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SEVENTH FRAMEWORK PROGRAMME

WISER

Water bodies in Europe: Integrative Systems to assess Ecological status and Recovery

Half time public report (extracted from the project periodic report to the European Commission in November 2010)

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Project context and objectives

WISER aims at supporting the implementation of the Water Framework Directive (WFD) by developing tools for the integrated assessment of the ecological status of European surface waters with a focus on lakes and coastal/transitional waters, and by evaluating recovery processes in rivers, lakes and coastal/transitional waters under global change constraints.

Few countries have completed the development of WFD-compliant systems for assessing ecological status in all surface waters. In most countries, assessment systems for several relevant biological quality elements (BQEs: fish, benthic invertebrates, aquatic macrophytes and macroalgae, phytobenthos, phytoplankton) are still missing and the impact of some stressors—in particular hydromorphological degradation—on the biota is widely unknown; there is little information on the uncertainty associated with most assessment systems and the comparability of status assessments between Member States. Furthermore, there is insufficient knowledge on how BQEs recover from degradation and respond to climate change, thus limiting the predictability of the success of future restoration endeavours.

Against this background, four major research questions have been defined:

1. Which biological indicators are best suited for the assessment of aquatic ecosystems? This question in particular addresses indicator reliability in lakes and in coastal and transitional waters.
2. How can assessment results obtained with different BQEs or from different sites best be compared, intercalibrated and combined into an integrated appraisal of ecological status?
3. How do BQEs recover from degradation, in particular hydromorphological degradation and eutrophication, and how is assessment and restoration affected by climate change?
4. How (un)certain are ecological status assessment results and predictions of the outcome of management measures? This question addresses quantification and minimization of uncertainty.

WISER is composed of five scientific modules, plus two modules on coordination and dissemination. The module ‘data and guidelines’ (Module 2) is mainly a supporting module, compiling all the data accessible to the project, closing gaps in the data sources, storing the data generated in the project’s field campaigns, evaluating and comparing existing assessment methods, and developing common guidelines for indicator development.

Two modules address ‘Ecological indicators for assessment and intercalibration’ in lakes and transitional/coastal waters. The lake module (Module 3) is dealing with four BQEs used for lake assessment: phytoplankton, macrophytes, benthic invertebrates and fish. It develops and improves state-of-the-art assessment methodologies, taking into account the remaining needs to complete intercalibration of assessment systems. Hydromorphological degradation and remaining gaps in assessment of eutrophication are being addressed with a special focus on uncertainty estimation. The transitional/coastal waters module (Module 4) uses similar approaches as the lake module and also deals with four BQEs (phytoplankton, macroalgae/angiosperms, benthic invertebrates and fish). The aim is to complete the set of assessment methodologies for transitional/transitional waters, to develop a tool for uncertainty estimation and to support the intercalibration exercise.

Impacts of pressure reduction and climate change on the ecological status’ are addressed by Module 5. The module explores recovery processes of the biota in rivers, lakes and coastal/transitional waters under different climatic conditions. For lakes and marine ecosystems the focus is on oligotrophication, whereas the effects of restoring hydromorphology are investigated for rivers, but also lakes. In concert, these investigations will give guidance on the ecological effectiveness of management and rehabilitation measures.

The module on 'integration and optimisation' (Module 6) summarises the outcomes of Modules 3–5. It guides and evaluates the exercises to estimate uncertainty, it compares the responses of different BQEs and different water categories to degradation and to pressure reduction and it addresses interactions between water categories. Module 6 provides scientific support to the design of monitoring programmes and tests methods on how to best integrate results for single BQEs into a holistic assessment of water bodies.

Finally, a separate module on 'dissemination' (Module 7) is responsible for maintaining the project website www.wiser.eu and for providing concise and up-to-date information on the project for water managers, scientists and the general public. Particular focus is on the involvement of end users (e.g., river basin and water resources managers, Geographical Intercalibration Groups) in the elaboration and discussion of results to obtain feedback on the relevance and applicability of the project's results.

Description of work performed in months 1–18 and major achievements

Data and guidelines

Two major data sources have been established to provide a sound basis for the different kinds of empirical analyses and predictions. First, more than 90 databases compiled in previous and ongoing projects and monitoring activities, representing data from nearly 100,000 samples taken at 60,000 sites were entered in a meta database to enable identification of constituent datasets to address the various objectives. Existing data are being individually compiled and used depending on the individual purposes of the workpackages.

The second data source comprises the results of two extensive WISER field campaigns that were conducted at 33 lakes and 8 transitional and coastal case study areas in 2009 and 2010. All field data are being stored and maintained in a central project database in line with common database standards. Several tools are provided to assist a map-based data search and data extraction, for instance, for uncertainty analysis.

Data on national assessment methods were collected by means of a questionnaire circulated to the Member States via the CIS Working Group "Ecological Status" (ECOSTAT) on October 8th, 2009. Altogether, 259 assessment methods were reported back from 29 European countries (EU Member States plus Norway and Croatia) and transferred into the WISER 'Methods database' (http://www.wiser.eu/programme-and-results/data-and-guidelines/method-database/) which is particularly useful for the intercalibration exercise.

A guideline ('cook book') on indicator development was produced to assist and harmonize the development of common metrics for intercalibration in 2010. It covers important characteristics of metric development, such as ecological relevance, practical applicability, and statistical power.

Assessment of lakes and transitional/coastal waters

A standardised field protocol and a replicate sampling design were applied at 33 lakes in 11 countries and 8 transitional/coastal waters in 7. The sampling campaigns lead to comparable biological, physico-chemical and hydromorphological data from all stations, while the extensive replicate sampling programme provided the basis for the analysis uncertainty sources linked, for instance, to the location of sampling in a lake or the index or metric calculated with that sample. Samples of all BQEs were taken at 18 lakes and 3 transitional/coastal waters. The sampling campaigns are finished and the majority of samples have been processed. Both the lake and transitional/coastal Modules started uncertainty analysis.

Draft common metrics for intercalibration and assessment systems have been analysed for all BQEs in lakes based on existing data from up to 6,900 lakes. For instance, a new pan-European phytoplankton taxonomic index (PTI) has been developed that can be used as a common metric for several GIGs or for those countries that still lack such a metric in their national assessment system. To better account for functional impacts of eutrophication, a Morpho-Functional Group (MFG) Index has been developed based on phytoplankton functional traits. For fish in lakes, the catch per unit effort (CPUE) and the biomass per unit effort (BPUE) revealed the strongest relationships to eutrophication.

In transitional/coastal waters focus was on the development of common methods, which could be used in different countries. Intercalibration was further supported by joint data compilation and evaluation exercises of WISER and the GIGs.

Impacts of pressure reduction and climate change

A general conceptual framework has been developed to identify cause-effect relationships for degradation and restoration trajectories in rivers, lakes and transitional/coastal waters. This framework, the Driver-Pressure-State-Impact-Response-Recovery chains (DPSIRR), has been discussed with end users and improved during a workshop. For a selection of case study sites/catchments, the responses of BQEs, as influenced by stressor increase and decrease, is being evaluated in more detail, while mainly statistical models are used to predict the impact of different pressure reduction scenarios, catchment management options temperature effects.

For rivers, a large-scale database has been compiled using existing data of >4,500 stations in 10 countries. This data is being used to identify the effects of degradation on fish, benthic invertebrates, macrophytes and benthic diatoms. A restoration database on ca. 70 control/impact serves the analyses of the effects of pressure reduction on BQEs and floodplain vegetation and fauna. A literature review on the effects of river restoration revealed limited and heterogeneous effects of reach-scale restoration of in-stream and riparian habitats. The identified cause-effect relationships are currently being prepared for a publication on the project website.

For lakes, palaeo-limnological changes in the diatom assemblages with reduced nutrient loading (re-oligotrophication) were assessed using sediment core data. Based on the analysis of the cores taken at 10 sites, it can be concluded that i) the observed changes do reflect a recovery process and ii) the recovery is more clearly seen in deep lakes, iii) the recovery process has a long way to go in all cases and iv) the recovery pathway appears to be returning back along the enrichment pathway for the deep lakes but this is less clear for the shallow lakes. An online tool to estimate target nutrient loads based on ‘good ecological status’ in terms of the good/moderate class boundary for total phosphorous, total nitrogen and chlorophyll *a* has been developed and is currently being tested.

For transitional and coastal waters, long-term data on six case study catchments have been compiled: Danish estuaries (minimum 7 sites with data covering 3–4 decades), Dutch coastal waters (3–4 decades), Oslo Fjord (3–4 decades), Helsinki Bay area (3–4 decades), Gulf of Riga (3–4 decades) and Nervion River estuary (1–2 decades). The response of phytoplankton biomass (as chlorophyll *a*) to changing nutrient levels has been investigated for Danish estuaries and Dutch coastal waters combined with data from the Chesapeake Bay and Tampa Bay (USA). The results suggest that chlorophyll *a* per unit total nitrogen has almost doubled in coastal waters during the last 30 years. This shift in baseline might be related to climate change and overfishing (impact on the food web), but more important, the results imply that it can be difficult to achieve stressor target values based on historical data because of shifting baselines.

Integration and optimisation

Two workshops were organised and provided guidance on the design of replicate field studies to obtain the data necessary for uncertainty analysis and on the application of software tools and statistical packages to estimate and quantify uncertainty. Therefore, a guideline document has been provided on the use of the statistical software package ‘R’ to analyse uncertainty in the WISER field and existing data and to estimate the size and relative importance of spatial, temporal and sampling/sub-sampling components of variance in metrics. This helps guide the WISER field data uncertainty component analyses and will lead to a summary guidelines manuscript/report for future use. A generally applicable software tool to help assess the confidence in a water body’s estimated WFD ecological status class was developed. The trial version of this new software package ‘WISERBUGS’ (WISER Bioassessment Uncertainty Guidance Software) has been made available online for internal testing and usage and, after the test period, will be made available on the public part of the website.

With regard to the combination of BQE results into a complete water body assessment, a review of 15 national assessment systems for combining BQEs in their WFD monitoring methods was completed.

Only a few Member States apply the ‘one out-all out’ principle straight away (e.g., Portugal, Slovakia, Ireland). Others use ‘one out-all out’, but only after a pre-selection of most sensitive BQEs (e.g., UK, Scotland, Northern Ireland, Germany), i.e. they do not apply the principle to all BQEs. Others employ alternative rules of a different nature (e.g., Spain, Finland, Czech Republic Italy, France, Denmark). The comparative analysis and the evaluation of the consequences of the application of the one-out-all-out principle are planned for the second half of the project.

The comparison of assessment methods and recovery processes across water categories are planned for the second half of the project, as both workpackages will largely base their analysis on data to be compiled during the first 1.5 years. The compilation of this data is almost finished.

Dissemination

WISER has addressed >250 end users in Geographical Intercalibration Groups (GIGs), international water agencies and national water authorities to obtain feedback on the project plans and first results. As the focus during the first half of the project was on the development of common metrics to assist the intercalibration exercise, a close cooperation was particularly established with the relevant lake and transitional/coastal GIGs across Europe. The preliminary results and draft metrics are regularly presented and discussed at the GIG, ECOSTAT and COAST meetings. End users have also been invited to project workshops to discuss conceptual approaches of ecosystem recovery and its usefulness for practical water management.

Preliminary results and project outcome is also frequently announced through the project website www.wiser.eu and through the bi-annual project newsletters. An intranet facilitates the internal exchange of information and data (incl. the end users which have been granted access to the Intranet.)

Expected final results and their potential impact and use

The common metrics developed in WISER will facilitate the intercalibration of national BQE assessment systems for lakes and transitional/coastal waters. Moreover, the various new metrics developed for all BQEs in these water categories will help fill the gaps in national assessment methods in many European countries. The uncertainty analysis will help identify the best-suited and reliable metrics to address specific stressors and combinations of them. Hence, WISER will contribute to the implementation of WFD-compliant assessment in many countries, which is a prerequisite for river basin management and eventually for the improvement of its ecological quality.

The analysis and prediction of the effects of pressure reduction in rivers, lakes and transitional/coastal waters will provide guidance on the various aspects of cost-effective and successful ecosystem management and rehabilitation. The identification of short-term and long-term biological indicators will help design appropriate schemes to assess the success of river basin management measures. The prediction of the spatial and temporal recovery of water bodies will help identify the spatial and temporal extent of management measures in order to be effective and successful. Hence, WISER will provide extensive guidance on future aquatic ecosystem management towards the good ecological status, which is a prerequisite for the sustainable use of the related ecosystem services.

Project objectives, work progress and achievements, project management

Project objectives for the period

WISER develops new WFD-compliant systems for assessing ecological status of lakes, transitional and coastal waters, and will fill existing gaps in water quality classification for several relevant BQEs. WISER puts focus also on the impact of hydromorphological degradation and its effect on the biota. WISER contributes to identify and quantify the sources of uncertainty associated with most assessment systems and the comparability of status assessments between Member States. Finally, WISER contributes to the knowledge on how BQEs recover from degradation and respond to climate change, thus limiting the predictability of the success of future restoration endeavours.

The WISER consortium addresses the following questions:

- Which **biological indicators** are best suited for the assessment of aquatic ecosystems? Which are most reliable? Which are redundant? This aim is limited to lakes (with a special focus on hydromorphological degradation) and coastal and transitional waters.
  The answers to these questions constitute the knowledge base to develop assessment systems for those BQEs, water categories and regions that are still missing, learning from approaches developed within previous EU-funded projects and results from the intercalibration exercise.
- How can assessment results obtained with different BQEs or from different sites best be compared, intercalibrated and combined into an **integrated appraisal** of ecological status?
  WISER aims to support the next steps of the intercalibration exercise in close cooperation with the Geographical Intercalibration Groups (GIGs). WISER will test different ways of combining assessment results (different BQEs and different sampling sites and dates within a water body), and their implications for the precision and accuracy of water body status classification.
- How do **BQEs recover from degradation**, in particular hydromorphological degradation and eutrophication, and how is assessment and restoration affected by climate change?
  To address these questions, an important objective of WISER is to assess the responses of different BQEs to catchment management measures including shifting thresholds, possible time-lags, hysteresis and the effects of the recolonisation potential. Building on experience and results from the EURO-LIMPACS and THRESHOLDS projects, WISER will address the impacts of climate change on BQEs, especially on the good/moderate class boundary and on recovery processes. A focus will be on the effect of restoring hydromorphological conditions. The results will be used to derive solid, evidence-based guidance on the cost-effectiveness of management measures. Empirical modelling will be the principal method to achieve these objectives
- How (un)certain are ecological status assessment results and predictions of the outcome of management measures? How can uncertainty be quantified and consequently minimised?
  WISER aims at estimating uncertainty in bioassessment, with a focus on spatial and temporal variability for field methods and metrics currently accepted and being developed in the project for lakes and coastal/transitional waters. This is being targeted through a centrally organised field exercise addressing all BQEs and will lead to a comprehensive uncertainty estimation tool.

The objectives are being achieved by (1) combining and evaluating a large number of databases provided by the partners and resulting from WFD monitoring programmes and (2) by a dedicated field exercise targeted towards the estimation of uncertainty and towards the comparison of different BQEs. The consortium aims to work in close connection with international, national and regional authorities responsible for WFD implementation, in order to ensure efficient links between science and policy.

Altogether, WISER is structured into seven Modules, the first of which (Module 1) is dedicated to the project management. The project objectives of Modules 2–7 during the reporting period were:

- Module 2 (Data and guidelines, two Workpackages WP2.1 and 2.2): to compiling all existing data accessible to the project in a meta database, to close gaps in the data sources, to establish a central

project database and provide guidance to individual Workpackage databases, to evaluate and compare existing assessment methods, and to develop common guidelines for indicator development.
- Module 3 (Ecological indicators for assessment and intercalibration: lakes, four Workpackages WP3.1–3.4): to design and implement a lake field campaign and sample four BQEs (phytoplankton, macrophytes, benthic invertebrates and fish), physico-chemical and hydromorphological parameters, to design a scheme for uncertainty estimation and include it into the field campaign, to draft and test common Intercalibration metrics and to start develop and improve state-of-the-art assessment methodologies.
- Module 4 (Ecological indicators for assessment and intercalibration: coastal-/transitional waters, four Workpackages WP 4.1–4.4): to complete the steps outlined above for the lake Module also for a set of sampling sites in transitional and coastal waters.
- Module 5 (Impacts of pressure reduction and climate change on the ecological status, three Workpackages WP5.1–5.3): to complete databases on existing data for BQEs and pressures in rivers, lakes and transitional/coastal waters, to compile existing data and the existing literature on restoration and biological recovery in the three water body categories, to identify and develop cause-effect chains (Conceptual Models) for pressure-impact chains and for restoration-recovery chains based on the literature and the databases on data from previous EU-funded projects.
- Module 6 (Integration and optimisation, four Workpackages WP6.1–6.4): will summarise the outcomes of Modules 3-5. It will centrally guide and evaluate the exercises to estimate uncertainty, will compare the responses of different BQEs and different water categories to degradation and to pressure reduction and will address interactions between water categories. It will provide scientific support to the design of monitoring programmes and test methods on how to best integrate results for single BQEs into a holistic assessment of water bodies.
- Module 7 (Dissemination, Workpackages WP7.1 and 7.2): aims at establishing end user groups (e.g., water managers, GIG leaders) and involving them directly in the development of deliverables and other products. Module 7 is responsible for the website and specific dissemination products, such as frequent newsletters, and will organise the final project conference.

WP 1 Management, coordination and reporting

- Coordinate the project to ensure achievement of objectives and deliverables.
- Ensure adequate and appropriate resource use and accounts.
- Communicate with the Commission, including timely reporting.
- Represent and present the project to the outside world to ensure the link to water managers and officers
- responsible for WFD implementation in conjunction with Module 7.

WP 2.1 Data service

The main objective of WP 2.1 is to assist the WISER partners with obtaining efficient access to all relevant project data. The project data will consist of both existing data and new data from the field exercise and from ongoing monitoring programmes. The project partners will contribute with >90 databases (see Table 5), resulting from previous EU-funded and national projects, and from finalised and ongoing monitoring initiatives. In addition, new data will be collected for assessing uncertainty in estimates of the WFD ecological status (WP6.1). Specifically:

- Develop a meta database that provides information on availability and accessibility of all project data for the project partners via the project website (WP7.1).
- Develop templates and guidelines for storing of new data and meta data in collaboration with WP6.1, Module 3 and Module 4.
- Assist the WPs with compilation of existing and new datasets and in making these accessible for project partners; directly from original data (using web service technology) and/or from database copies.

- Develop user interfaces for downloading data from different sources in a harmonised format with
- Functionalities according to the data users' needs; from the project website (web services) and in database copies.

WP 2.2 Review and guidelines

- Generate an overview of biological assessment methods for lakes, rivers, transitional and coastal waters currently in use or under development for the implementation of the WFD.
- Compare and evaluate intercalibration approaches applied in the WFD intercalibration exercise by the Geographical Intercalibration Groups (GIGs).
- Provide water managers in Europe with a concise and easily accessible summary of methods being approved and under development.
- Produce practical guidance for all steps of indicator development within Modules 3 and 4, to ensure harmonised procedures.

WP 3.1 Lake phytoplankton

- Develop and validate indicators and multi-species metrics for phytoplankton composition and algal blooms in relation to eutrophication pressure for application in all GIG regions.
- Produce tools and practical guidance for sampling and analyses to harmonise methods across the EU and reduce uncertainty in phytoplankton classifications.
- Quantify the main sources of uncertainty in phytoplankton metrics (chlorophyll, composition and bloom frequency/intensity).
- Examine combination rules for the use of chlorophyll, composition and bloom metrics in ecological status assessment, specifically in relation to eutrophication pressure.
- Evaluate the potential and limitations for the use of pigment sensors.

WP 3.2 Lake macrophytes

Validate and supplement lake macrophyte metrics based on species composition, abundance and community structure for assessment of impacts of eutrophication. Determine and evaluate their sensitivity and usefulness as indicators, and quantify the uncertainty inherent in their use, including use of palaeoecological approaches (plant macrofossil records) to define reference conditions and to assess ecological status for selected lake types.

- Develop relevant metrics to assess response of lake macrophytes to water level fluctuations, and quantify the uncertainty in their use.
- Test combination rules for single metrics to either one multi-metric or to one final assessment result for benthic macroflora (element-level assessment).
- Evaluate the potential and limitations for using aerial photography as a low-cost-monitoring method for macrophyte assessments.

WP 3.3 Lake macroinvertebrates

- Identify responses of sublittoral and eulittoral benthic invertebrates in lakes to hydromorphological pressures based on existing data and new data obtained during the joint field sampling campaign.
- Recommend techniques to sample and process benthic invertebrates in lakes in order to minimise sources of uncertainty influencing the final assessment score. This will also substantially support the harmonisation work of ECOSTAT.
- Develop and validate an indication tool based on benthic macroinvertebrates for hydromorphological alterations (e.g. alterations of shore morphology or water level fluctuations) for four lake types typical for different regions of Europe.
- Recommend under which conditions low-cost monitoring methods on lake shores - such as lake habitat survey - may partially replace indication by lake invertebrates.

WP 3.4 Lake fish

- Develop fish-based ecological status indicators for lakes exposed to hydromorphological and eutrophication pressures in different regions of Europe, including uncertainty assessment.
- Improve lake fish survey methods through comparisons of data collected by different methods (gill-net, hydroacoustics and electrofishing) and combinations of these.

WP 4.1 Phytoplankton in coastal and transitional waters

In coastal and transitional waters mainly the biomass indicator chlorophyll a has been used up to now. This WP aims at developing phytoplankton community indicators that reflect the impacts of pressures in the composition of phytoplankton determined by traditional microscopy and through analyses of pigments. Multi-metric indices, which take into account species composition, size distribution and biomass parameters will be tested and evaluated using data from coastal and transitional waters. Specific objectives are:

- Develop and validate multi-species or assemblage phytoplankton metrics.
- Evaluate the potential use of pigment data in phytoplankton assemblage metrics.
- Evaluate uncertainty on determinations of phytoplankton biomass and community composition due to temporal and spatial heterogeneity.

WP 4.2 Benthic macroflora in transitional and coastal waters

- Develop benthic macroflora indicators of ecological status in transitional waters, a multi-metric index for macroalgae in coastal waters that incorporates both littoral and sublittoral assemblages, and an index for angiosperms in marine waters of the North Sea.
- Review and validate existing seagrass and macroalgae indicators and multi-metric indices to assess ecological status in transitional and coastal waters. Intercalibrate and harmonise metrics within ecoregions and simplify existing benthic macroflora metrics.
- Develop pressure-response empirical models of coastal and transitional benthic macroflora indicators. Define reference conditions and class-boundaries for seagrass and macroalgal indicators and metrics.
- Estimate uncertainty of ecological status classification and indicator-pressure responses.

WP 4.3 Macroinvertebrates in transitional and coastal waters

- Identify pressure-response relationships of coastal and transitional benthic invertebrates based on existing data and new data obtained during the joint field sampling survey, using seven case-study sites across Europe. Discriminate the response of indicators to morphological pressures, including the assessment of the good ecological potential in HMWBs (modelling approach).
- Develop indicators for hard-bottom substrate fauna.
- Refine numerical models linking the biological and environmental aspects to define reference conditions (using multiple and logistic regression and multivariate methods).
- Define reference conditions, particularly concerning the role of single and complex habitats, in ecological status assessment of transitional waters.
- Determine the risk of misclassification for different indicators and scales (sampling station, water body)

WP 4.4 Fishes in transitional and coastal waters

Further derive, refine, validate and calibrate indices relating to structural and functional aspects of fishes in transitional and coastal waters with the ultimate goal of a multi-metric fish index applicable throughout Europe.

- Evaluate the uncertainty associated to assessment methods for fish in transitional and coastal waters.
- Propose and where possible test new approaches for the modelling of transitional and coastal water fish communities to be used in defining reference conditions.

WP 5.1 Effects of management and climate change: Rivers

WP5.1 will address the future changes in the ecological status of European rivers, in particular recovery from degradation and the effects of climate change. Individually, we aim at:

- Generate driver-pressure-impact-response-recovery chains for fishes, benthic macroinvertebrates and aquatic flora to describe the effects of hydromorphological stress and of the combined effects of eutrophication, catchment land use and hydromorophological stress. These chains will include both degradation and recovery components. The effect of global/climate change on both pressures and on recovery processes, as described by BQEs, will be estimated.
- Develop statistical models and applying existing mechanistic models to predict the response of BQEs to pressure reduction and finally the conditions required to reach good ecological status. This includes considering the potential recolonisation of restored sites in catchments with different densities of source populations.
- Describe best-practice measures of pressure reduction (e.g. restoration measures) and management options to improve the ecological quality of rivers.

WP 5.2 Effects of climate change and management: lakes

WP5.2 will address the impact of catchment management strategies and climate change on pressures and ecological status of lakes. Specifically:

- Assess the impacts of catchment management strategies on BQEs and ecological status of lakes. The pressures addressed include eutrophication and hydromorphological alterations (mainly lake level regulation).
- Assess the impacts of climate change on ecological status of lakes, focusing on impacts on the thresholds used to set the good/moderate class boundary for the various BQEs.
- Assess the uncertainty and risks of failing to achieve and maintain the good status objective under various climate change scenarios.
- Develop and apply models and tools that can be used for estimating the required pressure levels to achieve good ecological status.
- Develop guidelines for using case-specific mechanistic models/empirical analysis of large datasets for designing the programme of measures under climate change.

WP 5.3 Effects of management and climate change: Transitional and coastal waters

WP5.3 will address the combined effects of reducing nutrient inputs and climate change on the ecological status of transitional and coastal waters, in particular:

- Develop tools to estimate required pressure reductions to achieve good ecological status.
- Develop tools to quantify uncertainty associated with these estimates.

WP 6.1 Uncertainty

Facilitate estimation of uncertainty associated with the various BQEs to be used in lakes, transitional and coastal waters and thus provide the tools being developed within Modules 3 and 4 with the necessary means to make confident assessments of ecological quality.

WP 6.2 Combination of BQEs into a complete water body assessment

WP 6.2 will address the problem of combining information from different BQEs into a complete water body assessment, taking into account the pressures, the response signatures of the indicators, redundancy, and uncertainty. The underlying hypothesis is that response signatures as well as the uncertainties associated with the classification are different between indicators, both within a BQE and between BQEs, and that these differences have major consequences for the classification outcome when combining results for different BQEs. The objectives are:

- Demonstrate the practical implications of the ‘one-out all-out’ approach and alternative approaches for assessment of water bodies.
- Make practical recommendations for end users on the combination of metrics and BQEs.

WP 6.3 Comparison of assessment methods across water categories

Selection of a response variable ideally should be a knowledge-based decision using stress-response information to select the “best” indicator (i.e. high sensitivity and low uncertainty) for the stressor of interest. BQEs (organism group and metrics) are expected to respond differently to different stressors and vary among systems and among habitats within systems depending on first and secondary principle relations. The main objectives of this WP are to test the hypotheses that:

- BQE responses based on first principle relations have higher precision and sensitivity than secondary principle relations;
- BQE response signatures are water category- and habitat-specific.

WP 6.4 Comparison of recovery processes between water categories

Catchment wide integrated basin management requires knowledge on cause-effect and recovery chains within water bodies as well as on the interactions between water bodies and categories. Approaches include processes related to biology (connectivity, metapopulation and dispersal) and global change (climate change, land and water use). The main stressors studied here will be acidification, eutrophication and hydromorphological changes. The objectives are:

- Analyse and compare cause-effect and recovery chains between water categories based on processes and functional features and over-arching biological processes and global change.
- Detect the antagonistic, neutral, additive or synergistic nature of the impact of multiple stressors within one water body/category.
- Detect commonalities among different chains and to develop a method to combine recovery effects in a summarising ‘catchment’ metric.

WP 7.1 Internal and external information sharing

- Provide information on the project to project partners and end users.
- Provide tools for storage and facilitating exchange and share of information for project partners.
- Disseminate and make available the project databases for project partners.
- Make reports, publications and other results available for end users and for the public.
- Get feedback from relevant end users and inform project partners about that.

WP 7.2 Final conference

Disseminate the major scientific results by organising an international conference in Month 34. The conference aims at providing a platform to present applicability of the developed tools and approaches. The focus will be on a science-policy interface with specific sessions for in-depth scientific presentations and hands-on sessions for the end users.

Work progress and achievements during the period

Module 1 Management, coordination and reporting

Module 1 deals with the overall project coordination, but in particular aims at providing support in the transition zone of project management and science. The main objectives of Module 1 are:

- to coordinate the overall scientific workflow in the project and to ensure the achievement of objectives, milestones and deliverables,
- to manage administrative issues and budget and to ensure an adequate and appropriate use of resource,
- to communicate with the European Commission, including timely reporting and
- to represent and present the project to the outside world to ensure the link to water managers and officers responsible for WFD implementation in conjunction with Module 7

The pure management tasks of Module 1 are described in section 3.2.3. Here, we focus on scientific coordination.

Summary of progress towards objectives and details for each task

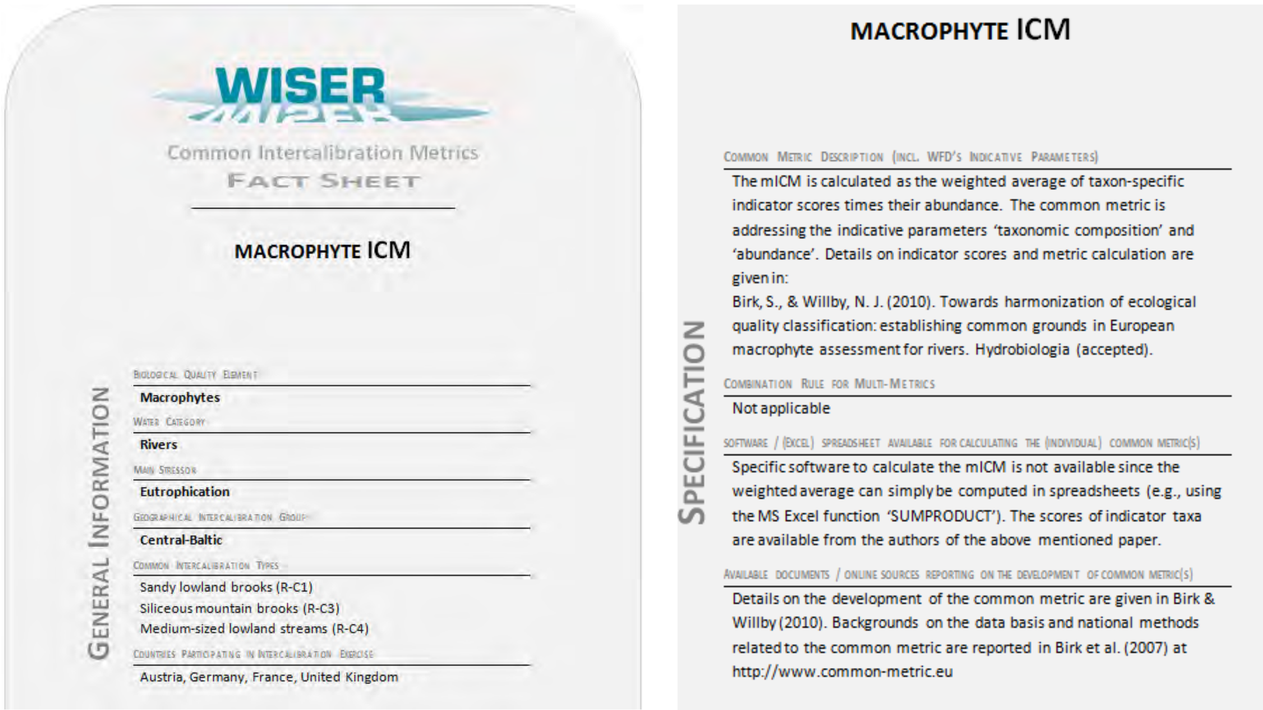
The day-to-day scientific coordination of the project was mainly handled through the monthly Steering Group meetings and email meetings. These covered topics of general relevance, such as data transfer between workpackages, sampling schemes, the development of common metrics, meeting preparation as well as administrative issues such as budget shifts. Topics relevant for more than one workpackage within a module were discussed and decided on a module level, mainly on physical and video meetings. The workpackage leaders were responsible for workpackage-specific issues, such as sampling methodologies, workpackage databases and data evaluation within a workpackage.

