MID-TERM REPORT OF WATERS: Waterbody Assessment Tools for Ecological Reference conditions and status in Sweden

WATERS Report no. 2013:3

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Deliverable Mid-term report

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WATERS partners:

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WATERS is a five-year research programme that started in spring 2011. The programme's objective is to develop and improve the assessment criteria used to classify the status of Swedish coastal and inland waters in accordance with the EC Water Framework Directive (WFD). WATERS research focuses on the biological quality elements used in WFD water quality assessments: i.e., phytoplankton, macrophytes, benthic invertebrates, and fish; in streams, benthic diatoms are also considered. The research programme will also refine the criteria used for integrated assessments of ecological water status.

WATERS is funded by the Swedish Environmental Protection Agency (SEPA) and coordinated by the Swedish Institute for the Marine Environment. WATERS stands for "Waterbody Assessment Tools for Ecological Reference conditions and status in Sweden". Programme details can be found at: http://www.waters.gu.se

This is the mid-term report of WATERS prepared for the evaluation of the programme by SEPA.

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Summary and outlook

WATERS is a five-year research programme initiated and developed to produce new knowledge and improved criteria for assessing the ecological status of Swedish coastal and inland waters according to the Water Framework Directive (WFD). During its first 22 months, the programme has successfully initiated or completed a majority of the tasks outlined for this period. We conclude that the formal aims of the first two-year period in terms of deliverables and milestones stated in the proposal have largely been achieved or will be completed before month 24. In terms of specific achievements, WATERS now has:

- Well-functioning steering documents, routines, and platforms for internal as well as external communication, an active steering group, and established collaborations and meeting routines among the participating research groups. Furthermore, during this first period, WATERS has become established and is now well known among relevant national authorities. This is demonstrated by WATERS' often being cited in important national contexts concerning water and environmental management, for example, the Swedish governmental response to the European Commission's "Assessment of River Basin Management Plans",[1] the river basin district authorities' analysis of the weaknesses of and need to develop WFD assessment tools,[2] and the report on Swedish Marine Strategy Framework Directive (MSFD) implementation.[3]
- Extensive and overarching reviews including all biological quality elements (BQEs) concerning general principles for reference conditions, class boundaries, and uncertainty in the Swedish assessment criteria. These reviews are fundamental

[1] Miljödepartementet. 2011. Svar på frågor om Sveriges förvaltningsplaner och åtgärdsprogram för genomförandet av Europaparlamentets och rådets direktiv 2000/60/EG om upprättande av en ram för gemenskapens åtgärder på vattenpolitikens område. M2011/3092/Nm.

[2] Vattenmyndigheterna 2012. Behovs- och bristanalys avseende riktlinjer och bedömningsgrunder för statusklassificering, påverkansanalys och riskbedömning i ytvatten. Dnr 537-2113-12.

[3] SwAM 2012., "God havsmiljö 2020, Marin strategi för Nordsjön och Östersjön Del 1: Inledande bedömning och socioekonomisk analys" and "Del 2: God miljöstatus och miljökvalitetsnormer".

to developing increased transparency and harmonization among WFD BQEs and in relation to other policy documents (e.g., the MSFD and the Habitats Directive).

- Established a strong interdisciplinary network through a number of workshops involving freshwater and marine scientists working together with statisticians to develop indicators, quantify uncertainty components, and for optimal design of the gradient studies.
- General frameworks for assessing and minimizing the uncertainty of status assessments of individual BQEs and for combining BQEs into integrated assessments. The uncertainty framework has been applied to a number of indicators and BQEs, and this work will continue with the aim of compiling a complete catalogue quantifying the various sources of uncertainty associated with indicators used for ecological status assessment.
- For coastal areas, reviews of potential indicators and sampling methods for macrophytes and phytoplankton have been completed. The existing indicator for benthic invertebrates is being refined. For all BQEs in coastal areas, including fish, extensive databases, which constitute an invaluable platform for ongoing work on developing and testing indicators in the second phase of WATERS, are being compiled.
- For inland waters, sampling methods and existing metrics for macrophytes, phytoplankton, benthic diatoms, benthic invertebrates, and fish have been reviewed. Furthermore, efforts have been made to produce templates to facilitate the import of monitoring data into databases currently being populated. At present, 11 municipalities have uploaded regional monitoring data. For the 2008–2012 period, we anticipate 500 phytoplankton, 29 macrophyte, 80 benthic diatom, and 3000 benthic invertebrate samples. Pre-2008 samples are also being uploaded, resulting in additional samples, although differences in sampling methods may limit their usefulness.
- Synoptic data on all BQEs along specific pressure gradients are now available for coastal water bodies (i.e., on the Baltic and west coasts) as well as lake and stream water bodies. These data and those collected during the second phase of the programme will be used in comparing and analysing pressure–response relationships among metrics and among BQEs.

These achievements are in agreement with the plans of the WATERS proposal and they provide a solid foundation for the remaining years of the programme. Of particular importance for the development, refinement, and validation of BQEs, which are fundamental tasks for both coastal and inland waters, are (1) the compilation of existing data and (2) the collection of new data along common pressure gradients. These two activities have been central to all BQEs and have engaged most of our biological experts. Nevertheless, because of practical circumstances, some of the work has not progressed entirely according to our plans.

First, the compilation of inland water data, particularly for macrophytes, macroinvertebrates, and fish, which was to be completed in year two, has not proceeded as planned. This work was delayed since the development and harmonization of templates for uploading species by site and background environmental data took longer than expected, and also because regional monitoring boards needed time to contact data holders (often consultants) and agree on procedures for uploading data to the database. Since the proposal did not include any particular deliverables or deadlines associated with the compilation of data (which is a more or less continuous activity), these delays have not resulted in any deviations from our formal measures of programme progress. Nevertheless, these delays have meant that the planned work on indicator development and improvement could not be started. Consequently, staff appointments and spending in general have been put on hold and many resources for work in inland waters have therefore been reserved for the second phase of the programme.

Second, there have been some delays and budgetary changes in connection with the gradient studies, relative to the original proposal. In coastal waters, the extent and distribution sampling have been largely according to plan. However, by seizing opportunities for additional funding (which had to be spent in 2012) by coordinating and collaborating with external projects, we chose to reallocate funds among years and use the additional funds to obtain even better data by collecting additional samples in coming field campaigns. Note that the additional funds were not used for the sole purposes of WATERS, but also in some cases resulted in additional results (reported elsewhere). Nevertheless, the additional funds will result in more robust gradient studies and they nearly fulfil our explicit aim of obtaining SEK 3.3 million from external sources in 2012–2013, as stated in the proposal.

For inland waters, it was agreed that performing five gradient studies spanning large geographic regions was logistically too taxing, so it was decided to perform two gradient studies in 2012 (for one lake and one stream, both examining nutrient enrichment) and three gradient studies in 2013 (one in central and two in northern Sweden).

The use of data reflecting the specific conditions and expected environmental variability characterizing Swedish coastal and inland water bodies is of fundamental importance for the reliability of WATERS' work and its relevance to the management community. Compiling existing monitoring data will ensure that WATERS reflects most types of relevant water bodies and that analyses and indicators are based on commonly used sampling techniques. The collection of synoptic data on biological indicators along pressure gradients allows WATERS to quantify and test pressure–response relationships under realistic conditions, i.e., under the influence of uncertainties caused by random or predictable sources of variability associated with spatial, temporal, or methodological factors. This emphasizes the empirical focus of WATERS and highlights a number of key factors for the successful completion of WATERS in the upcoming programme period:

- **Collaboration between the integrative work packages responsible for "Integrated assessment" and the work packages involved in indicator development and gradient studies.** The full potential of the programme can be achieved only if the benefits of the general reviews and frameworks are combined with, applied to, and tested with the BQE data collected and compiled within the programme. This means that WATERS needs to maintain and develop additional ways of interacting within the programme. In particular, the workshops organized within the "Statistical support" work package are important in this context, and we would like to expand this activity in comparison with what was originally planned. Other activities to increase this type of collaboration may also be possible, but overall interactions between general (FA2) and specific (FA3 and FA4) parts of the programme are crucial both for the further development of general routines and to promote consistency among individual BQEs.

- **Continued and intensified interactions with and knowledge transfer to national and regional authorities.** WATERS is committed to contributing knowledge and routines that can be used in assessing the ecological status of BQEs, *sensu* WFD, in Swedish water bodies according to the WFD. To maximize relevance, to provide advice that is realistic with respect to practical and economical constraints, and to facilitate the implementation of results, it is crucial that WATERS have close and frequent interactions with responsible officials at national authorities. This particularly concerns the Swedish Agency for Marine and Water Management (SwAM), the river basin district authorities (RDBAs), and the county administrative boards (CABs, Länsstyrelser), which are responsible for developing routines for the WFD and other directives in agreement with EU guidelines (SwAM) and for using them in the practical management of water quality (RDBA and CAB). To this end, WATERS has involved these authorities in steering and reference groups, organized a number of activities, and provided expert resources in many different contexts. Nevertheless, WATERS aims to further intensify these interactions during the remainder of the programme. This is particularly important considering that the second WFD cycle has now been initiated, which means that the status of Swedish water bodies will be classified and that work on revising monitoring programmes will be developed in 2013–2014. Since the results of WATERS cannot be fully implemented until the third WFD cycle and because there is a pressing need for guidance in other contexts (e.g., the MSFD), resources can only be optimally used if there are different forms of knowledge transfer between WATERS and its researchers and responsible authorities. Such initiatives may involve the joint definition of additional tasks (with appropriate funding). A user-oriented workshop (i.e., "users' forum") and presentations at SwAM's yearly seminar are already planned for 16–17 April 2013.
- **International interactions and dissemination.** Implementing and refining the WFD is a pan-European endeavour. In terms of promoting both scientific quality and consistency from a management point of view, interacting with the international community is crucial. WATERS benefits from the extensive international involvement and experience of many of its individual partners and associated network of reference people. This is both with respect to participation in major European projects (e.g., STAR, EUROLIMPACS, WISER, and

REFRESH) and in active policy-related contexts (e.g., intercalibration, HELCOM, ICES, and OSPAR). By publishing reports in English, WATERS also makes all its results accessible to a wide range of stakeholders. To maintain close contacts with ongoing developments in policy and research, to learn from experiences in other countries, and to contribute to the body of scientific work aimed at WFD development, intensified international interaction is a high priority to WATERS in coming years.

We conclude that, in its first 22 months, WATERS has successfully dealt with the tasks defined in the project proposal. Some delays are noted, but overall the programme is progressing according to plan. The results produced during the first period, in terms of new knowledge and the establishment of administrative, communication, and networking routines, indeed provide a solid foundation for achieving the aims of WATERS at the end of the planned programme period.

List of abbreviations

Swedish full names are given in parenthesis when applicable.

Common abbreviations

BQE	Biological Quality Element (biologisk kvalitetsfaktor)
BQI	Benthic Quality Index
EQR	Ecological Quality Ratio (ekologisk kvalitetskvot)
SEPA	Swedish Environmental Protection Agency (Naturvårdsverket)
SwAM	Swedish Agency of Marine and Water Management (Havs- och vattenmyndigheten)
CAB	County Administrative Board (länsstyrelse)
RBDA	River Basin District Authority (vattenmyndighet)
HELCOM	The Helsinki Commission
OSPAR	The Oslo Paris Commission
ICES	International Council for the Exploration of the Sea
MSFD	Marine Strategy Framework Directive (havsmiljödirektivet)
WFD	Water Framework Directive (ramdirektivet för vatten)

Abbreviations used in WATERS

WP	Work package
FA	Focus area
SG	Steering group
RG	Reference group

1. Goals and organization

1.1 Goals and objectives

The WATERS research programme started on 1 April 2011 and is planned as a five-year programme. This report describes the results and progress achieved up to month 22. WATERS is a coordinated response to fulfil the objectives of the Swedish Environmental Protection Agency (SEPA, Naturvårdsverket) call of January 2009. The process leading to this call involved an evaluation of the first round of status assessments according to the WFD (Rolff 2009) and a questionnaire sent to county administrative boards (CABs), which are mainly responsible for carrying out the assessments. Consequently, the call identified needs to develop new indicators, refine existing indicators, and develop harmonized principles concerning reference conditions and uncertainty classification. The overall scientific goals for WATERS were outlined as follows:

- **More reliable and sensitive indicators –** the key success factors here are better knowledge of dose–response relationships and of species- and disturbance-specific sensitivity, validation of indicators through independent testing, and harmonization between Biological Quality Elements (BQEs).
- **Common strategies for defining reference conditions and class boundaries** will result in more appropriate classifications of the ecological status of individual BQEs.
- **Common strategies for accounting for the uncertainty of estimates and classification** are crucial for assessing the reliability of indicator estimates and classifications, and for designing cost-effective monitoring.
- **A coherent framework for whole-system assessment** will ensure the appropriate weighting of individual BQEs in whole-system assessment and provide methods for spatial extrapolation, necessary to assess water-bodies given that the data are insufficient.

To best achieve these objectives, WATERS is organized in three scientific focus areas (FAs) and 15 research work packages (WPs) (Figure 1.1 and Table 1.1). In addition, a fourth FA is responsible for programme coordination.

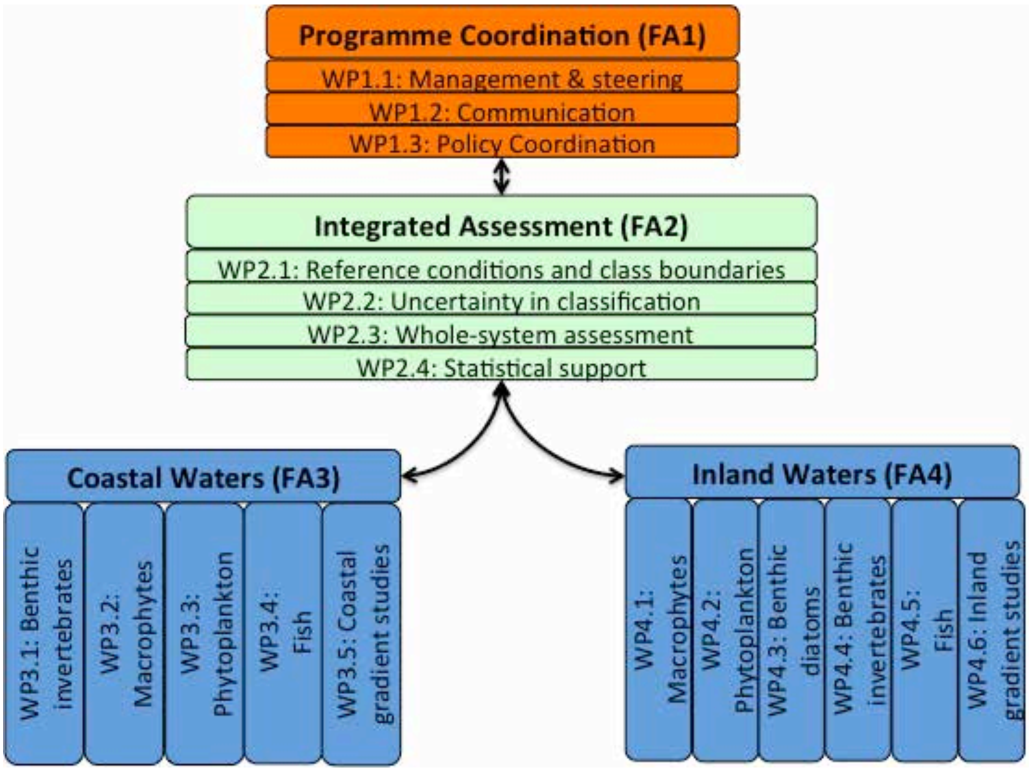

FIGURE 1.1
Organization and structure of WATERS.

In addition to these scientific components, the call also emphasized continuous communication and dialogue, both internally within the programme and externally with the scientific community and managing authorities, as key responsibilities. Therefore other important goals of WATERS are:

- **Efficient internal communication** allows cross-fertilization of ideas for indicator development and general assessment routines between BQEs and overarching parts of the programme. Particularly, and to the extent possible, exchanging ideas and approaches between freshwater and marine scientists is emphasized.
- **Continuous dialogue with national and regional authorities** ensures that programme relevance is constantly fine-tuned and that implementation is facilitated at all levels.
- **Frequent international interactions**, especially via the international peer-review process, is fundamental to the progress of science. Similarly, involvement in intercalibration groups and other processes at the European level ensures that new findings and approaches will influence the work within WATERS.

TABLE 1.1 Work areas and participants in WATERS as of January 2013.

AREA	PEOPLE	PARTNER
FA1 Programme coordination	**Mats Lindegarth (lead)**	GU
	Ulla Li Zweifel	GU
FA2 Integrated assessment	**Jacob Carstensen (FA lead)**	AU
WP 2.1 Reference conditions and class boundaries	Richard Johnson (WP lead)	SLU
WP 2.2 Uncertainty in classification	Mats Lindegarth (WP lead)	GU
WP 2.3 Whole-system assessment	Jacob Carstensen (WP lead)	AU
	Jesper Andersen	AU
WP 2.4 Statistical support	Ulf Grandin (WP lead)	SLU
	Anders Grimvall	GU
	Torsten Balsby	AU
FA3 Coastal waters	**Leif Pihl (FA lead)**	GU
WP 3.1 Benthic invertebrates	Rutger Rosenberg (WP lead)	MM
	Marina Magnusson	MM
WP 3.2 Macrophytes	Mats Blomqvist (WP lead)	Hafok
	Dorte Krause Jensen	AU
	Per Olsson	Toxicon
	Sofia Wikström	Aquabiota
	Susanne Qvarfordt	SVEAB
WP 3.3 Phytoplankton	Jakob Walve (WP lead)	SU
	Helena Höglander	SU
	Agneta Andersson	UmU
	Bengt Karlsson	SMHI
	Marie Johansen	SMHI
WP 3.4 Fish	Lena Bergström (WP lead)	SLU
	Martin Karlsson	SLU
	Leif Pihl	GU
	Ronny Fredriksson	SLU
WP 3.5 Gradient studies	Leif Pihl (WP lead)	GU
FA4 Inland waters	**Richard Johnson (FA lead)**	SLU
WP 4.1 Macrophytes	Frauke Ecke (WP lead)	SLU
WP 4.2 Phytoplankton	Stina Drakare (WP lead)	SLU
WP 4.3 Benthic diatoms	Maria Kahlert (WP lead)	SLU
WP 4.4 Benthic invertebrates	Richard Johnson (WP lead)	SLU
WP 4.5 Fish	Kerstin Holmgren (WP lead)	SLU
	Ulrika Beier	SLU
	Björn Bergquist	SLU
	Magnus Dahlberg	SLU
	Anders Kinnerbäck	SLU
WP 4.6 Gradient studies	Brendan McKie (WP lead)	SLU
	Amélie Truchy	SLU

1.2 Organization and operation

The coordination of WATERS forms a fourth and administrative FA organized around three WPs:

- WP 1.1 Management and steering
- WP 1.2 Communication
- WP 1.3 Policy coordination

WP 1.1 and WP 1.2 involve the coordination and organization of programme-level administration, reporting, and communication and are presented in chapters 1 and 2 of the report. WP 1.3 provides programme support concerning important developments in national and international policies and procedures for water quality management.

Management and steering

The steering of WATERS is based on the following functions (Figure 1.2):

- A secretariat including a programme coordinator and programme secretary. The programme coordinator is responsible for the overall management and steering of the programme, including chairing the steering group (see also below).
- A steering group consisting of the programme coordinator, FA leaders, and one representative from each of SEPA and the Swedish Agency of Marine and Water Management (SwAM, Havs- och vattenmyndigheten; see also below).
- FA leaders (including deputies), one for each of the three scientific FAs of WATERS, are responsible for coordinating work among WPs within individual FAs and for representing their FAs in the steering group.
- WP leaders are responsible for carrying out the tasks and completing the deliverables and milestones for each of the 15 WPs.

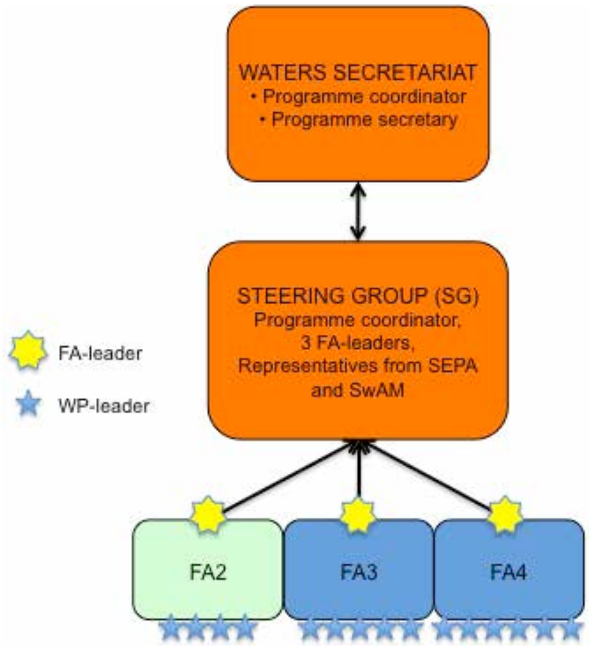

FIGURE 1.2
Schematic figure of the components and links connecting the steering functions in WATERS.

WATERS secretariat. WATERS is coordinated by the Swedish Institute for the Marine Environment, and the WATERS secretariat is located at the Institute's head office in Gothenburg. The secretariat consists of the programme coordinator and the programme secretary.

Steering group. The steering group (SG), the decision-making body of WATERS, makes formal and strategic decisions about the programme's budgets and overall research priorities. Rules for the SG are outlined in the WATERS consortium agreement. SG participants are, as of January 2013, one representative of SwAM, one representative of SEPA, the WATERS programme coordinator, and the three FA leaders. The programme secretary of WATERS participates in all meetings.

