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Local environmental impact

Local nature system data availability and local characterization modelling

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Contents

Background and purpose

This study is divided in two major parts; an inventory of the available information sources for local nature system data in Sweden and an overview of the needs of nature system data for local adaptation of impact assessment tools and methods.

The study is a result from the CPM project IMPRESS (IMPlementation of integRated Environmental information SystemS). It is a pre-study for the activity "Development of strategies for continuous data acquisition" in the "General methodology development" subproject.

The intended application of the data is for local adaptation of impact assessment models which will be made in the "Environmental management at site and group level" subproject of IMPRESS. The local impact assessment models can be used for life cycle assessment (LCA), in environmental management systems (EMS) or for other suitable purposes.

The today available impact assessment methods have only modelled the effects on the macro scale, i.e. for the whole geographical area that the method is valid for. The Swedish method EPS 2000 has a global range and the models are thus on a global scale the Danish method EDIP has a European range and the models are on a European scale etc. Information about the environmental impacts on a global scale is seldom enough for an industrial company, as local environmental impacts from the company's activities are what most concerns stakeholders such as local authorities, neighbors and NGOs.

Nature system data

With nature system data is meant data about the nature and changes in the nature conditions, in opposition to technical and social system data that lies outside the scope of this study. An example of a nature system data source is the Swedish Species Information Centre[1] (ArtDatabanken) which contains lists of endangered species, their habitats and the main cause to why they are threatened.

Technical system data is data about products, services or production processes for which the source is generally the company itself. An example of a technical system data source (outside the scope of this study) is the Swedish pollutant release and transfer register[2] (Kemikalieutsläppsregistret).

Social system data is data about prioritizations between different environmental problems. This data is the subjective observations and valuations of people. An example of a social system data source (outside the scope of this study) is the official statistics

[1] http://www.artdata.slu.se/
[2] http://www.naturvardsverket.se/kur/

provided by the National Board of Health and Welfare[3] (Socialstyrelsen) about health and disease, health care and medical services and care of individuals and families.

The figure below describes the relations between the three types of data that is needed to make an impact assessment of a human activity.

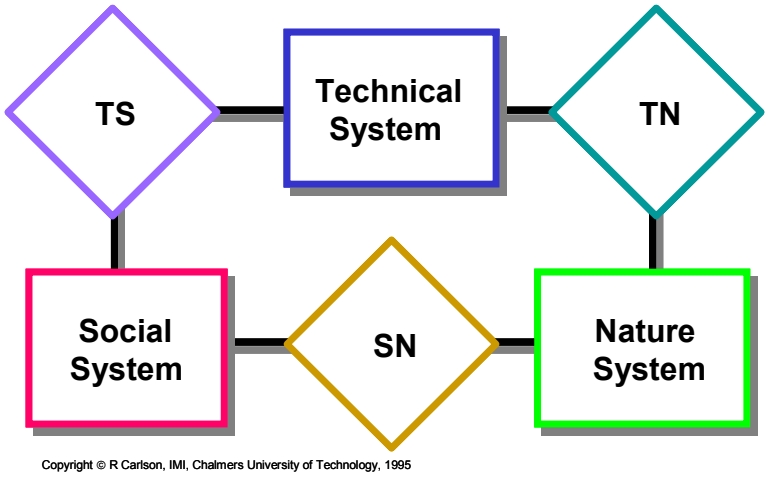

Figure 1 is a conceptual model that describes the three different origins of environmental information. The Technical system represents information that describes industrial processes and systems of such processes, i.e., data from engineering disciplines. The Nature system represents information that describes nature or other human living spaces, i.e., data from ecological disciplines. The Social system represents information about the non-physical aspects of human beings, i.e., data from humanities disciplines.

[3] http://www.socialstyrelsen.se/

Inventory of nature system data sources

As the intended application of the data is for future local adaptation of impact assessment models, the scope for the inventory is continuous data sources. With continuous data sources is meant that the data collection is continuous. The data sources must also be publicly available to be considered interesting as a source for impact assessment. Data can either be downloaded directly from a web site or deliveries are made on demand, and sometimes an administrative fee must be paid. The geographical scope of the inventory is Sweden, and as example for the regional and municipal data sources is chosen the Gothenburg region.

The inventory shall by no means be seen as a complete list of the sources for nature system data in Sweden but the results of a three week project in Spring 2005. The data quality of the different sources has not been assessed, more than that the availability of the data is sufficient. An aggregated list of all inventoried Swedish information sources and references to where to find them is provided in Swedish in Appendix I.

Swedish Environmental Monitoring Programme (Miljöövervakningen)

National monitoring programme

The national monitoring programme is a system for continuous documentation of the state of and change in the environment, divided in ten different program areas:

- Air
  Air pollutants and precipitation
- Sea and coastal areas
  Stock size, brood size and hazardous substances in marine fauna
- Freshwater
  Physical, chemical and biological parameters in freshwater
- Mountains
  Changes in vegetation and species, hazardous substances in fauna
- Forests
  Soil, soil chemistry and changes in vegetation and species
- Agriculture
  Nutrients and pesticides in surface water and groundwater
- Health related environmental monitoring
  Exposure from air and food, allergic responses
- Landscape
  Landscape structure, land use and biodiversity
- Wetlands
  Wetland conditions and biodiversity
- Toxic substances coordination
  Screening and specimen banking

The program areas are in their turn divided in subprograms, see Appendix II (only in Swedish). The assignment of funds for the national monitoring programme is made by

the Swedish Environmental Objectives Council at the Swedish EPA, and was 132 million SEK in 2005[4]. The execution of the surveillance is commissioned to other parties, e.g. universities, consulting agencies, research institutes or other authorities. Eight of the parties also function as "data hosts":

- Swedish Meteorological and Hydrological Institute (SMHI)
- IVL Swedish Environmental Research Institute
- The Geological Survey of Sweden (SGU)
- The Swedish University of Agricultural Sciences (SLU)
- The National Board of Fisheries
- Department of Systems Ecology, Stockholm University (SU)
- The Institute of Environmental Medicine, Karolinska Institutet (IMM)
- Swedish Institute for Infectious Disease Control (SMI)

Figure 2 below shows a graphical description of the national monitoring programme.

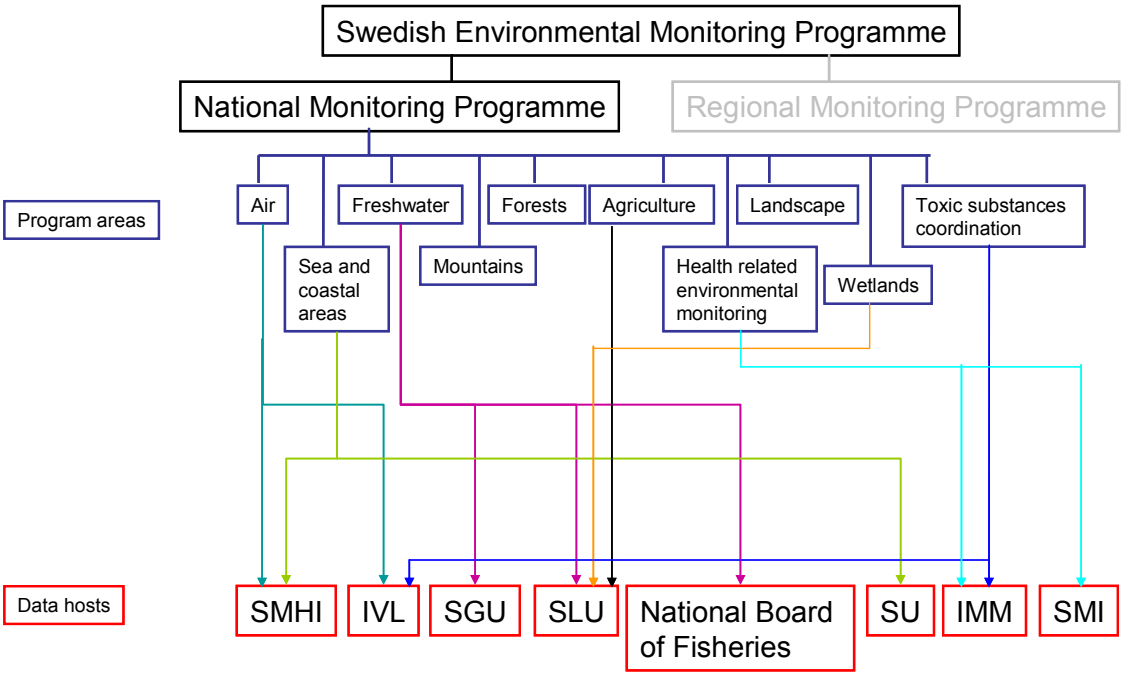

Figure 2. The national monitoring programme and the data hosts. The program areas that have no arrows connecting them to a data host store the data at the local County Administrations.

The data hosts are responsible for collecting, storing, quality reviewing, aggregating and administering the data. The Swedish EPA has developed guidelines for planning and design of monitoring activities[5] and also quality directives for the data management[6].

[4] Naturvårdsverket; "Samordnad miljöövervakning i Sverige (version 2005)"; http://www.naturvardsverket.se/dokument/mo/modok/export/nymo2005.pdf
[5] http://www.naturvardsverket.se/dokument/mo/hbmo/del1/plan/upplagg4.pdf

They are obliged to deliver data on request in exchange for an administrative fee for non-commercial interests, and for payment for commercial interests. See Appendix III for more specific information about format and links.

