Revised manuals of pre-existing manuals
and
Manual with new harmonized methods

(Manual of harmonised methods for environmental indicators across different ecosystems)

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	NOTE: The deliverables I. and II. have been merged to one document, as the pre-existing manuals are the basis for the harmonization of methods. Thus the merge is an added value for the deliverable itself, as the separate treatment would create a lot of redundancies.
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Creation date	15/12/2011
Date of last revision	12/01/2012
Subject	
Status	☐ Draft ☒ Final
Publisher	EnvEurope project
Type	Text
Description	The present manual is a result of expert knowledge of EnvEurope partners / LTER-Europe community and the analysis of pre-existing manuals developed by various indicator initiatives. It comprises a composition of fact sheets of environmental indicators for terrestrial, river, lake and marine ecosystems. The fact sheets are based on the ecological integrity concept.
Contributor	EnvEurope partners, EXPEER partners, LTER-Europe members
Revised by	Mark Frenzel (UFZ)
Format	Doc
Source	
Rights	☐ Restricted ☒ Public
Identifier	PD_A2.1.2ab_Frenzel_et_al-ManualRevisedNewMethods-Rev1_1.docx / pdf
Language	En
Relation	
Coverage	Project duration

These are Dublin Core metadata elements. See for more details and examples http://www.dublincore.org/

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Version	Date	Author	Task
1.0	2011-12-15	Frenzel	Text and mail merge of table contents to text document
1.1	2012-01-12	Frenzel	Adjustments; completion of text; formatting

Content

1   Introduction

Why to create another manual of manuals for ecosystem-related research and monitoring? We would like to emphasize that the separation between the research and monitoring communities is often artificial, as data gained by monitoring are often the base for research on long term time series. Furthermore, ecosystem research often develops methods that, later on, are taken up in ecosystem monitoring. Thus in our understanding, beside the long-term research, the monitoring aspect is always included in the Long Term Ecosystem Research (LTER) background. The idea for this kind of compendium was born within the LTER-Europe (http://www.lter-europe.net/) community and may be of relevance to all networks which need to ensure comparability of data and therefore have to agree on common standards to exploit the added value of networking. Since the foundation of LTER-Europe there was a demand for standardised parameters and harmonised methods which should be applied throughout all LTER-Europe sites, but indeed this concerns in general all sites dealing with aspects of ecosystem research. The willingness to work on these issues was manifested in 2008 by the establishment of an expert panel "Standardisation and Harmonisation" within the LTER-Europe network, which recently merged with the expert panel "Technology" to form the panel on "Standardisation and Technology" (http://www.lter-europe.net/ep/ep-std). The starting ground for this expert panel was already prepared by the network of excellence ALTER-Net (A Long-Term Biodiversity, Ecosystem and Awareness Research Network; http://www.alter-net.info/). In 2010 this task has been essentially boosted by the Life+ project EnvEurope (http://www.enveurope.eu/) focusing on the assessment of environmental quality and pressures across Europe making use of the LTER network as an integrated and shared system for ecosystem monitoring.

At this time, LTER-Europe covers more than 300 sites throughout Europe (67 of which are included in EnvEurope). The single LTER-Europe sites have been established for different reasons. Many of those established on terrestrial systems have joined the LTER network coming from the International Cooperative Programmes Integrated Monitoring (ICP IM) and ICP Forest, focusing on the impact of air pollution on ecosystems. These sites are often operated since at least one decade, measuring numerous parameters following well elaborated protocols. Some of them are highly instrumented, even beyond the needs from the ICP monitoring programmes. Other LTER-Europe sites developed from more specific research questions and projects run by their responsible institutions. These sites often provide more heterogeneous data and time series of different lengths but sometimes focus on very relevant research issues (e.g. climate change impacts on ecosystems). Both type of sites can benefit by entering a common network (e.g. LTER), bringing specific approaches for a fruitful integration. Furthermore, LTER sites are also quite heterogeneous in terms of the investigated ecosystem (terrestrial, freshwater and marine environments), size (plot to landscape scale), complexity (more ecosystems included, social scale considered), infrastructure, instrumentation, staff resources and long-term funding. This heterogeneity, on one side may limit the generation and use of data-sets suitable for cross-site analysis which is one of the basic aims of the LTER network while, on the other side, can offer material for analysis of ecological processes in different eco-domains.

Hence the need for common sets of parameters and methods is obvious, although we are aware of a possible low level of commitment to implement these sets at individual sites, due to the lack of available supporting central funding within the network. For that reason the first intended classification of mandatory and optional parameters (and related methods) was changed to a recommendation of first and second level indicators / parameters. In the process of dealing with this issue in an iterative and participative way by including the ecosystem research community, we realized that several goals had to be modified to meet the needs of the "practitioners" which are in most cases the site managers; as an example, people may not be willing to switch to different methods if they are expected to continue producing time series of comparable data for reporting duties. Therefore we propose rather to develop and agree on data standards like frequency, accuracy

and spatial scale of parameter measurements than to elaborate new methods. This approach was stimulated by the data product descriptions scheme developed for the National Ecological Observatory Network (US) –NEON (http://www.neoninc.org/) which will enter its construction phase in 2013.

Thus harmonisation of methods is interpreted in the sense of this manual as the setting of data properties of parameters enabling for comparison of data sets with the aim of joint analysis. At the same time, the used methods need to be reported and should be chosen among methods proposed by existing networks or projects (i.e. accepted at "large scale"), methods generally used by the relevant scientific community and in the interested ecosystem and/or methods already published (i.e. peer reviewed).

Parallel to the bottom-up process of selecting suitable parameters and methods that are commonly applied, represent the state of the art and ensure comparability of the data, an overarching concept was chosen that ties these data together. The selected conceptual framework of Ecological Integrity is described in chapter 4. In this integrated approach, many indicators will be a novel concept for many sites, since only few sites will deal with an observation of ecosystems based on the ecological integrity framework.

Starting to work on this task we did not realize the dimension of the product, because it was intended to comprehensively cover research and monitoring at LTER sites. At the same time, we were not looking to "reinvent the wheel" and we were ready to consider taking on board already established and accepted methods in the different eco-domains. Furthermore, we did not foresee the related conceptual work, the challenging task of motivating people to contribute and the implication of dealing with terrestrial, river, lake and marine systems. Hence it turned out to be quite demanding in terms of knowledge that had and still has to be collected. Thus this manual is intended to be a "living document" which means that the present version is the "final" starting point and that we are looking forward to filling the remaining empty cells or change entries after being analysed through expert knowledge from the ecosystem research community. Considering this, it is evident that this manual will need regular updates to incorporate new approaches and methods and will be subjected to continuous review in order to be at pace with the developments in Long Term Ecosystem Research and monitoring.

2   Definitions

Especially often used terms should be defined unambiguously to safeguard a common understanding. Therefore we provide the following definitions:

Index: A complex measure based on several parameters and / or calculations (e.g. Shannon index). Indices are often used as indicators too.

Indicator: A proxy for several ecosystem aspects. Individual indicators are designed to translate complex information in a concise and easily understandable manner in order to represent a particular phenomenon (e.g. biodiversity). It quantifies e.g. the magnitude of stress, habitat characteristics, degree of exposure to stressors or of ecological response. Indicators may be simple (e.g. just one indicator species) or complex (e.g. habitat connectivity) and, sometimes, can be equal to a parameter.

Manual: A user guide which is a technical communication document intended to give assistance to people using particular methods.

Method: A method of procedure consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses. Methods are the key to interpretation, reliability and evaluation of results and the way allowing other people to repeat and reproduce results. Compared to a protocol it is less detailed.

Monitoring: "Monitoring is an intermittent (regular or irregular) series of observations in time, carried out to show the extent of compliance with a formulated standard or degree of deviation from an expected norm." (after Hellawell 1991, modified by Brown 2000)

"Monitoring in the sense used here, is distinct from surveillance, which is repeated survey using a standard methodology undertaken to provide a series of observations over time. Surveillance can yield valuable information on trends in the state of biodiversity and Earth science, but does not by itself establish whether objectives or standards have been met. Information derived from surveillance may be used to inform judgements on the condition of features on sites." (Joint Nature Conservation Committee)

Observation: Any "measurement" by human sense impressions (subjective, qualitative) or by use of technical devices, e.g. sensors, measuring tape, satellite image (objective, quantitative). Quantitative measurements reduce an observation to a number which can be recorded.

Parameter: Same meaning as "variable", "the measured item". Parameters will often be identical with the indicator itself, but not every indicator is identical with the parameter assigned to it.

Protocol: A predefined written procedural method in the design and implementation of technical sequences in experiments and observations. They are used whenever it is desirable to standardise a laboratory or field method to ensure successful replication of results by others.

3   Related approaches

Being aware of the work done about identification of environmental indicators we did not intend to start from scratch, but it is important to know that the indicator sets mentioned below have been developed for specific purposes. The following list of "indicator initiatives" is extracted from the report "Conceptual framework for indicator assignment and selection for LTER-sites" which is available as download at the LTER-Europe website (http://www.lter-europe.net/ep/ep-std).

Examples on indicator initiatives for biodiversity:

- Streamlining European 2010 Biodiversity Indicators (SEBI 2010)

- Group on Earth Observations Biodiversity Observation Network (GEO BON)

- Living Planet Index (LPI)

- Species Trend Index (STI)

- National Biodiversity Index (NBI)

- Red Lists

- Biomare

Examples on initiatives for integrative environmental indicators:

- Sustainability indicators (EU)

- EEA core set of environmental indicators

- OECD key environmental indicators

- TEEB (The Economics of Ecosystem and Biodiversity)

- Natural Capital Index (NCI)

- HANPP (Human appropriation of net primary productivity)

- Critical Load Exceedence Index (CLE)

- Connectivity Indices

- Corine Land Cover (CLC)

- National Ecological Observatory Network (US) –NEON

Compared to the approach taken in EnvEurope, the above mentioned initiatives are not aimed at getting an holistic view on ecosystems, but on particular aspects like halting biodiversity loss and relevance for policy (SEBI 2010; http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2010:1165:FIN:EN:PDF) or focusing at policy-relevant indicators giving answers to selected priority policy questions (EEA core set of indicators 2004; http://www.eea.europa.eu/data-and-maps/indicators/freight-transport-demand/eea-core-set-of-indicators-csi).

4 The conceptual framework: Ecological Integrity

Why is it advisable to develop and tune a conceptual framework for the specific needs of ecosystem research? The first important reason is that there is no such concept developed and agreed within the LTER community, which opens the opportunity to assign each measured parameter to a conceptual framework that takes into consideration all aspects of ecosystems. Another important argument is that any indicator selection has to be defensible by explaining why a specific set of indicators and parameters set is chosen for monitoring. In the EnvEurope project this framework has been developed by Benjamin Burkhard & Felix Mueller (University Kiel, 2011) on the base of the ecological integrity concept. Having this generic framework at hand was regarded as a considerable progress by the LTER community. The detailed report "Conceptual framework for indicator assignment and selection for LTER-sites" is available at http://www.lter-europe.net/ep/ep-std.

Briefly, the idea of ecological integrity is based on the guiding principle for precaution against unspecific ecological risks in the framework of sustainable development. Its aim is to safeguard relevant ecosystem services and preserve the capability to continue self-organized development of systems and services. The self-organizing capacity of ecosystems describes (a) their ability to develop towards a higher degree of self-organization, which is characterized by more complex structures, or (2) to adapt to changing external conditions by keeping the current degree of self-organization. Thus, the result of self-organizing processes in ecosystems is the build-up and the maintenance of complex structures.

Table 1 shows the main components of the ecological integrity concept, starting from the structural components describing biotic diversity and abiotic heterogeneity and considering also, as well as processes (input, output, storage) related to the energy, matter and water balances. While the structural components describe mainly the state of the system (that can react to pressures, e.g. land use), the process components are directly reflecting states, changes and pressures (e.g. nitrogen input). If there would be one "ideal" quantifiable indicator for each of the higher level of ecological integrity indicators (Table 1, right column), we will end up with 19 indicators for characterisation of an ecosystem. However, this number easily increases two- or three fold since often several indicators (e.g. bird, butterfly diversity) are necessary to feed in the information for a higher level indicator (e.g. fauna diversity).

The fact sheets of the indicators are basically structured according to the scheme of ecological integrity.

Table 1: The components and basic indicators of Ecological Integrity. Note that the expert work starts with identifying the concrete lower indicators to be measured pointing at the higher ecological integrity indictors.

