National Environmental Research Institute
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NOVANA

National Monitoring and Assessment Programme for the Aquatic and Terrestrial Environment

Programme Description – Part 1

NERI Technical Report, No. 532

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Abstract:	This report is Part 1 of the Programme Description of NOVANA – the Nationwide Monitoring and Assessment Programme for the Aquatic and Terrestrial Environments. Part 1 comprises a general description of the background for the programme, including the international obligations and requirements for monitoring of nature and the environment. The overall objective and the scientific and strategic background for the priorities upon which NOVANA programme is based are described, as are the organization of the programme, the overall economy and the technical assumptions made. Finally the scientific content of NOVANA is outlined. The content of the programme is described in detail in Part 2 of the Programme Description, while technical appendices are given in Part 3 (available in Danish on the NERI website: http://www.dmu.dk/Overvågning/NOVANA/)
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Foreword

When the Action Plan on the Aquatic Environment was adopted in 1987, a monitoring programme was established in order to follow development in the actual nutrient discharges and losses to the aquatic environment and to record the ecological effects of the reduction in discharges. The monitoring programme was initiated on 1 October 1988 (Danish EPA, 1989).

The programme – which supplemented environmental supervision by the regional authorities pursuant to Section 66 of the Environmental Protection Act (Ministry of Environment and Energy, 2001) – monitors the air, the groundwater, agricultural catchments, watercourses, lakes, marine waters and wastewater treatment plants and other point sources.

The monitoring programme was adjusted in 1992 (Danish EPA, 1993) and revised in 1997 (Danish EPA, 2000), at which time monitoring of hazardous substances was included. The revised programme for the period 1998–2003 was called NOVA-2003 (Danish Aquatic Monitoring and Assessment Programme, 1998-2003).

The Nationwide Monitoring and Assessment Programme for the Aquatic and Terrestrial Environments – called NOVANA – runs over the period 2004–2009 and integrates national monitoring of nature and the environment. Among other things, monitoring of species and terrestrial natural habitats has been included, and greater priority has been accorded to aquatic species and habitats. On the other hand, reductions have been made in the monitoring of nutrients and their effects and of hazardous substances.

The Programme Description consists of three parts:

Part 1 comprises a general description of the background for the programme, including national requirements and international obligations as to monitoring of nature and the environment. The overall objective and the scientific and strategic background for NOVANA are also described, as are the organization of the programme and the overall economy.

Part 2 comprises a description of the individual NOVANA subprogrammes.

Part 3 deals with the general aspects concerning quality assurance, data storage and reporting, and provides detailed tables showing the monitoring variables and frequencies at the stations encompassed by each element of the various subprogrammes. In addition, Part 3 includes a number of technical notes and further details of certain subprogrammes.

The first chapter of this report summarizes the content and structure of Part 1 of the Programme Description.

Part 1 of the Programme Description was prepared in part using material from the NOVA-2003 Programme Description (Danish EPA, 2000) and in part from material prepared by the Programme Management Board together with input from the Topic Centres, etc. All those who contributed to Part 1 of the Programme Description are acknowledged for their input and comments.

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1 Summary

The Nationwide Monitoring and Assessment Programme for the Aquatic and Terrestrial Environments (NOVANA) entered into force on 1 January 2004.

- **The objective of the programme is to follow the status of the aquatic and terrestrial environments and the main pressures upon them.**

- **The programme will describe sources of pollution and other major pressures and their effects on the aquatic and terrestrial environments.**

- **In addition, the programme will document the overall effects of national nature and environment action plans and assess whether the quality of nature and the environment meets the policy objectives, and whether the trend is in the right direction.**

With this programme Denmark can fulfil its international monitoring and reporting obligations and other important national obligations pertaining to nature and the environment – at least at a minimum level.

The NOVANA programme replaces the Danish Aquatic Monitoring and Assessment Programme (NOVA-2003), which had been running since 1998. This programme derived from the 1987 Action Plan on the Aquatic Environment, which included the establishment of a monitoring programme for the aquatic environment. For the Ministry of the Environment and the regional authorities (the Counties, Regional Municipality of Bornholm, Copenhagen Municipality and Frederiksberg Municipality), the intention of NOVANA was to incorporate nature monitoring and especially monitoring of species and terrestrial natural habitats into the national monitoring, not least in the light of Denmark's obligations under the Habitats Directive. In contrast to NOVA-2003, NOVANA therefore includes monitoring of species and terrestrial natural habitats. Moreover, greater priority has been accorded to aquatic species and habitats.

In 1987, a governmental block grant for monitoring the aquatic environment was agreed with the Counties, Copenhagen Municipality and Frederiksberg Municipality. Moreover, further governmental resources were allocated to cover the monitoring activities run by the Ministry of the Environment. The Counties have incorporated part of their environmental supervision activities into the aquatic environment monitoring programme. Additional funds have not been allocated for monitoring in NOVANA, and the programme keeps within the framework for subsidies to the regional authorities specified in the current official document about the Nationwide Monitoring Programme under the Action Plan on the Aquatic Environment (Ministry of the Interior, 1987). The aquatic monitoring has therefore been reduced, especially monitoring of nutrients, hazardous substances, geographic coverage, etc. A further consequence has been that the programme primarily fulfils requirements pursuant to international agreements, while national requirements are not met to the same extent as previously.

A draft of the NOVANA programme underwent public hearing during the period December 2002 to January 2003. This resulted in 31 submissions. Several of these expressed regret about the reductions in the monitoring of hazardous substances, and calls were made for the reasons for the reductions. This is explained in more detail in Section 4.1.4.

Reference is sometimes made in this report to the Programme Description for NOVA-2003. This contains some detailed information and background information that can be useful in relation to NOVANA. A translation of the NOVA-2003 Programme Description is available at:

http://www.dmu.dk/Overvågning/NOVA-2003+arkiv/ and choose "Programbeskrivelse".

NOVANA is carried out collaboratively by institutions within the Ministry of the Environment (Geological Survey of Denmark and Greenland, National Environmental Research Institute, Danish EPA and Danish Forest and Nature Agency) and the regional authorities. Overall coordinating responsibility for the programme lies with the National Environmental Research Institute.

Part 1 of the Programme Description describes the background for NOVANA as well as the assumptions, overall aims, overall strategy, a brief review of the programme content, organization, economic framework, etc. The individual NOVANA subprogrammes are described in Part 2 of the Programme Description.

The chapters of Part 1 of the Programme Description contain the following:

Chapter 2 describes the assumptions on which NOVANA is based.

The overall objective of the programme, which is summarized above, is described in **Chapter 3**.

The programme strategy and the overall content of the subprogrammes and the most important changes relative to NOVA-2003 are described in **Chapter 4**. NOVANA consists of a number of subprogrammes:

- Background monitoring of air quality and atmospheric deposition
- Point sources
- Agricultural catchments
- Groundwater
- Watercourses

- Lakes
- Marine waters
- Species and terrestrial natural habitats
- The National Air Quality Monitoring Programme.

The detailed strategy and the detailed content of the subprogrammes are presented in Part 2 of the Programme Description, Chapters 3 to 11.

Chapter 5 describes how the programme is managed, what roles the individual actors play, and what tasks they perform. NOVANA is a cooperation between institutions within the Ministry of the Environment and the regional authorities. The organization in place under the existing NOVA-2003 programme will continue, however, although in an expanded form that also encompasses the subprogramme for species and terrestrial natural habitats. The Steering Committee for marine waters and the atmosphere has now been divided into two Committees.

The subprogrammes' overall economy is described in **Chapter 6** together with some general calculation assumptions.

Chapter 7 describes a number of technical assumptions for accomplishment of the programme, including rules and agreements about data storage and transfer, programme deadlines, quality assurance and necessary supplementary data.

Chapter 8 describes NOVANA reporting agreements and the types of reporting.

Chapter 9 describes the timetable and plan for future adjustment and revision of NOVANA.

2 Assumptions

2.1 Introduction

The Nationwide Monitoring Programme under the Action Plan on the Aquatic Environment is permanent in nature (Ministry of the Interior, 1987). The programme is drawn up for a number of years at a time and subsequently revised to incorporate new knowledge and to take into account new measures to achieve the stipulated objectives for environment and nature quality and new monitoring obligations. NOVA-2003 was revised in 1997, and the content of the revision was agreed upon for the period up to and including 2003.

Monitoring of hazardous substances and heavy metals was incorporated in NOVA-2003, thereby shifting the focus from a programme specifically directed at demonstrating the effects of the Action Plan on the Aquatic Environment to one that included the environmental quality of groundwater and inland waters in general.

Before revision of NOVA-2003 was started the regional authorities and the Ministry of the Environment decided that a future monitoring programme should also cover a number of aspects of nature.

The Danish EPA and the Danish Forest and Nature Agency prepared an inventory of monitoring requirements that provides a general description of Denmark's international and national monitoring and reporting obligations. Moreover, in its 2001 agenda the Government stressed that Denmark should continue to meet the obligations entailed by the international environmental agreements.

Major changes have been required relative to the NOVA-2003 programme, not least due to monitoring requirements pursuant to new directives and international conventions, e.g. the Water Framework Directive, the Habitats Directive and the Stockholm Convention. In addition, directives are underway concerning air quality, groundwater, reporting, etc.

Prior to the revision of NOVA-2003 an international evaluation of the programme was performed. In addition, a statistical optimization project was initiated which recommended changes to selected parts of the monitoring programme. Conclusions and recommendations from the project were utilized in the revision process.

With regard to the incorporation of nature monitoring the report of the Wilhjelm Committee (Wilhjelm Committee, 2001) recommended that nature should be monitored and proposed a strategy for how this could be done. It is on the basis of this strategy that nature monitoring has been incorporated in NOVANA.

The foundation for the programme can be summarized as follows:

- Official Document No. 46 of 19 October 1987 on the Nationwide Monitoring Programme under the Action Plan on the Aquatic Environment (Ministry of the Interior, 1987)
- The Danish EPA and Danish Forest and Nature Agency's inventory of monitoring requirements listing Denmark's international and national monitoring and reporting obligations (2001): http://www.dmu.dk/Overvågning/NOVANA/Programbeskrivelse+del+3/Forpligtelser/
- Recommendations resulting from the international evaluation of the existing monitoring programme NOVA-2003 (2002): http://www.dmu.dk/Overvågning/NOVANA/Programbeskrivelse+del+3/Baggrund/
- Recommendations of the Wilhjelm Committee report "Danish Nature – Status, trends and recommendations for future biodiversity policy" concerning nature monitoring: http://www.sns.dk/wilhjelm/endelig/pdffiler/Hovedrapengelsk.pdf
- Recommendations of the project on statistical optimization of NOVA-2003: http://www.dmu.dk/Overvågning/NOVANA/Programbeskrivelse+del+3/Baggrund/
- The regional budget for the programme has to be the same as for NOVA-2003, while the Ministry of the Environment's budget for the programme is reduced by 10%.

The extended monitoring and reporting requirements have necessitated considerably focussing and prioritization of the programme. The process to reach finally agreement upon the content of NOVANA has thus been protracted. Apart from the above-mentioned foundation for NOVANA, the most important elements of this process have been:

- The decision that NOVANA shall include monitoring of species and natural habitats (terrestrial and aquatic)
- Discussion at Aquatic Environment and Nature Days of the overall content of and strategy for NOVANA, December 2001 (see Section 5.2.3 regarding Aquatic Environment and Nature Days)
- Approval by the Ministry of the Environment Board of Directors of a strategy for incorporating nature monitoring and the relevant parts of the monitoring obligations pursuant to the Water Framework Directive into NOVANA, early 2002
- Establishment of a Revision Committee under the Programme Management Board to carry out the revision, spring 2002 (see Section 5.2.1)

- Approval by the Ministry of the Environment Board of Directors of an overall prioritization plan with overall objectives and strategies for the content of NOVANA, May 2002
- Start of the Revision Committee's work on drawing up a NOVANA programme in cooperation with the Topic Centres and Steering Committees, June 2002
- Public hearing of the draft NOVANA programme, December 2002–January 2003
- The Revision Committee considers the hearing submissions and adjusts the NOVANA programme. Preparation of a memorandum with the Revision Committee's decisions on the hearing submissions (May 2003). http://www.dmu.dk/Overvågning/NOVA-2003+arkiv/
- Meetings with a number of the organizations and institutions that have submitted hearing responses about species and natural habitats (April 2003)
- Meetings with the regional authorities about NOVANA (April–June 2003)
- Approval by the Programme Management Board of NOVANA agreements with the regional authorities (October 2003)
- Signature by the regional authorities of NOVANA agreements including appendices listing monitoring stations, monitoring variables and monitoring frequencies (December 2003–January 2004)
- Completion and publication of programme descriptions and technical instructions (March 2004).

The programme has been drawn up cooperatively by the partners involved in NOVANA. Based on the Ministry of the Environment's prioritization plan and the viewpoints of the regional authorities the Revision Committee has set the framework for the various subprogrammes (air quality, point sources, agricultural catchments, groundwater, watercourses, lakes, marine waters, and species and terrestrial natural habitats). The Topic Centres (see Section 5.3.4) have drawn up the scientific content of the subprogrammes. These have been discussed in the Steering Committees and subsequently approved by the Revision Committee.

2.2 Inventory of monitoring requirements

NOVANA is requirement-controlled, i.e. tries to meet political-administrative requirements to the greatest extent possible within its economic framework, including meeting Denmark's international obligations. It is the responsibility of the Ministry of the Environment to ensure that this is achieved.

As mentioned earlier, the Danish EPA and the Danish Forest and Nature Agency prepared an inventory of monitoring requirements with regard to data on the state of the environment, including identification of Denmark's international monitoring obligations pursuant to directives and international conventions (see http://www.dmu.dk/Overvågning/NOVANA/Programbeskrivelse+del+3/Forpligtelser/).

These obligations are summarized in the table on pages 9-10.

This inventory of monitoring requirements has thus served as one of the foundation stones for planning NOVANA.

The inventory of monitoring requirements revealed that the primary monitoring requirements relate to international obligations and agreements, environmental policy increasingly being agreed internationally due to the transboundary nature of the environmental problems. Additional national monitoring requirements emanate from special national issues and obligations in action plans, strategies, etc.

The inventory of monitoring requirements also emphasized that a future integrated monitoring programme must include monitoring of terrestrial nature (monitoring of species and terrestrial natural habitats) and aquatic species as well as nature monitoring in relation to nature restoration on the river Skjern and of wetlands established pursuant to Action Plan on the Aquatic Environment II.

In addition, monitoring required under the Water Framework Directive that can be a natural part of a national monitoring programme is to be integrated into the programme (see Section 4.1.2).

Monitoring programmes should rightly be founded on operational objectives. In the case of species and terrestrial natural habitats, however, it is necessary that the objectives be developed in parallel with the initial monitoring. This part of the programme will thus have to be adjusted during the course of the programme period 2004–2009.

Quite naturally, the political/administrative monitoring requirements are partly determined by the political agenda. It is therefore important that the design of the monitoring programme is sufficiently flexible to allow the programme to be adjusted in accordance with important requirements that may arise during the programme period.

The overall monitoring requirements pursuant to the Water Framework Directive are not encompassed by the inventory of monitoring requirements as these will first be clarified among the EU Member States during the course of 2002–2004. The Water Framework Directive is therefore likely to necessitate adjustment of NOVANA during the programme period.

In planning NOVANA the consequences of future directives such as the forthcoming daughter directives on air have been taken into account as far as possible.

Summary of reporting obligations fulfilled via NOVANA	**Agricultural catchments**	**Groundwater**	**Watercourses**	**Lakes**	**Point sources**	**Marine waters**	**Background monitoring of air quality and atmospheric deposition**	**Nationwide Air Quality Monitoring Programme**	**Terrestrial natural habitats**	**Species**	***Emissions to the atmosphere***	***Forest monitoring***
European Union												
Urban Wastewater Treatment Directive					■							
Dangerous Substance Discharges Directive					■							
A number of minor directives on hazardous substances					■							
EU monitoring mechanism for emissions of CO_2 and other greenhouse gasses*											■	
EU Programme for large rivers			■									
Regulation on protection of forests against air pollution												■
Regulation on a European Forest Information and Communication System												■
Regulation establishing the European Environment Agency and the EIONET		■	■	■	■	■	■	■	■	■	■	
Birds Directive				■		■				■		
Groundwater Directive – in preparation *		■										
Habitats Directive *			■	■		■	■		■	■		■
IPPC Directive					■							
Air Framework Directive and daughter directives								■				
Nitrates Directive	■	■	■	■		■						
Reporting Directive					■							
Water Framework Directive *	■	■	■	■	■	■						
Marine agreements												
HELCOM			■	■	■	■	■					
OSPAR			■	■	■	■	■					
Wadden Sea Cooperation										■		

(continued)

Summary of reporting obligations fulfilled via NOVANA	**Agricultural catchments**	**Groundwater**	**Watercourses**	**Lakes**	**Point sources**	**Marine waters**	**Background monitoring of air quality and atmospheric deposition**	**Nationwide Air Quality Monitoring Programme**	**Terrestrial natural habitats**	**Species**	***Emissions to the atmosphere***	***Forest monitoring***
Other international agreements												
Climate Convention*												
Ministerial Conference on the Protection of Forest in Europe												
OECD/Eurostat Joint Questionnaire												
Stockholm Convention												
UNECE/CLRTAP/EMEP (Geneva Convention)												
National												
Statutory Order on freshwater fish farms												
Statutory Order on mariculture												
Statutory Order on monitoring of atmospheric ozone**												
Statutory Order on limit values for the air content of sulphur dioxide, atmospheric nitrogen dioxide and nitrogen oxides, lead and particulates*												
Environmental Protection Act												
Protection on Nature Act												
Monitoring of cormorants: Red Lists												
River Skjern nature restoration monitoring programme												
Forests Act												
Statutory Order on urban wastewater												
Sustainable Forestry Strategy												
Tønder Marshes Act												
Action Plan on the Aquatic Environment I												
Action Plan on the Aquatic Environment II												
Action Plan on the Aquatic Environment III*												

* New obligations/requirements under NOVANA relative to NOVA-2003.