Some of the data hosts (SMHI and SGU) keep their data centrally available in the database MiljöDataSök, which is publicly available on the internet[7]. Here data from the national monitoring programme can be found with different search criteria, e.g. data host, chemical or physical variables and drainage areas. Other data hosts plan to make it available there in a short time (IVL, SLU). The data from the national monitoring programme is also used for international reporting, to the EEA and other authorities, with supplementing additions from the regional monitoring programme.

More information about the national monitoring programme can be found at the Swedish EPA website[8].

Regional monitoring programme

The Swedish EPA is also responsible for coordination of the regional monitoring programme, which is independently performed by the County Administrations[9] (Länsstyrelser). The County Administrations coordinate the different activities in the county performed by Regional Forestry Boards, Air and Water Conservation Societies, municipalities and other local authorities, industries and NGOs.

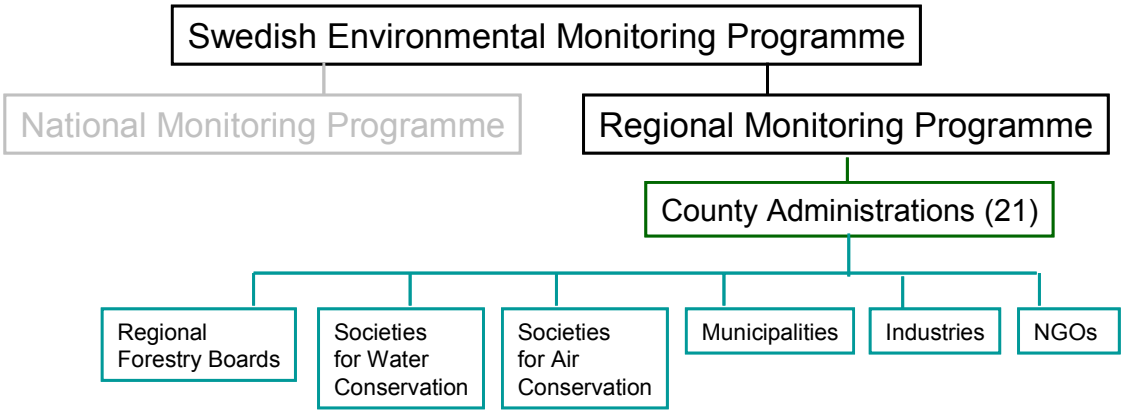

Figure 3. The regional monitoring programme. The data is stored at the County Administration or at the original data source. There are 21 County Administrations in Sweden, one for each county.

There is no gathering of the regional data at national level, the County Administrations produce annual reports to the EPA with qualitative descriptions of the work that they have performed, but quantitative data is not included there. The aim with the regional

[6] Naturvårdsverket; ”Naturvårdsverkets kvalitetssystem för samordnad miljöövervakning”; http://www.naturvardsverket.se/dokument/mo/modok/export/kvalsystem.pdf
[7] http://www.naturvardsverket.se/miljodatasok/start.jsp
[8] http://www.internat.naturvardsverket.se/index.php3?main=/documents/issues/monitor/monitor.htm
[9] http://www.lst.se/

monitoring programme is to provide information about the state of the environment to the citizens of the Counties. The national data hosts do not yet provide reporting and presentation of the data on regional basis and the Counties do therefore not see enough benefits for them to make it worth the cost of delivering their data. EPA encourage the Counties to deliver as much data as possible to the national data hosts, but all data is still not transferred due to lack of money, time and mismatching data formats and nomenclatures. This means that data produced within the regional monitoring programme is spread out on the respective Counties and the national data hosts. There is currently no reference register of all the data kept in the different databases[10].

The County Administration of Södermanlands län is responsible for the database DMN (Databas för Miljö- och Naturvård) in which the data from the regional monitoring programme was previously supposed to be gathered[11]. The thought of keeping one big database with all data from the Counties has now been abandoned by the EPA, but is thus kept on in Södermanlands län[12].

The assignment of funds for the regional monitoring programme is made by the Swedish Environmental Objectives Council at the Swedish EPA, and was 23 million SEK in 2005[13]. More information about the national monitoring programme can be found at the Swedish EPA website[14].

Swedish Meteorological and Hydrological Institute (SMHI)

SMHI, Swedish Meteorological and Hydrological Institute[15], is the national data host for atmospheric air and marine data. In addition to administering the data from various measurement stations, SMHI runs the subprogram Sverigemodellen which is a model for calculation of dispersion and downfall of air pollutants. The model divides Sweden in sections and calculates values also where there are no measurement stations with the MATCH (Mesoscale Atmospheric Transport and CHemistry) model[16]. For air pollutants there is thus measured or modelled data covering the whole country. The calculations are based on data from Nordic EMEP[17] stations and the Swedish Luft och Nederbördskemiska Stationsnätet.

SMHI has also developed a web based tool for assessment of air quality in areas close to roads (SIMAIR)[18] together with the Swedish Road Administration, the Swedish EPA, the Swedish Energy Agency, University of Stockholm and IVL Svenska Miljöinstitutet AB.

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[10] Interview with Anders Foureaux, Miljöövervakningen, Swedish EPA.
[11] Interview with Susanne Vävare, Miljöövervakningen, Swedish EPA.
[12] http://www5.d.lst.se/
[13] http://www.naturvardsverket.se/index.php3?main=/dokument/mo/modok/reg_utv/regutv.htm
[14] http://www.internat.naturvardsverket.se/index.php3?main=/documents/issues/monitor/monitor.htm
[15] http://www.smhi.se/
[16] http://www.smhi.se/sgn0106/if/meteorologi/match.htm
[17] Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air pollutants in Europe, http://www.emep.int/
[18] http://simair.smhi.se/

The Swedish University of Agricultural Sciences (SLU)

SLU, the Swedish University of Agricultural Sciences[19] is the national data host for agricultural, wetland and inland water data. In addition, SLU has been commissioned to run the work with the Swedish Species Information Centre (ArtDatabanken) together with the Swedish EPA. The Swedish Species Information Centre's main tasks are to collect, evaluate and store the most important information about threatened and rare plant and animal species. A basic part of this work is to assess the types and degrees of threat, and to prepare the national Red List and Red Data Books. In the Red Lists every species is described with Red List Category and their occurrence in different administrative provinces.

IVL Swedish Environmental Research Institute

IVL Swedish Environmental Research Institute [20] is the national data host for air pollution and toxic substances in biota. The data is presented for each measurement station in the form of maps and reports. IVL is also commissioned by the Swedish government to run a competence centre for effects of discharges of oil and chemicals. An atlas is being constructed that informs about particularly sensitive areas.

The Swedish National Atlas (SNA)

The Swedish National Atlas[21] is the official thematic map office in Sweden, operated by Lantmäteriverket[22]. Six Swedish authorities are participating in the work; the Swedish EPA, Statistics Sweden (SCB), Riksantikvarieämbetet, the National Board of Forestry, the Geological Survey of Sweden (SGU) och Lantmäteriverket. SNA provides books, the GIS based PC-Atlas, the WebAtlas and a Swedish Gazetteer[23]. The themes are Work and leisure, Population, Geology, Climate, lakes and rivers, Environment etc. Under the theme Environment can be found information about acidified lakes, distribution of rare species, occurrence of heavy metals in animals etc., presented graphically with maps.

The Swedish Radiation Protection Authority, SSI

The Swedish Radiation Protection Authority[24] has the responsibility to follow up the environmental objective "A Safe Radiation Environment". A database with radiation environment data is currently being built up. Information about radiation doses, content of cesium-137 in different species etc. can be found.

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[19] http://www.slu.se/
[20] http://www.ivl.se/
[21] http://www.sna.se/
[22] http://www.lantmateriet.se/, Lantmäteriet provides the Swedish society - the public and private sectors, the general public and a wide range of other users - with geographic information in the form of maps, aerial photography and satellite imagery.
[23] Ortregistret in Swedish.
[24] http://www.ssi.se/

The County Administration of Västra Götaland

The County Administrations[25] are responsible for coordination of the regional monitoring programme in the county. The information from the regional environmental monitoring is intended to be used to provide information to the County citizens and also for environmental impact assessments[26]. The environmental impact assessments are performed when companies and other organizations plan to start or enlarge activities or measures that may have detrimental impact on the environment and require a permit[27].

In the County of Västra Götaland, data is stored at the County Administration and/or at the national data hosts, in Excel or Access format. The data is public and delivered for free on demand. In addition, there is data about marine and fresh water conditions stored at the water conservation societies of the Bohus Coast, Göta Älv etc.[28] A list with all the water conservation societies in the County of Västra Götaland is found in Appendix IV.

Several organizations participate in the data collection for the regional environmental monitoring, and data can also be retrieved directly from them. For example there is a Gothenburg Region's Air Quality Programme[29] which is based on work co-operation between the local councils and companies in the region, also including the counties of Västra Götaland and Halland, Chalmers University of Technology, and the University of Gothenburg.

Göteborgs stad

Miljöförvaltningen[30] is the municipal body with responsibility for the follow-up of the environmental goals of the city of Gothenburg and for informing the citizens of the municipal environmental condition in Göteborg, and performs local inventorying and monitoring of air, water and ground. Some examples are monitoring of beaches and inventorying of polluted land areas. Both measured and calculated data is used. The data is stored at Miljöförvaltningen and published in reports.