Components I	Components II	Ecological integrity indicators
ECOSYSTEM STRUCTURES		
	Biotic diversity	Flora diversity
		Fauna diversity
		Within habitat structure
		Additional variables when indicated
	Abiotic heterogeneity	Soil
		Water
		Air
		Habitat
		Additional variables when indicated
ECOSYSTEM PROCESSES		
	Energy budget	Input
		Storage
		Output
		Other state variables when indicated
		Efficiency measures
	Matter budget	Input
		Storage
		Output
		Other state variables when indicated
		Efficiency measures
	Water budget	Input
		Storage
		Output
		Other state variables when indicated
		Efficiency measures

5   The process of indicator selection

The process was guided by

(1) assignment of indicators to the conceptual framework of ecological integrity,

(2) including as much expert knowledge as possible and

(3) applying a participative, bottom-up approach which aims at including the LTER community and especially the site managers who are intended as the end users of selected indicator sets.

The main steps towards this target were several EnvEurope workshops (Halle 2010, Budapest 2011, Rome 2011, Bucharest 2011) with group working dedicated to this issue and furthermore by demanding email requests to EnvEurope and EXPEER partners to amend and contribute to a continuously increasing table of indicators, parameters and a lot of descriptive characteristics.

The first prioritisation of the best indicators targeting at the higher ecological integrity indicators was done by "acclamation" and group discussion based on expert experience and knowledge. The next step has to go back to the basic criteria for indicator selection. They need to be

- biologically relevant (maintaining balanced communities)

- providing univocal information

- broadly applicable to many sites and stressors

- Integrative (biotic indicators)

- interpretable: distinguishing "good from bad" states

- and last but not least cost-effective: maximum information per unit effort

The review of the indicators presented in the fact sheets of this manual will be an iterative process which again needs to be done with the support of the LTER community.

Of course the importance or applicability of several indicators will be habitat-specific which again will increase their numbers. Just imagine the differences in the approaches for forests or semi-dry grasslands or deserts. Some basic or core indicators will be the same, but there will be specific sets important for a certain habitat only.

For the final "distillation" of all indicators down to a manageable set the fruitful combinations of certain parameters creating most added value will be considered. This supports strongly the criterion of cost-effectiveness. An example for the added value of the combination of certain parameters is bird species richness + habitat mapping + richness of vascular plants.

6 Data characteristics

The data characteristics are the backbone of the indicator fact sheets. All information about an indicator and / or parameter is considered as "Data" in this context. This approach of characterizing indicators is chosen in order to create a matrix for comparison and comparability of indicators and the data generated by the methods related to them. The comparability of data is often related to certain basic features like frequency of measurements, spatial scale covered etc. Method references are separated according to national / international use. Only those references described in English and applied at an international level (or intended to become a kind of international standard) are recommended for LTER-Europe-wide use.

List of data characteristics:

- **Indicator name**

- **Explicit parameters**: in case that the indicator is not the same as the parameter. In most cases the parameter will be the item to be measured.

- **Important related indices** – related to the described parameter (e.g. species richness; a related index is Shannon diversity)

- **Property: Frequency**   - of measurements

- **Property: Time scale (incl. seasonality), temporal resolution** – time of the season when measurements should be performed, accuracy of temporal resolution (e.g. seconds, minutes, hours)

- **Property: Basic spatial scale** – spatial scale (plot size up to landscape) of measurement

- **Property: Base Units** – recommended units, e.g. m, mm, mmol

- **Mandatory meta data** – to characterize the parameter and the method

- **Method applied (key words)** – short method characterization

- **Method references** (specific to sites, not internationally applied) – actually not widely approved within LTER, mostly only in national language available

- **Method references** (established, internationally applied) – elaborated and proved methods, available in English

Not included yet:

- **Method used by international networks** - names of networks applying this method

- **Parameter used by modelling community** - important to increase synergies between field measurements and modellers

- **SITES using this method** (list) - site identifiers or site names; important for knowledge exchange about exact protocols and popularity of a method

7   References

NOTE: This section still needs to be completed, as all the references mentioned in the fact sheets have to be listed here! This is scheduled for the next version of the manual.

Brown, A. (2000): Habitat Monitoring for Conservation Management and Reporting. 3: Technical Guide. Life-Nature Project no LIFE95 NAT/UK/000821. Integrating monitoring with management planning: a demonstration of good practice in Wales: Countryside Council for Wales, Bangor

Burkhard, B. & F. Mueller (2011): Conceptual framework for indicator assignment and selection for LTER-sites - http://www.lter-europe.net/ep/ep-std

EEA (2004): European Environment Agency Core Set of Indicators - http://www.eea.europa.eu/data-and-maps/indicators/freight-transport-demand/eea-core-set-of-indicators-csi

Hellawell, J.M. (1991): Development of a Rationale for Monitoring. – In: Goldsmith, F.B. (ed): Monitoring for Conservation and Ecology. – London (Chapman and Hall) *p 1-14*

Joint Nature Conservation Committee: www.jncc.defra.gov.uk/page-2268

SEBI (2010): Streamlining European 2010 Biodiversity Indicators - http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2010:1165:FIN:EN:PDF

8   Fact sheets: Recommendations for Indicators and Parameters

The following section provides the list of fact sheets for each indicator which was proposed to be important and representative for the target ecological integrity indicators listed in table 1.

Each indicator fact sheet extracts basic information from the even more comprehensive worksheets for the different ecosystems. The information preceding each fact sheet including the heading is intended to assign an indicator to

1. the base components of Ecological Integrity: **Ecosystem Structures** or **Ecosystem Processes**

2. the following components of Ecological Integrity: **Biotic Diversity** and **Abiotic Heterogeneity**; **Energy, Matter, Water** and **Budget**

3. the (higher) ecological indicator (e.g. **Flora Diversity**)

Fact sheets are organized in two columns standing for two levels of indicators:

- The 1st level indicators are given highest priority in terms of importance, feasibility, and cost-efficiency. Mostly these will be more simple to be measured than 2nd level indicators.

- The 2nd level indicators are often supporting the 1st level indicators in a way that they aim at a similar subject, but are more demanding to be measured than 1st level indicators. E.g., a 1st level indicator could focus at species list of breeding birds, while the 2nd level indicator includes abundance of each species too. However, 2nd level indicators may be different in terms of the subject compared to 1st level indicators

8.1   Terrestrial Systems

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.1   **Flora Diversity ⇨ 1ˢᵗ level: Species and functional diversity / 2ⁿᵈ level: Diversity of rare and endangered species**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Species and functional diversity	**Indicator**: Diversity of rare and endangered species
Parameter: Full Species list (vascular plants mandatory, mosses, lichens), coverage in %/ no. of individuals (frequency)	**Parameter**: Selected Species, coverage in %/ no. of individuals (frequency); Focal vascular plants (eg. sensitive to climate and land use change - anthropogenic effects, Habitat Directive; rare species)

Important related indices

Shannon, Simpson, Eveness, species turn-over, rarefaction curves, phylogenetic diversity	Shannon rarity index population size

Property: Frequency

Annual/periodic - able to be related to single year as basic unit	Annual/periodic - able to be related to single year as basic unit

Property: Time scale (incl. seasonality), temporal resolution

Depending on the community. More than once a year if necessary but generally all species occurring per year should be recorded.	To characterise community annually (more than once per year if necessary)

Property: Basic spatial scale

Stratified random sampling - independent plots representative for the site and/or the habitats within the sites; at least 10 replicats; minimum standard sample unit 1x1m	Plot (representative for the site)

Property: Base Units

Species number, percentage cover, frequency (no. of individuals)	Percentage cover, frequency (no. of individuals)

Mandatory meta data

Survey date, location (XY coordinates), plot/area size, frequency of observations, biotope discription, method reference, design of sampling	Survey date, location, plot/area size, frequency of observations, biotope discription, method reference, selection procedure

Method applied (key words)

Large plots: vegetation relevés compatible to Braun-Blanquet, e.g. 5 x 5m in open habitat types, 10 x 10m in woody habitat types or transects (at least 20m long) with application of point intercept method; small plots (e.g. 1x1m): point frame method or simple frame method	Vegetation relevés compatible to Braun-Blanquet, plot random sampling; censuses (number of individuals)

Method references: specific to sites, not internationally applied

Espelta et al. (2008). Ecology, 89: 805-817;	Espelta et al. (2008). Ecology, 89: 805-817;
Matuszkiewicz, W. (2001);	Matuszkiewicz, W. (2001);
Ostrowska et al. (1991);	Ostrowska et al. (1991);
Petriccione (2005). Acta Botanica Gallica 152: 545-561;	Petriccione (2005). Acta Botanica Gallica 152: 545-561;
Rossi et al. (2006). Biodiversity and Conservation 15: 3881-3893;	Rossi et al. (2006). Biodiversity and Conservation 15: 3881-3893;
Rossi et al. (2009). Plant Biosystems 143: 104-113;	Rossi et al. (2009). Plant Biosystems 143: 104-113;
Sparks et al. (2009): Advancing phenology in Europe's last lowland primeval forest: non-linear temperature response. Climate Research, 39: 221-226.;	Sparks et al. (2009): Advancing phenology in Europe's last lowland primeval forest: non-linear temperature response. Climate Research, 39: 221-226.;
Stanisci et al. (2005). Biodiversity and Conservation 14: 1301-1318;	Stanisci et al. (2005). Biodiversity and Conservation 14: 1301-1318;
Stanisci et al. (2010). Plant Ecology 212: 595-600;	Stanisci et al. (2010). Plant Ecology 212: 595-600;
http://icts.ebd.csic.es/CambiarIdiomaAction.do;jsessionid=DC4D0AC18742FC6CC3A2740B92181DD2.icts_A?idioma=ingles;	http://icts.ebd.csic.es/CambiarIdiomaAction.do;jsessionid=DC4D0AC18742FC6CC3A2740B92181DD2.icts_A?idioma=ingles;
https://spreadsheets.google.com/embeddedform?formkey=dDNJMWR3LVFaclRLRC1HY256QVlGb0E6MQ;	https://spreadsheets.google.com/embeddedform?formkey=dDNJMWR3LVFaclRLRC1HY256QVlGb0E6MQ;
http://observatoriosierranevada.iecolab.es/index.php/Flora	http://observatoriosierranevada.iecolab.es/index.php/Flora

Method references: established, internationally applied

ICP IM Manual => http://www.ymparisto.fi/default.asp?node=6329&lan=en ;	ICP IM Manual => http://www.ymparisto.fi/default.asp?node=6329&lan=en ;
ICP Forest => http://icp-forests.net/page/icp-	ICP Forest => http://icp-forests.net/page/icp-

forests-manual;	forests-manual;
GLORIA => http://www.gloria.ac.at/;	GLORIA => http://www.gloria.ac.at/;
http://www.forestbiota.org/docs/report_GV.pdf; population trends=>	http://www.forestbiota.org/docs/report_GV.pdf ; population trends=>
http://www.sinauer.com/detail.php?id=5460#or%28s%29;	http://www.sinauer.com/detail.php?id=5460#or%28s%29;
Functional dviersity: Petchey, O. L., E. O'Gorman, et al. (2009). A functional guide to functional diversity measures. Biodiversity, ecosystem functioning, and human wellbeing: an ecological and economic perspective: 49.	Functional dviersity: Petchey, O. L., E. O'Gorman, et al. (2009). A functional guide to functional diversity measures. Biodiversity, ecosystem functioning, and human wellbeing: an ecological and economic perspective: 49.
Phylogenetic diversity: Cadotte et al. (2010). Ecology letters 13(1): 96-105.	Phylogenetic diversity: Cadotte et al. (2010). Ecology letters 13(1): 96-105.

