3-4	21,5	15,1	8,79	7,52	19,7	2,71	2,33
Penta-klorbenzen	µg/kg v.v.	H 3-4	<1	<1	m	<1	<1	<0,2	<0,2
Hexa-klorbenzen	µg/kg v.v.	H 3-4	2	3	2	2	6	1,0	1,0
Alfa-hexakl.cyclohex.	µg/kg v.v.	H 3-4	1	1	1	<1	2	<0,2	<0,2
Gamma-hexakl.cyclohex	µg/kg v.v.	H 3-4	<1	s1	<1	m	s1	s0,6	s0,7
Polyklorertbifenyl 28	µg/kg v.v.	H 3-4	<1	<1	<1	<1	1	<0,2	<0,2
Polyklorertbifenyl 52	µg/kg v.v.	H 3-4	1	1	1	<1	2	<0,2	<0,2
Oktaklorstyren	µg/kg v.v.	H 3-4	<1	<1	<1	<1	<1	<0,2	<0,2
Polyklorertbifenyl101	µg/kg v.v.	H 3-4	4	4	3	1	8	<0,2	<0,2
4,4-DDE	µg/kg v.v.	H 3-4	16	32	16	6	66	8,1	16,6
Polyklorertbifenyl118	µg/kg v.v.	H 3-4	5	7	4	2	13	2,1	5,0
Polyklorertbifenyl153	µg/kg v.v.	H 3-4	13	19	10	4	34	6,6	17,3
4,4-DDD	µg/kg v.v.	H 3-4	3	4	2	1	12	0,5	0,5
Polyklorertbifenyl105	µg/kg v.v.	H 3-4	2	2	1	1	5	0,8	2,0
Polyklorertbifenyl138	µg/kg v.v.	H 3-4	8	12	6	2	24	3,6	8,4
Polyklorertbifenyl156	µg/kg v.v.	H 3-4	1	1	1	<1	4	0,5	1,4
Polyklorertbifenyl180	µg/kg v.v.	H 3-4	4	6	4	1	15	2,4	7,0
Polyklorertbifenyl209	µg/kg v.v.	H 3-4	<1	<1	<1	<1	1	<0,2	0,3
4,4-DDT	µg/kg v.v.	H 3-4	5	7	3	2	20	m	m
Sum PCB	µg/kg v.v.	Beregnet*	38	52	30	11	107	16	41.4
Seven Dutch	µg/kg v.v.	Beregnet*	35	49	28	10	97	14.7	37.7
PAH i biol. matr.	µg/kg v.v.	H 2-3	u			u	u		

m: Analyseresultat mangler pga maskert topp
u: Analyseresultat er vedlagt i egen analyserapport.
s: Analyseresultat er suspekt.
* : Analysemetoden er ikke akkreditert.

Kommentarer

15 Prøven er tatt i aug.+sept. 96.
17 Prøven er tatt i mars 97.

NIVA

ANALYSE RAPPORT

NORSK AKKREDITERING Nr. P009

Rekv.nr. 1997-1019

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings-dato	Mottatt NIVA	Analyseperiode
			970530	970728-970813
			970530	970728-970813
			970530	970728-970813
25	Teist, lever HA-MA nov. 95		970530	970728-970813
26	Teist, lever HA-MA apr. 96		970530	970728-970813
27	Teist, lever HA-MA aug. 96		970530	970728-970813
28	Teist, lever HA-MA nov. 96		970530	970728-970813