The general outlines of the project were steered by the coordinators. Although the workplan has been described in much detail in the Description of Work and further specified in the minutes of the kick-off meetings, some major changes and additions were performed:

- ECOSTAT and the GIGs strongly recommended an early development of common metrics by the WISER Module 3 and 4 workpackages to support the intercalibration. Originally the finalization of WISER assessment schemes was planned for the end of the project; however, due to the late start of WISER, there was a mismatch with the schedule of the second phase of the intercalibration exercise, which ends in summer 2011 and required common metrics in 2010. Following these suggestions the WISER consortium agreed to develop draft common metrics much earlier, i.e. in 2010, to provide the GIGs with draft tools for intercalibration. The common metrics are developed using common guidelines and will be centrally reported in a common form designed and provided by the coordinator (Figure 1.1).
- Initiated by the coordination team, the WISER Steering group produced a paper reviewing the experiences with the implementation of the Water Framework Directive 10 years after its implementation. Some details of this paper are further described under “Notable findings and results”.

Publications

- Hering, D., A. Borja, J. Carstensen, L. Carvalho, M. Elliott, C.K. Feld, A.-S. Heiskanen, R.K. Johnson, J. Moe, D. Pont, A. Lyche Solheim, W. van de Bund (2010): The European Water Framework Directive at the age of 10: A critical review of the achievements with recommendations for the future. Science of the Total Environment 408: 4007-4019.



WISER

Common Intercalibration Metrics
FACT SHEET

MACROPHYTE ICM

GENERAL INFORMATION

BIOLOGICAL QUALITY ELEMENT
Macrophytes
WATER CATEGORY
Rivers
MAIN STRESSOR
Eutrophication
GEOGRAPHICAL INTERCALIBRATION GROUP
Central-Baltic
COMMON INTERCALIBRATION TYPES
Sandy lowland brooks (R-C1)
Siliceous mountain brooks (R-C3)
Medium-sized lowland streams (R-C4)
COUNTRIES PARTICIPATING IN INTERCALIBRATION EXERCISE
Austria, Germany, France, United Kingdom

MACROPHYTE ICM

SPECIFICATION

COMMON METRIC DESCRIPTION (INCL. WFD'S INDICATIVE PARAMETERS)
The mICM is calculated as the weighted average of taxon-specific indicator scores times their abundance. The common metric is addressing the indicative parameters 'taxonomic composition' and 'abundance'. Details on indicator scores and metric calculation are given in:
Birk, S., & Willby, N. J. (2010). Towards harmonization of ecological quality classification: establishing common grounds in European macrophyte assessment for rivers. Hydrobiologia (accepted).
COMBINATION RULE FOR MULTI-METRICS
Not applicable
SOFTWARE / (EXCEL) SPREADSHEET AVAILABLE FOR CALCULATING THE (INDIVIDUAL) COMMON METRIC(S)
Specific software to calculate the mICM is not available since the weighted average can simply be computed in spreadsheets (e.g., using the MS Excel function 'SUMPRODUCT'). The scores of indicator taxa are available from the authors of the above mentioned paper.
AVAILABLE DOCUMENTS / ONLINE SOURCES REPORTING ON THE DEVELOPMENT OF COMMON METRIC(S)
Details on the development of the common metric are given in Birk & Willby (2010). Backgrounds on the data basis and national methods related to the common metric are reported in Birk et al. (2007) at http://www.common-metric.eu

Figure 1.1: First two pages of the WISER reporting form for common metrics.

Notable findings and results

The WISER Steering Group performed a general review of achievements and problems with the implementation of the Water Framework Directive, which is now 10 years old, and provided recommendations to further improve the implementation process. In particular, three fields were addressed: (i) the development of assessment methods (including reference conditions, typologies and intercalibration); (ii) the implementation of assessment systems in monitoring programmes; and (iii) the consequences for river basin management plans (such as the design, monitoring and success of restoration measures).

The development of assessment methods has been a transparent process and has resulted in improved and more standardised tools for assessing water bodies across Europe. The process has been more time consuming, and methods are more complex, than originally expected. Future challenges still remain, including the estimation of uncertainty of assessment results and a revision of rules in combining the results obtained with different Biological Quality Elements.

A huge amount of monitoring data is now being generated for WFD purposes. Monitoring data are not centrally stored and thus poorly accessible for purposes beyond the WFD. Future challenges include enhanced data accessibility and the establishment of a Europe-wide central monitoring network of reference sites.

The WFD River Basin Management Plans base management decisions on the response of aquatic organisms to environmental stress. In contrast to the effects of degradation, the biotic response to restoration is less well known and poorly predictable. The timescale of the WFD (obtaining good ecological status in all surface waters by 2027) is over-ambitious. Future challenges include long-term monitoring of restoration measures to understand the requirements for ecosystems to recover and prioritisation of measures according to re-colonisation potential.

The draft common metrics for lakes developed in the first half of WISER are specified in Table 1.1. They were developed by the workpackages 3.1 to 3.4 following a common scheme proposed by the coordinators and agreed with the Steering Group. The common metrics will be further refined and validated in the second half of the project, but already now they provide a tool for intercalibration, against which national assessment methods can be compared. Common metrics are closely related to national methods, show a general response to stress gradients and are applicable in large geographic areas.

Table 1.1: Draft common metrics developed by the WISER lake workpackages.

BQE	Common metric selected	GIGs covered
Phytoplankton	• Chlorophyll • Phytoplankton Taxonomic Index • Morpho-Functional Group index • Evenness • Cyanobacterial bloom metric	All lake types (except alpine GIG)
Macrophytes	• Water level fluctuation metric • Maximum colonization depth • Taxonomic richness metric	N-GIG, CB-GIG (EC-GIG, Med-GIG)
Invertebrates	• lbfICM (# EPTCBO taxa, ASPT, % Odaonata; % ETO, % Crustacea , % habitat preference lithal	L-CB1 L-CB2
Fish	• Catch per unit efford (number) • Biomass per unit efford • Number of omniv. per unit efford	All GIGs, in particular N-GIG and CB-GIG

Module 2 Data and guidelines

Module 2 is mainly a supporting module, compiling all the data accessible to the project, closing gaps in the data sources, storing the data generated in the project's field campaigns, evaluating and comparing existing assessment methods, and developing common guidelines for indicator development.

The main objective of Module 2 is to provide information, guidelines and technical solutions (e.g., templates and software tools) for the work on indicators in other modules. The main challenges of combining the existing data from several sources are to harmonise stations lists, taxonomic lists, and parameter units. Biological data are considerably more difficult to harmonise than chemical/physical parameters, especially for species-rich BQEs such as phytoplankton. Thus, a central data service as provided with WP2.1, is required to ensure data consistency and comparability.

Module 2 has developed a general database structure for all data (existing and field campaign data), which is being followed by the individual WP databases in Modules 3, 4 and 5. A second database on metadata (including information on intellectual property rights) of existing data sources has been developed to assist individual WPs with the identification of data suitable for their purposes.

In the reporting period main parts of Module 2 were finalized: The overall database structure was agreed, most workpackages (Modules 3, 4 and 5) have already delivered their data to WP2.1 within the reporting period or shortly afterwards, a database on assessment methods for European aquatic ecosystems was finalized and published on the website, and guidelines for indicator development within Modules 3 and 4 were written.

WP2.1: Data service

*Contractors involved: **NIVA**, UDE, NERC, BOKU, UCL*

Summary of progress towards objectives and details for each task

The main objective of WP 2.1 is to assist the WISER partners with obtaining efficient access to all relevant project data. The project data consist of both existing data and new data from the field exercise and from ongoing monitoring programmes.

<u>Communication with the consortium</u>

A team of WP data managers (one person responsible for data management and communication with WP2.1 in each WP) was established during the kick-off meeting in Month 1. WP2.1 has had regular communication with all WPs regarding data needs (especially WPs 5.2-6.4), data delivery to the Central database (WPs 3.1-5.1), WP database structures, common database structure (WPs 3.1-5.1), need for data management tools, and need for other assistance.

<u>Central database</u>

A Central database has been constructed (in Oracle) and is being managed at NIVA. A draft version (in Access) of the database structure ("WISER DB structure") including standard code lists was distributed to all WPs for feedback during Month 3. The DB structure has been revised based on feedback from the WPs, and updated versions have been distributed. All tools provided by WP2.1 are based on this DB structure.

Data have been delivered from each of the WPs 3.1-5.1 during Month 16-18. For each WP, tailor-made queries for import to the Central DB are under development in communication with the WP data manager. A user interface for searching and downloading data from the Central DB is under development (presented for WP data managers during the mid-term meeting).

<u>Meta database</u>

Before the kick-off meeting, a meta database structure was developed, and an online questionnaire for collecting metadata for existing available datasets was developed and distributed to partners. This questionnaire offers a clear structure and easy-to-use features as checkboxes and selection lists as well as help tool. An overview of the first version of the meta database could thus be presented to all partners during the kick-off meeting. The partners' online entries of the metadata have been quality-checked regarding completeness of recorded data and obvious errors, and the content of the meta database has been evaluated several times during the reporting period. The meta database has been made available for partners as Access file on the intranet; and all metadata can be examined by all partners via the web interface. The development of a variety of query options for the metadata via the web interface is currently under process.

Compilation of new data (from WISER field campaign)

All new data from the WISER field campaign (WPs 3.1-4.4) are currently being compiled into the Central database. WP2.1 has provided a template (Excel tables) for structuring data and guidelines for transferring and importing these tables to the WISER database structure (in Access). The template and guidelines were offered as a tool for WPs who have chosen to use the WISER DB structure for their WP database, and have been used by some of the WPs. WPs that have chosen other WP database structures, have received assistance data compilation upon request.

In addition, an online tool for recording taxonomic data according to standard taxa lists has been provided (http://www.freshwaterecology.info/TaxaDB_TET.php).

Compilation of existing data (from project partners or external collaborators)

More than 90 existing datasets are available from project partners (Annex I ‘Description of Work’, DoW), Table 5). A selection of these datasets will be included in the Central database: (1) datasets that WPs 3.1-5.1 have included in their WP database and delivered to WP2.1, and (2) other datasets that any of WPs 5.2-6.4 need to receive from the Central database. In addition, some WPs have acquired data from external collaborators (e.g. Geographical Intercalibration Groups). The Excel template provided by WP2.1 for compilation of new data has also been used by some WPs for compiling existing internal data as well as for acquiring external data.

Data selection, formatting and extraction for partners

A first version of the meta database (Access database) was presented for all partners during the kick-off meeting, to facilitate the selection of relevant datasets for their WPs. During Month 1-18 a set of tools have been under development (presented for WP data managers during the mid-term meeting).

- A user interface for searching the meta database; will be available from the project website
- A web-based user interface for searching the Central database and downloading selected datasets
- A tool (Access form) for selecting and formatting data, resulting in a single table for data analysis

An integration of these three tools is planned, which will allow the users to combine searches of the meta database and the Central database into a common export file.

Additional tasks

In addition to the tasks planned according Annex I, WP2.1 has performed certain task based upon the needs of project partners.

- Training of data manager (WP3.1).
- Compilation of WP database (WP4.2).
- Development of tailor-made template for external data request (WP3.1).
- Data service for external collaborators (GIGs) has been discussed. WP2.1 participated in the Lake Intercalibration meeting (JRC, November 2009) and presented options for collaboration.
- Management of harmonised taxa lists from each WP, available through the Taxa Entry Tool.
- Incorporation of biological metrics in the Central database has been discussed.

Publications

WP2.1 has not yet produced any papers.

Notable findings and results

WP2.1 is a "service WP" and does not produce scientific results; the most important outcome of this WP is the tools and services provided for other WPs. All products from WP2.1 are available for partners from the WISER intranet.

The meta database currently contains 115 records, of which 89 represent the existing internal data (from project partners), for which most of the metadata are entered. For the remaining 26 datasets, 10 represent new data (from WISER field campaign) and 16 represent existing external data (from other collaborators); for these the metadata remain to be entered. The metadata represent more than 60 000 sites from ca. 35 000 rivers, 19 000 lakes, 5400 coastal waters and 1800 transitional waters.

The meta database query options, which will soon be available online, include the following selection options: water category, GIGs and/or typological criteria. The query result will include:

- Number of sites available for the selected criteria
- Additional available information for the dataset that fulfils the above selected criteria
- Link to the metadata for each dataset
- Link to the contact persons for each dataset
- Information on IPR issues for each dataset (also indicated by a "traffic light system")
- Information on the availability of real data in the WISER Central database, and possibility to select and extract these datasets

The WISER database structure has been developed in order to accommodate data from all WPs and make them available for other WPs in a standardised format. The data flow in WISER is rather complex, and the WISER database structure is therefore a result of several compromises. We have tried to ensure that all critical information from all WPs can be included (e.g. information on sampling methodology), but at the same time exclude information that is not necessary for calculation of biological metrics and that would complicate the table structure further (e.g. information on individual fish specimens). A key purpose of the WISER DB structure is to facilitate data extraction uncertainty analysis based on the new field data (cf. WP6.1). Hence, the DB has a hierarchical table structure corresponding to the WISER sampling design (t_Waterbody, t_Station, t_SampleBio, t_ SubsampleBio). The "sample" is a key concept in the uncertainty analysis; we have therefore tried to ensure that all components of the sample definitions for all WPs are represented by fields in the sample table (e.g. SampleDate, SampleDepthUpper, SampleDepthLower, SampleMethod, etc.).

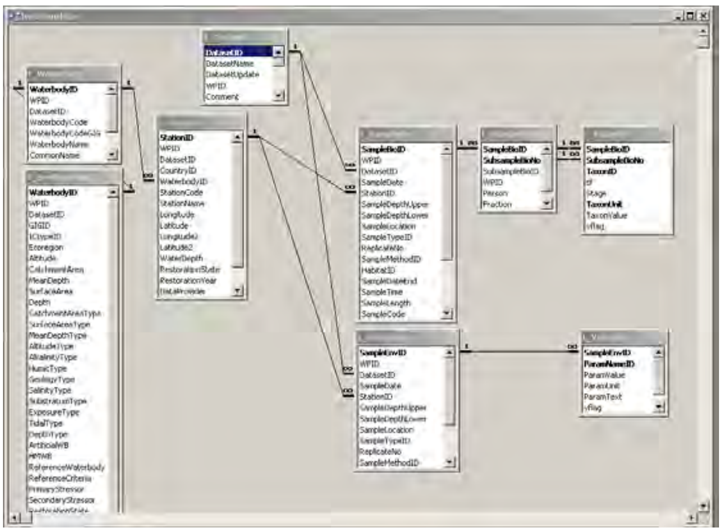


Figure 2.1.1: The WISER common database structure: illustration of the table relationships.

A map-based search tool is under development (Figure 2.1.2), and will be made available on the website. The map shows locations with biological data. Individual stations can be selected, and a pop-up window displays information on the dataset to which the station belongs; the dataset can then be added to a list for data export. The final list of datasets can be exported as an Access database (with the WISER DB structure), which also contains the Data extraction tool (see below).

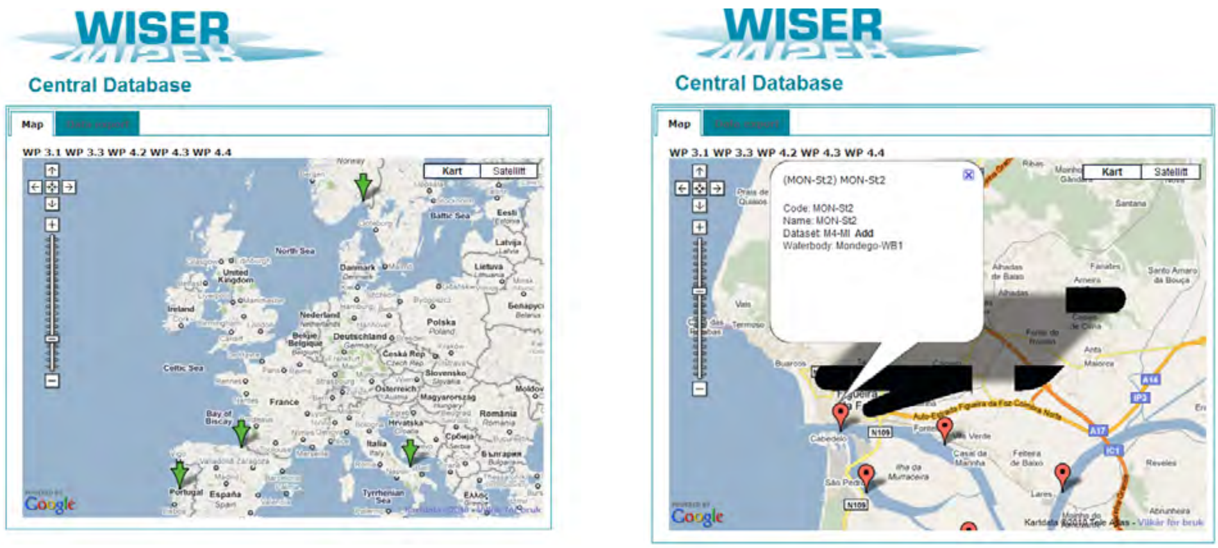


Figure 2.1.2: Example of web-based search tool for the Central database.

A data extraction tool has been developed to allow extraction and compilation of any WISER data, from any database with the WISER DB structure. The user interface of the tool is an Access form (Figure 2.1.3). The underlying series of Access queries is available to the users, so that WP data managers have the possibility to modify these queries after their own preferences. The tool extracts the selected and aggregated data into a single table, which can be exported to other software for data analysis. The tool was originally developed for extraction of phytoplankton data in communication with WP3.1, but will be extended to apply for all biological groups. The tool currently includes options for (1) data selection and restriction (e.g. biological group; requirements to corresponding environmental data) and (2) data aggregation (geographical, temporal, and taxonomical). Possible further developments include calculation of biological metrics and EQR values.

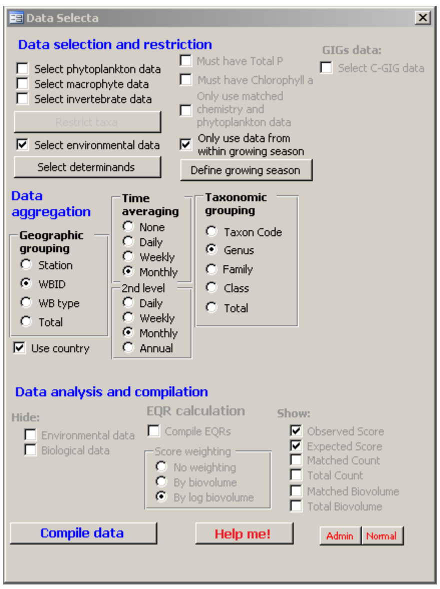


Figure 2.1.3: Data extraction tool.

WP2.2: Review and guidelines

Contractors involved: ***UDE****, AZTI, EC-JRC, FVB*

Summary of progress towards objectives and details for each task

Biological assessment methods are key elements of the management of surface waters. They classify the ecological status of water bodies and inform on the effects of restoration or conservation measures. Many different methods are currently used in Europe, covering biological quality elements within four water categories: rivers, lakes, coastal waters and transitional waters. Workpackage 2.2 first provides a detailed overview of national assessment methods. Second, a guideline for indicator development was produced to harmonise method development within WISER. Third, we aim at reviewing the techniques of intercalibration of national assessment methods.

Overview of national assessment methods

The WFD requires classifying the quality status of rivers, lakes, coastal and transitional waters. The ecological status is evaluated by biological assessment methods using selected biological quality elements (BQE), i.e. phytoplankton, macrophytes and phytobenthos (lakes and rivers), angiosperms and macroalgae (coastal and transitional waters), benthic invertebrate fauna and fish fauna. The 27 European Member States are in charge of developing these methods, and the classification of good ecological status is harmonised in a Europe-wide intercalibration exercise. Against this background there is a growing need for the exchange of information and data on biological assessment methods. Most methods have been developed only recently, and Member States are interested in improving and updating their schemes. The obligation to intercalibrate the national classification of good ecological status further requires precise descriptions of the national methods' features.

A main objective of the WISER project was thus to generate an overview of biological assessment methods for lakes, rivers, coastal and transitional waters currently in use for the implementation of the WFD. Furthermore, the project provides the water managers in Europe with a concise and easily accessible summary of methods being approved and under development. Data on national assessment methods were collected by means of a questionnaire circulated to the Member States via the CIS Working Group "Ecological Status" (ECOSTAT) on October 8th, 2009. The preparation of the survey was done in a joint activity with the Intercalibration Steering Group (Joint Research Centre, Ispra, Italy). The questionnaire was divided into three sections covering the topics A - General information, B - Data acquisition and C - Data evaluation. The enquiry was mostly focussing on general aspects that all biological assessment methods have in common – irrespective of water category or biological quality element. However, the completion of the questionnaire required good knowledge about the respective national method, thus it was best undertaken by persons responsible for method development or implementation. The questionnaire is available for downloading at http://www.wiser.eu/programme-and-results/data-and-guidelines/questionnaire/.

Data on a total number of 259 assessment methods were collected from 29 European countries (EU Member States plus Norway and Croatia) (Table 2.2-1). The Wiser methods' database (Figure 2.2-1) provides water managers and applied scientists with a concise and easily accessible summary of assessment methods used in European quality classification. It facilitates the intercalibration exercise by providing an essential data source for the obligatory steps of the process. The analysis of the acquired data will yield an overview of the state-of-the-art of aquatic bioassessment in Europe.

Guidelines for indicator development

The development of WFD-compliant assessment systems is a pivotal aim of WISER. Assessment systems translate biological information of a water body to an ecological status class. Within the WISER project assessment systems are developed for different water categories (lakes, transitional and coastal waters) and different BQE. The development of assessment systems is part of Modules 3 (lakes; workpackages 3.1-3.4) and Module 4 (coastal and transitional waters; workpackages 4.1–4.4). Phytoplankton, macrophytes, macroalgae and angiosperms, benthic invertebrates and fish are sampled with different methods and devices and the resulting data are thus differently structured; there are also differences in data generated for lakes and transitional and coastal waters. Some differences among assessment systems developed in WISER are unavoidable owing to the individual requirements of the BQE or water types. However, certain features of the development process and, thus, of the resulting assessment systems should be similar and provide a harmonized WISER assessment methodology to be adopted. Wherever possible, the process for developing assessment systems, therefore, needs to be harmonized and applied in a similar way by the workpackages within Modules 3 and 4. Another important aim of WISER is to support the intercalibration process. The guidelines for the second phase of the intercalibration process include a strict time plan. One of the first steps is to derive "common metrics", i.e. biological measures created for benchmarking and comparison of national assessment systems. Also the process of developing common metrics needs to be harmonized among WISER workpackages.

Consequently, the guidelines for indicator development produced within Workpackage 2.2 have two aims: (1) to guide and harmonize the rapid and preliminary development of common metrics in 2010; and (2) to guide and harmonize the development of assessment methodologies among the relevant WISER workpackages. The guidance is structured accordingly, with one chapter dealing with common metrics and one with assessment systems. Each chapter covers criteria of the methods to be developed (e.g. applicability, statistical features), the development process (e.g. data sources and statistical methods to be used) and a brief description of the envisaged product. While the guidance strives for a harmonized approach it still allows for flexibility; it is generally difficult to transform biota and their response to stress into simple numbers and, therefore, different problems will appear for the individual BQE and water types. The two main chapters overlap considerably. They represent "cook books" for slightly different purposes and we strived for a complete description of each procedure within a single chapter, which can be applied without consulting other chapters or documents.

Reviewing the techniques of intercalibration

The design of national assessment methods is significantly influencing the techniques of intercalibration. Therefore, the WISER project is asked to provide advice for the future of the intercalibration exercise, e.g. suggestions on which BQE/water type combinations should not be intercalibrated. This advice will be based on reporting of the intercalibration groups and outputs of the workpackages in Modules 3 and 4, in particular the common metric development carried out in these modules. Since most of these tasks have not yet been accomplished, the foreseen review of methods and recommendations for current and planned intercalibration work (D2.2-4) is deferred.

Table 2.2-1: Number of assessment methods per water category included into the WISER method database.

Water category	Number of assessment methods
Lakes	72
Rivers	73
Coastal Waters	66
Transitional Waters	48

Publications

WP2.2 has not yet produced any papers.

Notable findings and results

First outcomes reveal that methods' availability is different among European regions (Figure 2.2-2). None of the regions completely cover all BQE at all relevant water categories. However, countries in Western Europe are most advanced in method development. Concerning the methods' availability per BQE, benthic invertebrates are the best-covered quality element (Figure 2.2-3). Macrophytes and phytobenthos are currently assessed by only half of the countries that potentially have to evaluate this quality element in their rivers and lakes. Another notable finding relates to the pressure-impact-relationships that are validated for only two-third of the methods. Especially methods for coastal and transitional waters have not been tested regarding their response to anthropogenic disturbance.

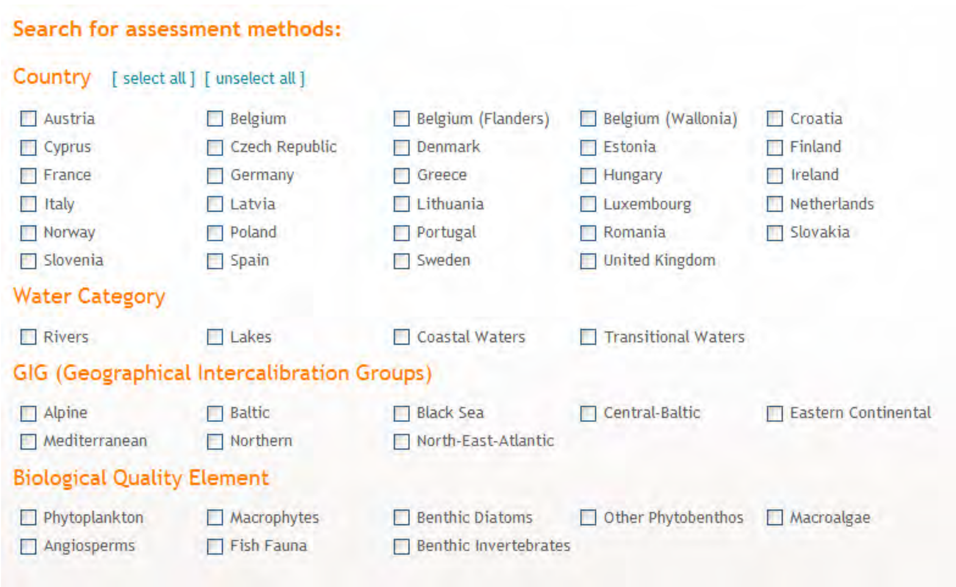


Figure 2.2-1: Search form of the WISER methods' database.

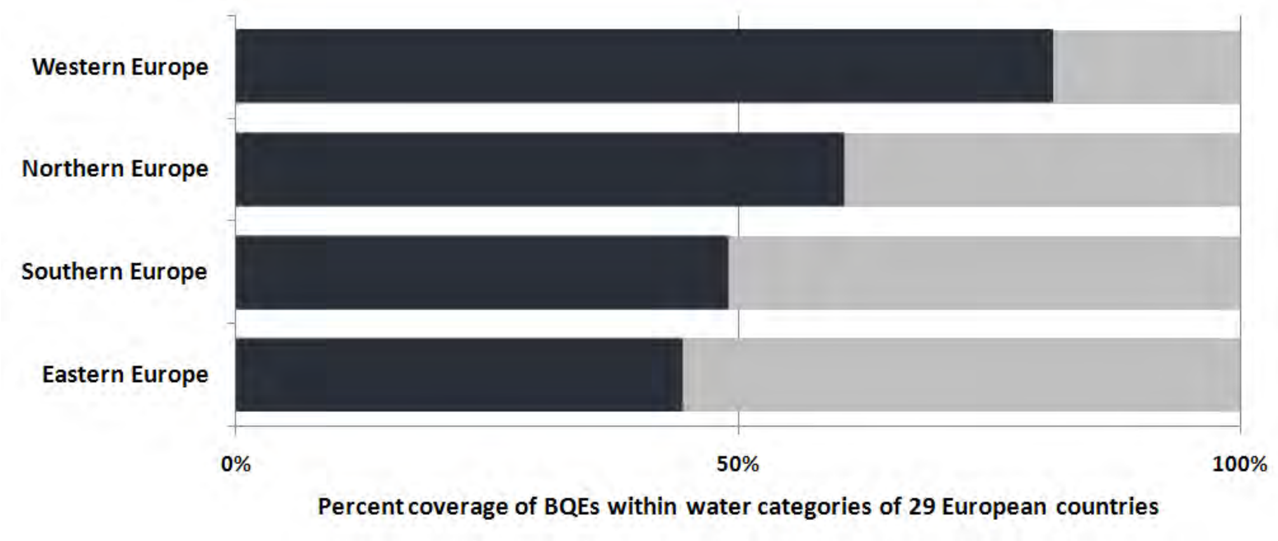


Figure 2.2-2: Completeness of ecological status classification per region (based on assessment methods reported for relevant BQEs and water categories per country). Western Europe: Austria, Belgium, France, Germany, Ireland, Luxembourg, Netherlands and United Kingdom. Northern Europe: Denmark, Finland, Norway and Sweden. Southern Europe: Cyprus, Greece, Italy, Malta, Portugal and Spain. Eastern Europe: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.

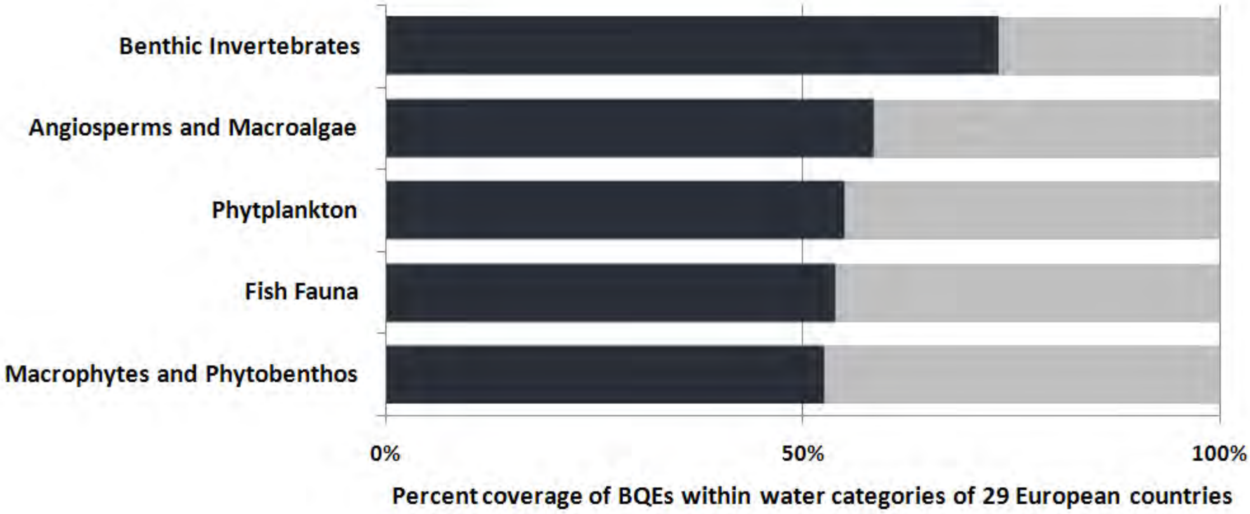


Figure 2.2-3: Completeness of ecological status classification per biological quality element (based on assessment methods reported for relevant BQEs and water categories per country).