** Some of the national obligations are consequences of EU directives. The Water Framework Directive and Habitats Directive will require the introduction of new Statutory Orders.

The columns in ***italics*** describe monitoring activities that are not included in NOVANA.

2.3 International evaluation

In January 2001, NERI requested the European Environment Agency (EEA) to independently evaluate how well from the technical and scientific points of view the NOVA-2003 programme fulfils the national and international requirements. To this end, the EEA appointed an expert panel chaired by Steve Nixon, WRc PLC, UK.

The panel completed its work in November 2002. The final report is available at: http://www.dmu.dk/Overvågning/NOVANA/Programbeskrivelse+del+3/Baggrund/.

The report concluded that the programme is suitably designed and meets the requirements of existing EU directives and international conventions, and that the quality assurance and quality control measures are satisfactory.

The most important recommendations were as follows:

- The use of models in the agricultural catchments subprogramme should be extended to encompass transport models for phosphorus and pesticides
- The lake monitoring programme should consider reducing the frequency of macrophyte samples and the inclusion of periphytes and benthic invertebrates. Biota and sediment content of PCBs and dioxins should also be included in the monitoring
- The marine waters subprogramme should consider reducing the amount of data collected so as to ensure sufficient resources to analyse all the data
- The subprogramme for background monitoring of air quality and atmospheric deposition should change the duration of the precipitation sampling period from two weeks to one week in line with international guidelines and should extend the programme to also encompass analysis for hazardous substances.

Other recommendations were as follows:

- Within a number of subprogrammes it could be necessary to change the emphasis from nutrients to hazardous substances
- Data on hazardous substances and heavy metals should be utilized when planning the next monitoring programme so that these substances are monitored in the media in which they are most likely to occur
- The political relevance of the programme should be enhanced through greater use of indicators when reporting the findings
- The structure of the reports spanning from the reports by the regional authorities to those by the Topic Centres to the national crosscutting summary report should be standardized so that it is possible to follow the path of the information from the regional level to the national level ("audit trail").

Part 2 of the Programme Description describes how the recommendations of the International Evaluation Panel have been taken into account in each of the subprogrammes.

With regard to reporting of the findings, it has been decided to adjust the reporting strategy towards a more indicator-based form of reporting for both the regional and national reports (se Chapter 8).

Based on experience gained from NOVA-2003, monitoring of hazardous substances in NOVANA will focus more on the media and matrices in which they can be expected to be detected in measurable concentrations. Substances for which no standardized analysis methods are available will not be included until such analysis methods have been developed and laboratories have been designated to carry them out. In addition, procedures have been developed for deciding how new substances can be included in NOVANA. Overall, the balance between nutrients and hazardous substances has not been substantially changed in NOVANA compared with NOVA-2003.

International evaluations will also be carried out during the NOVANA period, among other reasons due to the great significance of the international obligations, including the fact that data and assessments have to be internationally comparable (see Section 9.2).

2.4 Statistical optimization

As one of the premises for the revision of NOVA-2003, a statistical optimization project was initiated. The aim of this project was:

"... to identify and describe statistical methods that can be used when drawing up and optimizing monitoring programmes, and to apply the statistical methods to specific problems in the current monitoring programme in the environmental field".

The project addressed a number of questions pertaining to the NOVA-2003 subprogrammes.

The project focused on key problems such as to what extent the established station network provides a reasonable nationwide picture, and to what extent one can demonstrate a trend of say 1-2% per year in certain variables (e.g. nitrogen) with reasonable statistical certainty within 10, 15 or 20 years.

The resultant report stressed that the analysis is national in nature, and that the conclusions do not necessarily apply at the regional level.

The results of the statistical optimization project have been published as a report in Danish (Larsen, Jensen and Carstensen, 2002) that is available at: http://www.dmu.dk/Overvågning/NOVANA/Programbeskrivelse+del+3/Baggrund/.

The main conclusions are:

- The number of stations in the natural watercourses (i.e. unaffected by cultivation) should be increased, whereas the sampling frequency can be reduced to every second or every third year
- The number of stations in the other types of watercourse is appropriate
- Relevant trends in watercourses can be determined in less than 15 years
- The number of fauna stations in watercourses can be reduced if this harmonizes with other objectives of the monitoring programme. Fauna samples can be collected every third year if this is combined with annual sampling in a small number of watercourses
- In lakes the relative precision is low due to the great seasonal variation in the monitored chemical and in particular biological variables
- With a number of variables it is necessary to monitor for more than 30 years in lakes in order to be able to demonstrate a trend with reasonable statistical certainty
- With lakes it is necessary to monitor several variables simultaneously, for example to explain trends
- Continuation of an intensive lake programme is recommended
- Continuation of the selected strategy in the marine programme with a few intensive stations and several extensive stations is recommended
- A number of marine stations should be continued in order to ensure sufficiently long time series to be able to demonstrate any trend. In general, approx. 30 years of monitoring will be needed to demonstrate a trend in the order of 1–2% per year
- The number of stations in the atmospheric programme (background monitoring of air quality and atmospheric deposition) is appropriate, but consideration should be given to reducing the sampling frequency for filter samples
- As regards the groundwater programme, a trend of between 2% and 4% per year can be determined statistically reliably after 30 years of monitoring
- It is necessary to intensify parts of the groundwater programme and to develop and use methods that make use of the spatial correlation between measurements within the same areas
- With regard to pesticides, the NOVA-2003 data material is too small to allow anything certain to be said about the precision
- Climate corrections should be further developed for a number of variables. This will reduce the amount of data needed for the statistical analyses
- Any cutback in the monitoring programme should not be based on general cutbacks in all areas, but on the deletion of individual sub-elements of the programme.

The results of the statistical optimization project have been reviewed by the Topic Centres, and wherever possible the subprogrammes have subsequently been amended. It has not always been appropriate to amend the subprogrammes in accordance with the recommendations of the statistical optimization project, however. For example, international obligations have precluded reducing sample collection in atmospheric monitoring.

The description of each subprogramme in Part 2 of the Programme Description – typically in Chapter 4 on strategy – describes how the conclusions and recommendations of the statistical optimization project have been taken into account.

2.5 Economic framework

The regional authorities' overall budget for the programme consists of a government block grant of DKK 99.3 million per year (1987 prices) pursuant to the Official Document establishing the Nationwide Monitoring Programme under the Action Plan on the Aquatic Environment (Ministry of the Interior, 1987). In addition, the programme includes part of the regional monitoring activities – the so-called regional environmental supervision. During the latest revision of the programme for the period 1998–2003 (NOVA-2003) the agreed combined regional budget for the programme was approx. DKK 180 million per year (2001 prices). Of this, approx. DKK 100 million per year (incl. VAT) was for non-salary programme expenses.

The NOVANA programme for the period 2004–2009 assumes an unchanged regional economic framework in 2001-prices, even though the programme encompasses a number of new topics and areas. The framework has been increased by just over DKK 1 million, though, by agreeing that the Copenhagen Municipality's work under the Nationwide Air Quality Monitoring Programme (LMP IV) is incorporated in NOVANA as a new element. The total regional budget for the programme is therefore approx. DKK 181 million per year (2001 prices). Of this approx. DKK 98 million per year (incl. VAT) is for non-salary programme expenses.

The Ministry of the Environment budget for NOVA-2003 was DKK 57.9 million per year (2001 prices) including activities under the Nationwide Air Quality Monitoring Programme (LMP IV) and monitoring of species and terrestrial natural habitats. The Ministry of the Environment's budget for NOVANA is based on the Ministry's expected budget for 2005 according to the 2003 Budget proposal, and is DKK 51.7 million (2001 prices).

More economic information for the various subprogrammes is provided for the state and regional actors in Chapter 6 together with a brief description of the calculation assumptions.

2.6 Other considerations pertaining to the revision

From the EU's 6th Environment Action Programme (Decision No. 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme) it is apparent that the current data and reporting system only provides a cursory insight into the state of the environment and the associated socioeconomic tendencies. This seriously limits our possibilities to meaningfully assess EU legislation and to understand the effect on the environment.

This statement is founded on a number of European conferences and meetings under the theme "Bridging the gap" aimed at bridging the gap between the available environmental data and those needed by the politicians.

The conclusions of the above-mentioned conferences can be summarized as follows:

- Tools need to be developed – including politically relevant indicators
- Current reporting at EU level should be streamlined and rendered more politically relevant; moreover, and outmoded or superfluous reporting requirements should be eliminated
- New methods should be developed for collecting, analysing, modelling and comparing data
- Cooperation between countries and institutions should be optimized so that data only have to be reported to one place once per year, but are available to and can be used by many people.

There is now an acknowledged need for data suitable for evaluating existing EU legislation and for identifying the need for new or amended legislation.

NOVANA will help support this international development.

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3 Objective

The overall objective of NOVANA is to monitor the status of the aquatic and terrestrial environments and the pressures upon them.

NOVANA is designed to:

- Describe **sources of pollution** and other pressures and their impact on the status of the aquatic and terrestrial environments and identify trends
- Generally document the **effect** of national action plans and measures directed at the aquatic and terrestrial environments – including whether the objectives are achieved and whether the **trends** are in the desired direction
- Meet Denmark's **obligations** in relation to EU **legislation**, international conventions and national legislation
- Contribute to enhancing the **scientific basis** for future international measures, national action plans, regional management and other measures to improve the aquatic and terrestrial environments, including contributing to develop various tools.

The programme is designed in accordance with the DPSIR concept (Figure 3.1), which can be summarized as follows:

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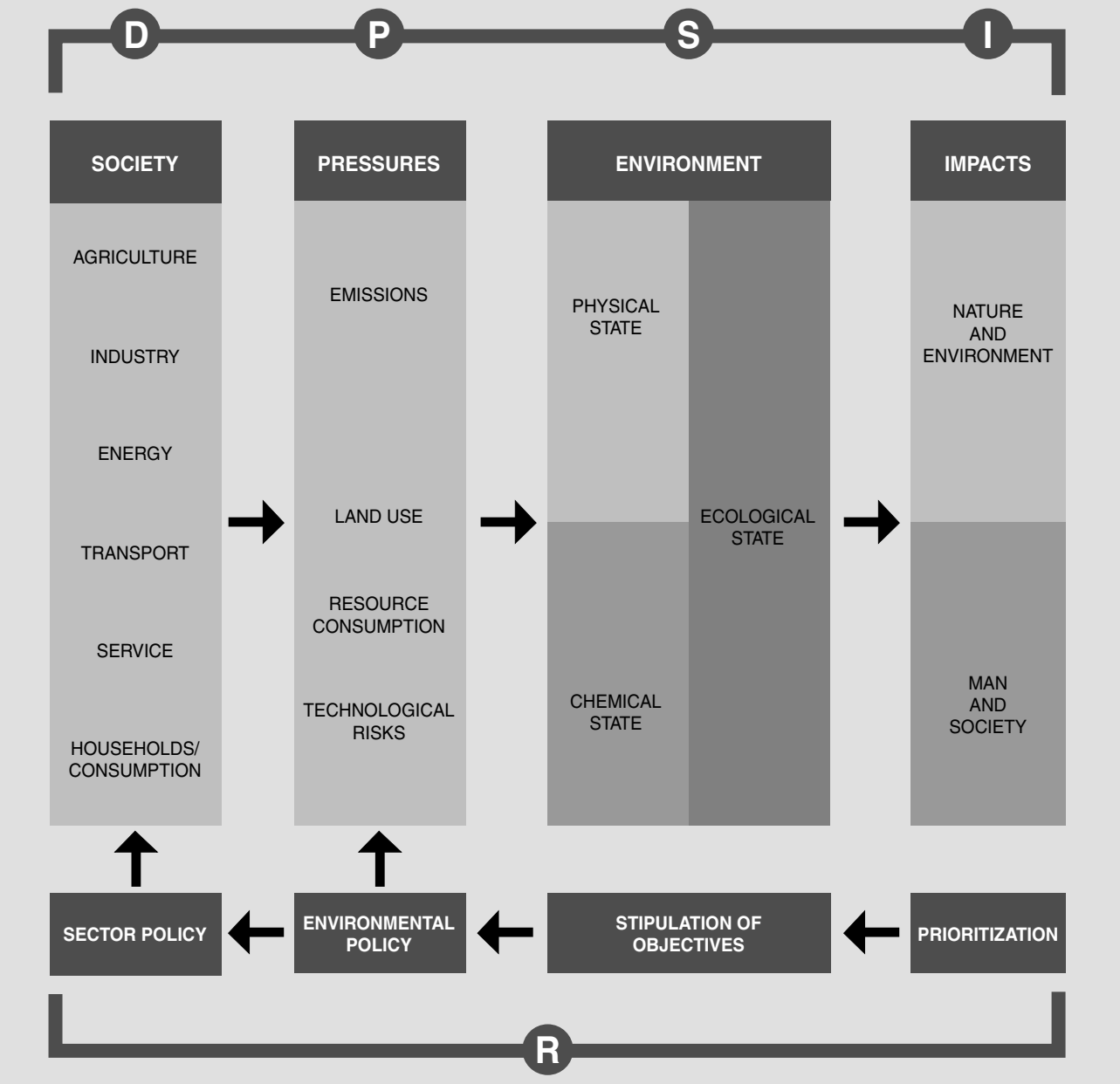

Figure 3.1 DPSIR concept.

- D: "Driving forces" – the causes
- P: "Pressures", e.g. sources of pollution
- S: "State" – state and quality of the aquatic and terrestrial environments
- I: "Impacts" – effects on and trends in the state of the aquatic and terrestrial environments
- R: "Responses" – regulatory measures in the widest sense, i.e. legislation, action plans, etc.

According to the nature monitoring strategy agreed in connection with the work of the Wilhjelm Committee, the primary focus of the monitoring programme should be on **P** (pressures), **S** (state) and **I** (impacts) and the trends therein (Wilhjelm Committee, 2001).

As a consequence, the trends in the sectors (D, driving forces) and the political reactions and resultant laws and action plans (R, responses) are not part of the monitoring programme. With regard to driving forces, the task of collecting such data is the responsibility of Statistics Denmark. Within the Ministry of the Environment, responsibility for monitoring lies with the scientific institutions – the National Environmental Research Institute and the Geological Survey of Denmark and Greenland. Responsibility for the political-administrative work lies with the agencies (Danish EPA and Danish Forest and Nature Agency).

The monitoring programme is designed to enable assessment of whether the political objectives have been met. Every four years, NERI complies a report on the trend in the driving forces (D), pressures (P), state (S) and impacts (I) as part of the foundation for the Government's strategic environmental planning (for the latest report see Bach, Christensen & Kristensen, 2002).

The current **objectives** for watercourses, lakes and coastal waters are not comparable and/or operational, however, although it is expected that this will be dealt with during implementation of the Water Framework Directive. In the initial phase the monitoring programme will be able to generate knowledge to support operationalization of the objectives.

Impact assessment of watercourse restoration has previously been carried out through a number of independent projects, for example concerning the rivers Gels, Brede and Skjern. It has only been possible to incorporate sufficient monitoring of the effects of watercourse restoration, nature management plans, etc. into NOVANA to enable the assessment of the long-term effects. The effects of the nature restoration work on the river Skjern and the reestablishment of wetlands under Action Plan on the Aquatic Environment II are included in NOVANA through the subprogrammes for watercourses, lakes, and species and terrestrial natural habitats. These only include a limited amount of such monitoring, though, and at a reduced level compared with previously.

It has generally been necessary to prioritize very strictly, focussing on fulfilment of international obligations. As a consequence, it has not been possible to fulfil a number of national and regional requirements. The regional authorities have a number of supervisory duties that can satisfy some of the regional requirements, however. Since inception of the national monitoring programme the intention has been that it should supplement the regional monitoring, not replace it. Through choice of localities and cooperation with the regional authorities, though, NOVANA can to some extent satisfy regional requirements and hence be utilized for regional supervisory purposes.

4 Strategy for and overall content of NOVANA

4.1 Strategy

4.1.1 Introduction

The strategy for the individual NOVANA subprogrammes is described in Chapters 3–10 of Part 2 of the Programme Description, as are the obligations that have influenced the selected strategy.

Under NOVANA, monitoring of nature and the aquatic environment has been combined. Monitoring of the aquatic environment over the past 10 years or so has provided experience that can be directly applied to the monitoring of nature, including experience concerning organization, structure, distribution of tasks, data storage and data transfer agreements, quality assurance procedures, etc.

NOVA-2003 already contained a number of nature elements as considerable monitoring of plankton, water plants and animals has been carried out over the years in watercourses, lakes and marine waters. Aquatic species and habitats are therefore integrated in the aquatic environment monitoring, while a new, integrated, nationwide subprogramme for species and terrestrial natural habitats has been established for the terrestrial environment.

In practice, it is not possible to differentiate between environment monitoring and nature monitoring. With both the aquatic and terrestrial environments, the biological components are utilized in conjunction with physical and chemical variables to determine and interpret the status and trend.

A monitoring programme has to be based on the current knowledge of causal relationships and pressures. It is important that this knowledge is developed through research, and that attempts are made to ensure that NOVANA is sufficiently flexible to enable the incorporation of new knowledge. In addition, NOVANA will generate data and results that contribute to new knowledge, management tools, etc.

In principle, monitoring is long-term in character. Long time series are needed in order to be able to demonstrate small changes during the course of time with statistical certainty. They can be used as a reference for the assessment of more short-term measure. NOVANA therefore ensures the continuation of important long time series of status and pressure data.

The monitoring has been designed to differentiate as far as possible between natural variation and anthropogenic impacts, including the effects of action plans and other management. In order to be able to assess and correct for climatic effects, various climatic data will be obtained across the programme.