Analysevariabel	Enhet	Prøvenr Metode	22	23	24	25	26	27	28
Fett	%	H 3-4	3,08	1,85	2,23	3,61	3,62	4,94	3,39
Penta-klorbenzen	µg/kg v.v.	H 3-4	<0,2	<0,2	<0,2	0,2	<0,2	<0,2	<0,2
Hexa-klorbenzen	µg/kg v.v.	H 3-4	1,4	0,6	1,0	2,6	4,2	2,0	1,7
Alfa-hexakl.cyclohex.	µg/kg v.v.	H 3-4	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2
Gamma-hexakl.cyclohex	µg/kg v.v.	H 3-4	s1,0	s0,8	m	s0,8	m	s0,3	s0,5
Polyklorertbifenyl 28	µg/kg v.v.	H 3-4	<0,2	<0,2	<0,2	<0,2	0,5	0,2	<0,2
Polyklorertbifenyl 52	µg/kg v.v.	H 3-4	<0,2	<0,2	<0,2	<0,2	0,4	<0,2	<0,2
Oktaklorstyren	µg/kg v.v.	H 3-4	<0,2	<0,2	<0,2	<0,2	0,2	<0,2	<0,2
Polyklorertbifenyl101	µg/kg v.v.	H 3-4	<0,2	<0,2	<0,2	0,4	2,7	0,4	0,4
4,4-DDE	µg/kg v.v.	H 3-4	10,2	6,1	8,8	7,7	30,6	10,2	7,4
Polyklorertbifenyl118	µg/kg v.v.	H 3-4	4,1	1,9	1,6	2,3	9,5	3,9	1,6
Polyklorertbifenyl153	µg/kg v.v.	H 3-4	12,8	5,7	5,7	10,7	42,1	24,2	7,6
4,4-DDD	µg/kg v.v.	H 3-4	0,5	0,4	0,2	<0,2	0,4	m	<0,2
Polyklorertbifenyl105	µg/kg v.v.	H 3-4	1,4	0,7	0,5	0,8	3,2	1,5	0,6
Polyklorertbifenyl138	µg/kg v.v.	H 3-4	6,4	3,1	2,7	4,5	19,1	9,4	3,4
Polyklorertbifenyl156	µg/kg v.v.	H 3-4	1,0	0,4	0,4	0,9	3,5	1,8	0,7
Polyklorertbifenyl180	µg/kg v.v.	H 3-4	4,7	1,8	2,2	5,4	19,9	11,8	4,0
Polyklorertbifenyl209	µg/kg v.v.	H 3-4	0,2	<0,2	<0,2	<0,2	0,4	0,2	<0,2
4,4-DDT	µg/kg v.v.	H 3-4	m	m	m	m	m	m	m
Sum PCB	µg/kg v.v.	Beregnet*	30.6	13.6	13.1	25	101.3	53.4	18.3
Seven Dutch	µg/kg v.v.	Beregnet*	28	12.5	12.2	23.3	94.2	49.9	17

m: Analyseresultat mangler pga. maskert topp
s: Analyseresultat er suspekt.
* : Analysemetoden er ikke akkreditert.

Kommentarer

23 Prøven er tatt nov/des 96.
24 Prøven er tatt nov/des 96.

NIVA

ANALYSE RAPPORT

NORSK AKKREDITERING Nr. P009

Rekv.nr. 1997-1019

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings-dato	Mottatt NIVA	Analyseperiode
29	Teist, lever HA-MA jan.97 S		970530	970728-970813
30	Teist, lever HA-MA jan.97 H		970530	970728-970813
31	Teist, lever HU-MA apr. 96		970530	970728-970813
32	Teist, lever HU-MA aug. 96		970530	970728-970813
			970530	970728-970813
			970530	970728-970813
			970530	970728-970813