Module 3 Ecological indicators for assessment and intercalibration: lakes

The main objectives of Module 3 is to develop and validate assessment methods for common pressures affecting lakes, providing scientific support to the next phase of intercalibration, to the completion and harmonisation of classification systems, and to the implementation of WFD monitoring programmes. The major stressors considered are eutrophication and hydromorphological alteration.

Existing data and data from a new field campaign are being used. The field campaign has been finalised in 2010 and included 33 lakes in 11 countries, located in the Nordic, Central/Baltic, Eastern Continental and Mediterranean GIGs. The BQEs have been sampled in 33 (phytoplankton), 28 (macrophytes), 31 (benthic invertebrates) and 23 lakes (fish), respectively. Samples of all BQEs (fish, benthic invertebrates, macrophytes and phytoplankton) were taken at 18 lakes based on standardised methods and following a common sampling design. Hydromorphological and physico-chemical variables were recorded for all lakes in the field campaign. Most field data has already been transferred to the WP databases.

Besides, extensive existing data on up to 6,900 lakes has been compiled for certain quality elements. All data has been checked for quality and imported into the central WISER database (WP2.1). The data evaluation has been started and some results have already been published (partly based on existing data of previous projects).

The work in Module 3 is now focussing on the development of metrics for assessment and classification methods and on the quantification of uncertainties linked to the different steps of metric development (e.g., sampling, sorting and analysis). Deviating from the original schedule a special focus has been placed on the development of common metrics to support the intercalibration exercise. The common metrics are being provided much earlier than originally planned, as the 2nd phase of the intercalibration exercise will end in July 2011, and the Geographical Intercalibration Groups (GIGs) thus need such common metrics in autumn 2010.

WP3.1: Lake phytoplankton

Contractors involved: ***NERC****, NIVA, CEMAGREF, IEP, FVB, SYKE, CSIC, EMU, CNR*

Summary of progress towards objectives and details for each task

WP3.1 is dealing with data from all Geographical Intercalibration Groups (GIGs) in Europe. In close cooperation with the GIGs a database has been established with more than 16,000 phytoplankton samples from 6,900 lakes. These data have been used to identify draft common metrics applicable for intercalibration of assessment systems for phytoplankton in lakes throughout Europe. Individually, the objectives are:

<u>Develop and validate indicators and multi-species metrics for phytoplankton composition and algal blooms in relation to eutrophication pressure, for application in all GIG regions.</u>

Major progress has been achieved with two deliverables on candidate metrics for intercalibration produced by the end of August 2010 (see notable results). These are currently under review by the GIGs and all WP3.1 partners for finalisation in autumn 2010. Initial reaction from the GIGs has been very positive with much interest in adopting the WISER metrics as components in a common metric and also as national metrics by many countries. The metrics will be finalised in autumn 2010 to ensure IC can be achieved on schedule (by April 2011).

The major contributory tasks have included:

- **Data compilation and data service**: This was largely coordinated by NIVA with substantial contributions from IGB and GIG data leads. It included developing format of data request, compilation into a WISER central database and quality assurance of data, incl. harmonisation of a European lake phytoplankton taxa list with 2300 taxa (species and subspecies, with synonymous and common coding), frequent communication with data providers, and repeated corrections of errors. The taxalist is available at the www.freshwaterecology.info website. The database now contains data on biomass and taxonomic composition, as well as environmental data from 21 countries across Europe with 6900 lakes for chlorophyll and nutrients and 1,900 lakes for taxonomic data at species/genus level. This database now holds all the data being used for intercalibration of phytoplankton classification systems across Europe, and was used to construct common metrics for intercalibration of phytoplankton composition and blooms.

- **Data analyses and production of candidate metrics for phytoplankton composition and blooms**: A small working group of 8 people from WISER (NERC, NIVA, CNR, IGB, CEMAGREF) and the GIGs (Central Baltic, Mediterranean and Northern) was established to develop candidate metrics. Regular monthly meetings were held using the WISER videoconference facility to develop ideas and discuss progress. One physical meeting was held at London Gatwick airport in January 2010. Four candidate metrics have been examined, two for phytoplankton composition (led by NIVA and CNR) and two for blooms (led by IGB and NERC). These have been described in two reports (D3.1-1 lake phytoplankton composition metrics and D3.1-2 lake phytoplankton bloom metrics), delivered in August 2010.

Quantify the main sources of uncertainty in phytoplankton metrics (chlorophyll, composition and bloom frequency/intensity)

New field data were collected in summer 2009 from 33 European lakes in 11 countries (11 lakes in each of Central Baltic, Mediterranean and Northern GIGs) and 6 lake types. Sampling adopted a nested hierarchical sampling structure that will allow an assessment of uncertainty in phytoplankton data and metrics in common lake types along the eutrophication gradient. The sampling design and analysis was consistent with WP4.1 coastal phytoplankton to enable cross-ecosystem comparisons of variability in phytoplankton communities. Analysis has been completed for chlorophyll (analysed by spectrophotometer, HPLC and fluorescence) and composition (counts and HPLC pigments) and is in the process of being collated into the WISER central database. The field data will be used to examine how uncertainty is affected by spatial variability within and between lakes and across the eutrophication gradient. It will help quantify which sampling design and analytical methods have the most cost-effective precision in terms of metrics. Temporal variability and the cost-effective precision associated with sampling frequency will be assessed using existing data from sites with long-term monitoring data.

The major contributory tasks have included:

- Field work and sample analysis: All nine WP partners, two non-WP partners (SLU and AU) and one external body (CEDEX, Spain) carried out fieldwork in summer 2009 following agreed sampling guidance (see objective 3).
- Data compilation: NERC, NIVA and EMU developed data templates for entering count, chlorophyll and chemistry data into the common WISER database. Most of the new data collected in the field exercise in 2009 has now been compiled.

Produce tools and practical guidance for sampling and analysis to harmonise methods across the EU and reduce uncertainty in phytoplankton classifications

Tools and practical guidance have been developed for sampling and counting lake phytoplankton samples and chlorophyll analysis. Three workshops were organised in Finland, Germany and Spain (by SYKE, IGB-FVB and CEDEX) for WISER partners and GIG experts to harmonise counting methodologies and agree species identities across regions of Europe. Tools and guidance will be finalised following analysis of the field exercise data, which will identify optimal sampling location and effort.

The major contributory tasks include:

- Developing standard methods: (NERC, EMU, IGB, SYKE)
- Standard protocol was developed for spectrophotometric (SF) analysis of chlorophyll.
- Standardised recorder forms were developed for phytoplankton counting to ensure data had consistent taxonomic coding and bio volume measurements. Counting workshops were organised aimed at the

harmonization of phytoplankton analysis in 3 GIG regions. In total about 30 experts around Europe attended.

Examine combination rules for the use of chlorophyll, composition and bloom metrics in ecological status assessments, specifically in relation to eutrophication pressure.

This work did not start in the first 18 months of the project in accordance with the work plan

Publications

Paper writing is planned in months 24-36 after metric and uncertainty analysis is complete. WISER is acknowledged in the following publications as they fit into the WISER context, although, the WISER database was not used in these publications.

- Nõges, T. 2009. Relationships between lake morphometry, geographic location and water quality parameters of European lakes. Hydrobiologia 633: 33–43.
- Nõges, P., Poikane, S., Kõiv, T. & T. Nõges 2010. Effect of chlorophyll sampling design on water quality assessment in thermally stratified lakes. Hydrobiologia, 649: 157–170.
- Nõges, P., Mischke, U., Laugaste, R., Solimini A.G. 2010. Analysis of changes over 44 years in the phytoplankton of Lake Võrtsjärv (Estonia): the effect of nutrients, climate and the investigator on phytoplankton-based water quality indices. Hydrobiologia 646: 33–48.

Notable findings and results

Development of candidate metrics for intercalibration has been a very significant result from WP3.1 during the first 18 months. These are much need for the IC process; particularly bloom metrics for which no existing scheme had been developed by any member state. If successfully applied, these metrics may contribute to the harmonisation of assessment systems across Europe in the years to come. Two candidate metrics have been developed for phytoplankton composition and two for phytoplankton bloom frequency and intensity. These are detailed further below:

Phytoplankton composition metrics

1. Phytoplankton Trophic Index (PTI)

A new pan-European phytoplankton taxonomic index (PTI) has been developed that can be used as a common metric for several GIGs, or as a national metric for the 2nd phase of Intercalibration, for those countries that still lack such a metric in their national assessment system. As for many existing national metrics, the new PTI index is developed from trophic scores of phytoplankton taxa along the eutrophication gradient. This pan-European PTI, however, uses data from 1656 lakes from 19 countries providing comprehensive gradients for modelling species responses. The PTI metric shows a very significant relationship to total phosphorus (r^2 = 0.667 in all lakes) (Figure 3.1-1). As well as ‘global’ index scores derived from the whole dataset, GIG-specific index scores have been produced. Provisional reference conditions and boundary values have also been established for one lake type, and the metric will become available soon in the WP database.

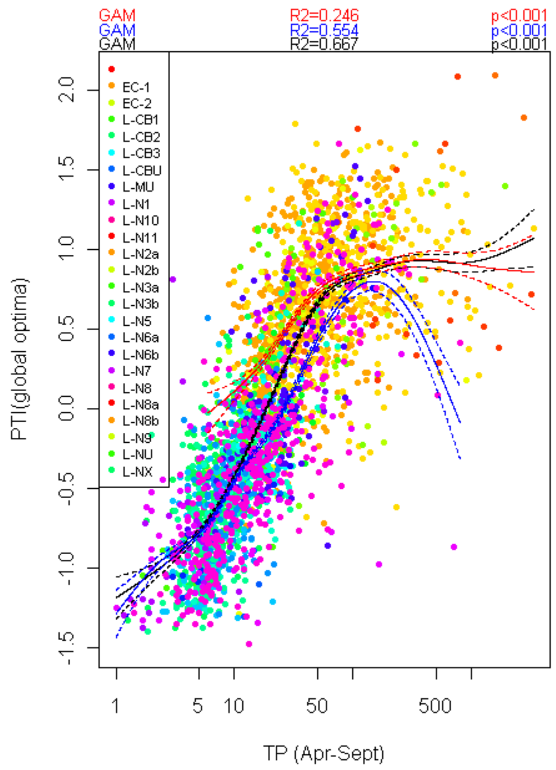


Figure 3.1-1: Relationship between PTI site scores and growing season total phosphorus concentrations. Lines are GAM models, black = all lakes, blue = NGIG, red=CBGIG. Points are coloured by GIG type.

2. Morpho-functional groups and size classes

To provide a better assessment of the functional impact of eutrophication, a novel phytoplankton composition metric, based on functional traits has been developed. The assemblage is classified by size classes and morpho-functional groups outlined in the scientific literature. The changes in these groups have been analysed in a set of about 200 European lakes of the same type (lowland and shallow or very shallow). The results indicate that shifts from smaller to larger taxa, as well as a change in the importance of the different morpho-functional groups takes place across the trophic gradient (Figure 3.1-2). Two indices, based on size spectra and morpho-functional groups respectively have been proposed and are being considered by the GIGs alongside the PTI as candidate composition metrics towards the development of a common phytoplankton metric for the second phase of the intercalibration process.

Phytoplankton bloom metrics

Until now, there has been little progress in developing classification schemes for phytoplankton bloom frequency and intensity for the WFD. No consistent definition for an algal bloom even exists across Europe. WP3.1 established a number of characteristics that define a bloom:

- High phytoplankton abundance relative to typical levels of abundance for that time of year (i.e. there should be a critical density above which a bloom is defined).
- Uneven community – dominance by one or two species
- Abundance of nuisance species e.g. potentially toxic cyanobacteria

These three characteristics were incorporated into the following two metrics, which will be combined to create a candidate bloom metric for IC purposes. As no national metrics are available, it is likely that this will be adopted as a constituent of a common metric by the GIGs, and as a national metric by many Member States for the 2nd phase of Intercalibration.

3. Evenness

The evenness of the phytoplankton community is expected to decrease during algal blooms as one or two species become dominant. Evenness may also be low in very low nutrient conditions as well as other high stress environments (low light). For this reason the evenness metric is combined with a "critical bloom density" based on the IC agreed chlorophyll good/moderate boundary, i.e. at high or good status chlorophyll, a bloom is not present and, therefore, evenness, is not a relevant bloom metric. Evenness was calculated according to Pielou's evenness index. The results indicate a decline in evenness with increasing nutrient pressure (TP) in many of the most common IC lake types (Figure 3.1-3). There appeared to be a threshold in evenness around 25 µg L^{-1} TP. Evenness in reference lakes was generally higher and was significantly different from non-reference lakes in several N-GIG lake types. The analysis has also shown that evenness is not greatly influenced by the number of taxa detected in a sample, and is, therefore, better than richness-based diversity measures which can often be biased by counting effort/quality. The analysis does, however, indicate that the metric should not be applied in a few lake types, where the relationship with pressure is not clear.

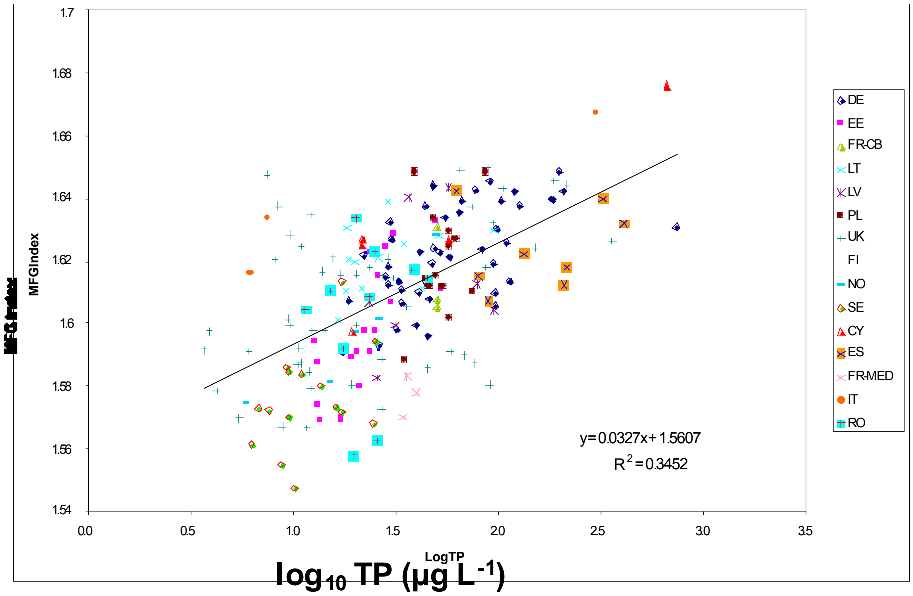


Figure 3.1-2: Relationship between the Morpho-Functional Group Index and total phosphorus.

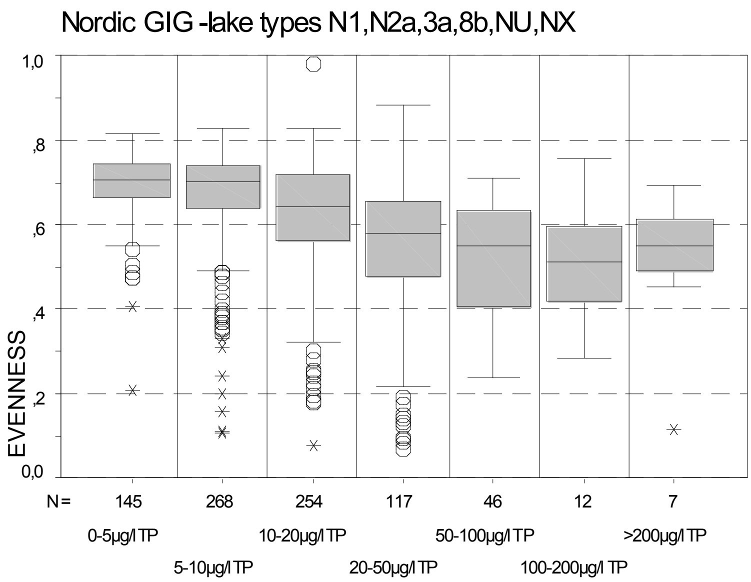


Figure 3.1-3: Box plots of observed evenness in seven TP classes in Northern GIG lake types.

4. Cyanobacteria Blooms

Incorporating a metric for cyanobacterial abundance in the assessment of ecological status is of great relevance to the ultimate goal of the WFD, the sustainable use of our freshwaters. In the context of harmful cyanobacterial blooms, as a precautionary approach, it would be better to consider the potential maximum cyanobacterial abundance that the current environment could bring about. For modelling the relationship between cyanobacterial abundance and nutrient pressure, it was, therefore, considered more relevant to model maximum abundance instead of mean abundance. Quantile regression was used to estimate a range of distributions of the response variable (cyanobacteria bio volume) conditional on the predictor variable (total phosphorus), rather than only the mean distribution. There were highly significant relationships between cyanobacteria bio volume and TP for quantiles 50%, 75%, 90% and 95% ($p<0.001$) in all three GIGs examined (Central-Baltic, Mediterranean, Northern). Figure 3.1-4 illustrates the median (50%) and 90% response curves from Central-Baltic GIG lakes. It shows that there is a 90% likelihood of being below the World Health Organisation (WHO) low/medium risk threshold at about 20 µg L^{-1} TP, compared with only a 50% likelihood at about 80 µg L^{-1} TP. Reference lakes also had significantly lower cyanobacterial bio volumes than non-reference lakes in all three GIGs. A provisional approach to setting status class boundaries has been outlined based on the frequency of samples that exceed the WHO risk thresholds.

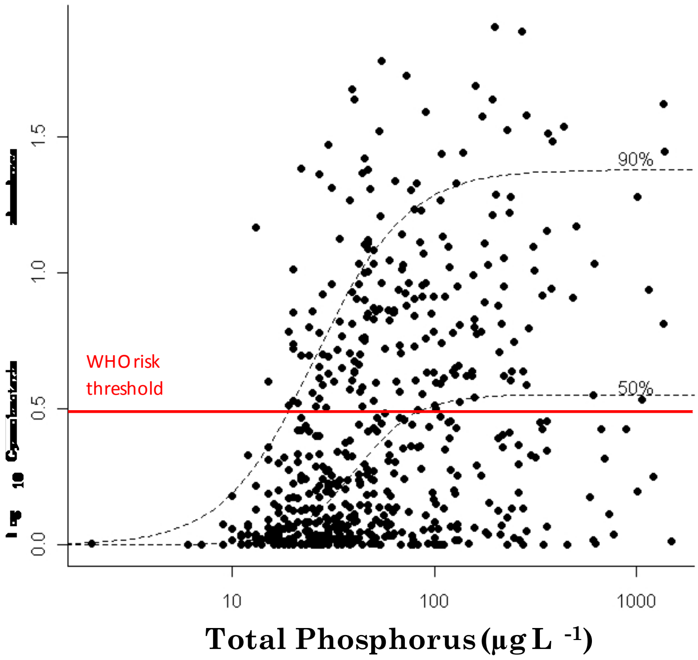


Figure 3.1-4: Scatter plot of cyanobacterial abundance against TP in CB GIG lakes. Fitted non-parametric quantile regression curves are shown for the median (50%) and 90% response curves.

WP3.2: Lake macrophytes

*Contractors involved: **IEP**, NIVA, NERC, AU, CEMAGREF, SLU, SYKE, EMU, UCL, DELFT*

Summary of progress towards objectives and details for each task

The main objectives of WP3.2 are to validate and supplement macrophyte metrics on species composition and abundance for assessment of impacts of eutrophication and water level fluctuation, to determine and evaluate their sensitivity and usefulness as indicators, and quantify the uncertainty inherent in their use. An additional task is to establish and validate reference conditions for selected lake types using contemporary data (land use-aquatic vegetation relationships) and historical data (palaeo-analyses on macrofossils).

Compilation of existing data

For macrophyte metrics development and testing, the existing macrophyte data and associated physical and chemical data from over 2000 lakes in 16 European countries have been collected. The macrophyte common database consists of all the relevant datasets as indicated in the Table 4 of the Annex 1, supplemented with data newly collected by some member states, e.g. from France, Poland and Romania and also datasets compiled by macrophyte experts involved in intercalibration exercise (GIGs). Most of these datasets have been already translated and imported into WISER database format (a tool created by WP2.1). The final database will be completed in autumn 2010. NERC is responsible for providing data services to the other partners in the work-package, including data collection, collation, translation, import into the common database and data extraction for analysis, also for other WPs.

The common macrophyte taxa list for European lakes to be used by all WISER partners, the intercalibration experts and the wider scientific community has been created by NERC with a support of CEMAGREF. The list comprises a total of app. 1100 taxa (species and subspecies, with synonymous and common coding) and, in addition to aquatic vascular plants, it includes also macroscopic algae (characeans), bryophytes, ferns and semi-aquatic helophytes. This list is maintained as a MySQL database, with a live interface to the www.freshwaterecology.info website.

Field campaign using standard methods

To estimate the precision and sensitivity of different macrophyte metrics and quantify the confidence in classification, a targeted field campaign in vegetation season 2009 has been designed. Beforehand, in spring 2009, all partners delivered the descriptions of national macrophyte sampling standards and the overview and comparison of existing survey methods used in European countries have been completed. Based on that, the harmonised hierarchical sampling procedure, including a common sampling protocol, was elaborated and published in a form of report (Deliverable 3.2-1).

In September 2009 the sampling campaign was successfully completed by IEP, NIVA, NERC, AU, CEMAGREF, SLU, SYKE and EMU and, additionally, by FVB and CNR (not WP3.2 partners). 28 lakes from 10 countries, representing 6 lake types have been surveyed according to the common sampling procedure described in Deliverable D3.2-1. Macrophytes were sampled from 6 locations in each lake with 3 replicates from each location. To collect the data on physical habitat characteristics on transect and lake level, the simplified and adapted Lake Habitat Survey protocol (rapid protocol) has been applied.

The newly collected field data were compiled using the common template. During the autumn and winter 2009 the data from all 10 countries has been compiled, translated and submitted to the common WISER database.

Indicator development and improvement (including reference conditions)

To facilitate a close WISER-IC collaboration, during the reporting period one joint personal meeting (Ispra, Italy, 4–6/11/09) and two videoconferences (22/01 and 11/02/10) involving WISER and IC macrophyte experts were organised. The detailed work-plan, the responsibilities and deadlines were discussed and the principles of a close cooperation between WISER and IC experts were established.

To fulfil the WP3.2 objectives, a set of analytical groups (sub-WPs) dealing with different tasks has been created: (i) abundance metrics for eutrophication (growing depth and % cover); (ii) taxonomic composition metrics for eutrophication (iii) metrics for impacts of water level fluctuation; (iv) contemporarily- and historically-derived reference conditions.

Uncertainty

To estimate the uncertainty in selected macrophyte metrics and to identify different sources of uncertainty in assessment process (primarily uncertainty in sampling and in spatial variation of vegetation pattern) the analytical group composed of IEP, NERC and DELTARES has been created. The preliminary analyses on uncertainty in macrophyte metrics have started and will be continued in close collaboration with WP6.1.

Publications

- Søndergaard, M., Johansson, L.S., Lauridsen, T. L., Jørgensen, T. B., Liboriussen, L., Jeppesen, E. 2010. Submerged macrophytes as indicators of the ecological quality of lakes. Freshwater Biology vol. 55: 893-908.

Notable findings and results

Abundance metrics for eutrophication

The main activity of the group working on the quantitative metrics consists of investigation of the potential use of submerged macrophyte abundance measures in lakes with focus on their response to eutrophication. Abundance indices include primarily plant maximum depth of colonization (C-max) and macrophyte coverage (%cover). The AU is responsible for the activity in this task with a support of IEP and IC experts.

A review paper on the use of macrophytes in Danish lakes as indicators of ecological quality has been published in Freshwater Biology with acknowledgments to WISER project (Søndergaard et al. 2010). The paper was used as a starting point in the research on quantitative metrics conducted by AU. The data on maximum colonisation depth of aquatic vegetation provided by the WISER partners and intercalibration leaders was subsequently collected. The majority of the data constitute the CB-GIG database, supplemented with data from Italy, Sweden, Norway, Finland, UK and Ireland. The dedicated dataset includes a total of approximately 1,000 lake-years from 16 European countries.

The C-max index has been tested against eutrophication gradient with total phosphorus (TP) and chlorophyll *a* (chl-*a*) used as a pressure proxy. In lakes with different abiotic features the response of C-max varied significantly. The index has been proved to be a very good ecological state indicator in stratified lakes (mean depth 3-15 m). In very shallow lakes, where maximum depth of a lake is smaller than theoretical colonisation depth of aquatic vegetation, the alternative abundance metric, macrophyte coverage (%cover), is more appropriate.

The potential use of maximum colonisation depth (C-max) as a metric to indicate eutrophication pressure in other lake types (including other lake features, e.g. water colour, altitude and longitude) will be explored.

Taxonomic composition metrics for eutrophication

The metric on macrophyte taxonomic composition to assess the impact of eutrophication is being elaborated in close collaboration with IC members (external expert: Nigel Wilby, from University of Stirling, UK). The index has been completed and successfully tested on N-GIG dataset. The metric will be presented to the partners in October 2010 and will be tested for other GIGs' data included in the common database. Also, other composition metrics (no of taxa, no of functional groups) are considered and will be investigated.

Water level fluctuation

The main task of the sub-WP, led by SYKE, is to establish an index for aquatic macrophyte response to water level fluctuations (WLF). Work started by compiling separate dataset from Finland, Norway and Sweden (77 lakes: 22 natural and 55 regulated ones) and elaborating a preliminary WLF-index for

Nordic countries (published earlier in Hellsten & Mjelde 2009). As it was demonstrated, slight water level fluctuations enhance biodiversity; large isoetids typically disappear, whereas small isoetids are more common. However, no clear relationship between WLF and number of species was found. A list of key species sensitive, indifferent and tolerant to with WLFs were identified and used to elaborate an index based on species composition. Another potential index to be investigated is vertical extension of a species in relation to WLF.

To test the applicability of WLF-index elaborated for the Northern GIG in other GIGs, a request for data related to water level fluctuations and additional helophytes data was send out as a part of CB-GIG data request. It appeared that water level fluctuation data from Central European and Alpine lakes are very limited and more effort on personal contacts and discussions with data provides is required.

The activity on development of WLF-macrophyte index for shallow lowland lakes of Central Europe has started in DELTARES. Data of 12 years monitoring of approximately 70 floodplain lakes for macrophytes, WLF and nutrients has been collated. The links between cover of submerged macrophytes and water depth (WLF proxy), size of the lakes and nutrient loading have been analysed. A temporary drawdown of a lake in preceding year has been recognised as a factor stimulating submerged macrophyte cover in subsequent year. The water level fluctuations of approximately 40-60 cm height result in highest number of helophytes and floating leaved species. Individual species respond differently to drying-out conditions. Similar results were obtained in UK in highly alkaline shallow lakes.

The results will be used to elaborate a list of species tolerant, sensitive and indifferent to drying-out situations. Further development work was decided to focus on more sophisticated, European-wide metric(s), including statistical analysis performed in close collaboration of SYKE, NIVA and DELTARES.

Contemporarily- and historically-derived reference conditions

One of the main tasks of the group dealing with spatially based reference conditions, led by SLU, was to evaluate the effect of land use on macrophytes with the aim to develop land use criteria for reference status. The work so far has been concentrated on compiling the requested comprehensive GIS-databases. From some countries (Finland, Poland, Sweden, Denmark, Italy) very detailed and complex data has been delivered and already collated. For some other countries, data still need to be complemented. Initial analyses have been started on whole catchment analyses. The next step will be to finalize the datasets and to continue with GIS-analyses at the sub-catchment scale.

The main aim of the palaeo-study, conducted by UCL, is to employ palaeo-ecological approaches (plant macrofossil records) to define reference conditions and to assess ecological status for selected lake types. Existing palaeo-ecological data (aquatic plant macrofossils) have been collated by UCL. This has involved development of a single coding system for the taxa and harmonisation of numerous data files. The database currently holds records for over 500 samples and approximately 250 types of aquatic plant remains.

Preliminary analyses of the database have been carried out to establish reference conditions for macrophytes in high alkalinity, shallow lakes prior to enrichment. Over the next few months, the palaeo-derived reference conditions will be compared with those produced by methods using contemporary data from reference sites.

The results on the macrophyte metric development and testing are expected to be described and compiled in a form of deliverable 3.2-3 by the end of October 2010. They will be presented to IC-Leads for comments and to be used in intercalibration process. The deliverable 3.2-2 on uncertainty analyses results will be completed by the end of February 2010.

Several manuscripts are considered to be prepared by the end of the project and published further in scientific journals.

WP3.3: Lake macroinvertebrates

Contractors involved: ***FVB****, UDE, NIVA, NERC, SLU, EC-JRC, SYKE, ALTERRA, TCD, UNIROMA1*

Summary of progress towards objectives and details for each task

The assessment of lakes using benthic invertebrates has not been dealt by any international project team before. Also, national projects on that issue were scarce. Hence, the development of scientific basics for lake assessment using this BQE had to start at the by far lowest level within module 3. As on one side eutrophication pressure is best reflected by plants, and there exists so far no assessment tool to assess the ecological effects of hydromorphological alterations on the other side, it was agreed beforehand to focus work on lake invertebrates on the assessment of hydromorphological alterations. More specifically, WP work concentrates on the assessment of the ecological effects of morphological shoreline modification, and therefore aims to find indicators among the eulittoral invertebrate community, which reacts to such alterations most directly.

Development of a common sampling protocol

Shortly after the start of the project all WP 3.3 partners met at a WP 3.3 workshop in Berlin in April 2009 in order to agree on a common WP 3.3 lake macroinvertebrate sampling protocol. According to this sampling protocol nine lakes should be selected in Sweden, Ireland, Germany and Italy, which should cover a range of trophic pressures (oligotrophic, mesotrophic, eutrophic states represented ideally by 3 replicates each) and ideally show two different shoreline morphological alteration types in each of the selected lakes.

Field sampling exercise

This agreed sampling schedule also reflects the outcome of extensive discussions on a balanced sampling scheme held with WP 6.1 (Uncertainty) at the WISER kick-off meeting in Mallorca. The actually planned number of 36 lakes to be sampled in WP 3.3 increased to 51 lakes as 15 additional lakes selected for the WISER uncertainty field exercise, which partly did not possess all necessary morphological alteration types, had to be sampled for macroinvertebrates additionally. In Italy, 2 additional lakes were sampled, in order to adequately cover both Italian lake areas in Northern and Central Italy. This sums up to a total of 39 lakes, which were sampled according to the agreed WISER WP 3.3 sampling protocol. Further 12 lakes were sampled for macroinvertebrates in order to meet the requirements of the WISER uncertainty field exercise, including cross-BQE comparisons. Only those cross-BQE lakes, which fitted the WISER WP 3.3 sampling protocol were sampled accordingly. From the additional lakes only composite samples were collected.

During the sampling protocol workshop in Berlin an introduction to the Lake Habitat Survey (LHS) methodology was, furthermore, given by Elaine McGoff (formerly TCD now SLU) and it was agreed to conduct a complete LHS for each lake as well as hab-plot/site specific LHS at each macroinvertebrate sampling site.