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.2   Flora Diversity ⇨ 1ˢᵗ level: Population trends of vascular plants: endangered, rare, at the limit of distribution, or ecological indicators / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Population trends of vascular plants: endangered, rare, at the limit of distribution, or ecological indicators	**Indicator**:
Parameter: changes in population size over time	**Parameter**:

Important related indices

Population growth rate (number of plants in t+1/t) within conficence limits, and population viability in the future	

Property: Frequency

Once a year if possible. Longer time lags are also possible	

Property: Time scale (incl. seasonality), temporal resolution

Spring to summer, in order to be able to combine with sampling of reproductive indexes and recruitment success	

Property: Basic spatial scale

Permanent plot (size variable) or the whole population is small	

Property: Base Units

Percentage cover, frequency (no. of individuals)	

Mandatory meta data

Survey date, GPS location, Area size, biotope discription, method of counting or estimation of population or area size	

Method applied (key words)

Counting individuals	

Method references: specific to sites, not internationally applied

https://spreadsheets.google.com/embeddedform?formkey=dDNJMWR3LVFaclRLRC1HY256QVlGb0E6MQ	https://spreadsheets.google.com/embeddedform?formkey=dDNJMWR3LVFaclRLRC1HY256QVlGb0E6MQ

Method references: established, internationally applied

Morris W.F. & Doak D.F. (2002). Quantitative Conservation Biology: Theory and Practice of Population Viability Analysis. Sinauer Associates, Sunderland, MA.	Morris W.F. & Doak D.F. (2002). Quantitative Conservation Biology: Theory and Practice of Population Viability Analysis. Sinauer Associates, Sunderland, MA.

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.3   Fauna Diversity ⇨ 1st level: Species richness: Birds / 2nd level: Number of rare species, number and abundance of FFH-species, number of species with national/regional responsibility

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Species richness: Birds	**Indicator**: Number of rare species, number and abundance of FFH-species, number of species with national/regional responsibility
Parameter: Full Species list: Common Birds	**Parameter**: Selected Species, Number of Individuals (= Population Size)

Important related indices

Shannon; Simpson	Shannon

Property: Frequency

Yearly up to every 3 years, 3-4 surveys per year during the breeding season starting at sunrise; point transect: 5-10 minutes count per point	Depends on specific focus, but should be able to be related to single year as basic unit

Property: Time scale (incl. seasonality), temporal resolution

February-September	To characterise annual "population"

Property: Basic spatial scale

Line transects: 1-2 km, if several lines, then at least 200m apart; avoid crossing markedly different habitats; Point transects: distance between points at least 200m, about 20 points per site	Plot (representative for the site)

Property: Base Units

Numbers of individuals; behaviour categories	Number

Mandatory meta data

Survey date and time, location, area size, distance	Survey date, location, plot/Area size, frequency of

| bands, frequency of observations, behaviour categories, biotope discription, method reference, design of sampling | observations, biotope discription, method reference, design of sampling |

Method applied (key words)

| Line transects, point transects, point counts, point-stop, fixed distance bands, regular or systematic approach, random approach | Many different species-specific trap types and designs, different chemicals for conservation, hard to compare --> specific case for new agreed protocols |

Method references: specific to sites, not internationally applied

| DDA (Dachverband Deutscher Avifaunisten, in German): http://www.dda-web.de/index.php?cat=monitoring&subcat=ha_neu&subsubcat=kartiermethode

Observatorio del cambio global de Sierra Nevada (in Spanish):
http://observatoriosierranevada.iecolab.es/index.php/Transectos_Passeriformes_y_Otras_Aves | DDA (Dachverband Deutscher Avifaunisten, in German): http://www.dda-web.de/index.php?cat=monitoring&subcat=ha_neu&subsubcat=kartiermethode

Observatorio del cambio global de Sierra Nevada (in Spanish):
http://observatoriosierranevada.iecolab.es/index.php/Transectos_Passeriformes_y_Otras_Aves |

Method references: established, internationally applied

| EBCC - European Bird Census Council: Best Practice Handbook:
http://www.ebcc.info/index.php?ID=365
ECN UK - Environmental change network UK:
http://www.ecn.ac.uk/measurements/terrestrial/b/bi/bb
BTO - British Trust for Ornithology
http://www.bto.org/volunteer-surveys/bbs/taking-part/download-forms-instructions
Software TRIM (TRends and Indices for Monitoring data)
http://www.ebcc.info/trim.html
Bibby et al. (2000)
Sutherland et al. (2004)
Greenwood and Robinson (2006b) Gibbons and Gregory (2006) | EBCC - European Bird Census Council: Best Practice Handbook:
http://www.ebcc.info/index.php?ID=365
ECN UK - Environmental change network UK:
http://www.ecn.ac.uk/measurements/terrestrial/b/bi/bb
BTO - British Trust for Ornithology
http://www.bto.org/volunteer-surveys/bbs/taking-part/download-forms-instructions
Software TRIM (TRends and Indices for Monitoring data)
http://www.ebcc.info/trim.html
Bibby et al. (2000)
Sutherland et al. (2004)
Greenwood and Robinson (2006b) Gibbons and Gregory (2006) |

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.4   Fauna Diversity ⇨ 1ˢᵗ level: Species richness: Butterflies / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Species richness: Butterflies	**Indicator**:
Parameter: Full Species list: Butterflies	**Parameter**:

Important related indices

Shannon; Simpson	

Property: Frequency

Yearly, at least 5 (detection of about 80% of species), better 7-10 surveys	

Property: Time scale (incl. seasonality), temporal resolution

March-October (depends on region)	

Property: Basic spatial scale

50m (line transects)	

Property: Base Units

Numbers	

Mandatory meta data

Survey date, location, transect length size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Line transect, counts of individuals	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

The UK Butterfly Monitoring Scheme (UKBMS):	The UK Butterfly Monitoring Scheme (UKBMS):

http://www.ukbms.org/resources.htm	http://www.ukbms.org/resources.htm
ECN UK - Environmental change network UK:	ECN UK - Environmental change network UK:
http://www.ecn.ac.uk/measurements/terrestrial/i/ib	http://www.ecn.ac.uk/measurements/terrestrial/i/ib
Pollard, E. (1977): A method for assessing changes in the abundance of butterflies. Biol. Conserv., 12:115-13	Pollard, E. (1977): A method for assessing changes in the abundance of butterflies. Biol. Conserv., 12:115-13
Pollard, E., Yates, T.J., (1993) Monitoring butterflies for ecology and conservation. Chapman & Hall, London	Pollard, E., Yates, T.J., (1993) Monitoring butterflies for ecology and conservation. Chapman & Hall, London

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.5   Within Habitat Structure ⇨ 1ˢᵗ level: Within habitat diversity / 2ⁿᵈ level: Layer structure

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Within habitat diversity	**Indicator**: Layer structure
Parameter: Vertical and horizontal structure; Number, type and coverage of layers, life forms = species trait (recommended)	**Parameter**: Number, type and coverage of layers,

Important related indices

Age structure, fractal dimension; LSM (landscape metrics)	

Property: Frequency

Periodic (yearly or every 3-5 years)	Annual/periodic

Property: Time scale (incl. seasonality), temporal resolution

To characterise annual "community"	To characterise the plot

Property: Basic spatial scale

Vector data, habitat map (representative for the site)	Plot (representative for the site)

Property: Base Units

Year, fractal dimension	

Mandatory meta data

Survey date, location, area size, year of observation, methods of sampling	Survey date, location, plot/Area size, frequency/date of observations, biotope discription

Method applied (key words)

Remote sensing, aerial photographs, verified through field work	Surveys, remote sensing

Method references: specific to sites, not internationally applied

Jakucs P. (1985): Ecology of an oak forest in	Jakucs P. (1985): Ecology of an oak forest in

Hungary. Akadémia Kiadó, Budapest;	Hungary. Akadémia Kiadó, Budapest;
http://www.forestbiota.org/docs/eee_HabitatClassificationForestBIOTA.pdf	http://www.forestbiota.org/docs/eee_HabitatClassificationForestBIOTA.pdf

<div align="center">

Method references: established, internationally applied

</div>

http://www.forestbiota.org/docs/eee_HabitatClassificationForestBIOTA.pdf	http://www.forestbiota.org/docs/eee_HabitatClassificationForestBIOTA.pdf
EUNIS => http://eunis.eea.europa.eu/habitats.jsp	EUNIS => http://eunis.eea.europa.eu/habitats.jsp

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.6   Within Habitat Structure ⇨ 1st level: Deadwood / 2nd level: Number of ancient trees (DBH > 100m)

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: Deadwood	**Indicator**: Number of ancient trees (DBH > 100m)
Parameter: Volume of deadwood (CWD), position of deadwood, decaying rate of deadwood	**Parameter**: Number of ancient trees on the basis of 9 types of dead wood microhabitats
Important related indices	
	Decay holes, hollows, cavities, decay fungi, limbs of decaying wood, hollowing in the trunk or major limbs, dendrotelmic cavities, loss of bark. sap runs, crevices in the bark.
Property: Frequency	
10 year	10 years
Property: Time scale (incl. seasonality), temporal resolution	
Trees without leaves , no smow	Trees without leaf
Property: Basic spatial scale	
	Survey at stand level
Property: Base Units	
m3/ha (volume of deadwood), 9 classes (position), 5 classes (decaying rate)	Presence/absence
Mandatory meta data	
Method applied (key words)	
Transects	Survey
Method references: specific to sites, not internationally applied	
Method references: established, internationally applied	

Harmon et al. (1986). Ecology of coarse woody debris in temperate ecosystems. Advances in Ecological Research, 15, 133-302.	Harmon et al. (1986). Ecology of coarse woody debris in temperate ecosystems. Advances in Ecological Research, 15, 133-302.

Harmon et al. (1986). Ecology of coarse woody debris in temperate ecosystems. Advances in Ecological Research, 15, 133-302.

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures* ⇨ *Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.1.7 **Soil ⇨ 1ˢᵗ level: Soil physical characteristics: soil horizons, soil water retention curves, total porosity, particle size distribution, stone content / 2ⁿᵈ level: Soil basic characteristics (physical, chemistry, mineralogy)**

INDICATOR FACT SHEET

LEVEL 1 Indicator   LEVEL 2 Indicator

Indicators and explicit parameters

Indicator: Soil physical characteristics: soil horizons, soil water retention curves, total porosity, particle size distribution, stone content	**Indicator**: Soil basic characteristics (physical, chemistry, mineralogy)
Parameter: Soil type (FAO) WRB 2006	**Parameter**:

Important related indices

Diagnostic horizons, geomorphic conditions	Moisture, soil and air temperature

Property: Frequency

Periodic (yearly or every 3-5 years)	Once and every 5-10 years for soil chemistry

Property: Time scale (incl. seasonality), temporal resolution

Once (per year?)	Once

Property: Basic spatial scale

Site 5 replicates per site type (soil depth to be included)	Site

Property: Base Units

Horizon, pedon, soil order (classification)	

Mandatory meta data

Survey date, location, area size, year of observation, methods of sampling	Survey date, Area size, year of observation, methods of sampling

Method applied (key words)

Soil survey (FAO)	Soil sampling

Method references: specific to sites, not internationally applied

National Soil Classification System;	National Soil Classification System;

Buzás I. (szerk.) (1993): Talaj- és agrokémiai vizsgálati módszerkönyv 1. A talaj fizikai, vízgazdálkodási és ásványtani vizsgálata. INDA 4231 Kiadó, Budapest. 357 p. (ISBN 963 85126 0 1);	Buzás I. (szerk.) (1993): Talaj- és agrokémiai vizsgálati módszerkönyv 1. A talaj fizikai, vízgazdálkodási és ásványtani vizsgálata. INDA 4231 Kiadó, Budapest. 357 p. (ISBN 963 85126 0 1);
Buzás I. (szerk.) (1993): Talaj- és agrokémiai vizsgálati módszerkönyv 2. A talajok fizikai-kémiai és kémiai vizsgálati módszerei. Mezőgazdasági Kiadó, Budapest. (ISBN 963 232 657 1)	Buzás I. (szerk.) (1993): Talaj- és agrokémiai vizsgálati módszerkönyv 2. A talajok fizikai-kémiai és kémiai vizsgálati módszerei. Mezőgazdasági Kiadó, Budapest. (ISBN 963 232 657 1)

Method references: established, internationally applied

World reference base for soil resources => http://www.fao.org/ag/agl/agll/wrb/doc/wrb2007_corr.pdf	World reference base for soil resources => http://www.fao.org/ag/agl/agll/wrb/doc/wrb2007_corr.pdf
Soil Survey Staff (2010): Keys to Soil Taxonomy. Eleventh edition. United States Department of Agriculture and Natural Resources Conservation Service. Washington, D.C..	Soil Survey Staff (2010): Keys to Soil Taxonomy. Eleventh edition. United States Department of Agriculture and Natural Resources Conservation Service. Washington, D.C..

