RIVO-Netherlands Institute for Fisheries Research

P.O. Box 68
NL 1970 AB Ymuiden
The Netherlands
Phone: +31 255 564646
Fax: +31 255 564644
E-mail: fisheriesresearch.asg@wur.nl
Internet: www.rivo.wageningen-ur.nl

Centre for Shellfish Research
P.O. Box 77
NL 4400 AB Yerseke
The Netherlands
Phone: +31 113 672300
Fax: +31 113 573477

Report

Number: C079/04

MonitoringBase

Collation and evaluation of monitoring programmes and measured environmental concentration data on organic chemicals in European aquatic environments

Heather Leslie, Michiel Kotterman, Pim Leonards

Commissioned by: CEFIC LRI
Brussels

Project number: 3.44.12280.36

Approved by: dr. J. de Boer
Head of Department Environment and Food Safety

Signature: _____

Date: 15 November 2004

Number of copies: 20
Number of pages: 17
Number of tables: 6
Number of figures: 6
Number of annexes: 5

Table of Contents

Table of Contents 2

Preface 3

1. Summary 4

2. Objectives 7

3. Report overview 7

4. Database development 8

4.1 Technical aspects of MonitoringBase 8

4.2 Monitoring programmes 10

4.2.1 Data Input Monitoring Programmes 11

4.3 Measured Concentrations 12

4.4 Database facts and figures 13

5. Concluding remarks 17

6. Recommendations 18

Appendices

Preface

This report consists of the development of a database (MonitoringBase) for monitoring programmes on contaminants in the European aquatic environment, including measured environmental data in water, sediment and biota for a selected number of chemicals.

The study was commissioned and funded by CEFIC, and was part of CEFIC's Research & Science Programme, the Long-Range Research Initiative (LRI) to help understand and predict the behaviour of chemicals in the environment. The development of MonitoringBase was carried out by the Netherlands Institute for Fisheries Research (RIVO) in consultation with a CEFIC Research Liaison Team: D. van Wijk (Chairman), M. Comber, M. Holt, and R. Bruyndonckx.

The authors wish to express their gratitude to all people who kindly provided information about monitoring programmes, data on measured concentrations, and on-line databases. We would like to thank especially S. Wilson from the Arctic Monitoring and Assessment Programme (AMAP) who kindly provided information and the structure of the AMAP database, which was of great help in the development phase of MontioringBase, and several people from the UK Environmental Agency which supplied detailed information on monitoring programmes and data from the UK.

1. Summary

Part of Cefic's Research & Science Programme, the Long-Range Research Initiative (LRI) aims to identify and fill gaps in our understanding of the possible potential hazards posed by chemicals and to improve the methods available for assessing the associated risks.

In these efforts, the LRI has for example developed various models (e.g. multi-media, estuary models) to help understand and predict the behaviour of chemicals in the environment. To facilitate retrieval of background concentrations and ranges of organic chemical concentrations in the marine and freshwater environment as input for various LRI models, 'MonitoringBase' was developed. Accompanied by a Users' Manual, this database includes information, references and links to more than 160 planned, on-going and completed contaminant monitoring, survey and screening studies in the European and Arctic aquatic environment. The information and references for monitoring programmes can be used to optimise cooperation with on-going and planned monitoring campaigns. This acts to maximise the amount of data and limit the number of samples. Such cooperation is sometimes hampered by limited accessibility to monitoring information and data from different countries. The accessibility aspect (e.g. by way of on-line data presented in the English language) could be improved in Europe.

In addition to monitoring programmes, MonitoringBase includes measured environmental data in water, sediment and biota mainly determined in the European aquatic environment. The selection of organic chemicals for the database was based on the EU Water Framework Directive List of Priority Substances with the exception of metals, pesticides and pharmaceuticals but contains many more substances (total 111).

The development of MonitoringBase was carried out by the Netherlands Institute for Fisheries Research (RIVO) over a 1.5-year period in consultation with the CEFIC Research Liaison Team, which monitored the project on behalf of the Cefic Long-range Research Initiative (LRI). MonitoringBase was developed to aid those seeking information on chemical monitoring activities in Europe. Although not intended to be an exhaustive list of monitoring programmes and certainly not to include all measured concentration data, it will provide guidance in searching for information on the majority of monitoring programmes in Europe, in extracting measured concentration data from various other sources (e.g. databases available on internet), and for making contacts with other monitoring programmes.