Work progress in field sampling and sample processing

Sampling for lake benthic macroinvertebrates using the agreed WP 3.3 common sampling protocol has been completed in all countries (Finland: 4 lakes, September/October 2009; Germany/Denmark: 11 lakes, April/May 2010; Ireland: 9 lakes, April/May2009; Italy: 15 lakes, August-November 2009; Sweden: 9 lakes, November 2009; UK: 3 lakes, October 2009). Whole lake and hab-plot/site-specific LHS has been carried out in all lakes in all countries (Finland: September/October 2009; Germany: August 2010; Ireland: September 2009, Italy: October 2009; UK: October 2009). WISER WP 3.3 macroinvertebrate samples are currently still being processes. Progress on sample processing is summarized in Table 3.3.1.

Table 3.3.1: Overview on the work progress in processing the samples from the WP 3.3 field sampling exercise.

Finishing dates for sample processing						
	All BQE lakes composite samples		Remaining composite samples		Habitat samples	
	Sorting	*ID work*	*Sorting*	*ID work*	*Sorting*	*ID work*
Germany	Aug 2010	Oct 2010	Aug 2010	Oct 2010	Jan 2011	March 2011
Denmark/Germany	Aug 2010	Oct 2010	Aug 2010	Oct 2010	Jan 2011	March 2011
Sweden	Dec 2010	Dec 2010	2011	March 2011	not specified	not specified
Finland/Sweden	Aug 2010	Dec 2010	n.a.	n.a.	not specified	not specified
UK/Ireland	April 2010	April 2010	n.a.	n.a.	n.a.	n.a.
Ireland	n.a.	n.a.	Oct 2010	Dec 2010	Nov 2010	February 2011
Italy	Aug 2010	Oct 2010	Aug 2010	Jan 2011	April 2011	June 2011

Existing data

A Microsoft Access database was created and adapted to the needs of the existing data. Modules for metric calculation and data checking were programmed (UDE/Jürgen Böhmer). Queries for data transfer into the WISER database structure were built. Biological and abiotic data (including eutrophication and hydromorphology parameters) for about 150 lakes of 7 countries of the Central/Baltic GIG have been collated. Furthermore, biological and abiotic data (including eutrophication parameters) for 4 countries of the Northern GIG were compiled. The lake GIG macroinvertebrate experts have been involved by information exchange with WISER consortium people, who participated at expert group meetings, and by supplying monitoring data.

Common metric development on the basis of existing data has started and first results were supplied for the ECOSTAT meeting in October 2010 (UDE/Jürgen Böhmer). Common metrics are planned to be developed for the Central Baltic, Northern and Alpine GIGs. Common metrics development will initially be based on existing data. However, also expert judgement will be included when the statistics give no clear decisions (e.g. when selecting from candidate metrics of similar performance). Suggested metrics will be tested using the WISER WP 3.3 field exercise data set with the purpose to develop a draft new common metric on hydromorphological pressures in the lake littoral (SLU/UniRoma/IGB/TCD).

Publications

No papers have yet been produced by WP3.3.

Notable findings and results

Development of a joint sampling protocol applicable in all WP partner countries

Morphological alterations were classified as "soft alteration" (e.g. riparian clear-cutting, recreational beaches) and "hard alteration" (e.g. retaining walls, rip-rap). Macroinvertebrate samples should be collected from 3 soft alteration, 3 hard alteration and 3 unmodified sites within each lake. Each sampling site should represent a shoreline section of minimum 25 m length representing either soft alteration, hard alteration or unmodified sites. If either of the two alteration types was not present at a lake, the number of sampling sites was still kept constant (9 sites per lake). Sampling was carried out in the season most representative for each ecoregion.

At each sampling site a number of habitat samples (minimum number of habitats = 3; number of habitat samples kept constant among all sampling sites and lakes in each country, even at sites which only showed one or two habitats) plus one composite sample had to be collected. Composite samples comprise a standardised 1 min sample including sampling of all habitats proportional to their availability within each sampling site. Habitat-specific samples comprise the collection of 1 m² samples per habitat.

Training in ‘Lake Habitat Survey’ methodology

The European Water Framework Directive has been an important driver for the development of survey tools such as the Lake Habitat Survey (LHS), which provides a method for characterizing and assessing the physical habitat of lakes and reservoirs (Rowan et al., 2004, 2006). LHS includes quantitative descriptions of canopy, macrophytes along the lakeshore, the amount of shoreline affected by human activities, and the dominant littoral substrate. Many of the measured attributes might be important for the macroinvertebrate community of lakes. The LHS approach is based on the combination of 10 so called hap-plot observations with a collection of whole-lake metrics for each lake and has been based on lake habitat characterisation techniques developed in the United Stated by the Environmental Mapping and Assessment Program (EMAP) as well as the River Habitat Survey (RHS) in the UK. It has been proposed that LHS might be used to describe hydromorphological reference conditions for lakes and determine the characteristics of hydromorphology that supports the biological elements for varying levels of ecological status (good, moderate and bad). LHS is carried out using a combination of field surveys and a minimal amount desk-based information gathering. The field survey is preferable carried out by boat, but a foot-based option is also available. The first hab-plot is positioned randomly, and the remainder are distributed evenly around the perimeter of the lake. Additional hab-plots may be placed non-randomly if required and recorded for specific purposes, for example to provide habitat information to accompany biological data such as macroinvertebrates samples. More general observations of the lake’s perimeter and the catchment are made during the boat cruise, covering habitats for biota and human activities within and close to the lake. The LHS field form, a field survey guidance manual as well as a detailed report on LHS development can be downloaded under:

http://www.sniffer.org.uk/project-search-results.aspx?searchterm=wfd99&selectedtab=active

As part of the agreed common sampling protocol all WP 3.3 partners have conducted whole-lake and hab-plot specific LHS in all lakes sampled as part of the field campaign of WP 3.3. This information will provide important information on hydromorphological characteristics of the studied lakes.

References:

- Rowan JS, Duck RW, Carwardine J, Bragg OM, Black AR, Cutler MEJ. 2004. Development of a technique for Lake Habitat Survey (LHS): Phase 1. Report for SNIFFER Project (WFD40) (www.sniffer.org.uk), Edinburgh.
- Rowan JS, Carwardine J, Duck RW, Bragg OM, Black AR, Cutler MEJ, Soutar I, Boon PJ. 2006. Development of a technique for Lake Habitat Survey (LHS) with applications for the European Union Water Framework Directive. Aquatic Conservation: Marine and Freshwater Ecosystems 16: 637–657.

Overview on European lake types and status

The analyses performed in WP3.3 deliverable 1 have come to the following conclusions:

There are two parameters commonly used in almost all typologies: (1) lake depth (mainly mean depth, also mixing regime), (2) hardness of water (described by alkalinity, conductivity, pH) that makes it possible to compare national systems with the common IC types;

Nevertheless there is a wide variety both in typology factors and values (e.g. such factors as Schindler`s ratio used by Poland, volume quotient by Germany, sediment type by Netherland and Belgium) which makes the comparison of typologies a complicated and creative task;

Most of the countries use a factor “geology” which has been interpreted in a number of ways:

usually some water chemical characteristics as alkalinity, conductivity and colour are used as a proxy of catchment of geology (high alkalinity characterising “calcareous geology”, high colour corresponding to “peat geology”);

in several cases catchment geology has been described in different ways (e.g., Italy has defined from geological maps).

(iv) Also different methods are used for type differentiation: types maybe delineated using various mathematical statistical clustering methods (Free et al., 2006, Kolada et al., 2005) or using more intuitive methods, including expert opinion; (v) There is a common tendency to start from more complicated and numerous types and move in direction of simple and practical typological schemes.

(v) Human pressures officially addressed with assessment methods based on lake invertebrates used in EU member states so far include eutrophication, general degradation, habitat destruction, heavy metals pollution, hydromorphological degradation, impact of alien species, pollution by organic compounds, pollution by organic matter, riparian habitat alteration, catchment land use, flow modification, acidification.

Identification of candidate common metrics based on existing data

Four national methods for eulittoral invertebrates are to be intercalibrated so far, developed in BE, DE, EE, NL. The database of existing data (see also chapter 'Existing data' above) has been built up so far with data from 9 countries, as BE, DE, DK, EE, LT, LV, NL, PL, UK. It includes data from 197 lakes, 873 stations and 991 samples. Variables include lake data (country, lake name, coordinates, IC-type, national type, etc.), sample data (station, date sampling device, substrates etc.), stressor data (water chemistry, hydromorphology, land use etc.) and biological data (ID_ART code, taxon name, abundance). The invertebrate taxalist includes 1191 taxa.

The selection of candidate common metrics for intercalibration was performed by running correlations (see Table 3.3.2) of various metrics with national methods. Good results were achieved for all countries for taxa number and sensitive taxonomic groups (e.g. percentage of ETO—Ephemeroptera-Trichoptera-Odonata, and number of species for ETO, EPTCBO—Ephemeroptera-Plecoptera-Trichoptera-Crustacea-Bivalvia-Odonata, and Trichoptera). Based on correlations with national methods and stressor parameters the following metrics are suggested: number of EPTCBO taxa, ASPT, % Odonata, % ETO (% in relation to abundance classes), % Crustacea, % Habitat preference lethal. The next step will be the normalisation of the candidate metrics, which is needed for the calculation of a multi-metric index. However, normalisation is hampered by a lack of suitable data, especially there are too few reference lakes.

It is concluded that national methods correlate more or less with the same metrics for all countries. However, metric responses to stressor parameters vary between countries, due to differences in impairments, but also in sampling design (e.g. multihabitat sampling versus focus on specific habitats). Final core metric selection for a common multi-metric index will have to be mainly based on correlations with the national methods and on a general agreement of all countries.

Table 3.3.2: Spearman correlation coefficients of tested candidate metrics with national methods.

	NL	DE	BE	EE	AVG
afil%	-0,231624	-0,111021	-0,168694	-0,263115	-0,19361333
AHT1%	0,296717	0,011507	0,162728	0,113880	0,1462078
AHT1_HK%	0,292974	0,007998	0,160647	0,113880	0,14387484
AKA%	0,421395	0,157265	0,365026	-0,107638	0,20901206
AKA_HK%	0,405666	0,109968	0,315408	0,181025	0,2530169
AS	0,550282	0,118522	0,390632	0,346121	0,35138898
ASPT	0,414678	0,183327	0,480779	0,446577	0,38134021
ASPT_IZ	-0,005051	0,115422	0,436559	0,502310	0,26230994
chiro%	-0,006195	0,019754	0,045794	-0,121093	-0,01543512
Chironominae	0,051216	-0,036592		-0,221548	-0,05173108
Coleoptera%	0,429064	0,136751	0,273190	0,496255	0,33381488
Crust%	-0,261498	-0,125818	-0,095554	-0,153982	-0,15921303
D_HK	-0,385001	-0,199279	-0,011212	-0,252458	-0,2119875
EP%	-0,305021	-0,088171	0,295840	0,098668	0,00032891
EPT%	0,592869	0,289742	0,377528	0,544169	0,451077
EPT_HK%	0,704929	0,371227	0,395776	0,511280	0,495803
EPTCBO%	0,310592	0,138718	0,373055	0,476896	0,32481522
ER%	0,212833	0,034789	-0,294381	-0,165942	-0,05317519
ETO_Art%	0,718185	0,498727	0,489360	0,396002	0,52556853
ETO_HK%	0,715364	0,513061	0,430848	0,602917	0,56554723
eukrenal%	0,348360	-0,026738		-0,113953	0,05191699
faf_fpf	-0,470894	-0,020940	-0,432173	-0,007184	-0,23279773
Gastropoda%	0,358986	0,003490	-0,043892	-0,357298	-0,00967841
gather%	0,142461	0,061109	0,154422	0,113618	0,11790251
gather_HK	-0,217734	0,034624	0,033993	-0,038869	-0,04699638
grazer%	0,407901	0,047992	0,109655	-0,067274	0,12456858
grazer_HK	0,491155	-0,035376	0,120459	-0,127072	0,11229117
HR%	0,339267	0,121361	0,295840	-0,071759	0,17117719
hypokr%	0,162486	-0,053339	0,202293	-0,164568	0,03671818
IN%	-0,103824	-0,063772	-0,351257	-0,309459	-0,20707818
IN_HK%	-0,423798	-0,297848	-0,362086	-0,325395	-0,35228162
Insecta%	0,309520	0,158550	0,204560	0,778880	0,36287758
krenal_ges%	0,171992	-0,073782	0,202293	-0,127166	0,04333424
Lake%	0,511346	0,081556		-0,316975	0,06898178
LB_HK%	0,431770	0,045801	-0,053089	0,286257	0,17768434
LIT_HK	-0,251166	-0,387075	0,398844	-0,089764	-0,08229032
litoral%	0,305156	0,174371	-0,261537	0,116608	0,08364963
lse%	-0,273514	-0,088613	-0,314484	-0,342348	-0,25473979
lsw_HK	0,454928	-0,106744	0,270808	-0,182386	0,10915144
MP%	-0,461345	-0,235940	0,278094	-0,357298	-0,19412229
MR%	0,418294	0,084471	-0,005107	-0,171922	0,0814341
N	0,625529	0,318234	0,539058	0,418509	0,47533276
no_C	0,439961	0,176575	0,253694	0,419379	0,32240218
no_E	0,618644	0,472056	0,530200	0,374735	0,49890878
no_EPT	0,730649	0,415100	0,698454	0,625288	0,61737274
no_EPTCBO	0,700233	0,514327	0,788286	0,743185	0,68650802
no_ETO	0,735363	0,568783	0,763584	0,667694	0,68385597
no_individuals	0,389445	-0,160375	0,142208	0,124922	0,12405012
no_P		0,025894			0,00647351
no_Taxa	0,655864	0,382879	0,711732	0,550272	0,57518677
no_Tricho	0,725671	0,317020	0,554932	0,532530	0,53253835
Odo%	0,496936	0,628330	0,299752	-0,095678	0,33233479
oligo_HK%	0,089087	-0,113296		0,077738	0,01338256
PEL%	0,035241	0,114425	-0,302170	-0,061294	-0,05344951
pfil%	0,589688	0,129262	0,191261	-0,013555	0,2241641
PHY%	0,110208	0,200452	0,118387	-0,064284	0,09119077
Pleco%		0,025011			0,00625269
POM%	0,164914	-0,028585	-0,043768	-0,402147	-0,07739649
potamal_ges%	-0,505498	-0,270996	0,287682	-0,152487	-0,16032489
prodiamesinae%		0,015166			0,00379147
PSA%	0,013718	0,005647	0,136970	0,025414	0,04543721
PTI	-0,638358	0,026391	-0,207407	-0,168932	-0,24707653
R_Art	0,320627	0,309921	-0,145255	0,110124	0,14885413
rheo_HK	0,376038	0,220391		0,438052	0,25862011
rheo_IZ	0,383651	0,265823		0,450775	0,27506232
rhithral_ges%	0,361816	0,096722	-0,004200	-0,025414	0,10723096
rk	-0,498884	-0,484478	-0,186812	-0,248134	-0,35457721
RP%	0,052394	-0,193315		0,00	-0,03523029
RP_HK%	-0,073265	-0,250157		0,00	-0,08085537
RTI	0,322395	0,005021	0,215236	0,183269	0,18148006
shred%	-0,100847	0,035653	0,202641	-0,266105	-0,03216443
ShW	0,426677	0,237386	0,462739	-0,278064	0,21218448
SI	-0,197813	0,012207	0,043493	-0,574069	-0,17904538
sza%	0,376427	0,069706		-0,366268	0,01996631
szo%	-0,038120	-0,118911		-0,026909	-0,04598515
szp_HK	-0,077629	-0,180742		-0,399451	-0,16445546
Tanypodinae%		0,118292			0,02957308
Tricho%	0,560492	0,183402	0,421814	0,224246	0,3474886
xeno%	0,385512	0,175181		0,251504	0,20304923
xeno_HK%	0,309462	0,145124		0,293268	0,1869636
xenoligo	-0,030311	-0,112502		-0,026909	-0,04243061

WP3.4: Lake fish

*Contractors involved: **AU**, NIVA, NERC, CEMAGREF, EC-JRC, FVB, BOKU, CNR-ISE*

Summary of progress towards objectives and details for each task

An important first objective was that the partners agreed on the content and the structure of the common fish database. The structure fitted well into the overall WISER database structure and all partners have since the first meeting contributed with data to the database.

For the WISER field exercise the partners agreed on using the European Standard CEN 14757:2005 as common methodology. The argument for this methodology is that it is well documented and already used by several European member states. With respect to a hydroacoustic methodology a CEN standard has not yet been developed. It was therefore decided to use the methodologies already applied by the WP3.4 members, despite divergence in hardware. Experiences have been exchanged on methods and all field data are being compiled in a common database. The final data analysis on the entire hydroacoustic dataset will be undertaken by the relevant WP partners..

Gill netting is highly work-intensive and at the first WISER meeting it was agreed that WP3.4 would include less than 27 lakes. However, in 2009 28 lakes were sampled and another 4 lakes will be sampled in 2010, giving a total of 32 lakes. Data from these lakes will be included in the common database.

An important part of the field campaign was for the WP partners to meet in order to intercalibrate field sample procedures. Five partners met and gill netted two lakes jointly, agreed on fish handling, etc. Fishing activities in Italy involved stakeholders such as provincial and regional authorities, fishing associations, wildlife protection associations and local fishing rights owners. The campaign was performed in October 2009 and included a one-day workshop in which the future plans were discussed, with particular emphasis on how to deal with the hydroacoustics data and the comparison of gill-net data.

In February 2010 a second workshop was held to discuss the content of deliverable no. 1 (Analysis of fish communities along a eutrophication gradient across Europe) and no. 2 (Analysis of fish size structure along a eutrophication gradient across Europe) supplemented with a discussion of methods to deal with functional traits.

Publications

- Beklioglu M., M. Meerfhoff , M. Søndergaard & E. Jeppesen , 2010. Eutrophication and Restoration of Shallow Lakes from a cold Temperate to a warm Mediterranean and a (Sub)Tropical climate. in AA Ansari-S Singh-GR Lanza-W Rast (Editors). Eutrophication: Causes, Consequences and Control. Springer.
- Jeppesen, E., Meerhoff, M., Holmgren, K., Gonzalez-Bergonzoni, I., Teixeira-de Mello, F., Declerck, S.A.J., De Meester, L., Søndergaard, M., Lauridsen, T.L., Bjerring, R., Maria Conde-Porcuna, J., Mazzeo, N., Iglesias, C., Reizenstein, M., Malmquist, H.J., Liu, Z., Balayla, D. & Lazzaro, X. 2010. Impacts of climate warming on lake fish community structure and potential effects on ecosystem function. Hydrobiologia 646: 73-90.
- Lund S.S, F. Landkildehus , M. Søndergaard , T. L. Lauridsen , S. Egemose , H.S. Jensen , F.Ø. Andersen, L.S. Johannson , M. Ventura, & E. Jeppesen, 2010. Fast changes in community structure, abundance and habitat distribution of fish in a Danish lake following restoration by aluminium treatment.- Freshwat. Biol – 55:1036-1049.

Notable findings and results

<u>Database</u>

CEMAGREF has established the fish database including 2188 lakes (1820 natural lakes). In the development of common metrics we only use lake data based on CEN standards, which means 1750 natural and 80 artificial lakes (Figure 3.4-1).

Environmental data such as nutrient data and data on catchment areas were available in January, but data on hydromorphology are still required. Data from the WISER field campaign are not included in the database yet, but will be so later.

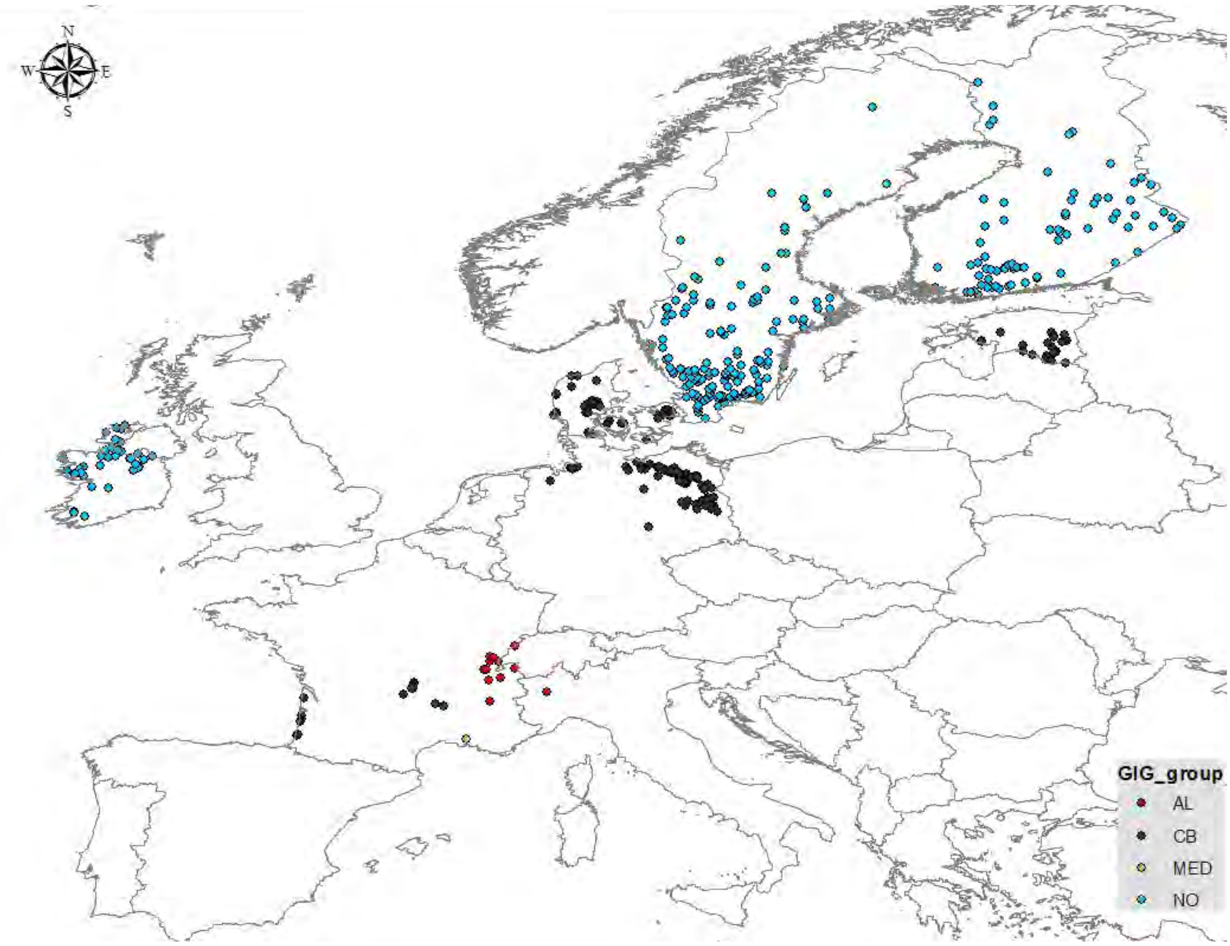


Figure3.4-1: Distribution of European natural lakes by GIG and sampled with CEN benthic gillnets. AL = Alpine GIG, CB = Central Baltic GIG, MED = Mediterranean GIG, NO = Nordic GIG.

A workshop was held in Italy in October 2009, hosted by CNR, and a second workshop was held in Aix en Provence, France, in February 2010, hosted by CEMAGREF. The aims were to intercalibrate sample handling and agree on the content of deliverables and future steps in the WP.

The field campaign was conducted in the Nordic, Central Baltic and Mediterranean GIG, 28 lakes were gill netted and 16 lakes have been sampled with hydroacoustics, respectively. Finland, Estonia and Poland have contributed to the database.

Contacts have been established to local authorities, local anglers and scientists.

Fish community structure in European lakes

This deliverable describes the environmental variables influencing fish communities in European lakes along a latitudinal gradient and how fish communities respond to eutrophication. The analysis is based on data from 694 lakes with one sampling occasion per lake. Pressures are eutrophication, in-lake pressures, and hydrological and morphological pressures. Descriptors of fish communities are NPUE, BPUE, the NPUE/BPUE ratio, species richness, diversity and evenness. Regression tree analyses were performed with CPUE (catch per unit effort) and richness/diversity as response variables. A joint paper is in progress led by JRC and AU.

It is concluded that:

- Eutrophication is the main pressure affecting number and biomass of fish (Figure 3.4-2) and that higher temperatures are associated with higher fish densities.
- Diversity and richness are determined by geographical and morphological gradients (higher richness and diversity at lower latitude (<54° N).
- BPUE/NPUE ratio is related to precipitation (surrogate to longitude and temperature amplitude).

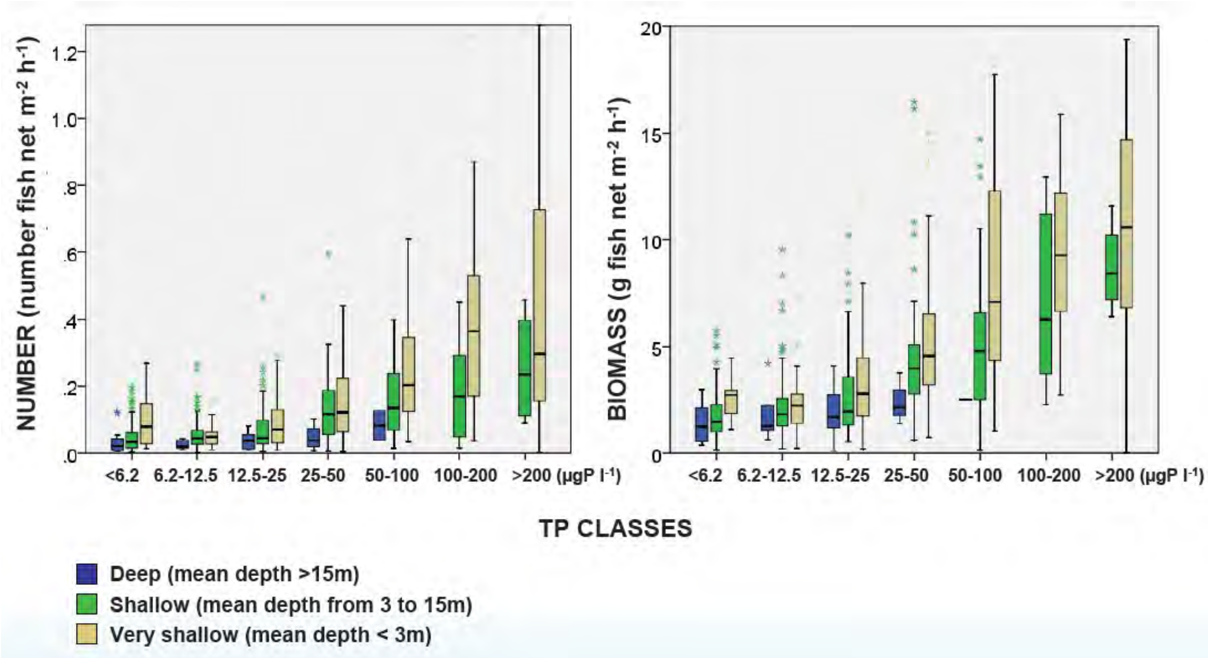


Figure 3.4-2: Fish abundance along a TP gradient in European lakes.

In addition, a review paper has been published in Hydrobiologia in 2010 about changes in fish community structure and dynamics with changes in climate- led by AU.

<u>Analysis of size spectra in lake fish communities</u>

This is an explorative analysis based on 78 North German lakes and >130,000 fishes >8 cm. Sixteen size-related variables were calculated, including different length variables, weight variables, condition factor and size diversity. Seven of these 16 variables were weakly cross-correlated and chosen for further analysis and exposed to a **n**on-metric **m**ultidimensional **s**caling (NMS) analysis with 18 descriptors of lake morphology, lake productivity, human-use intensity, and taxonomic and functional fish community composition.

It is concluded that:

- Correlations of maximum length, slopes of the normalized length spectra, size diversity (Figure 3.4-3) and in particular the exponent *c* of Pareto type II weight spectra were the most sensitive size-related variables.
- Non-taxonomic, size-related metrics may be a superior tool to elucidate systematic shifts in lake fish communities along environmental gradients to assess the ecological integrity of lakes.

In Deliverable D3.4-2 these experiences and the analysis techniques will be applied to the European dataset.

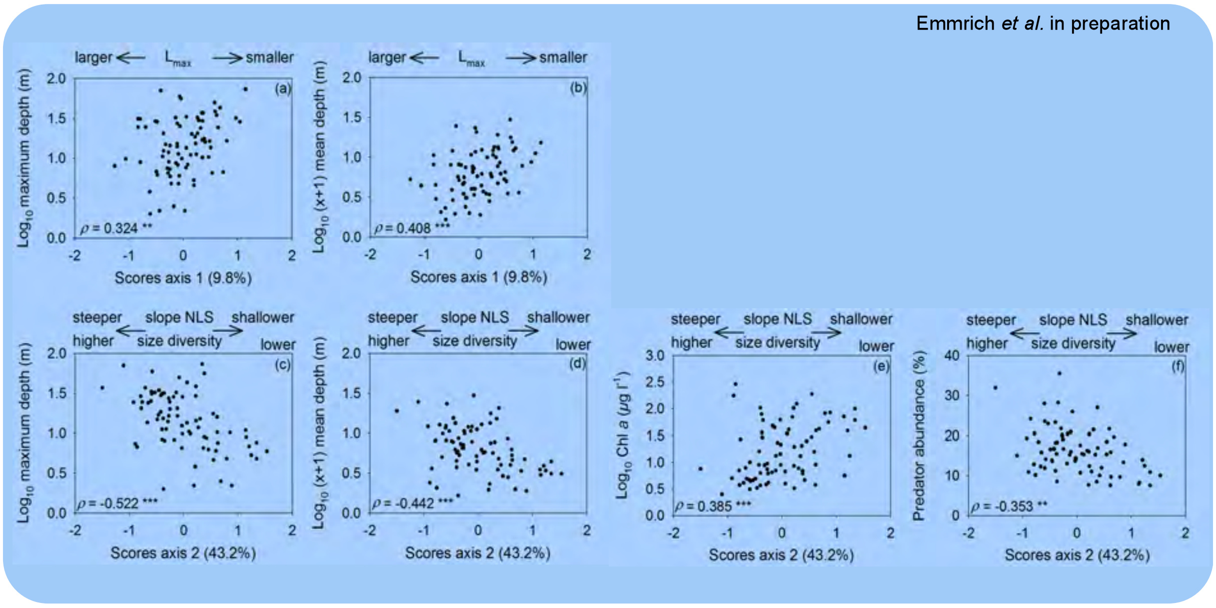


Figure 3.4-3: Correlations between log_{10} maximum depth, log_{10} mean depth and fish maximum length (top left), size diversity (lower left), and between log_{10} Chl-a, predator abundance and size diversity (right).

<u>Status of the common metric development</u>

Analyses were performed on a dataset including 419 natural lakes (one campaign per lake only), mainly from the northern GIG (Figure 3.4.1). Forty different metrics were chosen based on bibliography and previous research and expert opinions, and were tested on the European dataset.

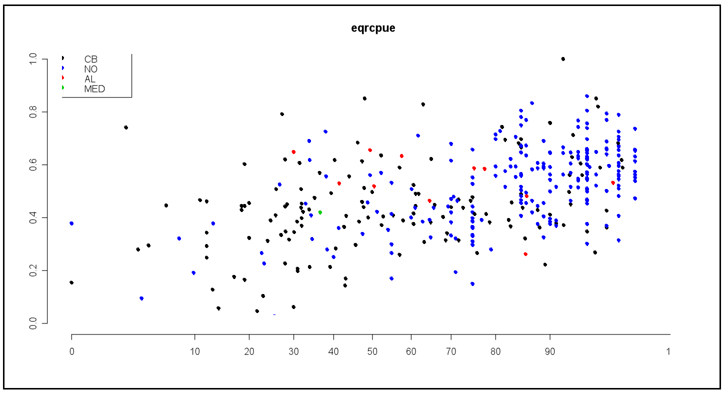
In this study reference conditions were:

- identified as part of the intercalibration process.
- determined by the hindcasting approach using models.