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.8 **Soil ⇨ 1ˢᵗ level: Bulk density / 2ⁿᵈ level: Density of the soil, indicator for soil air and water regime**

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: Bulk density	**Indicator**: Density of the soil, indicator for soil air and water regime
Parameter: Bulk density	**Parameter**:
Important related indices	
	Bulk density
Property: Frequency	
At beginning of survey, periodic (every 3 - 5 years)	Once
Property: Time scale (incl. seasonality), temporal resolution	
Once (per year?)	Once
Property: Basic spatial scale	
At least 3 replicates per horizon at every chosen plot	Plot
Property: Base Units	
Density of natural undisturbed soil	
Mandatory meta data	
Survey date, location, area size, year of observation, methods of sampling	Survey date, Area size, year of observation, methods of sampling
Method applied (key words)	
Stainless steel cylinder of known volume (normally 100 cm3)	Intact soil sampling
Method references: specific to sites, not internationally applied	
Method references: established, internationally applied	

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures* ⇨ *Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.1.9   Soil ⇨ 1st level: Soil chemistry (profile) / 2nd level: Soil chemistry

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Soil chemistry (profile)	**Indicator**: Soil chemistry
Parameter: C and N content, base saturation, pH value, cation exchange capacity	**Parameter**:

Important related indices

Organic and inorganic C, total N, pH, exchangeable cations, base saturation	C stock, N stock, base saturation

Property: Frequency

Continuous/periodical, every year or seasonal	

Property: Time scale (incl. seasonality), temporal resolution

Once (per year?)	Once

Property: Basic spatial scale

	Plot

Property: Base Units

Content of elements, pH, exchangeable cations	

Mandatory meta data

Survey date, location, area size, year of observation, methods of sampling	Survey date, Area size, year of observation, methods of sampling

Method applied (key words)

	Soil sampling

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.10   Water ⇨ 1st level: Soil moisture (profiles) stream discharge; groundwater depth and variability / 2nd level: Moisture regime of the soil/site (sensitivity to drought, access to water table, leaching)

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Soil moisture (profiles) stream discharge; groundwater depth and variability	**Indicator**: Moisture regime of the soil/site (sensitivity to drought, access to water table, leaching)
Parameter: Soil moisture (profiles); Soil solution chemistry: pH, Base cations (K, Na, Ca, Mg), SO42-, NO3-, Cl-, Pb, Cd,	**Parameter**:

Important related indices

N, C, P	

Property: Frequency

Continuous/periodical, every 2-3 months	Once

Property: Time scale (incl. seasonality), temporal resolution

Continuous/periodical	Once

Property: Basic spatial scale

Plot	Site

Property: Base Units

Water content, water potential, concentration of ions	

Mandatory meta data

Survey date, location, area size, year of observation, methods of sampling	Survey date, Area size, year of observation, methods of sampling

Method applied (key words)

Device (sensors ,e.g. TDR; tensiometer)	

Method references: specific to sites, not internationally applied

Jakucs P. (1985): Ecology of an oak Forest in	Jakucs P. (1985): Ecology of an oak Forest in

Hungary. Akadémiai Kiadó, Budapest; Buzás I. (szerk.) (1993): Talaj- és agrokémiai vizsgálati módszerkönyv 1. A talaj fizikai, vízgazdálkodási és ásványtani vizsgálata. INDA 4231 Kiadó, Budapest. 357 p. (ISBN 963 85126 0 1); Buzás I. (szerk.) (1993): Talaj- és agrokémiai vizsgálati módszerkönyv 2. A talajok fizikai-kémiai és kémiai vizsgálati módszerei. Mezőgazdasági Kiadó, Budapest. (ISBN 963 232 657 1)	Hungary. Akadémiai Kiadó, Budapest; Buzás I. (szerk.) (1993): Talaj- és agrokémiai vizsgálati módszerkönyv 1. A talaj fizikai, vízgazdálkodási és ásványtani vizsgálata. INDA 4231 Kiadó, Budapest. 357 p. (ISBN 963 85126 0 1); Buzás I. (szerk.) (1993): Talaj- és agrokémiai vizsgálati módszerkönyv 2. A talajok fizikai-kémiai és kémiai vizsgálati módszerei. Mezőgazdasági Kiadó, Budapest. (ISBN 963 232 657 1)

Method references: established, internationally applied

Fundamentals of Soil Physics, 1980. Academic Press Inc ICP IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en ICP Forests => http://icp-forests.net/page/icp-forests-manual	Fundamentals of Soil Physics, 1980. Academic Press Inc ICP IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en ICP Forests => http://icp-forests.net/page/icp-forests-manual

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.11   Air ⇨ 1ˢᵗ level: Basic climate of the site (ranges, interannual variability, extremes, etc.) / 2ⁿᵈ level: Ozone concentration

INDICATOR FACT SHEET

LEVEL 1 Indicator   LEVEL 2 Indicator

Indicators and explicit parameters

Indicator: Basic climate of the site (ranges, interannual variability, extremes, etc.)	**Indicator**: Ozone concentration
Parameter: Radiation (incoming, reflected, below canopy, direct, diffuse, PAR), T, VPD, wind speed, CO2, Ozone, SO4, NOx concentrations	**Parameter**:

Important related indices

Fluxes of chemicals in the atmosphere	

Property: Frequency

Continuous/daily	On monthly basis using the passive samplers or continuously with ozone monitors

Property: Time scale (incl. seasonality), temporal resolution

Continuous/daily	

Property: Basic spatial scale

Site	

Property: Base Units

Concentration per time unit (mg/m)	

Mandatory meta data

Survey date, location, area size, year of observation, methods of sampling	Survey date, Area size, year of observation, methods of sampling

Method applied (key words)

Devices	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

WMO - World Meteorological Organization => http://www.wmo.int/pages/prog/www/IMOP/IMOP-home.html	WMO - World Meteorological Organization => http://www.wmo.int/pages/prog/www/IMOP/IMOP-home.html
ICP IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en	ICP IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en
ICP Forests => http://icp-forests.net/page/icp-forests-manual	ICP Forests => http://icp-forests.net/page/icp-forests-manual

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures* ⇨ *Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.1.12   Habitat ⇨ 1ˢᵗ level: Cover of CORINE land use/EUNIS habitats; EU Habitat Directive (connection to remote sensing) / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Cover of CORINE land use/EUNIS habitats; EU Habitat Directive (connection to remote sensing)	**Indicator**:
Parameter:	**Parameter**:

Important related indices

Landscape metrics (e.g. SHDI, MPS, PROX, ENN)	

Property: Frequency

Periodic (depends on community dynamics)	

Property: Time scale (incl. seasonality), temporal resolution

Every 3 years (depends on dynamics of land use changes and community changes)	

Property: Basic spatial scale

Site/landscape	

Property: Base Units

Landscape	

Mandatory meta data

Survey date, location, area size, year of observation, methods of sampling	Survey date, Area size, year of observation, methods of sampling

Method applied (key words)

Maps (surveys/checked)	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.13   Additional Variables ⇨ 1ˢᵗ level: Type and intensity of management / 2ⁿᵈ level: Natural disturbances

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Type and intensity of management	**Indicator**: Natural disturbances
Parameter: Age, species, size distributions of forest stands, fields, roads, wetlands, lakes	**Parameter**:

Important related indices

Hemeroby/ naturalness	

Property: Frequency

Depending on management	Occasional

Property: Time scale (incl. seasonality), temporal resolution

Depending on management	Not relevant

Property: Basic spatial scale

Site	Site

Property: Base Units

%, ha	

Mandatory meta data

Survey date, location, area size, year of observation, methods of sampling	Survey date, Area size, year of observation, methods of sampling

Method applied (key words)

Survey, questionnaire, management plan	Survey/knowledge/history

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.14   E_input ⇨ 1ˢᵗ level: Energy input: a) Radiation; b) Agronomic operation / 2ⁿᵈ level: Energy input 2

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Energy input: a) Radiation; b) Agronomic operation	**Indicator**: Energy input 2
Parameter: a) Photoshynthetic active radiation (PAR); direct and diffuse sky radiatio; b) Type of fertilizers, all details about tillage, weed control, pest control, irrigation, harvest…	**Parameter**: Temperature (air)

Important related indices

Property: Frequency

Continuous (half hourly) / site characterisation	Daily

Property: Time scale (incl. seasonality), temporal resolution

Continuous / annual	Daily

Property: Basic spatial scale

Site	Site

Property: Base Units

Mandatory meta data

Location, plot/Area size, frequency of observations, biotope discription, method reference	Location, plot/Area size, frequency of observations, biotope discription, method reference

Method applied (key words)

Device / calculation	Device

Method references: specific to sites, not internationally applied

Donana => http://icts.ebd.csic.es/CambiarIdiomaAction.do?idi	Donana => http://icts.ebd.csic.es/CambiarIdiomaAction.do?idi

oma=ingles	oma=ingles

Method references: established, internationally applied

WMO - World Meteorological Organization => http://www.wmo.int/pages/prog/www/IMOP/IMOP-home.html	WMO - World Meteorological Organization => http://www.wmo.int/pages/prog/www/IMOP/IMOP-home.html
ICP IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en	ICP IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en
ICP Forests => http://icp-forests.net/page/icp-forests-manual	ICP Forests => http://icp-forests.net/page/icp-forests-manual

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.15   E_input ⇨ 1ˢᵗ level: Energy input - radiation / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Energy input - radiation	**Indicator**:
Parameter: Incoming short wave radiation	**Parameter**:

Important related indices

Property: Frequency

Continuous (10 min)	

Property: Time scale (incl. seasonality), temporal resolution

Continuous	

Property: Basic spatial scale

Site	

Property: Base Units

Mandatory meta data

Location, plot/Area size, frequency of observations, biotope discription, method reference	

Method applied (key words)

Pyranometer	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

http://www.wmo.int/pages/prog/www/CIMO/CIMO15-WMO1064/1064_en.pdf	http://www.wmo.int/pages/prog/www/CIMO/CIMO15-WMO1064/1064_en.pdf

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.16   E_input ⇨ 1ˢᵗ level: Energy capture / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Energy capture	**Indicator**:
Parameter: Absorbed radiation	**Parameter**:

Important related indices

Property: Frequency

Continuous (half hourly)	

Property: Time scale (incl. seasonality), temporal resolution

Continuous	

Property: Basic spatial scale

Plot	

Property: Base Units

W/m-2	

Mandatory meta data

Combine with e.g. data on canopy greening, fluorescence,…	

Method applied (key words)

Radiometers	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.17   E_input ⇨ 1st level: Photosynthetic energy fluxes: a) energy input (light absorption); b) energy partitioning (photochemical vs non-photochemical) / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Photosynthetic energy fluxes: a) energy input (light absorption); b) energy partitioning (photochemical vs non-photochemical)	**Indicator**:
Parameter: a) Light absorption: greeness indexes, e.g. NDVI b) Energy partitioning: PRI (Photochemical Reflectance Index), Active Fluorescence (see Established Protocols, line 42), Passive Fluorescence	**Parameter**:

Important related indices

NDVI, PRI, NPQ, Photochemical Yield, Non-Photochemical Yield, Light Use Efficiency	

Property: Frequency

Measurements are continuous (30 min averages). But Active Fluorescence has a minimum practical Frequency of 5-15 minutes.	

Property: Time scale (incl. seasonality), temporal resolution

Annual coverage. Snow problems.	