The monitoring has also been designed to separate the various types of sources, including point sources from diffuse sources and natural sources from anthropogenic sources. As far as concerns agricultural loading, it is not presently possible to differentiate between various input pathways. An EU research project is being carried out to test the usefulness of various models, however. When more operational models become available, it will be possible to incorporate them in NOVANA.

In order to be able to take into account a number of the above-mentioned aspects the fundamental strategy employed in NOVANA is one entailing a few intensively monitored localities/areas and many extensively monitored localities/areas (see Section 4.1.3).

With NOVANA, attempts are being made to further integrate the various subprogrammes of the nationwide monitoring programme so that they support each other. Thus where relevant, methods, data and variables are integrated and if possible linked.

It is the goal of the NOVANA partners that data collected at public expense should be publicly available, and the strategy is to make the data available on the Internet. At the same time it is important – among other reasons for use of the data for research purposes – that the level of quality assurance of the data is very clear. All things being equal, this strategy will enhance utilization of the data for research purposes. Data that are reported to the EU, international conventions, Statistics Denmark, etc. will also be made available on the Internet.

4.1.2 Strategy regarding the Water Framework Directive and the Habitats Directive

The EU's **Water Framework Directive** requires Member States no later than 22 December 2006 to establish programmes for the monitoring of water status in order to establish a coherent and comprehensive overview of ecological and chemical water status and trends within each river basin district.

The Water Framework Directive encompasses groundwater and surface waters, including coastal waters within 1 nautical mile of the so-called baseline from which the width of territorial waters is measured, as well as some protected areas. Open marine waters are only encompassed as far as concerns chemical status. The monitoring obligations pursuant to the Water Framework Directive will therefore affect much of the aquatic environment monitoring. The responsibilities of the regional authorities in this respect are described in the Environmental Objectives Act and associated explanatory comments.

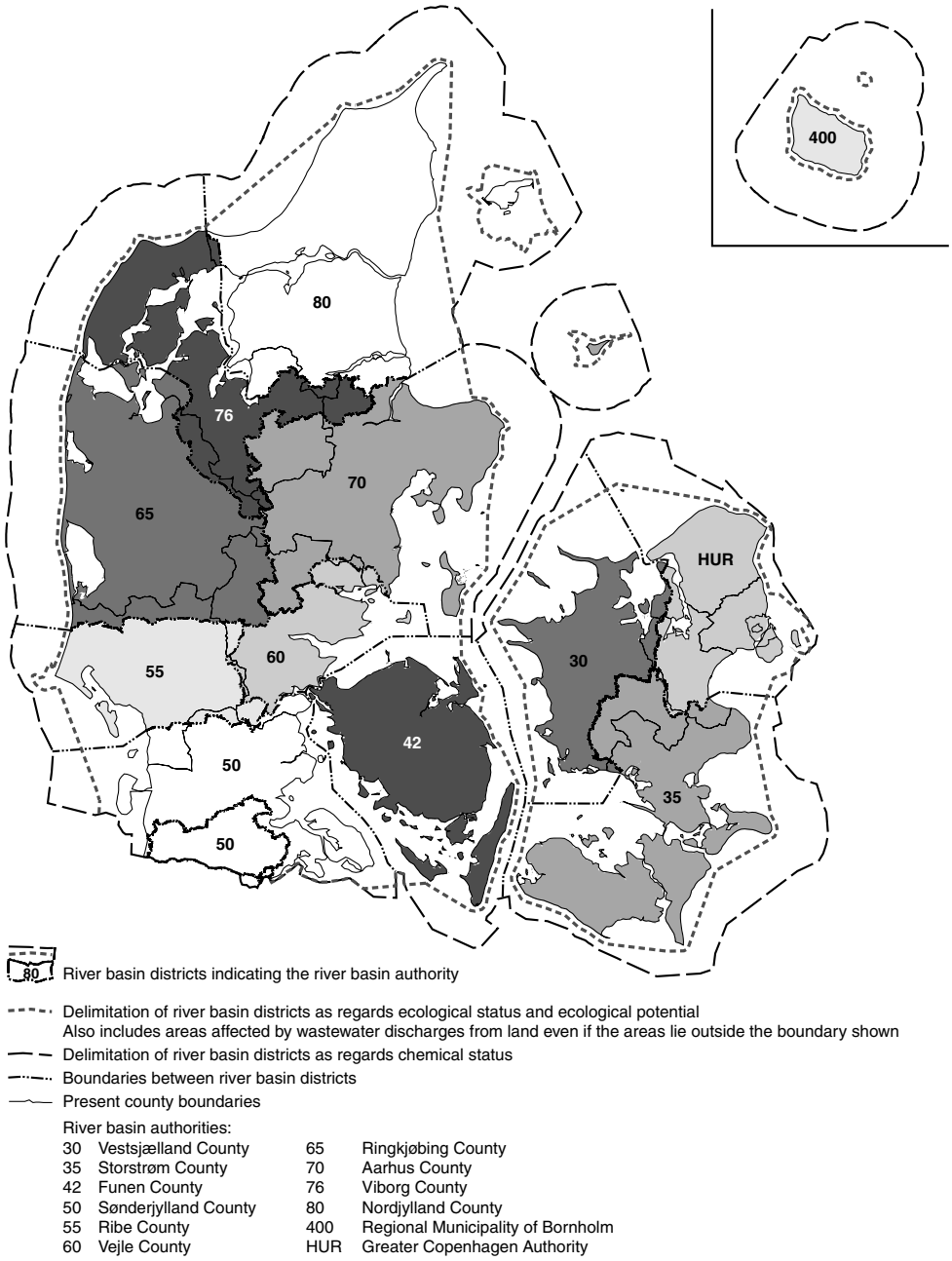

Figure 4.1 Geographic boundaries of river basin districts indicating the river basin authority. The light part of area 50 is an international river basin district shared with Germany.

The Water Framework Directive operates with three types of monitoring of surface waters:

1. Surveillance monitoring, which is intended "to provide an assessment of the overall surface water status within each catchment or subcatchments within the river basin district".

2. Operational monitoring, which is undertaken to "establish the status of those bodies identified as being at risk of failing to meet their environmental objectives" and to "assess any changes in the status of such bodies resulting from the programmes of measures".

3. Investigative monitoring, which "shall be carried out:
   - where the reason for any exceedances is unknown,
   - where surveillance monitoring indicates that the objectives set out in Article 4 for a body of water are not likely to be achieved and operational monitoring has not already been established, in order to ascertain the causes of a water body or water bodies failing to achieve the environmental objectives, or
   - to ascertain the magnitude and impacts of accidental pollution,

- and which shall inform the establishment of a programme of measures for the achievement of the environmental objectives and specific measures necessary to remedy the effects of accidental pollution".

In the case of groundwater, only the first two types of monitoring are carried out. The way they are formulated differs, but they largely encompass the same elements as for surface waters.

NOVANA incorporates Denmark's obligations under the Water Framework Directive regarding surveillance monitoring of groundwater and surface waters. In addition, NOVANA can fully or partly meet the requirements for operational monitoring in the case of those water bodies/groundwater bodies and associated catchments encompassed by the programme.

Together with NOVANA, the operational and investigative monitoring required under the Water Framework Directive will comprise the foundation for the programmes of measures and serve to evaluate the effects of the programmes of measures.

With both surveillance monitoring and operational monitoring, NOVANA is designed to help clarify the relationship between groundwater and surface water and reveal the need for possible programmes of measures. In a manner representative for the country as a whole the programme is designed to enable an overall assessment of the status of the water bodies and the pressures on them. In relation to planning and following up on the programmes of measures the content of the monitoring of water bodies will vary depending on the character and extent of the problem. Moreover, it requires considerable local knowledge. It is therefore appropriate that such monitoring takes place outside NOVANA. In the case of the water bodies/groundwater bodies and associated catchments covered by NOVANA, the regional authorities will be able to make use of the results obtained under the programme in connection with the programmes of measures.

With groundwater and drinking water, the monitoring and supervisory activities prescribed under Danish law in connection with the water supply will continue to remain outside NOVANA.

On the basis of the Article 5 reports prepared in 2004, the monitoring obligations pursuant to the Water Framework Directive have to be initiated no later than 22 December 2006. In the period 2005–2009, the river basin districts have to prepare river basin management plans containing programmes of measures.

Denmark is subdivided into 13 river basin districts, and the river basins that extend beyond Denmark's borders have been assigned to an international river basin district (see Figure 4.1). Within the EU there is a common understanding that it is acceptable to monitor representative water bodies and that it is not necessary to monitor every single water body. Moreover, there is a common understanding within the EU that river basin districts can "borrow" monitoring results from reference water bodies, etc. in other river basin districts provided the biogeographical conditions permit (Littlejohn *et al.*, 2002).

Based on experience with NOVANA and the work within the EU to decide on the monitoring strategy and requirements it is intended to adjust NOVANA and the regional supervisory and monitoring activities in 2005 and 2006 to meet the requirements of the Directive with effect from 1 January 2007.

Part 2 of the Programme Description explains how the overall strategy for NOVANA is implemented for each subprogramme.

The terrestrial environment part of NOVANA reflects the monitoring requirements pursuant to the **Habitats Directive** and stems from the obligations under the Rio Convention to prepare a national strategy for conserving biodiversity. The Convention defines biodiversity on three different levels:

- Ecosystem diversity
- Species diversity
- Genetic diversity.

NOVANA covers – representatively for the country as a whole – the two first levels through monitoring of ecosystems/habitat types and monitoring of individual species. NOVANA has been designed to enable assessment – representatively for the country as a whole – of the conservation status of habitat types and species in relation to the conservation objectives stipulated in the regional Natura 2000 plans. However, the programme does not necessarily provide adequate coverage at the regional/local levels in relation to specific management plans for the special areas of conservation (SACs) designated pursuant to the Habitats Directive.

At present it is not possible to design a realistic monitoring programme for genetic diversity.

The Habitats Directive employs the term "habitat types" for the ecosystem level. The Directive defines the terms "favourable conservation status" for both habitat types and species. The directive requires that conservation objectives be established for habitat types and species both nationally and locally (Natura 2000 areas). The monitoring obligations under the directive encompass both the national and the local levels. In planning the monitoring of natural habitats, efforts have primarily focussed on covering the Natura 2000 areas and monitoring the habitat types for which the areas have been designated.

In an ideal world, the conservation objectives should be established and adopted before monitoring is initiated to determine whether the objectives have been achieved. The process to establish the criteria for conservation objectives has taken place in parallel with the establishment of subprogramme for species and terrestrial natural habitats and the inclusion of monitoring of aquatic habitats in the aquatic subprogrammes. Despite the fact that the conservation objec-

tives have not been established, the criteria that are expected to be included were known. Thus the monitoring programme established is expected to be able to assess the future conservation objectives representatively at the national level. As already mentioned, this will not necessarily be the case at the local level, however.

Monitoring of natural habitats is a new area for the national monitoring programme, new experience will be gained in the area that will be regularly incorporated into NOVANA. The overall intention is to apply largely the same methods in the nature part of the aquatic subprogrammes and in the subprogrammes for species and terrestrial natural habitats.

4.1.3 Strategy for intensive and extensive monitoring

The subprogrammes are fundamentally subdivided into intensive monitoring and extensive monitoring.

The **intensive monitoring** is carried out at a small number of localities/areas. The monitoring is frequent (typically one or several times per year) and generally encompasses more variables than the extensive monitoring. Among other things, the aim of the monitoring is to determine seasonal variations and interannual variations and to determine the relationship between pressures and state and thereby establish the basis for interpretation of the extensive monitoring. The intensive monitoring can demonstrate a given change fairly rapidly. The intensive monitoring can also be carried out in high-priority localities/areas or where the state differs markedly from the objective.

The **extensive monitoring** is intended to provide a nationwide picture and is therefore carried out at many localities/areas, where monitoring is carried out less frequently (typically every third or every sixth year) and encompass fewer variables.

A combination of intensive and extensive monitoring will provide a statistically reliable picture of the status and trend in the various types of water body and terrestrial habitat. Moreover, through an appropriate choice of monitoring variables they will reveal the effects of various nature and environmental policy measures.

With regard to the species monitoring, the intensive monitoring consists of the determination of population size, while the extensive monitoring consists of monitoring of species distribution.

To assist in the determination of natural variation some of the subprogrammes encompass **reference localities/areas,** for example representing watercourse reaches or lakes whose status is only very slightly affected by human activities.

The terrestrial habitat monitoring also includes **survey activities** to monitor the spatial extent of the terrestrial habitat types. This is because the general survey of the natural areas carried out pursuant to Section 3 of the Protection of Nature Act differs significantly from the requirements of the Habitats Directive.

In principle, the monitoring of forest habitats is part of NOVANA. During the first three years, surveying work will be carried out by the Danish Forest and Nature Agency in combination with relevant partners. Thereafter, i.e. from 2007 onwards, the monitoring of habitat types in forests will be incorporated in NOVANA.

4.1.4 Strategy for hazardous substances

The list of hazardous substances and heavy metals encompassed by NOVANA has been drawn up in the light of:

- Requirements in directives and conventions
- Results from previous monitoring and other investigations
- Recommendations from the international evaluation of NOVA-2003 and a common understanding within EU Member States to focus monitoring of hazardous substances and heavy metals on those matrices in which measurable concentrations are most likely to occur
- A desire that there should be the maximum possible coherence in the NOVANA programme across matrices
- A decision that new substances are not to be included unless the need is documented and it is possible to analyse for them (cf. Section 7.5).

The list of hazardous substances and heavy metals encompassed by NOVANA is given in Part 2 of the Programme Description at the end of the individual subprogrammes. Part 3 of the Programme Description provides a complete list of these substances that will be regularly updated.

Monitoring of hazardous substances and heavy metals is included in all the subprogrammes except the subprogramme for species and terrestrial natural habitats.

The following matrices are monitored: Groundwater, large watercourses, sea water, marine sediment, marine bivlaves and fish, wastewater and sludge from wastewater treatment plants, wastewater from separate industrial discharges, stormwater outfalls and precipitation.

In addition, crosscutting investigation of inland surface waters including lakes, a large number of minor watercourses and drainage water will be carried out during the programme period. In lakes, special attention will be accorded to the occurrence of hazardous substances in sediment and to a certain extent in biota. The occurrence of hazardous substances in the water phase of lakes is not expected to be significantly different from that in the water phase of large watercourses. The monitoring of hazardous substances and heavy metals in precipitation will initially be undertaken in such a way that the programme can be adjusted in the light of the experience gained and with a

view to subsequent expansion to also encompass particles.

In principle, the list of hazardous substances and heavy metals encompasses those substances that the NOVA-2003 results indicate are still relevant to monitor. The extent of the monitoring has been reduced in NOVANA compared to NOVA-2003, primarily due to acknowledgement that NOVA-2003 included some substances that are not relevant in relation to the present monitoring programme. Moreover, the international evaluation of NOVA-2003 points out that the monitoring of hazardous substances should focus on the sources. Finally, it has proven necessary to prioritize the NOVA-2003 activities in order to make room for new activities in NOVANA within the same economic framework.

NOVANA does not include all the substances that are encompassed by the current and future directives and conventions. Some substances are not included because they have not been detected during the previous monitoring and hence are not considered to be relevant. Still others have to undergo the assessment and screening processes discussed below in order to document whether it is relevant to monitor them in Denmark. As regards the Water Framework Directive, a common understanding exists between EU Member States that a substance that is not used in a river basin and which is not expected to occur in the aquatic environment can be omitted from the monitoring on the basis of an "expert assessment".

New substances
Since the latest revision of the programme, attention has been focussed on a number of new substances that it might be relevant to include in NOVANA. These include the substances on the Water Framework Directive's list of priority substances[1] and the oestrogens. These candidate substances have not been included in NOVANA from the start of the programme period. In parallel with the monitoring of hazardous substances, however, new substances will be assessed and possibly also screened in order to enable substances that prove to be relevant to monitor under NOVANA to be included during the programme period. A few new substances/substance groups for which documentation exists that monitoring is relevant have been included, among others brominated flame retardants and some degradation products of pesticides.

[1] Substances for which agreement has been reached on their phase-out or the cessation of discharges, emissions or losses within 20 years after adoption of the directive with the ultimate aim of achieving concentrations in the marine environment approaching background values for naturally occurring substances and close to zero for man-made synthetic substances (European Parliament and Council Decision No. 2455/2001/EC of 20 November 2001 establishing the list of priority substances in the field of water policy and amending Directive 2000/60/EC.)

Early warning
NOVANA is not intended to provide early warning of new problem substances. Under NOVANA, monitoring is carried out systematically in accordance with a previously determined and agreed programme – a conservative set of substances. If other early warning systems such as the Danish Pesticide Leaching Assessment Programme reveal substances that should be encompassed by the monitoring programme, it will be possible to incorporate such substances.

4.1.5 Crosscutting activities

Experience with NOVA-2003 revealed the need to be able to meet new requirements that arise underway, to change the list of monitored substances and to carry out crosscutting activities across the subprogrammes. Attempts have been made to incorporate this flexibility in NOVANA by operating with crosscutting activities where investigations can be made across the various subprogrammes, for example of hazardous substances. This aspect is further described in Section 7.8.

4.1.6 Performance of the monitoring

Data should as far as possible be utilized regionally, nationally and internationally. Moreover, local knowledge of an area should be used. Data collection, data processing, data quality assurance and regional reporting can therefore be beneficially carried out regionally. This principle has hitherto been applied in the aquatic environment monitoring and will likewise serve as the principle for the monitoring of terrestrial natural habitats. As far as concerns species monitoring, atmospheric monitoring and monitoring of the open marine waters, the task is so specialized that it is best carried out centrally.

In a number of cases the regional authorities use consultants for both fieldwork and analysis of biological variables and for data processing and reporting. In addition, analysis laboratories are used for chemical analyses. Similarly, NERI uses consultants for certain monitoring tasks. Moreover, a consultant has been used to operate a marine model (the marine waters model "Farvandsmodellen"), and resources have been allocated under NOVANA for a replacement of the existing marine model, a task that will be put out to tender.