Meetings are held electronically once or twice each month. Twenty SG meetings had been convened as of January 2013. Discussions and decisions from all meetings are reported through minutes (available through the programme's intranet).

Internal communication

Communication, both internal and external, is the main activity of WP 1.2 and the responsibility resides with the programme coordinator. External communication, for example, via the WATERS reference group and users' fora, is described in chapter 2. The formal tools for internal communication are described below.

The electronic programme platform. The programme coordinator communicates with WATERS participants primarily using a web-based platform. A blog is used to continuously inform participants about WATERS secretariat activities, SG decisions, and relevant activities and news from important stakeholders. The blog is also open to individual partners to initiate discussions, exchange information among participants, and raise issues that might need further discussions or decisions in the SG. The platform also contains document depositories for contracts, meeting minutes, deliverables, scientific articles, discussion fora, and workspaces for all FAs.

Programme forum (PF). WATERS programme fora, which involve all WATERS scientists, are held every year. Programme fora offer opportunities for participants to present results, exchange experiences, and plan upcoming activities. They are particularly important for coordinating work between the scientific FAs. Programme fora were held in April 2011 and 2012; the third programme forum is planned for 16 April 2013.

Policy coordination

As part of the coordination, the WATERS proposal included a special work package (WP 1.3) aimed at providing analyses and syntheses of cross-disciplinary matters and policies. These activities are in-kind contributions from the Swedish Institute for the Marine Environment and are not funded by SEPA.

Several relevant issues have been identified under the common theme "Compatibility and conflicts between the WFD and other relevant directives and policies" for which we intend to produce policy briefs that raise and clarify issues where the outcomes of WATERS may have important consequences for water management. This theme resulted from discussions of the WATERS secretariat, steering group, reference group, and external researchers from the Swedish Institute for the Marine Environment. In particular, the collaboration with the research programme "A systems perspective on environmental quality standards" (SPEQS), also funded by SEPA and coordinated by the Institute, has been influential in forming ideas for the initial activities within this theme. SPEQS is led by Lena Gipperth and focuses on legal aspects of environmental quality standards in general and, in particular, on those related to aquatic environments.

The first policy brief will be entitled "The principles for dealing with uncertainty in status assessments using environmental quality standards" and is intended to clarify certain ecological and legal consequences of alternative principles for how uncertainties and the burden of proof is distributed (to be completed in month 24). Activities of this WP also include representing WATERS at a SPEQS stakeholder seminar in Uppsala and organizing a WFD legal–ecological workshop at the Swedish Institute for the Marine Environment attended by 15 researchers in law and ecology.

1.3 Scientific focus areas

This section refers to a number of deliverables constituting products outlined in the WATERS programme proposal. Expected deliverables and their statuses are summarized in Annex 1 of the report and published deliverables are available on WATERS web site (http://www.waters.gu.se).

FA2 – Integrated assessment

The objective of the FA on Integrated Assessment is to develop methods and routines to combine the information from existing BQE indicators with that developed in FA3 and FA4 into a holistic framework for assessing the ecological status of a water body.

To fulfil the objectives, the work in FA2 is organized in four WPs:

- WP 2.1 Reference conditions and class boundaries
- WP 2.2 Uncertainty in classification
- WP 2.3 Whole system assessment
- WP 2.4 Statistical support

WP 2.1 Reference conditions and class boundaries. This WP entails close collaboration with the BQE WPs in FA3 and FA4 to develop and communicate a coherent and transparent strategy for setting reference conditions and class boundaries, ensuring that all quality elements are properly and equally accounted for in the classification process. The WP will develop a framework for establishing reference conditions and coordinating their specific quantification within each of the BQE WPs in FA3 and FA4. The major objective is to ensure harmonized reference conditions and class boundaries across the BQEs developed in FA3 and FA4. WP 2.1 also develops methodologies and guidelines, whereas specific values for the different BQEs are developed in FA3 and FA4.

WP 2.2 Uncertainty in classification. This WP is developing a methodological framework for assessing uncertainties at various levels throughout the classification and uses this framework to devise improved monitoring strategies with improved classification precision. In collaboration with WPs in FA3 and FA4, this WP is developing tools for quantifying the magnitudes of various uncertainty components from monitoring data. In particular, the propagation of uncertainties from indicators to sub-elements and from sub-elements to BQE classifications through various models and decision rules is investigated.

WP 2.3 Whole system assessment. This WP is developing an assessment system including all BQEs. Indicators developed in FA3 and FA4 are combined in a rule-based system that reflects our scientific understanding of ecosystem functioning and diversity. This implies challenging the "one-out-all-out" principle and developing the simple heuristic rules formulated in the WFD. The assessment system will take into account interactions between BQEs as opposed to considering them as independent.

WP 2.4 Statistical support. This WP builds on a core group of scientists with extensive statistical expertise (with strong connections to the FAMILJ project funded by SEPA, with Ulf Grandin as project coordinator) who provide statistical support for the indicator development in FA3 and FA4 as well as the uncertainty framework development in FA2. The core group consists of statisticians with experience of analysing biological data from both fresh and marine waters. The core WP 2.4 group mainly advises the scientists in the other WPs on the appropriate statistical tools and ensures the correctness of the chosen statistical methods, but does not carry out the data analyses. This statistical support is provided through annual workshops, each having a main theme, but with the focus on analysing project data.

FA2 Coordination

The WP leaders in FA2 (i.e., Mats Lindegarth, Richard Johnson, and Jacob Carstensen), are all members of the steering group, that hold regular monthly meetings addressing the progress in FA2. In addition, the WP leaders frequently use Skype for discussions and email to exchange documents. The deliverables produced so far in FA2 have resulted from a joint effort involving all partners. Two meetings have been organized (in Roskilde and Tjärnö) to develop the uncertainty framework in WP 2.2, and this kind of collaboration has shown itself to be productive for developing and exchanging ideas. The web-based project platform has similarly been used to discuss broader issues amongst a wider group of WATERS participants.

Two statistical workshops have been collaboratively planned in WP 2.4 by the two co-leads, with Ulf Grandin handling the practical organization of the first workshop (Uppsala, February 2012) and Jacob Carstensen managing the second workshop (Tjärnö, January 2013).

FA2 Deliverables

A large part of the FA2 activities will occur in the last years of the WATERS programme because of the integrative nature of FA2. Therefore, several of the tasks have not been initiated yet, since they rely on results from FA3 and FA4 (see chapter 3). All deliverables planned for 2011–2012 are on time or in progress according to new deadlines approved by the SG, and the milestones have also all been attained (see also Annex 1, Deliverables).

- D 2.1-1: Database of published literature used in the review task. A literature study has been carried out to provide a state-of-the-art analysis of the methodologies used to determine reference conditions and class boundaries. The papers found by this literature study have been uploaded to a specific folder on web-based platform used by the programme, which constitutes the database.
- D 2.1-2: Review of existing literature on reference conditions and class boundaries. This deliverable was postponed from month 12 to month 18 by the SG. A report, describing various approaches to determining reference conditions and class boundaries from various EU and Swedish projects, will be published in the WATERS report series as report 2013:2.

- D 2.2-1: Review of uncertainty assessment of ecological data. This deliverable was postponed from month 12 to month 18 by the SG. A report, describing a novel uncertainty framework developed within WATERS, has been published in the WATERS report series as report 2013:1. The uncertainty framework is illustrated with studies of eelgrass in Öresund as well as benthic fauna along the coasts of Skagerrak and the Gulf of Bothnia.
- D 2.2-2: Guidelines for sampling designs for assessing various uncertainty components. This deliverable was postponed from month 12 to month 24 by the SG, because it depended on the outcome of D 2.2-1. Work on this deliverable has been initiated and a draft outline produced. The report will be delivered according to the new deadline.
- D 2.4-1: Workshop summary report year 1. This deliverable summarizes the outcome of the first statistical workshop, which was held in Uppsala in February 2012.

FA3 – Coastal waters

The focus of this FA is to develop operational indicators of eutrophication, and to develop a detailed understanding of how benthic invertebrate, macrophyte, phytoplankton, and fish species respond to eutrophication gradients in coastal areas. Central themes are to understand the relationships between community composition and stress, and to identify how biodiversity and community functions are related. Reference values and class boundaries will be suggested for each indicator and tested over different geographical scales. Because this work is based mainly on compilations of data available from existing monitoring and research activities, which differ greatly between BQEs, the details of the obtained results will differ between indicators.

For some BQEs, the work focuses on further developing existing indices, but for others new and alternative indices will be developed. Furthermore, to harmonize, compare, and validate the suggested indicators, their response will be evaluated in common pressure gradients. The dose–response relationships will be quantified across BQEs in common field campaigns in two geographic areas: the west and east coasts of Sweden.

FA3 is organized around five WPs:

- WP 3.1 Benthic invertebrates
- WP 3.2 Macrovegetation
- WP 3.3 Phytoplankton
- WP 3.4 Fish
- WP 3.5 Gradient studies

Common aims of all WPs are: 1) to develop operational indicators and detailed understanding of how species respond to eutrophication, 2) to develop reference values and class boundaries for each indicator tested over different geographical scales, 3) to harmonize, compare, and validate the suggested indicators' responses to eutrophication in common pressure gradients, and 4) to evaluate indicators based on their sensitivity to pressure, associated uncertainty, and relevance as descriptors of ecological status according to the WFD.

WP 3.1 Benthic invertebrates. The focus of this WP is to assess the status of coastal marine habitats based on studies of benthic macrofaunal composition and the presence/absence of sensitive and tolerant species. This will be achieved by using and refining the existing benthic quality index (BQI). The classification of the good–moderate status boundary will also be evaluated for various salinities, exposures, and transitional waters. The BQI should harmonize with other classifications for marine coastal areas.

WP 3.2 Macrophytes. In relation to the present WFD indicator system, new indicators selected from the literature and/or novel indicators based on species/group traits are evaluated in relation to anthropogenic and natural stressor gradients. The high diversity in habitats and present field methods along the coast will be related to different stratifications (e.g., depth, substrate, and exposure) and suitable sampling methods and designs will be evaluated to obtain adequate data for robust assessment using selected indicator(s).

WP 3.3 Phytoplankton. The current assessment system for phytoplankton uses chlorophyll and phytoplankton biovolume, if such data are available. The focus of this WP is to improve assessment routines using existing indicators and to develop new improved indicators that include taxonomic and functional properties of phytoplankton.

WP 3.4 Fish. The focus is to develop new tools for the status assessment of coastal fish communities. Coastal fish is not one of the mandatory BQEs of the WFD, but is a component of the ecosystem-based approach prescribed by the MSFD and was therefore an important part of the WATERS proposal. WP 3.4 aims to provide a coherent view of the biodiversity of coastal fish communities and the main pressures along the Swedish coast, based on existing and developing knowledge. Currently applied and developing indicator-based status assessment tools (e.g., HELCOM and MSFD) are evaluated from the WFD perspective and developed further to suggest consistent recommendations for coastal fish monitoring and management.

WP 3.5 Gradient studies. With the aim of harmonizing, comparing, and validating the suggested indicators, their individual responses will be evaluated in common pressure gradients. The dose–response relationships will be quantified across BQEs in common field campaigns on the west and east coasts of Sweden. With the common sampling campaign it is possible to study the precision and sensitivity of indicators from different taxonomic groups. The suggested reference values and class boundaries can also be evaluated individually for each indicator. The gradient study is a common approach for the quality assessment of indicators in the coastal environment.

FA3 Coordination

The coordination of FA3 is ongoing via monthly contacts between the FA leader and the WP leaders. In addition, there have been five 1–2 day workshops organized by the FA3 leader. Workshops including all WP leaders, and on some occasions specially invited experts as well, were arranged in April and November 2011 and in February, April, and December 2012. During these workshops, ongoing work was reported and common future activities were discussed and decided.

FA3 Deliverables

The work in FA3 is accomplished according to the project plan for 2011 and 2012. Three deliverables were planned during the first 18 months of the project in FA3 (see also Annex 1, Deliverables):

- D 3.2-1 Macrophytes: Report on potential indicators of Swedish coastal macrophytes (month 12)
- D 3.3-1 Phytoplankton: Report on results of literature survey of phytoplankton indices (month 18)
- D 3.4-1 Fish: Report on assemblage structure of littoral fish in Swedish coastal waters (month 18)

All these reports have been delivered and were approved by the WATERS SG.

Furthermore, the gradient study (WP 3.5) was initiated in 2012 and is planned to continue through 2013. Samples were collected from May to September 2012, and data will be analysed and reported in winter 2013.

FA4 – Inland waters

The focus of FA4 is to coordinate the development of WFD-compliant indicators to detect human-induced stress in inland waters. A particular focus is on how selected pressures affect the biodiversity and function of lake and stream ecosystems. Five taxonomic groups (aka BQEs according to the WFD), i.e., macrophytes, phytoplankton, benthic diatoms, benthic invertebrates, and fish, as well as additional functional responses, for example, leaf litter decomposition and ecosystem metabolism, are being studied. The common general approach of WPs 4.1–4.5 is to combine and collate monitoring data from national and regional monitoring activities. These data will then be used to study the response of metrics currently used in ecological classification (SEPA 2007). The focus will be on identifying ecological breakpoints, and examining how these relate to WFD-normative definitions of ecological status. If needed, adjustments will be proposed in classification schemes, for example, changes in class boundaries or in uncertainties. Moreover, besides assessing the response of metrics currently used in ecological assessments, the biological response to hitherto poorly studied pressures (e.g., hydromorphological alteration) will also be studied. In addition to studying structural components, using data from field campaigns, FA4 is also addressing functional responses to selected pressures. Data from the gradient studies will be used to validate BQE response to stress, and to compare the responses of different taxonomic groups to selected pressures. The strengths and uncertainties associated with response metrics will be useful in designing more cost-effective monitoring.

FA4 is organized around six WPs:

- WP 4.1 Macrophytes, streams and lakes
- WP 4.2 Phytoplankton, lakes
- WP 4.3 Benthic diatoms, streams and lakes
- WP 4.4 Benthic invertebrates, streams and lakes
- WP 4.5 Fish, streams and lakes
- WP 4.6 Gradient studies, stream and lakes

Common goals of all WPs are: 1) to validate indicator response to selected pressures (i.e., elevated nutrient concentrations, acidity, and hydromorphological alteration), 2) to calibrate new metrics (e.g., hydromorphological alteration), 3) to compare structural and functional responses to selected pressures, 4) to harmonize reference conditions for all BQEs (i.e., revising the pressure filter), 5) to evaluate type- versus site-based approaches to partitioning natural variability and estimating reference conditions, 6) to harmonize approaches used in quantifying the uncertainty associated with using different BQEs, and 7) to use harmonized approaches to setting class boundaries. Points 4–7 are done in collaboration with work in FA2.

WP 4.1 Macrophytes, streams and lakes. This WP has two objectives. First, existing macrophyte metrics for assessing ecological status in lakes and streams will be evaluated and, if necessary, new indices and metrics will be developed. The pressures to be studied are eutrophication, acidification, and alterations in hydromorphology. The uncertainty associated with the use of macrophyte metrics to assess the ecological status of selected lake and stream types will be quantified. Second, the potential and limitations of using aerial photography (including unmanned aerial vehicles, UAV) as a low-cost monitoring method for macrophyte assessments will be evaluated.

WP 4.2 Phytoplankton, lakes. The objective of this WP is to validate existing metrics using data from the field campaign (i.e., on eutrophication pressure) and data from the CABs to complement the national phytoplankton monitoring datasets. The eutrophication metrics developed during the ECOSTAT Intercalibration and WISER projects will be tested using these new data. If data cover lakes subject to other pressures, new metrics will be developed. Phytoplankton data from the gradient study will also be used to test new and promising DNA methods for measuring phytoplankton.

WP 4.3 Benthic diatoms, streams and lakes. The main objective of this WP is to validate existing and develop new stream indices for eutrophication, acidification, alterations in hydromorphology, and forestry. The uncertainty associated with using benthic diatom metrics to assess the ecological status of selected stream types will also be quantified. Building on experiences using benthic diatoms in stream ecosystems, the efficacy of lake littoral benthic diatom assemblages to detect human-generated stress will be evaluated. New approaches to developing more cost-effective variables will be assessed, such as the use of pigment data as opposed to taxonomic information for assessing ecological status.

WP 4.4 Benthic invertebrates, streams and lakes. National datasets, complemented with data from regional monitoring boards, will also be used to validate current metrics. Furthermore, for pressures not currently addressed in classification schemes, these datasets will be used to calibrate new metrics if adequate pressure–response relationships are identified. One of the main objectives of this WP is to validate existing metrics using data from the field campaigns. Gradient studies will focus on nutrient concentrations in lakes and streams, and on hydromorphological alteration and forestry effects on streams.

WP 4.5 Fish, streams and lakes. Existing metrics for assessing the ecological status of fish assemblages in lakes and streams will be validated using existing data and data generated in the standardized field campaign. Furthermore, new indicators will be developed for eutrophication, acidification, alterations in hydromorphology, and forestry (e.g., riparian integrity) in lakes and streams. The uncertainty associated with the use of fish metrics to assess the ecological status of selected lake and stream types will be quantified.

WP 4.6 Gradient studies, stream and lakes. The main objectives of this WP are: 1) to design a robust field assessment of indicator response to selected pressures and 2) to evaluate the precision and sensitivity of different taxonomic groups and functional response variables to selected pressures. This knowledge will be used to improve our understanding of stress–response relationships and, subsequently, of how this information can be used to design more robust management programmes. In addition, data from the field study will be used to validate current classification criteria, and, if necessary, develop and calibrate new stressor-specific metrics. WP 4.6 focuses on three stressor classes: 1) nutrient enrichment, 2) hydromorphological alteration and, 3) forestry.

FA4 Coordination

Coordination of FA4 Inland waters has been ongoing via periodic (often monthly) contact between the FA4 leader and the WP leaders. In addition, meetings have been organized in the form of workshops and annual project meetings. To date, most discussions have addressed issues related to data collation (constructing templates for uploading data from regional monitoring activities) and field campaign design and implementation.

FA4 Deliverables

The deliverable "Macrophytes: Manuscript on the use of aerial photographs of macrophyte assemblages in environmental assessment" (D 4.1-1), due in month 24, has been submitted to a peer-reviewed scientific journal. Milestones due in month 24, i.e. collation of macrophyte, phytoplankton, benthic diatom, benthic invertebrate, and fish data, have been delayed due to problems uploading of regional monitoring data. Best estimates are that data will be uploaded by February 2013, and then WP leaders will start collating the biological and environmental data.

2. Communication and external interactions

This chapter outlines the external communication and interaction of WATERS. These activities are the responsibilities of the programme coordination, WP 1.2 Communication, and of the external contact people of all WATERS partners.

2.1 Communication plan and shared elements

The communication strategy outlined in the WATERS application was detailed in a plan for internal and external communication at the start of the programme (available in Swedish). External activities and dissemination are detailed in sections 2.2 and 2.3.

To create a recognizable visual identity for WATERS, a common graphic profile has been established for the programme, including a logotype, PowerPoint template, and report template.

In addition, joint author instructions have been formulated for the two main scientific outputs of WATERS: reports and peer-reviewed articles (available in Swedish).

2.2 Activities

Outreach activities over the first two years of WATERS are summarized in Table 2.1.

TABLE 2.1
WATERS external activities. SwAM = Swedish Agency for Marine and Water Management, RBDAs = river basin district authorities, CABs = county administrative boards, SYKE = Finnish Environment Institute, DN = Norwegian Directorate for Nature Management.

Activity	Participants	Executed
Reference group (RG) meetings	SwAM, 5 RBDAs, SYKE, DN (January 2013)	RG1: 15 Nov 2011 RG2: 19 Apr 2012 RG3: 26 Oct 2012
Workshops with CAB	WATERS, CABs	14 Nov 2011
Users' forum	CABs, RBDAs, other Swedish water authorities, Scandinavian RBDAs	Planned, 18 April 2013
External presentations	Various	Ongoing – see Annex 2
WP–CAB interactions	WATERS, CABs	Ongoing – see Table 2.2 and Annex 3

Reference group meetings

Reference group (RG) meetings are held at least once per year. Reference group participants comprise, as of January 2013, a representative of SwAM, representatives of the five river district basin authorities (RDBA, Vattenmyndigheter), a representative of the Finnish Environment Institute (SYKE), and a representative of the Norwegian Directorate for Nature Management (DN). Participants from WATERS are the secretariat and FA leaders.

The reference group advises the programme and provides information on activities and national and international water management issues relevant to WATERS. Advice from the reference group is not binding but highly respected and carefully considered in WATERS. The meetings are reported in meeting minutes (available through the programme's intranet).

Workshops with county administrative boards

Workshops with external participants were not explicitly planned for in the WATERS application but are greatly desired by representatives of CABs and RBDAs. Although no funds are allocated for this purpose, WATERS has tried to accommodate this request as far as possible, by providing the following:

1. **A dedicated seminar.** A half-day seminar with representatives of CABs and RBDAs was held in November 2011. The purpose of the seminar was to incorporate the experience and problems encountered by CAB representatives when implementing the current Swedish assessment criteria. BQE-specific issues were discussed in sub-groups focusing on coastal and inland waters, respectively. The meeting was attended by 23 external participants. Meeting minutes documented the presentations and discussions.
2. **WATERS statistical workshops**. Representatives of CABs and RBDAs are invited to the annual statistical workshops arranged by FA2, WP 2.4.
3. **Direct interactions between WPs and CABs**. Many WPs have ongoing direct communications with the CABs, and this interaction is anticipated to increase as the development and testing of indicators moves into an active phase in the upcoming period of WATERS (Table 2.2, Annex 3).
4. **Users' forum.** The upcoming WATERS users' forum (see below) will focus on interactions with CABs.

Users' forum

A users' forum will be held twice during the programme period, with the first forum planned for 18 April 2013. Users' fora were initially intended as broad stakeholder meetings including people working on water management as well as representatives of interest groups, such as farmers, industries, and environmental organizations.