Miljöförvaltningen runs the biodiversity database ADA[31] (Göteborgs artdataarkiv) which contains information about the biodiversity and red listed species in the municipality of Gothenburg. The air quality measurements are performed cooperatively with the Gothenburg Region's Air Quality Programme (see above). Miljöförvaltningen offers an on-line service called Luftnet[32] with reports on weather and air quality in Gothenburg.

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[25] Länsstyrelser in Swedish, http://www.lst.se/
[26] Miljökonsekvensbeskrivning (MKB) in Swedish.
[27] The Swedish Environmental Code, http://www.sweden.gov.se/content/1/c6/02/28/47/385ef12a.pdf
[28] Interview with Katrina Envall, Miljöövervakningen, Länsstyrelsen Västra Götaland.
[29] http://www.gr.to/luftvardsprogrammet/
[30] http://www.miljo.goteborg.se/
[31] http://www.miljo.goteborg.se/sub/info/ADA_-_information___rad/ada_-_information___rad.htm
[32] LUFTNET: http://www.miljo.goteborg.se/luftnet/

Non-continuous data sources

Non-continuous data sources have the disadvantage that they might possibly not be updated in the future. It might also not be possible to find data back in time to compare the new figures with. However, non-continuous data sources like scientific studies, studies made by non-governmental organization, companies etc. can provide useful nature system information.

SWECLIM

SWECLIM[33] is an example of a non-continuous data source. The Swedish Regional Climate Modelling Programme (SWECLIM) was part of an international and Nordic cooperation in the field of climate modelling. A set of regional climate modelling tools were established and regional climate scenario examples were provided for Swedish users. The aim was to increase the knowledge and awareness of long term climate changes.

European data sources

There is also nature system data that is compiled at a European level. Most of it is however aggregated national data from the European countries.

European Environmental Agency (EEA)

The European Environmental Agency (EEA)[34] is commissioned to provide decision makers in the European Union with the necessary information to design, implement, and follow up an efficient environmental politic. EEA is also commissioned the task of maintaining and developing the European network for environmental information and environmental monitoring. There are several useful products provided by EEA, some of which are presented below.

Europe's Environment

The third pan-European state of the environment report produced by the EEA[35]. It was prepared for the 'Environment for Europe' Ministerial Conference being held under the auspices of the UN Economic Commission for Europe in Kiev, Ukraine on 21-23 May 2003. In contrast to previous reports issued in 1995 (the Dobris assessment) and 1998, it covers for the first time the entire Russian Federation and the 11 other Eastern European, Caucasus and Central Asian (EECCA) states.

EUNIS

The EEA provides access to the database EUNIS (EUropean Nature Information System)[36]. EUNIS consists of a central unit integrating data models on species, habitats and sites; several secondary databases which are managed by different partners; and an

[33] http://www.smhi.se/sweclim/
[34] http://www.eea.eu.int/
[35] http://reports.eea.eu.int/environmental_assessment_report_2003_10/en
[36] http://eunis.eea.eu.int/index.jsp

increasing number of satellite databases. Data include for example those provided by Member States when describing the proposed NATURA 2000 sites. Provided by the European Topic Centre on Biological Diversity (ETC/NPB)[37].

Waterbase

Waterbase is the generic name given to the EEA's databases on the status and quality of Europe's rivers, lakes, groundwater bodies and transitional, coastal and marine waters, and on the quantity of Europe's water resources. Waterbase contains data collected from EEA member countries through the Eurowaternet[38] (EWN) process. EWN selects validated monitoring data from national databases and adds information on the physical characteristics of the water bodies being monitored and on the pressures potentially affecting water quality. Provided by the European Topic Centre on Water (ETC/WTR)[39].

Databases on Air Quality, Air Emissions & Climate Change in Europe

Databases with data on the European air are provided by the European Topic Centre on Air and Climate Change (ETC/ACC)[40].

[37] http://biodiversity.eionet.eu.int/
[38] The European Environment Agency's Monitoring and Information Network for Inland Water Resources, http://reports.eea.eu.int/TECH07/en/tab_abstract_RLR
[39] http://water.eionet.eu.int/
[40] The ETC/ACC has been established in 2001 by the EEA. The ETC/ACC is a consortium of 14 European institutions with RIVM-MNP as its lead organization. Viewed at http://air-climate.eionet.eu.int/

Data need in methods and tools

The aim with the study was to adapt a global impact assessment model for local impact assessment and state which nature system data is needed for the local conditions.

The general form for an impact model is a mathematic expression for the impact on an indicator as the consequence of a certain load. The mathematical expression is built up of nature and/or substance properties, as illustrated in the figure below.

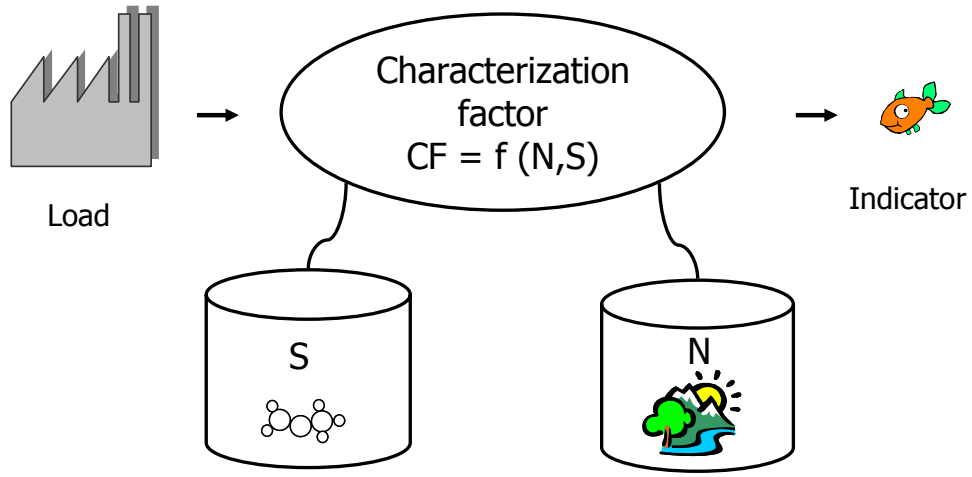

Figure 4. A general impact model. The characterization factor is a mathematical expression for the impact on an indicator as the consequence of a certain load. The characterization factor is a function of nature and/or substance properties.

To be able to identify *exactly* which nature system data is needed, a case study was made where the eutrophication impact modelling method of EPS 2000 was adapted to local impact assessment. Three substances were chosen, N-tot (total emission of nitrogen to water), P-tot (total emission of phosphorous to water) and COD (chemical oxygen demand).

Eutrophication

An increased input of phosphorus and nitrogen to water bodies with low oxygen concentrations leads to eutrophication, which has negative effects such as increased turbidity, accelerated oxygen depletion due to the decay of organic matter, and changes in the diversity and composition of flora and fauna. In fresh water, it is usually the supply of phosphorus that regulates the production of algae and other plants, while in marine water it is the supply of nitrogen[41]. COD (chemical oxygen demand) refers to a group of substances that also contributes to the damage by consuming oxygen in water bodies where the oxygen concentration is already low. In water bodies without risk for oxygen deficiencies the nutrients can have positive effects such as increased fish production.

41 http://www.internat.naturvardsverket.se/index.php3?main=/documents/legal/assess/assedoc/lakedoc/nutri1.htm

Oxygen depletion is widely used as an indicator for eutrophication. While oxygen levels above 4.5 ml/l are considered to cause no problems for macroscopic animals, levels below this cause increasing stress to most organisms.[42] Another indicator of eutrophication is the concentrations of nutrients in the water body. A lake is considered hypertropic if the phosphorous content is more than 100 µg P/l[43]. A third indicator of eutrophication is the primary production (the synthesis of organic matter (C) by plants) that is dependent on phosphorous emissions, turbidity and depth. A lake is considered eutrophic if the primary production exceeds 75-250 g C/m^2 and year[44].

Eutrophicating environmental aspects

To be able to take care to the different nature conditions described in the previous section a distribution model for water bodies can be created that will describe which areas that are exposed to the emissions. Distribution models are in general very expensive and another solution is to divide the emissions of N-tot, P-tot and COD into different environmental aspects after the nature criteria:

N-tot

- Emission of N-tot to fresh water with high oxygen concentration
- Emission of N-tot to fresh water with low oxygen concentration
- Emission of N-tot to marine water with high oxygen concentration
- Emission of N-tot to marine water with low oxygen concentration

P-tot

- Emission of P-tot to fresh water with high oxygen concentration
- Emission of P-tot to fresh water with low oxygen concentration
- Emission of P-tot to marine water with high oxygen concentration
- Emission of P-tot to marine water with low oxygen concentration

COD

- Emission of COD to fresh water with high oxygen concentration
- Emission of COD to fresh water with low oxygen concentration
- Emission of COD to marine water with high oxygen concentration
- Emission of COD to marine water with low oxygen concentration

This way, the responsibility for estimating (or measure) the conditions of the local environment is given to the person collecting the emission data for the environmental aspects, which is supposed to be a person with good knowledge of the geographical location. Generally, the marine water bodies south of the Åland Sea are considered to be N limited, and the water bodies north of the Åland Sea P limited. Fresh water bodies such as lakes and water courses are P limited. Suggested local characterization factors for these environmental aspects can be found in Appendix VI.