Property: Basic spatial scale

From a few mm (leaf level measurements) to tenths of meters (tower level measurements)	

Property: Base Units

Mandatory meta data

PAR, Temperature, precise sensor orientation (canopy level), Stand structure (BRDF computing): tree density, size, LAI,…	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

Method applied (key words)

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.18   E_storage ⇨ 1ˢᵗ level: Energy storage / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Energy storage	**Indicator**:
Parameter: Biomass	**Parameter**:

Important related indices

Volume/mass of ecosystem components	

Property: Frequency

Annual	

Property: Time scale (incl. seasonality), temporal resolution

Annual (more sampling may be needed)	

Property: Basic spatial scale

Site	

Property: Base Units

Cubic meters, metric tons	

Mandatory meta data

Date, location, plot/area size, frequency of observations, biotope discription, method reference	

Method applied (key words)

Sampling	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.1.19   E_storage ⇨ 1ˢᵗ level: / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	**Indicator**:
Parameter: Canopy temperature	**Parameter**: Soil temperature (I consider this storage)

Important related indices

Property: Frequency

Continuous if possible (half hourly)	Continuous

Property: Time scale (incl. seasonality), temporal resolution

Continuous	Continuous

Property: Basic spatial scale

Plot	Plot

Property: Base Units

°C	

Mandatory meta data

Combine with other environmental data (e.g. wind speed, absorbed radiation, etc)	

Method applied (key words)

Non-contact T sensor or infrared camera	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.20   E_output ⇨ 1st level: Energy output / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Energy output	**Indicator**:
Parameter: Albedo and heat flux; respiration	**Parameter**:

Important related indices

Eddy covariance	

Property: Frequency

Albedo: half hourly; Respiration: 3x per year	

Property: Time scale (incl. seasonality), temporal resolution

Periodical	

Property: Basic spatial scale

Site	

Property: Base Units

Weight/volume units per time units	

Mandatory meta data

Location, plot/Area size, frequency of observations, biotope discription, method reference	

Method applied (key words)

Measured on selected meteorological stations	

Method references: specific to sites, not internationally applied

Donana => http://icts.ebd.csic.es/CambiarIdiomaAction.do?idioma=ingles	Donana => http://icts.ebd.csic.es/CambiarIdiomaAction.do?idioma=ingles

Method references: established, internationally applied

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| http://www.ymparisto.fi/default.asp?node=6412&lan=en | http://www.ymparisto.fi/default.asp?node=6412&lan=en |

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.1.21 E_other state variables ⇨ 1st level: Basic climate of the site (ranges, interannual variability, extremes, etc.) / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Basic climate of the site (ranges, interannual variability, extremes, etc.) **Parameter**: Air humidity, Air temperature, Windspeed/-direction	**Indicator**: **Parameter**:

Important related indices

Property: Frequency

Continuous (10 min)	

Property: Time scale (incl. seasonality), temporal resolution

Continuous	

Property: Basic spatial scale

Site	

Property: Base Units

Mandatory meta data

Location, plot/Area size, frequency of observations, biotope discription, method reference	

Method applied (key words)

Meteorological Multisensors, Standard Monitoring Stations	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

http://www.wmo.int/pages/prog/www/CIMO/CIMO15-WMO1064/1064_en.pdf	http://www.wmo.int/pages/prog/www/CIMO/CIMO15-WMO1064/1064_en.pdf

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.22   E_efficiency measures ⇨ 1ˢᵗ level: Energy efficiency / 2ⁿᵈ level: Remote sensing derived ANPP-NPP

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Energy efficiency	**Indicator**: Remote sensing derived ANPP-NPP
Parameter: ANPP (as a proxy and relation to Remote Sensing) (NPP where possible)); Net radiation	**Parameter**:

Important related indices

Eddy covariance	

Property: Frequency

Half hourly	Annual/seasonal

Property: Time scale (incl. seasonality), temporal resolution

Annual (more sampling may be needed)	Annual/seasonal

Property: Basic spatial scale

Plot/site	Site

Property: Base Units

Weight/volume units per time units	

Mandatory meta data

Location, plot/Area size, frequency of observations, biotope discription, method reference	Location, plot/Area size, frequency of observations, biotope discription, method reference

Method applied (key words)

Sampling/biometry/proxy variables	Remote sensing

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.23 E_efficiency measures ⇨ 1st level: Branch CO2 exchange / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Branch CO2 exchange	**Indicator**:
Parameter: Branch-level CO2 exchange	**Parameter**:

Important related indices

CO2 uptake, respiration, NPP	

Property: Frequency

Continuous, temporal resolution 30 min	

Property: Time scale (incl. seasonality), temporal resolution

Continuous	

Property: Basic spatial scale

Tree individual	

Property: Base Units

nmol m-2 s-1, mg g-1 h-1	

Mandatory meta data

Location, time, enclosure type, duration of closure, PAR, temperature, flow rate, measurement method	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.24   E_efficiency measures ⇨ 1st level: Stand CO2 flux / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Stand CO2 flux	**Indicator**:
Parameter: Net ecosystem exchange, gross primary productivity, ecosystem respiration	**Parameter**:

Important related indices

Light-use efficiency	

Property: Frequency

Continuous, temporal resolution 30 min	

Property: Time scale (incl. seasonality), temporal resolution

Continuous	

Property: Basic spatial scale

Site	

Property: Base Units

µmol m-2 s-1	

Mandatory meta data

Measuring height, fetch, type of gas analyser (closed, open, enclosed),	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.1.25 E_efficiency measures ⇨ 1st level: Energy Budget / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Energy Budget	**Indicator**:
Parameter: Albedo/Radiation Budget	**Parameter**:

Important related indices

Light-use efficiency	

Property: Frequency

Continuous, temporal resolution 10-30 min	

Property: Time scale (incl. seasonality), temporal resolution

Continuous	

Property: Basic spatial scale

Site	

Property: Base Units

$\mu mol\ m{-}2\ s{-}1$	

Mandatory meta data

Measuring height, fetch, type of gas analyser (closed, open, enclosed), location, plot/Area size, frequency of observations, biotope discription, method reference	

Method applied (key words)

4-component net radiation sensors	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.26   E_efficiency measures ⇨ 1st level: Energy Budget / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Energy Budget	**Indicator**:
Parameter: Photosynthetic active radiation	**Parameter**:

Important related indices

Property: Frequency

Continuous (10 min)	

Property: Time scale (incl. seasonality), temporal resolution

Continuous	

Property: Basic spatial scale

Site	

Property: Base Units

Mandatory meta data

Location, plot/Area size, frequency of observations, biotope discription, method reference	

Method applied (key words)

Filter radiometer	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.27   E_efficiency measures ⇨ 1st level: Energy Budget / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Energy Budget	**Indicator**:
Parameter: Sensible and latent heat flux	**Parameter**:

Important related indices

Property: Frequency

Continuous (30 min)	

Property: Time scale (incl. seasonality), temporal resolution

Continuous	

Property: Basic spatial scale

Site	

Property: Base Units

Mandatory meta data

Location, plot/Area size, frequency of observations, biotope discription, method reference	

Method applied (key words)

EC (H2O, T, u, v, w, pressure)	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.1.28   E_efficiency measures ⇨ 1st level: Energy Budget / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Energy Budget	**Indicator**:
Parameter: Greenhouse Gas Fluxes	**Parameter**:

Important related indices

Property: Frequency

Continuous (30 min)	

Property: Time scale (incl. seasonality), temporal resolution

Continuous	

Property: Basic spatial scale

Site	

Property: Base Units

Mandatory meta data

Location, plot/Area size, frequency of observations, biotope discription, method reference	

Method applied (key words)

EC (CH4, N2O, Trace gases)	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.29   M_input ⇨ 1st level: Deposition of main nutrients (measurements) (input of fertiliser if relevant: fertilization using mineral / organic fertilizers, exceeding crop removal) / 2nd level: Average deposition of main nutrients (modelling/maps)

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: Deposition of main nutrients (measurements) (input of fertiliser if relevant: fertilization using mineral / organic fertilizers, exceeding crop removal)	**Indicator**: Average deposition of main nutrients (modelling/maps)
Parameter: Deposition: Base cations (K, Na, Ca, Mg), SO42-, NO3-, Cl-, Pb, Cd, pH; Weathering rate: Base cations, Pb, Cd; Biomass production	**Parameter**: Atmospheric deposition
Important related indices	
Concentration, ion ratio	
Property: Frequency	
Monthly to Annual; (Ignatova) => deposition measurements every 15 days; Weathering- once	Annual, monthly measurements
Property: Time scale (incl. seasonality), temporal resolution	
Periodical (monthly)	Annual
Property: Basic spatial scale	
Site	Site; plot
Property: Base Units	
kg/ha,	
Mandatory meta data	
Date, location, plot/area size, frequency of observations, biotope discription, method reference	Location, plot/Area size, frequency of observations, biotope discription, method reference
Method applied (key words)	
Collectors; sampling	Deposition collector, model calculations

Method references: specific to sites, not internationally applied

Filippa et al. (2010): Major element chemistry in inner alpine snowpacks (Aosta valley Region, NW Italy) Cold Regions Science and Technology. doi:10.1016/j.coldregions.2010.07.005	Filippa et al. (2010): Major element chemistry in inner alpine snowpacks (Aosta valley Region, NW Italy) Cold Regions Science and Technology. doi:10.1016/j.coldregions.2010.07.005

Method references: established, internationally applied

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TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.30   M_input ⇨ 1ˢᵗ level: Atmospheric deposition, branch scale / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: Atmospheric deposition, branch scale **Parameter**: O3 deposition	**Indicator**: **Parameter**:
Important related indices	
Ozone exposure index, O3 stomatal and nonstomatal deposition	
Property: Frequency	
Continuous, temporal resolution 30 min	
Property: Time scale (incl. seasonality), temporal resolution	
Continuous	
Property: Basic spatial scale	
Tree individual	
Property: Base Units	
nmol m-2 s-1, mg g-1 h-1	
Mandatory meta data	
Location, time, enclosure type, duration of closure, PAR, temperature, flow rate, relative humidity, measurement method	
Method applied (key words)	
Method references: specific to sites, not internationally applied	
Method references: established, internationally applied	

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.31   M_input ⇨ 1st level: Atmospheric deposition, stand scale / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: Atmospheric deposition, stand scale **Parameter**: O3 flux, O3 deposition velocity	**Indicator**: **Parameter**:
Important related indices	
Ozone exposure index	
Property: Frequency	
Continuous, temporal resolution 30 min	
Property: Time scale (incl. seasonality), temporal resolution	
Continuous	
Property: Basic spatial scale	
Site	
Property: Base Units	
µmol m-2 s-1, ppb s-1	
Mandatory meta data	
Measuring height, fetch, type of measurement (e.g. Eddy covariance, eddy accumulation, relaxed eddy accumulation), O3 concentration	
Method applied (key words)	
Method references: specific to sites, not internationally applied	
Method references: established, internationally applied	

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.32   **M_storage ⇨ 1ˢᵗ level: Matter storage / 2ⁿᵈ level: Stem and branches chemistry; below ground storage**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Matter storage	**Indicator**: Stem and branches chemistry; below ground storage
Parameter: Vegetation biomass (including roots); Base cations (K, Na, Ca, Mg), S, N, Pb, Cd in the biomass	**Parameter**: Base cations (K, Na, Ca, Mg), S, N, Pb, Cd in the biomass; Vegetation biomass (below ground) (DOC, DON, PFLA, Cmic)

Important related indices

Concentration, ion ratio	

Property: Frequency

Annual/periodic	Annual / periodical

Property: Time scale (incl. seasonality), temporal resolution

Depend on site type	Annual/periodical

Property: Basic spatial scale

Plot/site	Plot/site

Property: Base Units

kg/ha,	

Mandatory meta data

Date, location, plot/area size, frequency of observations, biotope discription, method reference	Location, plot/Area size, frequency of observations, biotope discription, method reference

Method applied (key words)

Estimation, surveys, biometry, proxies (e.g. plant height in grasslands)	Sampling, (chemical) analyses: AAA, ICP

Method references: specific to sites, not internationally applied

Holub et al. (2005): Organic matter manipulations have little effect on gross and net nitrogen transformations in two temperate forest mineral soils in the U.S.A and central Europe. Forest Ecology and Management, 214: p. 320-330	Holub et al. (2005): Organic matter manipulations have little effect on gross and net nitrogen transformations in two temperate forest mineral soils in the U.S.A and central Europe. Forest Ecology and Management, 214: p. 320-330

Method references: established, internationally applied

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ICP Forests => http://icp-forests.net/page/icp-forests-manua	ICP Forests => http://icp-forests.net/page/icp-forests-manua

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.33   M_storage ⇨ 1ˢᵗ level: Matter storage / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Matter storage	**Indicator**:
Parameter: Aboveground biomass per species	**Parameter**:

Important related indices

Property: Frequency

Annual/bi-annual	

Property: Time scale (incl. seasonality), temporal resolution

Once a year	

Property: Basic spatial scale

Plot (1x1m)	

Property: Base Units

g/species and area unit	

Mandatory meta data

Date, location, plot/area size, frequency of observations, biotope discription, method reference	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.34   **M_output ⇨ 1ˢᵗ level: Significant matter export: 1. harvesting, grazing; 2. leaching; 3. gas emissions (NH3, denitrification products) / 2ⁿᵈ level: Uptake by the biomass, leaching by the runoff, lateral immissions**

INDICATOR FACT SHEET

LEVEL 1 Indicator	**LEVEL 2 Indicator**
Indicators and explicit parameters	
Indicator: Significant matter export: 1. harvesting, grazing; 2. leaching; 3. gas emissions (NH3, denitrification products) **Parameter**: Utilized matter (harvesting, grazing); Leaching	**Indicator**: Uptake by the biomass, leaching by the runoff, lateral immissions **Parameter**: Base cations (K, Na, Ca, Mg), S, N, Pb, Cd in the biomass and runoff; erosion
Important related indices	
Exploitation, water/wind transport of materials	
Property: Frequency	
Annual/seasonal, monthly calc. from daily flow	Annual estimates
Property: Time scale (incl. seasonality), temporal resolution	
To characterise the site (when relevant)	Annual
Property: Basic spatial scale	
Site	Plot/site
Property: Base Units	
Metric tons per area unit	
Mandatory meta data	
Date, location, plot/area size, frequency of observations, biotope discription, method reference	Location, plot/Area size, frequency of observations, biotope discription, method reference
Method applied (key words)	
Estimation, surveys	Sampling; (chemical) analyses: AAA, ICP model calculations;

	measurements

Method references: specific to sites, not internationally applied

Tóth et al. (1975): Litter decomposition in oak forest ecosystem (Quercetum petraeae-cerris) of northern Hungary studied in the framework of „Síkfőkút Project".- In: Kilbertus, G.(ed): Biodegradation et Humification (Rapport du 1 Colloque Int., Nancy, 1974) Sarreguemines, Perron, pp. 41-58.	Tóth et al. (1975): Litter decomposition in oak forest ecosystem (Quercetum petraeae-cerris) of northern Hungary studied in the framework of „Síkfőkút Project".- In: Kilbertus, G.(ed): Biodegradation et Humification (Rapport du 1 Colloque Int., Nancy, 1974) Sarreguemines, Perron, pp. 41-58.