In the course of planning and after discussions with SwAM representatives, the intended stakeholder group has been reconsidered. The WATERS users' forum will include only people involved in water management. The main target groups are: 1) representatives of CABs and RBDAs, 2) other Swedish authorities interested in water management, and 3) special invitees from Scandinavian river basin authorities with which Sweden must interact in future WFD intercalibration exercises. During the meeting, workshops will be held specifically focusing on particular BQEs.

To achieve the goal of informing and reaching out to a wider group of stakeholders, WATERS will present the programme and results on 17 April 2013 at the upcoming annual SwAM conference.

External presentations

WATERS frequently gives presentations on request in various fora interested in water management, for example, seminars organized by CABs, organizations, and related research and management initiatives. External presentations are summarized in Annex 2.

External cooperation and contacts of individual work packages

WATERS participants frequently and continuously interact with various national and international stakeholders (Table 2.2 and detailed in Annex 3). When preparing this report, we documented more than fifty ways in which WATERS participants have interacted with regional, national, and international stakeholders in matters related to their work within WATERS. Many of these interactions were not defined in the WATERS proposal but are the result of needs and opportunities identified in the daily work.

Mutual benefits are evident in the many cooperative activities between WATERS and Swedish water authorities, including engagements in monitoring or database services. In addition, WATERS participants frequently participate in expert or reference groups, various projects and seminars, as well as individual consultations. Table 2.2 shows that all WPs of WATERS frequently interact with national and international water management and stakeholder communities. This is and will be crucial for disseminating and incorporating WATERS results into water management.

TABLE 2.2
Summary of stakeholder contacts of WPs or WP participants in WATERS. A) External cooperation. B) Participation in expert groups. SwAM = Swedish Agency for Marine and Water Management, SEPA = Swedish Environmental Protection Agency, RBDAs = river basin district authorities, CABs = county administrative boards, VVF = vattenvårdsförbund (water association), IC = intercalibration, IRP = international research projects, BMB = Baltic Marine Biologists.

A. External cooperation

Activity	SwAM	SEPA	CAB	RDBA	VVF	IRP
Individual consultation and participation in meetings	3.4	2.2	2.2 3.4	2.2 3.4	3.3	
Joint projects	3.4 3.5 4.2 4.5	3.1 3.4 3.5 4.5	2.2 3.4 3.5	2.2		3.3 3.2
Collaboration in monitoring or database matters	4.3 4.5	3.2 4.3	4.3 4.5 4.6			

B. Participation in expert groups

Activity	SwAM	HELCOM	OSPAR	ICES	IC	IRP	BMB
Expert or reference groups	1.3 2.2 3.4 4.2	1.3 2.1 2.3 3.2 3.3 3.4	1.3 3.3	3.3 3.4	3.2 4.1 4.2 4.3 4.4 4.5	4.5	3.2

2.3 Dissemination

Information is disseminated in various ways, as summarized in Table 2.3.

TABLE 2.3
WATERS external dissemination activities.

Dissemination mode	Target groups	Executed
Website	General interest groups, scientists, and experts	Oct 2011
Leaflet	General interest groups	Dec 2011
Newsletters	Water management	Pending
@WATERS_SWE/twitter	General interest groups	Feb 2011
Reports	Water management	Ongoing, first report Sept 2012
Scientific papers	Scientists and experts	Ongoing, first draft Oct 2012

WATERS website at http://www.waters.gu.se

Since October 2011, WATERS has had a dedicated website available in Swedish and English. The website has the following main pages:

1. **About WATERS.** Information about the WATERS programme, the WFD, and the Swedish assessment criteria for implementing the WFD. The information targets interested parties in general.
2. **Research.** Information about the scientific WPs of WATERS. The information targets scientists and people working on water management.
3. **Publications.** Presentations, reports, and newsletters from WATERS. This is the main platform for the external distribution of WATERS results and products.
4. **Events.** Advertising upcoming events.
5. **Contact us.** Contact information for WATERS participants.

WATERS leaflet

A brief information leaflet targeting interest groups in general was released in December 2011. The leaflet is available in Swedish and English and is distributed at conferences, meetings, etc.

WATERS newsletters

Newsletters are the only planned communication mode that has not yet been realized. The newsletters are intended to target people working on water management in Sweden to inform them about WATERS and maintain interest in the programme. No newsletters have been produced yet because there has so far been little news to report from WATERS. As more results and reports become available, the amount of news to report will increase. Newsletters are foreseen as an important information dissemination tool in the upcoming phase of WATERS, and their graphic design and technical elements are ready for use.

@WATERS/twitter

WATERS has a Twitter account, @WATERS_SWE, through which anyone interested can follow news updates and interact with the WATERS programme coordinator at any time. Twitter also allows WATERS to follow the debate on water-related environmental issues in Sweden and Europe. As of mid January 2013, @WATERS_SWE had 75 followers, including several civil servants at relevant authorities, interest-group and NGO representatives, academics, politicians, and members of the general public. @WATERS_SWE was not included in the original communication plan, but was initiated in response to current developments in social media.

WATERS report series

Many WATERS deliverables are reports, several of which are already available (see WATERS web site at http://www.waters.gu.se). The reports target professionals working on water management. The reports are written in English since they will likely interest people involved in developing water quality indicators across Europe. The report summaries, however, are also written in Swedish.

The reports are reviewed in the applicable FAs, the SG, and, as of October 2011, also by the RG. They are frequently also distributed for comments among all WATERS participants. Final pre-publication approval of the reports is granted by the SG. In approving reports, the SG considers whether they fulfil the tasks outlined in the programme application. The reports form part of a dedicated WATERS report series published by the Swedish Institute of Marine Environment.

The reports are made available as pdf files on the WATERS website and are distributed by email to interested parties. The recipient list is revised depending on the report topic, but includes several hundred recipients, for example, Swedish water authorities, experts associated with HELCOM, OSPAR, and EU working groups, and experts previously involved in the WISER project.

Scientific papers

Deliverables from WATERS also include scientific papers, peer-reviewed through the target journals. Before submission, the articles are approved as deliverables of WATERS by the SG.

These scientific papers are supplemented with extended summaries in Swedish and English. These summaries highlight the papers' practical implications for water management and are intended to present the results more accessibly than in the papers and their abstracts. When a paper is published in a journal, a link to it is placed on the WATERS website.

A joint acknowledgment of WATERS and funding agencies has been formulated for inclusion in these scientific papers.

3. Results and future activities

This chapter refers to a number of tasks defined in the WATERS programme proposal. The start times differ between tasks, some of which have only recently begun and belong to future activities (years 3–5) of WATERS.

3.1 FA2 Integrated assessment

WP 2.1 Reference conditions and class boundaries

Well-defined reference conditions and class boundaries are fundamental to environmental assessment and integral issues affecting management decisions. The main objective of WP 2.1 is to coordinate the development and harmonization of reference conditions and classification schemes for inland and marine systems. This WP consists of four tasks:

Year	1		2		3		4		5	
WP2.1 Reference conditions and class boundaries										
Task 2.1.1 Review of methods										
Task 2.1.2 Modelling strategy framework										
Task 2.1.3 Uncertainty										
Task 2.1.4 Synthesis										

The first two deliverables, "Database of published literature used in the review task" (D 2.1-1) and "Establishing reference conditions and setting class boundaries" (D 2.1-2), reviewed current approaches to establishing reference conditions and setting class boundaries. The deliverable "Initial set of guidelines for reference conditions and class boundaries" (D 2.1-3), due in month 24, has been delayed due to problems receiving and collating regional monitoring data (see FA4 chapter 1).

Results and activities

A review of methods used to establish reference conditions as part of task 2.1.1 demonstrated that approaches varied markedly among habitat types (i.e., inland versus coastal/marine) (D 2.1-2). For inland surface waters, spatial approaches (typology) are commonly used to establish reference conditions, while for marine systems a suite of methods is currently used (e.g., typology, historical data, modelling, and expert judgment).

The approaches used to establish reference conditions for inland waters have been harmonized largely through collaboration among the working groups developing the current assessment criteria (SEPA 2007). In brief, following WFD recommendations, pressure criteria were used to identify pristine/minimally-disturbed sites, and then ecoregion delineations, in some cases combined with ecosystem types, were used to partition natural variability.

In coastal waters, several approaches are used to define reference conditions. Explicit pressure criteria, used to identify minimally disturbed areas, are not generally used to establish reference conditions in coastal BQEs. This likely reflects the openness and connectivity of marine systems and the relative importance of diffuse pressures, particularly excess nutrients, which makes it difficult to identify minimally disturbed areas. Instead, reference conditions for the individual BQEs in marine areas were to varying degrees defined using historical data in combination with expert judgment and modelling.

As with defining reference conditions, methods for establishing high–good (H–G) and good–moderate (G–M) boundaries differed markedly both within and between inland and marine systems. Related to the use of minimally disturbed sites in establishing reference conditions, classification schemes for inland waters often used distributions of high-quality sites in setting H–G boundaries. Given the importance of the G–M boundary in rehabilitation/mitigation (WFD), our review demonstrated that considerable attention was paid to accurately identifying this boundary when developing classification schemes. If thresholds were identified, these ecological breakpoints were used in setting the G–M boundary. Alternative methods included modelling and use of sensitive/tolerant taxa or equidistant classes. Regardless of the method used, for inland waters consideration was given to the normative definitions of the WFD. To set class boundaries below the G–M boundary, many approaches employed generic methods, such as using equidistant classes.

In coastal waters, despite the general focus on the G–M boundary, there are occasionally substantial differences among BQEs and among regions. This is the case for both absolute estimates of Ecological Quality Ratios (EQR)and relative values of biological response variables. In conclusion, for the coastal BQEs, the G–M boundary was set such that 50–125% deviations were tolerated for phytoplankton, 50–75% for benthic fauna, and 50% for vegetation expressed on a relative scale of response variables. It is important to stress that these differences may well be biologically justified. Nevertheless, these patterns reflect inconsistencies that have not been clarified.

Future work

Given that our review identified many discrepancies in the methods used to define reference conditions and set class boundaries, future work (task 2.1.3) in WATERS will address many of the issues. During the next year, the focus will be on revising methods used to establish reference conditions for inland waters (e.g., revising the pressure filter). This will be done by improving, where necessary, threshold values for some criteria (e.g., nutrient thresholds) and adding new criteria if data are readily available (e.g., for hydromorphological alteration and invasive species effects). For marine systems, the focus will be on refining and harmonizing definitions of reference conditions, for example, using historical data and modelling. In addition, there is a growing concern that typology-based systems are not as robust as site-specific approaches to establishing reference conditions and detecting ecological change. WATERS will test the usefulness of typology- versus modelling-based approaches. Finally, as uncertainties are inherent to all environmental assessments, WATERS will identify how various forms of uncertainty (e.g., method-based and natural variability) affect ecological classifications. Work on setting class boundaries done in WP 2.1 will connect to other tasks planned for WP 2.2 (e.g., task 2.2.2) and WP 2.3 (e.g., task 2.3.1).

WP 2.2 Uncertainty in classification

The WFD requires member states to assess and report aspects of uncertainty. The overall aim of this WP is to develop more coherent and robust methods for addressing uncertainty in classification. To realize this aim, this WP considers the following five tasks:

Year	1		2		3		4		5	
WP2.2 Uncertainty in classifications	■	■	■	■	■	■	■	■	■	■
Task 2.2.1 Review of methods	■	■								
Task 2.2.2 Development of uncertainty framework	■	■	■	■						
Task 2.2.3 Identification and quantification of uncertainties			■	■	■	■	■	■		
Task 2.2.4 Uncertainty propagation through classification							■	■	■	■
Task 2.2.5 Monitoring designs to reduce uncertainty									■	■

The first deliverable of this WP, "Uncertainty of biological indicators for the WFD in Swedish water bodies: current procedures and a proposed framework for the future" (D 2.2-1), fully covers the first two tasks while the third and fourth tasks are partly covered. The second, ongoing deliverable, "Uncertainty of biological indicators for the WFD in Swedish water bodies: theoretical and practical sampling designs to quantify overall uncertainty and its components" (D 2.2-2), exemplifies how the findings of the first deliverable can be used to help complete the fifth task. The completion of the last three tasks is dependent on upcoming work on specifying new and existing indicators, which is due to be completed in the second phase of the programme.

Results and activities

The results of the initial reviews (task 2.2.1) clarify that two aspects of uncertainty are defined in the WFD: precision and confidence in classification. Despite the technical definitions of these concepts being well known, issues to do with acceptable levels of confidence and burden of proof are still open to debate and value judgement. Reviews of Swedish assessment procedures as developed in "the handbook" (SEPA 2010) demonstrate that the approach to and practical application of uncertainty assessments differ greatly among BQEs. This is partly because of issues related to differences in biology and sampling methods, but also partly because of seemingly arbitrary differences in the approaches applied to assess uncertainty. Furthermore, we conclude that none of the BQEs in the handbook provide a comprehensive treatment of spatial and temporal sources of uncertainty in a way that reflects the uncertainties associated with assessment throughout a six-year cycle. Consequently, the uncertainty, in terms of both precision and confidence, likely differs among BQEs, among water bodies, and among water types, and that there often is a risk that the uncertainty of an estimate or a classification is unknown.

As a possible way to resolve these inconsistencies, a general framework for treatment of monitoring uncertainties is proposed (task 2.2.2). This framework involves the conceptual identification and quantitative estimation of relevant random (unpredictable) and fixed (predictable) components of variability, and provides a method for estimating the total, combined uncertainty at a certain spatial and temporal scale. The general structure of estimates of total variability can be described as follows (*CAPITAL* letters indicate random sources and *lower case* letters fixed sources):

$$y = \mu + \underbrace{year + YEAR + season + SEASON \times YEAR + DIURNAL + IRREGULAR}_{temporal\ sources\ of\ uncertainty}$$
$$+ \underbrace{gradient + GRADIENT + PATCHINESS}_{spatial\ sources\ of\ uncertainty}$$
$$+ \underbrace{YEAR \times GRADIENT + SEASON \times GRADIENT}_{spatio-temporal\ interactions}$$
$$+ \underbrace{sampling\ devices + PERSON + instrument + REPLICATE}_{sampling\ and\ measurement\ uncertainties}$$

Focusing on uncertainties at spatial and temporal resolutions consistent with those defined in the WFD, this framework is applied to analyse how designs differing in spatial and temporal replication, in combination with existing patterns of spatio-temporal variability, may influence sampling design optimization. This framework was used for assessing two case studies of benthic vegetation and invertebrate fauna.

The analyses contained in the first report generally conclude that the uncertainty framework can help improve the consistency and transparency of uncertainty assessments in Swedish coastal and inland waters. Opportunities to develop a catalogue of uncertainty estimates for Swedish indicators, based on extensive, quality-controlled datasets, should be developed (i.e., task 2.2.3). Such a catalogue would provide an important tool for future status assessments, particularly when monitoring programmes are not particularly extensive.

The developed framework constitutes an important foundation for the further development of monitoring designs in subsequent work in FA2, for future work on harmonizing Swedish assessment procedures in collaboration with FA3 and FA4 (as well as with the authorities in an WFD context), and possibly whenever needs arise in related contexts such as the MSFD. In the near term, it will be used in ongoing work on the second deliverable. This work will explore various sampling strategies and their utility for quantifying individual components of variability and their combined effects on overall uncertainty (task 2.2.4). We are also assessing these alternative designs in relation to current monitoring practices in terms of sampling frequencies, number of stations, and sample sizes for different BQEs in coastal and inland water bodies (Table 3.1). Together with future estimates of different components of variability, this overview permits the analysis of general differences in uncertainty among BQEs and the evaluation of strategies for monitoring programme optimization (tasks 2.2.3–2.2.5).

TABLE 3.1
Summary of monitoring data potentially available for WFD status assessment per BQE and water body. Note that the data from all sampled water bodies may not fulfil the requirements specified in the Swedish assessment criteria (NSF 2008: 1). Numbers reflect the most common metric for BQEs when several metrics are defined. Data were derived from VISS (http://www.viss.lansstyrelsen.se) in October 2012.

BQE	No. of stations sampled	No. of water bodies sampled	% of all water bodies	Typical no. of times per WFD cycle	Typical no. of stations per water body	Typical no. of samples per station and time
Costal waters						
Benthic invertebrates	155	77	12.8	6	1	1–5
Macrophytes	156	77	12.8	6	1	1
Phytoplankton	240	160	26.6	30	1	1
Lakes						
Benthic invertebrates	237	192	2.7	2	1	5
Macrophytes	49	48	0.7	1	1	1
Phytoplankton	459	459	6.3	6	1	1
Fish	215	204	2.8	1	1	1
Streams						
Benthic invertebrates	731	629	4.0	2	1	5
Benthic diatoms	413	376	2.4	3	1	1
Fish	1056	645	4.1	3	1	1

Future work

Preliminary results indicate that the uncertainty of estimates and classifications for different BQEs is caused by complex combinations of errors arising from sampling methods and from spatio-temporal variability. A comprehensive analysis of all these conceptual sources of uncertainty in a general framework is imperative for the design and optimization of robust sampling programmes. Furthermore, compilations of current monitoring designs for coastal and inland waters, using data from VISS, are used to produce an overview of current monitoring designs. Unsurprisingly, these compilations indicate differences among systems and BQEs in terms of sampling frequency, number of stations, and samples per water body (Table 3.1). These differences are clearly justified by the characteristics of spatio-temporal variability, but the overall effects of these differences among BQEs on estimation and classification uncertainty remain to be evaluated. This work will subsequently form the basis for activities in years 3–5 of the WATERS programme. In particular, the combination of information about current monitoring designs and the forthcoming development of a comprehensive library of the estimated magnitudes of various components of uncertainty will be used in assessments: 1) to provide the uncertainty of status classifications using current and future monitoring designs (tasks 2.2.3 and 2.2.4) and 2) to reduce uncertainty by providing guidelines for modifying monitoring designs (task 2.2.5).

WP 2.3 Whole system assessment

The aim of WP 2.3 is to develop an integrated assessment system that combines indicators of the different BQEs for the overall assessment of ecological status (task 2.3.5). This also involves incorporating the confidence of the different indicators into the assessment. WP 2.3 will address such issues in the development of the integrated assessment system (tasks 2.3.2 and 2.3.3).

Year	**1**		**2**		**3**		**4**		**5**	
WP2.3 Whole system assessment			■	■	■	■	■	■	■	■
Task 2.3.1 Review of assessment systems			■	■						
Task 2.3.2 Conceptual framework			■	■	■	■				
Task 2.3.3 Verification of assessment system					■	■	■	■	■	■
Task 2.3.4 Whole-system assessment, non-monitored sites									■	■
Task 2.3.5 Synthesis for whole-system assessment									■	■

Results and activities

The activities related to the integrated assessment of ecological status have so far focused on further development of the HELCOM Eutrophication Assessment Tool (HEAT), originally developed for assessing the ecological/eutrophication status of both coastal waters (cf. the WFD) and offshore waters (cf. the Baltic Sea Action Plan and the EU MSFD). The HEAT tool produces a primary assessment of "eutrophication status" or "ecological status" depending on how the indicators are grouped. The principles and methods of HEAT are described by Andersen et al. (2010a). HEAT also produces a secondary assessment of the confidence of the primary status classification, currently based on qualitative expert judgement (see Andersen et al. 2010b for details).

Recent HEAT developments include:

1. Simplification of the tool by reducing the number of themes (equivalent to groups/quality elements) to three (i.e., causative factors, direct effects, and indirect effects or, alternatively, phytoplankton, submerged aquatic vegetation, and benthic macrofauna). The number of themes was reduced in line with the EC decision regarding the MSFD. Reintroducing a fourth group/category (e.g., fish) or supporting indicators (e.g., hydromorphological quality elements or nutrients) would be straightforward.
2. A more balanced estimate of confidence in the final classification is one in which the tool equally weights the target (calculated on the basis of information on reference conditions and acceptable deviation) and monitoring data. In the first version of HEAT, the confidence was estimated by scoring the accuracy of the values representing reference conditions, acceptable deviation, and current status – all per indicator. Indicator scores were combined per quality element, and quality scores were subsequently combined into a final estimate of confidence. See Andersen et al. (2010b) for a full description of the scoring methodology.

The HEAT tool has recently been tested for application to Baltic Sea open water basins, and both "eutrophication status" and "confidence" have been estimated for a transect along the Swedish coast from the Kattegat through the Øresund to the Bothnian Bay (Figure 3.1).

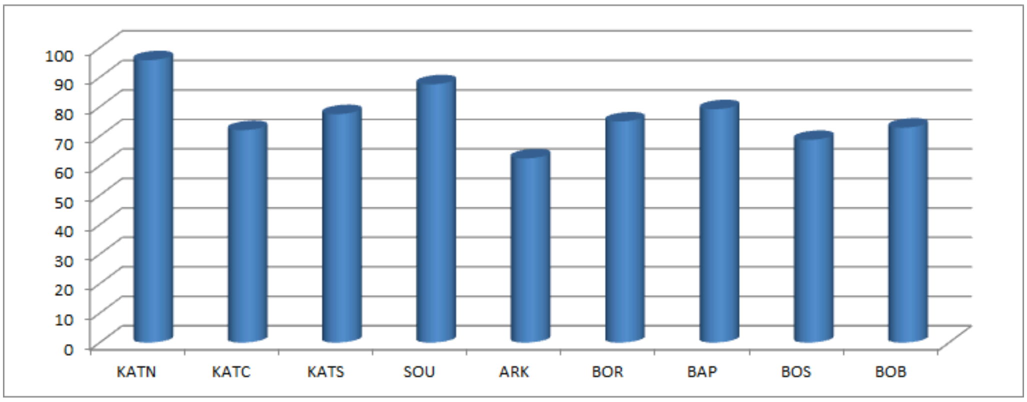

FIGURE 3.1
Preliminary estimates of confidence in eutrophication status classifications of open basins along the Swedish coast from the Kattegat to the Bothnian Bay (unpublished data).