The organizational aspects of the NOVANA cooperation and programme are described in Chapter 5.

4.1.7 Consequences of NOVANA

When selecting the activities that it was possible to include in the programme given the economic framework, efforts were made to ensure a reasonable balance between the state resources in the Topic Centres and the monitoring activities of the regional authorities, among another reasons to ensure that only monitoring data that could be processed are collected.

In relation to the political/administrative needs, NOVANA is expected to have the following consequences:

- EU directives/Council decisions will be met, largely at the minimum level
- There will be certain shortfalls in Denmark's compliance with obligations under a few conventions (e.g. in relation to HELCOM, OSPAR and EMEP), especially in relation to geographic and temporal coverage and to monitoring of some hazardous substances
- Other national requirements will only be met to a limited extent
- Regional requirements will to some extent be met when NOVANA is planned in detail.

4.2 NOVANA's overall structure and content

4.2.1 Sources and pathways

NOVANA includes the main sources and pathways for the input of nutrients and other substances to the aquatic environment. For nitrogen and phosphorus, some of the most important are shown in Figures 4.2 and 4.3.

The majority of the nitrogen is transported in aqueous media in dissolved form. In addition, nitrogen is transported in the atmosphere in dissolved form and as particles, but to a large extent also in the form of various gasses.

The majority of phosphorus is transported as particles, while a minor proportion is transported in dissolved form. Phosphorus does not occur in gaseous form, and atmospheric transport of phosphorus takes place either in dissolved or particle-bound form.

The nitrogen cycle is outlined in Figure 4.2. There is no corresponding cycle for phosphorus, and consequently only the sources and transport pathways are shown in Figure 4.3.

Other substances such as heavy metals and hazardous substances will also occur, primarily in dissolved form or in particulate form. Explained simply, their occurrence and pathways will be similar to that of either nitrogen or phosphorus, but other combinations are also found.

4.2.2 Overall structure of NOVANA

NOVANA is subdivided into nine subprogrammes:

- Background monitoring of air quality and atmospheric deposition
- Point sources
- Agricultural catchments
- Groundwater
- Watercourses
- Lakes
- Marine waters
- Species and terrestrial natural habitats
- Nationwide Air Quality Monitoring Programme (LMPIV).

NOVANA encompasses the main sources of inputs of nutrients, organic matter, heavy metals and hazardous substances to the aquatic environment (Figures 4.2 and 4.3). The nationwide calculations of discharges and losses, occurrence and transport are most comprehensive for nitrogen, phosphorus and organic matter. The calculations of discharges and losses, transport and occurrence of heavy metals and hazardous substances chiefly focus on the sources, pathways and media where they can be expected to occur in significant concentrations.

Discharges from **point sources** include municipal wastewater treatment plants, separate industrial discharges, stormwater outfalls, sparsely built-up areas, freshwater fish farms and mariculture. In addition, calculations are made of discharges to the sea from offshore installations and from marine dumping of seabed material. This is covered by the subprogramme for point sources. Emissions to the air, for example from traffic, including ship traffic, combustion (e.g. from combined heat and power plants), etc. are not part of the NOVANA programme, but these data are available to the programme.

NOVANA also includes losses to the aquatic environment from **diffuse sources**. The aquatic and terrestrial environments receive inputs of substances from the air, and these are calculated in the subprogramme for background monitoring of air quality and atmospheric deposition. Substances are lost to the aquatic environment from both cultivated and natural areas. The total loss from both cultivated and natural areas is determined in the watercourses subprogramme. In the agricultural catchments subprogramme, losses via the root zone to the groundwater and via drainage water to watercourses are measured and modelled in a few small cultivated catchments. The trend in these catchments is utilized to describe the trend at the national level. The subprogramme for agricultural catchments also includes calculation of nutrient balances at farm level (inputs minus outputs), with information statistics being used to determine total inputs of commercial fertilizer and manure to cultivated land. The findings from the catchments in the subprogramme for agricultural catchments are thus used to evaluate changes in agricultural practice, including the trend in losses from the agricultural sector.

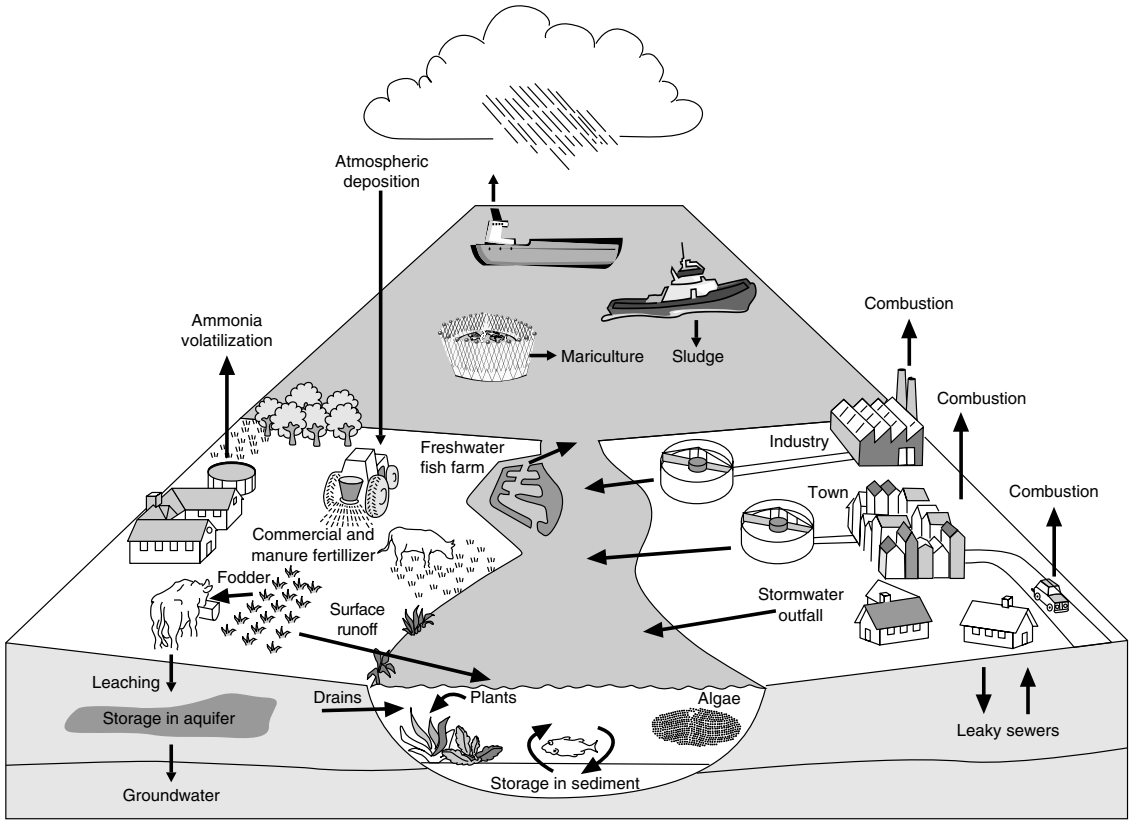

Figure 4.2 Nitrogen cycle. Some of the main sources and pathways are shown, many of which are encompassed by NOVANA. Input to the atmosphere via combustion is not included in NOVANA, but is calculated by the Ministry of the Environment via an emissions programme, the results of which are available to NOVANA. A number of point sources are shown on the right side of the figure, while the left side shows diffuse sources, which also include atmospheric deposition. Other sources not shown are diffuse input to the aquatic environment from natural areas and inputs from stormwater outfalls. (Adapted from Danish EPA, 1999).

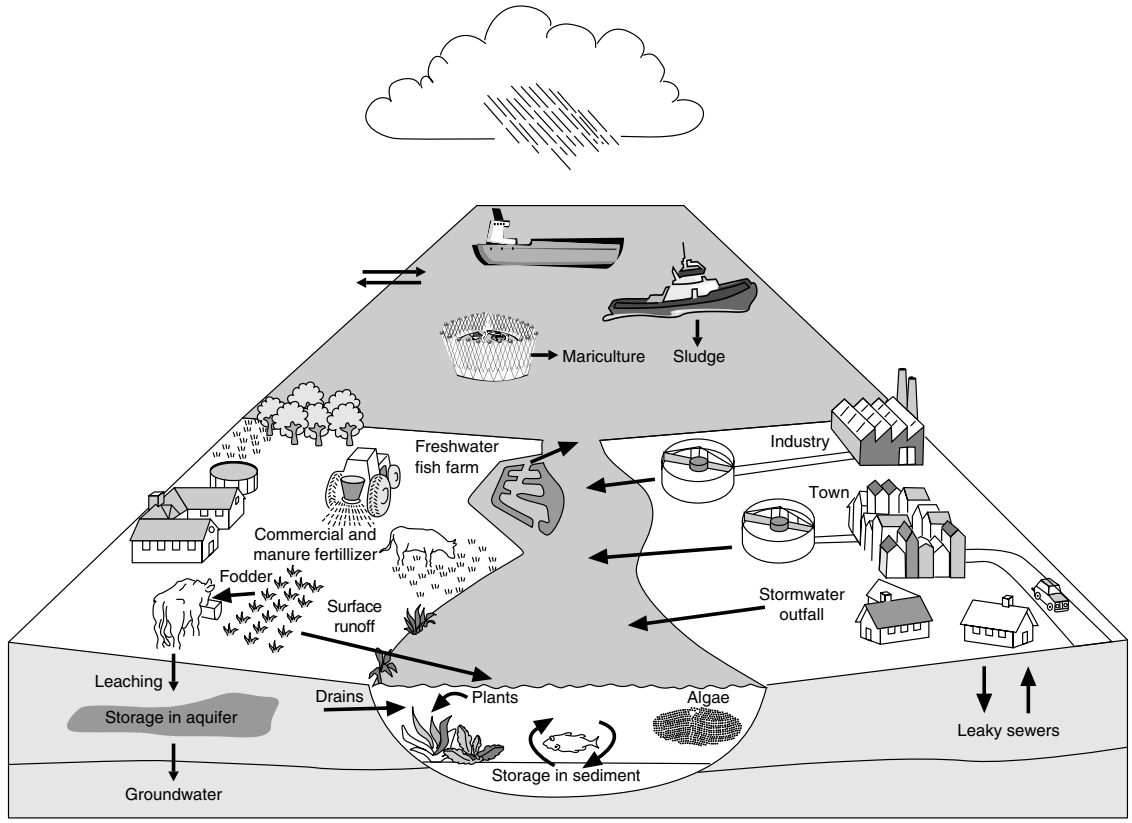

Figure 4.3 Main phosphorus sources and pathways. See also the legend to Figure 4.2. (Adapted from Danish EPA, 1999).

The total riverine **inputs to the sea** are calculated in the subprogramme for watercourses. By incorporating data from the subprogramme for point sources it is possible to include direct wastewater discharges to the sea are included. The source apportionment of nutrient losses and discharges to inland surface waters and to the sea, respectively, is also determined. Nutrient and organic matter inputs to lakes and the source apportionment thereof are determined in the subprogramme for lakes. In the subprogramme for marine waters the calculated inputs from the subprogramme for watercourses and from atmospheric deposition are combined with exchange of water and nutrients from the adjoining marine waters to yield the total inputs to Danish marine waters. More detailed calculations of inputs to selected marine areas are coordinated with the subprogramme for watercourses.

Status and trend are included in all subprogrammes. In the subprogrammes for background monitoring of air quality and atmospheric deposition, point sources, agricultural catchments and groundwater, status and trend are determined for a number of chemical and physical variables. In the remaining subprogrammes, status and trend are also determined for the biological variables, and the interrelationships between the various components of the ecosystem are studied.

Atmospheric deposition of ammonia is a major pressure on a number of habitat types. The subprogramme for background monitoring of air quality and atmospheric deposition and the subprogramme for species and terrestrial natural habitats will therefore cooperate closely on the monitoring and detailed modelling of ammonia deposition.

The subprogramme for agricultural catchments investigates the relationship between land use, cultivation practice and nutrient losses from the root zone. The results and experience of activities on cultivated land are utilized in the subprogrammes for watercourses, lakes and groundwater and efforts are being made to utilize them in the subprogramme for species and terrestrial natural habitats.

A number of pressures are specific for a local area or for a subprogramme and hence cannot be immediately utilized across NOVANA. Thus water table variation and soil humidity conditions are important for a number of terrestrial habitat types and have to be measured specially for these. In groundwater, the geological conditions and the hydraulic conductivity of the geological layers play a decisive role for the chemical composition of the groundwater and the groundwater flow pattern.

Within each subprogramme, specific interpretations will be made of the relationship between pressure and status and trend. Ecosystems are extremely complex, e.g. in a lake, a fjord or an open marine water. The time frame that needs to be considered also differs. In the older groundwater, for example, some pressures will have occurred far in the past. In the marine areas, some of the pressures will be due to substances transported from afar.

The use of **models** differs from subprogramme to subprogramme. The subprogramme for background monitoring of air quality and atmospheric deposition has a long tradition for extensive and complex modelling activity. Over the years, the subprogramme for lakes has developed empirical models for such aspects as the relationship between physical and chemical variables and selected biological variables. In the subprogramme for marine waters, models are used to generate boundary condition data, data on water and nutrient transport between marine areas and data on mass, salt and nutrient exchange with adjoining marine water in a number of selected coastal waters. In the subprogramme for agricultural catchments, modelling is used to calculate leaching of nutrients from the root zone, etc. Additional modelling is planned in NOVANA relative to NOVA-2003, for example in the subprogramme for groundwater.

Some data have to be utilized in several NOVANA subprogrammes, for example climate data, land use data, data on the number of livestock in different catchments, etc. The provision of these data is coordinated across the various subprogrammes (see Section 7.7).

The remainder of this section briefly describes the overall content of the subprogrammes. A more detailed description of each subprogramme is provided in Part 2 of the Programme Description, including the number of localities/areas encompassed by the subprogramme, the variables monitored and the monitoring frequencies. Part 3 of the Programme Description provides comprehensive summaries of the specific localities/areas encompassed by NOVANA, the variables monitored and the monitoring frequencies.

4.2.3 Background monitoring of air quality and atmospheric deposition

The subprogramme consists of intensive monitoring of air quality and deposition in combination with modelling.

The actual concentrations and amounts of deposition are measured at a network of monitoring stations, while the model calculations are used to calculate deposition on terrestrial and aquatic areas. The monitoring forms the basis for evaluating the trend and the quality of the modelling results. The activities can be summarized as follows:

- Measurement of air concentrations and wet deposition of nitrogen compounds, phosphorus, sulphur compounds, basic cations (sodium, potassium, calcium and magnesium), heavy metals and selected hazardous substances
- Measurement of air concentrations and wet deposition of nitrogen compounds in natural areas by means of "mobile" monitoring stations

- Model calculation of the deposition of relevant substances at the national, regional and local scales.

The monitoring is carried out at a number of "fixed" monitoring stations distributed throughout the country and at two "mobile" stations that are relocated at 1–2 year intervals.

4.2.4 Point sources

The point source monitoring comprises calculation of discharges of organic matter, nutrients, heavy metals and hazardous substances from the individual types of point source. The amount of water discharged is calculated to facilitate calculation of total discharges of these substances. The activities encompass:

- Municipal wastewater treatment plants: Calculation of the discharged organic matter, nutrients, heavy metals and hazardous substances on an annual and national basis based on measurements. The concentration level in the discharges and the degree of purification (treatment efficiency) are also determined
- Separate industrial discharges: Calculation of the discharged organic matter, nutrients, heavy metals and hazardous substances on an annual and national basis based on measurements. The concentration levels in the discharges are also examined
- Stormwater outfalls: Calculation of the discharged organic matter, nutrients, heavy metals and hazardous substances on an annual and national basis based on empirical data and precipitation. In addition, an intensive monitoring programme is conducted at two outfalls
- Sparsely built-up areas: Calculation of the discharged organic matter, nutrients, heavy metals and hazardous substances on an annual and national basis based on the number of settlements, etc. The planned development in discharges is also examined
- Freshwater fish farms: Calculation of the discharged organic matter, nutrients, heavy metals and hazardous substances on an annual and national basis based on feed consumption
- Mariculture (sea-based and terrestrial saltwater fish farms): Calculation of the discharged organic matter, nutrients, heavy metals and hazardous substances on an annual and national basis based on feed consumption.

The reporting also includes s offshore installations and marine dumping of seabed material.

4.2.5 Agricultural catchments

The monitoring is performed by annual determination of fertilization practice, pesticide consumption and land use in the monitoring catchments. In addition, direct measurements are made of nitrate and phosphorus losses from the root zone of cultivated land and in the other parts of the hydrological cycle, including drainage water and the upper groundwater. Moreover, pesticides are measured in the upper groundwater.

The monitoring is carried out in six agricultural catchments selected so as to cover variation in agricultural practice, soil type and climate. The activities, which are carried out to a varying degree in the various catchments, include:

- Interview surveys about agricultural practice, pesticide use and nutrient balances at farm level
- Monitoring of the hydrological cycle (soil water, drainage water, watercourses and groundwater)
- Determination of the phosphorus binding capacity of the soil
- Monitoring of nutrient leaching from the root zone
- Determination of nutrient transport in drainage water and watercourses, including intensive phosphorus monitoring
- Monitoring of the occurrence of nutrients, pesticides, organic micropollutants and inorganic trace elements in groundwater in relation to the groundwater's age
- Modelling of nutrient leaching and hydrology.

4.2.6 Groundwater

The groundwater is monitored through the subprogramme for groundwater and the subprogramme for agricultural catchments, and comprise monitoring or analysis of:

- The groundwater's age
- The groundwater's main chemical elements (incl. state variables)
- Inorganic trace elements (mainly heavy metals)
- Organic micropollutants
- Pesticides and their degradation products
- Abstraction volume and size of the water resources.