Method references: established, internationally applied

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TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.35   **M_output ⇨ 1st level: Soil respiration, CH4+N2O fluxes, DOC, DON, Water + mineral runoff / 2nd level:**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Soil respiration, CH4+N2O fluxes, DOC, DON, Water + mineral runoff **Parameter**: GHG fluxes (dynamic enclosures), catchments	**Indicator**: **Parameter**:

Important related indices

Property: Frequency

Constant	

Property: Time scale (incl. seasonality), temporal resolution

Constant	

Property: Basic spatial scale

Site	

Property: Base Units

g m-2	

Mandatory meta data

Date, location, sample area, sample flow, temperature, snow cover, soil moisture, measurement method	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.36 **M_other state variables ⇨ 1ˢᵗ level: C-N (plant, soil) / 2ⁿᵈ level: Soil/water chemistry as basic information for the quality of matter cycling processes**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: C-N (plant, soil)	**Indicator**: Soil/water chemistry as basic information for the quality of matter cycling processes
Parameter:	**Parameter**: pH (soil, water)

Important related indices

Property: Frequency

Annual/periodic	Depends on biotope type (periodiccally)

Property: Time scale (incl. seasonality), temporal resolution

Annual/periodic	Depends on biotope type (periodiccally)

Property: Basic spatial scale

Plot/site, forest floor and soil	Plot

Property: Base Units

Mandatory meta data

Date, location, plot/area size, frequency of observations, biotope discription, method reference	Location, plot/Area size, frequency of observations, biotope discription, method reference

Method applied (key words)

Sampling and analysis	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

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TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.37 **M_efficiency measures ⇨ 1ˢᵗ level: Nutrient cycling: a) mineral and organic fertilization balancing crop removal; depositions during grazing; b) crop residue decomposition (including green manuring) / 2ⁿᵈ level:**

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: Nutrient cycling: a) mineral and organic fertilization balancing crop removal; depositions during grazing; b) crop residue decomposition (including green manuring)	**Indicator**:
Parameter: (DEMANDING) Litter residence time / decomposition	**Parameter**:
Important related indices	
Property: Frequency	
Annual/periodic	
Property: Time scale (incl. seasonality), temporal resolution	
Annual/periodic	
Property: Basic spatial scale	
Plot/site	
Property: Base Units	
Mandatory meta data	
Date, location, plot/area size, frequency of observations, biotope discription, method reference	
Method applied (key words)	
Litterfall/standing litter; litterbags	
Method references: specific to sites, not internationally applied	
Tóth et al. (1975): Litter decomposition in oak	Tóth et al. (1975): Litter decomposition in oak

| forest ecosystem (Quercetum petraeae-cerris) of northern Hungary studied in the framework of „Síkfőkút Project".- In: Kilbertus, G.(ed): Biodegradation et Humification (Rapport du 1 Colloque Int., Nancy, 1974) Sarreguemines, Perron, pp. 41-58. | forest ecosystem (Quercetum petraeae-cerris) of northern Hungary studied in the framework of „Síkfőkút Project".- In: Kilbertus, G.(ed): Biodegradation et Humification (Rapport du 1 Colloque Int., Nancy, 1974) Sarreguemines, Perron, pp. 41-58. |

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.38   W_input ⇨ 1ˢᵗ level: Precipitation, throughfall, runoff / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Precipitation, throughfall, runoff	**Indicator**:
Parameter: Precipitation	**Parameter**:

Important related indices

Property: Frequency

Continuous (10 min)	

Property: Time scale (incl. seasonality), temporal resolution

Continuous	

Property: Basic spatial scale

Site	

Property: Base Units

Mandatory meta data

Location, plot/Area size, frequency of observations, biotope discription, method reference	

Method applied (key words)

Tipping-bucket gauges, present weather sensors	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

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TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.39   W_input ⇨ 1st level: Precipitation, throughfall, runoff / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Precipitation, throughfall, runoff	**Indicator**:
Parameter: Troughfall	**Parameter**:

Important related indices

Property: Frequency

Continuous (10 min)	

Property: Time scale (incl. seasonality), temporal resolution

Continuous	

Property: Basic spatial scale

Site	

Property: Base Units

Mandatory meta data

Location, plot/Area size, frequency of observations, biotope discription, method reference	

Method applied (key words)

Tipping-bucket gauges	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

http://www.wmo.int/pages/prog/www/CIMO/CIMO15-WMO1064/1064_en.pdf	http://www.wmo.int/pages/prog/www/CIMO/CIMO15-WMO1064/1064_en.pdf

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.40   W_input ⇨ 1ˢᵗ level: Precipitation, throughfall, runoff / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: Precipitation, throughfall, runoff	**Indicator**:
Parameter: Snow Height	**Parameter**:
Important related indices	
Property: Frequency	
Continuous (30 min)	
Property: Time scale (incl. seasonality), temporal resolution	
Continuous	
Property: Basic spatial scale	
Site	
Property: Base Units	
Mandatory meta data	
Location, plot/Area size, frequency of observations, biotope discription, method reference	
Method applied (key words)	
Snow Height Sensors	
Method references: specific to sites, not internationally applied	
Method references: established, internationally applied	
http://www.wmo.int/pages/prog/www/CIMO/CIMO15-WMO1064/1064_en.pdf	http://www.wmo.int/pages/prog/www/CIMO/CIMO15-WMO1064/1064_en.pdf

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.41 **W_input ⇨ 1ˢᵗ level: Basic climate of the site (ranges, interannual variability, extremes, etc.) / 2ⁿᵈ level: Deposition; gGround water recharge wWeathering**

INDICATOR FACT SHEET

LEVEL 1 Indicator　　　　　　　　　　　　　　　　　**LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Basic climate of the site (ranges, interannual variability, extremes, etc.)	**Indicator**: Deposition; gGround water recharge wWeathering
Parameter: Deposition: Base cations (K, Na, Ca, Mg), SO42-, NO3-, Cl-, Pb, Cd, pH; Precipitation	**Parameter**: Deposition: Base cations (K, Na, Ca, Mg), SO42-, NO3-, Cl-, Pb, Cd, pH; ground water recharge

Important related indices

Property: Frequency

Continuous (every 15 days)	Every 15 days

Property: Time scale (incl. seasonality), temporal resolution

	Annual

Property: Basic spatial scale

	Plot/site

Property: Base Units

Mandatory meta data

Date, location, plot/area size, frequency of observations, biotope discription, method reference	Location, plot/area size, model tool reference

Method applied (key words)

Automatic stations	Model calculation

Method references: specific to sites, not internationally applied

Szabó (1975): Net precipitation in Hungarian oak forest ecosystem. - Acta Bot. Acad. Sci. Hung. 21:	Szabó (1975): Net precipitation in Hungarian oak forest ecosystem. - Acta Bot. Acad. Sci. Hung. 21:

| 150 -165. | 150 -165. |
| | |

Method references: established, internationally applied

| ICP IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en | ICP IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en |

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.42   W_input ⇨ 1st level: Precipitation, throughfall, runoff / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Precipitation, throughfall, runoff	**Indicator**:
Parameter: Precipitation gauges, precipitation radar	**Parameter**:

Important related indices

Property: Frequency

Continuous	

Property: Time scale (incl. seasonality), temporal resolution

Continuous	

Property: Basic spatial scale

Site, catchment	

Property: Base Units

Mandatory meta data

Date, location, sample area, temperature, snow cover	

Method applied (key words)

Method references: specific to sites, not internationally applied

World Meteorological Organization, 1983: Guide to Meteorological Instruments and Methods of Observation. Fifth edition, Chapter 7, WMO–No. 8, Geneva.	World Meteorological Organization, 1983: Guide to Meteorological Instruments and Methods of Observation. Fifth edition, Chapter 7, WMO–No. 8, Geneva.

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.43   W_storage ⇨ 1ˢᵗ level: Water storage / 2ⁿᵈ level: Snowpack (amount/duration)

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Water storage **Parameter**: SWC: ground water presence and recharge; Water level (depth, level)	**Indicator**: Snowpack (amount/duration) **Parameter**: Snowpack (amount/duration)

Important related indices

Concentration, ion ratio	

Property: Frequency

Annual/seasonal; level monthly	Periodic (seasonal)

Property: Time scale (incl. seasonality), temporal resolution

Continuous - to characterise the site (when relevant), water contents and flow	Periodic (seasonal)

Property: Basic spatial scale

Site/plot	Plot/site

Property: Base Units

%	

Mandatory meta data

Location, plot/Area size, model tool reference, device reference	

Method applied (key words)

Water balance, devices	Periodic measurements, devices

Method references: specific to sites, not internationally applied

Jakucs (1985): Ecology of an oak forest in Hungary. Akadémiai Kiadó, Budapest, (thermogravimetric	Jakucs (1985): Ecology of an oak forest in Hungary. Akadémiai Kiadó, Budapest, (thermogravimetric

| method); | method); |
| Kanalas et al. (2010): Seasonal and diurnal variability in sap flow intensity of mature sessile oak (Quercus petraea (Matt.) Liebl.) trees in relation to microclimatic conditions. Acta Biologica Hungarica, 61: 95-108. (Volumetric Water Content in soil profile by means of Decagon sensors) | Kanalas et al. (2010): Seasonal and diurnal variability in sap flow intensity of mature sessile oak (Quercus petraea (Matt.) Liebl.) trees in relation to microclimatic conditions. Acta Biologica Hungarica, 61: 95-108. (Volumetric Water Content in soil profile by means of Decagon sensors) |

Method references: established, internationally applied

| ICP IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en | ICP IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en |

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.44   W_storage ⇨ 1st level: Water storage / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Water storage	**Indicator**:
Parameter: Soil moisture	**Parameter**:

Important related indices

Property: Frequency

Continuous	

Property: Time scale (incl. seasonality), temporal resolution

Continous	

Property: Basic spatial scale

Point to field scale	

Property: Base Units

Mandatory meta data

Location, area, soil map	

Method applied (key words)

Electromagnetic sensors (TDR), wireless soil moisture sensor networks (for plot to field scale), 3 depths including repetitions	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.45   W_storage ⇨ 1ˢᵗ level: Water storage / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: Water storage	**Indicator**:
Parameter: Matrix potential	**Parameter**:
Important related indices	
Property: Frequency	
Continuous	
Property: Time scale (incl. seasonality), temporal resolution	
Continous	
Property: Basic spatial scale	
Point to field scale	
Property: Base Units	
Mandatory meta data	
Location, area, soil map	
Method applied (key words)	
pf-Meter, tensiometer	
Method references: specific to sites, not internationally applied	
Method references: established, internationally applied	