Future work

In 2013, the present scoring system, which is based on expert judgement (Andersen et al. 2010b), will be replaced with a data-driven confidence assessment or, alternatively, a data-driven scoring system for confidence. The output of our work is likely to be a tool for assessing the ecological status of surface waters (covering streams, rivers, lakes, and transitional and coastal waters) (task 2.3.3). Examples of the classification of the "ecological status" of a lake (Lake Furesøen, Denmark) and the "eutrophication status" of coastal waters (the Øresund) are given in Figures 3.2 and 3.3, respectively.

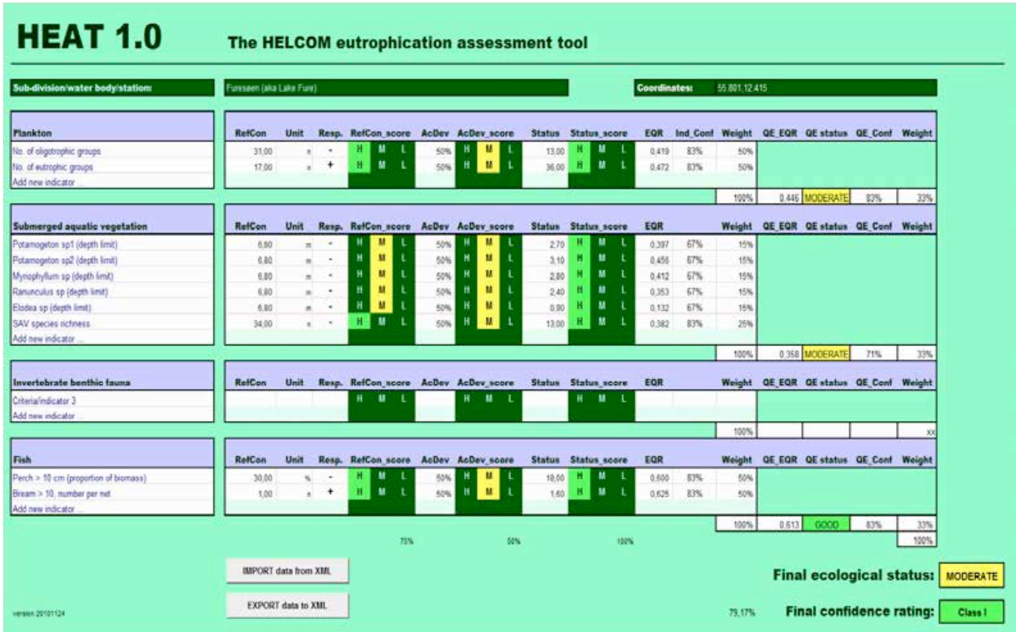

FIGURE 3.2
HEAT classification of ecological status in Lake Furesøen, Denmark. The primary classification of "ecological status" is based on indicators representing three quality elements (i.e., phytoplankton, submerged aquatic vegetation, and fish) and the result is "moderate status", while the secondary assessment of "confidence" is Class I, indicating that the confidence is "high" (unpublished data).

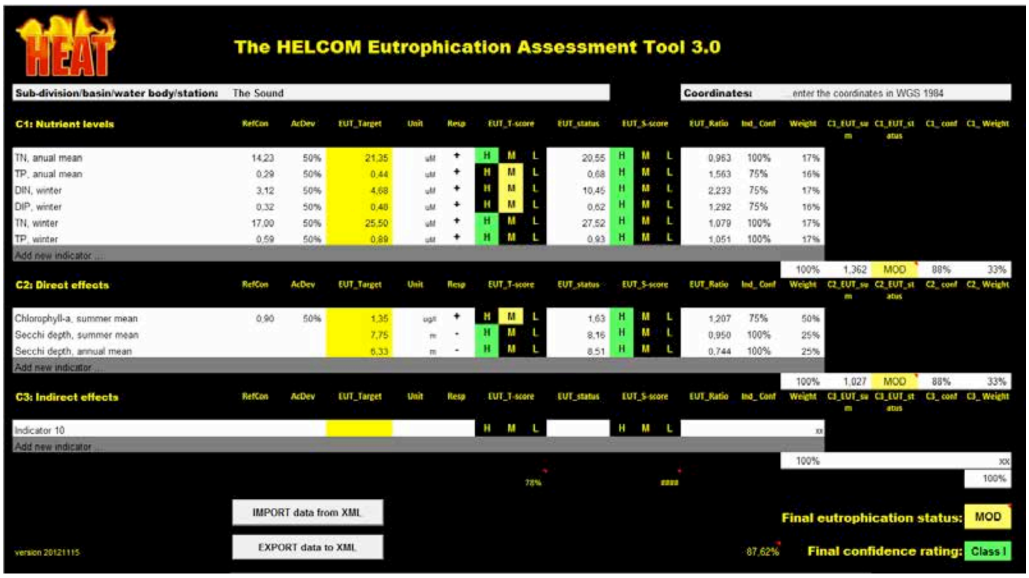

FIGURE 3.3
HEAT 3.0 classification of "eutrophication status" in the Øresund. The status is moderate and the confidence is Class I (high confidence). Note that the biological indicators used are also applicable in the WFD context.

The products of WATERS in the upcoming period will be a review of currently used indicator-based tools for assessing the ecological status of surface waters *sensu* the WFD (task 2.3.1, D 2.3-1 due month 24).

Downstream work involves testing and validation (task 2.3.3) as well as a scientific paper, in association with which the software (*.xls tentatively named the SWedish Ecological status Assessment Tool) for assessing the ecological status of surface waters will be published as online electronic supplementary material.

WP 2.4 Statistical support

The activities in this WP involve organizing annual statistical workshops and ongoing statistical support in the WATERS programme. The scientists involved in this WP all have comprehensive statistical training and have taught statistical classes with special emphasis on applying statistical methods to environmental data.

Year	1		2		3		4		5	
WP2.4 Statistical support										
Task 2.4.1 Statistical support to FA3, annual workshops										
Task 2.4.2 Statistical support to FA4, annual workshops										
Task 2.4.3 Statistical support in FA2										

In the first two years of WATERS, one workshop was held in Uppsala in February 2012 and a second workshop is planned for Tjärnö in January 2013. The outcome of the first workshop and the plan for the second are described below. In addition, statisticians from WP2.4 have been engaged in work in WP 2.1-3 (task 2.4.3).

Results and activities

The objective of the first workshop was to discuss the design of gradient studies, both freshwater and marine, from a statistical perspective (task 2.4.1 and 2.4.2). The workshop included four statistical lectures and presentations of the two gradient studies. The group tasks/discussions were divided between a freshwater and a marine group. The group discussions were supported by five trained statisticians.

Claudia von Brömssen from SLU gave a lecture on the basic principles of experimental design and the analysis of variance. First, the similarities between regression analysis and analysis of variance (ANOVA) were introduced, demonstrating how different datasets can be analysed using both types of analysis. The assumptions and general principles underlying different types of designs were then presented, exemplified with one-way ANOVA, two-way ANOVA, blocking, repeated measures, and split-plot models. The lecture also presented the interpretation of interactions in ANOVAs. Finally, differences between fixed and random factors, and the consequences of choosing one or the other for the interpretation of the results, were discussed.

Thorsten Balsby from AU gave a lecture on gradient studies and experimental design. Gradient studies differ from classic experimental designs, as the researcher cannot control the dependent variables. When planning a gradient study, the researcher should try to ensure that there will be variation along the gradients. If the results of gradient studies are to be used to make predictions about the response of an ecosystem to a pressure, it is assumed that the ecosystem response to the pressure should follow the same trajectory in response to increased and decreased pressure; however, ecosystems often follow different trajectories in response to increased and decreased pressure.

Jacob Carstensen from AU gave a lecture on statistical power in testing. Every statistical test has two types of errors: a Type I error (probability of α, typically max 5%) rejects the null hypothesis when in fact it is true, while a Type II error (probability of β, typically max 20%) accepts the null hypothesis when in fact it is not true. The power is defined as $1 - \beta$ and describes the probability of actually rejecting the null hypothesis when it is not true, i.e., detecting the difference present. The power can, for simple statistical tests, be calculated explicitly using formulas from statistical textbooks. However, in more complicated analyses, the easiest approach to calculating power is Monte Carlo simulation, in which the alternative hypothesis (a putative difference) is simulated many times and the proportion of tests that reject the null hypothesis is calculated.

Anders Grimvall from Havsmiljöinstitutet gave a lecture on visualizing environmental data. Chemical and physical water-quality data were taken as a point of departure for discussing data visualization and how such techniques can make it easier to move from overview to details, and vice versa. In particular, it was emphasized that animated scatter-charts can facilitate the detection of trends and change points in large datasets. Such techniques have two advantages: 1) a large number of charts can readily be produced and inspected and 2) in a long sequence of charts, each chart can be inspected while the previous chart is still fresh in one's memory.

A presentation on the planned marine gradient study was presented by Leif Pihl from GU, and the planned freshwater gradient study was presented by Stina Drakare from SLU. These two presentations, together with the statistical lectures, provided background material for concrete discussions of the statistical aspects of the planned gradient studies. The workshop laid the foundation for the final designs of the gradient studies (task 2.4.1 and 2.4.2).

Future work

The main objective of the second workshop is to analyse biological monitoring data in WATERS in relation to meteorological data and pressure data (e.g., nutrient inputs/concentration). The aim is to develop models that can partition the variation in biological indicators into functions of natural and human perturbations. This methodology will be essential to indicator development in FA3 and FA4 (task 2.4.1 and 2.4.2).

Five statistical lectures to be given during the three-day workshop will constitute the theoretical basis and inspire the indicator development. The five lectures are: 1) basic concepts and approaches to indicator development (Ulf Grandin), 2) multiple regression techniques (Anders Grimvall), 3) general and generalized linear models (Thorsten Balsby), 4) indicator development in practice – examples from freshwater (Ulf Grandin), and 5) indicator development in practice – examples from marine waters (Jacob Carstensen). The workshop is open to all WATERS participants and to people from CABs.

Three more workshops have been planned, one for each of the last three years of WATERS. These workshops will further address indicator development, assessing uncertainty assessment in indicators, and the propagation of uncertainty through the integrated assessment.

3.2 FA3 Coastal areas

WP 3.1 Benthic invertebrates

The aim of this WP is to further develop the already well-established benthic quality index (BQI). The BQI is based on the benthic macrofauna community and is used to classify quality status in coastal sedimentary habitats according to the WFD. When used in Swedish coastal waters, however, the BQI has displayed some weaknesses in areas where substrate composition is affected by low salinity and/or high exposure. The objectives of this WP are accordingly to account for natural environmental variability, for example, in salinity and sediment type, thereby building our knowledge of species sensitivity and contribute to increasing the accuracy of BQI in future assessments. The WP consists of the following five tasks:

Year	1		2		3		4		5	
WP3.1 Benthic invertebrates	■	■	■	■	■	■	■	■	■	■
Task 3.1.1 Sensitivity classification	■	■	■	■						
Task 3.1.2 Validation of BQI for eutrophication	■	■	■	■						
Task 3.1.3 Testing BQI in new areas			■	■	■	■	■	■		
Task 3.1.4 Definition of class boundaries				■	■	■	■	■	■	■
Task 3.1.5 Optimization of sampling design				■	■	■	■	■	■	■

Results and activities

The main emphasis in the first years has been on the sensitivity classification and on reducing uncertainty in the BQI by accounting for salinity and sediment type (task 3.1.1). This will result in two publications to be finished in month 24. A workshop for WP 3.1 participants was held in February 2012 at the Sven Lovéns Centre for Marine Sciences, Kristineberg, to discuss several different approaches, such as the possibility of using either sediment descriptions from sampling or models of sediment type and salinity to obtain a factor for each parameter usable in calculating the BQI. Salinity data to be used are gathered from the SHARK database and VattenWeb. Since this meeting, the quality of existing sediment descriptions for some of the benthic fauna stations from SMHI, the national data host, has been reviewed; this was done using the benthic fauna database BEDA,[4] to be more consistent and more in accordance with standard methods. Data from several other studies, both old and new, have also been imported into BEDA in cooperation with the data owners. This work has also included an attempt to classify samples according to the main substrate (e.g., clay, silt, sand, and shell gravel), each class being assigned a specific value to be used as a factor in the BQI formula.

A new parameter, maximal fauna depth (MFD), was introduced during the sampling of benthic fauna in 2012. MFD is the depth in the sediment to which fauna (in the region) would be expected if hypoxia did not occur in the bottom water. This parameter was introduced in an attempt to simplify sediment description in relation to infaunal activity, with the aim that this new parameter could be used as a BQI factor that takes the type of

[4] BEDA was developed on behalf of the Swedish Environmental Protection Agency in 2011 to facilitate the entry and delivery of benthic data to the national data host and to facilitate status classification according to the WFD. BEDA targets both data providers and clients, i.e., those performing the fieldwork and authorities working on water management. It is based on standardized methods and includes primarily data collected using grab or core sampling, but data obtained using other types of gear, such as case traps, can also be entered and managed.

substrate into account. The use of this parameter has yet to be evaluated, though primary results indicate that its use will be limited.

In addition, the WP intends to compare exposed areas, such as the outer coastal waters of Halland, with more protected areas, such as the inner coastal waters of Bohuslän, using a simplified wave model (SWM) according to Isaeus (2004) and Bekkeby et al. (2008). The outcome of this comparison and the method to be used to refine BQI will be evaluated during a second workshop for WP3.1 participants held in February 2013.

Work on validating the BQI for eutrophication and harmonizing the BQI with other BQEs (task 3.1.2) has been initiated, using data collected in the 2012 gradient study. Preliminary results from this task can be expected after two years (month 24), when data from all BQEs will be analysed. Complete evaluation of this task, however, will require data from the gradient sampling performed in both 2012 and 2013, and also depends on the development of indicators in WP 3.2, 3.3, and 3.4 for harmonizing BQI with other BQEs. Therefore this task is planned to finish in month 48. The work done so far is based on data from the 2012 gradient sampling, and WP participants were involved in designing the gradient study.

Future work

Ongoing work will follow the plans of the WATERS proposal, though the initial focus will be on planning the 2013 joint field study in cooperation with other WPs in FA3. Validation of BQI with regard to eutrophication (task 3.1.2) will thereafter be continued using data from the 2012 joint field study. Testing the new improved BQI will then be performed using available samples from the coast and from open sea areas off the Swedish coast to assess the possibility of using the same approach in the open sea as in the coastal zone (task 3.1.3). After improvement of the BQI index, the boundaries of the BQI will be revised in collaboration with monitoring programmes within and outside the WATERS programme. Consensus on reference conditions (task 3.1.4) and sampling design optimization will be achieved using analyses of the variation of available data and associated methods for fauna on shallow bottoms, to try to establish optimal sampling periods and methods (task 3.1.5).

WP 3.2 Macrophytes

The general aim of WP 3.2 is to evaluate and test the performance of existing and novel macrovegetation indicators in coastal areas. Tests will be based on existing vegetation data from the national data host and on new data collected during WATERS field studies.

Year	1		2		3		4		5	
WP 3.2 Macrophytes										
Task 3.2.1 Reviews										
Task 3.2.2 Collation of data										
Task 3.2.3 Development of indicators										
Task 3.2.4 Testing of indicators through field studies										
Task 3.2.5 Monitoring requirements										
Task 3.2.6 Guidelines for assessment										

Results and activities

In the first two years, a review was performed to identify candidate vegetation indicators for soft- and hard-bottom areas in marine and brackish waters along the diverse Swedish coastline (task 3.2.1). The most important criteria were that the indicators should respond to anthropogenic pressure (particularly eutrophication), allow assessment of ecological status according to WFD demands, and be ecologically relevant. This review corresponds to the deliverable “Potential eutrophication indicators based on Swedish coastal macrophytes” (D 3.2-1) and has been published in the WATERS report series. This review covers the scientific basis of coastal macrophyte indicators and includes an evaluation of the current Swedish vegetation indicator and an overview of the types of available vegetation data along the Swedish coast.

Large amounts of data on vegetation and environmental variables have been collected in databases, for analyses to be performed as a basis for upcoming deliverables (task 3.2.2). As a basis for analyses based on species traits, information on the traits of various species found along the Swedish coast has been gathered (task 3.2.3).

In summer/autumn 2012, fieldwork was performed within the joint FA3 gradient study (tasks 3.2.4, 3.2.5, and also 3.5.2). Vegetation data from both hard-stable and soft substrates were collected in the field. New methods for sampling were used to facilitate analyses of indicator response (Figure 3.4). Data were collected per substrate type from selected strata to minimize variation attributable to sources other than eutrophication (task 3.2.5). On the west coast, vegetation on hard-stable substrates was sampled by diving from 5 × 5-metre squares at depths of 3–5 metres. Eelgrass cover on soft substrates was sampled using a video sledge towed along transects perpendicular to depth curves. At the lower depth limit of eelgrass, 6–8 observations of the maximum depth limit were made using a separate drop video camera moving in a zig-zag pattern. On the east coast, vegetation on both hard-stable and soft substrates was sampled using a 5 × 5-metre-square method similar to that used on the west coast hard-stable substrates. Different sampling methods were chosen for soft substrates on the west and east coasts based on vegetation differences: eelgrass is very dominant on the west coast, where it forms meadows, while several rooted vascular plants and characeans are common on soft substrates on the east coast. The methods used are based on sampling methods used in Denmark, Germany, and the County of Skåne.

FIGURE 3.4
Methods used for collecting vegetation data in the gradient studies. Left: video sledge used to sample eelgrass meadows on the west coast. Middle: video transects (red line) and maximum depths (red dots) from three eelgrass sites. Right: a diver collecting data in a 5 × 5-m square. Sources: photos – David Börjesson (left) and Sandra Andersson (right); middle image – ©Lantmäteriet dnr 109-2011/3027.

Future work

In winter 2012–2013, indicators selected in our first deliverable (D 3.2-1) will be evaluated by analysing the relationship between these indicators and impact measures (i.e., nutrient concentrations, Secchi depth, and chlorophyll) as well as other environmental factors (i.e., substrate, salinity, and wave exposure) using multiple linear models. This will be done using both data from the gradient studies (task 3.2-3) and data collated in databases (task 3.2-2). The results of the gradient studies will be compared with responses from indicators in other WPs in FA3. The use of the new sampling methods will also be evaluated (task 3.2-5). Based on these results, we will plan fieldwork together with other WPs in FA3 in the continued joint gradient study in 2013 (tasks 3.2-4 and 3.2-5). We are also planning to cooperate with other projects to further develop field methods for sampling vegetation (task 3.2-5).

WP 3.3 Phytoplankton

This WP focuses on exploring potential indices based on phytoplankton species information, to complement the existing phytoplankton assessment system. For the general improvement of the assessment system, this work also includes an evaluation of different seasonal periods from those currently used.

Year	1		2		3		4		5	
WP 3.3 Phytoplankton	■	■	■	■	■	■	■	■	■	■
Task 3.3.1 Review of phytoplankton as indicators	■	■	■							
Task 3.3.2 Collation of data	■	■	■	■						
Task 3.3.3 Development of indicators					■	■	■	■	■	■
Task 3.3.4 Field studies to evaluate indicators		■	■	■	■	■				
Task 3.3.5 Testing assessment period	■	■	■	■						

Results and activities

The use of phytoplankton as indicators in environmental assessment (task 3.3.1) was reviewed during the first period of WATERS, resulting in the report “Overview of coastal phytoplankton indicators and potential use for Swedish waters” (D 3.3-1). The report gives an overview of indicators implemented by other European countries as part of their WFD assessment systems, and also includes indicators tested in other contexts. It also gives an overview of the current availability (in the national database) of phytoplankton data for Swedish coastal waters. The report concludes by listing promising indicators that merit further testing. For the WFD biomass parameter, which is already included in the Swedish assessment system (as chlorophyll and biovolume), a primary question identified in the report is how the use of 90^{th} percentile chlorophyll *a* measurements, adopted by other countries around the north-east Atlantic, relates to the current Swedish assessment system (which uses an average value for the summer). Another identified question is how the use of carbon, rather than biovolume, might improve the assessment system, considering the large biovolume, but low carbon biomass, of certain phytoplankton species.

Several high-priority indices based on species composition are proposed for further testing in WATERS. Of primary interest are the ratios of certain species/groups (e.g., chlorophytes and cyanophytes) to total biomass as well as the absolute biomass of certain indicator species/groups. For high-frequency sampling stations, it is possible to include indices based on the seasonal succession of phytoplankton groups and the frequency of blooms, in terms of frequency of elevated biomass.

The collation of phytoplankton data (task 3.3.2) is an important task, enabling the testing of proposed indicators and the exploration of data for other potential indicator species. The collation of such data has been initiated but is not yet complete. The priority is high-quality data not previously used or not reported to the national database.

Field studies (task 3.3.4) have been carried out in 2012 on both the Swedish west and east (i.e., Baltic Proper) coasts. The results are reported as part of WP 3.5.

Testing of the assessment period (task 3.3.5, D 3.3-2) has been initiated but not yet completed. The work has progressed according to plan for the Gulf of Bothnia area, where the current assessment period is considered the most problematic. The work in other areas has been delayed because of more intensive fieldwork than originally anticipated (because extra resources were provided for the 2012 gradient studies, see WP 3.5).

Future work

Ongoing work will follow the plans of the WATERS proposal. The initial focus of the ongoing work will be on data collation (task 3.3.2) and analysing the pros and cons of the different seasonal periods used for assessment (task 3.3.5). The next phase (task 3.3.3) involves exploring data for potential indicator species and testing the indices proposed in the review report (D 3.3-1).