The subprogramme also utilizes the results of waterworks well surveillance (well control), i.e. analysis of water quality in the individual abstraction wells, in combination with the regional authorities' records of the amount of water abstracted at the individual waterworks. The regional authorities also register and report waterworks measurements of the groundwater level and analysis of drinking water quality at the outlet from the waterworks and in the supply network (drinking water control), but these data are not part of NOVANA. The state and trend are described for the groundwater's content of:

- Naturally occurring main chemical elements
- Inorganic trace elements
- Pesticides and organic micropollutants.

The quality of the near-surface water in the deeper aquifers is described partly as a function of time and

partly as a function of anthropogenic pressures. These pressures include contamination of the groundwater caused by agriculture and waste disposal, etc. and of chemical changes in the quality of the groundwater caused by water abstraction.

In addition, the trend in groundwater recharge and the size of the water resources is evaluated (especially by modelling) taking into account climatic conditions such as precipitation and evaporation, as well as water abstraction, groundwater pressure and runoff to the sea.

4.2.7 Watercourses

The subprogramme for watercourses consists of two main parts:

- Watercourse ecological quality
- Water chemistry and transport of nutrients, organic matter and other substances.

In addition, it includes a modest programme to monitor the effects of the river Skjern nature restoration project and of the biological effects of establishment of the wetlands established pursuant to Action Plan on the Aquatic Environment II.

The part of the subprogramme that deals with watercourse ecological quality encompasses:

- Biological variables such as macroinvertebrates, water plants and fish
- Physical conditions such as run off, morphology, hydrological regime, deposition/erosion, physical index, flooding of riparian areas etc.
- Nutrients, macroions and organic matter
- Characterization of riparian areas, management practices
- Review of status and trends for Natura 2000 habitat types, cf. the Habitats Directive concerning watercourses.

The part of the subprogramme dealing with water chemistry and transport of nutrients etc, encompasses:

- Monitoring of runoff, nutrients, organic matter, macroions, physical characteristics, etc. in some reference catchments
- Monitoring of run off, nutrients, organic matter, physical characteristics, etc. in a number of catchments affected by cultivation and/or wastewater discharge and calculation of source-apportioned riverine inputs to marine waters
- Surveying and risk assessment of soil and bank erosion
- Nitrogen modelling
- Monitoring of heavy metals and hazardous substances in a few large watercourses.

4.2.8 Lakes

The subprogramme encompasses monitoring at four levels (one intensive and three extensive levels).

Level 1: The intensive monitoring encompasses the following elements:

- Trend in input, retention and loss of nutrients in the lakes on an interannual and seasonal basis, including determining the causes of the changes, for example changes in lake biological structure or the climate
- Review of the status and trend for Natura 2000 habitat types and species, cf. Habitats Directive
- Trend in key biological variables (phytoplankton and zooplankton, submerged water plants, bank vegetation and reed belt vegetation, fish) and the interrelationship between them and the causes of the changes
- Sediment chemistry
- Benthic invertebrates and water birds
- Assessment of the reference conditions of lake types
- Development of tools/models for consequence assessment and to establish scenarios for the analysis and interpretation of the extensive lake programmes in both the national and the regional management of the lakes.

Heavy metals and hazardous substances are included in the subprogramme via screening of inland surface waters in that a number of selected lakes and watercourses will be studied. The details of this screening have not yet been finalized.

Levels 2–4, which are the extensive levels and which are new additions to the lakes subprogramme, are intended to provide an overall description of key nature and environment indicators in various important types of lake:

Level 2: Lakes over 5 ha:

- In habitat types encompassed by the Habitats Directive the overall biological structure and the interactions between the central biological elements, loading and other possible threats are described through monitoring of:
- A number of physical and chemical variables in the water phase
- Sediment chemistry
- Biological analyses (phytoplankton, zooplankton, fish, water plants)
- Inputs and other pressures
- Plants in relation to species and habitat types.

Level 3: Lakes of 0.1–5 ha:

- A number of physical and chemical variables in the water phase
- Water plants
- Assessment of nutrient inputs and other pressures
- Plants in relation to species and habitat types.

Level 4: Ponds and water holes (a representative selection) – including temporary ponds.

In principle, the monitoring programme includes the same variables as for small lakes (0.1 to 5 ha), but monitoring takes place only once a year every sixth year as compared to five times a year every sixth year in the small lakes.

In addition, the distribution of species considered particularly worthy of conservation is determined in selected Danish lakes.

4.2.9 Marine waters

The monitoring of marine waters encompasses a number of activities that can be subdivided into the following main groups:

- Eutrophication and physical conditions, including modelling of water and nutrient transport
- Species and habitats
- Hazardous substances and biological effects.

Generally speaking, these monitoring activities are performed in both coastal waters and in the open marine waters. The monitoring in the open marine waters is largely performed by the State, while the monitoring of coastal waters is carried out by the regional authorities. The monitoring activities relating to eutrophication and biological effects include:

- Physico-chemical conditions in the water column (profile measurements) – including nutrients and oxygen
- Plankton (both phytoplankton and zooplankton)
- Bottom vegetation
- Benthic invertebrates
- Sediment (including internal loading)
- Modelling of boundary conditions for selected coastal waters and of water and nutrient transport in open marine waters (also encompasses operation of three automatic marine buoys and three intensive marine stations)
- Modelling of coastal waters (including mass, salt and nutrient exchange with adjoining marine waters).

The monitoring activities relating to species and habitats focus on protected marine habitat types and monitoring of fish in a number of coastal waters, and include:

- Fish
- Soft bottom macrofauna
- Macroalgae and hard bottom fauna on stone reefs and so-called bubble reefs (i.e. submarine structures made by leaking gasses – Natura 2000 code 1180).

Monitoring of plankton, submerged aquatic vegetation and benthic invertebrates under the eutrophication programme will be incorporated when assessing the biodiversity of the Danish marine waters and the status of the marine habitats.

The monitoring activities relating to hazardous substances and biological effects include:

- Hazardous substances and heavy metals in sediment
- Hazardous substances and heavy metals in bivalves and fish
- Effects of antifouling agents from hull paints through investigation of the occurrence of sexual abnormalities in gastropods (imposex)
- Effects on fish and bivalves.

4.2.10 Species and terrestrial natural habitats

The **species** monitoring comprises either determination of population size or, more frequently, of distribution, and include:

- Birds and effects of birds in Tønder Marsh
- Birds in the Wadden Sea
- Seals in the Wadden Sea and the inner Danish marine waters
- Breeding populations of cormorants
- Selected species on the Danish Red List
- Status and trend for selected Danish plant and animal species on Annex II and IV of the Habitats Directive
- Birds pursuant to the Birds Directive.

In total, approx. 170 species are included in the species part of the subprogramme. These include mammals, birds, amphibians, fish, insects, snails, bivalves and plants.

Population size of species for which special areas of conservation (SACs) have been designated pursuant to the Habitats Directive and special protection areas (SPAs) have been designated pursuant to the Birds Directive are intensively monitored provided suitable operational methods are available. This is done by:

- Total counting (e.g. the ladyslipper orchid and the fen orchid)
- Transect surveys (certain marine bird species)
- Capture-recapture (houting).

Mapping of species distribution (extensive monitoring) is carried out in order to be able to assess whether the

distribution of a given species is stable, increasing or declining in Denmark, with the country being subdivided into 650 10 km x 10 km quadrants that are used as the basis for data collection.

The monitoring of **terrestrial natural habitats** primarily focuses on the habitat types that are prioritized in the Habitats Directive. The subprogramme encompasses eighteen of the non-forest habitats. In addition, 14 other non-forest habitats can occur as mosaics in the monitored habitat types and will therefore also be included during the random selection of test plots.

With each habitat type, monitoring is carried out at both extensive and intensive stations. The stations are located in the SACs, but also outside them. In selecting the habitat types and station locations, consideration has been given to ensuring good representation of the Habitats Directive's priority habitat types. Urban nature is consequently not included, but the subprogramme does encompass a minor programme for small biotopes in arable land.

The subprogramme includes monitoring of vegetation in the protected habitat types, including species that are listed as character species in the Habitats Directive interpretation manual. A number of more common plant species will therefore also be included in the monitoring.

The subprogramme will include:

- Description of the status of selected habitat types and assessment of their conservation status (area and distribution, structure, character species and function) and the trend therein
- Vegetation analyses and character species, soil chemistry, soil water chemistry and nitrogen content of shoots and leaves, mosses and lichens
- The main pressures (eutrophication, hydrology, changed land use, operational history, etc.)
- Charting the occurrence and distribution of the monitored habitat types within the SACs, as well as an extensive survey of their occurrence outside the SACs to establish a statistical basis for assessing their status. An initial assessment of the conservation status will be made, but no actual monitoring will be initiated in connection with the survey.

Ten of the terrestrial habitat types included in the Annex to the Habitats Directive are forest habitats (three priority habitat types). These are not yet encompassed by NOVANA. It is agreed that the Danish Forest and Nature Agency carries out a survey of forests to serve as a basis for including nature monitoring of forests at the midterm adjustment of the programme as per 1 January 2007.

4.2.11 The Nationwide Air Quality Monitoring Programme (LMPIV)

The programme consists of monitoring and model calculations of air quality with the focus being on health-related air pollution. The programme includes:

- Monitoring of air quality in the four largest towns: Sulphur dioxide (SO_2), nitrogen oxides ($NO_2/NO_{x)}$), particles (PM_{10} and to a lesser extent $PM_{2.5}$), lead, benzene, CO, and ozone (O_3)
- Monitoring of air quality in the four largest towns: The heavy metals arsenic, nickel and cadmium, and the PAHs (pursuant to coming directives)
- Monitoring of air quality in two background areas: Particles (PM_{10}), ozone (O_3) and nitrogen oxides (NO_2/NO_x)
- Monitoring of meteorological variables in the four largest towns in parallel with monitoring of air quality, which is necessary to enable assessment of the results of the air quality monitoring
- Use of monitoring data to validate and improve tools (models) to assess air pollution in Danish towns.

The assessment of air quality is performed using monitoring and model calculations. The monitoring in the four largest cities is carried out at monitoring stations established in cooperation with the regional/municipal authorities in question, which also contribute to the operating costs.

The monitoring in the subprogramme for background monitoring of air quality and atmospheric deposition is coordinated with the monitoring and model calculations performed in the present subprogramme.

4.3 Main changes in activities relative to NOVA-2003

Part 2 of the Programme Description explains for each subprogramme what changes have been made in NOVANA relative to NOVA-2003, both generally and in more detail.

Generally speaking, the main change is incorporation of the monitoring of species and terrestrial natural habitats and the greater priority accorded to aquatic nature. In addition, the Nationwide Air Quality Monitoring Programme has been incorporated in NOVANA. Concurrently, the monitoring of nutrients and hazardous substances in the aquatic environment has been reduced.

The programme has been focussed on meeting Denmark's international monitoring and reporting obligations in relation to the aquatic environment and nature. Consideration for monitoring obligations under the Water Framework Directive and the Habitats Directive has considerably influenced the content of NOVANA.

The main changes in each of the subprogrammes are summarized below.

4.3.1 Background monitoring of air quality and atmospheric deposition

The main changes in the subprogramme for background monitoring of air quality and atmospheric deposition relative to NOVA-2003 are:

- Changes in the monitoring frequency for gasses and particles at three monitoring stations such that the subprogramme will consist of diurnal measurements at three stations and weekly measurements at three stations
- Establishment of a monitoring programme for more detailed monitoring of ammonia concentrations and ammonia deposition on natural areas, including the establishment of two "mobile" monitoring stations
- Initiation of monitoring of selected hazardous substances
- Extension of model calculations with higher geographical resolution. For nitrogen the calculations have been extended to include calculations at the local scale for 20–30 selected areas (100 m x 100 m).

4.3.2 Point sources

The main changes in the subprogramme for point sources relative to NOVA-2003 are:

- At municipal wastewater treatment plants <1,000 PE, monitoring is now performed twice yearly instead of four times yearly
- The reporting frequency for sparsely built-up areas and stormwater outfalls has been reduced to every second year
- Intensive monitoring of stormwater outfalls has been reduced from three to two outfalls.

4.3.3 Agricultural catchments

The main changes in the subprogramme for agricultural catchments relative to NOVA-2003 are:

- Interview surveys and nutrient balances at farm level have been accorded greater priority
- Hydrological modelling has been accorded greater priority
- Analysis of pesticides in drainage water and watercourses has been discontinued
- One agricultural monitoring catchment has been discontinued.

4.3.4 Groundwater

The main changes in the subprogramme for groundwater relative to NOVA-2003 are:

- The number of groundwater monitoring sites subjected to the full programme has been reduced from 67 to 50. Concomitantly the number sites at which a reduced monitoring programme is carried out has been increased from 3 to 20
- The number of groundwater intakes in each groundwater monitoring site with the full programme has been increased from approx. 17 to 23. In addition, 22 of these have to be suitable for special analyses as compared with approx. 14 in NOVA-2003
- To facilitate monitoring of the quality of the youngest groundwater, 329 new shallow wells are being established
- The number of redox wells has been increased to a total of six
- The analysis programme for organic micropollutants has been reduced to only encompass the groundwater intakes already monitored at the groundwater monitoring sites
- The analysis programme for pesticides has been reduced to 34 substances as compared with 45 in NOVA-2003. The substances that have been deleted are those that have only been detected on very few occasions and only once at a concentration exceeding the limit value for drinking water
- The focus on the size and variation in the groundwater resource has been enhanced in NOVANA. Thus funds have been allotted to modelling of the size of the water resource for approx. 10 main catchments covering Denmark.

4.3.5 Watercourses

The main changes in the subprogramme for watercourses relative to NOVA-2003 are:

- Monitoring of "springs and spring brooks" has been discontinued
- Intensive monitoring of phosphorus transport has been discontinued
- Monitoring of pesticides in agricultural catchments has been discontinued
- The regional authorities have taken over operation of 22 national hydrometry stations with long time series from the Ministry of the Environment
- The number of stations at which the fauna index is measured annually has been reduced from 1,055 to approx. 450 (which is the original number of stations in the monitoring programme before 1998)
- The number of substance transport stations has been reduced by 5 to 179
- Ecological, physical and chemical quality elements have been added (water plants, fish, physical conditions, etc.) pursuant to the Water Framework Directive and the Habitats Directive
- A network of 50 intensive biological stations has been established.

4.3.6 Lakes

The main changes in the subprogramme for lakes relative to NOVA-2003 are:

- The number of intensive stations has been reduced from 31 to 23. These include 4 new reference lakes
- Catchment analysis has been discontinued in the intensive monitoring programme
- The fish fry investigations have been deleted from the intensive monitoring programme
- Monitoring of birds and benthic invertebrates has been added to the intensive monitoring programme
- The species and habitat elements have been accorded greater priority
- New extensive programmes have been established encompassing a large number of lakes
- The reporting strategy has been changed considerably in that the focus has been switched from reporting of the individual lakes to reporting of the lakes within a catchment or of a particular type.

4.3.7 Marine waters

The main changes in the subprogramme for marine waters relative to NOVA-2003 are:

Eutrophication and hydrography, etc.
The monitoring of eutrophication in coastal waters has been concentrated in fewer areas and stations. Stratification of the subprogramme has been strengthened such that level 2+ activities (corresponding to type areas) now supplement level 2 activities (corresponding to representative areas). The main changes are:

- The number of "representative" areas has been reduced from 40 to 34
- The number of fjords and coastal areas in which modelling is carried out has been increased from 6 to 11
- The number of intensive marine stations has been reduced from 16 to 14
- The monitoring of sediment chemistry now focuses solely on internal loading
- The monitoring of the benthic fauna in the open parts of the North Sea has been discontinued
- Summer monitoring cruises in the Skagerrak and the North Sea have been discontinued.

Biodiversity and habitats
In principle this is a new activity, even though plankton, submerged aquatic vegetation and benthic macrofauna have been included in the monitoring programme since 1988. The activity encompasses:

- Focussed monitoring of marine habitat types – a new activity as only the stone reefs were previously monitored systematically
- Species monitoring of fish has been added in seven marine areas
- The description of marine biodiversity is based on monitoring of marine habitat types and on the biological variables that are included in the monitoring of eutrophication.

Hazardous substances and biological effect monitoring
The main change in the monitoring of heavy metals and hazardous substances concerns the number of areas, stations and subsamples, and the monitoring frequencies, as summarized below:

1. The number of stations: Increased for sediment and bivlaves, but at lower frequency and with fewer subsamples
2. The number of subsamples: For sediment reduced from 2–4 to 1–2. For bivalves changed from 3 to 1-3.
3. Monitoring frequency: Monitoring of hazardous substances in the water phase has been transferred to the crosscutting screening programme. For sediment, monitoring frequency has been changed from twice per six years to once per 6 years.

Biological effect monitoring has been expanded to encompass bivalves and fish:

1. Bivalves: Cell damage in bivalves
2. Fisk (eelpout): Effect on reproduction/gender distribution and abnormalities in fish fry. Monitoring of the activity of detoxification enzymes in fish
3. Imposex: Monitoring frequency has been reduced from once annually to every second year. The number of stations has been increased from 21 to 33.

4.3.8 Species and terrestrial natural habitats

This is a completely new subprogramme with no similar activity under NOVA-2003. Thus this is the first time in Denmark that a coherent national programme has been established to monitor terrestrial species and natural habitats. The monitoring encompasses 28 Danish terrestrial habitat types, including all the habitat types designated as priority habitat types in the Habitats Directive. Monitoring of the aquatic habitat types is undertaken through other NOVANA subprogrammes. In addition, some 175 species will be monitored, including a very large proportion of the 96 species for which we have special responsibility, i.e. the species for which more than a fifth of the global population inhabits Denmark. Monitoring of other Habitats Directive species and habitat types takes place under other relevant subprogrammes.