[42] http://www.helcom.fi/environment2/eutrophication/en_GB/oxygen/
[43] http://www.ma.slu.se/Miljotillst/Eutrofiering/Hypertrofikarta.ssi
[44] Karin Sandqvist, ”Kriterier för en hållbar fisketurism i Sjuhärad”, Avdelningen för Tillämpad miljövetenskap, Göteborgs universitet, 2005

EPS 2000 – Environmental Priority Strategies in product development

The impact assessment method EPS 2000[45] was developed within CPM (Centre for the environmental assessment of Products and Material systems). EPS uses three different ways to model impact; *empiric*, where the top-down perspective is applied, *mechanistic*, where the bottom-up perspective is applied, and *equivalency* modelling where the impact from one substance is estimated based on comparison with the impact from a similar substance.

The environmental impact due to eutrophication is assigned to the following impact categories:

- **Biodiversity**
  Category indicator: NEX
  NEX is an abbreviation of "Normalised EXtinction of species". The extinction rate of species in the world is not known. The indicator value for normal extinction rate of species is set to 1 NEX (NEX is also the indicator unit). This means that an activity that hypothetically account for 50% of the world's extinction of species will get an indicator value of 0.5 NEX.
- **Ecosystem production capacity**
  Category indicator: Fish and meat
  The production rate of fish is an indicator of eutrophication. The indicator unit is kg.
- **Recreational and cultural values**
  Category indicator: *none defined*

Choice of local category indicators

The choice of category indicators for the local impact modelling was made by Professor Bengt Steen at the Department of Environmental Systems Analysis at Chalmers University of Technology together with Johan Tivander and Sandra Häggström, both at Industrial Environmental Informatics at Chalmers University of Technology.

Indicators for biodiversity

The extinction rate of species due to eutrophication is not known. In EPS it has been estimated with the fraction of red listed species that are assumed by science expertise to be threatened by eutrophication. In Scandinavia for example, 10% of the red listed species are assumed to be threatened by eutrophication[46]. The category indicator value for eutrophicating substances' impact on NEX is therefore 0.1 NEX. This empirical way of modelling does not suit adaptation to too small areas.

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[45] Steen B (1999a): "A systematic approach to environmental priority strategies in product development (EPS). Version 2000 – General system characteristics"; CPM report, Chalmers University of Technology, Sweden
Steen B (1999b): "A systematic approach to environmental priority strategies in product development (EPS). Version 2000 – Models and data of the default method"; CPM report, Chalmers University of Technology, Sweden

[46] ArtDatabanken, "Rödlistade arter i Sverige", http://www.artdata.slu.se/

Indicators for ecosystem production capacity
The effect on the production rate of fish due to addition of eutrophicating substances is described by the figure below.

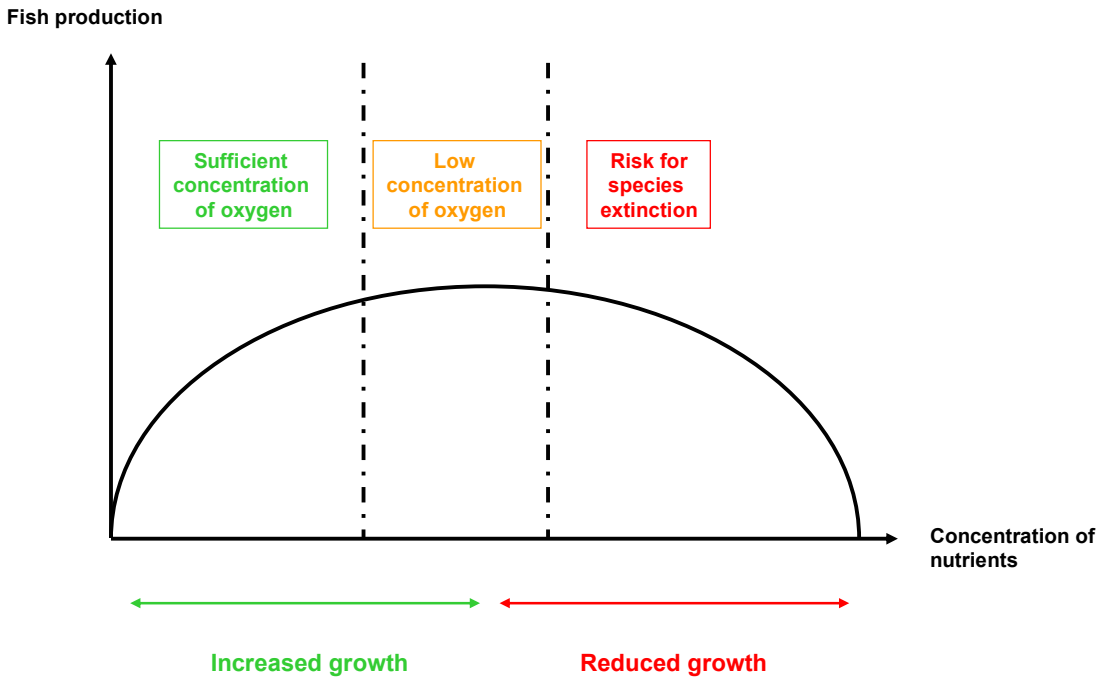

Figure 5. Fish production as a function of concentration of nutrients.

The effect of adding eutrophicating substances or nutrients to water is dependent on the oxygen concentration in the water. If the oxygen concentration is high, the nutrients will lead to an increase of fish production, but when the water is eutrophicated, the oxygen concentration will be so low that there is a reduction in fish production and also a risk that species can be extinct (i.e. impact on the NEX indicator). The local impact model will need to take care to the oxygen concentration of the drainage areas to which the emission of eutrophication substances is made. An introduction of conditions for the models will lead to that the model for increased growth can be used when the oxygen concentration is above a certain value and the model for decreased growth can be used when the oxygen concentration is below that value.

Indicators for recreational and cultural values
A discussion was held about other indicators of environmental impact that might be suitable for local impact modelling. The subjectivity of the selection of safe guard objects and/or environmental issues was however considered too high. Cultural and recreational values, the EPS impact category, can e.g. also be represented by the production rate of fish and additions of new category indicator were decided to be left outside the scope.

EPS characterization factors for eutrophication

Below are the specific expressions of the characterization factors (CF) in EPS 2000.

N-tot impact on NEX
Modelled with empirical method
CF = A*B/C

A = relative size of n-polluted (ocean) water area
B = ratio of extinction of species caused by eutrophication [NEX]
C = global emission of nitrogen to water [kg]

N-tot impact on fish and meat
Modelled with mechanistic method
CF = -A*B*(C-D)/(D*E)

A = share of nitrogen emissions ending up in areas where the growth rate is limited by nitrogen
B = average fish production in Swedish waters [kg/hectare*year]
C = weight of bottom fauna 1984 [g/m^2]
D = weight of bottom fauna 1912[g/m^2]
E = anthropogenic added nitrogen [kg/hectare]

COD impact on NEX (determined by an equivalency method using N-tot as a reference)
Modelled with equivalency method with N-tot as reference
CF = A*B*C

A = part of COD mineralized
B = relative rate of consumed oxygen for COD/N-tot
C = CF for N-tot

P-tot impact on NEX
Modelled with empirical method
CF = A*B/C

A = relative size of P-polluted (lake) area
B = ratio of extinction of species caused by eutrophication [NEX]
C = global emission of phosphorous to water [kg]

Adaptations

Phosphorous contribution to increased fish production

The impact on fish production from phosphorous was not modelled in EPS 2000 due to the fact that it has both positive and negative impacts depending on the oxygen level in the water[47]. By introduction of conditions in the model, phosphorous impact has been modelled here. When emitted to n-limited water bodies, phosphorous is assumed to have zero impact, and when emitted to p-limited water bodies it is assumed to cause all the eutrophication effects. If the oxygen concentration is below a certain value, then the "eutrophication model" is valid. If the oxygen concentration is above that value, then the "nutrient model" is used. The P-tot impact on fish and meat can be modelled with an equivalency method with N-tot as reference.

According to Matts-Ola Samuelsson[48], 1 mole of P equals 16 moles of N in eutrophicating effect and translated to kilograms 1 kg of P equals 7 kg of N. This figure corresponds to the content of nutrients in fish fodder[49] where there is 8 times as much P to N. The equivalence factor is thus set to 7. The uncertainty in the equivalence factor is assumed to be the same as for the equivalence factors in EPS 2000, i.e. described by a log-normal distribution with a standard deviation corresponding to a factor of 5.

Models for decrease of fish production due to eutrophication

The EPS model for increase of fish production due to anthropogenic emissions of nutrients is based on an investigation of the fish production in Skälderviken. The uncertainty factor when using the results for other parts of the world is assumed to be in the order of factor 4[50]. An investigation of Kalmarsund made by the National Board of Fisheries shows an example of reduced fish recruitment due to emissions of nutrients[51]. Using this data is here assumed to have the similar uncertainty as the Skälderviken data when applying it to other parts of the world.