As stated in the WATERS proposal (WP 3.3 Objectives): "Basic uncertainties about reference values and class boundaries for Secchi depth and nutrients, influencing reference values for chlorophyll *a* and biovolume, will need attention in complementing projects". Work in the WATERS programme would greatly benefit from collaboration, or from the results of related projects running in parallel with the upcoming period of WATERS. Such projects could generate new reference values by validating and possibly modifying background nutrient loads and concentrations. At least to some extent, such work has already been started.

WP 3.4 Coastal fish

The aim of this WP 3.4 is to develop a novel tool for the quality assessment of fish along the Swedish coast, as current WFD status assessments in Swedish coastal waters do not include fish. The tool is to be harmonized with other BQEs and with corresponding reporting in the MSFD.

Year	**1**		**2**		**3**		**4**		**5**	
WP 3.4 Fish	■	■	■	■	■	■	■	■	■	■
Task 3.4.1 Review data on quality assessment of littoral fish	■	■	■							
Task 3.4.2 Collation of data		■	■	■						
Task 3.4.3 Development of indicators			■	■	■	■	■	■		
Task 3.4.4 Testing of indicators					■	■	■	■		
Task 3.4.5 Monitoring requirements								■	■	■

The work builds on indicators for assessing the status of coastal fish developed in HELCOM.[5] These indicators are developed further with respect to: 1) general applicability considering geography and habitat types, 2) relationship to external pressure

[5] Bergström, L., Bergenius M., Appelberg M., Gårdmark A., Olsson J., and others (2012). Indicator-based assessment of coastal fish community status in the Baltic Sea 2005-2009. Baltic Sea Environment Proceedings 131B.

factors, and 3) management targets. Activities to support these aims include data collation (tasks 3.4.1-2, focus on years 1–2) and a review of existing information on tools for the quality assessment of fish (tasks 3.4.3-5, initiated in years 1–2, focus of years 3–5).

Results and activities

A main activity in the first two years of WATERS was to bring together information from existing monitoring and status assessments of littoral fish along the Swedish coast (task 3.4.1), and collate appropriate datasets for further analysis (task 3.4.2). Based on this, initial metrics to be further evaluated in upcoming years have been identified, initial quality checks performed, and potential routines for status assessment explored (task 3.4.3). The metrics can be easily computed in MS Excel or MS Access, and cover aspects of species identity (key species), functional properties, and size structure.

The following main datasets were collated for further analysis: 1) a qualitative dataset including all available data from monitoring and inventories in 1988–2011 (for geographical comparisons across the entire Swedish coast), 2–3) quantitative datasets including all data collated in 2011 with Nordic nets or Fyke nets (for geographical comparisons performed separately for the Swedish west coast and Baltic Sea), and 4) a quantitative dataset including data from areas where Nordic nets and fyke nets have been used in parallel (to compare the effects of different monitoring methods). In addition, data from the gradient studies (WP 3.5) will be used to evaluate indicator responses to identified external pressures, in parallel with corresponding studies of other quality elements being developed in WATERS FA3. Generally, the datasets represent depths of 0–10 m (in some cases, 0–20 m).

The first deliverable of this WP (D 3.4-1, "Report on assemblage structure of littoral fish in Swedish coastal waters") is a scientific article on the species composition of fish communities in shallow coastal and offshore waters along the Swedish coast. The study explores how changes in species composition translate into changes in species richness and functional properties along a gradient of decreasing salinity. Although the relationship between salinity level and species richness is well known in a general sense, this is the first time such a relationship has been assessed systematically in Swedish coastal waters. Fish assemblages in the Skagerrak–Kattegat were represented mainly by motile and migrant species, whereas coastal resident species dominated in the Baltic Sea. In parallel, a shift occurred from the dominance of demersal and benthic species to demersal–pelagic and pelagic species, and an increased proportion of planktivorous and omnivorous species. Species richness was consistently higher in the shallow coastal habitats than the shallow offshore habitats of a given geographical area, particularly in the near-shore part of the Baltic Sea. The results provide a basis for further indicator development by identifying potential geographical and taxonomical delineations for the different indicators. The study was based on dataset 1), as mentioned above. The results have been reported in a manuscript submitted for publication in a scientific journal, and as an extended summary in Swedish.

A second deliverable (D 3.4-2, “Report on harmonization of data from test fishing with different gear types”) is in preparation and will be submitted in month 24. In this study, we analyse how differences in gear type between monitoring methods affect the metric estimates, and how such differences should be considered in the status assessments. The following two methods are compared: monitoring using fyke nets (national standard on the Swedish west coast) and monitoring using Nordic nets (national standard in the Baltic Sea). The extent of the study is limited by the availability of studies in which monitoring was performed in parallel using both methods in such a manner that quantitative comparisons are feasible. The quantitative comparisons will be complemented by a general evaluation of the two monitoring methods. The results will be presented as a national report and are intended to feed into the ongoing work in WATERS, including indicator development (task 3.4.3) and the evaluation of monitoring requirements (task 3.4.5), as well as parallel needs in the Habitats Directive and MSFD.

Future work

We plan to continue indicator development by studying variability in the metrics among geographic areas and habitat types, as well as their relationships with different levels of anthropogenic pressure (task 3.4.3). The analyses will be performed using multivariate ordinations to compare the performance of the different metrics, and using generalized linear models to evaluate the relationship of individual metrics to external natural and anthropogenic pressures.

Milestone 1 of WATERS 3.4, which is planned for month 36, is intended as a first attempt to produce community indicators for the environmental assessment of littoral fish in Sweden. The analyses will be based on datasets 2) and 3), as defined above (D 3.4-3, “Report/article on community indicators and ecological thresholds for littoral fish in relation to natural pressure gradients in Sweden”).

In years 4–5 of WATERS, the responses of the metrics to known anthropogenic pressures will be further evaluated. This assessment will be conducted based on data from WP 3.5. (For fish, in WP 3.5, one area on the Swedish west coast was sampled in 2012, and one area in the Baltic Sea is to be sampled in 2013; D 3.4-4, “Species by site dataset of biological response variables in selected coastal areas”, month 40.) Changes in the fish metrics along a gradient of increasing eutrophication will be addressed using general linear models to relate the relative effects of eutrophication and other potential explanatory variables. Relative changes in metrics/indicators for all BQEs sampled in WP 3.5 will be assessed so as to be agreed on among all WPs of FA3 (D 3.4-5, “Report and/or scientific paper on special case studies along anthropogenic pressure gradients in collaboration with other sub-projects”).

The results of all studies will be synthesized into a suggested set of indicators for assessing ecological quality in coastal fish communities, including target levels in relation to specified geographical boundaries, measures of statistical certainty, and updated monitoring recommendations (Milestone 2. Updated recommendations for monitoring of littoral fish in Sweden).

WP 3.5 Gradient studies

The objective of WP 3.5 is to design and conduct a field study that will allow an assessment of indicator response to eutrophication in near-shore coastal areas. The study evaluates the sensitivity of different taxonomic groups and functional response variables to selected pressures in a spatially replicated field study, including assessment of precision.

Year	1		2		3		4		5	
WP 3.5 Gradient study										
Task 3.4.1 Development of experimental design										
Task 3.4.2 Sampling and analyses of gradient study										

The gradient study was designed and organized in cooperation with all WP leaders in FA3, with support from and in cooperation with "Integrated assessment" (FA2).

With the aim of harmonizing, comparing, and validating the suggested indicators, their response is evaluated in common pressure gradients. The dose–response relationships are quantified across BQEs in a common field campaign in two geographic areas: the west and east coasts of Sweden. The gradient studies are located in areas where background data on pressure factors are largely available from ongoing monitoring, but supplemented with complementary data collection. With the common sampling campaign, it is possible to study the precision and sensitivity of indicators from different taxonomic groups. Furthermore, the structure and function of indicators will be compared to investigate how these can be harmonized with each other, based on their response along the pressure gradient. The suggested reference values and class boundaries can also be evaluated individually for each indicator. The gradient study is a common approach to the quality assessment of indicators in the coastal environment, and this one is assigned a specific WP. The gradient study was initiated in 2012 and is planned to continue through 2013.

The investigation was carried out in areas with ongoing monitoring programmes, where results indicated the existence of gradients in nutrient concentrations. The monitoring programmes were supplemented with additional sampling to achieve better spatial and temporal resolution. Samples were taken along one gradient in the fjord areas of the islands of Orust and Tjörn on the Swedish west coast, and along three parallel gradients on the Baltic Sea coast of Östergötland County (Figure 3.5). In June, July, and August, samples were collected on three (east coast) or six (west coast) occasions at approximately four- or two-week intervals, respectively. All data will be analysed and the results will be reported in winter–spring 2013. Based on the analysed results, a new sampling campaign will be planned for 2013.

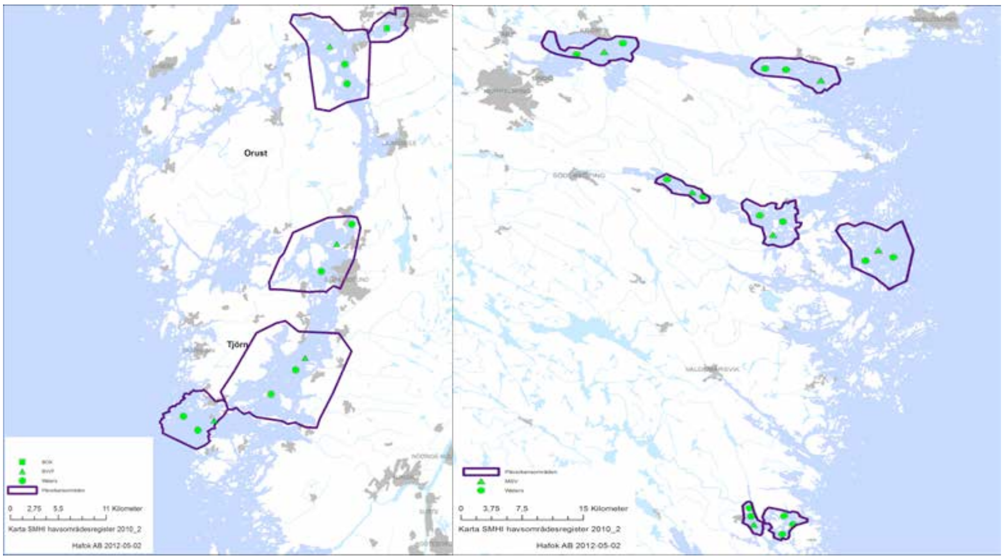

FIGURE 3.5
Maps showing the sampled areas on the Swedish west and east coasts. Samples were taken in Byfjord, Havstensfjord, Halsefjord, Hakefjord, and Marstrandsfjord on the west coast, and in the inner and outer Bråviken, Slätbaken/Trännöfjärden, and Kaggebofjärden/Lindödjupet with one area in the outer part of the archipelago common to the three gradients (Kärrfjärden) on the east coast.

Physical and chemical parameters (i.e., depth, temperature, salinity, oxygen, chlorophyll, Secchi depth, PO_4, P_{tot}, NO_2, NO_3, NH_4, N_{tot}, SiO_4, CDOM, DOC, and TSM) were measured along gradients on the Swedish west and east coasts according to the suggested sampling protocols. Samples were taken at three stations in each area; at one station in each area the sample collection was replicated (west coast) or supplemented with additional depths (east coast).

Phytoplankton. Phytoplankton were collected as an integrated sample within the depth range of 0–10 m (hose sample) at one station in each investigated area on the west and east coasts. On the west coast, three replicates were taken at each station.

Benthic macrofauna. Samples of benthic macrofauna were collected at randomly selected stations in each area along the gradients on the Swedish west coast and in the Baltic Sea. On the Swedish west coast, 15 (0.1 m^2) grab samples were taken at depths of 25–45 metres in four out of five areas along the gradient. Samples were also collected from Byfjorden, though in another research project, taken at depths of 13–42 metres. Secchi depth was measured at most stations and a new parameter called maximal fauna depth (MFD) was measured at all stations (MFD will be used together with the sediment description). Temperature, salinity, dissolved oxygen, and sediment profile images (SPI) were also recorded at three locations in each area along the west coast gradient.

Seven areas were sampled on the east coast with 15 grab samples in each. The sampled depth interval was 20–40 metres in the Baltic Sea, and the Secchi depth and MFD were measured at all stations.

Macrovegetation. On the Swedish west coast and in the Baltic Sea, samples of macrovegetation were collected from 5 × 5-m squares by means of SCUBA diving and were documented by video recording. Samples were taken randomly in each area along the gradients on rocky- and on sediment-bottom vegetated habitats. Sampling methods will be compared and evaluated.

Fish. Coastal fish were sampled only along the gradient on the Swedish west coast in 2012, and corresponding sampling in the Baltic Sea is planned for 2013. In each of the five areas, 60 randomly selected stations were sampled at depths of 0–10 m. Sampling was performed in August, by means of standardized test fishing using fyke nets. At each station, temperature, salinity, and Secchi depth were also recorded. In addition, the habitat type at each station was determined using drop video.

Oxygen. On the east coast, oxygen conditions were mapped on 6–10 September 2012. Oxygen, salinity, and temperature profiles were measured using a CTD instrument at 35 stations, located in the gradient areas and in neighbouring areas.

Results of gradient studies in the Baltic Sea 2012: Water chemistry

As expected, there were gradients in salinity, Secchi depth, total nitrogen and phosphorus, chlorophyll, and suspended matter in all areas (Figures 3.6 and 3.7). Suspended matter also decreased from north to south, i.e., the highest suspended matter concentrations were found in the Bråviken gradient (Figure 3.6). The largest and most stable salinity, nitrogen, and chlorophyll differences between inner and outer basins were found in the Slätbaken–Trännöfjärden gradient. In outer Bråviken, salinity was occasionally low. In contrast to other nutrients, inorganic phosphorus displayed reverse gradients with the highest concentration in the outer basins (Figure 3.7). Data from the gradient study of the west coast have not yet been analysed.

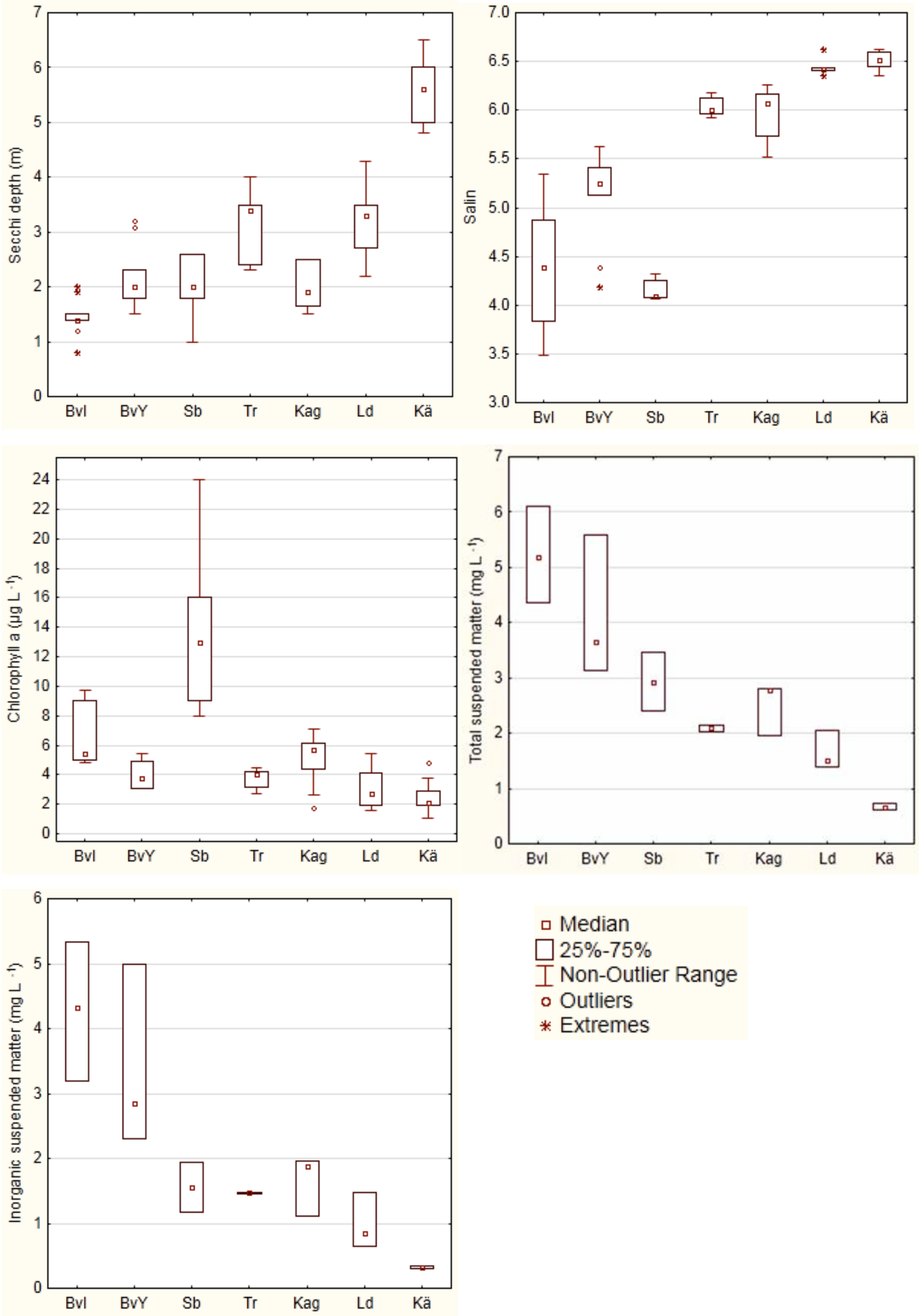

FIGURE 3.6
Results from the Östergötland gradients, June–August 2012. Data are from surface water sampled at three stations per basin on three occasions (*n* = 9). Suspended matter was sampled at only one station per area (*n* = 3). The northern gradient in Bråviken is represented by the inner Bråviken (BvI) and outer Bråviken (BvY), the middle gradient by the Slätbaken (Sb) and Trännöfjärden (Tr), and the southern gradient by Kaggebofjärden (Kag) and Lindödjupet (Ld). A common outer station, Kärrfjärden (Kä), is also included.

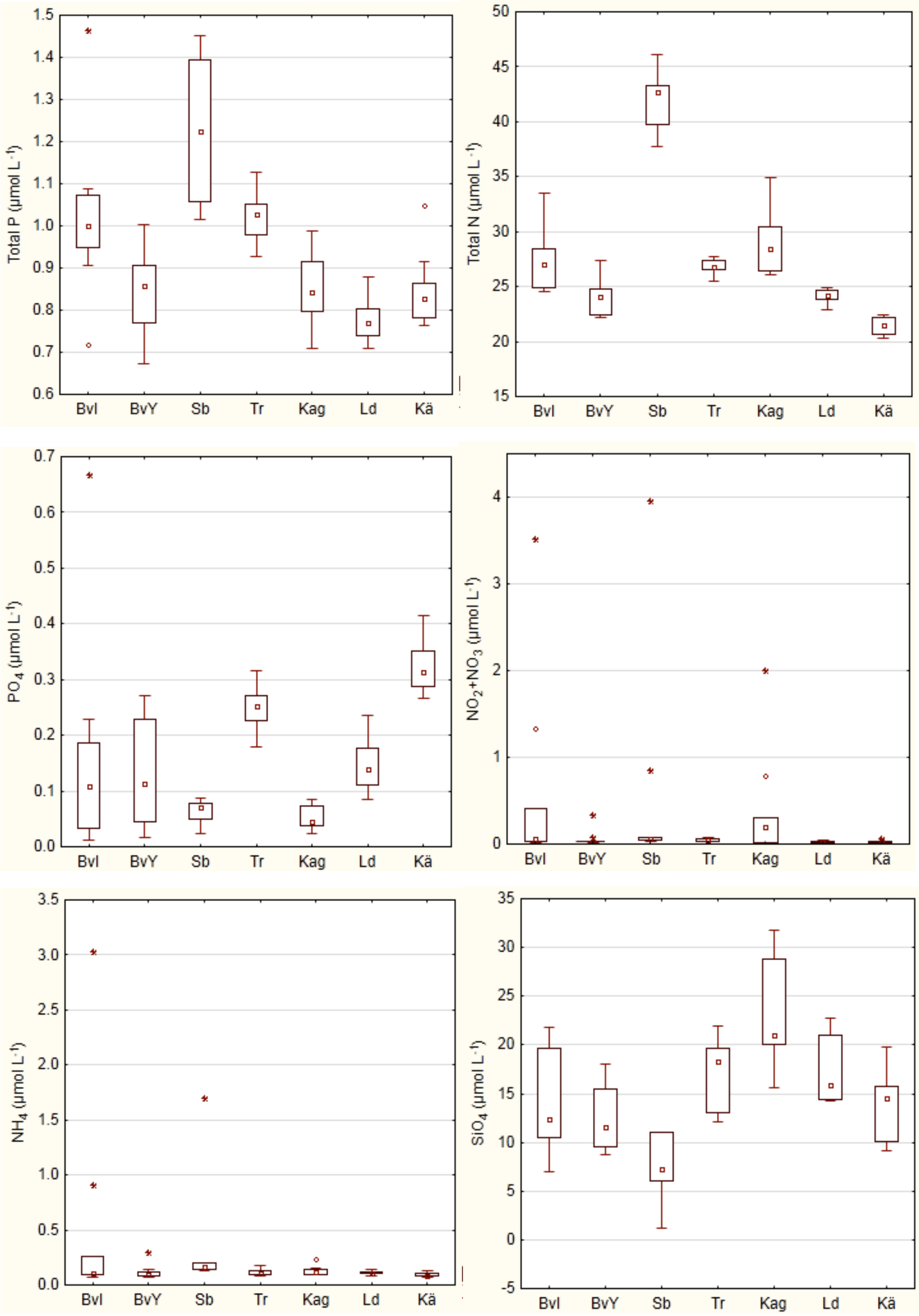

FIGURE 3.7
Results from the Östergötland gradients, June–August 2012. Data are from surface water sampled at three stations per area on three occasions (*n* = 9). The areas are the same as in Figure 3.6.