MonitoringBase will be made available for use by interested third parties, for example to help users identify programmes to build upon or become involved in, with relatively little effort. Cefic-LRI MonitoringBase has already been presented at both the 13th and 14th Annual European meetings of the Society of Environmental Toxicology and Chemistry (SETAC) in Hamburg, Germany (April 27-31, 2003) and Prague, Czech Republic (April 18-22, 2004). The database was also presented at the ECETOC Workshop on Availability, Interpretation and Use of Environmental Monitoring Data (March 20-21, 2003, Brussels). The Cefic-LRI Liaison Team has proposed a one-day workshop to be held with specific key people from monitoring, modeling and others in order to further publicize the existence and use of the database.
Potential users of MonitoringBase include: risk assessors, scientific researchers and environmental modellers from industry, academia, regulatory authorities and international organisations involved in monitoring and assessment, such as the European Environment Agency, UNEP, OECD and product stewardship committees. It is also hoped that this database will help to coordinate various

monitoring activities in Europe and to improve the broad access to measured data.

Questions Answered by MonitoringBase
for the European Aquatic Environment

- Which chemicals are being monitored?
- Which compartments are being monitored?
- Who is monitoring these contaminants, where and how often?
- Where can information on environmental measured concentrations be found? (e.g. useful for trends analysis, spatial distribution)
- What concentrations have been measured in the environment for a selected set of contaminants? (Data for 71 chemicals stored in MonitoringBase can serve as input or validation data for environmental models, e.g. exposure models, food chain models.)
- Where can databases containing information on environmental measured concentrations be found on the internet?

2. Objectives

The main objectives of the project were:

i) to identify on-going and planned European institutional field monitoring programmes including the Arctic.
ii) to review and catalogue available measured environmental concentrations of organic chemicals in water, sediment and biota from the freshwater and marine environment.

The main purpose of the database is to use the measured environmental data i) to retrieve background concentrations and ranges of concentrations for the marine and freshwater environment, and ii) to use the data as input for various LRI projects (e.g. multi-media modeling, estuary model, persistence study). In addition, the monitoring programme database can be used for joining on-going and planned monitoring campaigns that will maximise the amount of data and limit the number of samples.

Heavy metals and pesticides are included in monitoring programme data, but have been excluded from the measured concentration database in order not to duplicate other industry programmes. The focus of the measured concentrations section of the database is a selection of organic chemicals from the EU-Water Frame Work Directive Priority Substances list.

3. Report overview

This report was prepared by RIVO to describe the background, purposes, contents and functioning of MonitoringBase. For practical examples and step-by-step instructions for users of the database, the reader is referred to Appendices 1 and 2, "How to find data - Examples" and "MonitoringBase Users' Manual".

The following sections of the report outline various aspects of the development of MonitoringBase such as the strategies for finding information. The development of two major sections of the database, 'Monitoring Programmes' and 'Measured Concentrations' is described. Facts, figures and tables are included to give an overview of the contents of the database, the distribution of monitoring programmes in Europe, and what is being monitored. The database has been presented at different stages of development at various events, which are mentioned in the following section.

During the course of the database development, some trends in contaminant monitoring activities in Europe could be observed, and these are discussed in 'Concluding Remarks'. A list of recommendations is given which may be useful for future monitoring activities. Other appendices (3, 4) list the chemicals monitored in European monitoring programmes and the substances for which measured concentration data was entered into MonitoringBase. Future updates of MonitoringBase may benefit from a short list of key questions for additional monitoring programmes (Appendix 5).

4. Database development

4.1 Technical aspects of MonitoringBase

The database was created in Microsoft® Access 2000, which enables all information to be managed from a single database file. The various types of monitoring programme and measured concentration data were entered into separate tables for each specific data type and stored. Relationships between the tables were defined so that the data can be retrieved and viewed in different ways by users with different queries (selected parameters). Reports of retrieved data were designed for export to Word documents, Excel worksheets or for printing directly.

The construction of a database that provides a valuable function for users is dependent on establishing clear goals of not only the type of information that is included, but also *how* it is presented. At many stages during the construction of the database, choices have been made from numerous options.

- which data is included
- in which form data is included (i.e. how to group the data)
- how the data can be extracted
- how to design the searches and define search criteria
- how output is presented

In this respect, MonitoringBase was highly dependent on input during the construction phase from the ECETOC Research Liaison Team who monitored the project on behalf of the Cefic-LRI (users) who indicated from their vantage point which options they valued. The database was designed to take all suggestions and input into consideration.

The resulting database structure is shown schematically in Figure 1. The central table in the database contains general information on the monitoring, survey and screening programmes/projects, and is called "MSS projects". Linked to this table are three other major tables: i) detailed descriptions of the programmes, ii) measured concentrations stored in MonitoringBase, and iii) internet links to measured concentrations. Beside these tables, there are a number of tables that support the four major tables.