According to Fiskeriverket, the catch of perch was in the early 90's about 100 ton per year in the Kalmar coastal water body [52]. In 1995 the total emissions of nutrients to this area was 5000 ton of nitrogen/year. The catch of perch decreased in the period 1990 to

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[47] Steen B (1999b): "A systematic approach to environmental priority strategies in product development (EPS). Version 2000 – Models and data of the default method"; CPM report, Chalmers University of Technology, Sweden, page 268

[48] Samuelsson (1993): "Life cycle assessments and eutrophication – a concept for calculation of the potential effects of nitrogen and phosphorous"; IVL Report B 1119, Stockholm

[49] Jonsson, Alanärä (2000): "Svensk fiskodlings närsaltsbelastning – faktiska nivåer och framtida utveckling, Vattenbruksinstitutionen rapport 18, Umeå

[50] Steen B (1999b): "A systematic approach to environmental priority strategies in product development (EPS). Version 2000 – Models and data of the default method"; CPM report, Chalmers University of Technology, Sweden, page 267

[51] Johansson (2000):"Åtgärdsanalys av övergödningsproblemet i Kalmar läns kustvatten", Meddelandeserien nr 2001:18, ISSN 0348-8748

[52] A Gårdmark, T Aho, A-B Florin (2004), "Kustfisk och fiske – tillståndet hos icke kvotbelagda fiskresurser år 2003", Fiskeriverket

1997 with 12 percent per year, or 12 ton per year[53]. An empirical model can thus be made for the decrease of fish production due to nitrogen emissions, where the characterization factor **CF** = decrease in fish recruitment [kg fish/year] / emission of nitrogen [kg/year].

The decrease of fish production due to emissions of COD and phosphorous can be modelled with an equivalence method just as with the EPS characterization factor for COD and phosphorous impact on NEX.

Nature data needed for local impact assessment

The list below is a guide to some of the nature properties (in the models for eutrophication above) that are dependent on the local conditions, and where it is possible to find information. It is not intended as a complete list and the first part of this report, the inventory of nature data sources contains more references to possible data sources.

Oxygen concentration in fresh water bodies
Data about oxygen concentration in the reference water courses (50), river mouths (50) and lakes (95) can be found and downloaded for free at the website of the Environmental Assessment department[54] at the Swedish University of Agricultural Sciences. The location, year, month, day, depth [m], oxygen concentration [mg/l] is specified in the data set. Maps of the reference water courses, river mouths and lakes are found in Appendix V. If the fresh water area in a specific study is not a reference area, it has to be estimated with one.

High phosphorous content is another indicator of that the water area is eutrophicated if no reliable data about oxygen concentration can be found. For lakes, a list of the lakes that had a concentration of phosphorous of more than 100 µg/litre (yearly average) and thus regarded as hypertrophic was compiled in 1990 from a questionnaire to the County Administration[55].

Oxygen concentrations in marine water bodies
National monitoring programme data can be downloaded for free from the SHARK database (Svensk HavsARKiv)[56]. Regional data about marine concentrations of oxygen can be found and ordered at the Swedish Meteorological and Hydrological Institute for an administrative fee[57].

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[53] Jan Andersson et al. (2000), ”Recruitment failure and decreasing fish stocks in the coastal areas of Kalmarsund”, Fiskeriverket rapport 2000:5
[54] http://www.ma.slu.se/IMA/dv_program.html
[55] http://www.ma.slu.se/Miljotillst/Eutrofiering/Hypertrofikarta.ssi
[56] http://www.smhi.se/oceanografi/oce_info_data/shark/home_download_sv.html?language=s (My attempt to download data did not succeed however.)
[57] http://www.smhi.se/oceanografi/oce_info_data/shark/home_search_sv.html

Anthropogenic emissions of nutrients
The anthropogenic emissions of phosphorous and nitrogen in Sweden can e.g. be found at the Swedish Meteorological and Hydrological Institute [58] or the Swedish University of Agricultural Sciences [59]. Emissions of phosphorous and nitrogen in Europe can be found in the European Pollutant Emission Register (EPER)[60], which is a European-wide register of industrial (which includes e.g. agriculture) emissions into air and water (Norway and Hungary are also included).

Normal extinction rate of species (NEX)
The extinction rate of species due to eutrophication is not known. In EPS it has been estimated with the fraction of red listed species that are assumed by science expertise to be threatened by eutrophication. In Scandinavia, 10% of the red listed species are assumed to be threatened by eutrophication[61]. On a global scale it is supposed to be 1% as warmer regions are less sensitive to excess nitrogen[62]. This empirical way of modelling does not suit adaptation to too small areas, and using the fraction of red listed species to smaller areas than Scandinavia is therefore not recommended.

[58] Brandt, Svensson, Winqvist (2005): ”Källfördelning av näringsämnen på vattendistrikt. Tilläggsrapport till SMED&SLU rapport: Klassificering av påverkan av näringsämnen på rapporterings- och havsområden”, SMHI
[59] http://info1.ma.slu.se/db.html
[60] http://www.eper.cec.eu.int/eper/
[61] ArtDatabanken, ”Rödlistade arter i Sverige”, http://www.artdata.slu.se/
[62] Steen B (1999b): “A systematic approach to environmental priority strategies in product development (EPS). Version 2000 – Models and data of the default method”; CPM report, Chalmers University of Technology, Sweden, page 267

References

Andersson et al. (2000): ”Recruitment failure and decreasing fish stocks in the coastal areas of Kalmarsund”, Fiskeriverket rapport 2000:5

ArtDatabanken, http://www.artdata.slu.se/

Brandt, Svensson, Winqvist (2005): ”Källfördelning av näringsämnen på vattendistrikt. Tilläggsrapport till SMED&SLU rapport: Klassificering av påverkan av näringsämnen på rapporterings- och havsområden”, SMHI

EIONET, http://biodiversity.eionet.eu.int/, http://water.eionet.eu.int/ and http://air-climate.eionet.eu.int/

EMEP, Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air pollutants in Europe, http://www.emep.int/

EPER, http://www.eper.cec.eu.int/eper/

European Environment Agency, http://www.eea.eu.int/, http://reports.eea.eu.int/environmental_assessment_report_2003_10/en, http://eunis.eea.eu.int/index.jsp

The European Environment Agency's Monitoring and Information Network for Inland Water Resources, http://reports.eea.eu.int/TECH07/en/tab_abstract_RLR

Gothenburg Region’s Air Quality Programme, http://www.gr.to/luftvardsprogrammet/

Gårdmark, Aho, Florin (2004): “Kustfisk och fiske – tillståndet hos icke kvotbelagda fiskresurser år 2003”, Fiskeriverket

Göteborgs kommun, Miljöförvaltningen, http://www.miljo.goteborg.se/

Helsinki Commission, http://www.helcom.fi/environment2/eutrophication/en_GB/oxygen/

IVL, http://www.ivl.se/

Johansson (2000):”Åtgärdsanalys av övergödningsproblemet i Kalmar läns kustvatten”, Meddelandeserien nr 2001:18, ISSN 0348-8748

Jonsson, Alanärä (2000): “Svensk fiskodlings närsaltsbelastning – faktiska nivåer och framtida utveckling, Vattenbruksinstitutionen rapport 18, Umeå

Kemikalieutsläppsregistret (Swedish pollutant release and transfer register) http://www.naturvardsverket.se/kur/

Lantmäteriverket: http://www.lantmateriet.se/

LUFTNET: http://www.miljo.goteborg.se/luftnet/

Länsstyrelsen Södermanlands län, http://www5.d.lst.se/

Länsstyrelsen Västra Götaland, Interview with Katrina Envall, Miljöövervakningen

Naturvårdsverket; ”Samordnad miljöövervakning i Sverige (version 2005)”; http://www.naturvardsverket.se/dokument/mo/modok/export/nymo2005.pdf

Naturvårdsverket, http://www.naturvardsverket.se/dokument/mo/hbmo/del1/plan/upplagg4.pdf

Naturvårdsverket; ”Naturvårdsverkets kvalitetssystem för samordnad miljöövervakning”; http://www.naturvardsverket.se/dokument/mo/modok/export/kvalsystem.pdf

Naturvårdsverket, http://www.naturvardsverket.se/miljodatasok/start.jsp

Naturvårdsverket, http://www.internat.naturvardsverket.se/index.php3?main=/documents/issues/monitor/monitor.htm

Naturvårdsverket, Interview with Anders Foureaux, Miljöövervakningen

Naturvårdsverket, Interview with Susanne Vävare, Miljöövervakningen

Naturvårdsverket, http://www.naturvardsverket.se/index.php3?main=/dokument/mo/modok/reg_utv/regutv.htm

Naturvårdsverket, http://www.internat.naturvardsverket.se/index.php3?main=/documents/legal/assess/assedoc/lakedoc/nutri1.htm

Samuelsson (1993): “Life cycle assessments and eutrophication – a concept for calculation of the potential effects of nitrogen and phosphorous”; IVL Report B 1119, Stockholm

Sandqvist, Karin: ”Kriterier för en hållbar fisketurism i Sjuhärad”, Avdelningen för Tillämpad miljövetenskap, Göteborgs universitet, 2005

SLU, http://www.slu.se/, http://www.ma.slu.se/Miljotillst/Eutrofiering/Hypertrofikarta.ssi, http://www.ma.slu.se/IMA/dv_program.html, http://www.ma.slu.se/Miljotillst/Eutrofiering/Hypertrofikarta.ssi and http://info1.ma.slu.se/db.html

SMHI, http://www.smhi.se/, http://www.smhi.se/sgn0106/if/meteorologi/match.htm, http://simair.smhi.se/, http://www.smhi.se/sweclim/, http://www.smhi.se/oceanografi/oce_info_data/shark/home_download_sv.html?language=s and http://www.smhi.se/oceanografi/oce_info_data/shark/home_search_sv.html

SNA, http://www.sna.se/

Socialstyrelsen (National Board of Health and Welfare) http://www.socialstyrelsen.se/

SSI, http://www.ssi.se/

Steen B (1999a): “A systematic approach to environmental priority strategies in product development (EPS). Version 2000 – General system characteristics”; CPM report, Chalmers University of Technology, Sweden