4.3.9 The Nationwide Air Quality Monitoring Programme

This monitoring programme is new in NOVANA, but the monitoring was started as far back as 1981. The programme is intended to fulfil monitoring obligations under the EU Directives on air quality and provide information and knowledge about air quality in Danish towns.

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5 Responsibilities and organisation

5.1 General

NOVANA is carried out cooperatively by the Danish EPA, the National Environmental Research Institute, the Geological Survey of Denmark and Greenland, the Danish Forest and Nature Agency and the regional authorities in Denmark.

The National Environmental Research Institute has overall responsibility for implementation of the monitoring programme and for preparing the crosscutting scientific summary report to the Danish Parliament.

Figure 5.1 shows the decision-making structure in NOVANA, and Figure 5.2 describes the roles of the parties involved in the programme. Data flow is shown in Figure 5.3 and is detailed in Chapter 5.2.

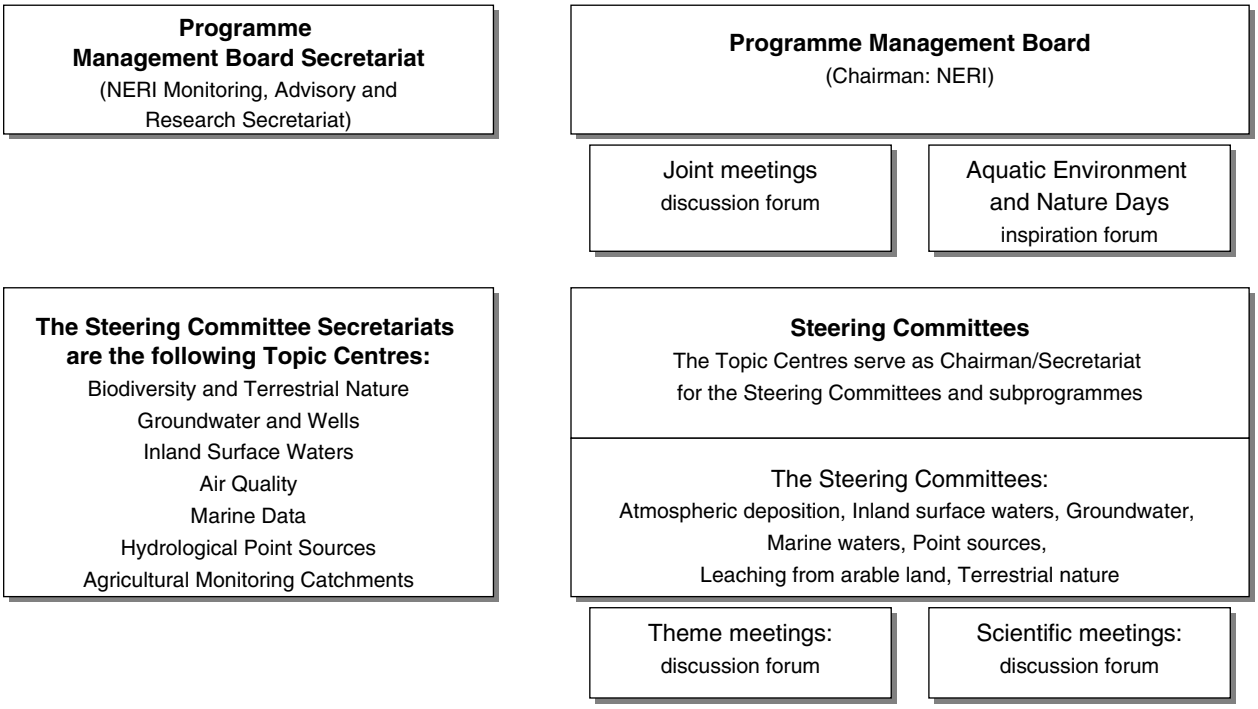

Figure 5.1 Decision-making structure in NOVANA.

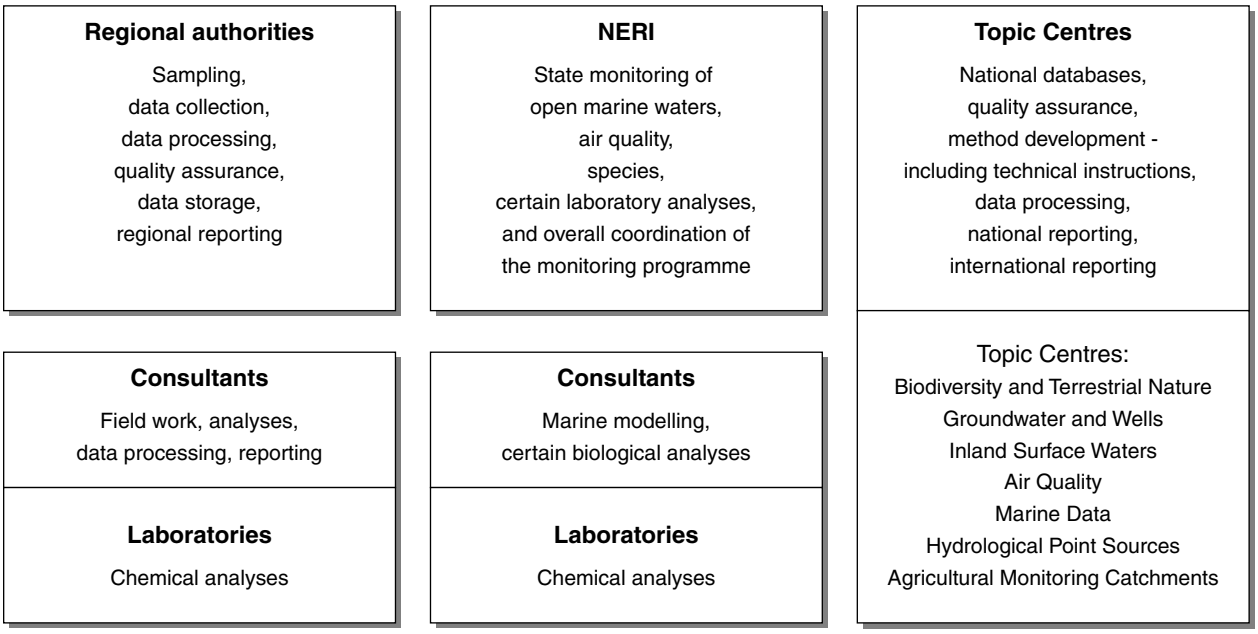

Figure 5.2 Roles of the parties carrying out NOVANA.

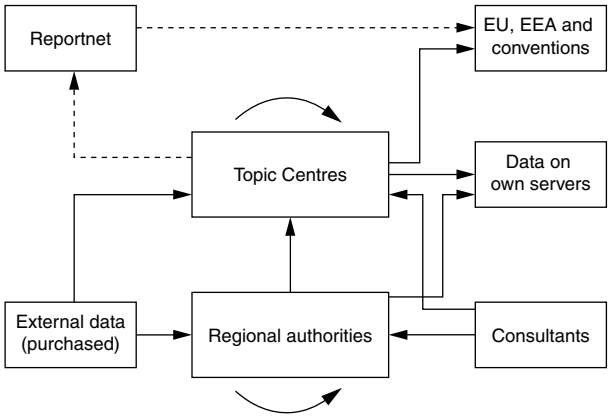

Figure 5.3 Data flow in NOVANA. The broken lines in Figure 5.3 indicate that it is presently only the Topic Centres in NERI that report to the EU initiative Reportnet/CiDeR (http://cdr.eionet.eu.int). The curved arrows indicate that data is exchanged internally, for example between Topic Centres.

5.2 Organizational aspects

To manage and coordinate NOVANA, a three-tiered organizational structure has been established:

- Programme Management Board
- Steering Committees
- Scientific and theme meetings.

The Programme Management Board has the same function within NOVANA as a Board of Directors in a company. The Programme Management Board shall ensure that the monitoring programme functions and is carried out as agreed.

The main task of the Steering Committees is to ensure operation of the individual subprogrammes. This is done in cooperation with the Topic Centres.

The scientific meetings are a forum for discussion of the scientific content of the programme, including adjustments to the programme.

The regular evaluation of the subprogrammes takes place in the Steering Committees and Programme Management Board. In addition, large parts of the programme will be subjected to an international evaluation during the programme period.

5.2.1 Programme Management Board

The Programme Management Board is responsible for the following tasks:

- Ensuring implementation of the programme
- Deciding all major changes upon the recommendation of the Steering Committees or the Programme Management Board Secretariat
- Approving all proposals for and adjustments to the paradigms for data transfer and reporting, including the time schedules
- Discussing and approving annual evaluations of monitoring activities, data transfer and reporting, including ensuring that the evaluations are carried out uniformly
- Discussing and approving all aspects of the programme that have economic consequences
- Making decisions about crosscutting regional activities and about NOVANA-financed research and development projects related to monitoring in the Topic Centres
- Preparing and undertaking evaluations and revisions of the overall programme
- Disseminating information on the monitoring programme.

The Programme Management Board Secretariat, which is located in the National Environmental Research Institute (Monitoring, Advisory and Research Secretariat), is responsible for:

- Preparing Programme Management Board meetings
- Disseminating Programme Management Board decisions to the involved parties
- Compiling and presenting the Steering Committees' contributions and recommendations concerning the annual evaluations of sampling, analysis, quality assurance and submission of data to the Topic Centres by the regional authorities
- Compiling and presenting the Steering Committees' contributions and recommendations concerning the annual evaluations of the reports by the regional authorities and Topic Centres and preparing the crosscutting scientific summary by the National Environmental Research Institute
- Drawing up proposals for the programme for the annual "Aquatic Environment and Nature Days" in cooperation with the Steering Committees
- Arranging the annual "Aquatic Environment and Nature Days" in cooperation with the Topic Centres
- Compiling collated drafts of the paradigms for reporting based on the contributions from the Topic Centres
- Drawing up and presenting recommendations for crosscutting regional activities based on the prioritised contributions of the Steering Committees and drawing up and presenting recommendations concerning NOVANA-financed research and development projects in the Topic Centres
- Keeping regular check on the programme finances
- Participating in subgroups under the Programme Management Board and presenting their contributions and recommendations.

The composition of the Programme Management Board is as follows (the number of representatives is given in parentheses):

- Danish EPA (1)
- National Forest and Nature Agency (2)
- Geological Survey of Denmark and Greenland (1)
- National Environmental Research Institute (3) – serves as Chairman and Secretariat of the Programme Management Board
- The regional authorities (4),
- Association of County Councils in Denmark (2)
- Copenhagen and Frederiksberg Municipalities (1).

It is presumed that the members of the Programme Management Board have the necessary scientific insight and authority to make decisions.

All matters concerning the monitoring programme's economy and overall operation have to be put before the Programme Management Board upon recommendation of a Steering Committee or the Programme Management Board Secretariat. The Board may only agree upon matters that extend beyond the time frame of the programme period in connection with revision of the programme. When the programme is to be revised, the Programme Management Board will appoint a Revision Committee to perform the revision on behalf of the Programme Management Board. The Revision Committee reports to the Programme Management Board and will consist of some members from the Programme Management Board supplemented with further representatives from the regional authorities and the National Environmental Research Institute, the Geological Survey of Denmark and Greenland, the Danish EPA and the Danish Forest and Nature Agency.

Changes to the programme during the programme period may not alter the objective of the monitoring programme. Moreover, the changes have to be described in accordance with the principles for the calculation of the programme's economy approved by the Programme Management Board (Programme Management Board, 1998). Changes in the activities of the regional authorities must be kept within the framework agreed upon between the individual regional authority and NERI.

The Programme Management Board can establish subgroups to deal with crosscutting technical matters. The subgroups report to the Programme Management Board and in principle consist of representatives from the regional authorities, the Topic Centres and the Programme Management Board Secretariat. Three permanent subgroups have been established, namely the Subgroup on analysis and quality assurance (AVA subgroup), the Subgroup on hazardous substances and the Subgroup on crosscutting data. The composition of the three subgroups is shown in Table 5.1.

Table 5.1 NOVANA – composition of the subgroups under the Programme Management Board.

Subgroup	Representatives (No.; Chairman and Secretary in the shaded boxes)					
	NERI	GEUS	DEPA	DFNA	Counties + RMB[1)]	Copenhagen + Frederiksberg Municipalities
Analysis and quality assurance (AVA-group)	5	1	3		1	
Hazardous substances[2)] (Interministerial group)	6	1	5		2	
Crosscutting data	5	2	1		2	

[1)] Regional Municipality of Bornholm

[2)] NERI Chairman; Danish EPA Secretary

The AVA subgroup deals with analytical questions and quality assurance of analysis results and sampling. The subgroup consists of representatives of the regional authorities, the Topic Centres, the reference laboratories, the NERI Monitoring, Advisory and Research Secretariat and the Danish EPA, the latter being responsible for selecting the laboratories.

The Interministerial subgroup on hazardous substances is responsible for assessing "new" hazardous substances that are potential candidates for monitoring and thereafter for making recommendations to the Programme Management Board concerning the substances for which screening investigations are to be performed. The Subgroup is comprised of representatives from the regional authorities, the Topic Centres, the relevant divisions of the Danish EPA and the NERI Monitoring, Advisory and Research Secretariat.

The Subgroup on crosscutting data is responsible for annually evaluating and making recommendations concerning common crosscutting data in NOVANA. The Subgroup consists of representatives from the regional authorities, the Topic Centres and the NERI Monitoring, Advisory and Research Secretariat.

The composition and responsibilities of the subgroups are described in detail in Part 3 of the Programme Description.

In order to ensure well-structured and understandable material for meetings in the Programme Management Board and Steering Committees, guidelines have been drawn up regarding the holding of meetings, the preparation of meeting material, deadlines for sending out material, minutes, address lists, lists of the members of the Programme Management Board and the Steering Committees and lists of addresses of the

persons and institutions that should be informed about meeting material and minutes. The Programme Management Board may regularly update the guidelines.

5.2.2 Steering committees

To ensure scientific coordination of the operation of the individual subprogrammes, Steering Committees have been established for:

- Atmospheric deposition
- Inland surface waters
- Groundwater
- Marine waters
- Point sources
- Leaching from arable land
- Terrestrial nature.

The Steering Committees are responsible for:

- Ensuring implementation of the subprogrammes
- Taking the initiative to hold scientific meetings arranged by the Topic Centres
- Considering all proposals for changes to the subprogramme, both scientific and economic
- Submitting proposals for changes to the Programme Management Board with a recommendation. If the recommendation is not unanimous, the opinions of the minority must be provided
- Approving minor changes to subprogrammes if they are cost-neutral and provided that prior delegation of responsibility from the Programme Management Board has been obtained
- Considering and recommending paradigms for theme reporting and other reporting to the Programme Management Board
- Carrying out uniform annual evaluations of sampling, analysis, quality assurance and submission of data from the regional authorities to the Topic Centres
- Carrying out standardized annual evaluations of the annual reports by the regional authorities and Topic Centres and of the crosscutting scientific summary report from NERI
- Proposing crosscutting regional initiatives
- Participating in the process regarding adjustment and revision of the programme, including the scientific prioritization and economic assumptions.

The Steering Committee Secretariats (the Topic Centres) are responsible for:

- Preparing the Steering Committee's meetings
- Disseminating the Steering Committee decisions and recommendations to the parties involved and to the Programme Management Board
- Preparing and drawing up programmes for scientific and theme meetings.

The composition of the various Steering Committees is shown in Table 5.2.

It is presumed that the members of the Steering Committees have the necessary scientific insight and authority to make decisions. As far as possible, each Steering Committee should contain at least one member of the Programme Management Board.

Table 5.2 NOVANA – composition of the Steering Committees.

Steering Committee	Representatives (No.; Chairman and Secretary in the shaded boxes)					
	NERI	GEUS	DEPA	DFNA	Counties + RMB[1)]	Copenhagen + Frederiksberg Municipalities
Atmospheric deposition	2		1	1	3	1
Inland surface waters	2		1	1	3	1
Groundwater		2	1		3	2 *
Marine waters	2		1	1	3	1
Point sources	1		2	1	3	
Leaching from arable land	2	1	1	1	3	
Terrestrial nature	2	1		1	3	1

1) Regional Municipality of Bornholm

* Of whom 1 is from Danish Water and Waste Water Association (Local Government Denmark).

Table 5.3 Composition of the Task Group on the marine model complex and the Steering Committee on STANDAT (see Section 7.2).

	Representatives (No.; Chairman and Secretary in shaded boxes)					
	NERI	**GEUS**	**DEPA**	**DFNA**	**Counties + RMB[1)]**	**Copenhagen + Frederiksberg Municipalities**
Task Group on the marine model complex	2		**	**	3*	1*
STANDAT ***	2	1	1	1	1	1

[1)] Regional Municipality of Bornholm
* The distribution between the counties, RMB and Copenhagen Municipality has not been settled
** Offered observer status
*** and the analysis laboratories: 1.

Under the Steering Committee for marine waters, a scientific Task Group on the marine model complex has been established with responsibility for a number of operational tasks. The Task Group reports to the Steering Committee. The tasks are described in Part 3 of the Programme Description. The composition of the Task Group is shown in Table 5.3 together with that of the Steering Committee on STANDAT.

The names of the members of the various committees and groups are provided in Part 3 of the Programme Description.

5.2.3 Scientific meetings, "Aquatic Environment and Nature Days", and theme meetings

The purpose of the scientific meetings, "Aquatic Environment and Nature Days" and theme meetings is to:

- Comprise a forum for scientific discussions of the programme's structure, results, time schedule and paradigms
- Discuss and evaluate proposals for changes to the programme, including the scientific and economic considerations.

The participants in the scientific meetings are the Topic Centres, the regional authorities, the Danish EPA, the National Forest and Nature Agency, the Geological Survey of Denmark and Greenland and the National Environmental Research Institute. External parties participate as required.

The scientific meetings are held at the initiative of the Steering Committees and arranged by the Topic Centres.