The hindcasting method does not need to select and determine reference sites. This approach includes anthropogenic factors as predicting variables in addition to the environmental variables. In the prediction of reference conditions, acidified lakes were excluded and the CLC (Corine Land Cover) "natural land" was set to 90%.

For validation of the models, two methods were used. First, we compared the EQR metric values on the reference and disturbed sites and the metrics were accepted if significant differences appeared between the two different types of sites (box plots). Secondly, we used Spearman's rank correlation analysis to identify metrics correlated to land use. Metrics significantly correlating ($P \leq 0.05$) to CLC land use were accepted for further consideration.

Three metrics showed a significant correlation: CPUE (catch per unit effort, numbers), BPUE (biomass per unit effort) and, though to a lesser extent, percent omnivores (by numbers). Morphometric and physical parameters selected in the stepwise multiple linear regressions with the CPUE metric were: maximum depth, lake area, altitude, catchment area, average temperature and temperature amplitude. All these parameters, combined with eutrophication pressures (CLC natural) explained 53 % of the natural variability (adjusted R-squared). The CPUE metric also responded to the %CLC natural with a correlation score of 54 % (Figure 3.4.4). At a GIG level, the metrics work well in the N-GIG, not that well in the CB-GIG and not well in the M-GIG.



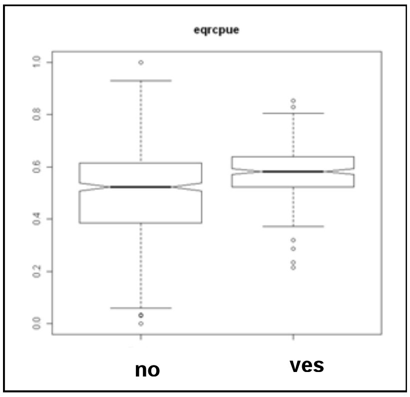


Figure 3.4-4: Validation test of the hindcasting CPUE model by comparing EQR against a pressure gradient (a) and by box plots of EQR CPUE values divided into reference and disturbed sites (b).

Module 4 Ecological indicators for assessment and intercalibration: coastal/transitional waters

The main objective of Module 4 is to provide a complete set of assessment systems for BQEs relevant for coastal/transitional waters (phytoplankton, macroalgae/angiosperms, benthic invertebrates, fish), which requires the validation of indicators, and in some cases the development of new indicators. Particular focus is on the evaluation of the impacts of hydromorphological pressure (mainly in transitional waters, for example, structural changes, residence and flushing time alterations), eutrophication and pollution (metals and organic compounds). Hence, Module 4 will also contribute to intercalibration.

The data basis for Module 4 is provided by a large body of existing datasets and a joint field sampling campaign that was conducted in 2009 and 2010. All field work is finished and included eight case study stations: 1) Oslofjord/Skagerrak (NO), 2) Orwell/Stour (UK), 3) Helsinki Bay (FI), 4) Basque Country (ES), 5) Mondego (PT), 6) Balearic Islands (ES), 7) Lesina Lagoon (IT) and 8) Varna Bay (BG). The stations cover the North-East Atlantic (NEA), Baltic, Mediterranean and Black Sea Geographical Intercalibration Groups (GIGs). Accounting for differences between BQE data across Europe, each workpackage focuses on a different set of case study stations.

Between 40 and 900 samples were taken for each BQE according to common sampling procedures. Samples for all BQEs were taken at three locations, while a replicate sampling design was applied at all stations to gather for the uncertainty analysis. Based on this data, Module 4 will develop and test metrics combination of metrics. In particular, Module 4:

- focuses on the development of metrics for BQEs that are still missing after the first phase of intercalibration of assessment systems,
- explores, if national taxonomic metrics can be applied at broader and, hence constitute common metrics for intercalibration,
- explores different ways of combining single metrics into multi-metrics or holistic assessment,
- tests correlations between the sensitive metrics/indicators and data generated using low-cost monitoring methods,
- quantifies the main sources of uncertainty for recommended metrics and tools for assessing the overall uncertainty and risk of misclassification,
- gives recommendations on combination rules for different single metrics into holistic assessments of the ecological status for each BQE (will feed into WP6.2),
- evaluates low-cost monitoring methods based on the correlation of such methods with the holistic assessment results for each BQE, .
- gives recommendations on monitoring design based on the analyses of the misclassification risk for different levels of sampling frequency and number of sites and
- produces a concise guidance (book or e-book) summarising the outcome
- supports intercalibration by suggesting assessment methods, which can be applied in different countries, and partly by the development of common metrics.

WP4.1: Phytoplankton in coastal and transitional waters

*Contractors involved: **AU**, NIVA, AZTI, SYKE, CSIC, IMAR, IO-BAS, USALENTO*

Summary of progress towards objectives and details for each task

- •Develop and validate multi-species or assemblage phytoplankton metrics.
- •Evaluate the potential use of pigment data in phytoplankton assemblage metrics.
- •Evaluate uncertainty on determinations of phytoplankton biomass and community composition due to temporal and spatial heterogeneity.

<u>Objective 1: Develop and validate multi-species or assemblage phytoplankton metrics.</u> A key step in the development of indicators for the assessment of the phytoplankton quality is the establishment of the reference conditions (the conditions that would exist under no or very minor anthropogenic impact).

Thus, Deliverable D4.1-1 is addressing this issue to gain a better understanding of the reference conditions for phytoplankton composition in three different ecoregions: the Baltic, the North-East Atlantic and the Mediterranean ecoregion. This deliverable provides a description of the composition of phytoplankton communities in several water bodies in Europe that are considered to be at high ecological quality status. These communities are representative of the reference conditions. In addition, data from the non-pristine Baltic Sea are evaluated to provide a characterisation of phytoplankton under good or high ecological status. This report also provides information about different methodologies for the study of the phytoplankton communities. These methodologies involve a range of aspects: from the approach for selecting the most suitable data sets, to the laboratory techniques and the mathematical and statistical analyses employed.

The potential of phytoplankton indicators based on size structure of phytoplankton communities is presently being explored on data collected during the field campaign. Different approached have been taken testing size structure and surface/bio volume indices for assessment the response of phytoplankton communities to pressure (eutrophication) gradients. Furthermore examination of the use of the functional groups concept (C-R-S strategy species) for further development of relevant metrics has been initialised.

Objective 2: Evaluate the potential use of pigment data in phytoplankton assemblage metrics.
Phytoplankton pigments have been analysed by HPLC from samples collected during the field campaign in 2009. This data will be used for i) characterisation of phytoplankton communities for comparison with traditional examination of phytoplankton by microscopy, ii) evaluation of the use of pigment data as an indicator of water quality by statistical analyses of relationships between individual or combinations of pigments and eutrophication and iii) as part of the uncertainty analysis where information from pigments will reveal the importance of small and large scale patchiness in community composition in addition to variations in total biomass.

Data from the 2009 field campaign as well as historical data from the Baltic region, the Black Sea and the Spanish Atlantic Coast are being compiled in a common database for subsequent analysis and development of phytoplankton metrics.

Objective 3: Evaluate uncertainty on determinations of phytoplankton biomass and community composition due to temporal and spatial heterogeneity. Data for the uncertainty analysis have been compiled and analyses will be initiated during autumn 2010.

Publications

No papers with reference to WISER have been published yet. However, several presentations have had and will have reference to WISER.

Notable findings and results

A preliminary evaluation of the response of metrics and indices based on phytoplankton community size structure and surface/bio volume has shown a clear response to eutrophication gradients. The phytoplankton surface index has been tested on data from the Black Sea (Figure 4.1-1) while a multi-metric index of size-spectra (P-ISS index) based on phytoplankton size class sensitivity to anthropogenic disturbance and on species richness has been tested on data from Italy (Figure 4.1-2). The adequacy of the P-ISS index was evaluated describing the discrimination power of the index to classify disturbed and undisturbed sites along stress gradients. The obtained results emphasized that P-ISS shows a consistent pattern along the stress gradient and is much more invariant with sample size than taxonomically based ones. The multi-metric index is a precise and sensitive tool for discriminating various levels of marine ecosystem perturbation.

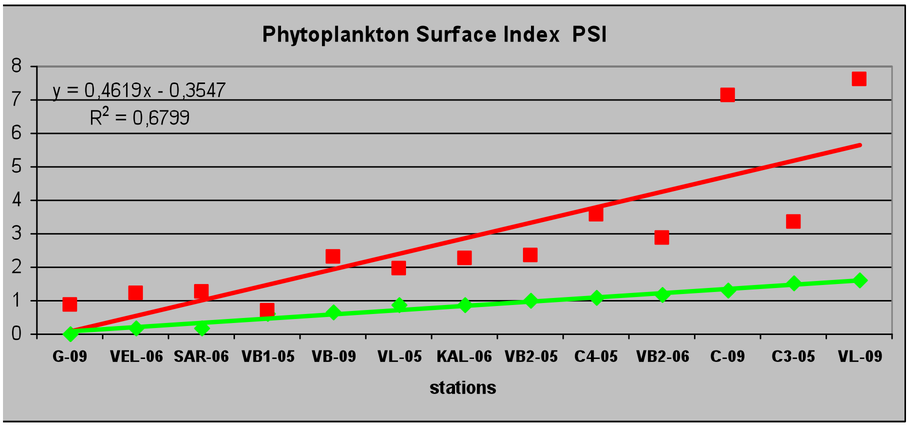


Figure 4.1-1: Phytoplankton Surface Index (PSI) along a nutrient gradient in Varna Lake-Varna Bay, the Black Sea.

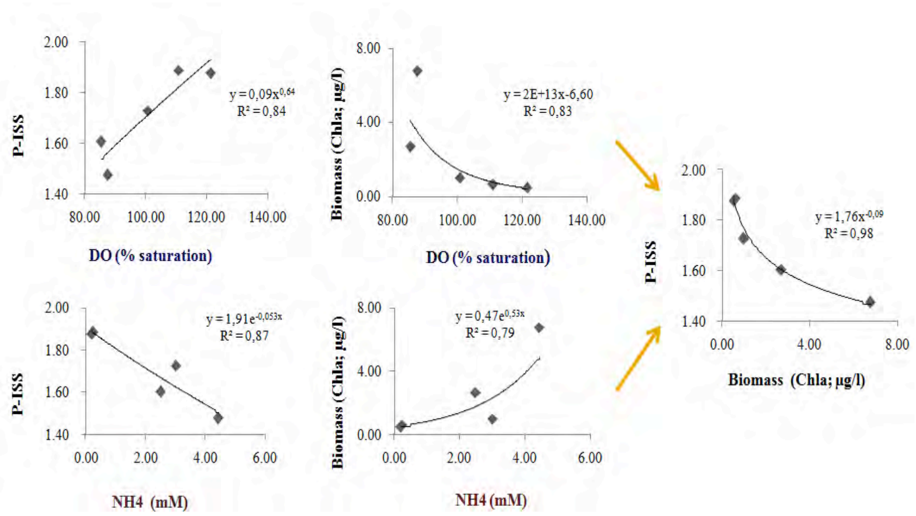


Figure 4.1-2: Correlation between the multi-metric index of size-spectra (P-ISS), dissolved oxygen (DO), ammonia (NH4) and phytoplankton biomass (as chlorophyll a).

Type-specific phytoplankton assemblages were identified for the outer coastal water types of the Bothnian Bay, the Quark, the Archipelago Sea and the eastern Gulf of Finland from present-day coastal monitoring data using “the best samples", which means samples which can be regarded as reference phytoplankton communities that refer to waters at good or high ecological status (Figure 4.1-3). The criteria for phytoplankton samples chosen as "the best samples" were at first that in the concurrent water quality samples the concentrations of chlorophyll *a*, total nitrogen and total phosphorus should not exceed the type-specific reference values that were previously empirically derived from samples in Finnish coastal water types (also included in this study, see D4.1-1) for details.

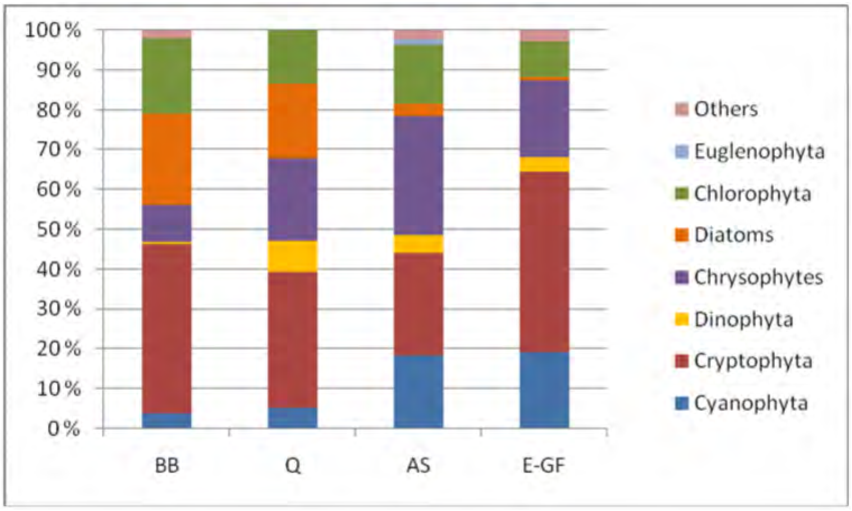


Figure 4.1-3: Estimates of relative biomasses of different phytoplankton groups under reference conditions at four stations in the Baltic Sea: the outer coastal water types of the Bothnian Bay, the Quark, the Archipelago Sea and the eastern Gulf of Finland (taken from Deliverable D4.1-1).

Initial results relating to the uncertainty analysis show variability associated with the expert analysing samples in the microscope (Figure 4.1-4) and large-scale variability in total phytoplankton biomass across a water body (Figure 4.1-6) as well as in phytoplankton community composition evaluated by pigment content (Table 4.1-1). Further analyses for quantification of uncertainties will be initiated during autumn 2010.

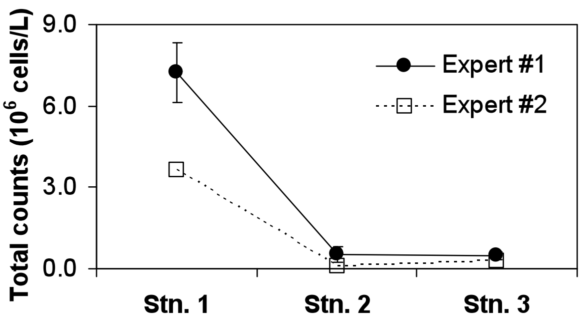


Figure 4.1-4: Phytoplankton density in the surface waters of the Basque coast analysed by two taxonomists from the same laboratory. Total abundance presented a high spatial variability, with a maximum at Stn. 1 (Estuary plume). Large differences were found between experts in the total counts, although similar spatial trends were detected by both of them.

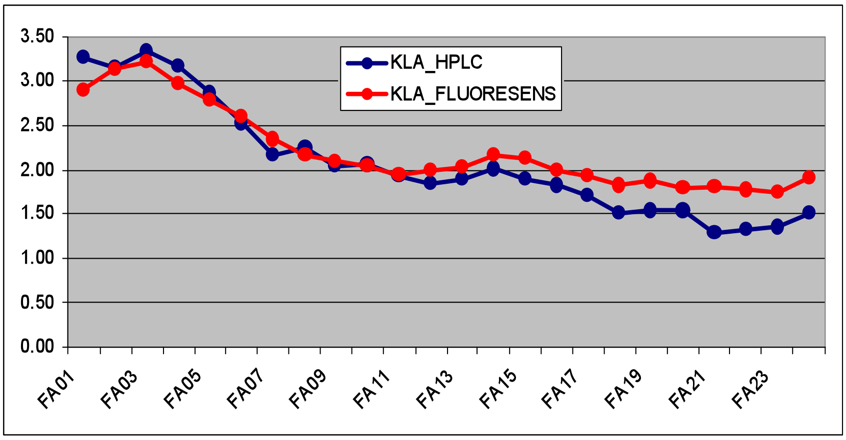


Figure 4.1-5: Large-scale variability in phytoplankton concentration along the transect in the Inner Oslo Fjord in August 2009 measured by HPLC and chlorophyll a fluorescence.

Table 4.1-1: Coefficients of variance (CV) for individual pigments detected in field samples from the Oslo Fjord 2009. Coefficient of variance is given for replicate samples as well as between the three main sampling stations. Variations were generally larger between stations than between replicates indicating large scale patchiness in the phytoplankton. Furthermore the difference between replicates and stations was not similar for all pigments showing different communities at the three stations.

Pigment	CV (%) replicates	CV (%) stations
Chl C1/2	6	7
Peridinin	8	15
19-But-Fucoxanthin	13	16
Fucoxanthin	5	10
Neoxanthin	5	7
Prasinoxanthin	9	49
Violaxanthin	10	8
Diadinoxanthin	6	14
Alloxanthin	15	11
Diatoxanthin	11	48
Zeaxanthin	11	14
Lutein	6	4
Chl *b*	5	7
Chl *a*	5	6
Beta-carotene	11	7

WP4.2: Benthic macroflora in coastal and transitional waters

Contractors involved: ***CSIC****, NIVA, AZTI, AU, IMAR, IO-BAS, USALENTO*

Summary of progress towards objectives and details for each task

Objective 1: Develop benthic macroflora indicators of ecological status. During the first half of the project, the effort has been allocated i) to the sampling at six case study sites in 2009 (Varna Bay, Lesina lagoon, Mallorca coast, Mondego Estuary, Basque coast and Oslo Fjord), taxonomic analysis of the samples, and the supply of data to the central project database; ii) to compile existing data, iii) to develop and review benthic macroflora indicators and multi-metric indices, iv) to initiate the development of pressure-response empirical models of benthic indicators and v) to estimate uncertainty of ecological status classification using some indicators.

Data from existing monitoring programmes in the Basque Country from 1995 to 2010, recorded at several sampling sites within two coastal water bodies affected by two submarine outfalls, have been compiled. The IMAR's historical data are available for use in the WISER project, namely regarding intertidal seagrasses and opportunistic macroalgae.

Objective 2: Review and validate existing seagrass and macroalgae indicators and multi-metric indices to assess ecological status in transitional and coastal waters. The seagrass and macroalgae indicators and metrics currently used in European and worldwide monitoring programs have been compiled. A book chapter on coastal monitoring programs has been written (Carstensen et al, see publications list below). The seagrass indicator potential has been reviewed and a manuscript is being prepared.

Objective 3: Develop pressure-response empirical models of coastal and transitional benthic macroflora indicators and define reference conditions and class-boundaries for seagrass and macroalgal indicators and metrics. We have initiated to explore pressure-response relationships for some indicators. A manuscript on the combined effects of light attenuation and sediment characteristics on the indicator 'eelgrass depth limit' has been prepared. The effects of increased nutrient loads on the environmental status of Danish fjords have been analysed and summarised in a Danish report. The use of stable isotope 34S as indicator of seagrass health has been analysed.

Objective 4: Estimate uncertainty of ecological status classification and indicator-pressure responses. Uncertainty analysis of benthic macroflora indicators has been initiated. An overview of previous analyses of uncertainty for the metrics 'eelgrass depth limit' and 'total macroalgal cover' has been started. Uncertainty analysis of different indexes, but paying special attention to the POMI index using STARBUGS (software package similar to WISERBUGS, see workpackage 6.1) has been conducted, and one manuscript compiling these results is in preparation.

Publications

- Carstensen J, Dahl K, Henriksen P, Hjorth M, Josefson A, Krause-Jensen D. In press. Coastal monitoring programs Ch. 7.12 *in* Wolanski E & McLusky D (Eds) Treatise on Estuarine and Coastal Science. Elsevier.
- Markager S, Carstensen J, Krause-Jensen D, Windolf J, Timmermann K. 2010. Effects of increased nutrient loads on the environmental status of Danish fjords (In Danish). NERI, Aarhus University. 54 pp Scientific report # 787. http://www.dmu.dk/Pub/FR787.pdf
- Tovar-Sánchez, A., J. Serón, N. Marbà, J. M. Arrieta, and C. M. Duarte (2010), Long-term records of trace metal content of western Mediterranean seagrass (Posidonia oceanica) meadows: Natural and anthropogenic contributions, J. Geophys. Res., 115, G02006, doi:10.1029/2009JG001076.

Notable findings and results

We analysed plausible effects of increasing the nitrogen loads to selected Danish fjords by up to 10% (Markager et al. 2010). The analyses are based on a series of empirical and dynamic models which describe the chain of mechanisms that nitrogen load initiates: increased nitrogen concentration, which stimulates phytoplankton growth and causes increased chlorophyll concentration, which contributes to attenuate the light through the water column and shade eelgrass so that the depth limit is displaced towards shallower water. The results show that a 10% increase in nitrogen load results in a 10% increase of inorganic nitrogen, an increase of total nitrogen by 6%, an increase in chlorophyll *a* by about 3% and a reduction in water clarity by 1%, followed by about 1% shallower depth limits of eelgrass (Figure 4.2-1). The effect thus declines along the chain of mechanisms. This is partly because not only chlorophyll *a*, but also suspended particles and dissolved organic matter contribute to light attenuation in the nutrient-rich Danish fjords where the sea floor in many places is devoid of vegetation and, thus, easily resuspended.

The study concludes that an increase in nitrogen load will push the ecosystems further in the negative direction and away from the aim of reaching a good ecological status. The report also provides a conceptual model for the status of the fjords in relation to eutrophication. In the later years the environmental conditions of a number of fjords have improved as a response to reductions in nutrient loads, but a set of mechanisms, caused by eutrophication, act to maintain the fjords in impoverished conditions. For example, resuspension of the bare sea floor counteracts improvements in water clarity. Moreover, frequent occurrence of anoxia that kills flora and fauna imply that nutrients are maintained in the system. These effects delay a return to a situation with expanded eelgrass beds and rich populations of fish and bottom invertebrates. It is not clear exactly how much nutrient loads need to be reduced in order to shift the state of the ecosystem but additional reductions represent a step in the right direction.

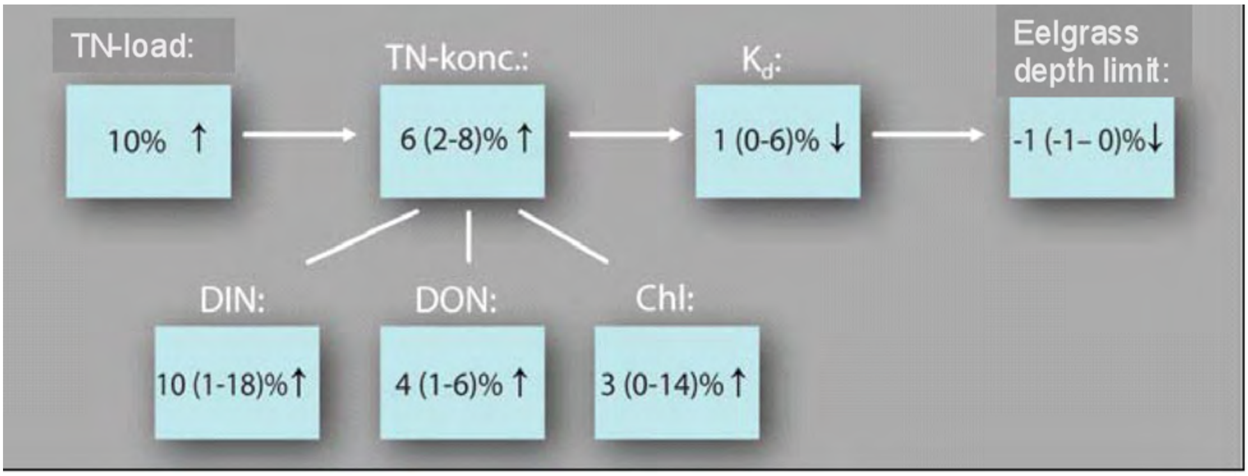


Figure 4.2-1: Scenario for a 10% increase in TN load. The percentage changes in total nitrogen concentrations (TN-konc) and concentrations of the various components of total nitrogen i.e. dissolved inorganic nitrogen (DIN), dissolved organic nitrogen (DON) and particulate nitrogen in terms of chlorophyll (Chl), light attenuation coefficients (Kd) and eelgrass depth limit. From Markager et al. 2010 http://www.dmu.dk/Pub/FR787.pdf.

WP4.3: Macroinvertebrates in coastal and transitional waters

*Contractors involved: **AZTI,** NIVA, UHULL, FVB, IMAR, IO-BAS, USALENTO*

Summary of progress towards objectives and details for each task

Objective 1: Identify pressure-response relationships of coastal and transitional benthic invertebrates based on existing data and new data obtained during the joint field sampling survey.

Task 1: Compilation of data: On the kick-off meeting it was decided not to transform all existing data into the same format, but using individual data sets depending on the research question. For instance, for Deliverable D4.3-1, all partners used their individual data to calculate metrics and to develop a new method on size-spectra (ISS). This approach turned out to be appropriate because of the different characteristics of the case study catchments, from which existing data is available.

Task 2: Field campaign using standard methods: Altogether five case study catchments were included in the extensive field campaign: Lesina lagoon (Italy), Varna Bay (transitional/coastal area in the Black Sea (Bulgaria), the Mondego estuary (Portugal), the Basque coast (Atlantic coastal area in Spain) and the Oslo Fjord (Norway). All samples were taken in summer 2009 and processed. The taxa lists and environmental parameters were supplied to the central WISER database (workpackage 2.1).

Task 3: Indicator development and improvement (including reference conditions): Existing methodologies for soft-bottom habitats have been evaluated to test their capability to discriminate gradient pressures between different stressors (eutrophication, toxic stress, habitat degradation, hydromorphological changes) covering all European coastal areas (Deliverable D4.3-1). We have developed also a new index, based upon size-spectra (ISS), for soft-bottom fauna. The analyses on the responses of benthic communities to changes in hydromorphological pressures in order to assess the good ecological potential and the development of reference conditions for transitional waters have not yet started. This is planned for the second half of the project. Indicators for hard-bottom substrates have been developed.

Task 4: Indicators for hard-bottom substrates in coastal areas will be developed: This task is planned for the second half of the project. Some preliminary analysis using Bayesian networks has already been started.

Task 5: Uncertainty: The task will start soon.

Publications

- Basset, A. 2010. Aquatic science and the water framework directive: a still open challenge towards ecogovernance of aquatic ecosystems. Aquatic Conservation: Marine and Freshwater Ecosystems, 20: 245–249.
- Couto, T, J. Patrício, J.M. Neto, F. R. Ceia, J. Franco, J.C. Marques, 2010. The influence of mesh size in environmental quality assessment of estuarine macrobenthic communities. Ecological Indicators, 10 (6): 1162–1173.
- Neto, J.M., H. Teixeira, J. Patrício, A. Baeta, H. Veríssimo, R. Pinto, J.C. Marques (2010). The Response of Estuarine Macrobenthic Communities to Natural- and Human-Induced Changes: Dynamics and Ecological Quality. Estuaries and Coasts 33: 1327–1339. DOI 10.1007/s12237-010-9326-x
-

Notable findings and results

Altogether, 13 single metrics and 8 of the most common indices used within the Water Framework Directive (WFD) for benthic assessment were selected to assess the five sampling locations based on the stressors indicated above (classification into three classes only). As single metrics abundance, species richness (as number of taxa), Shannon's diversity (H'), AMBI (AZTI's Marine Biotic Index), the 5 Ecological Groups (EG) in AMBI (from sensitive to opportunistic species), Margalef index (d), SN, and Hurlbert indices ES_{100} and ES_{50} were calculated. As multi-metric or multivariate methods the Index of Size Spectra (ISS), BAT (Benthic Assessment Tool), NQI (Norwegian Quality Index), M-AMBI (multivariate AMBI), BQI (Biological Quality Index), BEQI (Benthic Ecosystem Quality Index), BITS (Benthic Index based on Taxonomic Sufficiency), and IQI (Infaunal Quality Index) were calculated.

From Pearson correlation, it was determined that the pressure index is independent from the environmental variables, when using the whole dataset. The unique exception is the significant correlation with the distance, due to the selection of the samples in a spatial pressure gradient. When studying single metrics, the strongest correlations were found between the pressure index and diversity, ES_{50}, SN, ES_{100}, EG I (sensitive species), Margalef and AMBI. In all cases, there was a negative correlation between environmental quality and pressure. In the case of methods for the ecological status assessment, the highest correlations were found between pressure and BAT, M-AMBI, NQI, BQI and IQI (correlation ranging from -0.52 to -0.73), with BEQI showing the lowest significant correlation (r: -0.45). In turn, BITS and ISS did not show a significant correlation, at alpha 0.05.

In systems where several pressures were identified, almost all single and multi-metric indices showed higher Spearman rank correlation coefficients with the overall pressure index than with any specific type of pressure. A detailed analysis of single and multi-metric indices' performance by system, allowed seeing that their efficiency was not independent of the type of system. In Varna bay, single and multi-metric indices' results were hardly correlated with each other and none of them detected the pressure gradients described. On the contrary, in the Basque coast, the single and multi-metric indices were almost all significantly and many of them highly correlated with each other. The multi-metric indices significantly correlated with the pressure gradients also varied according to the system.

The regression models, including all available data from the locations, for each metric or multi-metric method, show that those detecting the pressure gradient with higher correlations are: Shannon's diversity, ES_{50}, SN and the Ecological Group I, as single metrics (Figure 4.3-1), and BAT, M-AMBI and NQI, as multi-metric or multivariate methods (Figure 4.3-1). This result indicates that these metrics are showing clear gradients of degradation within each system.

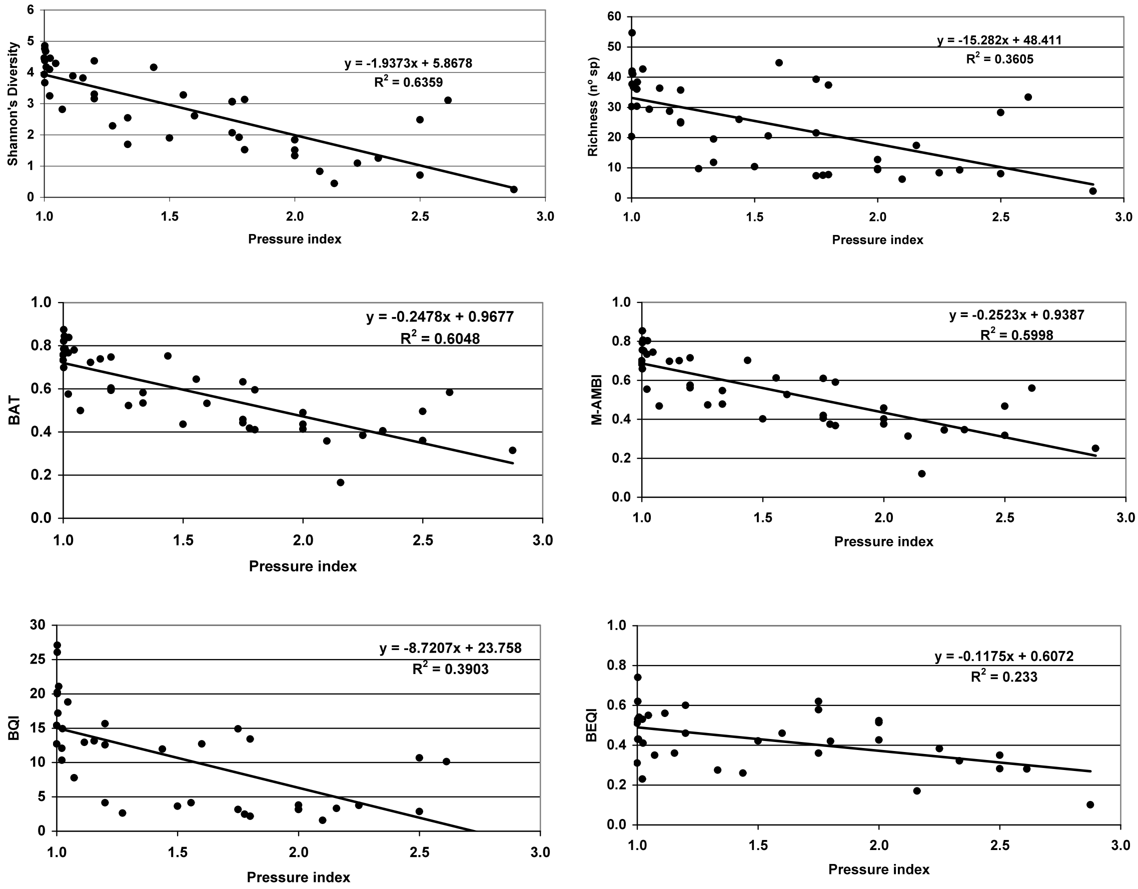


Figure 4.3-1. Regression between the pressure index and some selected single metrics and multi-metric methods, in assessing the benthic status.