Steen B (1999b): “A systematic approach to environmental priority strategies in product development (EPS). Version 2000 – Models and data of the default method”; CPM report, Chalmers University of Technology, Sweden

The Swedish Environmental Code, http://www.sweden.gov.se/content/1/c6/02/28/47/385ef12a.pdf

Appendix I

Addresses to nature system data sources in Sweden (in Swedish)

Fiskeriverket

Fiskeriverket, Sötvattenslaboratoriet:
http://www.fiskeriverket.se/laboratorier/sotvatten/projekt/provfiske.htm

Göteborgs stad

Miljöförvaltningen: http://www.miljo.goteborg.se/
LUFTNET: http://www.miljo.goteborg.se/luftnet/

IVL

IVL Svenska miljöinstitutet AB: http://www.ivl.se/
Databasen och klickbara kartor hittas på: http://www.ivl.se/miljo/db/

Karolinska Institutet

IMM, Institutet för miljömedicin: http://www.imm.ki.se/

Länsstyrelsen

Länkar till alla länsstyrelsers hemsidor: http://www.lst.se/

Miljöövervakningen

Den nationella Miljöövervakningens nås på Naturvårdsverkets hemsida:
http://www.naturvardsverket.se/
Den regionala Miljöövervakningen nås från respektive Länsstyrelses hemsida:
http://www.lst.se/

Miljöövervakningen i Södermanlands län

Länsstyrelsens hemsida: http://www.d.lst.se/d/amnen/Miljo/Miljoovervakning/
Miljöövervakningen:
http://www5.d.lst.se/verksamhetsomraden/Miljo_Natur/miljoovervakning/miljooverv.htm

Miljöövervakningen i Västra Götalands län

Länsstyrelsens hemsida: http://www5.o.lst.se/projekt/miljoovervakning/
Göteborgsregionens luftvårdsprogram: http://www.gr.to/luftvardsprogrammet/
Luft i Väst: http://liv.vg/
Bohuskustens vattenvårdsförbund: www.bvvf.com
Göta älvs vattenvårdsförbund: http://www.gotaalvvvf.org/

SGU

Sveriges Geologiska Undersökning: http://www.sgu.se/
Miljöövervakningsdata: http://www.naturvardsverket.se/miljodatasok/start.jsp

SLU

Sveriges Lantbruksuniversitet: http://www.slu.se/
ArtDatabanken: http://www.artdata.slu.se/
SLU, Institutionen för miljöanalys: http://www.ma.slu.se/
SLU, Institutionen för markvetenskap: http://www-mv.slu.se/
SLU, Miljödata: http://www.md.slu.se/

SMHI

Sveriges meteorologiska och hydrologiska institut: http://www.smhi.se/
Miljöövervakningsdata: http://www.naturvardsverket.se/miljodatasok/start.jsp
MATCH-modellen nås genom Klimat & Miljö – Datavärdskap – Sverigemodellen eller direkt på http://www.smhi.se/sgn0102/n0205/nvv/1999/lansmap.htm
SIMAIR: http://simair.smhi.se/

SMI

SMI, Smittskyddsinstitutet: http://www.smittskyddsinstitutet.se/

SNA

Sveriges Nationalatlas: http://www.sna.se/
Lantmäteriverket: http://www.lantmateriet.se/

Socialstyrelsen

Den officiella statistiken: http://www.sos.se/sos/statisti.htm

SSI

Statens strålskyddsinstitut: http://www.ssi.se/

Stockhoms Universitet

Stockholms Universitet, Systemekologiska institutionen: http://www.ecology.su.se/

Appendix II

Sub-programmes of the national monitoring programme (in Swedish)

Program	Delprogram
Luft	1. Luft- och nederbördskemi inom EMEP (European Monitoring and Evaluation Programme) 2. Metaller i luft och nederbörd 3. Organiska miljögifter i luft och nederbörd 4. EU:s varningssystem för marknära ozon 5. Luft- och nederbördskemiska nätet. 6. Krondroppsmätningar 7. Klimatpåverkande ämnen och växthusgaser 8. Ozonskiktet 9. Sverigemodellen (datamodell för beräkning av spridning och nedfall av luftföroreningar) 10. Mätning av inandningsbara och sura partiklar 11. Miljögifter i urban miljö 12. Deposition på hög höjd 13. Kartering av metallhalter i mossa
Kust och hav	1. Makrofauna mjukbotten, trend- och områdesövervakning 2. Embryonalutveckling hos vitmärla, trend- och områdesövervakning 3. Vegetationsklädda bottnar, trend- och områdesövervakning 4. Fria vattenmassan 5. Kustfiskbestånd, trend- och områdesövervakning 6. Kustfisk hälsa, trend- och områdesövervakning 7. Toppkonsumenter, trend- och områdesövervakning 8. Metaller och organiska miljögifter i marin biota, trend- och områdesövervakning 9. Badvatten
Sötvatten	1. Referensstationer - grundvatten 2. Referensstationer - vattendrag 3. Flodmynningar 4. Referensstationer - sjöar 5. Stora Sjöarna 6. Miljögifter - provbankning 7. Miljögifter - analyser 8. Inventeringar av sjöar och vattendrag (kemiska och biologiska parametrar)
Fjäll	1. Biodiversitetsövervakning av fjäll genom NILS-programmet 2. Smådäggdjursövervakning - Fjäll 3. Miljögifter i ren 4. Undersökningar av strålning, cesiumhalter etc. (finansieras inte via den nationella miljöövervakningen)

Skog	1. Riksinventering Skog - Markinventeringen (RIS-MI) 2. Integrerad övervakning 3. Smådäggdjursövervakning 4. Metaller i älg
Jordbruksmark	1. Observationsfält 2. Typområden på jordbruksmark 3. Mätningar av pesticider 4. Mark- och grödoinventering 5. Miljögifter i biota 6. NILS-programmet 7. Markpackning
Hälsorelaterad miljöövervakning	1. Exponering via luft - Exponering för cancerframkallande ämnen i tätortsluft - Halter av cancerframkallande ämnen i tätortsluft 2. Besvärsstudier - Dagboksstudier - ENHIS 3. Exponering för miljöföroreningar - Metallmätningar hos gravida kvinnor - Exponering för kadmium i en riskgrupp - Exponering för organiska ämnen - Exponering för metaller - Exponering via livsmedel - Persistenta organiska föreningar i bröstmjölk -regionala skillnader - Exponering via livsmedel
Landskap	1. Heltäckande satellitövervakning 2. NILS-programmet 3. Sträckfågelräkning vid Falsterbo 4. Fågelräkning och ringmärkning vid Ottenby 5. Svensk sjöfågelinventering 6. Häckfågeltaxering
Våtmark	1. Våtmarksinventeringar (VMI) 2. Våtmarkernas funktion och tillstånd 3. Myllrande våtmarker 4. Biodiversitetsövervakning av våtmarker genom NILS-programmet
Miljögiftssamordning	1. Miljöprovbank 2. Retrospektiva studier 3. Screening 4. Miljögifter i urban miljö

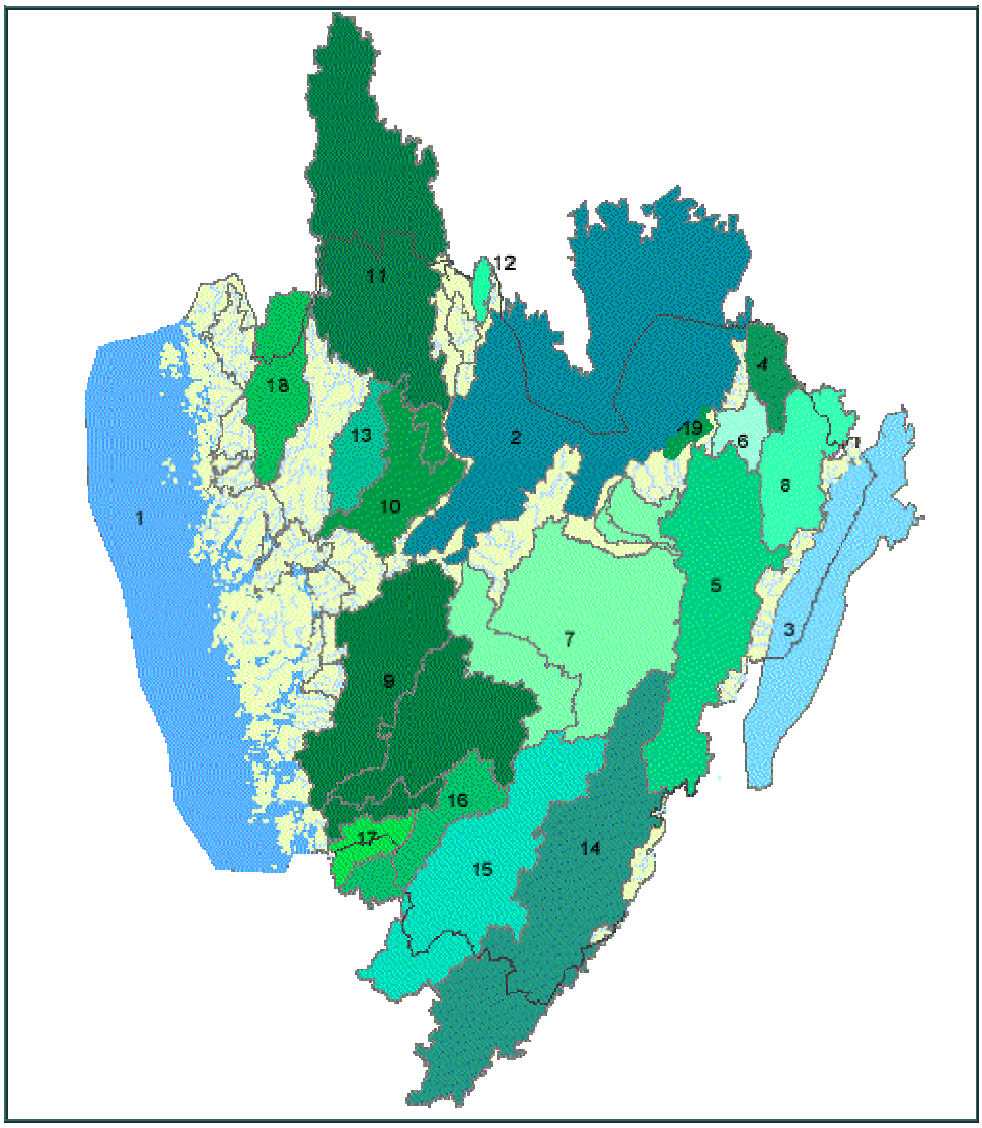
Appendix III

Data and data formats of national data hosts (in Swedish)