Aquatic Environment and Nature Days are held once yearly as a joint scientific meeting with the NERI Monitoring, Advisory and Research Secretariat as the arranger in collaboration with the Topic Centres and the regional authorities.

Theme meetings arranged by the Topic Centres are held to allow discussion of special issues among the parties involved.

Meetings between the Programme Management Board, the Topic Centres, the Steering Committees and the contact persons from the regional authorities are arranged at intervals by the NERI Monitoring, Advisory and Research Secretariat to allow discussion of special issues among the parties involved.

5.3 Areas of responsibility

The overall division of labour between the involved parties is stipulated among other places in Document 46 of 19 October 1987 (Ministry of the Interior, 1987). In connection with implementation of the programme the Programme Management Board has subsequently specified this in further detail and agreed upon specified guidelines aimed at promoting the routine cooperation between the parties involved.

5.3.1 Regional tasks

The regional authorities are responsible for carrying out the majority of the agreed monitoring of agricultural monitoring catchments, groundwater, watercourses, lakes, point sources and coastal marine waters, as well as the monitoring of species and terrestrial natural habitats. The regional authorities are also responsible for the quality of the sampling, analysis, data processing, data transfer and regional reporting (see Figure 5.2).

The regional authorities are responsible for the regional scientific reporting of the results of the monitoring of the aquatic and terrestrial environments . The content and extent of the reporting are described in the paradigms for the annual standard report and the theme reports, as well as in the agreements on oxygen deficit reporting.

For the operational period 2004–2009, a formal agreement has been entered into between the National Environmental Research Institute and the individual regional authorities concerning implementation of NOVANA.

5.3.2 Ministry of the Environment's tasks

The Ministry of the Environment's responsibilities under NOVANA encompass a number of administrative tasks pertaining to management and coordination of the programme, a number of specific scientific tasks and some special operational tasks (see Figure 5.2).

5.3.3 Administrative tasks

NERI holds the posts of Chairman and Secretary of the Programme Management Board. The NERI Monitoring, Advisory and Research Secretariat serves as Secretariat for the Programme Management Board and the NOVANA programme.

The workload in the Steering Committees, etc., is shared among the relevant Topic Centres (see Table 5.2 and Section 5.2.2).

NERI is responsible for the data coding and data exchange system STANDAT and for fact sheets for substances encompassed by NOVANA, and coordinates and runs the hydrological reference (see Chapter 7).

The Danish EPA is responsible for selecting the laboratories that are qualified to perform the analysis tasks under NOVANA. This is done on the basis of performance testing undertaken by the Danish accreditation body DANAK at the request of the Danish EPA. In the case of new variables, which first have to be quality-assured by method testing or in some other way, the capacity is limited to a few annual tests. This only applies to inorganic nutrients and hazardous substances.

5.3.4 Scientific tasks

The Ministry of the Environment has a number of Topic Centres whose responsibilities include preparing technical guidelines and proposals for paradigms for monitoring as well as proposals for scientific meetings/theme meetings and "Aquatic Environment and Nature Days". They are also responsible for the annual national scientific reports for relevant subprogrammes. The tasks are handled in collaboration with the regional authorities through the Steering Committee for each topic.

The Topic Centres are responsible for the collection, storage and quality assurance of the monitoring data at the national level. The collected and stored data shall always be at the disposition of and available to the parties involved for use in national and international reporting.

The following Topic Centres participate in NOVANA:

- Topic Centre for Marine Data (NERI)
- Topic Centre for Biodiversity and Terrestrial Nature (NERI)
- Topic Centre for Inland Surface Waters (NERI)
- Topic Centre for Groundwater and Wells (GEUS)
- Topic Centre for Hydrological Point Sources (Danish EPA)
- Topic Centre for Air Quality (NERI)
- Topic Centre on Agricultural Monitoring Catchments (NERI).

Since 2003, the Topic Centre for Hydrometry has been part of the Topic Centre for Inland Surface Waters.

The Topic Centres perform the following tasks in NOVANA:

- Method development for sampling
- Preparation of technical instructions for sampling and data analysis
- National data storage and data processing
- Preparation of scientific proposals for the Steering Committees
- Preparation of drafts for paradigms for subprogramme reporting
- Preparation of nationwide scientific reports of the subprogrammes
- Arranging scientific meetings and theme meetings and assisting with "Aquatic Environment and Nature Days" pursuant to decisions of the Programme Management Board and Steering Committees.

In connection with the Topic Centres, Task Groups have been established to discuss questions about data-related issues, including data and reporting obligations. Apart from the representatives from the regional authorities and institutions under the Ministry of the Environment, the Task Groups can also contain representatives from external actors. The newly established Topic Centre for Biodiversity and Terrestrial Nature will establish a scientific Task Group under the Centre. A number of interest organizations will be invited to participate pursuant to the Topic Centre's terms of reference, which are available in Danish on the NERI website.

In addition, the NERI Monitoring, Advisory and Research Secretariat is responsible for preparing the annual summary of the monitoring programme results.

5.3.5 Operational tasks

The National Environmental Research Institute is responsible for monitoring the open marine waters, for monitoring and calculation of atmospheric deposition in terrestrial and aquatic areas, and for part of the monitoring of terrestrial species. Some of these tasks are handled by consultants.

The Geological Survey of Denmark and Greenland is responsible for monitoring the size of the groundwater resource, while the regional authorities run the national network of stations for measuring the groundwater level.

6 Economy and resources

6.1 General

The NOVA-2003 and NOVANA activities carried out by the regional authorities are funded via government block grants. The size of these was agreed upon in 1987 in connection with adoption of the Action Plan on the Aquatic Environment. In addition, a number of the regional monitoring activities (environmental supervision) are included in the programme. The Ministry of the Environment's NOVANA expenses are allocated via the Government Budget.

6.2 Principles and assumptions

In connection with the 1997 revision of the monitoring programme a number of principles and assumptions were stipulated for determining how the individual NOVA-2003 activities should be costed, with the costs being set in 1996-prices (Danish EPA, 2000). This is a precondition for being able to compare costs across the programme.

The same assumptions were applied to NOVANA, although prices have been adjusted by 14% corresponding to the official price increase over the period 1996–2001 as NOVANA is costed in terms of 2001-prices. In cases where new analyses, new field methods and changed data processing or reporting in NOVANA are included, revised economic calculation assumptions have been agreed upon. As a consequence of an agreement between Danish Regions and the Ministry of the Interior, a higher labour cost rate is applied for those man-years used by the regional authorities over and above the man-years used for NOVA-2003 (referred to as compensation for extra man-years). It should be noted that the different regional authorities carry out the NOVANA tasks differently, which is why the calculation principles are not necessarily applied by the individual regional authority.

As discussed in Section 2.5, the overall economic framework is unchanged except for the inclusion of the Nationwide Air Quality Monitoring Programme (LMPIV). New activities in NOVANA are therefore financed through reprioritization within the programme.

Part 3 of the Programme Description, Chapter 3 explains in more detail some of the general principles and calculation assumptions pertaining to the financing of NOVANA. At the beginning of 2004, a summary will be prepared of the calculation assumptions applicable to NOVANA (see also Chapter 9.1).

Part 3 of the Programme Description, Section 3.1 describes the man-year prices, number of hours per man-year, what the overhead encompasses, etc.

6.3 Budget for the NOVANA subprogrammes

6.3.1 State financing

The Ministry of the Environment annual budget for NOVANA is DKK 51.7 million in 2001-prices (see Table 6.1). To enable comparison of NOVANA with NOVA-2003, the present activities concerning monitoring of species and terrestrial natural habitats and the Nationwide Air Quality Monitoring Programme (LMP IV) are included in the table. The figures for Ministry of the Environment financing of NOVANA are based on the known financial framework for 2005 as stipulated in the 2003 Government Budget.

The State runs a number of Topic Centres (see Chapter 5). With the subprogrammes for background monitoring of air quality and atmospheric deposition, marine waters, species and terrestrial natural habitats and the Nationwide Air Quality Monitoring Programme (LMP IV), the State itself carries out (part of) the monitoring activities. Operation of 22 water discharge stations with time series of up to 80 years is transferred from the State to the regional authorities as of 1st January 2004.

Under NOVA-2003, the marine modelling was financed from the Ministry of the Environment NOVA-2003 budget. Under NOVANA, the marine modelling is financed via the regional authorities' NOVANA budget (see Section 6.3.2 and Table 6.2).

A sum has been allocated for the development and description of the new methods, etc. that are to be used in NOVANA (see Section 7.8). In NERI, a sum has also been allocated to help purchase the necessary common data (see Section 7.7).

A sum has been allocated for coordination of the state activities in NOVANA, for running the Secretariat of the Programme Management Board and NOVANA, for the STANDAT Secretariat and for coordination of the hydrological reference, etc.

6.3.2 Regional economy

Reprioritization, including incorporation of new monitoring activities, is reflected as differences in the financing of NOVANA compared with NOVA-2003 (see Table 6.1 and 6.2). At the same time, major reprioritization has taken place within the majority of the subprogrammes in that a greater proportion of the resources is devoted to the nature elements in NOVANA. In all it is estimated that the nature elements in NOVANA account for approx. DKK 53 million, of which approx. 39 million is accounted for by the regional part of the programme.

Table 6.1 Ministry of the Environment financing of NOVANA compared with NOVA-2003 (man-years and total cost in DKK million per year in 2001-prices including operating expenses).

	NOVA-2003		NOVANA	
	Man-yr	**Cost (m DKK)**	**Man-yr**	**Cost (m DKK)**
Background monitoring of air quality and atmospheric deposition	9.7	11.1	10.8	9.5
Point sources	3.1	2.6	2.4	2.0
Agricultural catchments	2.4	1.8	2.3	1.7
Groundwater	2.6	1.9	2.3	1.7
Watercourses (including hydrometry)	6.1	5.1	5.7	4.1
Lakes	2.3	1.6	2.8	2.0
Marine waters	12.3	13.2	8.3	9.4
Species and terrestrial natural habitats	3.0*	6.0*	3.5	5.6
Nationwide Air Quality Monitoring Programme	8.8*	7.1*	9.2	7.7
Developmental tasks and crosscutting data	1.0	0.7	1.5	1.2
Coordination, Secretariat, STANDAT, marine buoys, etc.	4.5	6.8	4.5	6.8
Total	**55.8**	**57.9**	**53.3**	**51.7**

* Not included in the original economic framework for NOVA-2003, but included here to allow comparison with NOVANA.

Table 6.2 Regional authority financing of NOVANA compared with NOVA-2003 (man-years and total cost in DKK million per year in 2001-prices including operating expenses). Prices include VAT on operating expenses.

	NOVA-2003		NOVANA	
	Man-yr	**Cost (m DKK)**	**Man-yr**	**Cost (m DKK)**
Point sources	45.6	36.2	35.1	29.0
Agricultural catchments	13.3	16.8	11.7	13.6
Groundwater	17.1	30.6	17.2	25.2
Watercourses	26.7	29.7	31.0	28.9
Lakes	15.3	16.1	19.8	18.8
Marine waters	46.9	50.3	35.7	40.0
Species	0.0	0.0	0.0	3.0
Terrestrial natural habitats	0.0	0.0	19.5	12.7
Nationwide Air Quality Monitoring Programme		0.0		2.5
Marine model complex		0.0		4.2
Crosscutting activities		0.0		2.3
Crosscutting data		0.0		0.8
Total	**165.0**	**179.7**	**169.9**	**181.0**

The main differences between NOVANA and NOVA-2003 are described in Section 4.3. The majority of the subprogrammes have been reduced in order to release funds for the monitoring of species and habitats.

The subprogramme for species and terrestrial natural habitats and the Nationwide Air Quality Monitoring Programme in towns (LMP IV) are new in relation to NOVA-2003. They now comprise part of NOVANA, and it has been agreed that the LMP IV activities in Copenhagen Municipality are to be integrated in NOVANA. Relative to NOVA-2003, the total budget for NOVANA has therefore been increased by approx. half of the regional LMP IV budget for Copenhagen Municipality.

The regional budget includes VAT on operating expenses but not on man-years (see Table 6.2). The man-year cost takes into account the agreement that extra man-years relative to NOVA-2003 are to be calculated at a higher man-year price.

The budget for the subprogramme for watercourses takes into account that the regional authorities take over operation of 22 hydrometric monitoring stations for which long time series are available.

The marine model complex encompasses marine modelling by consultants, operation of three intensive marine stations and three marine buoys as well as calculation of nutrient transport from three large fjords.

Crosscutting activities refers here to activities of a crosscutting nature undertaken by the regional authorities. They are typically undertaken for one or two years and are prioritized once annually by the Programme Management Board (see Section 7.8).

Crosscutting data encompass the necessary external data that need to be procured in order to be able to make calculations and interpretations in connection with data processing, modelling and reporting. They are described in Section 7.7.

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7 General principles and methods and assumptions

The parties involved have agreed upon a number of principles and methods for implementing NOVA-2003 that also apply to NOVANA. Procedures have thus been agreed upon concerning:

- Storage of data and data transfer from the regional authorities to the Ministry of the Environment (Section 7.1)
- Data exchange format and code system for all variables (Section 7.2)
- Deadlines for data transfer (Section 7.3)
- A reference system for unique site identification to link data from different subareas (Section 7.4)
- Quality assurance, field and analysis methods (Section 7.5)
- Collection of fact sheets for the properties of chemical substances (Section 7.6)
- Procurement of the necessary external data, including climate data (Section 7.7)
- The extent, form and deadlines for reporting of the collected results (Chapter 8).

These aspects are discussed briefly here and in greater detail in Part 3 of the Programme Description. Responsibility for planning, maintaining and changing the various elements is described in Chapter 5.

7.1 Data storage and transfer

It is of vital importance to the monitoring that the collected and processed data can be exchanged safely and rapidly between the participating authorities and institutions. In order to ensure that all the involved parties can exchange data among themselves a common, standardised data exchange format, STANDAT, has been developed. The regional authorities use STANDAT to transfer the collected data to the respective Topic Centres.

Within their area, each of the state Topic Centres is responsible for maintaining up-to-date national databases containing quality-assured data. The databases are updated a minimum of once yearly. It is from the state databases that reporting is made to the EU, international conventions and organizations, etc. In addition, both the regional authorities and the state Topic Centres make data available to the public. Many data are currently available on Internet, especially a number of aggregated data, and primary data are also available via Internet or upon request. It is the aim of the NOVANA partners that data collected at the public expense should be available to the public. The strategy is for both the Ministry of the Environment and the regional authorities to make as many NOVANA data as possible available on Internet. At the same time it is important, among other reasons for use of the data in research, to ensure that the performed quality assurance of the individual data sets is clearly apparent. This will help ensure the exploitation of monitoring data for research purposes.

Topics related to data procedures are further explained in Part 3 of the Programme Description.

7.2 STANDAT

STANDAT is a standard for electronic exchange of data in the environmental area. Having a standard ensures that data can be exchanged safely and easily between the parties that collect and use the data. STANDAT concomitantly ensures that every variable and parameter can be clearly identified.

The STANDAT Steering Committee ensures that STANDAT is maintained and developed based on user needs. The STANDAT Secretariat carries out this maintenance (updating of code lists) and development of STANDAT. The STANDAT Secretariat is located in the NERI Monitoring, Advisory and Research Secretariat.

Detailed information about STANDAT is available on the Internet at:
http://www.dmu.dk/Overvågning/Standat/.

Consideration is being given to whether the STANDAT exchange format should be revised as XML (Extensible Markup Language) is expected to become a standardized exchange format in the future. Standardization work is being carried out within the State and it would be appropriate to follow this. With regard to the existing databases it will require considerable investment to fully convert from STANDAT to XML. Among other things, the data models and data exchange programmes will have to be modified/changed. It would be appropriate to establish preferably identical and at minimum coordinated data models in the regional authorities and the Ministry of the Environment for the individual subprogrammes. Common databases should also be considered for some subareas. In the case of new subprogrammes – for example species and terrestrial natural habitats – it has been decided to establish common data models from the start and to use XML as the exchange format.

Questions related to general data exchange formats and data exchange procedures in NOVANA are decided by the Programme Management Board. In the case of some data reported under NOVANA by the regional authorities the data exchange procedures are stipulated by law or statutory order or are agreed upon by groups outside the NOVANA cooperation.

Irrespective of the data exchange format, STANDAT will continue to be used as the coding system to

ensure unique identification of variables and parameters.

7.3 Deadlines for data transfer

The agreed deadlines for data transfer aim to ensure that the data can be quality-assured regionally and transferred to the Ministry of the Environment in time to meet international data reporting deadlines and the deadline for state reporting to Parliament, as well as to ensure the necessary quality assurance of data before the Ministry of the Environment reports are published.

A number of general deadlines have been set for data transfer from the regional authorities to the Topic Centres and from the State to the regional authorities and between the Topic Centres. It is assumed that prior to the deadlines for data transfer, all data have been quality-assured and have been received by the Topic Centres in such a manner that they are immediately available for data analysis and interpretation. The primary quality assurance is performed as close to the source as possible.

The Topic Centres control the submitted, quality-assured, regional data for transfer errors. In addition, the Topic Centres perform quality assurance based on the possibility for making some national comparisons and control procedures able to reveal errors that are not otherwise possible to detect. When errors are suspected, the Topic Centres contact the regional authorities to determine whether an error is a transfer error or an actual error in the data. In the latter case, the error has to be corrected at the regional authority as well as in the Topic Centre database. The Topic Centres do not allow access to the data until the quality assurance procedures have been performed.

Data are transferred to the Topic Centres each year for inclusion in the national databases. The data should preferably be submitted regularly in appropriate quantities and prior to the deadline. The amount, timing and means are decided upon by the individual subprogramme Steering Committees and are apparent from the annual paradigms for data transfer and reporting (See Part 3 of the Programme Description).