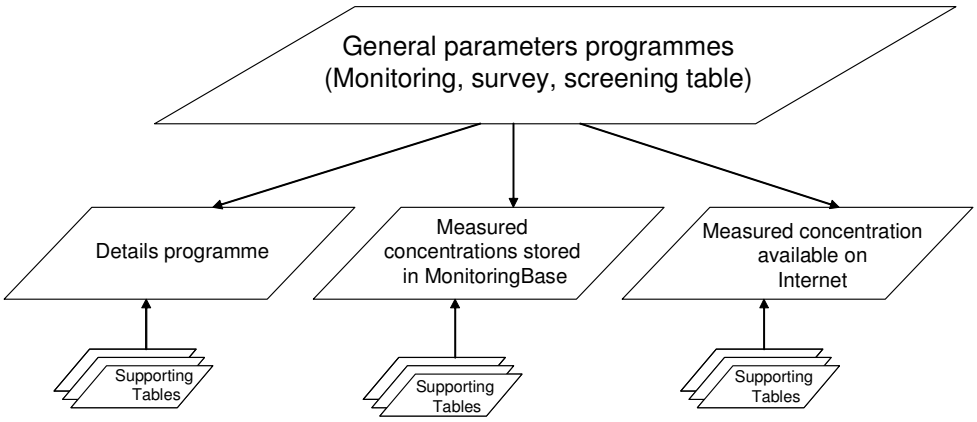

Figure 1: Overview structure of MonitoringBase.

When the database is launched, a title page with start menu (Figure 2) appears, offering three options:

- *Monitoring programmes*: to search for information on European monitoring programmes
- *Measured concentrations*: to search for measured concentrations stored in MonitoringBase, or available on internet.
- *Other*: Users' manual and links.

A separate users' manual is provided to accompany the database containing detailed instructions on how to use the menus and extract data from the database. Briefly, by clicking on one of the buttons of the menu a search screen will appear. All search screens have the same lay-out, and contain three major boxes:

- Search
- Overview results
- Output

The logical sequence to start a search is to first select the search criteria and to follow with a search action. The main results of the search are displayed in the "Overview results" box. More detailed information on a specific programme can be obtained by clicking on the cells of the programme number or name. The search results can be printed or exported to a Word or Excel document.

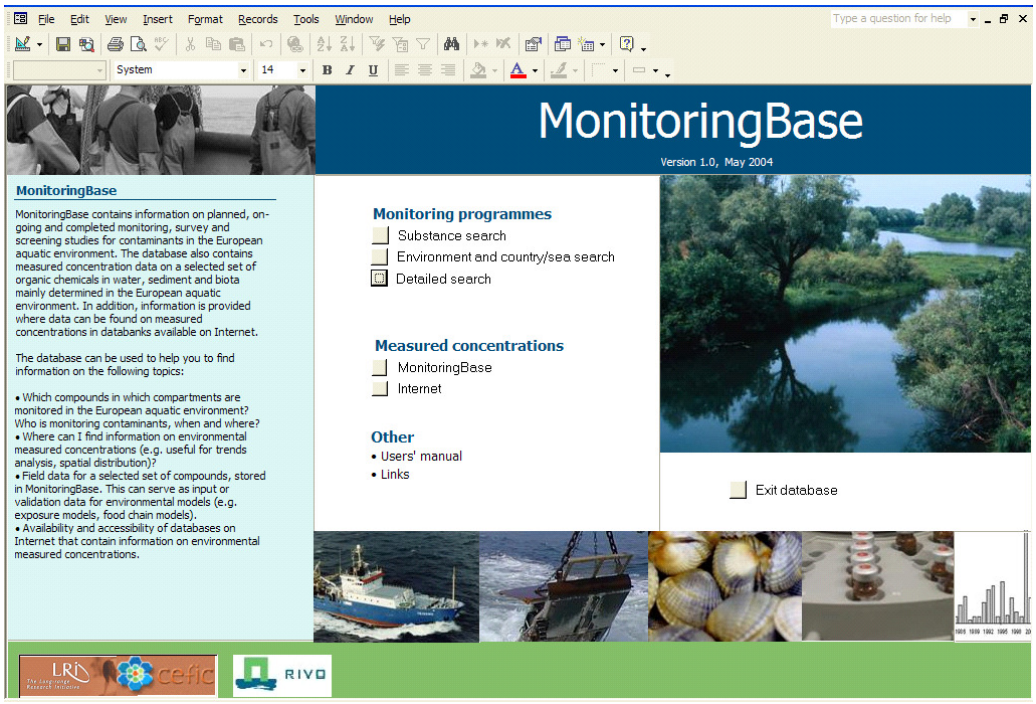

Figure 2. Title page and start menu of MonitoringBase.

4.2 Monitoring programmes

The monitoring programmes included in the database were selected based on certain criteria (Table 1). Not only monitoring programmes, but also surveys and screening projects (see textbox below) were included since the latter two are also valuable sources of environmental concentration data for contaminants. While the goal was to find as many monitoring programmes as possible for MonitoringBase, it was not within the scope and time frame of the project to produce an exhaustive list of all surveys. Surveys were added to supplement the information available from the monitoring programmes. The selection of surveys for MonitoringBase was based on usefulness for food chain model validation, spatial distribution and chemicals that are technically challenging to analyse.