Huvudsakligt ämnesområde	Typ av data inom datavärdskapet	Datavärd	Uppgett leveransformat
Luft	Atmosfärskemiska data. Ozon och spridningsberäkningar	SMHI	Excel, ASCII,
	Luft-data	IVL Svenska Miljöinstitutet AB	Excel, Access, html, xml (har Oracle databas)
	Luftföroreningsdata från Sveriges tätorter.	IVL Svenska Miljöinstitutet AB	Excel, Access, html, xml (har Oracle databas)
Sötvatten	Grundvattenkemidata.	SGU, Sveriges Geologiska Undersökning	ASCII- (inkl. CSV) Excel- XML- Access filer (har Oracle databas).
	Kemiska och biololgiska data i sjöar och vattendrag. (Ej fisk, se nedan)	SLU, Institutionen för miljöanalys	Excel, (har 4D-databas)
	Fiskdata från Sveriges sjöar och vattendrag samt kusten.	Fiskeriverket. Sötvattens-laboratoriet	Excel, Access, Dbase (går från access-db till Oracle-server)
Kust och hav	Hydrografiska och kemiska data från Östersjön och Västerhavet	SMHI	Excel/Shape/gridascii-filer eller GIS/HDF5/ NetCDF/GRIB-format
	Marinbiologiska data från Östersjön och Västerhavet	SU, Systemekologiska institutionen	Excel (dbf-filer)
Jordbruks-mark	Närsalter i ytvatten och grundvatten i jordbruksmark. Närsalter, metaller och miljögifter i mark och gröda	SLU, Institutionen för markvetenskap	Excel, Access
Våtmarker	Våtmarksinventeringen (under uppbyggnad)	SLU, Miljödata	Excel, Access
Miljögifter	Screeningdatabas. Miljögifter och metaller (under uppbyggnad)	IVL Svenska Miljöinstitutet AB	Excel, Access, html, xml (har Oracle databas)
	Miljögifter och metaller biologiskt material (ej människa)	IVL Svenska Miljöinstitutet AB	Excel, Access
	Miljögifter och metaller i människor.	IMM, Institutet för miljömedicin	Pdf
Påverkan på människor	Yttre miljöns påverkan på människors hälsa	IMM, Institutet för miljömedicin	Pdf
	Badvattenkvalitet	SMI, Smittskydds-institutet	ASCII (förr: access-db, nu: sql-server)

Appendix IV

Water Conservation Societies in the County of Västra Götaland



Adress	Kontaktpersoner på Länsstyrelsen 2004	
1. Bohuskustens vattenvårdsförbund Box 305 451 18 UDDEVALLA www.bvvf.com	Karin Pettersson 031-605251	Margareta Hernebring 031-605292
2. Vänerns vattenvårdsförbund	Lennart Olsson	Eva Griphammar

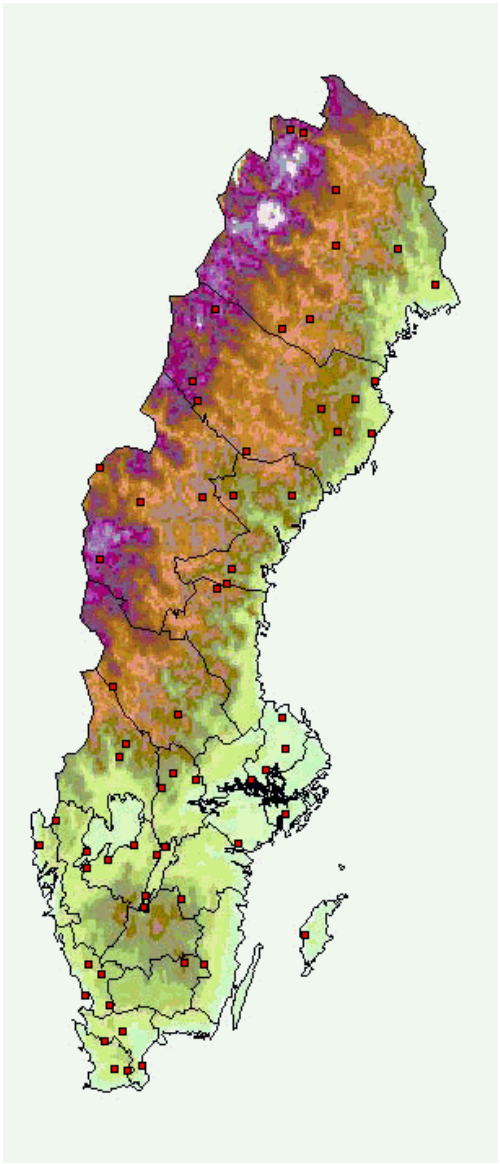
Länsstyrelsen Västra Götaland 542 85 MARIESTAD www.vanern.se	0521-605456	0521-605507
3. Vätternvårdsförbundet Länsstyrelsen Jönköpings län 551 86 JÖNKÖPING www.vattern.org	Susanna Hogdin 0501-605398	Agneta Christensen 0501-605385
4. Gullspångälvens vattenvårdsförbund Gullspångsälvens Vattenvårdsförbund, c/o Karlskoga kommun 691 83 KARLSKOGA	Susanna Hogdin 0501-605398	
5. Tidans vattenförbund Tidans Vattenförbund, Skogsvårdsstyrelsen Förrådsgatan 45 542 35 MARIESTAD	Eva Griphammar 0521-605507	Bengt Norrman 0501-605406
6. Friaåns recipientsamverkan Töreboda kommun, Börstorpsgatan 1 545 30 TÖREBODA	Vakant	
7. Lidan-Nossans vattenvårdsförbund Hasselgatan 15 521 30 FALKÖPING	Eva Griphammar 0521-605507	Bengt Norrman 0501-605406
8. Norra Vätterns tillrinningsområde Askersunds kommun, Stöökagatan 8, 696 30 ASKERSUND	Vakant	
9. Göta älvs vattenvårdsförbund Göteborgsregionens kommunalförbund Box 5073, 402 22 GÖTEBORG	Hans Oscarsson 031-605062	Eva Griphammar 0521-605472
10. Dalbergsån-Holmåns vattenvårdsförbund Vänersborgs kommun 462 33 VÄNERSBORG	Dan Hellman 031-605142	Arne Johansson 0521-605470
11. Dalslands kanals vattenvårdsförbund Box 24 660 11 BILLINGSFORS	Lennart Olsson 0521-605456	Peter Fabo 0521-605454
12. Åmålsvikens recipientkontroll Åmåls kommun, Kungsgatan 26 662 31 ÅMÅL	Dan Hellman 031-605142	Eva Griphammar 0521-605472
13. Valboåns recipientkontroll Färgelanda kommun 458 32 FÄRGELANDA	Dan Hellman 031-605142	Eva Griphammar 0521-605472
14. Ätrans vattenvårdsförbund Falkenbergs kommun 311 80 FALKENBERG	Dan Hellman 031-605142	Siv Hansson 0521-605468

www.falkenberg.se		
15. Viskans vattenvårdsförbund Marks kommun 511 80 KINNA www.viskan.nu	Dan Hellman 031-605142	Siv Hansson 0521-605468
16. Lygnerns vattenvårdsförbund Marks kommun 511 80 KINNA	Anna Ek 0320-21 70 00	
17. Kungsbackaåns vattenvårdsförbund Kungsbacka kommun, Stadshuset, 434 81 KUNGSBACKA	Hans Oscarsson 031-605062	
18. Enningsdalsälvens vattendragsförbund Tanums kommun, Miljöavdelningen, 457 81 TANUMSHEDE	Lennart Olsson 0521-605456	Christer Larsson 0521-605482
19. Mariestadsfjärdens recipientsamverkan Mariestads kommun 542 86 MARIESTAD	Vakant	