Analysevariabel	Enhet	Prøvenr Metode	29	30	31	32	33	34	35
Fett	%	H 3-4	3,80	3,45	4,50	4,54	5,50	5,70	4,44
Penta-klorbenzen	µg/kg v.v.	H 3-4	0,2	0,2	0,3	<0,2	0,2	0,3	<0,2
Hexa-klorbenzen	µg/kg v.v.	H 3-4	2,6	2,8	7,9	1,7	4,1	2,9	3,1
Alfa-hexakl.cyclohex.	µg/kg v.v.	H 3-4	<0,2	<0,2	<0,2	<0,2	0,4	0,6	0,3
Gamma-hexakl.cyclohex·	µg/kg v.v.	H 3-4	s0,5	s0,4	s0,6	s0,2	s0,7	s0,7	s0,9
Polyklorertbifenyl 28	µg/kg v.v.	H 3-4	<0,2	<0,2	0,7	0,2	0,5	0,4	0,4
Polyklorertbifenyl 52	µg/kg v.v.	H 3-4	<0,2	<0,2	0,4	<0,2	m	<0,2	<0,2
Oktaklorstyren	µg/kg v.v.	H 3-4	<0,2	<0,2	0,2	<0,2	0,2	0,2	0,2
Polyklorertbifenyl101	µg/kg v.v.	H 3-4	0,5	0,3	2,3	0,3	s0,3	0,4	s0,4
4,4-DDE	µg/kg v.v.	H 3-4	12,8	7,2	23,7	8,9	37,5	14,5	36,5
Polyklorertbifenyl118	µg/kg v.v.	H 3-4	3,1	2,2	11,2	4,0	17,7	6,2	16,5
Polyklorertbifenyl153	µg/kg v.v.	H 3-4	12,7	10,0	37,0	20,2	52,1	14,9	50,9
4,4-DDD	µg/kg v.v.	H 3-4	m	<0,2	0,4	<0,2	m	s0,9	s1,1
Polyklorertbifenyl105	µg/kg v.v.	H 3-4	1,2	0,9	4,0	1,4	5,3	2,3	4,8
Polyklorertbifenyl138	µg/kg v.v.	H 3-4	6,2	4,2	17,7	7,9	22,4	8,5	23,9
Polyklorertbifenyl156	µg/kg v.v.	H 3-4	1,1	0,9	3,2	1,4	4,0	1,3	4,4
Polyklorertbifenyl180	µg/kg v.v.	H 3-4	5,8	4,9	17,0	8,5	18,5	4,5	29,1
Polyklorertbifenyl209	µg/kg v.v.	H 3-4	<0,2	<0,2	0,2	0,2	0,2	<0,2	0,2
4,4-DDT	µg/kg v.v.	H 3-4	m	m	m	m	m	m	m
Sum PCB	µg/kg v.v.	Beregnet*	30.6	23.4	93.7	44.1	120.7	38.5	130.2
Seven Dutch	µg/kg v.v.	Beregnet*	28.3	21.6	86.3	41.1	111.2	34.9	120.8

m: Analyseresultat mangler pga maskert topp.
s: Analyseresultat er suspekt.
* : Analysemetoden er ikke akkreditert.

NIVA

ANALYSE RAPPORT

NORSK AKKREDITERING Nr. P009

Rekv.nr. 1997-1019

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings-dato	Mottatt NIVA	Analyseperiode
			970530	970728-970813
37	Emballasje plast		970530	970728-970813
38	Emballasje glass		970530	970728-970813

Analysevariabel	Enhet	Prøvenr Metode	36	37	38
Fett	%	H 3-4	5,06	4,33	3,76
Penta-klorbenzen	µg/kg v.v.	H 3-4	<0,2	0,2	<0,2
Hexa-klorbenzen	µg/kg v.v.	H 3-4	1,6	2,4	2,3
Alfa-hexakl.cyclohex.	µg/kg v.v.	H 3-4	0,4	<0,2	<0,2
Gamma-hexakl.cyclohex	µg/kg v.v.	H 3-4	m	s0,7	s0,5
Polyklorertbifenyl 28	µg/kg v.v.	H 3-4	0,2	<0,2	<0,2
Polyklorertbifenyl 52	µg/kg v.v.	H 3-4	<0,2	<0,2	<0,2
Oktaklorstyren	µg/kg v.v.	H 3-4	<0,2	<0,2	<0,2
Polyklorertbifenyl101	µg/kg v.v.	H 3-4	0,2	0,4	0,4
4,4-DDE	µg/kg v.v.	H 3-4	14,9	8,4	7,5
Polyklorertbifenyl118	µg/kg v.v.	H 3-4	4,4	2,1	1,8
Polyklorertbifenyl153	µg/kg v.v.	H 3-4	11,7	10,0	7,9
4,4-DDD	µg/kg v.v.	H 3-4	s0,8	<0,2	<0,2
Polyklorertbifenyl105	µg/kg v.v.	H 3-4	1,5	0,8	0,6
Polyklorertbifenyl138	µg/kg v.v.	H 3-4	6,6	4,0	3,1
Polyklorertbifenyl156	µg/kg v.v.	H 3-4	1,0	0,9	0,7
Polyklorertbifenyl180	µg/kg v.v.	H 3-4	4,3	5,2	4,2
Polyklorertbifenyl209	µg/kg v.v.	H 3-4	<0,2	<0,2	<0,2
4,4-DDT	µg/kg v.v.	H 3-4	m	m	m
Sum PCB	µg/kg v.v.	Beregnet*	29.9	23.4	18.7
Seven Dutch	µg/kg v.v.	Beregnet*	27.4	21.7	17.4

m: Analyseresultat mangler pga. maskert topp
s: Analyseresultat er suspekt.
* : Analysemetoden er ikke akkreditert.