Table 1. Selection criteria for contaminant monitoring programmes for MonitoringBase.

- European or Arctic region
- Aquatic environment: freshwater, estuarine or marine
- Matrices: water, sediment, suspended matter, biota
- Ongoing or planned programmes

Information on contaminant monitoring programmes for MonitoringBase was collected according to several strategies. Internet searches were performed, emails sent, and telephone calls made to different contacts at national and regional level, and a request for input was made in SETAC Globe. The contacts included persons involved in regional, national or international monitoring programmes who were employed by governmental organisations or by various research institutions and universities.

The usefulness of internet resources depends strongly on the country in question, with some websites supplying a full description of the programme with downloadable data, in some cases even raw data. For other countries, we could find no information on their webpages, which were additionally hindered in accessibility by providing information exclusively in the native language.

The European Environment Agency was contacted in an early stage of the development since this organisation has access to a large amount of monitoring information. However, the EEA was unfortunately unable to participate in providing data at the time of development due to permission constraints. . Access to WATERBASE is also still unavailable and could therefore not be included.

SCREENING – SURVEY - MONITORING

The term 'monitoring programme' normally refers to long-running campaigns to comprehensively measure contaminants in a certain region, often with a frequency of e.g. once a year or once a month. Many are part of national programmes to check water quality and observe time trends. The compounds measured in monitoring programmes have often been chosen due to results of a survey. Surveys are short-running, normally with the purpose of establishing a relationship between contamination and effects, determining typical concentration ranges or the distribution area of a chemical, or to investigate the occurrence of a new compound in the environment. The choice of substances for surveys can be based on the existence of a known source of the contaminant or for example, that a particular contaminant was detected in a screening. Screening projects give a basic overview of the presence or absence of contaminants, which are detected through applying a variety of analytical methods. Screenings proceed relatively fast because the goal often is to find fast answers to the question of which contaminants might be causing an

4.2.1 Data Input Monitoring Programmes

The data input for monitoring programmes was done in two stages. First, general details about the monitoring programmes were entered (see Table 2). Summaries provide users with an overview of the activities in the monitoring programmes. An important point is the contact addresses for the programmes, as most individuals are willing to provide more specific information than is available on Internet sites or in databases. In many cases, respondents may be willing to provide up-to-the-minute datasets directly upon request. Examples of these are the Environmental Agency for England and Wales, RIZA in the Netherlands, and AMAP for the Arctic.

The size of individual monitoring programmes in Europe varies considerably, and there is some overlap between them as well. Some countries use the data generated for their own national programmes for other international monitoring commitments, for example, HELCOM, ICES (JAMP) or OSPAR. Some programmes are very large, and consist of numerous smaller parts covering different matrices, regions and often, different sampling frequencies. The United Kingdom's National Marine Monitoring Programme (NMMP) and the Dangerous substance programme, which encompasses many smaller projects, is a case in point. The result is that a vast amount of data is generated within this single programme.

In a second step, specific information on the different matrices and specific compounds in the monitoring programmes were entered. These include the type of environment (e.g. estuarine, marine, fjord) the country and region, matrix (e.g. sediment, freshwater fish, marine benthos, seawater/suspended particulate matter, marine bird eggs, fresh water), frequency of sampling, (e.g. annually, monthly). In addition, it was indicated if the data is present in MonitoringBase's Measured Concentrations or if there is a database available for this programme. The contaminants monitored were entered per monitoring programme by chemical name. Through discussions with the RLT, it was decided that CAS numbers were to be excluded. In many cases, single compound names were entered. However, when programmes only indicate which compound classes were measured, the compound class was entered instead of an individual chemical name. Examples of this are 'organochlorine pesticides' without specifying, say, 'DDT' or 'alkylated phenols' without specifying nonylphenol. For some compounds, e.g. PCBs, PAHs, chlorobenzenes, compound classes were made to reduce the number of hits per search.

Therefore, when searching for all programmes in which a specific compound is measured, it may be advisable to search both for the chemical name and the chemical class or group, e.g. pentachlorophenol *and* chlorophenols.

Table 2. General monitoring programme details entered into MonitoringBase.