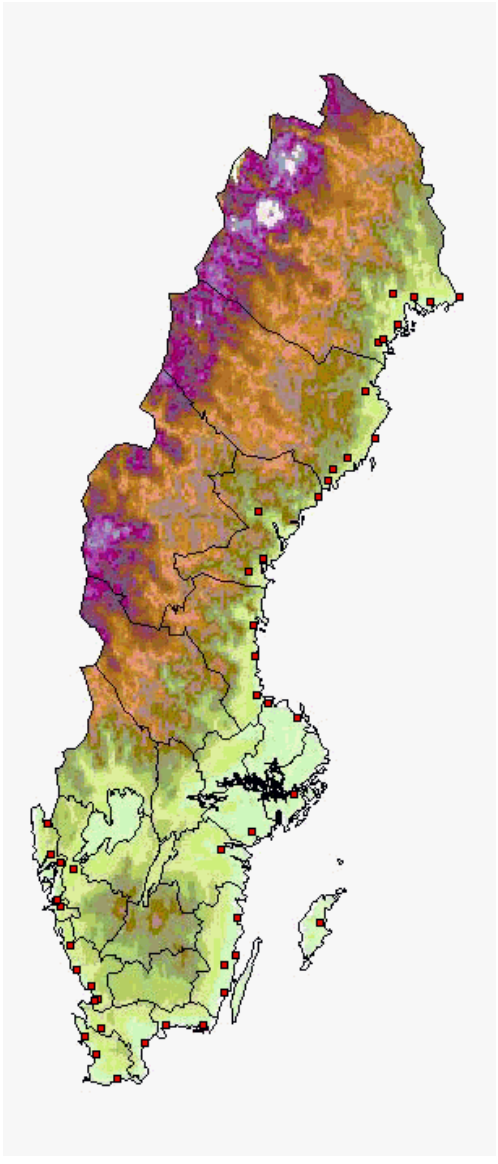
Appendix V

Maps over reference water courses, river mouths and lakes

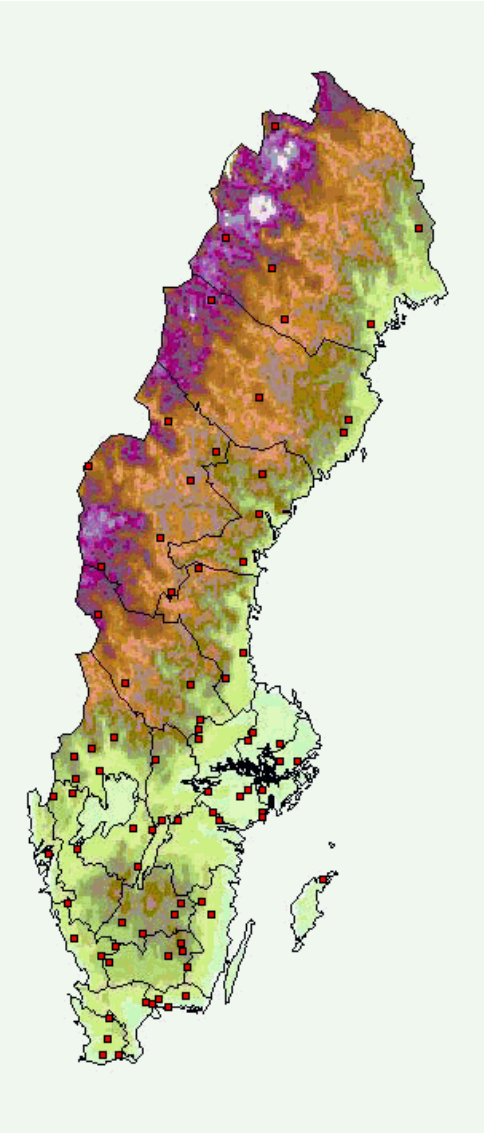
Referensvattendrag



Referensflodmynningar



Referenssjöar



Appendix VI

Suggestions for local impact modelling

The following environmental aspects are classified to the impact category NEX:

- Emission of N-tot to marine water with low oxygen concentration
- Emission of P-tot to fresh water with low oxygen concentration
- Emission of COD to fresh water with low oxygen concentration
- Emission of COD to marine water with low oxygen concentration

The following environmental aspects are classified to the impact category increased fish production:

- Emission of N-tot to marine water with high oxygen concentration
- Emission of P-tot to fresh water with high oxygen concentration

The following environmental aspects are classified to the impact category decreased fish production:

- Emission of N-tot to marine water with low oxygen concentration
- Emission of P-tot to fresh water with low oxygen concentration
- Emission of COD to fresh water with low oxygen concentration
- Emission of COD to marine water with low oxygen concentration

If other sources for the data are not specified, the data is taken from the EPS report[63], pages 262-266.

Models for impact on NEX

The geographical scope for this model is Scandinavia.

N-tot impact on NEX
Modelled with empirical method
CF = A*B/C = 0.9*0.1 NEX/8.6 E6 kg = **1.05 E-8 NEX/kg**

A = relative size of n-polluted (ocean) water area
B = ratio of extinction of species caused by eutrophication [NEX] = 0.1 NEX (1990?)
C = Scandinavic emission of nitrogen to water [kg] = 8626 ton (2001)[64]

P-tot impact on NEX
Modelled with empirical method
CF = A*B/C = 0.1*0.1 NEX/0.9 E6 kg = **1.1 E-8 NEX/kg**

[63] Steen B (1999b): "A systematic approach to environmental priority strategies in product development (EPS). Version 2000 – Models and data of the default method"; CPM report, Chalmers University of Technology, Sweden
[64] EPER, http://www.eper.cec.eu.int/eper/

A = relative size of p-polluted (lake) water area
B = ratio of extinction of species caused by eutrophication [NEX] = 0.1 NEX (1990?)
C = Scandinavic emission of phosphorous to water [kg] = 899 ton (2001)[65]

COD impact on NEX
Modelled with equivalency method with N-tot as reference
CF = A*B*C = 0.5*0.102*1.05 E-8 NEX/kg = **5.36 E-10 NEX/kg**

A = part of COD mineralized = 0.5
B = relative rate of consumed oxygen for COD/N-tot = 0.102
C = CF for N-tot = 1.05 E-8 NEX/kg (see above)

Models for increase of fish production

The geographical scope for the nitrogen model is Skälderviken, but it is assumed that the figures can be applied also at other locations where no eutrophication exists. The use of the results in other parts of the world introduces an uncertainty, which is assumed to be in the order of a factor of 4[66].

N-tot impact on fish increase
Modelled with empirical method
CF = -A/B = -25/56.1 = **-0.446 kg fish/ kg N-tot**

A = increased fish production = 25 kg/hectare*year
B = anthropogenic added nitrogen = 56.1 kg/hectare

P-tot impact on fish increase
Modelled with equivalency method with N-tot as reference
CF = -A*B = -0.446*7 = **-3.122 kg fish/kg P-tot**

A = CF for N-tot = 0.446 kg fish/kg N-tot (see above)
B = relative rate of nutrient need kg N-tot/ kg P-tot = 7[67]

Models for decrease of fish production

The geographical scope for the nitrogen model is Kalmarsund, but it is assumed that the figures can be applied also at other locations where eutrophication exists [68]. The uncertainty is assumed to be the same as for increased fish production (see above).

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[65] EPER, http://www.eper.cec.eu.int/eper/
[66] Steen B (1999b): "A systematic approach to environmental priority strategies in product development (EPS). Version 2000 – Models and data of the default method"; CPM report, Chalmers University of Technology, Sweden, page 264.
[67] According to Matts-Ola Samuelsson [Samuelsson (1993): "Life cycle assessments and eutrophication – a concept for calculation of the potential effects of nitrogen and phosphorous"; IVL Report B 1119, Stockholm], 1 mole of P equals 16 moles of N in eutrophicating effect and translated to kilograms 1 kg of P equals 7 kg of N. This figure corresponds to the content of nutrients in fish fodder where there are 8 times as much P to N [Jonsson, Alanärä (2000): "Svensk fiskodlings närsaltsbelastning – faktiska nivåer och framtida utveckling", Swedish University of Agricultural Sciences, Umeå]. The reliability of the figures is however not guaranteed.

N-tot impact on fish decrease
Modelled with empirical method
CF = A/B = 12/5 = **0.0024 kg fish/ kg N-tot**

A = decreased fish production = 12 ton/year
B = anthropogenic added nitrogen = 5 000 ton N-tot/year

P-tot impact on fish decrease
Modelled with equivalency method with N-tot as reference
CF = A*B = 0.0024*7 = **0.0168 kg fish/kg P-tot**

A = CF for N-tot = 0.0024 kg fish/ kg N-tot (see above)
B = relative rate of nutrient need kg N-tot/ kg P-tot = 7[69]

COD impact on fish decrease
Modelled with equivalency method with N-tot as reference
CF = A*B = 0.0024 *0.102 = **0.00024 kg fish/ kg COD**

A = CF for N-tot = 0.0024 kg fish/ kg N-tot (see above)
B = relative rate of consumed oxygen for COD/N-tot = 0.102

[68] Andersson et al. (2000), "Recruitment failure and decreasing fish stocks in the coastal areas of Kalmarsund", Fiskeriverket rapport 2000:5 and
Fiskeriverket (2001), "Småskaligt kustfiske och insjöfiske – en analys"
[69] According to Matts-Ola Samuelsson [Samuelsson (1993): "Life cycle assessments and eutrophication – a concept for calculation of the potential effects of nitrogen and phosphorous"; IVL Report B 1119, Stockholm], 1 mole of P equals 16 moles of N in eutrophicating effect and translated to kilograms 1 kg of P equals 7 kg of N. This figure corresponds to the content of nutrients in fish fodder where there are 8 times as much P to N [Jonsson, Alanärä (2000): "Svensk fiskodlings närsaltsbelastning – faktiska nivåer och framtida utveckling", Swedish University of Agricultural Sciences, Umeå]. The reliability of the figures is however not guaranteed.