When single metrics are represented following the pressure gradient, two patterns can be seen (Figure 4.3-2): i) AMBI (this metric has decreasing values with increasing quality status) and N tend to decrease with the decreasing pressure gradient, except in the case of N at Varna Bay; and ii) in turn, the rest of the single metrics tend to increase with the decreasing pressure gradient, being very consistent the pattern in all locations. Only station A36 (outside Oslo Fjord) showed lower values for single metrics than expected in the pressure gradient.

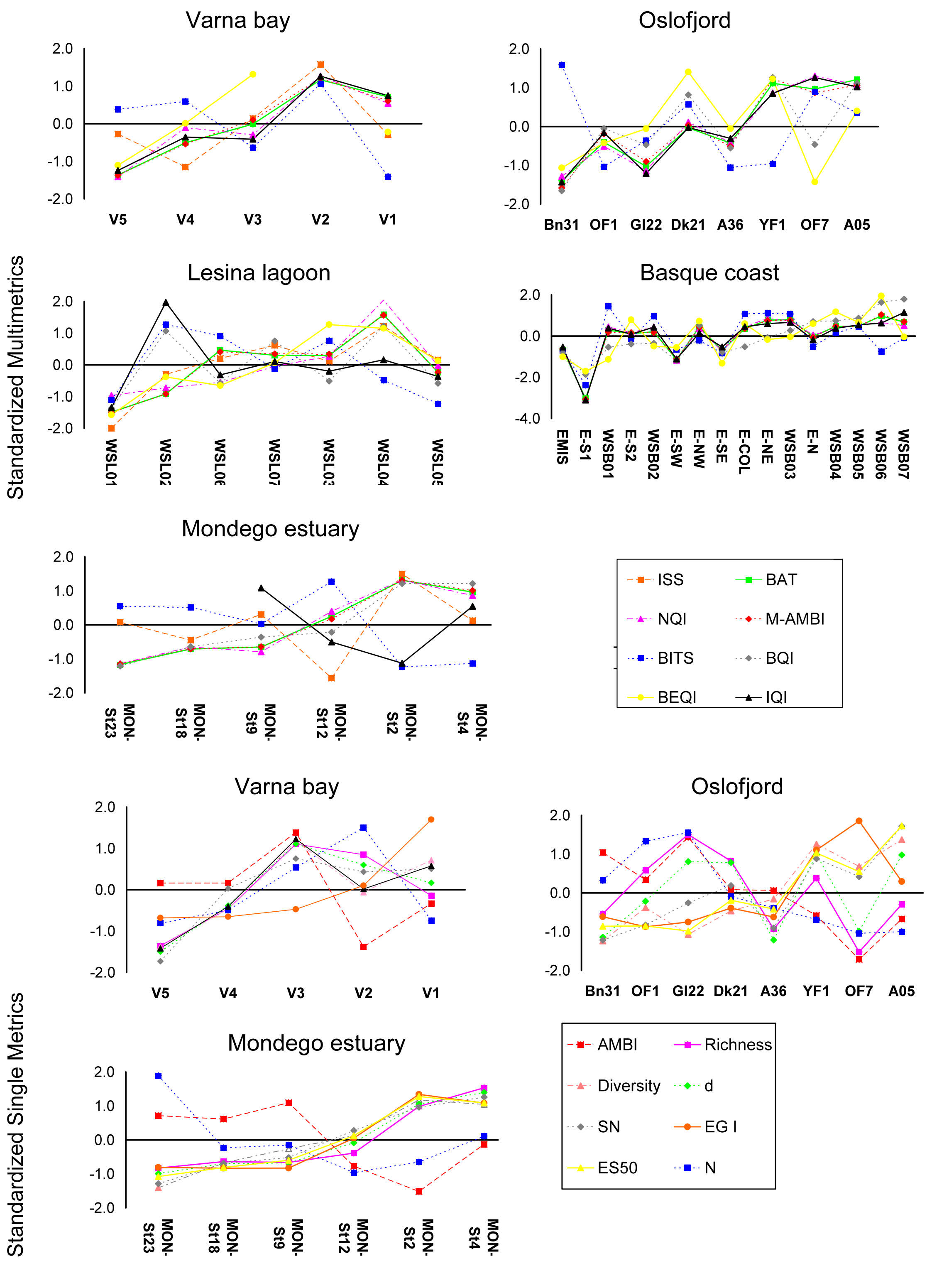


Figure 4.3-2. Standardized multi-metric (top) and single metrics (down, only 3 out of the 5 sites), following the pressure gradient, at each location.

From the analyses undertaken, some encouraging results have been found, demonstrating that the different indices are largely consistent in their response to a pressure gradient, except in some particular cases (i.e. BITS, in all cases, or ISS when a low number of individuals is present). Inconsistencies between indicator responses were mostly in transitional waters (i.e. IQI, BEQI), highlighting the difficulties of the generic application of indicators to both transitional (estuaries, lagoons) and marine (coasts, fjords) environments. However, some of the single (i.e. ecological groups approach, diversity, richness, SN) and multi-metric methods (i.e. BAT, M-AMBI, NQI, and ISS, the latter accounting for the sample size cited restrictions) were able to detect such gradients both in transitional and coastal environments. Finally, this study highlights the importance of survey design and good reference conditions for some indicators and systems (i.e. estuaries and lagoons), which should be addressed in further investigations. In this context, the correct identification and quantification of pressures acting on a system are crucial to: i) indices' calibration; and ii) the establishment of successful monitoring and management actions. Not all indicators can be successfully applied in hindsight (e.g. BEQI) or to all data sets.

A new index of size-spectra (ISS) has been developed and will be submitted for publication soon (Figure 4.3-3).

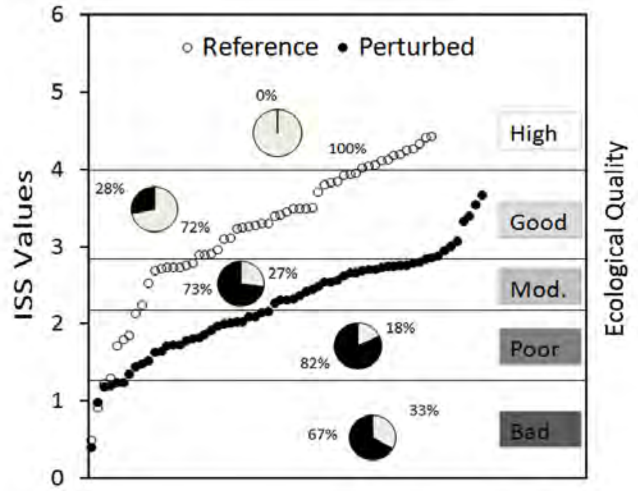


Figure 4.3-3: Performance of the Index of Size-Spectra (ISS) to assess the ecological quality. Pie charts indicate, for each quality class, the proportion of reference and disturbed sites of all samples in that quality class.

WP4.4: Fishes in coastal and transitional waters

*Partners involved: **UHULL**, AZTI, CEMAGREF, IMAR, IO-BAS*

Summary of progress towards objectives and details for each and task

Progress has been made towards all of the objectives listed in Annex 1 although as yet, and in line with the DoW, they have not yet been fully completed. However, the first objective (to further derive, refine, validate and calibrate indices relating to structural and functional aspects of fishes in TW and coastal waters with the ultimate goal of a multi-metric fish index applicable throughout Europe) has been by necessity scaled back given that the 'ultimate goal of a multi-metric fish index applicable throughout Europe' is no longer regarded (by the partners and the GIGs) as a realistic or desirable objective because of methodological and geographical differences. It has been replaced by the aim of learning lessons from the several multi-metrics presently used and by testing the performance of metrics and multi-metrics against each other.

Publications

No publications during the reporting period.

Notable findings and results

Workpackage 4.4 has produced a comprehensive review of the relevant literature and an overview of developmental strategies of fish indices of ecological quality as a means towards indicating common approaches to metrics (rather than having a common metric which has never been proposed amongst the transitional waters fish community and is now regarded as unattainable and over-ambitious). In total a sample of 16 indices (Table 4.4-1) were reviewed in detail. The review investigated the developmental methodology (Table 4.4-2), assessment metrics (Table 4.4-3 and Figure 4.4-1), the combination rules for multi-metric indices and the formulation of thresholds for ecological status class for quality scoring methods (i.e. WFD-compliant and non compliant indices). The deliverable further indentified (1) the evaluation of the misclassification levels, (2) the detailed description of methodologies, (3) the index of sensitivity to pressure, and (4) the index value to end-users as areas often lacking on current or historical indices. Finally the deliverable identified three future areas of improvement (i) to expand the geographical relevance of indices (and include more function-related metrics), (ii) to improve reference condition definition and (iii) to assess uncertainty sources and improve precision.

Table 4.4-1: List of indices reviewed for fish in transitional waters (D4.4-1).

Tool name		Area of use	Type (# of metrics)	WFD	References
Index of biotic integrity	IBI [1]	Transitional (Louisiana, USA)	Multimetric (13)	NO	Thompson and Fitzhugh 1986
Community degradation index	CDI	Transitional (South Africa)	Single metric	NO	Ramm, 1988
Index of biotic integrity	IBI [2]	Transitional (Maryland, USA)	Multimetric (9)	NO	Jordan and Vaas 1990, Vaas and Jordan 1991
Biological health index	BHI	Transitional (South Africa)	Single metric	NO	Cooper et al., 1994
Estuarine Biotic Integrity Index	EBI [1]	Transitional (Massachusetts, USA)	Multimetric (12)	NO	Chun et al. 1996, Deegan et al 1997
Recruitment Index	RI	South Africa	Single metric	NO	Quinn et al 1999
Index of biotic integrity	IBI [3]	Transitional (Nagarranset bay, USA)	Multimetric (6)	NO	Meng et al. 2002
AZTI's Fish Index	AFI	Transitional (Basque Country, Spain)	Multimetric (9)	YES	Borja et al. 2004, Uriarte and Borja 2009
Estuarine fish community index	EFCI	Transitional (South Africa)	Multimetric (14)	NO	Harrison and Whitfield, 2004 & 2006
WFD Fish Index for Transitional waters	FITW	Transitional (Holland)	Multimetric (10)	YES	Jager. and Kranenbarg 2004
Fish -based Estuarine Biotic Index	EBI [2]	Transitional (Brackish Scheldt, Belgium)	Multimetric (5)	YES	Breine et al. 2007
Transitional fish classification index	TFCI	Transitional (United Kingdom)	Multimetric (10)	YES	Coates et al., 2007
MJ nursery index	MJNI	Transitional (France)	Multimetric (3)	NO	Courrat et al. 2009
Habitat Fish Index	HFI	Transitional & coastal (Venice Lagoon, Italy)	Multimetric (16)	YES	Franco et al. 2009
Zone-specific Fish -based Estuarine Biotic Index	Z-EBI	Transitional (Brackish & freshwater Scheldt, Belgium)	Multimetric (6)	YES	Breine et al. 2010
French Multimetric Fish Index	f-MFI	Transitional Atlantic coast (France)	Multimetric (4)	YES	Delpech et al 2010

Table 4.4-2: Developmental sequence for fish-based indices of ecological integrity in transitional waters.

	Index development sequence (Tasks)
1.	**Review of pressures and index requirements**
	Determine pressure field, index scope and quality targets
	Selection of ecologically relevant metric types according to relevant pressures
	Classify habitat typology and fish functional guilds
2.	**Selection of sampling methods**
	Sampling tools, sampling standardisation and sample analysis
	Indexing period and sampling sites
	Effort level. Precision and accuracy in the assessment
3.	**Metrics selection and evaluation**
	Determine responsiveness to pressures; Metric redundancy assessment
	Define metric thresholds and scoring system; Development of reference conditions
	Optimization of sampling methods
4.	**Index scoring method and ecological status class**
	Metric combination rules
	Define ecological quality ratio and thresholds
	Assignment to ecological status class
5.	**Index calibration and appraisal**
	Misclassification rate, sensitivity analysis
	Global uncertainty assessment
	Presentation format and value to end -user

Table 4.4-3: Meta-analysis of metrics used in fish-based indices of ecological integrity in transitional waters.

Metrics	Number of metrics
Species Richness -Composition (40 metrics in family)	
Number or Proportion of indicator species	19
Total number of species	8
Number of species that make up 90% of abundance	6
Species composition (Similarity or dissimilarity index)	4
Number of species without freshwater species	1
Seasonal overlap of fish community	1
Shannon diversity H'	1
Habitat use Guild (30 metrics in family)	
Number or proportion of estuarine species or individuals	12
Number or proportion of benthic species or individuals	5
Number or proportion of diadromous species or individuals	4
Number or proportion of habitat sensitive species	3
Proportion of estuarine -dependent marine species	2
Number and identity of marine species	2
Number and identity of freshwater species	1
Functional guild complexity (number of habitat guilds)	1
Nursery function	
Number or proportion of juvenile resident species or individuals	14

Metrics	Number of metrics
Trophic Guild (27 metrics in family)	
Number or proportion of piscivores & carnivores species or individuals	14
Number or proportion of benthic -feeding species or individuals	8
Number or proportion of demersal & pelagic -prey feeding species	2
Number or proportion of individuals as omnivorous	2
Feeding guild complexity (number of trophic guilds)	1
Abundance & Condition (17 metrics in family)	
Number or Proportion of indicator individuals	6
Proportion of disease or abnormal individuals	4
Number or density of individuals	4
Species relative abundance (BC similarity)	3

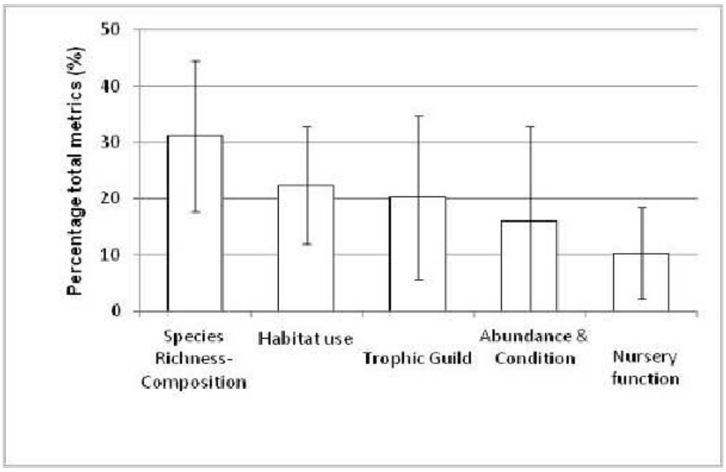


Figure 4.4-1: Relative importance of the different metric families in multi-metric fish indices.

In total, the WISER field sampling exercise consisted in 180 sampling events and over 80 fish species recorded across 5 distinct transitional water body types and salinity areas. The standardisation of the method used in the fish sampling campaign and the inclusion of replicates at different levels will be used to conduct the uncertainty exercise following the initial description for deliverable D4.4-2.

Table 4.4-4: WISER field sampling campaign for fish in transitional and coastal (TraC) waters. The sampling campaign in the Lesina lagoon used resources and assistance from the USalento.

WATER BODIES	County & WP4.4 Partners involved in sampling	Sampling events; date	Salinity zones	Gear	Total Catch (Species#)
Basque estuaries	Spain AZTI	47; May 09	Polyhaline -4 estuaries	Beam trawl	550 (7)
Stour & Orwell	UK UoH	32; July 09	Polyhaline -5 sites	Seine - Fyke nets -	1826 (19)
Varna bay and Lake	Bulgaria IO-BAS; UoH, CEMAGREF	27; Sept 09	Mesohaline -4 sites	Beam Trawl & Fyke nets	1003 (27)
Mondego	Portugal IMAR, UoH, CEMAGREF	47; Sept 09	Oligo- Meso - Polyhaline -1 site	Beam Trawl & Fyke nets	825 (26)
Lesina lagoon	Italy UoH, CEMAGREF	27; Sept 09	Mesohaline -4 sites	Fyke nets	4747 (19)*

The production of the first of the projected 5 deliverables has taken approximately 18% of the allocated man months although some partners have used more of the available allocation. Therefore the allocated budget for all 5 deliverables in the workpackage is been used according to the plan in Annex 1 and the WP does not anticipate any over expenditure over the project life span.

In addition to the agreed deliverables and milestones leading to them, there has been a number of other activities that have contributed with additional outputs to WISER. These are mainly research papers and presentations at several meetings and symposia.

Module 5 Impacts of pressure reduction and climate change on the ecological status

River Basin Management and climate change will constitute two major drivers of aquatic ecosystem change in the future. The latter is expected to result in additional threats on ecosystem integrity, both directly through temperature increase and indirectly through interaction with other stressors (e.g., land use changes). Module 5 – in contrast to Modules 3 and 4 – covers also river ecosystems and examines and predicts the recovery processes of different BQEs following pressure reduction (e.g, hydromorphological restoration in rivers, oligotrophication in lakes, land use management in entire river basins) and investigates how climate change might affect recovery-trajectories toward the target 'good ecological status'.

The work in Module 5 is based on existing data from national monitoring programmes and recent EU-funded projects. Module 5 focuses on alternative management options, their ecological effects, associated uncertainties and costs.

A conceptual framework has been developed to identify different cause-effect relationships along the degradation and restoration trajectories, and to structure the outcome to better address the end users. This framework, the Driver-Pressure-State-Impact-Response-Recovery chains (DPSIRR), is being jointly used in all WPs of Module 5. For a selection of case study sites/catchments, the responses of BQEs, as influenced by stressor increase and decrease, will be evaluated in more detail, while mainly statistical models are used to predict the impact of different pressure reduction scenarios, catchment management options and climate change scenarios (temperature effects only).

In particular, Module 5 addresses:

- the suitability and efficiency of management measures improve the BQEs and to achieve 'good ecological status',
- the uncertainty of pressure reduction, ecological effects and modelling,
- the effects of climate and land use changes on ecological thresholds (reference status, good/moderate class boundaries) and
- the effects of climate change on recovery processes and restoration measures in the presence of ecosystem regime shifts.

Where possible, the conceptual cause-effect relationships are being tested with existing data. In some pilot analyses, a combination of empirical (including Bayesian techniques) and mechanistic models has already been applied. The final outcome of all WPs will be a guidance summarising important cause-effect chains for the impact of pressure reduction and climate change on BQEs. This guidance will recommend ecologically most (cost) effective management options and address changes in the good/moderate boundaries in classification systems.

WP5.1: Effects of management and climate change: Rivers

Contractors involved: ***UDE****, CEMAGREF, ALTRERRA, BOKU*

Summary of progress towards objectives and details for each task

<u>Objective 1: Generate Driver-Pressure-Impact-Response-Recovery chains for pressures and pressure combinations, and for fishes, benthic invertebrate and aquatic flora. Estimate the effects of global/climate change on degradation and recovery processes.</u>

<u>Task 1:</u> Structure and establish three workpackage databases as a basis for conceptual and statistical modelling.

5. Large-scale WP5.1 database on environmental and biological data from rivers in three European regions: Northern/Boreal, Central Baltic and Alpine). This data has been compiled from national monitoring data in Austria, France, Germany, Sweden and the Netherlands, and from previous EC-funded research projects (AQEM, STAR, FAME, EFI+). The database contains samples from >4,500 stations in 10 countries (Figure 5.1-1), including up to four BQEs (fish, invertebrates, macrophytes

and benthic diatoms) and three stressors (16 parameters of hydromorphological degradation, 13 physico-chemical parameters of and 6 catchment- and reach-scale land use) per station. The database structure is in line with WP2.1 (Central WISER database); all WP5.1 data have been made available to the workpackages in synthesis and integration in Module 6.

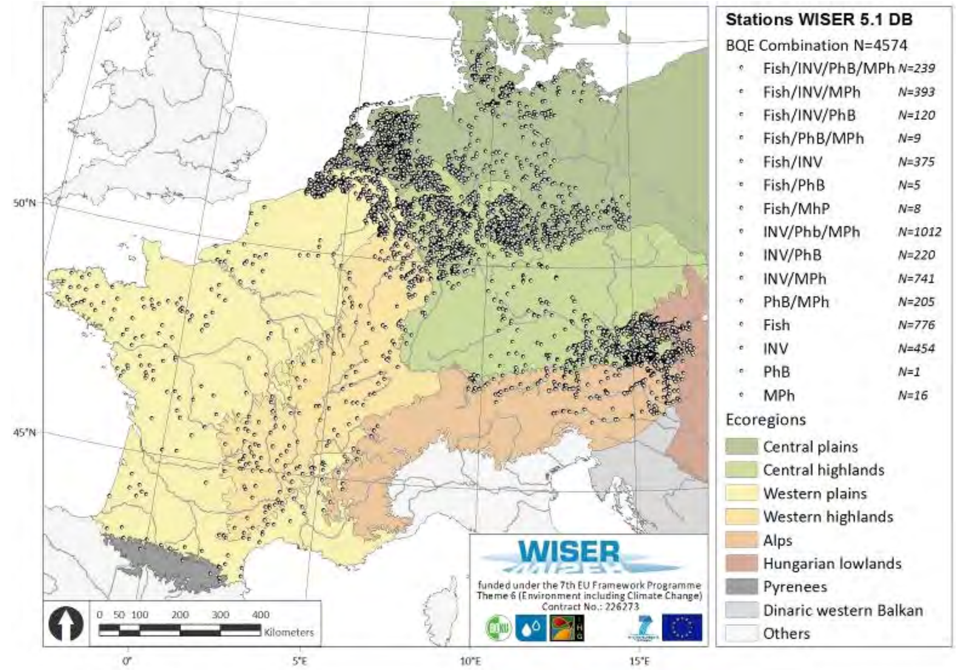


Figure 5.1-1: Overview of stations in the WP5.1 large-scale database.

6. Restoration database on ca. 70 control/impact studies in Austria, Germany and the Netherlands. The database contains environmental information (river/bank/floodplain hydromorphology, physico-chemical parameters, floodplain and catchment land use) and biological samples (fish, benthic macroinvertebrates, macrophytes, benthic diatoms, and partly floodplain vegetation and riparian ground beetles).
7. Literature database on restoration studies. Continuous effort is being spent on a compilation of peer-reviewed restoration studies with a clear focus on studies that report practical river restoration and its implications on riverine and floodplain structures and biota. Altogether, information on 25 variables is extracted from each study (e.g. continent, country, number and location of sites, altitude, kind of management measure, abiotic and biological effects, limitations, strength of the study). This data has been extensively used to conceptualise well-reported Response-Recovery chains for three selected groups of river restoration measures: riparian buffer instalment, weir removal and improvement of in-stream habitat structures (D5.1-1).

In addition, comprehensive data has been compiled for three case study catchments in Austria (river Drava/Traun system), France (river Seine) and the Netherlands (river Vecht). This data provides a particularly high data density and long-term coverage including temperature data. The data is used to evaluate the statistical models developed and the relationships identified using the large-scale database (1).

<u>Task 2:</u> Develop Driver-Pressure-Impact-Response-Recovery chains

Altogether, 18 WISER scientists and three external end users (river basin managers from France, Germany and the Netherlands) attended a workshop on conceptual modelling of degradation and restoration effects on riverine biota (November 2009, Wageningen). The experts developed Response-Recovery chains for several restoration/management scenarios (e.g., riparian buffer instalment, in-stream habitat improvement, weir removal) which were later fit into a conceptual framework and provided the basis for D5.1-1 (Conceptual Models and effects of river rehabilitation and restoration measures on aquatic organisms). Altogether, six different conceptual models have been drafted during the workshop on water quality improvements in i) low- and ii) high-energy rivers, on mesohabitat improvements in iii) low- and iv) high-energy rivers, on v) weir removal, and on vi) lake oligotrophication and vii) the reduction of lake water level fluctuations. Three combined models (water quality improvement, mesohabitat improvement and weir removal) have eventually been selected for an extensive literature review. This review also provided the analytical basis to describe the effects of river restoration/management on the aquatic fauna and flora.

The multivariate analysis to analyse the Driver-Pressure-Impact chains have not yet started due to the delayed finalisation of the large-scale database. This also applies to the estimation of the effects of global/climate change on degradation and recovery, which is planned for the second half of the project.

Objective 2: Develop mathematical models to predict the response of BQEs to pressure reduction and finally the conditions required to reach good ecological status.

Task 3: The development of statistical and mechanistic models on the recovery of BQEs has not yet started. This also applies to the analysis of data from practical restoration measures (before-after and control-impact studies) and the investigation of thresholds.

Task 4: The development/adjustment of statistical and mechanistic models for the three case studies has not yet started.

Objective 3: Describe best-practice measures of restoration and management options to improve the ecological quality of rivers.

Task 5: The synthesis of major outcomes and recommendations has not yet started. However, five major questions have been formulated and discussed during the project meeting in September 2010:

1. How do drivers impact stressors, especially in relation to global/climate change?
2. How do stressors (hydromorphology, combined hydromorphology/land use/eutrophication/acidification) impact BQEs (degradation) and to which states/conditions does this lead?
3. How do management and policies respond to such degradation and what management/restoration measures are taken?
4. How do BQEs respond to stressor reduction?
5. How does global/climate change affect BQEs along or after restoration?

Publications

No papers of WP5.1 were published in the reporting period.

Notable findings and results

Restoration ecology is often assuming that communities are beginning to recover as soon as the pressures are reduced or removed. However, the simple reversal of degradation equally often does not show the desired and anticipated ecological effect and the biota continue to stay ‘degraded’. The reasons for failure are often of hypothetical nature and address, for instance, the mismatch of scaling of pressures and response and of the time scales of degradation and recovery.

Practical restoration data including detailed records of environmental and biological changes after restoration is still sparse and mostly incomparable in multivariate analysis due to methodological inconsistencies. Therefore, workpackage 5.1 developed a conceptual framework to assist and better structure a review of the existing peer-reviewed literature on practical restoration and its biological effects. The general framework (conceptual model) has been developed on a workshop of WISER experts of Modules 5 and 6 together with practical river basin managers from France, Germany and the Netherlands (Figure 5.1-2). Therein, each arrow refers to a referenced relationship in the restoration literature, either positive (red), negative (blue) or undetermined (grey), while the arrow number is linked to a matrix of references and its data (e.g., meta data of the study, type of restoration measure, abiotic and biological effects, strengths and limitations). This matrix allowed of a descriptive analysis of the state-of-the-art of the effects of practical river restoration. The framework was applied to four river restoration measures (riparian buffer instalment, instream habitat improvement, weir removal, and re-meandering) and the results have been summarised in D5.1-1.

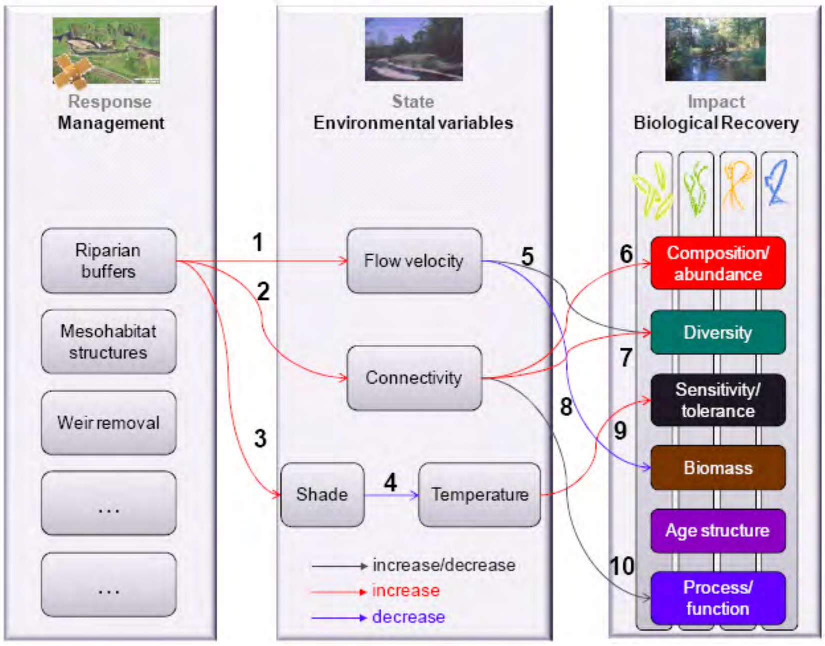


Figure 5.1-2: General conceptual framework of abiotic (State) and biological effects (Recovery) of restoration and management measures (Response) in rivers.

Several findings are notable and deserve a brief reference here. First, the majority of peer-reviewed studies come from North America, while practical restoration gained increasing interest since the late nineties of the past decade (Figure 5.1-4 and 5.1-5). Second, most studies report local restoration measures (<1 km length), while restoration studies at the river stretch/section level (several up to tens of kilometres) are very sparse. Third, most studies report effects of the improvement of in-stream structures and habitat, of which large wood (LWD) is in the first place. The introduction of LWD can be seen as a "popular" measure, however with ambiguous effects (success); LWD is usually introduced at the local scale. Fourth, benthic macroinvertebrates are the most frequently applied indicator group (Figure 5.1-6) to measure the effects of restoration on species, communities and their ecological attributes (traits). Second come fish, followed by macrophytes; benthic diatoms are the least used indicator group.

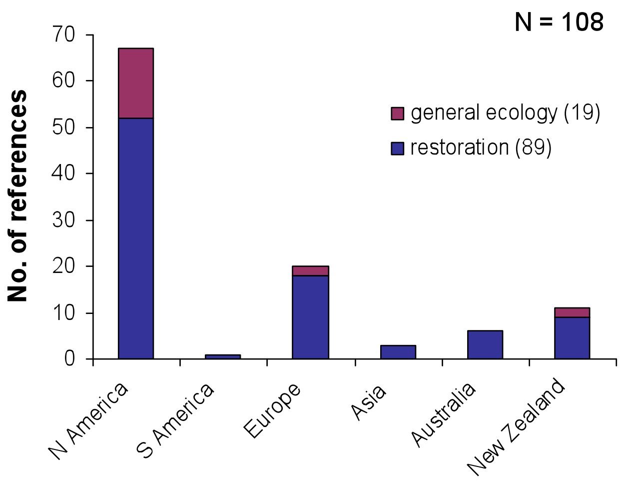


Figure 5.1-4: Origin of 108 out of a total of 112 references on practical restoration.