Title	Databank links (max 2)
Organising country	Contact person names
Programme summary	Mailing address
Status (ongoing, completed)	Telephone number
Type (monitoring, survey, screening)	Fax number
Start year	Email address
End year	Specimens banked
Website link	

4.3 Measured Concentrations

The database contains over 5000 measured concentration data for 111 organic chemicals (Appendix 4). The measured concentration data of the WFD priority substances that are stored in MonitoringBase are not comprehensive, which was not in the scope and time frame of the current project. Data stored in the database was mainly selected based on criteria like spatial distribution, temporal trends and accumulation in food chains. Many of these are organic chemicals from the EU's Water Framework Directive Priority list are included and additional substances were chosen based on a wide range of physical-chemical properties and biodegradability (Fig. 3). The PAHs (given in red, Fig. 3) represent intermediate hydrophobicity and biodegradation probability and compliment the above set of chemicals. However, since they are covered in many monitoring programmes for which up-to-date data is accessible via the internet, only specific studies (e.g. food chain) for PAHs were entered into the Measured Concentrations section of the database. Also other substances that would risk overloading the database (such as PCBs) were not included in the "Measured Concentrations" section.

The remaining chemicals for Measured Concentrations were selected based on discussions between RIVO and the RLT. In some cases, organic chemicals were short-listed because they are not common in many widely available monitoring data. These measured concentrations were therefore found in the published peer-reviewed literature and in the grey literature. Other chemicals were added to the database because they happened to be present in the same study as the target (WFD) chemicals. For these chemicals only limited data are available in the database.

The data for measured concentrations of organic chemicals from a variety of sources were entered manually into the database. Table 3 shows the parameters entered in the measured concentration section. The analytical quality of the data was judged based on the criteria given in Table 4.

Table 3: Parameters entered in "Measured Concentration" section.

Title	N (number of specimen per sample)
Environment	N (number of analysed samples)
Country/Sea	Lipid weight (%)
Region	Dry weight (%)
Matrix	Length (cm)
Species	Weight (g)
Tissue	Sex
Year of sampling	Age (year)
Substance	Reference ID
Measured concentration	Author
Unit	Title source
RSD (%)	Journal
Sample type	Quality
Data type	

The chemicals cover a wide range of hydrophobicity, chemical structures and biodegradation probability. Using the EPI Suite program, BIOwin version 4.01, (US EPA), the MITI non-linear biodegradation probability was estimated (>0.5 readily biodegradable; < 0.5 not readily biodegradable).

Table 4. Criteria for judgment of analytical quality of measured concentrations entered in MonitoringBase.

Quality flag	Criteria
Low	No blanks, recoveries
Moderate	Blanks, recoveries
High	Blanks, recoveries, reference materials or round robin test
Unknown	No QA/QC data reported

The measured concentration data of the WFD priority substances that are stored in MonitoringBase are not comprehensive, which was not in the scope and time frame of the current project. Data stored in the database was mainly selected based on criteria such as spatial distribution, temporal trends and accumulation in food chains.

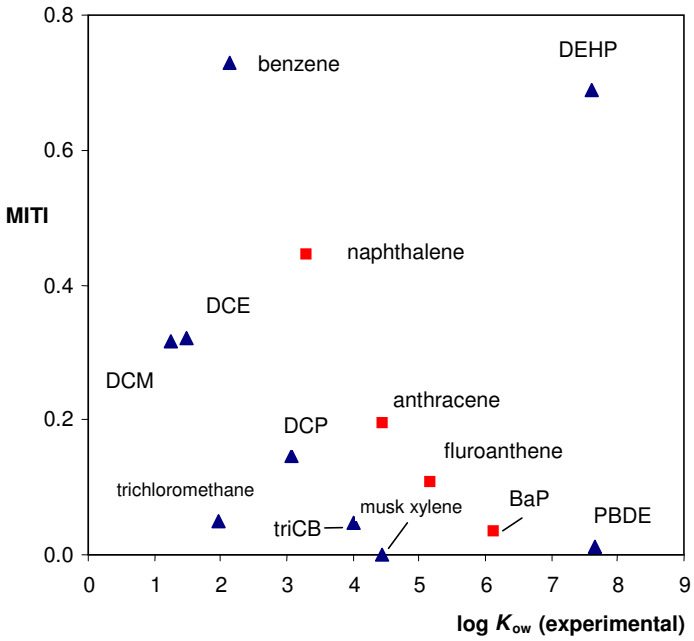

Figure 3. Short list of WFD chemicals for Measured Concentrations in MonitoringBase. MITI biodegradability index of selected chemicals (blue triangles) with a range of hydrophobicities (log K_{ow}). PAHs shown (red squares).

4.4 Database facts and figures

An overview of the number of monitoring and survey programmes per country or sea is provided is Figure 4. Northern countries seem to be more active in monitoring than southern European countries. Spain did not have a national chemical monitoring programme, but was setting up a programme for metals. Most detailed information was found for the UK, Sweden, Germany, Netherlands, Norway, Finland, Estonia and Belgium.