Cooperation and external funding

Gradient studies are planned for 2012 and 2013. Activities in the first year were considered a pilot study to find natural gradients and to test the sampling design. In 2012, the project was supported by an additional SEK 2 million provided by national funding for "special measurement campaigns" within the national marine monitoring programme ("Programområde: Kust och Hav") run by SwAM and SEPA. Furthermore, by coordinating the WATERS gradient study with other planned field campaigns addressing the development of new monitoring programmes and biogeographic mapping of Natura 2000 habitats, additional resources totalling SEK 488,000 from the County of Västra Götaland and SEK 60,000 + SEK 889,000 from SwAM and SEPA, respectively, were made partly available for the WATERS gradient study. Note, however, that these additional resources could not all be used to meet the specific WATERS needs, but were largely used to complete the tasks of the collaborative projects. Nevertheless, these additional funds allowed us to better identify potential field sites and to increase the number of samples and sites included in the gradient studies in the Baltic Sea and on the west coast. In 2013, the ongoing gradient studies will be financed mainly through funds from the WATERS programme budget.

Future work

After evaluating the results of the 2012 pilot study, a new sampling campaign will be planned for 2013. Nutrient gradients will be identified from the 2012 sampling programme and data will be statistically evaluated for precision and variation in the measured BQEs to optimize the sampling design for 2013.

3.3 FA4 Inland waters

WP 4.1 Macrophytes, streams and lakes

The objective of this WP is twofold. First, existing macrophyte metrics (e.g., TMI, Free index, Schaumburg index, Ellenberg index, measures of taxonomic composition, and BC index) for assessing ecological status in lakes and streams will be evaluated and, if necessary, new indices and metrics will be developed. The pressures to be studied are eutrophication, acidification, and alterations in hydromorphology. The uncertainty associated with the use of macrophyte metrics to assess the ecological status of selected lake and stream types will be quantified. Second, the potential and limitations of using aerial photography (including unmanned aerial vehicles, UAV) as a low-cost monitoring method for macrophyte assessments will be evaluated. This evaluation relates to tasks 4.1.1–4.1.5 and includes also a cost–benefit analysis of the UAV method compared with common field methods.

Year	1		2		3		4		5	
WP 4.1 Macrophytes	■	■	■	■	■	■	■	■	■	■
Task 4.1.1: Review of methods	■	■								
Task 4.1.2 Compilation of data	■	■	■	■						
Task 4.1.3 Indicator development and improvement			■	■	■	■	■	■	■	■
Task 4.1.4 Uncertainty							■	■	■	■
Task 4.1.5 Integrated assessment							■	■	■	■

Results and activities

The first objective of this WP is related to tasks 4.1.1–4.1.3. A new database template for data collection, launched in May 2012, was developed in collaboration with Lars Sonesten, SLU. The template can be found and downloaded at: (http://www.slu.se/sv/fakulteter/nl-fakulteten/om-fakulteten/institutioner/institutionen-for-vatten-och-miljo/datavardskap/dataleveranser/). So far, data from 57 lakes in Jönköpings län have been uploaded. To start conducting relevant analyses, we first need to gather data from at least 300 lakes. To this end, historic macrophyte data were compiled into a common database; although these data are qualitative (i.e., presence/absence), they provide important information on baseline conditions and can also be used for testing various matrices.

Together with colleagues from Norway (Marit Mjelde, NIVA) and Finland (Seppo Hellsten), an index for assessing the impact of water level drawdown (hydromorphological impact) was developed (draft manuscript, see section 2.3 Dissemination). This index is based on macrophyte response to water level drawdown in winter (i.e., the average difference between the highest water level in the October–December period and the lowest level in the following April–May period). Macrophytes were classified as sensitive or tolerant to water level fluctuations using a percentile approach. Sensitive species include *Sparganium angustifolium* and *Limosella aquatica*, whereas *Isoetis lacustris*, *I. echinospora*, and *Myriophyllum alterniflorum* are examples of sensitive species. The index is calculated as follows:

$$WI_c = \frac{N_S - N_T}{N} \times 100$$

where WI_c is the winter drawdown index, N_S the number of sensitive species, N_T the number of tolerant species, and N the total number of species in the lake. The index represents the further development of an index originally developed for Finnish species and systems.

Together with Sebastian Birk (University of Duisburg-Essen, Germany), the performance of a remote sensing index (RemS index) for water quality assessment was tested (draft manuscript, see section 2.3 Dissemination). The performance of the RemS index was compared with that of two common indices for ecological status assessment (i.e., the common intercalibration metric and the Ellenberg index). The RemS index is similar to the Swedish TMI index, but excludes submerged vegetation forms (e.g., isoetids and elodeids). These were excluded since they are not detectable using current remote sensing techniques in lakes of high colour. The RemS index performed well and is a promising method for integrating remote sensing via unmanned aircraft systems into the national monitoring programme.

Sweden so far has no assessment system for macrophytes in rivers, mainly because of the lack of a national method for sampling them. Instead of developing a new method, the potential of sampling methods used in other Nordic countries should be tested. To this end, F. Ecke participated in a Finnish macrophyte workshop (18–20 June 2012) to learn about Finnish methods for sampling macrophytes in rivers. The official Danish field sampling method, also valid in Sweden for several years, was used in the gradient study.

In 2011, two aquatic systems, the lake Ostträsket and river Vormbäcken, were sampled using an unmanned aircraft system (UAS). The remote sensing sessions were complemented with comprehensive field sampling to determine species composition, abundance, and biomass. The results were presented at several conferences and resulted in a preliminary scientific manuscript (draft manuscript). The results indicate that UAS offers great potential for mapping riparian and aquatic vegetation. The main future challenge is to identify and/or develop automatic methods for classifying the aerial photographs taken from the UAS.

Future work

The applicability and suitability of various methods for sampling macrophytes in rivers will be further assessed. The plan is to organize a Nordic macrophyte workshop in 2013 to compare different sampling methods and to discuss the potential for developing a common Nordic macrophyte-based metric for assessing the ecological status of rivers. Several draft manuscripts have been produced that will be finalized in the upcoming period.

The most important task in 2013 will be to compile all the macrophyte data to be submitted by the CABs and to evaluate and further develop indices and metrics. The CAB data are the core pillar of this development. In this work, it is important to divide the dataset into, for example, different typology groups as well as calibration and validation datasets. Such a procedure requires large datasets with a sufficient number of replicates in each group. Given the data available today, it was impossible to perform any uncertainty analysis of the assessment based on macrophytes. If new quantitative data are provided by the CABs, uncertainty analysis will form an integral part of metric development.

WP 4.2 Phytoplankton, lakes

The objective of this WP is to validate existing metrics (i.e., total biomass, proportion of cyanobacteria, trophic plankton index – TPI, number of species, and chlorophyll) using data from the field campaign (capturing eutrophication pressure) and from the CABs to complement the national phytoplankton monitoring datasets. The eutrophication metrics developed during the ECOSTAT Intercalibration (WFD intercalibration) and WISER (www.wiser.eu) projects (Carvalho et al. 2012, Järvinen et al. 2012, Phillips et al. 2012) will be tested with data provided by the CABs. These metrics include an alternative to the TPI metric, the plankton trophic index (PTI), which includes more species than does TPI as well as an alternative to the proportion of cyanobacteria (i.e., cyanobacteria biomass). New metrics will be developed covering selected pressures if data are available. Phytoplankton data from the gradient study will be used to validate existing metrics and to test new and promising DNA methods for measuring phytoplankton more cost-effectively (task 4.2.3, Eiler et al. 2013).

Year	1		2		3		4		5	
WP 4.2 Phytoplankton										
Task 4.2.1 Review of methods										
Task 4.2.2 Compilation of data										
Task 4.2.3 Indicator development and improvement										
Task 4.2.4 Uncertainty										
Task 4.2.5 Integrated assessment										

Results and activities

Some of the activities of the first two-year period have sought to obtain an overview of project needs and methods, and to determine how methods for developing phytoplankton metrics for lakes can be applied to coastal and marine phytoplankton (task 4.2.1). CAD expectations were discussed after evaluating the results of a SEPA questionnaire (task 4.2.1). Regarding the European perspective, much information has been obtained from work in the EU WISER project and through participation in the Northern GIG of the ECOSTAT Intercalibration (task 4.2.3) project. An internal WATERS workshop on statistics and approaches to metric development has also been helpful.

A new database template for data collection was developed in collaboration with Lars Sonesten, SLU. Version 2 of the phytoplankton template was launched in June 2012 (task 4.2.2). The template can be found and downloaded at: http://www.slu.se/sv/fakulteter/nl-fakulteten/om-fakulteten/institutioner/institutionen-for-vatten-och-miljo/datavardskap/dataleveranser/. The first data are expected to be uploaded soon; contact with selected CABs indicates that this work is currently in process. Data from national monitoring are already in the SwAM-funded database; they cover 467 sites, from 1955 until the present, and approximately 1800 taxa. These data are most detailed and frequent from the approximately 120 lakes currently studied in national monitoring programmes, which primarily examine lakes with low human impact, so for metric calibration it is important that more impacted sites be included in the database. Few data have so far been uploaded by the CABs, though, for example, a long time series from 30 lakes was submitted by the Skåne CAB. Data on similar numbers of lakes are expected from all CABs covering at least the last six-year monitoring period. In total, phytoplankton data from at least 400 additional lakes/water bodies are expected with the help of the CABs (task 4.2.2, Table 3.1).

Updating the phytoplankton template also required the updating of the taxonomic lists in Dyntaxa (www.dyntaxa.se). Aided by the phytoplankton laboratory at the Department of Aquatic Sciences and Assessment, SLU, the current taxa list and taxonomic names in Dyntaxa have been reviewed and updated. The resulting suggestions for updates have been sent to contacts at Dyntaxa (task 4.2.2).

Ten lakes in Uppland were selected for gradient studies (tasks 4.2.2–4.2.4) to cover a broad nutrient loading gradient (for more details, see WP 4.6). Phytoplankton samples were collected in all lakes for analyses of taxonomic composition, biovolume, and chlorophyll *a* according to standard monitoring requirements. In addition, samples were collected and frozen for DNA analyses to enable comparison of microscopy and genetic data. Unfortunately, the cold and rainy summer of 2012 reduced the likelihood of sampling during phytoplankton bloom conditions, which we would have liked to do and would expect to be possible in selected lakes in warmer summers. Chl *a* samples have been analysed and microscopic analyses will be completed by June 2013. DNA samples will hopefully also be processed in 2013.

Future work

The most important task for 2013 will be to continue compiling phytoplankton data uploaded by CABs (task 4.2.2) and to start evaluating and developing indices and metrics (tasks 4.2.1–4.2.3).

Classification systems currently used for Swedish lake typologies will also be evaluated, as these are not deemed compatible with WFD requirements. The Swedish lake typology will be compared with other European typological approaches to evaluate discrepancies among approaches. Depending on how phytoplankton metrics vary along pressure gradients for different lake types and depending on whether there are large differences between the two approaches to classifying lakes, the typology-based approach to status classification using phytoplankton may need to be changed.

Comparisons of the efficiency of all included assemblages (ranging from phytoplankton to fish) for detecting human-induced changes will also be evaluated as part of FA2 (task 4.2.5).

WP 4.3 Benthic diatoms, streams and lakes

The main objective of this WP is to validate existing and develop new stream indices for eutrophication, acidification, alterations in hydromorphology, and forestry. The uncertainty associated with the use of benthic diatom metrics to assess the ecological status of selected stream types will also be quantified. Building on experiences using benthic diatoms in stream ecosystems, the efficacy of lake littoral benthic diatom assemblages in detecting human-generated stress will be evaluated. We will assess new approaches to developing more cost-effective variables, such as the use of pigment data as opposed to taxonomic information for assessing ecological status.

Year	1		2		3		4		5	
WP 4.3 Benthic diatoms	■	■	■	■	■	■	■	■	■	■
Task 4.3.1 Review of methods	■	■								
Task 4.3.2 Compilation of data	■	■	■	■						
Task 4.3.3 Indicator development and improvement			■	■	■	■	■	■	■	■
Task 4.3.4 Uncertainty							■	■	■	■
Task 4.3.5 Integrated assessment							■	■	■	■

Results and activities

A review of the use of benthic diatom assemblages and sampling methodologies in environmental assessment (e.g., current approaches, identifying gaps in indicator use and in knowledge of pressure–response relationships, and sampling methodology) (task 4.3.1) and the compilation of existing data on benthic diatoms and background environmental characteristics (i.e., land use/cover and water chemistry) (task 4.3.2) were completed in collaboration with the Delprogram kiselalger ("Subprogramme diatoms") project. This collaborative project involved regional and national water authorities, and focused on collating data and assessing the efficacy of using benthic diatoms in monitoring Swedish streams (and subsequently lakes as well). A preliminary summary of the data was presented in 2011 and the project was recently completed with additional diatom and background data (diatom data covering approximately 1600 streams and approximately 100 lakes are stored in an Excel database).

The main gaps identified concern methods used in sampling lake littoral regions and the impacts of toxic substances such as metals and pesticides on diatoms. In addition, small stream monitoring was shown to be rare, resulting in poor knowledge of these relatively common systems (~80% of Swedish streams belong to this category). Other stream types were also identified as poorly covered by monitoring, for example, polluted, acid (especially pH 5.5–6.2), alkaline (pH > 8), nutrient-rich (especially in northern Sweden), and high-altitude systems. In the WFD context, it was noted that there is a lack of monitoring and resulting knowledge of the biomass, production, and ecosystem functioning of non-diatom algae, for example, green, blue–green, and red algae. The database will be used to develop new indices and to quantify the uncertainty associated with using existing indices (task 4.3.4).

Another conclusion drawn from the review, and more recently from work done in WP 2.2 on D 2.2-1 ("Uncertainty of biological indicators for the WFD in Swedish water bodies"), was that replicate samples are needed to fully assess metric uncertainty. Funding was requested from SwAM (through Havs- och vattenmiljöanslaget) early in 2012 to analyse samples already collected; unfortunately, the funding application was unsuccessful.

Development of a diatom method for lakes (task 4.3.3) is underway, in cooperation with PhD student Steffi Gottschalk and SLU's Environmental Monitoring and Assessment

(EMA) programme Sjöar & Vattendrag ("Lakes & watercourses") as well as with the WFD lake intercalibration of diatom methods (cross-GIG), in which WP leader M. Kahlert participated. S. Gottschalk sampled and analysed approximately 100 lakes along a total P and pH gradient in 2008–2012, using the same methods as for streams. The results indicated that the method and classification boundaries currently used in assessing streams can be used for lakes (confirmed by the successful WFD lake intercalibration). SwAM (Christer Larsson) has agreed to incorporate the method into the national criteria in 2013.

The development of a new diatom method for assessing the impact of toxic substances started in 2011, again in cooperation with the Delprogram kiselalger ("Subprogramme diatoms") project and with the SLU EMA programme Giftfri miljö ("Non-toxic environment"). A screening method was developed for field studies, and an MSc student performed a laboratory experiment to assess the effect of zinc on benthic diatoms. Further cooperation and studies of the effects of toxic substances on diatoms are planned for 2013, both within SLU and in collaboration with Frederic Rimet and Soizic Morin, INRA, France. The screening method will be used in monitoring, resulting in better knowledge of interactions between diatoms and toxins. The data collected so far indicate that more studies of spatial variability are needed to fully develop this approach. Results of this study will be cited when applying for additional funding.

Since August 2010, a new instrument, BenthoTorch, has been used in several projects to evaluate the use of pigments in bioassessment (i.e., estimating biovolume and algal group distribution). The assessment of all algal groups and their biomass is to be applied in developing a method for using algae other than diatoms in monitoring. Initial results obtained using BenthoTorch, however, were not satisfactory, so more studies are planned.

As part of the gradient study conducted in 2012 (for details see WP 4.6), ten streams and ten lakes were sampled for diatoms using standard methods, and quantitative samples were taken to analyse all algal groups (via biovolume analysis using microscopy and BenthoTorch). These samples are currently being analysed (to be finished by June 2013); the results will be used to validate the current method, assess uncertainty, and develop new indices.

Future work

The Excel diatom database will be completed in December 2012. The future plan is to incorporate it into the new SwAM-funded database, still under development, and to directly link diatom taxa between this database and Dyntaxa. As a first step in developing new diatom indices, or in improving current ones, the data will be analysed (e.g., using self-organizing-maps and gradient forest analysis) to determine whether diatom florae differ according to water types, both WFD predefined types, and new types classified using diatom assemblages. This work will be conducted in collaboration with Isabelle Lavoie (Canada). Assisted by Cristina Trigal (SLU), we will use gradient forest analysis to identify thresholds (e.g., in background data, such as total P levels) of change in diatom assemblages.

The results of the first gradient study, together with earlier data, will be used in assessing the function of the BenthoTorch instrument. A manuscript is planned in cooperation with the Institute of Freshwater Fisheries, Iceland. A second gradient study, planned for 2013, will assess the effects of hydromorphology and forestry on diatom assemblages in streams. In addition, samples from other streams and lakes will be collected to complete the diatom database. This database will then be used in tasks 4.3.3 (Indicator development and improvement), 4.3.4 (Uncertainty), and 4.3.5 (Integrated assessment).

A manuscript is planned treating the new diatom lake index, and how benthic diatom communities differ between lakes and streams. Another manuscript is planned treating the new screening index to detect toxic impacts.

Together with SwAM and SEPA, two new methods will be implemented in 2013 as part of the national quality criteria: 1) the stream method will be used in lake studies and 2) the new screening method will be used to help identify streams that might be affected by toxins.

A new application will be made for a further study of the effects of toxins, especially in combination with low pH, on diatom communities (and consequences for the detection of these impacts by any new diatom index). Collaborations are planned with INRA (Thonon, France), Mark Dopson (Linné University), the Department of Microbiology (SLU), and colleagues in the Organic Environmental Chemistry and Ecotoxicology unit at the Department of Aquatic Sciences & Assessment (SLU) to better understand why certain taxa are more successful than others under certain circumstances, which is important when developing indices based largely on the occurrence and abundance of certain taxa. This planned project will include diatom culturing and laboratory experiments in microcosm in combination with field studies.

WP 4.4 Benthic invertebrates, streams and lakes

The objective of this WP is to validate existing metrics using data from field campaigns. Gradient studies will focus on nutrient concentrations in lakes and streams, and on hydromorphological alteration and forestry effects in streams. National datasets, complemented with data from regional monitoring boards, will also be used to calibrate and partly validate current metrics. In addition, for pressures not currently addressed in classification schemes, these datasets will be used to calibrate new metrics.

Year	**1**		**2**		**3**		**4**		**5**	
WP 4.4 Benthic invertebrates										
Task 4.4.1 Review of methods										
Task 4.4.2 Compilation of data										
Task 4.4.3 Indicator development and improvement										
Task 4.4.4 Uncertainty										
Task 4.4.5 Integrated assessment										

Results and activities

At the start of this work, comments and suggestions from a review of current systems for classifying the ecological status of lakes and streams using benthic macroinvertebrates were revisited (SEPA questionnaire) (part of task 4.4.1). Briefly stated, the criticisms focused on metrics considered to respond poorly to putative pressures (e.g., ASPT) and on the use of various sampling methods (e.g., EN SIS and M42). Other meetings and workshops focused on developing reference conditions for macroinvertebrates in lakes and streams and on understanding the uncertainty associated with classifications. Much knowledge has also been gained from participation in the final EU WISER project meeting/conference held in January 2012 (e.g., work on detecting the effects of the hydromorphological alteration of lake littoral regions).

For data collation (task 4.4.2), a new database template was developed in collaboration with Lars Sonesten of the Department of Aquatic Sciences and Assessment, SLU, and distributed to regional agencies in spring 2012. Version 1.0 of the benthic invertebrate template can be found and downloaded at: http://www.slu.se/sv/fakulteter/nl-fakulteten/om-fakulteten/institutioner/institutionen-for-vatten-och-miljo/datavardskap/dataleveranser/. The expected data comprise several thousand invertebrate samples taken from lakes and streams during the last six-year WFD cycle. CABs are currently working on uploading these data using the template and the new SLU data portal (http://www.slu.se/miljodata-mvm). These regional data will complement data from the national monitoring programme, which are already part of the national SwAM-funded database.

A weakness of earlier attempts to develop classification criteria has been the lack of sites of poor ecological quality, i.e., gradients used to calibrate response metrics were truncated, with a clear bias towards high-quality sites. We are hopeful that complementing gradients with results from more sites of bad and poor ecological quality will improve our understanding of the response of indicators to stress and the uncertainties associated with these relationships.

Ten lakes in the Uppland area and ten streams in the Östergötland area were sampled in autumn 2012 as part of the gradient study (task 4.4.3, for more details see the WP 4.6). Benthic macroinvertebrates were collected using standardized kick sampling (in streams and lake littoral regions) or using an Ekman sampler (in lake profundal zones). Five replicate samples were taken from each habitat and preserved in 70% ethanol. The samples are now stored at the Department of Aquatic Sciences and Assessment, SLU, to be processed in 2013.

Future work

Work in 2013 will focus on collating and extracting benthic invertebrate data from regional and national sources (task 4.4.1). Once all data are in place, data analyses will begin: applying appropriate data transformations, calculation of submetrics (e.g., using ASTERICS software), calculation of multimetrics, and finally regression of response metrics to pressure gradients of interest (e.g., nutrients, acidity, and hydromorphological alteration) (task 4.4.1). Early in the process of analysing the invertebrate data, one or more workshops will be organized with consultants and CAB personnel, at which we plan to present preliminary analyses and discuss ways forward.

Next year (2014) we also plan to hold a number of workshops to discuss, and likely revise, the list of operative taxa developed for the 1995 national lake and stream survey. Our plan is to invite national experts as well as taxonomists from Denmark, Norway, Finland, and Estonia to participate in this work. We plan to apply for funding from SwAM to finance this endeavour.