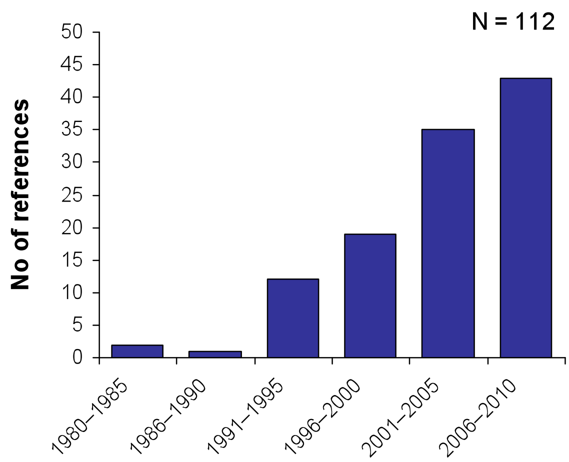


Figure 5.1-5: Time of publication of 112 references analysed.

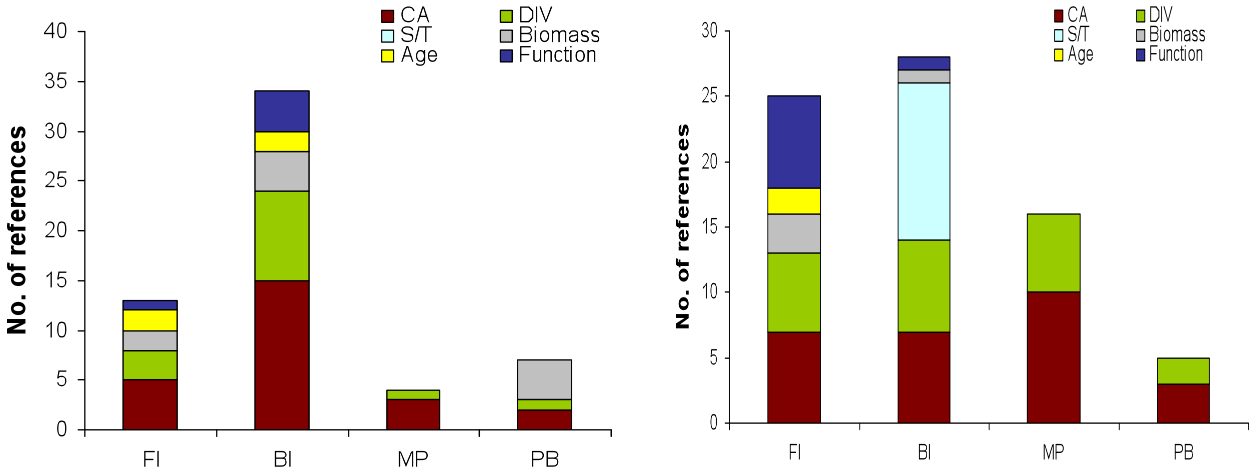


Figure 5.1-6: References to the community attributes composition/abundance (C/A), sensitivity/tolerance (S/T), age structure (Age), diversity (Div), biomass and function of fish (FI), benthic macroinvertebrates (BI), macrophytes (MP) and phytobenthos (PB) in studies on riparian buffer instalment (left) and on the removal of weirs <5 m height (right)..

WP5.2: Effects of management and climate change: Lakes

Contractors involved: ***SYKE****, NIVA, AU, UCL, DELFT*

Summary of progress towards objectives and details for each task

Task 1: Individual databases were established for lake case studies.

Task 2: Workpackage 5.2 participated in the combine Module 5/6 workshop (November 2009, Wageningen) and contributed lake recovery chains for eutrophication and hydromorphological alterations based on the peer-reviewed literature. The plans for the use of conceptual Driver-Pressure-State-Impact-Response-Recovery chains in workpackage 5.2 were updated and assigned to partners. The conceptual models will be used to plan, analyse and summarise the results of BQE data analysis and case study scenarios.

Palaeo-limnological changes in the diatom assemblages of lakes with reduced nutrient loading (re-oligotrophication) were assessed using sediment core data. To date, the analysis of sediment cores has been carried out on ten sites. From these results, we conclude that:

- the observed changes do reflect a recovery process
- the recovery is more clearly seen in the deep lakes where the diatom assemblages have started to revert back toward those seen prior to enrichment.
- the recovery process has a long way to go in all cases as the present assemblages remain very different from those seen in the pre-enrichment samples.
- the recovery pathway appears to be returning back along the enrichment pathway for the deep lakes but this is less clear for the shallow lakes

The outputs from a previous EC-funded project (Euro-limpacs) were reviewed with particular focus on the effects of climate change on reference conditions and ecological status of lakes to provide the foundation for assessing how climate change may affect recovery trajectories. The review has been brought together in a draft report, which is almost completed, and which will feed into Deliverable D5.2-5 (Report on the effects of climate change on reference conditions and ecological status in lakes").

A modelling study was carried out as batch simulations of phosphorus load reduction and warming impacts in 181 Norwegian lakes. The combined effects of management and climate change in the simulated data will be further analysed by various statistical methods.

A comprehensive review of existing lake models highlighting the role of joint applications of different approaches into combined models was conducted. Another literature review addressed the effects of hydromorphological changes (e.g., lake shoreline degradation and restoration, water level fluctuation) on lake BQEs (taxon and metric level).

Task 3: An online tool to estimate target nutrient loads based on 'good ecological status' in terms of the good/moderate class boundary for total phosphorous, total nitrogen and chlorophyll *a* has been developed. Therefore, data of chlorophyll *a* and nutrient loading in Finnish lakes has been analysed using hierarchical regression models. The trial LakeLoadResponse tool (LLR) has been published online for evaluation.

Task 4: Two case study lake models and different scenarios have been developed and evaluated of Lake Pyhäjärvi (Finalnd) and Lake Veluwe (the Netherlands). The respective Deliverable D5.2-1 (due in month 20) is being drafted.

Publications

- Beklioglu M., Meerfhoff, M. & Jeppesen, E. 2010. Eutrophication and Restoration of Shallow Lakes from a cold Temperate to a warm Mediterranean and a (Sub)Tropical climate. in AA Ansari-S Singh-GR Lanza-W Rast (Editors). Eutrophication: Causes, Consequences and Control. Springer -. in press.
- Jeppesen, E., Kronvang, B., Meerhoff, M., Søndergaard, M., Hansen, K.M., Andersen, H.E., Lauridsen, T.L.,Beklioglu, M., Özen, A. & Olesen, J.E. 2009. Climate change effects on runoff, catchment phosphorus loading and lake ecological state, and potential adaptations. Journal of Environmental Quality 38: 1931-1940.

• Jeppesen, E., Meerhoff, M., Holmgren, K., González-Bergonzoni, I., Teixeira-de Mello, F., Declerck, S.A.J., DeMeester, L., Søndergaard, M., Lauridsen, T.L., Bjerring, R., Conde-Porcuna, J.M., Mazzeo, N., Iglesias, C., Reizenstein, M., Malmquist, H.J. & Balayla, D. 2010. Impacts of climate warming on lake fish community structure and dynamics, and potential ecosystem effects. Hydrobiologia 646: 73-90.
• Lund S.S, Landkildehus, F., Søndergaard, M., Lauridsen, T.L., Egemose, S., Jensen, H.S., Andersen, F.Ø.,Johannson, L.S., Ventura, M. & Jeppesen, E. 2010. Fast changes in community structure, abundance and habitat distribution of fish in a Danish lake following restoration by aluminium treatment. Freshwater Biology 55: 1036-1049.
• Mooij, W.M., Trolle, D., Jeppesen, E., Arhonditsis, G., Belolipetsky, P.V., Chitamwebwa, D.B.R.,Degermendzholz, A.G., DeAngelis, D.L., De Senerpont Domis, L.N., Downing, A.S., Elliott, A., Fragoso,C.R., Gaedke, U., Genova, S.N., Gulati, R.D., Håkanson, L., Hamilton, D.P., Hipsey, M.R., 't Hoen, J.,Hülsmann, S., Los, F.J.H., Makler-Pick, V., Petzoldt, T., Prokopkin, I.G., Rinke, K., Schep, S.A.,Tominaga, K., Van Dam, A.A., Van Nes, E.H., Wells, S.A. & Janse, J.H. 2010. Challenges and opportunities for integrating lake ecosystem modelling approaches. Aquatic Ecology 44:633-667.

Notable findings and results

The trial version of the LakeLoadResponse (LLR) internet tool is available at http://lakestate.vyh.fi/cgi-bin/frontpage.cgi?kieli=ENG.

WP5.3: Effects of management and climate change: transitional and coastal waters

Contractors involved: ***CSIC****, AZTI, AU, SYKE, IO-BAS*

Summary of progress towards objectives and details for each task

Task 1: Establishment of databases: During the WISER kick-off meeting several coastal and transitional water bodies were identified that have experienced reductions in nutrient loads and that provide sufficient data on different BQEs to analyse potential recovery. A metadata analysis was carried out for 33 water bodies to i) identify the main pressures on the lake systems, ii) examine if there had been a reduction of pressures that would allow for a potential recovery, and iii) get an overview on the data availability for these sites for both pressures and responses. A closer examination of this information revealed that a considerable amount of the sites had not experienced reductions in nutrient inputs (or such pressure data were not available) and another considerable amount of sites did not have consistent time series to adequately assess time trajectories of recovery. Thus, the outcome of this metadata analysis was a reduced number of water bodies selected for further analysis:

1. Danish estuaries (minimum 7 sites with data covering 3–4 decades)
2. Dutch coastal waters (3–4 decades of data)
3. Oslo Fjord (3–4 decades of data)
4. Helsinki Bay area (3–4 decades of data)
5. Gulf of Riga (3–4 decades of data)
6. Nervion River estuary (1–2 decades of data)

Workpackage 5.3 will analyse time series of pressures and responses as annual values and the selection of data for this task will be hypothesis-driven, i.e. focusing on specific areas where the has been a long-term reduction in nutrient inputs that allows for identifying delayed responses in the biological components of the ecosystem. These time series will be stored in a conventional way using MS Excel™ or text files.

Task 2: Development of driver-pressure-impact-response-recovery chains: The response of phytoplankton biomass (as chlorophyll *a*) to changing nutrient levels has been investigated for Danish estuaries and Dutch coastal waters combined with data from the Chesapeake Bay and Tampa Bay (USA). The objective was to examine the universality of chlorophyll *a* vs. total nitrogen (TN) across ecosystems and time. Partitioning the generic relationship into its ecosystem-specific relationships revealed that there are significant spatial differences in the responses of chlorophyll *a* to changing TN levels, and furthermore, that the chlorophyll *a* response to decreasing TN levels is not constant over time (Figure 5.3-1). Our results from this study suggest that the chlorophyll *a* yield per unit of TN has almost doubled in coastal waters during the last 30 years, and we believe that this shift in baseline is related to climate change and overfishing of the food web. Thus, this study concludes that coastal ecosystems are exposed to multiple stressors, some of these believed to manageable and others not, that will affect reference conditions and class boundaries. If historical values are used as targets for coastal ecosystem recovery, it can be difficult to achieve these targets because of shifting baselines.

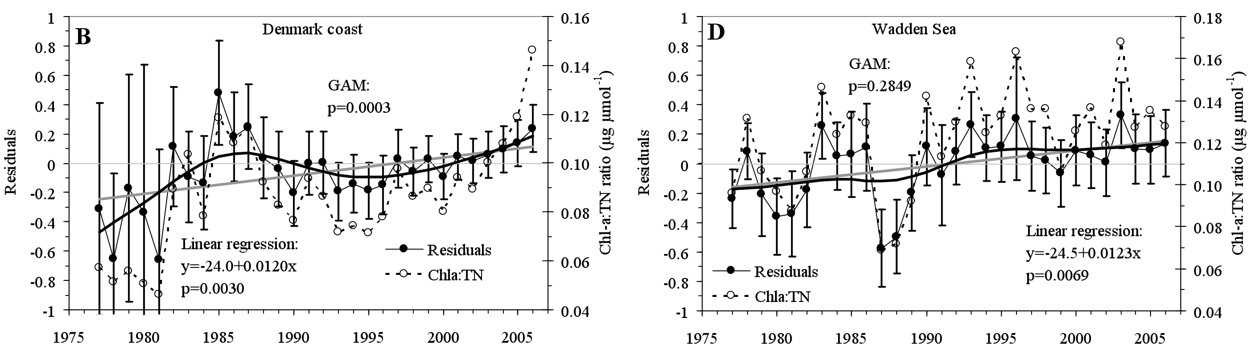


Figure 5.3-1: Trends of residuals from region-specific linear relationship between chlorophyll a (chla) and TN as well as the chl-a : TN ratio for Danish estuaries (left) and Dutch coastal waters (right). Figures from Carstensen et al. (in 2nd review).

In Denmark, nutrient concentrations have declined substantially following action plans to reduce inputs of nutrients from both point and diffuse sources. However, the only BQE to be used in the first river basin management plans (RBMP), eelgrass depth limits, apparently has not responded to the lower nutrient levels. Since eelgrass is growing in shallow coastal and transitional waters only, where water transparency measured by Secchi depth is frequently affected by recordings of sight to the bottom (termed censoring). Carstensen (2010) developed a method to produce estimates of water transparency unbiased by censoring and showed that traditional analysis for some coastal sites this may lead to misinterpreting the actual trend (Figure 5.3-2).

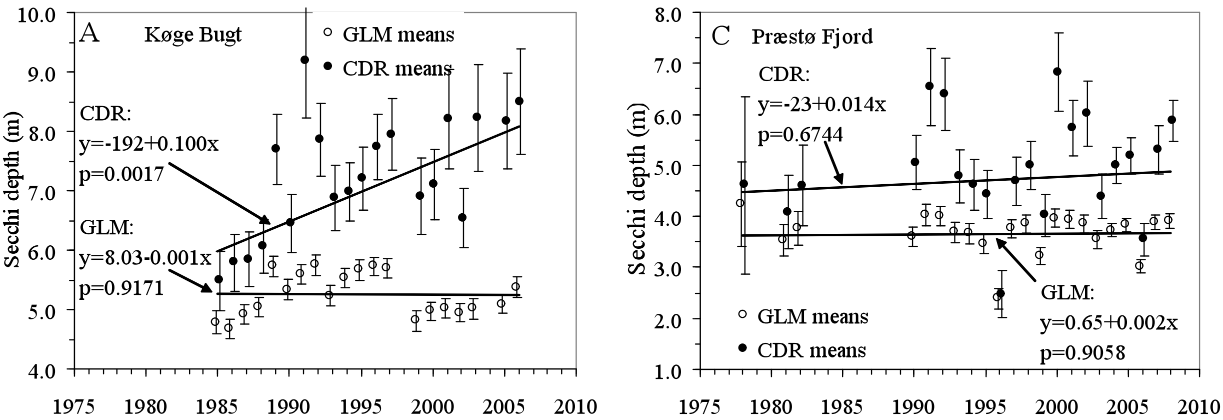


Figure 5.3-2: Trends of annual means of Secchi depths produced by ordinary Generalised Linear Model (GLM) and the more adequate Censored Data Regression (CDR). Figures from Carstensen (2010).

In a follow-up study the cause-effect chain from nutrient inputs to concentrations to light conditions to eelgrass depth limits was examined using 3 Danish estuaries. Although there have been major declines in TN concentrations, most of this decline is attributed to changes in the dissolved inorganic fraction (DIN) that does not attenuate light. This implies that light conditions have not improved considerably because there are still high levels of organic nitrogen absorbing the light and particulate nitrogen absorbing and scattering the light. Consequently, the fractions of organic and particular matter must be reduced to improve light conditions and allow for potential recovery of eelgrass.

Borja et al. (2010) have produced a list of recovery aquatic system rates, taking into account long-term datasets. Based upon one of the six examples above (Nervion estuary), a model of recovery was proposed (Figure 5.3-3).

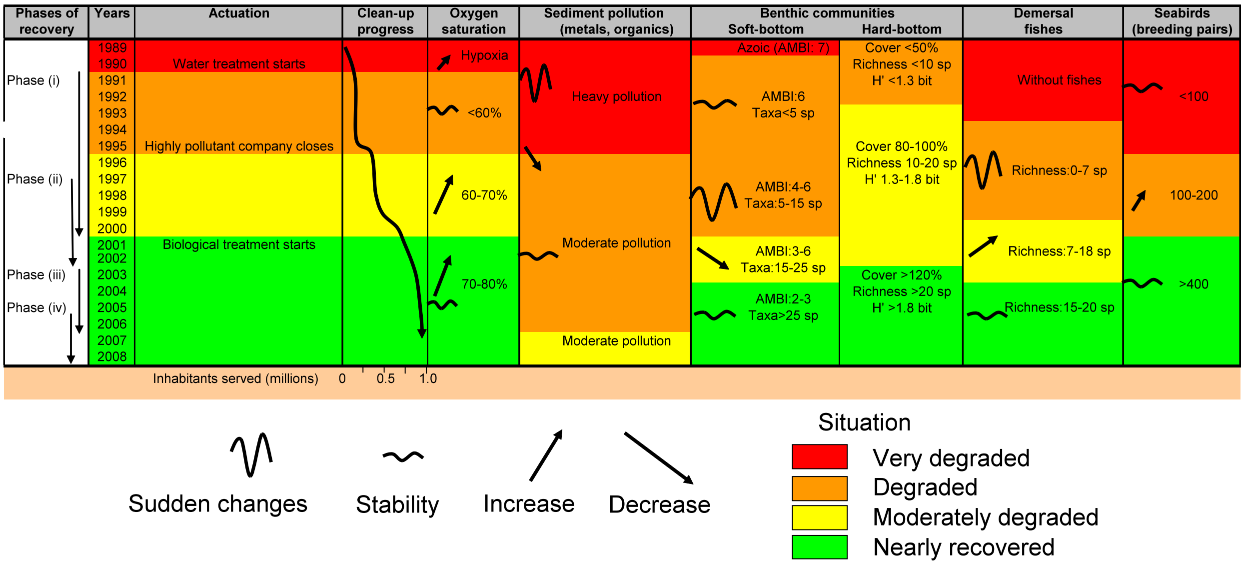


Figure 5.3-3: Recovery patterns and recovery phases of the quality within the Nervión estuary (Basque Country, northern Spain), during a period of water treatment progression. Notes: AMBI: AZTI's Marine Biotic Index (Borja et al. 2000), H': Shannon-Wiener diversity index. Figure from Borja et al. (2010).

Task 3: Development of predictive models: Hypoxia in coastal and transitional waters is a detrimental phenomenon that may exacerbate consequences of eutrophication further and lead to regime shifts through enhanced recycling of nutrients. To assess thresholds associated with hypoxia and the potential consequences this may have on marine ecosystems two studies addressing the non-linear responses associated with hypoxia have been carried out. Vaquer-Sunyer and Duarte (2010) have done a literature review clearly documenting even more adverse effects on the benthic fauna when hydrogen sulphide was present. Survival rates are reduced by approximately 30% in the presence of sulphide, and releases of sulphide may lead to a collapse of the ecosystem, making the recovery even more difficult. Hypoxia is believed to worsen with global warming, and in Vaquer-Sunyer and Duarte (in 2nd review) the combination of hypoxia with increasing temperatures was assessed from a meta-analysis of published experimental results evaluating the effects of increasing temperature on the median lethal time and median lethal concentration of benthic macrofauna under hypoxia (Figure 5.3-4). The meta-analysis confirmed that survival times under hypoxia were reduced by an average of 74% and that median lethal concentration increased by a mean of 16% in marine benthic organisms exposed to higher temperatures. The implication of these results is that the critical oxygen threshold, potentially leading to irreversible effects, will increase in a warmer climate. The established relationships can be employed to project consequences of low oxygen concentrations combined with temperature increases on the benthic community.

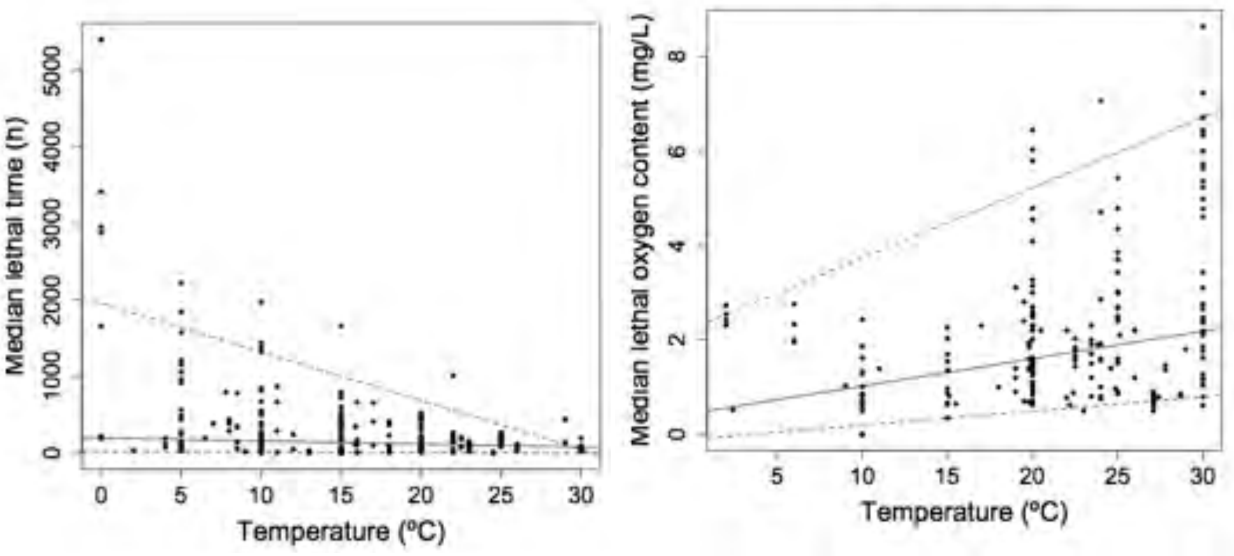


Figure 5.3-4: Left: Changes in median (solid line) and 95-percentile (dashed lines) lethal time for benthic organisms in response to temperature increases. Right: Changes in median (solid line) and 95-percentile (dashed lines) lethal concentration in response to temperature increases. Figures from Vaquer-Sunyer and Duarte (in 2nd review).

The Gulf of Riga is a coastal ecosystem that has experienced reductions in nutrient inputs, however, without any significant response in the biological system. Another analysis showed that the phytoplankton biomass is still high, because grazing pressure from zooplankton has been reduced over the last 30 years, most likely as a response through trophic cascades resulting from overfishing. Although there was no significant effect of temperature on the phytoplankton biomass as such, temperature did result in changes in the community leading to increasing proportion of chlorophytes and declining proportion of dinoflagellates for temperatures exceeding a threshold around 16 °C (Figure 5.3-5).

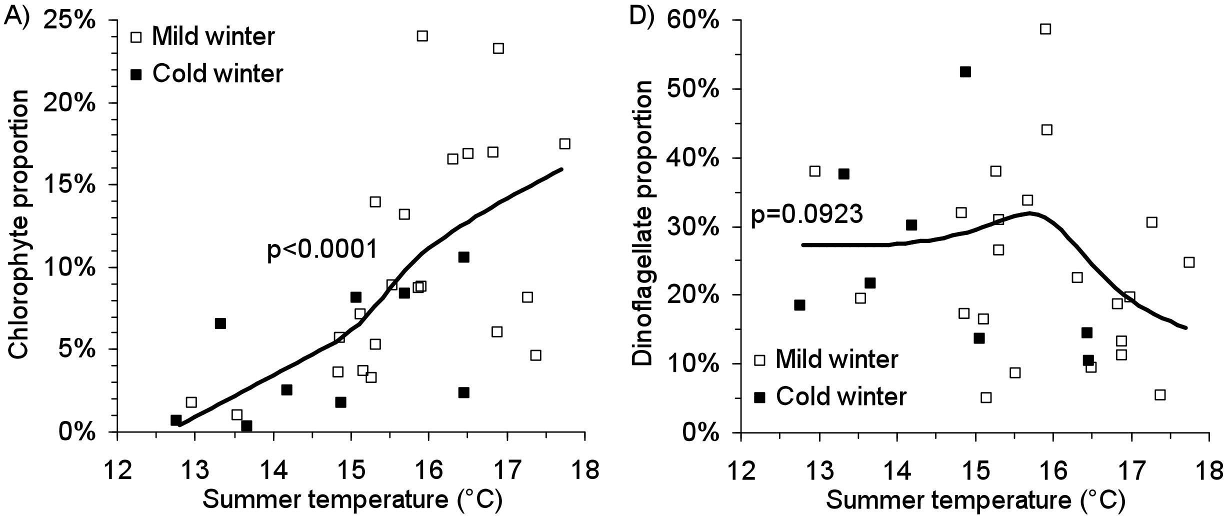


Figure 5.3-5: Responses in the summer proportion of chlorophytes (left) and dinoflagellates (right) to changing temperature.

Task 5.3.4: Development of mechanistic models for case studies. The mechanistic model for Nervion River Estuary will be initiated during autumn 2010. A 3-D mechanistic model (COHERENS) for Helsinki Bay area has been set up as a nested sub-model of a larger regional model for the Gulf of Finland to also assess effects from fluctuations in nutrient inputs at the regional level. The physical part of the model has been calibrated and biological part of the model is currently under development (phytoplankton only).

Task 5.3.5: Synthesis. This activity has not started yet.

Publications

- Borja, A., D.M. Dauer, M. Elliott, C. Simenstad (2010) Medium and long-term recovery of estuarine and coastal ecosystems: patterns, rates and restoration effectiveness. Estuaries and Coasts 33: 1249–1260.
- Carstensen, J. (2010). Censored data regression: Statistical methods for analyzing Secchi transparency in shallow systems. Limnology and Oceanography: Methods 8: 376–385.
- Carstensen, J., M. Sánchez-Camacho, C. M. Duarte, D. Krause-Jensen, N. Marbà (in 2nd review). Connecting the dots: responses of coastal ecosystems to changing nutrient concentrations. Limnology and Oceanography.
- Vaquer-Sunyer, R. and C.M. Duarte (2010). Sulfide exposure accelerates hypoxia-driven mortality. Limnology and Oceanography 55: 1075-1082.
- Vaquer-Sunyer, R. and C.M. Duarte (in 2nd review). Temperature effects on oxygen thresholds for hypoxia in marine benthic organisms. Global Change Biology.

Notable findings and results

Notable findings have already been described in the section on major achievements. In brief, the following results have already been achieved:

- Effects of hypoxia, sulphide and temperature increases on benthic organisms documented.
- Shifting baselines identified for phytoplankton biomass despite nutrient reductions.
- Changes in phytoplankton community in response to temperature increase documented.
- Eelgrass recovery should focus on reducing the organic matter to improve light conditions.
- Theoretical approach for recovery rates in different aquatic elements.

Module 6 Integration and optimisation

Module 6 addresses the questions i) how different BQEs and water categories respond to degradation and rehabilitation and ii) which sources of uncertainty might impact the results to what degree. Thus, Module 6 is basically synthesising the outcomes of Modules 3, 4 and 5 and in particular addresses four issues related to the use of multiple BQEs and systems/habitats to design robust monitoring programmes. Individually, WP6:

- provides guidance and evaluate field exercises performed in Modules 3 and 4 on uncertainty estimation associated with the use of multiple BQEs in lakes, transitional and coastal waters,
- provides guidance on how to best combine metrics into an overall assessment of a water body,
- compares the response signatures of different BQEs in different water categories and habitats to degradation and recovery and
- compares cause-effect-recovery chains for lakes, rivers and marine ecosystems, taking into account processes and functional features in different ecosystems and over-arching biological processes of connectivity and metapopulation dynamics.

Guidance on uncertainty analysis has already been given during two workshops back-to-back with the project kick-off and mid-term meetings. WP6.1, therefore, does primarily address the new data gathered in the Module 3 and 4 field campaigns that included the necessary replicate sampling design. The other workpackages in Module 6, however, also consider existing data from previous EU-funded projects and national monitoring schemes.

WP6.1: Uncertainty

Contractors involved: ***NERC****, NIVA, AU, SLU, EC-JRC, BourneU*

Summary of progress towards objectives and details for each task

Objective 1: Facilitate estimation of uncertainty associated with the various BQEs. At the initial WISER start-up meeting, a workshop was held attending by all WISER partners to explain the importance of being able to estimate the uncertainty associated with biological sampling methods, modelling and bioassessment approaches for WFD water bodies. Advice to all WP in Modules 3 and 4 in their sampling scheme designs for the WISER field campaigns has been provided, successfully encouraging the use of hierarchical replicated sampling to enable estimation of the amount of variance in BQE metric values due to spatial heterogeneity and sampling/sub-sampling procedures.

A guideline has been provided on the use of the statistical software package ‘R’ to analyse the WISER field and existing data and to estimate the size and relative importance of spatial, temporal and sampling/sub-sampling components of variance in metrics. This helps guide the WISER field data uncertainty component analyses and will lead to a summary guidelines manuscript/report for future use (Milestone 6.1-1 and Deliverable D6.1-2).

A generally applicable software tool to help assess the confidence in a water body’s estimated WFD ecological status class was developed. The trial version of this new software package ‘WISERBUGS’ (WISER Bioassessment Uncertainty Guidance Software) has been made available online for testing and usage. As this deliverable (D6.1-3) has been produced well ahead of the original deadline (month 30), there’s more time for use within WISER’s workpackages.

Publications

None published so far as dependent on data and analyses from Modules 3 and 4 (uncertainty sampling field campaign). A journal paper on the new WISERBUGS software is in preparation.

Notable findings and results

The uncertainty workshop at the start-up meeting highlighted immediately the importance of having a quantitative understanding of the sources and potential causes of uncertainty in any method for assessing the WFD ecological status class of water bodies and in any relationship between observed sample biotic metrics and measures of the underlying stressor gradient and pressures operating on each water body (Figure 6.1-1).

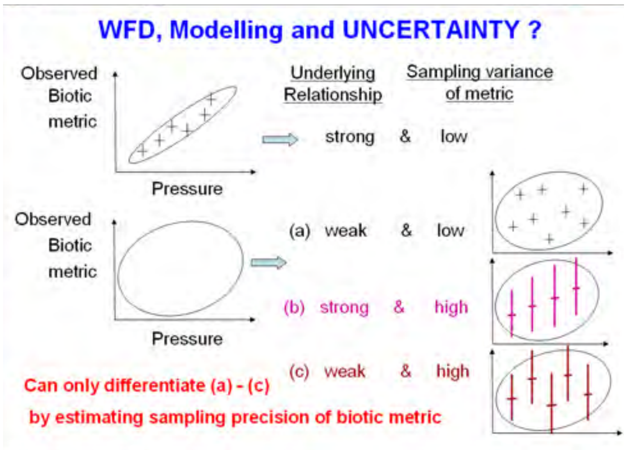


Figure 6.1-1 Illustration of the importance of quantifying the influence of metric sampling variability on observed relationship between biotic metric values and the measure of pressure or stress operating within a water body.

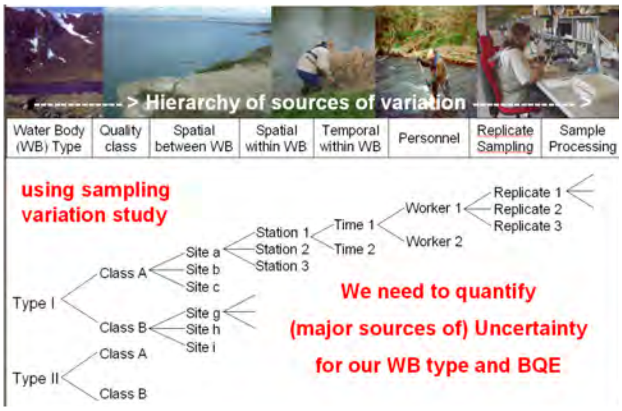


Figure 6.1-2 Field sampling campaigns designed to assess a range of the above sources of sampling variability.