Norsk institutt for vannforskning

Einar M. Brevik
Seksjonsleder

NORSK INSTITUTT FOR VANNFORSKNING
P.O.Boks 173 Kjelsås, 0411 OSLO

Navn/lokalitet	Færøyene
Adresse	
Oppdragsnr.	97025
Prøver mottatt	30.5.97
Lab.kode	1019 1,4,5,6,7,8
Jobb nr.	97/134
Prøvetype	Biol.materiale
Kons. i	Ug/kg våtvekt
Metode	H2-3
Dato	20.8.97
Analytiker	Brg

1: Sjøpindsvin 1-27
2: Blåmusling (613-3) 3<x<4cm
3: Blåmusling juni 96 587-1
4: Blåmusling sept.96 Svinari 587-1
5: Blåmusling des.96 587-3
6: Patella vulgata Kirkjubø

Parameter/prøve	1	2	3	4	5	6
						mar 96
Naftalen	<0.2	0.5	<0.2	<0.2	3.3	<0.2
2-M-Naf.	<0.2	2.9	<0.2	0.5	3.8	<0.2
1-M-Naf.	<0.2	2.1	<0.2	<0.2	2.9	<0.2
Bifenyl	0.3	0.4	0.2	0.5	0.5	<0.2
2,6-Dimetylnaftalen	0.4	0.7	<0.2	1	<0.2	0.2
Acenaftylen	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Acenaften	0.5	<0.2	<0.2	<0.2	<0.2	0.4
2,3,5-Trimetylnaftalen	<0.2	<0.2	<0.2	0.6	<0.2	<0.2
Fluoren	0.2	0.5	0.2	0.5	0.2	<0.2
Fenantren	<0.2	0.8	<0.2	1	<0.2	<0.2
Antracen	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1-Metylfenantren	<0.2	0.8	0.2	1.1	0.3	<0.2
Fluoranten	0.4	1.2	0.6	1.6	0.3	<0.2
Pyren	0.4	0.9	0.3	1.6	0.4	<0.2
Benz(a)antracen*	<0.2	0.5	<0.2	0.6	<0.2	<0.2
Chrysen/trifenylen	0.5	2.5	0.8	2.1	0.5	<0.2
Benzo(b)fluoranten*	<0.2	3.8	0.7	1.8	0.7	<0.2
Benzo(j,k)fluoranten*	<0.2	x)	<0.2	<0.2	<0.2	<0.2
Benzo(e)pyren	0.3	2.5	0.6	1.2	0.5	<0.2
Benzo(a)pyren*	<0.2	0.3	<0.2	<0.2	<0.2	<0.2
Perylen	<0.2	0.7	<0.2	0.2	<0.2	<0.2
Ind.(1,2,3cd)pyren*	<0.2	0.5	<0.2	0.2	<0.2	<0.2
Dibenz.(a,c/a,h)ant.* 1)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(ghi)perylen	<0.2	0.7	0.2	0.3	<0.2	<0.2
SUM	3	22.3	3.8	14.8	13.4	0.6
Derav KPAH(*)		5.1	0.7	2.6	0.7	
%KPAH		22.9	18.4	17.6	5.2	
%Tørrstoff						

x)-inkludert i benzo(b)fluoranten

* markerer potensielt kreftfremkallende egenskaper overfor mennesker etter IARC (1987), dvs. tilhørende IARC's kategorier 2A+2B (sannsynlige+trolige cancerogene).
Sum av * utgjør KPAH.

1) Bare (a,h)-isomeren.

NORSK INSTITUTT FOR VANNFORSKNING TESTRAPPORT
P.O.Boks 173 Kjelsås, 0411 OSLO

Oppdrag	Færøyene
Adresse	
Oppdragsnr.	97025
Prøver mottatt	30.5.97
Lab.kode	1019 9-13+15
Jobb nr.	97/134
Prøvetype	Biol.materiale
Kons. i	Ug/kg våtvekt
Metode	H2-3
Dato	20.8.97
Analytiker	Brg

1 :Patella vulgata Kirkjubø
2: Patella vulgata Kirkjebø
3: Patella vulgata des.96 Kirkjebø
4: Patella vulgata Kirkjebø
5: Sandfl.lever Mar.96 SK2-SK28
6: Sandflyndrelever SK90-SK147