In collaboration with work being coordinated by FA2, we will reconsider the variables and criteria used in establishing reference conditions (i.e., revising the pressure filter). Work will focus on revising, where necessary, inclusion/exclusion criteria and adding new parameters (e.g., hydromorphological alteration) if deemed necessary. Also in collaboration with work being coordinated by FA2, we will participate in modelling the probability of taxon occurrence (e.g., Hallstan et al. 2012). Models will be calibrated using only non-stressor variables. This work will test the utility of type- versus site-specific measures for estimating reference conditions (e.g., Davy-Bowker et al. 2006).

WP 4.5 Fish, streams and lakes

The current fish indices and metrics for determining the ecological status of lakes (EQR8) and streams (VIX) will be validated using existing data as well as data generated in the gradient studies of WP 4.6. A specific focus will be on developing new lake and stream indices for eutrophication, acidification, alterations in hydromorphology, and forestry (e.g., riparian integrity). The uncertainty associated with using fish metrics in assessing the ecological status of selected lake and stream types will be quantified.

Year	**1**		**2**		**3**		**4**		**5**	
WP 4.5 Fish	■	■	■	■	■	■	■	■	■	■
Task 4.5.1 Review of methods	■	■								
Task 4.5.2 Compilation of data	■	■	■	■						
Task 4.5.3 Indicator development and improvement			■	■	■	■	■	■	■	■
Task 4.5.4 Uncertainty							■	■	■	■
Task 4.5.5 Integrated assessment							■	■	■	■

Results and activities

The work in this WP is being conducted by a group with expertise on small and large lakes and streams.

Literature on fish sampling and status assessment was collated, as was more basic knowledge of macroecology and how fish are affected by their natural environments and anthropogenic pressures (task 4.5.1). The literature search focused on new publications since the current fish indices (EQR8 and VIX) were reported in 2007.

Many data providers have continuously delivered fish data to the National Register of Survey Test-fishing (NORS) and the Swedish Electrofishing Register (SERS) (task 4.5.2) (http://www.slu.se/sv/fakulteter/nl-fakulteten/om-fakulteten/institutioner/akvatiska-resurser/databaser/). For example, NORS now represents 1975 lakes sampled using multi-mesh Nordic gillnets according to the European standard (EN 14757). At present, data on the proportions of the lake area covered by different depth strata are available for only 51 of these lakes. Such information will be used to test whether the noise in indicator responses to pressures can be reduced by correcting catch data, using the proportions of nets used in each stratum, relative to the actual proportions of the lake in the same stratum. This past autumn, previous fish data providers were asked to deliver digital hypsographic maps of their sampled lakes, as well as data on temperature profiles taken when sampling for fish. Maps delivered before the end of this year (2013) will be used to increase the number of lakes that can be used in the catch correction test. Temperature profiles will facilitate the exploration of separate fish metrics for littoral/epilimnetic and profundal/hypolimnetic habitats, respectively.

In WP 4.6, ten lakes were selected for studying a gradient in total P concentration as a proxy for nutrient load. Seven of the lakes had been sampled for fish in 2007–2011, and one out of two presumed high-status lakes had been sampled more than once in the national environmental monitoring programme (Figure 3.8); therefore, no new fish samples were taken from these lakes. The other three lakes will be sampled in 2013. The remaining lakes were previously assigned bad or poor ecological status in VISS. A gradient in total-P was also studied in ten streams. Sampling for all BQEs was conducted from August to October 2012, but the fish data were not yet ready for the production of preliminary results.

Future improvement of Swedish fish assessment methods will benefit from experience gained from the WISER project and from ECOSTAT's intercalibration of national assessment methods, both projected to end in 2012 (task 4.5.3). There is, for example, a great need to improve procedures for setting class boundaries, for establishing pressure–response relationships for various pressures, and for better describing reference conditions. It is also desirabl e to include metrics more specifically related to fish age and/or size structure.

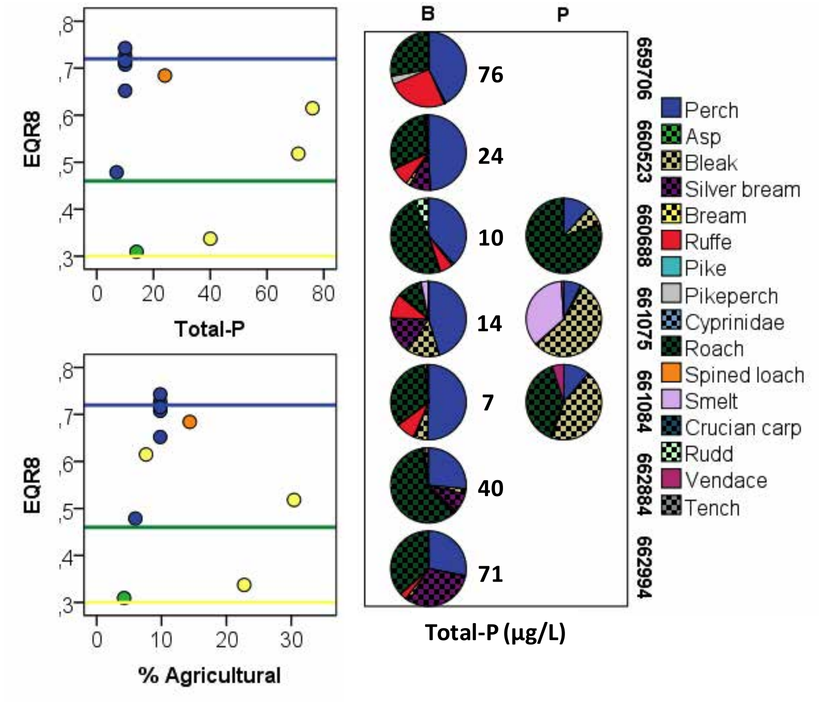

FIGURE 3.8
Results of fish sampling, 2007–2011, in seven of the ten lakes in the nutrient gradient. The left panels show EQR8 in relation to pressures, and the vertical reference lines indicate three of the current class boundaries (blue = H–G, green = G–M, and yellow = M–P). Colours of symbols represent the ecological status of each lake according to VISS. Pies illustrate the relative abundance of fish species caught in benthic (B) and pelagic (P) gillnets. Chequered fields refer to species of the family Cyprinidae.

Fish sampling and status assessment, however, will still be a challenge in very large lakes. Possibilities for assessing large Swedish lakes were tentatively explored. One issue that requires an adjustment of EQR8 is the expected number of species, which needs to be carefully adjusted to the total number of species, fished area, and fishing effort. In large lakes, both commercial and recreational fisheries have considerable impacts on the fish community. Mostly large, piscivorous species such as pikeperch (*Sander lucioperca*), salmon (*Salmo salar*), and Arctic char (*Salvelinus umbla*) are highly attractive species to catch, and pelagic planktivorous species such as vendace (*Coregonus albula*) are also of interest to the commercial fishery. Effects on fish communities can be sought in indicators reflecting size structure and trophic level. Examples of how two candidate indicators vary between lakes and years are shown in Figure 3.9. Determining reference values for these indicator candidates is a remaining task.

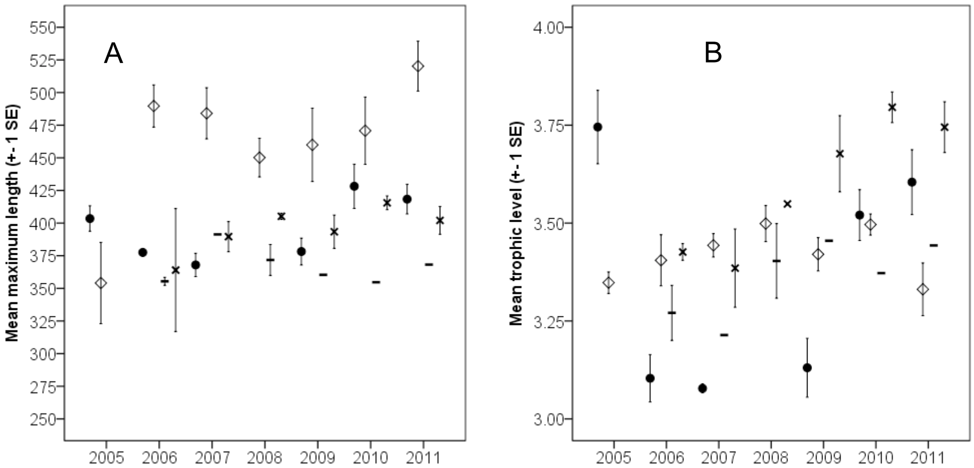

FIGURE 3.9
Data from Lake Vänern (filled circles), Lake Vättern (diamonds), Lake Mälaren (crosses), and Lake Hjälmaren (dashes) A: Mean maximum length of test-fishing data in the large lakes, 2005–2011. B: Mean trophic level calculated from test-fishing data in large lakes, 2005–2011.

In large and/or slow-flowing rivers, both the sampling and assessment of fish are particularly challenging. One possibility is to use multi-mesh gillnets adapted for use in slow-flowing rivers, so-called *strömöversiktsnät* (SÖN). This year we prepared a new field protocol, which was later used in some autumn surveys. Another sampling method usable in large rivers is elecrofishing with specially designed electrofishing boats. This might be a cost-effective method for sampling large areas in large rivers.

Future work

Existing lake fish data will be collated with new site information (e.g., from hypsographic maps of lakes) and with site-specific pressure data. Metric responses to pressure gradients will be compared before and after measures to reduce inherent noise in observed metric values and in predicted reference conditions (task 4.5.3). Site-specific reference values of current and additional metrics will be calibrated in relation to hydromorphological and biogeographical lake characteristics using large datasets. Age-based and/or fishery-related metrics may be included in a total index for ecological status, or alternatively be used on their own. The revision of assessment criteria for fish in small and medium-sized streams will use VIX as a starting point, and possibly include new metrics indicating pressure from forestry.

Time-series data will be used to evaluate uncertainty in assessing the ecological status of lakes and streams (task 4.5.4). Fish response to pressures will be compared with other BQEs using data from gradient studies in WP 4.6 (task 4.5.5).

Modified site-specific multi-metric fish indices will be better adapted to larger lakes and streams than are current methods. Complementary and/or alternative sampling and analytical methods will be described, as guidance for status assessment in large or otherwise distinctive lakes and streams. All upcoming deliverables from WP 4.5 will deal with indicator development and improvement (task 4.5.3), with or without specifically addressing uncertainty (task 4.5.4) and integrated assessment (task 4.5.6). They are scheduled for month 54 (D 4.5-1) or month 60 (D 4.5-2 and D 4.5-3).

WP 4.6 Gradient studies, streams and lakes

The main objectives of this WP are: 1) to design a robust field assessment of indicator response to selected pressures and 2) to evaluate the precision and sensitivity of different taxonomic groups and functional response variables to selected pressures.

Year	1		2		3		4		5	
WP 4.6 Gradient study	■	■	■	■	■	■	■	■	■	
Task 4.6.1 Development of experimental design	■	■	■							
Task 4.6.2 Sampling and analyses of gradient study		■	■	■	■	■	■	■	■	

This knowledge will be used to improve our understanding of stress–response relationships and, subsequently, of how this information can be used to design more robust management programmes. In addition, data from the field study will be used to validate current classification criteria and, if necessary, develop and calibrate new stressor-specific metrics. WP 4.6 focuses on three stressor classes: 1) nutrient enrichment, 2) hydromorphological alteration, and 3) forestry. Each stressor is studied in the region where the expected effects are strongest, i.e., nutrient enrichment in agricultural regions in central–south Sweden, in both lakes and streams, and forestry in the far north. Hydromorphological alteration will be studied in both the north and south, given the pervasive extent of this impact. For each gradient in each region, 9–11 sites are sampled spanning an increasing gradient of degradation, with an identical set of biological and functional indicators sampled from each (see below).

Results and activities

In February, the WP 4.6 working group decided that the 2012 fieldwork would focus on two nutrient gradients, one in streams and one in lakes. Sampling for the remaining three gradients – two hydromorphological and one forestry – is scheduled for 2013. The original plan to sample all five gradients in 2012 could not be realized for logistics and scheduling reasons. We decided to distribute the sampling campaigns over two years to alleviate difficulties related to organizing and implementing the simultaneous sampling of multiple biological indicators across a large number of sites distributed in both the north and south of Sweden. This adjustment also allows for more time to better define these gradients, which have not been extensively studied previously, and to develop better dialogue with stakeholders and choose appropriate study sites.

The site choice for the lakes and streams was finalized by early June 2012. For each ecosystem type, ten sites were chosen spanning, in the first instance, a gradient in total P concentrations, as an indicator of nutrient loadings (Table 3.2). In addition, the sites spanned all WFD ecological status classifications (Table 3.2). For the streams, local habitat characteristics were highly standardized over a 50–100-m reach, to avoid confounding the nutrient gradient with variation in other variables known to strongly influence the biota. Specifically, all streams were characterized by the presence of extensive rocky substrates over the sampling reach, and were well shaded by mature riparian vegetation. The lakes were standardized in area (1–3 km^2) and pH (ca. 7), and systems with extensive urbanization in the catchment, or that are subjected to liming, were excluded. All streams are located in the county of Östergötland (Figure 3.10) and all lakes in the county of Uppland (Figure 3.11), including the provinces of Uppsala and Stockholm.

Most biological indicator groups and water chemistry were sampled by personnel from SLU (Table 3.3). The exceptions were macrophytes in lakes, for which the external consultant Calluna was employed, and fish in both lakes and streams. Data on fish in streams is provided by the electrofishing programme of Östergötland. Data on fish from lakes will be also be provided by local provincial monitoring schemes, except for lakes Sparren, Långsjön, and Bottenfjärden, which will be sampled by SLU in 2013, allowing time to organize the appropriate permissions (fish community composition is not expected to vary greatly from year to year). In all cases, standard sampling protocols according to national monitoring/WFD guidelines are followed. Sampling periods are optimized for when the various groups can be most easily sampled and identified to a good level of taxonomic resolution (Table 3.3).

Additional measurements cover water chemistry (including nutrients, alkalinity, metal ions, and pH) and characterize the temperature and oxygen profiles of lakes, in order to assess the extent of lake stratification. Water chemistry measurements will be made on three occasions from both lakes and streams, while lake oxygen profiles were sampled once in September prior to water mixing (Table 3.3).

TABLE 3.2
Nutrient gradient studies in lakes and streams: location, total P concentrations (based on 2012 WATERS sampling in August and October), and current nutrient and ecological status classifications from VISS.

Name	*X*	*Y*	Total P (μg L^{-1})	Nutrient status, VISS	Ecological status, VISS
STREAMS					
Vadsbäcken	580853	6495045	342	Bad	Moderate
Kapellån	528455	6473295	166.5	Good	Moderate
Börrumsbäcken	595209	6468473	146.5	Moderate	Moderate
Stjärnorpebäcken	532935	6488390	141	Moderate	Good
Nedre Storån	571892	6444567	49	High	Moderate
Pinnarpsbäcken	530407	6425778	13	Good	Poor
Borkhultsån	569939	6460318	11	High	Moderate
Kisaån	535430	6426863	10	High	Poor
Silverån	521632	6398647	10	High	Good
Bulsjöån	521570	6413034	10	High	Good
LAKES					
Bottenfjärden	712071	6639749	131	Poor	Bad
Långsjön	686942	6626608	68	Bad	Bad
Lommaren	703700	6629640	64	Poor	Poor
Ullnasjön	678202	6598022	52.5	Poor	Poor
Syningen	689031	6629680	43	Moderate	Poor
Lejondalssjön	651948	6603438	39	Good	Moderate
Lilla Ullfjärden	642784	6608575	15	High	Good
Sparren	686449	6621668	11	Moderate	Poor
Tärnan	689838	6607854	12	High	High
Largen	698785	6611144	7.5	High	High

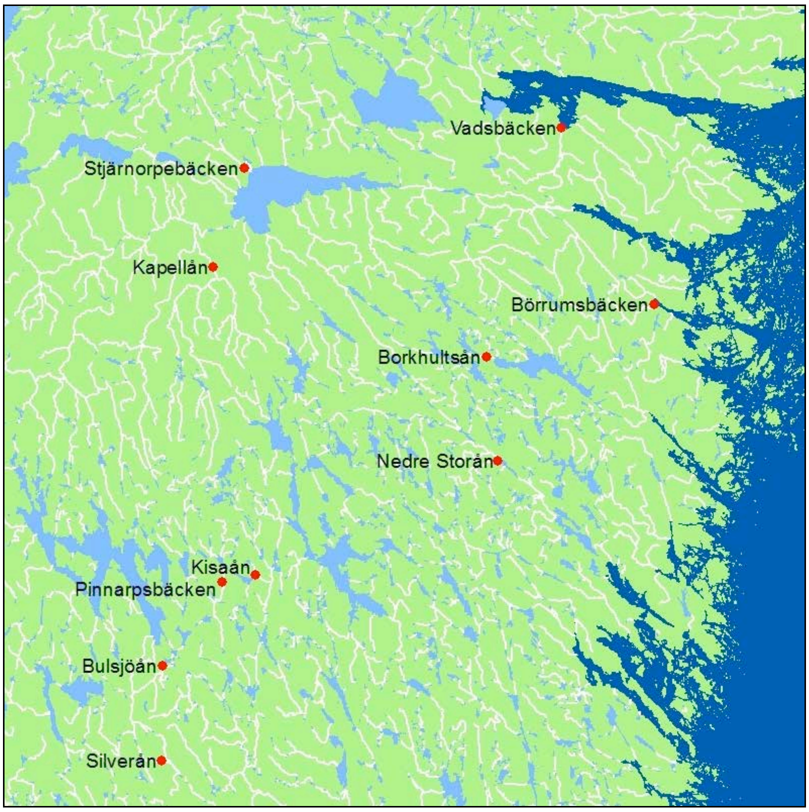

FIGURE 3.10
Location of the ten study streams in Östergötland.

FIGURE 3.11
Location of the ten gradient-study lakes in Uppland.

TABLE 3.3
Indicators measured from each lake and stream, and information on the sampling period and group executing the work for each indicator.

Indicator/group	Responsible group and sampling period
STREAMS	
Macrophytes and diatoms	SLU: August
Macroinvertebrates	SLU: October
Fish	Östergötlands county and national “Trend” electrofishing programmes: September–October
Water chemistry	SLU: August, October, planned Spring 2013
Ecosystem functioning	SLU student Amélie Truchy: productivity and decomposition, 2012; respiration, 2013
LAKES	
Diatoms and phytoplankton	SLU: August
Macrophytes	Calluna: August
Macroinvertebrates	SLU: October
Fish	Regional county programmes + one national “Trend” lake + SLU: four lakes in 2013
Water chemistry	SLU: August, October, planned Spring 2013
Oxygen profiles	SLU: September

Finally, a PhD student (Amélie Truchy, based at SLU) linked to the WATERS gradient studies has been appointed. Her role is to measure multiple functional response variables in the gradient study streams. Functional variables are direct measures of ecosystem processes, such as algal growth, leaf decomposition, and nutrient uptake, that underpin the delivery of ecosystem services (e.g., clean water and food) from streams. Along perturbation gradients, functional response variables provide an additional measure of environmental impact, and an additional means of validating taxonomic indicators. A key question is whether functional and taxonomic indicators respond with more, less, or equal sensitivity across the gradients. In 2012, Amélie initiated the functional assessment of the ten study streams in Östergötland by quantifying algal productivity and leaf litter decomposition.

Data on macrophytes, water chemistry, and fish will all be available from most systems by the end of 2012. Macroinvertebrate, phytoplankton, and diatom samples will be processed by the certified laboratory at SLU in 2013, and indicators are estimated to be available before midsummer 2013, or at the latest in autumn 2013. Note that for fish from lakes, the dataset will be completed using net fishing next summer. The main use of the WATERS data is in validating both current classification criteria and the new stressor-specific metrics developed with FA2.

Future work

The remaining three WP 4.6 gradients will be sampled in 2013: hydromorphology in the north of Sweden, hydromorphology in the south, and forestry in the north. These represent environmental impacts that have not been well characterized in the past, either in biomonitoring or basic research. Hence the current major focus in WP 4.6 is on defining these gradients and assessing where the major knowledge gaps lie.

To help define the two hydromorphological gradients, multiple CABs and government departments conducted surveys in September 2012. These bodies were asked to rank five broad categories of hydromorphological disturbance in order of importance: small hydropower dams, large hydropower dams, agricultural channelization, forest ditching, and channelization for timber-floating. All agreed that small hydropower dams represent a major, widespread class of impact affecting hydrology and connectivity, and sites for the study of this impact are being chosen in the county of Värmland.

For the second hydromorphological gradient, there was a strong split between northern and southern areas, with those in the north asking for a focus on forest ditching, and those in the south asking for agricultural channelization. Because of difficulties in defining agricultural channelization as a single stressor gradient, and the desirability of studying further gradients in northern Sweden, WP 4.6 will focus on forest ditching and its impacts on hydrology, stream network structure, and the transport of sediments and toxins, likely in the county of Västerbotten.

The final gradient, forestry, will also be studied in northern Sweden. Both the forestry and ditching impacts will be defined at a subcatchment–catchment scale. During the survey, several representatives of water management authorities expressed a need for information on how the number of clearcuts and extent of ditching are affecting biological indicators in medium–large-sized stream systems that deliver water for drinking and agriculture and that support recreational activities such as fishing. Accordingly, the most impacted sites will be those with the highest proportion of forestry activity or ditching in their catchment area. Potential catchments for both gradients are being targeted with the assistance of experts in geographic information systems, who also have detailed knowledge of these impacts, from SLU in Umeå.

The actual sampling work for these gradients will be identical to that for the nutrient gradients conducted in 2012, employing the same protocols and following a sampling schedule similar to that outlined in Table 3.3.