Part 3 of the Programme Description provides a detailed summary of the various deadlines for data submission. The most important deadlines are as follows:

- The general deadline for the regional authorities to submit error-free, quality-assured data from each calendar year to the Topic Centres is **1 May** the following year. In order to ensure time for quality assurance in connection with data transfer, a general deadline of **1 April** has been set for data submission to the Topic Centres. The following month is used to correct errors and deficiencies.
- The data submission deadline for terrestrial nature data is **1 December** for species data collected the same year and **1 February** for data on habitat types in general, although **1 April** for chemical analysis - results for data collected the previous year.
- No later than **three weeks following receipt** of data from the regional authorities the Topic Centre must report back about any errors and deficiencies in the submitted data. Hereafter the regional authorities have **four weeks** to submit corrected data. If the Topic Centres report back later than 1 April the deadline for submitting corrected/lacking data is **1 May**, though.

The deadlines for reporting are as follows:

- **1 May**: Standard reporting by the regional authorities, although **15 May** for reporting of scientifically focused issues
- **1 August:** The Topic Centre reports are submitted for a three-week hearing period among the NOVANA parties
- **1 September:** International data reporting
- **1 October:** Publication of the crosscutting scientific summary report and the Topic Centre reports.

With certain types of data, deviations from these general deadlines have been agreed upon. Moreover, deadlines have been agreed upon for data exchange between the Topic Centres. These deadlines are described in more detail in Part 3 of the Programme Description.

7.4 Hydrological reference

The hydrological reference system is used as a unique site identification to link data from different subareas.

The system is a precondition for optimal utilization of collected information, for example in order to be able to calculate discharges from point sources within the catchment to a lake, a watercourse station or a coastal area. The system does not presently function optimally and is therefore being revised. The NERI Monitoring, Advisory and Research Secretariat is responsible for coordinating the hydrological reference, while the task of maintaining and developing the system is the responsibility of the Topic Centre for Inland Surface Waters.

The hydrological reference system is used for the two following general functions:

- Linkage of monitoring data based on the geographic dimension as characterized by hydrological runoff of surface water to the sea
- As the geographical framework for a part of the "model-oriented" generation of data – especially diffuse inputs.

The link between sources and recipients is thus established via the hydrologic reference system in the monitoring programme.

The hydrological reference system is described in detail in Part 3 of the Programme Description. Any changes to the system will also be described there.

7.5 Technical instructions and quality assurance

As in NOVA-2003, NOVANA attaches considerable importance to the quality of the method, etc. used to obtain the individual measurements (sample collection, chemical analysis or monitoring of physical and biological conditions).

The technical instructions provide precise descriptions of such aspects as how samples are to be collected in the field, processed and possibly also analysed. To the extent that other descriptions and standard methods are publicly available, reference is often made to them.

The technical instructions are prepared and maintained by the Topic Centres. A precondition for being able to carry out an activity is that technical instructions including method descriptions have been prepared. Paradigms describe the coming year's activities in detail, including which data have to be submitted to the Topic Centres.

The requirements as to documentation of the quality of sampling and analysis are described in the memorandum "Krav til dokumentation af analysekvalitet (Requirements as to documentation of analysis quality)" in the technical guidelines and in the paradigms.

The chemical analyses have to be performed at laboratories accredited to perform the analyses such that they meet the applicable requirements as to detection limits, etc. To supplement this, the Danish EPA nominates laboratories that are qualified to analyse heavy metals, pesticides and other organic pollutants. This nomination is based on an evaluation of the laboratories' results upon performance testing or similar documentation for analysis quality. For a given analysis, laboratories have to be nominated no later than at the end of September if the analysis is to be included in the following year's programme.

Occasionally there may not be a laboratory that is accredited to perform a given analysis. During a transition period (until an accredited laboratory is available), the analyses are performed as non-accredited analyses. A precondition, though, is that the Danish EPA has the material necessary to be able to select laboratories for the analysis in question and that the selection process has been completed.

Part 3 of the Programme Description contains a list of substances specifying the heavy metals, pesticides and other hazardous substances that have to be measured in NOVANA as well as the requirements as to detection limits.

Quality assurance of the data beyond quality assurance of sample collection, chemical analysis and monitoring of physical and chemical conditions is being accorded greater priority under NOVANA through work aimed at establishing procedures for these aspects. It is important that the quality is high when Internet access is provided to the majority of data collected under NOVANA in the coming years.

7.6 Fact sheets

In connection with NOVA-2003, fact sheets were prepared for all the hazardous substances and heavy metals encompassed by NOVA-2003. The aim was to ensure a complete and up-to-date overview of their properties and coordinated collection of information on the substances.

The fact sheets contain an overview of the substances' chemical, toxicological and ecotoxicological properties as well as their known use and regulation. They are available at:
http://www.dmu.dk/Overvågning/NOVANA/Programbeskrivelse+del+3/Datablade+for+miljøfremmede+stoffer/.

The information contained in the fact sheets about the occurrence of the substances will be updated in the light of the NOVA-2003 and NOVANA results. Moreover, it is intended to prepare fact sheets concerning the new substances encompassed by NOVANA.

7.7 Crosscutting data

Various fundamental crosscutting data from external sources are needed in connection with evaluation and interpretation of the results of the various subprogrammes. Under NOVANA these data will be obtained through common agreements with external suppliers, who are the primary sources of these data. This ensures that the various actors use the same data foundation and that the data is used uniformly, among other means through the description of such aspects as how to use climate data to correct for climatic effects.

It has been agreed that the following crosscutting data is to be obtained:

- Climate and meteorological data via an agreement with the Danish Meteorological Institute (DMI)
- Data on farming practice, livestock herds and livestock density etc. from the Central Livestock Register (CHR) and the General Farming Register (GLR)
- Soil phosphorus status
- Data on land use (as orthophotos)
- Emissions from livestock housing.

Part 3 of the Programme Description contains a table of crosscutting data indicating how often these are to be obtained and describing what they are to be used

for and how they can be used in the individual subprogrammes.

7.8 Crosscutting activities

Crosscutting activities are activities a crosscutting nature undertaken by the regional actors in NOVANA. In principle, the crosscutting activities should encompass several subprogrammes and typically should not last for more than a year (possibly a few years). They are intended to provide knowledge about future monitoring strategies and reveal new knowledge before a decision can be made to incorporate an activity into the national monitoring programme (see Section 4.1.5). The crosscutting activities also encompass:

- Initial investigations in different media in connection with candidate substances for NOVANA – new hazardous substances (see Section 4.1.4)
- Control of analysis quality
- New unforeseen activities that are to be included in NOVANA.

Attempts have thus been made to ensure a certain degree of flexibility in NOVANA.

Once yearly in September the Programme Management Board will decide which crosscutting activities are to be accorded priority during the subsequent year in the light of proposals by the Steering Committees and a recommendation from the Monitoring, Advisory and Research Secretariat.

The state budget makes a small allocation for monitoring-related research and development projects in the Topic Centres. In order to ensure synergy among the regional actors in relation to the crosscutting activities, the Programme Management Board will also prioritise these activities in the light of a recommendation from the Environmental Monitoring Coordination Section. Research and development projects in the Topic Centres can include:

- Method testing and development in relation to NOVANA with subsequent preparation of a technical instruction
- Activities that support the build up of knowledge about future national monitoring
- Activities that support the crosscutting activities in NOVANA undertaken by the regional actors
- Activities that promote crosscutting and strategic aspects of NOVANA
- Activities that optimize the NOVANA programme.

8 Reporting

Each year the Government submits to Parliament a crosscutting scientific summary of the NOVANA results together with a political/administrative memorandum as its annual report on the state of the aquatic and terrestrial environments. The crosscutting scientific summary is prepared by NERI, while the political/administrative memorandum is prepared by the Danish EPA in cooperation with the Danish Forest and Nature Agency. As the basis for the scientific report the regional authorities prepare annual regional reports.

The general aim of the NOVANA reporting is to:

- Ensure an appropriate evaluation of the collected data so that the possible conclusions can be drawn concerning the environmental status of terrestrial habitats, water bodies and the groundwater, including the relationships between pressures and their effect on nature and the environment
- Ensure that the results of the monitoring programme are disseminated to the relevant target groups so that access to the results is rendered as easy and efficient as possible
- Contribute to evaluation of whether the politically adopted objectives have been met, and whether the measures implemented are adequate
- Contribute to the foundation for knowledge-based political decision-making on environmental policy issues.

The reports are aimed at informing Parliament, County Councils, Municipal Councils, organizations and other parties interested in the state of nature and the environment. The results and conclusions have to be easily understandable and thereby open for external scientific evaluation.

In addition to the annual standard reporting (Section 8.1), two crosscutting theme reports are prepared (Section 8.2), and the results of the marine oxygen deficit monitoring are reported in the form of a rapid report (Section 8.3).

8.1 Annual standard reporting

The standard reporting consists of a standardized indicator-based report and reporting of 1–3 selected scientifically focused issues of 4–6 pages for each subprogramme.

The standard reporting is performed annually at three levels:

1. The reporting by the regional authorities encompasses a presentation and technical/scientific evaluation of the results of the monitoring of species, habitat types, agricultural monitoring catchments, groundwater, watercourses, lakes, point sources and marine waters within each regional authority's geographical area of responsibility
2. The nationwide reporting by the Topic Centres encompasses a technical/scientific evaluation of the results of the monitoring of species, habitat types, agricultural monitoring catchments, groundwater, watercourses, lakes, point sources, marine waters and atmospheric deposition.
3. The National Environmental Research Institute prepares a crosscutting scientific summary report of the results of the monitoring of species, habitat types, agricultural monitoring catchments, groundwater, watercourses, lakes, point sources, marine waters and atmospheric deposition.

Each indicator presentation consists of 1–2 figures or tables and a brief but precise scientific explanation. The indicators are structured systematically.

Access to explanatory aspects can be ensured through links to notes, technical instructions, background data, etc. on the Internet.

8.2 Theme reporting

Two theme reports will be published in which the monitoring results will be evaluated across the NOVANA subprogrammes. These will be based on the water and chemical cycles and the resultant pressures on ecological conditions in habitat types and in the aquatic environment:

2005: Hazardous substances and heavy metals
2007: Nutrients.

8.3 Oxygen deficit reporting

The oxygen deficit reports are published at fixed intervals during the "oxygen deficit period" (August–November). The Topic Centre prepares nationwide maps indicating the measured oxygen concentrations and the extent of any areas affected by oxygen deficit.

8.4 Deadlines and publication

The annual reports by the regional authorities must be available by 1 May the following year, while the scientifically focussed issues must be reported by 15 May. The reports by the Topic Centres are published on their websites on 1 October.

The crosscutting scientific summary report is published on 1 October, both electronically on NERI's website and as a printed edition. An English translation is also published.

The Theme Reports are typically published in paper form and on the website of the responsible institution, to which a link will be established from the Monitoring, Advisory and Research Secretariat's website.

9 Adjustment and revision of NOVANA

NOVANA starts on 1 January 2004. During revision of NOVA-2003 and the planning of NOVANA it became clear that it would be necessary to adjust NOVANA within the six-year period for which the programme had been agreed.

In connection with the Water Framework Directive, work is going on to arrive at a common understanding and interpretation of the monitoring obligations. This can entail a need to adjust NOVANA. The ongoing work within the EU concerning the Habitats Directive can also entail a need for adjustment. In addition, monitoring of forest habitats is to be included in NOVANA from 1 January 2007.

During the course of 2005 and 2006, NOVANA will therefore undergo adjustment/minor revision with effect from 1 January 2007 (see Table 9.1).

There is a need for new knowledge about the development of monitoring programmes and the incorporation of new requirements. The crosscutting regional activities and the monitoring-related research and development projects in the Ministry of the Environment institutions are intended to provide new knowledge about monitoring-related elements before they can be incorporated in a monitoring programme. Resources for other research and development lie outside the programme. Monitoring-related knowledge is generated from research at universities, sector research institutes and other institutions. Relevant parts of this knowledge will be incorporated in connection with major revisions of the programme.

Cooperation has been established between the sector research institutions within the Ministry of the Environment and the universities through MSc and PhD projects, where the use of data from the monitoring programme often plays a central role.

The next major revision of the programme will begin in autumn 2007 and run to the beginning of 2009 such that a revised NOVANA can enter into force from 1 January 2010.

9.1 Plan for adjustment and revision of NOVANA

The Programme Management Board has agreed on a plan and timetable for the forthcoming adjustment and revision of NOVANA. This is described below and summarized in Table 9.1.

General principles

- NOVANA runs over the period 2004–2009. The overall timetable for NOVANA with an adjustment per 1.1.2007 and a revision of the programme for the period after 2009 is shown below. As of 1.1. 2007, NOVANA will be adjusted to incorporate the consequences of monitoring obligations pursuant to the Water Framework Directive and the Habitats Directive, experience gained with monitoring the terrestrial environment, surveying habitat types in forests, etc.
- New activities may only be initiated by either reprioritizing within the existing budget or by procuring the necessary additional resources
- In autumn 2003, the Programme Management Board agreed the form and plan for regular external evaluation of NOVANA
- The role of the Revision Committee and the Steering Committees in the adjustment and revision of NOVANA is explained in Part 1 of the Programme Description (Section 5.2).

Table 9.1 Timetable for adjustment and subsequent revision of NOVANA.

Name	Year	Program/activities
	1989–97	Nationwide Monitoring Programme under the Action Plan on the Aquatic Environment
NOVA-2003	1998–2003	The Danish Aquatic Monitoring and Assessment Programme 1998–2003. In 2003, agreement was reached on the monitoring programme after 2003
NOVANA	2004	1.1: Start of NOVANA Transition year with NOVA-2003 reporting of 2003 data and a theme report
	2005	Autumn: Start of work on adjustment of NOVANA
	2006	September: Approval of programme adjustment per 1.1.2007
	2007	1.1: Start of adjusted NOVANA Autumn: Completion of adjusted state and overall regional inventory of monitoring requirements
	2008	Early: Revision of NOVANA starts in the Revision Committee Autumn: Framework of the subprogrammes is settled, and a final draft of the subprogramme content is completed
	2009	March: Programme proposals to be negotiated with the regional authorities June: Programme Management Board approves the agreements with the regional authorities
New programme period	2010	1.1: Start of revised NOVANA for the period 2010–15 with a new six-year programme period Transition year with NOVANA reporting of 2009 data and a theme report

Economic assumptions:

- No transfer of resources will occur between the regional authorities and the Ministry of the Environment in a future revision
- The distribution of tasks between the regional authorities and the State may be altered within the agreed economic framework
- For the individual regional authorities, resource neutrality is assumed in relation to NOVANA, although with a certain degree of flexibility; the extent of this is to be agreed prior to the revision of NOVANA
- As of 1.1.2004, an overall set of economic calculation assumptions will be drawn up that also encompass the new areas of NOVANA
- In 2004, the Programme Management Board will carry out an analysis of all economic calculation assumptions and decide how the result of this can be used in the revision of NOVANA after 2009. The midterm evaluation of the programme will employ the economic calculation assumptions that were applied in the revision of NOVA-2003. However, the economic calculation assumptions for data processing, modelling and reporting will undergo final evaluation based on the experience gained in 2005–06
- In cases where man-year usage by regional authorities exceeds that assumed in the agreement on the NOVA-2003 programme, the excess is to be costed in the regional budgets at the man-year rate agreed between the parties
- It is agreed that possible renewal of regional monitoring vessels can be discussed at the next revision and be included in the economic calculations. Maintenance of ships and other equipment is part of overhead on the salaries
- In good time prior to the revision of NOVANA that will enter into force on 1 January 2010 an evaluation is to be made of the advantages and disadvantages of the crosscutting regional pool for crosscutting activities and data and the marine model complex in the programme for 2004–09. Moreover, a framework for future crosscutting pools is to be established. If the size of the pool is reduced or it is closed, the funds are to be returned in accordance with the block grant distribution key on which the pool is based.

9.2 Principles for evaluation of NOVANA

In order to ensure openness about the NOVANA programme, the Programme Management Board has established a set of principles for evaluation of the programme. In contrast to NOVA-2003, no overall evaluation of the programme will be made, but instead the subareas/topics under NOVANA will be regularly evaluated.

The evaluation of NOVANA is to be independent and international and will be carried out by asking the European Environment Agency to select relevant experts with international insight into monitoring. The evaluation will be initiated after the programme has been in operation for a couple of years in order to gain experience with NOVANA and thereby prepare the foundation for the evaluation. It is proposed that the evaluation should be conducted in 2006, 2007 and 2008. The evaluation has to be completed sufficiently early to enable it to be included in the revision of NOVANA, and the last evaluation thus has to be available by early 2008 at the latest.

The evaluation is financed 50% from the crosscutting pool and 50% as a state contribution.

The marine monitoring and groundwater monitoring have been changed considerably relative to NOVA-2003, among other things in relation to the extent and content of modelling, thus making an evaluation relevant. Monitoring of species and terrestrial natural habitats is a new element of the national monitoring and should be evaluated at the end of the programme period, when experience has been gained, in order to facilitate optimization of the monitoring in the subsequent programme period.

Experience with hazardous substances was insufficient to enable an evaluation to be performed in NOVA-2003, but it is considered relevant to perform a crosscutting evaluation of the monitoring activity at the end of the monitoring period.

The following preliminary plan has been drawn up for the evaluation:

2006: Groundwater. Modelling and reporting
2007: Marine waters. Modelling and reporting
2008: Hazardous substances, species and habitats.

Once yearly the Programme Management Board will discuss whether the plan needs to be adjusted/changed.

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This report is Part 1 of the Programme Description of NOVANA – the Nationwide Monitoring and Assessment Programme for the Aquatic and Terrestrial Environments. Part 1 comprises a general description of the background for the programme, including the international obligations and requirements for monitoring of nature and the environment. The overall objective and the scientific and strategic background for the priorities upon which NOVANA programme is based are described, as are the organization of the programme, the overall economy and the technical assumptions made. Finally the scientific content of NOVANA is outlined. The content of the programme is described in detail in Part 2 of the Programme Description, while technical appendices are given in Part 3.

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