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.46   W_storage ⇨ 1st level: Water storage / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: Water storage	**Indicator**:
Parameter: Soil Temperature	**Parameter**:
Important related indices	
Property: Frequency	
Continuous	
Property: Time scale (incl. seasonality), temporal resolution	
Continous	
Property: Basic spatial scale	
Point to field scale	
Property: Base Units	
Mandatory meta data	
Location, area, soil map	
Method applied (key words)	
Temperature Sensors	
Method references: specific to sites, not internationally applied	
Method references: established, internationally applied	

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.47   W_output ⇨ 1st level: Water output / 2nd level: Runoff (measured or modelled); Water circulation and residence time

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Water output	**Indicator**: Runoff (measured or modelled); Water circulation and residence time
Parameter: Potential evapotranspiration; Lysimetric water: Base cations (K, Na, Ca, Mg), SO42-, NO3-, Cl-, Pb, Cd, pH;	**Parameter**: Lysimetric water: Base cations (K, Na, Ca, Mg), SO42-, NO3-, Cl-, Pb, Cd, pH; Water circulation and residence time

Important related indices

Property: Frequency

Annual, every 2-3 months; monthly, daily	Annual, every 2-3 months; monthly, daily

Property: Time scale (incl. seasonality), temporal resolution

Annual	Annual

Property: Basic spatial scale

Site, catchment	Site

Property: Base Units

Mandatory meta data

Location, plot/area size, model tool reference	Location, plot/area size, model tool reference

Method applied (key words)

From basic climate parameters, models, discharge weirs	Catchment level measurements, modelling, calculated balance

Method references: specific to sites, not internationally applied

Jakucs P. (1985): Ecology of an oak forest in	Jakucs P. (1985): Ecology of an oak forest in

Hungary. Akadémiai Kiadó, Budapest. (lysimeter study)	Hungary. Akadémiai Kiadó, Budapest. (lysimeter study)

Method references: established, internationally applied

ICP IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en	ICP IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.48   W_output ⇨ 1ˢᵗ level: Water output / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Water output	**Indicator**:
Parameter: Evapotranspiration, latent heat flux, sensible heat flux	**Parameter**:

Important related indices

Property: Frequency

Continuous, temporal resolution 30 min	

Property: Time scale (incl. seasonality), temporal resolution

Continuous	

Property: Basic spatial scale

Site	

Property: Base Units

mmol m-2 s-1, W m-2	

Mandatory meta data

Method (e.g. Bowen ratio energy balance, eddy covariance), measuring height, fetch, type of gas analyser (closed, open, enclosed),	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.49   W_output ⇨ 1ˢᵗ level: Stomatal conductance / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Stomatal conductance	**Indicator**:
Parameter: Stomatal conductance	**Parameter**:

Important related indices

Property: Frequency

Depending on treatments; standard: bi-monthly	

Property: Time scale (incl. seasonality), temporal resolution

Most relevant during growing season	

Property: Basic spatial scale

Plant	

Property: Base Units

mmol m-2 s-1	

Mandatory meta data

Leaf/canopy temperature for correlations; SWC/SWP for thresholds	

Method applied (key words)

Porometer	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.50   W_output ⇨ 1ˢᵗ level: Runoff/Streamflow / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Runoff/Streamflow	**Indicator**:
Parameter: Runoff gauge	**Parameter**:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Location, plot, catchment size	

Method applied (key words)

e.g. Venturi flume, V-notch weir, Laser-Doppler	

Method references: specific to sites, not internationally applied

Guide to Hydrological Practices, Sixth Edition 2008, Volume I: Hydrology - From Measurement to Hydrological Information	Guide to Hydrological Practices, Sixth Edition 2008, Volume I: Hydrology - From Measurement to Hydrological Information

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.51   W_output ⇨ 1ˢᵗ level: Water Quality / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Water Quality	**Indicator**:
Parameter: Water Temperature; Water pH; Water Redox Potential; Chlorophyll a; O2-saturation; Turbidity; Cl, NO3	**Parameter**:

Important related indices

Property: Frequency

Continuous	

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Location, plot, catchment size	

Method applied (key words)

Multiparameter Probe	

Method references: specific to sites, not internationally applied

Guide to Hydrological Practices, Sixth Edition 2008, Volume I: Hydrology - From Measurement to Hydrological Information	Guide to Hydrological Practices, Sixth Edition 2008, Volume I: Hydrology - From Measurement to Hydrological Information

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.52 W_other state variables ⇨ 1st level: Lysimetric water / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Lysimetric water	**Indicator**:
Parameter: Base cations (K, Na, Ca, Mg), SO42-, NO3-, Cl-, Pb, Cd, pH; DOC, DON	**Parameter**:

Important related indices

Property: Frequency

Constant	

Property: Time scale (incl. seasonality), temporal resolution

Constant	

Property: Basic spatial scale

Site, chatchment	

Property: Base Units

g m-3	

Mandatory meta data

Date, location, plot/area size, frequency of observations, method reference	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

TERRESTRIAL SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.1.53   W_efficiency measures ⇨ 1ˢᵗ level: Water balance / 2ⁿᵈ level: Water circulation and residence time

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: Water balance	**Indicator**: Water circulation and residence time
Parameter: Water balance	**Parameter**: Water circulation and residence time
Important related indices	
Property: Frequency	
Annual	Annual
Property: Time scale (incl. seasonality), temporal resolution	
Annual	Annual
Property: Basic spatial scale	
Plot/site	Plot/site
Property: Base Units	
Mandatory meta data	
Location, plot/area size, model tool reference	Location, plot/Area size, model tool reference
Method applied (key words)	
Calculated/modelled	Model calculation
Method references: specific to sites, not internationally applied	
Method references: established, internationally applied	

8.2   River Systems

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.1   Flora Diversity ⇨ 1ˢᵗ level: Abundance (macrophytes, phytobenthos), Percentage cover (macrophytes) / 2ⁿᵈ level: Phenology/seasonality of primary producers

INDICATOR FACT SHEET

LEVEL 1 Indicator   LEVEL 2 Indicator

Indicators and explicit parameters

Indicator: Abundance (macrophytes, phytobenthos), Percentage cover (macrophytes)	**Indicator**: Phenology/seasonality of primary producers
Parameter: Abundance data (or other quantitative data) on macrophytes, phytobenthos;	**Parameter**: Same taxonomic groups as 1. level parameters
percentage cover (macrophytes);	
Focal vascular species (eg. sensitive to climate and land use change - anthropogenic effects, Habitat Directive)	

Important related indices

Shannon, Simpson,	
Species turn-over,	
Rarefaction curves,	
Phylogenetic diversity,	
Population growth rate,	
Eutrophication indicators e.g. ROTT	

Property: Frequency

Annual	Weekly/monthly

Property: Time scale (incl. seasonality), temporal resolution

Mostly summer. But in communities with strong seasonal gradients more than one sampling per year may be necessary (all species ocurring should be recorded).	Same as 1. level parameters
Phytobenthos: sampling after prolonged periods of low water is recommended to avoid atypical communities in areas of intermittent inundation	

Property: Basic spatial scale

Macrophytes: sampling of min. 100m reach, representative for the site, coverage of all microhabitats; Phytobenthos: sampling of min. 20m reach, representative for the site, coverage of all microhabitats; Sampling effort relative to microhabitat coverage within sampled reach	Same as 1. level parameters

Property: Base Units

%, number	Same as 1. level parameters

Mandatory meta data

Survey date, location, plot/area size, frequency of observations, biotope description, method reference, design of sampling	Same as 1. level parameters

Method applied (key words)

Macrophytes: Water Framework Directive-compliant vegetation relevee; Phytobenthos: filamentous algae: estimate of percent coverage of each microhabitat, diatoms: at least 5 subsamples of approx. 100 cm² per reach, at least a pooled sample volume of 5ml sedimented Phytobenthos material; species detection at 1000-1500 magnification, determination of min. 400 diatoms per sample	

Method references: specific to sites, not internationally applied

Komarkowa et al. (1995).; Ostrowska et al. (1991). Schaumburg et al. (2004a, b, c) and Schaumburg et al. (2005). Handlungsanweisung für die ökologische Bewertung von Fließgewässern zur Umsetzung der EU-Wasserrahmenrichtlinie: Makrophyten und Phytobenthos, Projekt-Acronym PHYLIB Weyer (2003). LUA-Merkblatt 39, Essen; http://wiki.flussgebiete.nrw.de/index.php/Leitfaden_Monitoring_Oberfl%C3%A4chengew%C3%A4sser_Teil_A_/_Biologische_Qualit%C3%A4tskomponenten	Komarkowa et al. (1995).; Ostrowska et al. (1991). Schaumburg et al. (2004a, b, c) and Schaumburg et al. (2005). Handlungsanweisung für die ökologische Bewertung von Fließgewässern zur Umsetzung der EU-Wasserrahmenrichtlinie: Makrophyten und Phytobenthos, Projekt-Acronym PHYLIB Weyer (2003). LUA-Merkblatt 39, Essen; http://wiki.flussgebiete.nrw.de/index.php/Leitfaden_Monitoring_Oberfl%C3%A4chengew%C3%A4sser_Teil_A_/_Biologische_Qualit%C3%A4tskomponenten

Method references: established, internationally applied

http://www.nsshare.com/publications/documents/Ecological%20Classification%20Tools/Methods%2	http://www.nsshare.com/publications/documents/Ecological%20Classification%20Tools/Method

0Manuals%20T1/Methods%20Manual%20I%20%20River%20Macrophyte.pdf;	s%20Manuals%20T1/Methods%20Manual%20I%20%20River%20Macrophyte.pdf;
http://ec.europa.eu/environment/water/water-framework/index_en.html	http://ec.europa.eu/environment/water/water-framework/index_en.html

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.2   Fauna Diversity ⇨ 1st level: Macroinvertebrate abundances / 2nd level: Biomass, phenology, age structure, emergence data

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Macroinvertebrate abundances	**Indicator**: Biomass, phenology, age structure, emergence data
Parameter: Densities of taxa on Operational taxa list (Detection of taxa to the lowest feasible taxonomic group)	**Parameter**: Same taxonomic groups as 1. level parameters

Important related indices

Shannon, Simpson, Species turn-over, Rarefaction curves, Phylogenetic diversity, Population growth rate; Indices indicating organic pollution and hydromorphological degradation (ASPT/Saprobic indices/Fauna Indices)	

Property: Frequency

Annual	Monthly to yearly, depending on group

Property: Time scale (incl. seasonality), temporal resolution

Spring/summer; depends on stream type and ecoregion	Same as 1. level parameters

Property: Basic spatial scale

Macroinvertebrates: sampling of min. 100m reach, representative for the site, coverage of all microhabitats; Sampling effort relative to microhabitat coverage within sampled reach	Same as 1. level parameters

Property: Base Units

Number	Same as 1. level parameters

Mandatory meta data

Survey date, location, plot/area size, frequency of observations, biotope description, method reference, design of sampling	Same as 1. level parameters

Method applied (key words)

Water Framework Directive-compliant sampling protocol	Same as 1. level parameters

Method references: specific to sites, not internationally applied

http://wiki.flussgebiete.nrw.de/index.php/Leitfaden_Monitoring_Oberfl%C3%A4chengew%C3%A4sser_Teil_A_/_Biologische_Qualit%C3%A4tskomponenten; http://www.fliessgewaesserbewertung.de/download/bestimmung/	http://wiki.flussgebiete.nrw.de/index.php/Leitfaden_Monitoring_Oberfl%C3%A4chengew%C3%A4sser_Teil_A_/_Biologische_Qualit%C3%A4tskomponenten; http://www.fliessgewaesserbewertung.de/download/bestimmung/

Method references: established, internationally applied

http://fame.boku.ac.at/downloads/D4_6_metrics_and_sampling_procedure.pdf; http://ec.europa.eu/environment/water/water-framework/index_en.html; AQEM/STAR protocols: http://www.eu-star.at/pdf/Deliverable8.pdf	http://fame.boku.ac.at/downloads/D4_6_metrics_and_sampling_procedure.pdf; http://ec.europa.eu/environment/water/water-framework/index_en.html; AQEM/STAR protocols: http://www.eu-star.at/pdf/Deliverable8.pdf

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.3 Fauna Diversity ⇨ 1ˢᵗ level: Fish / 2ⁿᵈ level: Biomass, phenology, age structure

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Fish	**Indicator**: Biomass, phenology, age structure
Parameter: Densities on full fish species list	**Parameter**: Same taxonomic groups as 1. level parameters