Guidance is provided on how to devise sampling studies and/or obtain existing data which can be assess at least the major sources of spatial, temporal and sampling variability (Figure 6.1-2).

A major use of any estimates of each proposed metric's uncertainty variance components is to assess the effects of sampling variance in one or more metrics and BQEs on the resulting uncertainty and confidence in assigning water bodies to each status class based on these sampling methods, individual metrics and multi-metric multi-BQE rules.

The uncertainty software package 'WISERBUGS' uses estimates of individual metric sampling variability for any specific water bodies in simulations of the metric sampling distributions to derive confidence limits for metric ecological quality ratio (EQR) values, and confidence of the water body belonging to each status class based on the selected metrics and multi-metric rules (Figure 6.1-3). WISERBUGS is designed to be very general, applicable to all metrics and BQEs and provides a convenient means of trying out the effect of apply each of a range of nested multi-metric assessments rules (e.g. averaging metric EQRs, using median or worst class amongst several metrics and/or BQEs) on both WB assessment class and its sampling uncertainty. The software package is currently downloadable from the WISER internal Intranet, but after internal testing by WISER partners, will be made available (in spring 2011) to the public and research community for general use.

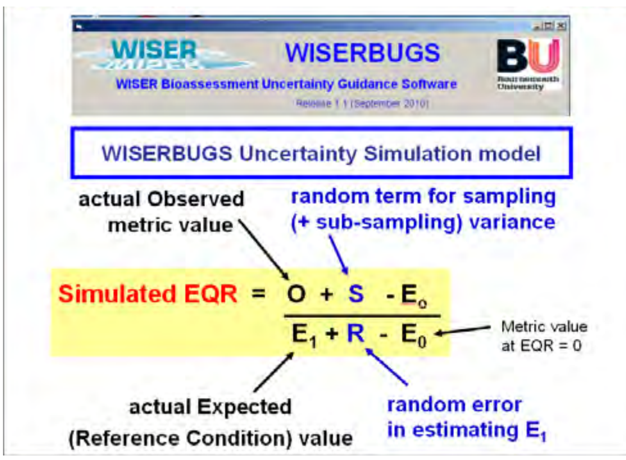


Figure 6.1-3: WISERBUGS software with uncertainty simulation.

WP6.2: Combination of BQEs into a complete water body assessment

*Contractors involved: **EC-JRC**, NERC, AZTI, SLU, BOKU*

Summary of progress towards objectives and details for each task

The main objective of workpackage 6.2 is to address the problem of combining information from different Biological Quality Elements (BQEs) into a complete water body assessment. In particular, the aim is to i) demonstrate the practical implications of the 'one-out all-out' approach and alternative approaches for assessment of water bodies and to ii) make practical recommendations for end users on the combination of BQEs.

During the reporting period, EC-JRC has completed a comparative analysis of approaches in different European countries for combining BQEs in their WFD assessment methods. This work resulted in Deliverable D6.2-1. The results of the review produced useful examples on practical application of combination rules for BQEs and will give a significant input for the successive task of testing different combination approaches.

The further tasks of workpackage 6.2 will be addressed in the second half of the project. The work will to a large extent depend on data collected in Modules 3 and 4, complemented with selected data containing monitoring information from multiple BQEs, and simulated data sets. Anticipating this work, AZTI has already completed an initial analysis of problems associated to the 'one out, all out' principle or the application of other integrative methods, using data from the Basque Country; these results are published in Borja and Rodriguez 2010.

Publications

- Borja, A., J.G. and Rodríguez, 2010. Problems associated with the ‘one-out, all-out’ principle, when using multiple ecosystem components in assessing the ecological status of marine waters. Marine Pollution Bulletin, 60(8): 1143–1146.

Notable findings and results

The review of how BQEs are combined in national WFD monitoring and assessment programmes includes information from fifteen EU Member States. It turned out that there were large differences between countries. Some Member States simply classify a water body by the worst of the BQEs, are adopting the ‘one out-all out’ principle straight away (for example Portugal, Slovakia, Ireland). Others use the ’ one out-all out’, but only after a pre-selecting of the most sensitive BQEs (UK, Scotland, Northern Ireland, Germany). Others employ alternative rules of a different nature (Spain, Finland, Czech Republic Italy, France, Denmark).

For most of the MS the available information was incomplete, unclear, or even missing. For only few Member States (UK, Basque Country-Spain, Finland, Portugal) comprehensive information was found; D6.2-1 describes the approaches followed by those countries in detail, together with practical examples of their application. Two examples from the Basque Country (Spain) and Finnland, are presented below. In both cases the ‘one out-all out’ principle hasn’t been applied straight away.

The Basque Country system integrates information from several BQEs (phytoplankton, macroalgae, fish and macrobenthos) and physico-chemical elements. Macrobenthos has a particular and more significant weight for the determination of the biological status in this classification approach. This is because macrobenthos is considered, the best-studied BQE, with more data available and with the most accurate methodologies available; furthermore, macrobenthos responds relatively rapidly to anthropic and natural pressures. The method thus emphasizes one BQE (macrobenthos) that allows to classify water bodies with a higher confidence than the others BQEs, giving less weight to information from the other, less reliable BQEs (see Figure 1, from Borja et. al, 2009).

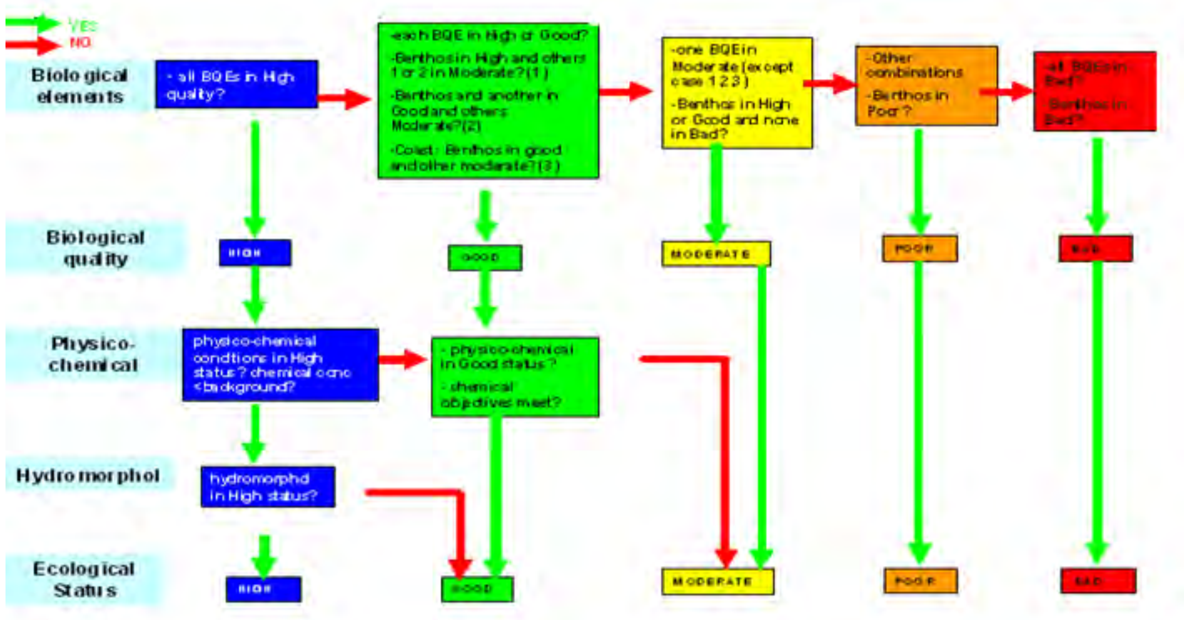


Figure 6.2-1: Methodology to assess coastal waters using multiple ecosystem components (from Borja et al., 2009).

The Finnish classification system (or so-called FinEQ) represents a holistic view of the ecosystem status and a tool for integrating multiple results and different assessments and evidences in the overall assessment of a water body. The FinEQ is based on the integration of multiple metrics and biological elements. The system harmonizes the metrics and quality elements by scoring them and expressing the overall calculated status class as a median score value across all quality elements. The calculated status class is further evaluated by weigh-of-evidence approach commonly used in risk assessment, in which quality elements and monitoring results are weighted according to their relevance and reliability and the strength of their associations with environmental pressures. According to this approach results based on low sampling frequency/replication and/or representing only a small proportion of the water body, as well as results having no credible associations with anthropogenic pressures, may be given lower weights in the final classification. By the same token, representative, comprehensive data with credible associations to pressures may be given a higher weight.

In conclusion, the review indicates that there are differences among Member States' approaches used for combining results in classification systems and that this will produce different classification final results across Europe. Although the development of ecological assessment and classification systems represents an important and crucial part of the implementation of the WFD, it appears that this process has not been applied in a consistent way by many Member States. In comparison, most of the attention has been concentrated on the developing of classification methods focused on just one or a few quality elements, with an extensive production and development of metrics and indices at element level.

WP6.3: Comparison of assessment methods across water categories

*Contractors involved: **SLU**, UDE, CSIC, ALTERRA*

Summary of progress towards objectives and details for each task

The majority of tasks in workpackage 6.3 are planned for the second half of the project, since it is primarily based on existing and new data (from the field campaigns) from other workpackages in Modules 3–5. This data is now available and workpackage 6.3 has made good progress with the study on the response signatures of different taxonomic groups from different habitats/water bodies to anthropogenic stress. The collation of data and the database structure have been provided by the central project database (workpackage 2.1: lakes and transitional/coastal waters) and by the workpackage 5.1 database (rivers only). A preliminary perusal of the database has been done. Data extraction for pilot analyses is planned for the second half of the project and is currently being conducted. The work on comparing response signatures of different BQEs within and across water bodies has progressed as planned.

Conceptual models of BQE's response to different stressors and their reduction, and how stress-response-recovery relationships vary between habitats within water bodies and among water bodies were discussed during two workshops (Wageningen 2009, Debe, 2010) and an electronic discussion. The workshops also addressed the analytical (statistical) approaches, namely regression and ordination.

Publications

No publications.

Notable findings and results

For workpackage 6.3 we have developed a conceptual model (Figure 6.3-1) which emphasizes community dynamics/assembly in different aquatic ecosystem types from a landscape perspective. Briefly, the blue box in the model "sets the stage" and emphasizes environmental gradients (often those associated with one or different forms of anthropogenic stress) and spatial gradients (location of the aquatic ecosystems in the landscape), which mediates among-site connectivity. These connections can either be "direct" (e.g. hydrological connectivity) or "indirect" (biotic connectivity through migration/dispersal). Depending on how well organisms are equipped for migration/dispersal, the red box in the model shows how meta-community dynamics (i.e. interaction of local communities across sites) may work.

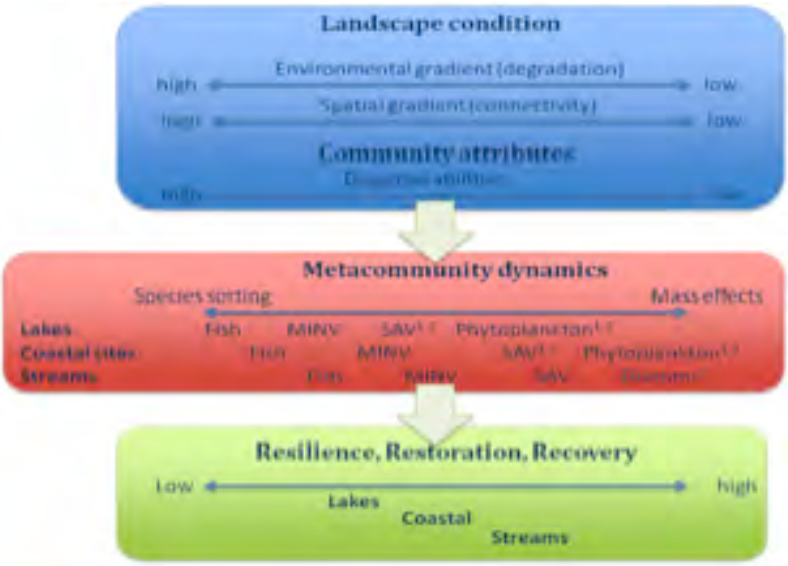


Figure 6.3-1: Conceptual model on metacommunity dynamics of different BQEs across aquatic ecosystem types as a function of landscape characteristics. Abbreviations: MINV, benthic macroinvertebrates; SAV (submerged

aquatic vegetation); 1, colonization through emergence from seed banks; 2, colonization through interhabitat/ecosystem dispersal. For further details see text.

The red box emphasizes community dynamics along a gradient where on the one side combined dispersal/migration and local environmental filtering (i.e. mass effects) or only environmental filtering (species sorting) take place. The model is based on the assumption that planktonic organisms (chiefly phytoplankton as a study object in this WP) and SAV (submerged aquatic vegetation) are more readily dispersed passively (e.g. wind, floods, birds) than larger organisms which have either good flying or swimming capacity (macroinvertebrates, fish). As a result, in all three ecosystem types (lakes, streams and coastal areas), phytoplankton and SAV are expected to follow more mass-effects meta-community models, while fish and macroinvertebrates are expected to follow the species-sorting model.

As a corollary, the model also emphasizes potential consequences for ecosystem resilience (”withstanding stress(ors)”) or restoration (”responding to interventions to counteract these stress(ors)”), thereby showing links to workpackage 6.4. Given that lakes are physically ”more isolated” landscape units, the model assumes that lakes, and their ecosystem services that derive from emergent community functions, may be less resilient to stress, simply because selected key organisms can not readily disperse between these ecosystems compared with hydrologically connected rivers and coastal sites.

WP6.4: Comparison of recovery processes between water categories

Contractors involved: ***ALTERRA****, NERC, SLU, EC-JRC, UCL*

Summary of progress towards objectives and details for each task

To reach the objectives of workpackage 6.4, a review of existing and suitable data sources has been conducted (Table 6.4-1). These data will be used to achieve the following objectives:

Objective 1: Analysis and comparison of processes and functional features of recovery from eutrophication, acidification or hydromorphological stress between water categories for four organism groups. ALTERRA collected all available BQE data and all physico-chemical and other environmental data for the case study catchment Vecht. A first analysis by using multivariate analysis failed, and a new concept is being drafted whereby a larger, aggregated-scale approach is foreseen. Historical and current land use is derived from GIS and will provide additional parameters for further analysis. Data on 10 Dutch restoration cases (control/impact studies) has been compiled. ALTERRA did a literature survey on the metapopulation dynamics, dispersal, and connectivity issues related to restoration success, which constitutes Deliverable D6.4-1.

UCL analysed 20 years of data from the UK Acid Waters Monitoring Network. This is being undertaken to assess the recovery trajectory of several BQEs (macro-invertebrates, macrophytes, diatoms and fish) in response to chemical recovery from acidification. The work will i) compare the biological response of the different BQEs and examine whether the biology is responding in a coherent fashion, ii) assess the nature of the response in stream and lake systems, iii) Examine whether the response to reductions in the emission and deposition of acidifying compounds are confounded by other factors and stresses.

SLU reanalyzed long-term monitoring data from four acidified and four non-acidified reference lakes to determine recovery patterns. Special focus was on comparing and contrasting organisms with putative high (pelagic phytoplankton) and low (littoral invertebrate assemblages) recovery potential. In addition, we analyzed climate data (e.g. NAO winter index) to assess the importance of interannual variability in confounding recovery.

Table 6.4-1: Existing data sources on restoration/management effects to be used in workpackage 6.4 (IN = benthic invertebrates, MP = macrophytes, AL = algae, FI = fishes, ZP = zooplankton).

	data source (n)	stressor-recovery	organism group	partner
rivers	5.1 (70)	hydromorphology	IN,MP, AL, FI, RV, GB	Alterra, UDE
	UK (11)	acidification	AL, IN, MP, FI (1sp)	UCL
	UK (1 time 40yrs)	eutrophication	IN	NERC
lakes	UK (11)	acidification	AL, IN, MP, FI	UCL, SLU
	UK (1)	eutrophication	AL, IN (lit+pro), MP, FI (in), ZP	NERC
	EU (35+7?)	eutrophication	AL, MP, FI	NERC
	S (110:30-35)	acidification, liming, reference	AL, FI, IN, MP	SLU

Objective 2: The detection of antagonistic, neutral, additive or synergistic nature of the impact of multiple stressors between water categories. This objective will be dealt with at a later stage of the project, when different individual water category data have been analysed and reported according to our common analysis structure.

Objective 3: The recognition of commonalities among different recovery processes between water categories. ALTERRA, together with UDE, organised and hosted a combined Module 5/6 workshop on Driver-Pressure-State-Impact-Response-Recovery chains; ALTERRA compiled about 100 peer-reviewed references on the effects of remeandering of lowland streams.

Objective 4: The development of a method to combine recovery effects in a summarising ‘catchment’ metric. Together with UDE, ALTERRA drafted a framework for the final WP5.1/WP6.4 synthesis and discussed this during the midterm meeting in Poland with all partners.

Publications

- Johnson R.K. and D.G. Angeler. 2010. Tracing recovery under changing climate: response of phytoplankton and invertebrate assemblages to decreased acidification. Journal of North American Benthological Society, in press.

Notable findings and results

Meta-populations are defined as a group of spatially delimited con-specific populations existing in a balance between extinction and recolonisation (Levin 1970), and spatially linked by dispersal (Hastings and Harrison 1994). The influence of biological factors such as dispersal, connectivity and meta-population dynamics on recovery processes was reviewed. The number of available titles is shown in Figure 6.4-1. In summary, five major restoration constraints can be derived from the literature:

- the effects of barriers (e.g., weirs, dams) on colonization and establishment,
- the introduction of non-native species that may outcompete or otherwise affect recolonisation by native species,
- considerations of scale in restoration projects, for instance, small-scale restoration in large-scale degraded systems,
- accumulation effects and
- aspects of objectives and monitoring (e.g., no clear definition of restoration targets and missing monitoring concepts to evaluate success and failure of restoration).

The knowledge on meta-populations and restoration constraints were combined to a biological Driver-Pressure-State-Impact-Response-Recovery chain (Figure 6.4-2). In conclusion, although the importance of establishing a suitable “abiotic environment” following restoration, it is emphasised by multiple studies, that other factors (see bullets above) should be considered in addition.

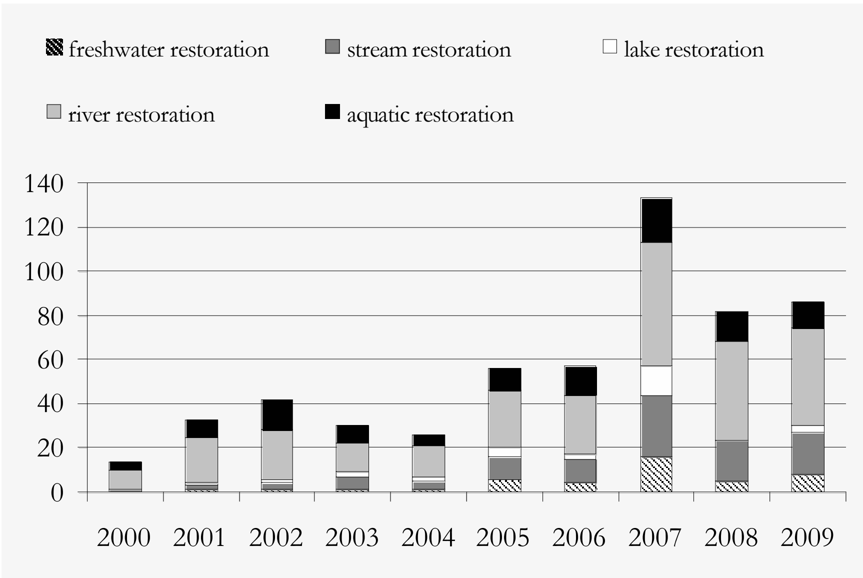


Figure 6.4-1: Number of papers (search ISI Web of Science 2000–2009), specifying the search terms: dispersal, connectivity, metapopulation dynamics.

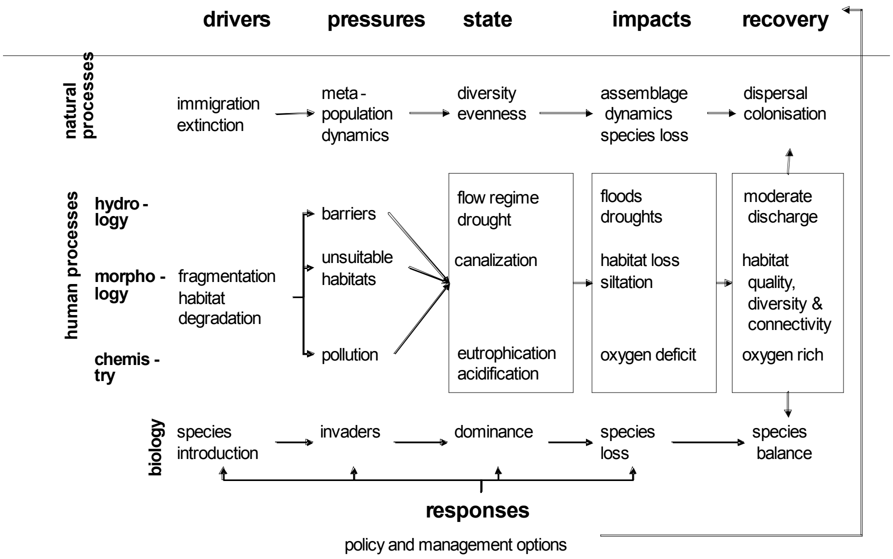


Figure 6.4-2: Conceptual framework of biology, and natural and human processes along the Driver-Pressure-State-Impact-Response-Recovery chain.

Module 7 Dissemination

Large international projects, such as WISER, often experience challenges with internal and external communication, with the availability and consistency of existing data, and with analytical approaches, all of which can jeopardise the success of individual workpackages or entire modules. Therefore, Module 7 developed and provided a series of web-based tools and documents to assist the dissemination of information within and outside the consortium. Much of the communication and document exchange takes place via an internal communication and dissemination platform, the Intranet. Altogether, ~250 consortium members, GIG representatives and other end users have registered to gain access to the Intranet. External communication is organised through regular meetings and workshops with end users, and through the frequent dissemination of information through the project website and through newsletters, the latter of which specifically target non-scientists. The scientific community is frequently being informed and updated about WISER on meetings, conferences, symposia and workshops.

WP7.1: Internal and external information sharing

*Contractors involved: **BOKU**, UDE, EC-JRC*

Summary of progress towards objectives and details for each task

Objectives 1, 2: To provide information on the project to WISER partners and end users as well as to offer tools for storage and facilitating exchange and share of information the following tools and documents were established for internal and external use:

Internal:

- Contact lists and email accounts: To facilitate the internal communication flow contact lists with all members of the different modules and workpackages were established as well as specifically dedicated WISER email-accounts (e.g. WP7.1@wiser.eu).
- Templates: To standardise and harmonise the layout and therefore to support the corporate identity of the project templates for PowerPoint presentations but also for reports and deliverables were designed.
- Intranet: To guarantee a simple and thus effective data flow as well as to provide a data exchange and storage facility an intranet for WISER partners was set up using the open source collaboration platform Feng Office.
- Video conference tool: To save travel costs and unnecessary CO_2 emission a simple but powerful video conference tool was offered to partners (Adobe Connect).
- Internal newsletter: To inform partners about ongoing activities apart from those mentioned on the webpage an internal newsletter is distributed periodically.

External:

- Website: To inform the scientific community, stakeholders, policy makers as well as the general public and the outside world about WISER, a state-of-the-art webpage was established right at the beginning of the project including relevant information on the aims, the partners and the progress of the project. The design of a WISER logo helped to increase the recognition value of the project within the worldwide web. The webpage is regularly updated.
- Flyer: To give WISER partners the opportunity to distribute a short summary of the project to other interested scientists in either printed or virtual way an information flyer was designed, which is downloadable from the website (www.wiser.eu/news/flyer/).
- Poster: To present WISER and spread its ideas to a broader scientific community at conferences and meetings a poster about the project's aims and approaches was created.
- Newsletter: To inform about the progress of the project a WISER newsletter was set up, which is now being circulated twice a year to interested individuals and groups. The newsletters can also be downloaded from the website (www.wiser.eu/news/newsletter/).

- End user involvement: To guarantee that the methods developed within WISER leave the scientific circle and reach the final users, stakeholders and other end users were invited to cooperate with the WISER consortium and to help achieving the needed goals.

Objectives 3, 4, 5: Regarding the task to disseminate and make available the project databases for project partners a first roadmap and a way forward was established including both the WISER meta-database and the central database in close collaboration with workpackage 2.1. All reports, publications and other results are frequently made available via the WISER website (public information) or via the Intranet (information restricted to the consortium and end users).

As to getting feedback from relevant end users and stakeholders, such parties were invited to work together with the WISER consortium and to help ensure the applicability and practicability of project results. Stakeholders and end user are invited to different kinds of WISER meetings and invited to discuss progress and results.

Publications

Not applicable.

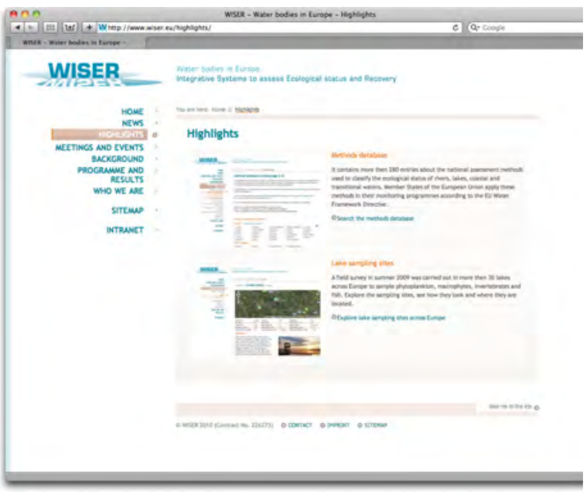
Notable findings and results

In times of increasing information flood via new media it is especially important to filter the relevant content of a comprehensive project like WISER and to present it attractively to all targeted groups (experts, end users, general public). Two important dissemination and communication strategies to facilitate the transmission of all kind of information are highlighted below:

The website provides information on the following subjects:

- News
- Highlights
- Meetings and events
- Background
- Programme and results
- Who we are
- Intranet

The website information addresses both scientific community and end users (stakeholder, policy makers). The section on the sampling campaigns in Modules 3 and 4 is being linked to Google map and provides a map on the location of all stations (lakes, transitional/coastal waters), a picture and selected environmental conditions of all stations (Figure 7.1-1, bottom right).



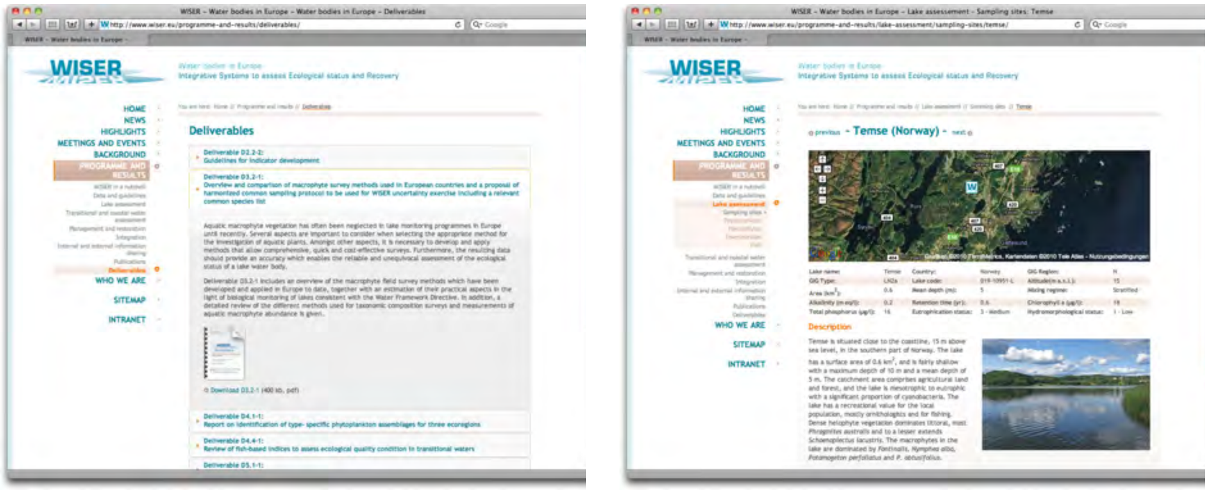


Figure 7.1-1: Screenshots of the WISER website.

The number of visitors of the project website is constantly growing, starting with <1,000 in the initial phase and reaching nearly 5000 visits per month at present (Figure 7.1-2). Most visitors are located in Europe, but there are numerous visits by people outside Europe, for instance, in India, Canada, USA, Russian Federation, Australia, Japan and China.

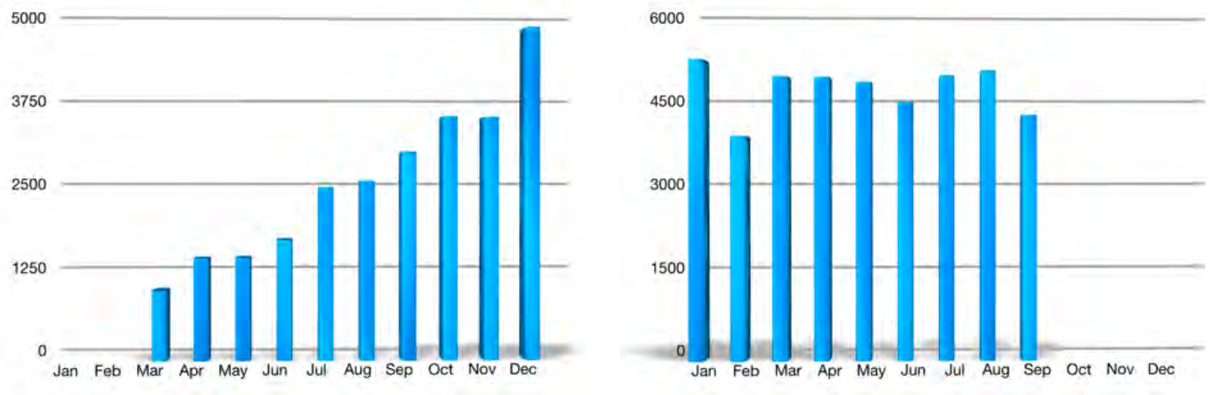


Figure 7.1-2: Number of visitors of the WISER website in 2009 (left) and 2010 so far (right).

Three project newsletters have been launched during the reporting period and are being available via the website; each issue has been downloaded by several hundreds of interested people. The newsletters have been acknowledged as useful to spread the latest news on WISER in a concise and generally understandable format.

WP7.2: Final conference

*Contractors involved: **EMU**, EC-JRC, SYKE, BOKU*

Summary of progress towards objectives and details for each task

The only task in this workpackage is to organise the WISER Final Conference. The activities started in May 2010. The conference logistics have been prepared, and the venue has been fixed in consultation with the WISER steering group. The first announcement of the conference was launched online on the project website in August 2010, which also constituted part of Deliverable D7.2-1) (http://www.wiser.eu/meetings-and-events/final-conference/). The WISER Final Conference will take place from 23–26 January 2012 in Tallinn, Estonia.

The Final Conference aims at providing a platform to present the applicability of the WISER project outcome. The focus will be on a science-policy interface with specific sessions for in-depth scientific presentations and hands-on sessions for the end users.

A scientific committee will be established in October 2010 to draft the agenda, to propose keynotes and keynote speakers and to discuss the preparation of conference proceedings. The second announcement and call for papers is planned for February 2011.

Publications

Not applicable.

Notable findings and results

Not applicable.