More than 230 chemicals are determined in European monitoring and survey programmes (see Appendix 3). European contaminant monitoring programmes often measure similar chemical sets, the "classical contaminants". As expected, the most monitored chemicals include: PAHs, PCBs, hexachlorocyclohexanes, DDTs, PCDDs/PCDFs and metals. Other frequently monitored chemicals are chlorobenzenes, chlorophenols, drins, PBDEs and TBT.

Several WFD priority list chemicals are already being monitored in numerous programmes, e.g. PAH, chloroethanes and methanes, metals, chlorobenzenes, HCHs and PBDEs, while several others have yet to be added to monitoring sets in Europe, e.g. polychlorinated alkanes, chlorpyrifos, chlorofenvinphos and DEHP (Table 5). With regard to the analytical quality of the less monitored WFD chemicals, it should be emphasized that European-wide quality control and quality control programmes (e.g. round robin test) are of high importance for the comparability of data. Especially, for the polychlorinated alkanes many analytical challenges have to be solved before a robust and standardized quantification method would be available. Measured concentration data for organic chemicals on the WFD priority list (excluding pesticides) that are seldom monitored have been entered into MonitoringBase (Table 5).

Monitoring in marine, estuarine and freshwater aquatic environments was targeted for MonitoringBase and different patterns were observed in the types of data collected for these different environments. In freshwater monitoring programmes, the most common matrix in which to measure contaminants is water, followed by fish, sediments, benthos, water/suspended particulate matter (SPM), mammals and other biota (Figure 5). In the marine programmes, more monitoring is done in benthos and fish, followed by sediments, water, bird eggs, mammals, other biota and SPM (Figure 6).

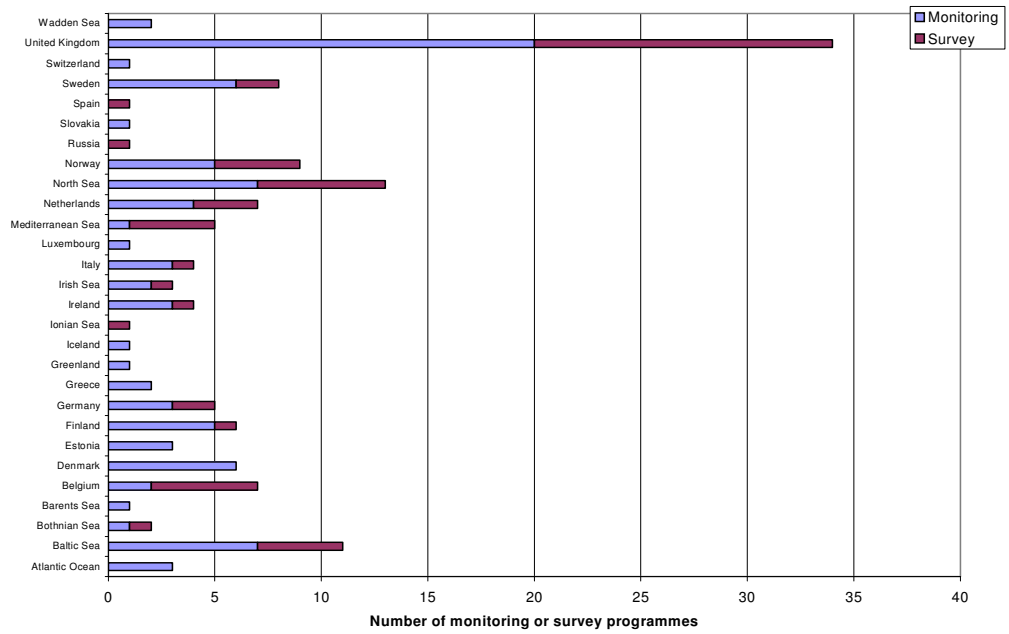

Figure 4. Number of contaminant monitoring and survey programmes in European aquatic environments in MonitoringBase per location (country and seas). Does not fully reflect relative monitoring effort because size can vary considerably from programme to programme.

A number of studies were found that show data for the accumulation of chemicals in the food chain (Table 6). An important observation is that many studies did not report the levels of the chemicals in the lower trophic levels (e.g. benthic animals) and water or suspended particulate matter, which form the basis for the uptake route to higher trophic levels. The water phase is a difficult compartment in which to measure highly hydrophobic, poorly soluble chemicals, although low concentrations in water can be measured with passive sampling techniques such as SPME and SPMD.

Another important issue for food chain modeling is the estimation of the trophic level of the different species. Most studies did not report the trophic level of the species or the food web structure. Stable isotope techniques (e.g. $^{15}N/^{14}N$) to determine the trophic levels are not routinely used, but have great potential for food chain modeling.

Table 5. Coverage of WFD priority substances in MonitoringBase. a) number of monitoring programmes and surveys that include the substances b) measured concentrations available for checked substances.