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Annex 1. Deliverables

D: Deliverables. M: Milestones, Green – completed, Yellow – in progress, Orange – revised delivery month. The mid-term report refers to deliverables up to month 22; deliverables up to month 24 are included in tables for information purposes.

FA1 Programme coordination, FA leader: Mats Lindegarth

Deliverable no./Milestone	WP	Deliverable title	Due month	Status
D 1.1-1	1.1	Programme agreements among partners	2	WATERS consortium agreement
D 1.2-1	1.2	Web platform for sharing and storing documents and for internal discussions	2	
D 1.2-2	1.2	External website	12 ⇒	http://www.waters.gu.se
D 1.2-3	1.2	Leaflet and PowerPoint presentation for external presentation of the project	12 ⇒	
D 1.1-2	1.1	Mid-term report to SEPA	23 ⇒ 22	This report

FA2 Integrated Assessments, FA leader: Jacob Carstensen

Deliverable no./Milestone	WP	Deliverable title	Due month	Status
M	2.4	Statistical support: Workshop on design of gradient studies	12	13–15 Feb 2012
D 2.1-1	2.1	Reference conditions and class boundaries: Database of published literature used in the review task	12	Available on web-based platform of the WATERS programme.
D 2.1-2	2.1	Reference conditions and class boundaries: Review manuscript/report of existing literature on reference conditions and classes	12 ⇒ 18	WATERS report 2013:2.
M	2.1	Reference conditions and class boundaries: Common workshop with scientists from FA3 and FA4 responsible for reference conditions and class boundaries	12	Initial discussion at WATERS PF2; to be continued at upcoming meetings
D 2.2-1	2.2	Uncertainty in classifications: Review manuscript/report for uncertainty assessment of ecological data	12 ⇒ 18	WATERS report 2013:!.
D 2.2-2	2.2	Uncertainty in classifications: Guidelines for sampling designs to assess different uncertainty components	12 ⇒ 24	Revised delivery month
D 2.4-1	2.4	Statistical support: Summary report for statistical workshop year 1	12	WATERS report 2012:1.
M	2.2	Uncertainty in classifications: Workshop for developing conceptual uncertainty framework	16	2–4 July 2012
M	2.4	Statistical support: Workshop on separating climate and anthropogenic signals	18 ⇒ 24	30 Jan–1 Feb 2013
M *D 2.1-3*	*2.1* *2.1*	*Reference conditions and class boundaries: Theoretical framework finished* *Reference conditions and class boundaries: Initial set of guidelines for reference conditions and class boundaries*	*24* *24*	*Upcoming*
M	*2.2*	*Uncertainty in classifications: Theoretical uncertainty assessment framework finished*	*24*	
D 2.3-1	*2.3*	*Whole system assessment: Report/manuscript reviewing existing assessment systems*	*24*	
D 2.4-1	*2.4*	*Statistical support: Summary report for statistical workshop year 2*	*24*	

FA3 Coastal waters, FA leader: Leif Pihl

Deliverable no./Milestone	**WP**	**Deliverable title**	**Due month**	**Status**
D 3.2-1	3.2	Macrophytes: Report on potential indicators of Swedish coastal macrophytes	12	WATERS report 2012:2.
M	3.5	Gradient study: Design of field study and selection of study sites	12	First gradient study completed summer 2012
D 3.3-1	3.3	Phytoplankton: Report on results of literature survey of phytoplankton indices	18 ⇒ 19	Draft completed and approved by the SG.
D 3.4-1	3.4	Fish: Report on assemblage structure of littoral fish in Swedish coastal waters	18	Article in review.
D 3.1-1	*3.1*	*Benthic invertebrates: Report/article documenting the improvement of the species sensitivity classification method*	*24*	*Upcoming*
D 3.1-2	*3.1*	*Benthic invertebrates: Report/article documenting the improved formulation of BQI to account for salinity and sediment type*	*24*	
D 3.3-2	*3.3*	*Phytoplankton: Report on recommendations on sampling period*	*24*	
D 3.4-2	*3.4*	*Fish: Report on harmonization of data from test fishing with different gear types*	*24*	

FA4 Inland Waters, FA leader: Richard K. Johnson

Deliverable no./Milestone	WP	Deliverable title	Due month	Status
M	4.6	Gradient study: Workshop with WP4 participants and representatives of regional monitoring boards (Swedish river basin district authorities), December 2011	9	12–13 Feb 2012 and ongoing
M	4.6	Gradient study: Design of field study	9	First gradient studies completed summer 2012
M	4.1	Macrophytes: Sampling protocol for gradient studies	14	
M	4.2	Phytoplankton: Sampling protocol for gradient studies	14	
M	4.3	Benthic diatoms: Sampling protocol for gradient studies	14	
M	4.4	Benthic invertebrates: Sampling protocol for gradient studies	14	
M	4.5	Fish: Sampling protocol for gradient studies	14	
M	4.6	Gradient study: Selection of lakes and streams to be used in the field campaign	14	First gradient studies completed summer 2012
M	*4.1*	*Collation of existing data on macrophyte assemblages and environmental variables in lakes and streams*	*24*	*Upcoming*
D 4.1-1	*4.1*	*Manuscript on the use of aerial photographs of macrophyte assemblages in environmental assessment*	*24*	Article in review.
M	*4.2*	*Collation of existing data on phytoplankton assemblages and environmental variables in lakes*	*24*	
M	*4.3*	*Collation of existing data on benthic diatom assemblages and environmental variables in streams*	*24*	
M	*4.4*	*Collation of existing on benthic invertebrate assemblages and environmental variables in lakes and streams*	*24*	
M	*4.5*	*Collation of existing data on fish assemblages and environmental variables in lakes and streams*	*24*	

Annex 2. External presentations

FA1. Programme coordination

Lindegarth, M. WATERS – nya bedömningsgrunder och vikten av ett samarbete mellan övervakare och forskare. Workshop on coastal monitoring organized by the RDBA. Stockholm, 4 April 2011.

Lindegarth, M. Nu startar WATERS! Waterbody Assessment Tools for Ecological Reference conditions and status in Sweden. "Havet" conference organized by SEPA and the Swedish Institute for the Marine Environment. Kosta, 2 May 2011.

Lindegarth, M. WATERS-projektet – nya Bedömningsgrunder. Miljöövervakningsdagarna organized by CABs. Örebro, September 20 2011.

Zweifel, U.L. WATERS: Ett forskningsprogram om bedömningsgrunder for vattenkvalitet i kust- och inlandsvatten, Annual meeting of the Swedish association of limnologists (Svenska Föreningen för Limnologi, Vattendagarna). Skövde, 30 November–1 December 2011. Presentation available at http://www.waters.gu.se

Lindegarth, M. Nu startar WATERS! Waterbody Assessment Tools for Ecological Reference conditions and status in Sweden. Workshop organized by the EU- Interreg programme. "Hav möter Land". Vann, 1 December 2011.

Lindegarth, M. Introduction to WATERS – Waterbody Assessment Tools for Ecological Reference conditions and status in Sweden. Joint workshop WATERS-SPEQS on ecological – legal aspects of ecological quality standards. Gothenburg, November 14 2012.

FA2. Integrated assessment

Carstensen, J. Transitional/coastal water management, restoration and the impact of global and climate change. Keynote at WISER End-user conference. Tallinn, 25–26 January 2012.

Balsby, T.J.S., Carstensen, J., Krause-Jensen, D. Sources of uncertainty in estimation of eelgrass depth limits. Poster at WISER End-user conference. Tallinn, 25–26 January 2012.

Lindegarth, M. Dimensionering av övervakning, uppföljning och kartering med hjälp av visuella metoder: tillämpning av ett sammanhållet ramverk för osäkerhetshantering. Workshop om ny marin teknik. Umeå, 3–4 December 2012

FA3. Coastal waters

Blomqvist, M. Revision av bedömningsgrunderna inom ramen för WATERS. Kustvatten. Konferens om Kartläggning och analys arrangerad av Länsstyrelserna och Vattenmyndigheterna. Stockholm, 2–3 Febuary 2012.

FA4. Inland waters

Ecke, F. Macrophyte workshop, County Administrative Board, Stockholm, 22 November 2011. Arranged by Mats Thuresson. Presentation of WATERS and discussion on compilation of macrophyte data.

Ecke, F. The potential of unmanned aerial systems for mapping and monitoring vegetation. Seminar, Division of remote sensing, SLU. Umeå, 16 November 2011.

Gottschalk S. (presenting) & Kahlert, M. Ecological guild composition of littoral diatom assemblages shifts along environmental gradients. 6th European Diatom Meeting. Innsbruck, 22–25 March 2012.

Kahlert, M. Diatoms in Swedish streams with low to high toxin contamination. 6th European Diatom Meeting. Innsbruck, 22–25 March 2012.

Kahlert, M. (presenting) & Gottschalk, S. Benthic diatom communities in lakes and streams of Sweden – why are they different? 60th Annual Meeting of the Society for Freshwater Science SFS/NABS. Louisville, Kentucky, 20–24 May.

Ecke, F. Recent advances in remote sensing techniques for future environmental monitoring. Workshop "Framtidens metoder i miljöövervakningen", arranged by Uppsala Water Centre, SLU. Uppsala, 14 June 2012.

Ecke, F. Presentation of WATERS and ongoing activities at macrophyte workshop. Södra Vixen, 1–3 August 2012.

Husson, E., Hagner, O., Lindgren & Ecke, F. Macrophyte monitoring at the species level using an unmanned aerial system. International Symposium on Aquatic Plants. Poster. Poznan, Poland, 27–31 August 2012.

Birk, S. & Ecke, F. Opportunities and limitations of remote sensing in ecological status monitoring – a case study of Swedish humic lakes. International Symposium on Aquatic Plants. Oral presentation. Poznan, Poland, 27–31 August 2012.

Kahlert, M. Using diatoms as a biological screening method for heavy metals, pesticides and other hazardous substances? Giftindex. The 22nd International Diatom Symposium. Ghent, Belgium, 26–31 August 2012.

Ecke, F. Miljöövervakning av vattenvegetation med obemannade flygplan – möjligheter och begränsningar. GeoInfo. Oral presentation & poster. Uppsala, 2–3 October 2012.

Kahlert, M. Using diatoms as a biological screening method for heavy metals, pesticides and other hazardous substances? Miljöövervakningsdagarna I Ronneby. Blekinge 19–20 September 2012.

Johnson, R. Revision av bedömningsgrunderna inom ramen för WATERS. Inlandsvatten. Konferens om Kartläggning och analys arrangerad av Länsstyrelserna och Vattenmyndigheterna. Stockholm, 2–3 February 2012.

Beier, U., M. Dahlberg, K. Holmgren, T. Axenrot & A. Sandström. Freshwater fish sampling using standardized methods – costs and benefits from a North European perspective. Oral presentation at 6th World Fisheries Congress. Edinburgh, Scotland, 7–11 May 2012 .

Beier, U., M. Andersson, T. Axenrot & A. Kinnerbäck. Species richness and fishery – consequences for ecological status. Oral presentation at "State of the Lake Vänern Ecosystem (SOLVE)", arranged by the University of Gothenburg and the Aquatic Ecosystem Health & Management Society, at Mötesplats Vänersborg Högskolecentrum. Vänersborg, 11–14 June 2012.

Dahlberg, M., A. Kinnerbäck & M. Andersson. Utbildning i utvärdering av nätprovfisken i sjöar. Presentation på ”Utbildning i utvärdering av nätprovfisken och elfisken". En två-dagars utbildning i samverkan mellan Länsstyrelsen i Jönköpings län och SLU (Sötvattenslaboratioriet). Drottningholm, 7–8 February 2012.

Holmgren, K. Increasing first-year growth of perch in Swedish forest lakes. Poster at Current Questions in Water Management: WISER final conference. Tallin, Estonia, 25–26 January 2012.

Holmgren, K. Fish monitoring and assessment of Swedish lakes – recent news and future perspectives. Presentation at "Nordic Freshwater Fish Group (NOFF). XVI Annual Workshop". Dunkeld, Scotland, 22–24 May 2012.

Annex 3. External interactions

External cooperation

WP 1.3

With the SEPA-funded research programme SPEQS (A Systems Perspective on Environmental Quality Standards) that evaluates the Environmental Quality Objectives implementing the WFD in Sweden. The cooperation takes place through joint seminars and through the role of Ulla Li Zweifel as programme secretary for SPEQS.

WP 2.2

With RDBA by providing comments and contributing to the document "Förslag till klassning av tillförlitlighet för ekologisk status" developed by Anders Rimne.

With SEPA/SwAM, University of Stockholm, County of Västra Götaland, and project "Hav möter Land" by contributing to analyses of uncertainty and development of sampling programmes using "Visual methods".

With CAB and RBDA through the invited participation in five meetings and workshops.

Contribution to development of common application to SwAM on "Havs- och vattenmiljöansökan för Modellstödd övervakning av Sveriges kustvatten" with RDBA (not funded).

WP 3.1

With contractors of the benthic national monitoring programme during gradient studies in summer/autumn 2012.

WP 3.2

With projects run by SEPA and SwAM during the gradient studies in summer/autumn 2012. 1) "Visual methods for monitoring of marine habitats" 2) "Mapping of reefs and sandbanks in the counties of Västra Götaland and Östergötland".

With the County of Västra Götaland and the project "Pilot study for a new vegetation monitoring programme in the west coast water district". Through this cooperation the WP has received external data to use in the analyses.

WP 3.3

With Svealands kustvattenvårdsförbund.

With the strategic research project ECOCHANGE.

WP 3.4

With the CAB of Västra Götaland (Inventering av fisk- och kräftdjursfauna i Stigfjorden sommaren 2012). The study was conducted in connection with the gradient studies and will contribute to the indicator development work within WATERS, and to the status assessment of coastal fish communities in the region.

Lena Bergström also participates in the development of coastal and marine fish status indicators in support of the MSFD (on commission from SwAM), and the Habitats Directive (on commission from the Swedish Species Information Centre).

WP 3.5

The gradient studies in coastal areas in the Baltic and on the Swedish west coast were carried out in cooperation with SEPA, SwAM, and CAB (the counties of Västra Götaland and Östergötland). In 2012, the gradient studies in coastal areas were to a large extent financially supported by SEPA/SwAM, and some of the sampling was performed in close cooperation with the counties of Västra Götaland and Östergötland.

WP 4.3

With SEPA and SwAM in ”Delprogram Kiselalger” (Sub-project diatoms). This is one of several sub-projects in an effort to coordinate regional and national monitoring.

With SEPA and SwAM in the project ”Utveckling av kiselalger som miljögiftsindikator” (Development of diatoms as indicators of hazardous substances)

With SEPA in the follow-up of the Swedish Environmental Objectives through the project ”Jämförelse av kiselalgers och bottenfaunas lämplighet som indikatorer för näringspåverkan och surhet inom miljömålsuppföljningen” (dnr 502-4736-08).

With the CABs, represented by Erik Årnfeldt and Juha Salonsaari, in the planning of WATERS gradient studies.

Maria Kahlert also participates in the development of a diatom database within DynTaxa ArtDatabanken (Swedish Species Information Centre), NordicMicroalgae (LifeWatch projekt) and SLUs FoMA projekt ”Sjöar och vattendrag”, ”Försurning” och ”Giftfri miljö”.

WP 4.5

With projects financed by SwAM also involving CABs: Integrerad KalkningsEffektuppföljning (IKEU). WP 4.5 participants are responsible for fish surveys and temperature logs.

Kerstin Holmgren participates in RepKÖP (related to representativity of monitoring), previously on commission from SEPA and currently led by the RBDA.

With SwAM through Ulrika Beier, participating in the project ”Metodutveckling i stora sjöar (MISS)” (developing methods for fish surveys in large lakes).

With SwAM through Kerstin Holmgren and Björn Bergquist, participating in planning the national monitoring in inland waters (programområdet Sötvatten) and conducting gillnet sampling in lakes in ”Delprogrammet Sjöar Trendstationer” and electrofishing in streams in ”Delprogrammet Vattendrag Trendstationer”.

With SwAM through Anders Kinnerbäck as data host for fish data (programområdet Stödssystem). The data host cooperates continuously with CABs and other providers of fish data from lakes, streams and coastal areas.

With CABs through Magnus Dahlberg and Anders Kinnerbäck as co-arrangers of a course in analysing data from fish sampling of lakes and streams, arranged in cooperation by the CAB in Jönköpings län, SLU i Drottningholm i February 2012.

WP 4.6

With CABs, particularly through support provided by CAB of Östergötlands, and especially Erik Årnfelt, in choosing gradient study sites and administration of landowner liaison. Nine of the ten sites were already part of existing electrofishing schemes, and Östergötland offered to fish the remaining site (Stjärnorpebäcken) to complete the dataset. In return, we have agreed to allow them the use of our data on the other biological indicators.

With CABs of Stockholm and Uppsala in finalizing the choice of lakes, and especially in gaining access to the lakes through locked gates. Additional water chemistry analyses and oxygen profiling in the lakes have been provided to WATERS free by the Geochemistry section of the Department of Aquatic Sciences and Assessment, SLU.

With CABs of Värmland, and especially Grete Algesten in planning the 2013 gradient studies of hydropower dams.

With SLU in Umeå (Hjalmar Laudon, Anneli Ågren, and Ryan Sponseller) and the CAB of Västerbotten in developing and planning the forestry and ditching gradient studies in northern Sweden.

Participation in expert groups

WP 1.3

Ulla Li Zweifel is: 1) co-chair of ICG-COBAM that develops biodiversity-related indicators for the implementation of the MSFD in the OSPAR area and 2) previous chair and current temporary chair of HELCOM CORESET, developing biodiversity-related indicators for the implementation of the MSFD in the HELCOM area.

These tasks are commissioned by SwAM.

WP 2.1

Jacob Carstensen is: 1) coordinator of the TARGREV project for HELCOM, revising targets for the ecological objectives for the eutrophication segment and 2) participant in

HELCOM CORE EUTRO as invited expert for indicator development and use of TARGREV results in future compliance assessments. The aim is to streamline the status assessment and reporting.

WP 2.3

Jesper Andersen participates in: 1) HELCOM CORE EUTRO, via the REACT project, with the objective of revising the HEAT tool in accordance with the MSFD and 2) HARMONY, a Danish, German, Norwegian, and Swedish initiative to harmonize implementation of the MSFD Initial Assessments across the North Sea–Baltic Sea transition zone.

WP 3.2

Mats Blomqvist is a member of: 1) WFD intercalibration groups in the Baltic and North-east Atlantic region, responsible for benthic invertebrates, macroalgaes, and angiosperms and 2) BMB expert group on Baltic higher plants and mosses.

Dorte Krause-Jensen is a member of: 1) WFD intercalibration group for the Baltic region, responsible for eelgrass and 2) Nordic Seagrass Network and the European Coast action on Seagrasses. She also participates in the EU project DEVOTES that tests and develops indicators for the MSFD.

Susanne Qvarfordt is a member of: BMB expert group on Baltic higher plants and mosses.

Sofia Wikström is a member of: HELCOM expert group Red List of Species and Habitats/Biotopes.

WP 3.3

Bengt Karlson is a member of: 1) ICES Working Group on Harmful Algal Bloom Dynamics and 2) OSPAR COBAM expert group on pelagic habitats.

Marie Johansen is a member of: 1) ICES Working Group on Phytoplankton and Microbial Ecology, 2) OSPAR COBAM expert group on pelagic habitats, and 3) HELCOM Phytoplankton Expert Group.

WP 3.4

Lena Bergström 1) is a member of HELCOM Fish Project (Baltic-wide assessment of coastal fish communities in support of an ecosystem-based management) 2) is co-chair of the ICES/HELCOM WGIAB (Working group for integrated assessments in the Baltic Sea), and 3) has been asked by SwAM to be a member of the reference group for "Programområde Kust och Hav" during the coming revision of the national aquatic environmental monitoring.

WP 4.2

Stina Drakare is a member of WFD intercalibration groups Northern GIG of phytoplankton in lakes and Cross GIG of Large Rivers. She was involved in the WISER project (www.wiser.eu), part of phytoplankton in lakes and has been asked by SwAM to be a member of the reference group for "Programområde Sötvatten" during the coming revision of the national aquatic environmental monitoring.

Stina Drakare is involved in Integrated Studies of the Effects of Liming Acidified Waters (ISELAW or IKEU), a programme financed by The Swedish Agency for Marine and Water Management (SwAM or HaV).

WP 4.5

Kerstin Holmgren, Magnus Dahlberg, and Ulrika Beier have been national experts in the second phase of intercalibration, and have also acted as group leaders in Nordic groups for fish in lakes as well as streams.

Kerstin Holmgren participated in the Advisory Board of the WISER project.

Annex 4. Publications

FA2

Balsby, T.J.S., Carstensen, J., Krause-Jensen, D. Sources of uncertainty in estimation of eelgrass depth limits. Hydrobiologia (in press)

FA3

Karlsson, M., Pihl, L., Bergström, L. Assemblage structure and functional traits of littoral fish in Swedish coastal waters. Submitted to Estuarine, Coastal and Shelf science (D 3.4-1, in review).

FA4

Husson, E., Hagner, O., Ecke, F. Macrophyte monitoring at the species level with an unmanned aerial system. Submitted to Applied Vegetation Sciences (D 4.1-1, in revision).

Kahlert, M. (2012). Utveckling av en miljögiftsindikator – kiselalger i rinnande vatten. Länsstyrelsen Blekinge län, Karlskrona, Report 2012:12, 40 pp.

Kahlert M. 2012. Påväxtalgsamhället i arktisk-alpina vattendrag. Dept. of Aquatic Sciences and Assessment, SLU, Report 2012:11, 28 pp.

Mjelde, M., Hellsten, S. and Ecke, F. 2012. A water level drawdown index for aquatic macrophytes in Nordic lakes. Hydrobiologia, 704: 141–151.

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