Parameter/prøve	1	2	3	4	5	6
	jun96	sep96	dec96	mar97		
Naftalen	2.3	1.8	1.8	x)	1	2.7
2-M-Naf.	1.1	0.9	0.7	x)	1.4	1.8
1-M-Naf.	0.6	0.5	<0.2	x)	1.7	2.3
Bifenyl	0.2	<0.2	<0.2	x)	0.9	0.7
2,6-Dimetylnaftalen	0.4	0.3	<0.2	x)	1.6	0.8
Acenaftylen	<0.2	<0.2	<0.2	x)	<0.2	<0.2
Acenaften	0.9	0.4	<0.2	x)	2.2	1.4
2,3,5-Trimetylnaftalen	<0.2	<0.2	<0.2	x)	1.2	<0.2
Fluoren	<0.2	<0.2	<0.2	x)	1.8	1
Fenantren	0.2	<0.2	0.2	x)	3.3	1.7
Antracen	<0.2	<0.2	<0.2	x)	<0.2	<0.2
1-Metylfenantren	<0.2	<0.2	<0.2	x)	0.7	0.2
Fluoranten	<0.2	<0.2	<0.2	x)	0.7	0.6
Pyren	<0.2	<0.2	<0.2	x)	0.6	<0.2
Benz(a)antracen*	<0.2	<0.2	<0.2	x)	<0.2	0.2
Chrysen/trifenylen	<0.2	<0.2	<0.2	x)	0.2	0.5
Benzo(b)fluoranten*	<0.2	<0.2	<0.2	x)	0.3	0.9
Benzo(j,k)fluoranten*	<0.2	<0.2	<0.2	x)	<0.2	<0.2
Benzo(e)pyren	<0.2	<0.2	<0.2	x)	0.2	0.4
Benzc(a)pyren*	<0.2	<0.2	<0.2	x)	0.2	0.3
Perylen	<0.2	<0.2	<0.2	x)	<0.2	<0.2
Ind.(1,2,3cd)pyren*	<0.2	<0.2	<0.2	x)	<0.2	<0.2
Dibenz.(a,c/a,h)ant.* 1)	<0.2	<0.2	<0.2	x)	<0.2	<0.2
Benzo(ghi)perylen	<0.2	<0.2	<0.2	x)	<0.2	0.4
SUM	5.7	3.9	2.7		18	15.9
Derav KPAH(*)					0.5	1.4
%KPAH					2.8	8.8
%Tørrstoff						

x)-ikke materiale for reanalyse

* markerer potensielt kreftfremkallende egenskaper overfor mennesker etter IARC (1987), dvs. tilhørende IARC's kategorier 2A+2B (sannsynlige+trolige cancerogene).
Sum av * utgjør KPAH.

1) Bare (a,h)-isomeren.

Table B.2.1 Heavy metals in black guillemots, in mg/kg w.w. liver. H:S gives the ratio of birds sampled near Hestoy to those taken near Sveipur.

	nov´95	**apr´96**	**apr´96**	**aug´96**	**aug´96**	**nov´96**	**jan/feb´97**	**jan/feb´97**	**jan/feb´97**	**jan/feb´97**
	Sveipur	Sveipur	Sveipur	Hestoy	Hestoy	Hestoy	H:S= 7:11	H:S=1:7	H:S= 3:11	H:S= 3:2
number of ind. in sample	4	12	6	8	5	8	18	8	14	5
Group	males, ad.	males, ad.	females, ad.	males, ad.	females, ad.	males, ad.	males, ad.	females, juv.	females, ad.	males, juv.
Dryweigth, %	31,1	32,4	33,1	29,8	31	30,4	32,1	31,5	31,9	32,1
Cadmium	0,69	1,07	0,94	1,33	1,73	1,42	1,18	0,94	1,23	1,11
Copper	6,01	6,14	5,89	6,34	7,85	6,89	7,70	7,94	7,68	14,1
Mercury	0,38	0,81	0,85	0,96	0,75	0,45	0,78	0,8	0,92	0,97
Lead	<0,02	<0,02	<0,02	<0,02	0,04	<0,02	<0,02	<0,02	<0,02	0,21

DEBESARTRØÐ
FO-100 TÓRSHAVN
FAROE ISLANDS
TEL +298 31 53 00
FAX +298 31 05 08
FEAGENCY@HFS.FO

HEILSUFRØÐILIGA STARVSSTOVAN
Food and Environmental Agency