WFD Priority Substances	a) Number of Programmes	b) Measured Concentration Data
1,2-Dichloroethane	See chloroethanes: 14	✓
Alachor	5	
Anthracene (PAH)	See PAH: 32	✓
Atrazine	10	
Benzene	12	✓
Brominated diphenylethers	17	✓
Cadmium and compounds	See metals: 56	
Chlorofenvinphos	4	
Chloroform	11	✓
Chlorpyrifos	2	
Di(2-ethylhexyl)phthalate (DEHP)	4	✓
Dichloromethane	See chloromethanes: 10	
Diuron	6	
Endosulfan	8	
Fluoranthene (PAH)	See PAH: 32	
Hexachlorobenzene	21	✓
Hexachlorobutadiene	10	✓
Hexachlorocyclohexane (HCH)	27	✓
Isoproturon	5	
Lead and compounds	See metals: 56	
Mercury and compounds	See metals: 56	
Napthalene (PAH)	See PAH: 32	✓
Nickel and compounds	See metals:56	
Nonylphenols	12	✓
Octylphenols	5	✓
Pentachlorobenzene	chlorobenzenes: 11	
Pentachlorophenol	3	✓
Polyaromatic hydrocarbons (PAH)	32	Some PAHs
Polychlorinated alkanes (C10-13-chloroalkanes)	5	✓
Simazine	8	
Tributyltin compounds	23	✓
Trichlorobenzenes (1,2,4-trichlorobenzene)	See chlorobenzenes: 11	✓
Trifluralin	6	

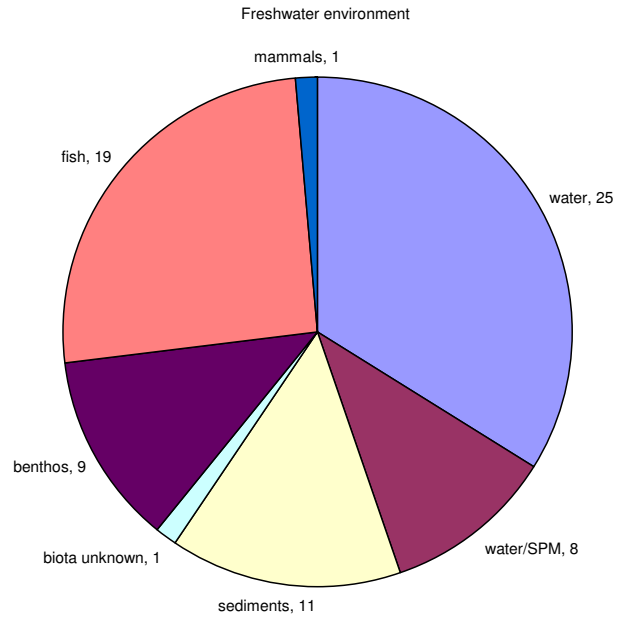

Figure 5. Matrices monitored in the freshwater environment showing the number of programmes including water, fish, sediment, benthos, water/suspended particulate matter (SPM), mammals and other biota.

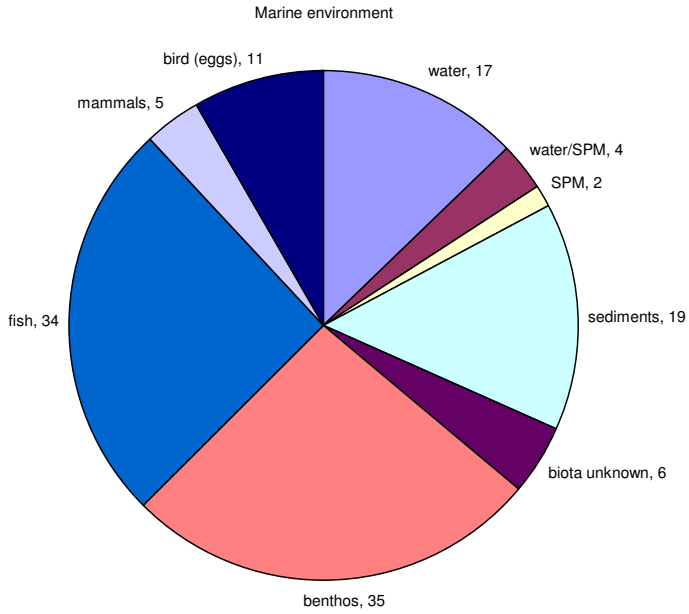

Figure 6. Matrices monitored in the marine environment showing a different pattern than freshwater in the number of programmes monitoring water, fish, sediment, benthos, SPM, mammals, bird eggs and other biota.

Table 6. Data suitable for food chain studies in MonitoringBase.

Country/Region	Environment	Substance	Compartments
Laboratory experiment	Fresh	HCB	Sediment, benthos, fish
Denmark, various lakes	Fresh/marine	PCBs	Sediment, fish, mammo
France, Seine	Fresh	PCBs, PAHs	Sediment, benthos, fish
Lake Baikal, RF	Fresh	HCB, PCB, DDT	Plankton, fish, mammal
Netherlands, Biesbosch	Fresh	PCBs, DDTs	Sediment, fish
Netherlands, Eems-Dollard	Marine	HCB	Sediment, mussel, fish
Netherlands, Westeinderplassen	Fresh	Organotins	Sediment, benthos, fish birds
Netherlands, Western Scheldt	Marine	PBDEs	Sediment, mussel, fish, b
North Sea	Marine	PBDEs	Benthos, fish, mammal
Polar regions	Marine	PCBs, PBDEs	Fish, mammal
Antarctic	Marine	PCB, DDT, HCB, Chlordane	Sediment, benthos, fish mammal, bird
Sweden, Baltic Sea	Marine	PAHs	Plankton, mussel, bird
Sweden, Baltic Sea	Marine	PBDEs, PCBs, DDTs, PCAs	Fish, mammal, bird
Sweden, Baltic Sea	Marine	PCNs	Sediment, benthos, fish
Poland, Baltic Sea	Marine	PCBs	Plankton, fish, mammal

5. Concluding remarks

- In general, more activity in monitoring of chemicals in the aquatic environment was found in northern European countries. The countries that were able to provide the most detailed information on their monitoring programmes were Germany, Finland, Sweden, Norway, UK, The Netherlands, Estonia and Belgium. Countries for which monitoring data was more difficult to find include France, Italy and Portugal.
- In many monitoring programmes in Europe, the same chemicals are measured in similar matrices. Especially the 'classic contaminants', PCBs, PAHs, metals, DDTs, etc. are common target chemicals. In the future, many countries will focus on Water Framework Directive chemicals. Some of the chemicals (e.g. chloroalkanes, chlorofenvinphos) on the WFD list are currently covered in very few European monitoring programmes (see Table 5). Analytical challenges can explain why certain chemicals are monitored less widely than others. For these chemicals, surveys were often also included in MonitoringBase.
- A large difference in quality and accessibility of websites to retrieve data was found. Some countries have very extensive foreign language options (e.g. English, German) on their websites, while others have exclusively the native language. Including an English version would strongly increase accessibility.
- It became clear during the course of this project that there are very few monitoring projects that are suitable for validating food chain models. This is because many do not cover enough different levels in the food chain, (or are missing the water compartment). About 14 programmes are suitable, and in addition, several surveys are very useful for food chain modelling. Also, few monitoring programmes are suitable for time trend analysis in food chains (n = 8).

- The creation of a meta-database in the future could help in steering the design of monitoring programmes by enhancing the sharing of contaminant monitoring information between different countries in Europe. However, a meta-database cannot provide answers to all questions and should not be regarded as a perfect solution for sharing monitoring data. The administrative, technical and financial aspects of such an undertaking are considerable. To a certain extent, it is still useful to perform searches focused on the exact information required by consulting Internet resources or persons involved in monitoring programmes directly. MonitoringBase can provide assistance for these types of searches. It might be added that full harmonisation of all monitoring programmes could introduce undesirable inflexibility in monitoring schemes and designs and limitations in certain types of information, including exclusion of certain chemicals from data sets. Probably a limited degree of harmonisation of monitoring programmes in Europe, restricted to the WFD chemicals, is a more realistic and worthwhile goal.

6. Recommendations

1. As mentioned above, sets of chemicals to be monitored in many programmes in Europe are similar to each other, and with the WFD coming into force this trend will be reinforced. Surveys provide a means of detecting new contaminants that are not on existing priority lists. Based on survey data, different chemicals could also be included in monitoring programmes in the future. Individual researchers as opposed to national institutes normally carry out current surveys. Investments should not only be made in monitoring programmes themselves, but also in surveys. Surveys identify problem contaminants missed in monitoring programmes and would help to ensure that most relevant chemicals are being monitored.

2. MonitoringBase may hopefully provide a basis/structure/template for future databases.

3. To improve internet access, it would be beneficial to make monitoring data available by in English, in addition to native languages.

4. The design of new monitoring or survey programmes to address longer food chains, especially the lower part of the food chain for lipophilic compounds, should be encouraged because of the importance of bioaccumulation and the low number of monitoring programmes providing data throughout the food chain.

5. Future chemical monitoring programmes designed to answer different questions posed by for example, food-chain modellers, environmental chemists and aquatic ecotoxicologists would be well received. This can be achieved by input and guidance from different groups of users.

6. Vast amounts of resource are being used across Europe to collect measured data. There are many opportunities to use existing on-going projects as a means of collecting samples in a more information rich way and programme designers/managers should be encouraged to consider multimedia approaches when choosing sampling sites.