Important related indices

Shannon, Simpson, Species turn-over, Rarefaction curves, Phylogenetic diversity, Population growth rate; Indices indicating organic pollution and hydromorphological degradation, e.g. European Fish Index	

Property: Frequency

Annual	Monthly to yearly, depending on group

Property: Time scale (incl. seasonality), temporal resolution

Summer/fall; depends on stream type and ecoregion	Same as 1. level parameters

Property: Basic spatial scale

Sampling of min. 200m reach (small stream), min 400m reach (large stream), coverage of all available microhabitats; Sampling effort relative to microhabitat coverage within sampled reach	Same as 1. level parameters

Property: Base Units

Number	Same as 1. level parameters

Mandatory meta data

Survey date, location, plot/area size, frequency of observations, biotope description, method reference, design of sampling	Same as 1. level parameters

Method applied (key words)

Electrofishing: Water Framework Directive-compliant protocol	Same as 1. level parameters

Method references: specific to sites, not internationally applied

Dussling et al. (2004)	Dussling et al. (2004)

Method references: established, internationally applied

http://fame.boku.ac.at/downloads/manual_Version_Februar2005.pdf	http://fame.boku.ac.at/downloads/manual_Version_Februar2005.pdf

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.4   Within Habitat Structure ⇨ 1ˢᵗ level: No high priority / 2ⁿᵈ level: Vegetation cover, shell beds

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: No high priority	**Indicator**: Vegetation cover, shell beds
Parameter:	**Parameter**: % coverage of ground, e.g. by submerged/emergent macrophytes, mussels,…

Important related indices

Property: Frequency

	Yearly

Property: Time scale (incl. seasonality), temporal resolution

	Summer, but depending on taxonomic group

Property: Basic spatial scale

	Plot

Property: Base Units

	%

Mandatory meta data

	Survey date, location, plot/area size, frequency of observations, biotope description, method reference, design of sampling

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.5   Additional Variables ⇨ 1ˢᵗ level: Proportion of invasive/non-native species / 2ⁿᵈ level: Proportion of invasive/non-native species based on biomass

INDICATOR FACT SHEET

LEVEL 1 Indicator   LEVEL 2 Indicator

Indicators and explicit parameters

Indicator: Proportion of invasive/non-native species	**Indicator**: Proportion of invasive/non-native species based on biomass
Parameter: Relative species number, relativ abundances in relation to native species	**Parameter**: Relative biomass in relation to native species

Important related indices

Proportion of invasive/non-native species in a group	

Property: Frequency

Monthly/yearly, depending on group	Monthly/yearly, depending on group

Property: Time scale (incl. seasonality), temporal resolution

All	All

Property: Basic spatial scale

Single point (depending on lake size many points)	Single point (depending on lake size many points)

Property: Base Units

%	%

Mandatory meta data

Survey date, location, plot/area size, frequency of observations, biotope description, method reference, design of sampling	Survey date, location, plot/area size, frequency of observations, biotope description, method reference, design of sampling

Method applied (key words)

Depends on taxon (macrophyte, phytobenthos, macroinvertebrate, fish)	

Method references: specific to sites, not internationally applied

See individual taxonomic groups	See individual taxonomic groups

Method references: established, internationally applied

See individual taxonomic groups	See individual taxonomic groups

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures* ⇨ *Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.2.6 **Soil ⇨ 1ˢᵗ level: Sediment characterization / 2ⁿᵈ level: Spatial substrate heterogeneity**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Sediment characterization	**Indicator**: Spatial substrate heterogeneity
Parameter: Granulometric fractions, proportion organic contents	**Parameter**: Variability of substrate types between plots

Important related indices

Sediment substrate composition	

Property: Frequency

After disturbance events/ yearly; Depending on river type, longer intervals may be sufficient	Same as 1. level parameters

Property: Time scale (incl. seasonality), temporal resolution

Not very important	Same as 1. level parameters

Property: Basic spatial scale

Generally three replicates per station	Same as 1. level parameters

Property: Base Units

%, concentrations, …	Same as 1. level parameters

Mandatory meta data

Survey date, location, plot/area size, frequency of observations, biotope description, method reference, design of sampling	Same as 1. level parameters

Method applied (key words)

Box corer	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures* ⇨ *Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.2.7   Water ⇨ 1ˢᵗ level: Turbidity, oxygen, conductivity, pH, water temperature, gauge level (or discharge) / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   LEVEL 2 Indicator

Indicators and explicit parameters

Indicator: Turbidity, oxygen, conductivity, pH, water temperature, gauge level (or discharge)	**Indicator**:
Parameter: Turbidity, oxygen, conductivity, pH, water temperature, gauge level (or discharge)	**Parameter**:

Important related indices

Daily/monthly/seasonal/annual means, maxima, minima, amplitudes	

Property: Frequency

Ideal resolution: daily or higher measuring frequency.	

Property: Time scale (incl. seasonality), temporal resolution

All year	

Property: Basic spatial scale

Site	

Property: Base Units

Depends on parameter, preferably SI units	

Mandatory meta data

Location, plot/area size that this measurement is representative for, frequency of observations, biotope description	

Method applied (key words)

Loggers	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

| ICP water protocols | ICP water protocols |

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.8   Air ⇨ 1ˢᵗ level: Basic climate of the site (ranges, interannual variability, extremes, etc.) / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Basic climate of the site (ranges, interannual variability, extremes, etc.) **Parameter**: Temperature, wind direction, wind speed, precipitation	**Indicator**: **Parameter**:

Important related indices

Wind fetch	

Property: Frequency

Continuous/daily, for analysis these data can be used to calculate monthly/seasonla/annual means…	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Site	

Property: Base Units

Mandatory meta data

Survey date, location, plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Automatic sampling devices	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.9   Habitat ⇨ 1ˢᵗ level: Habitat type diversity / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Habitat type diversity	**Indicator**:
Parameter: Coverage of different microhabitat types	**Parameter**:

Important related indices

Shannon, Spatial diversity indices	

Property: Frequency

Annually	

Property: Time scale (incl. seasonality), temporal resolution

Annual, together with biotic sampling	

Property: Basic spatial scale

Plot/stream reach	

Property: Base Units

Mandatory meta data

Survey date, location, plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures* ⇨ *Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.2.10   Additional Variables ⇨ 1ˢᵗ level: Hydromorphological intactness, land use in catchment / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Hydromorphological intactness, land use in catchment **Parameter**: Hydromorphology of the stream reach, land use in catchment	**Indicator**: **Parameter**:

Important related indices

Property: Frequency

5-annually	

Property: Time scale (incl. seasonality), temporal resolution

Uncritical, best together with biotic sampling	

Property: Basic spatial scale

Site/landscape	

Property: Base Units

Mandatory meta data

Survey date, location, plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Hydromorphology: WFD-compliant protocol (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000L0060:EN:NOT); land use: CORINE/EUNIS land use/habitats;	

EU Habitat Directive (connection to remote sensing)	

Method references: specific to sites, not internationally applied

http://www.idrolab.ise.cnr.it/index.php?option=com_content&view=article&id=71&Itemid=59&lang=en	http://www.idrolab.ise.cnr.it/index.php?option=com_content&view=article&id=71&Itemid=59&lang=en

Method references: established, internationally applied

APAT IRSA -CNR (2003), Metodi analitici per le acque. Manuali e linee guida 29/2003;	APAT IRSA -CNR (2003), Metodi analitici per le acque. Manuali e linee guida 29/2003;
Standard Methods for the Examination of Water and Wastewater, 20th Edition;	Standard Methods for the Examination of Water and Wastewater, 20th Edition;
Goltermann, H.L., R. S. Clymo & M. A. M. Ohnstad. 1978. Method for physical and chemical ana	Goltermann, H.L., R. S. Clymo & M. A. M. Ohnstad. 1978. Method for physical and chemical ana

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.11   E_input ⇨ 1ˢᵗ level: Radiation: total irradiance, PAR; Temperature: heat fluxes / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: Radiation: total irradiance, PAR; Temperature: heat fluxes **Parameter**: Air / water Temperature; Total irradience, PAR	**Indicator**: **Parameter**:
Important related indices	
Temperature: daily/monthly/seasonal/annual means, maxima, minima, amplitudes	
Property: Frequency	
Ideal resolution for temperature: daily or higher measuring frequency;	
Property: Time scale (incl. seasonality), temporal resolution	
All year (temperature); Summer (PAR)	
Property: Basic spatial scale	
Site	
Property: Base Units	
Diverse	
Mandatory meta data	
Location, plot/area size that this measurement is representative for, frequency of observations, biotope description	
Method applied (key words)	
Temperature loggers, remote sensing	
Method references: specific to sites, not internationally applied	

Method references: established, internationally applied

WMO - World Meteorological Organization => http://www.wmo.int/pages/prog/www/IMOP/IMOP-home.html	WMO - World Meteorological Organization => http://www.wmo.int/pages/prog/www/IMOP/IMOP-home.html
IPC IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en	IPC IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en
IPC Forests => http://icp-forests.net/page/icp-forests-manual	IPC Forests => http://icp-forests.net/page/icp-forests-manual

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.12   E_storage ⇨ 1st level: / 2nd level: Energy storage

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	**Indicator**: Energy storage
Parameter:	**Parameter**: Clorophyll a, Phytobenthos (etc.) biomass estimated from cell volume and abundance

Important related indices

Property: Frequency

	Monthly /fortnightly

Property: Time scale (incl. seasonality), temporal resolution

	All

Property: Basic spatial scale

	Station

Property: Base Units

Mandatory meta data

	Location, plot/area size that this measurement is representative for, frequency of observations, biotope description

Method applied (key words)

	Water column sampling, different levels (depths)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.13   E_output ⇨ 1ˢᵗ level: / 2ⁿᵈ level: Heat fluxes, light reflection

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator:	**Indicator**: Heat fluxes, light reflection
Parameter:	**Parameter**:
Important related indices	
Property: Frequency	
	Yearly
Property: Time scale (incl. seasonality), temporal resolution	
Property: Basic spatial scale	
	Catchment scale
Property: Base Units	
Mandatory meta data	
	Location, catchment data (e.g. size, biotope description), frequency of estimations
Method applied (key words)	
Method references: specific to sites, not internationally applied	
Method references: established, internationally applied	

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.14   E_other state variables ⇨ 1st level: / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	**Indicator**:
Parameter:	**Parameter**:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.15   E_efficiency measures ⇨ 1ˢᵗ level: / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	**Indicator**:
Parameter:	**Parameter**:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.16   M_input ⇨ 1st level: Nutrients (N, P) / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: Nutrients (N, P) **Parameter**: Standard (ISO) methods; monthly maxima	**Indicator**: **Parameter**:
Important related indices	
Property: Frequency	
Monthly	
Property: Time scale (incl. seasonality), temporal resolution	
All	
Property: Basic spatial scale	
Site	
Property: Base Units	
Mandatory meta data	
Location, plot/area size that this measurement is representative for, frequency of observations, biotope description	
Method applied (key words)	
Devices	
Method references: specific to sites, not internationally applied	
http://www.idrolab.ise.cnr.it/index.php?option=com_content&view=article&id=71&Itemid=59&lang=en	http://www.idrolab.ise.cnr.it/index.php?option=com_content&view=article&id=71&Itemid=59&lang=en
Method references: established, internationally applied	
APAT IRSA -CNR (2003), Metodi analitici per le	APAT IRSA -CNR (2003), Metodi analitici per le

acque. Manuali e linee guida 29/2003;	acque. Manuali e linee guida 29/2003;
Standard Methods for the Examination of Water and Wastewater, 20th Edition;	Standard Methods for the Examination of Water and Wastewater, 20th Edition;
Goltermann, H.L., R. S. Clymo & M. A. M. Ohnstad. 1978. Method for physical and chemical ana	Goltermann, H.L., R. S. Clymo & M. A. M. Ohnstad. 1978. Method for physical and chemical ana

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.2.17   M_storage ⇨ 1ˢᵗ level: Living biomass / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Living biomass	**Indicator**:
Parameter: Biomass of main groups of aquatic organisms (mostly fish, benthic invertebrates, phytobenthos)	**Parameter**:

Important related indices

Property: Frequency

Monthly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Point/plot measurement	

Property: Base Units

Mandatory meta data

Location, plot/area size that this measurement is representative for, frequency of observations, biotope description	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.18   **M_output ⇨ 1ˢᵗ level: Drift rates, emergence data, harvesting / 2ⁿᵈ level:**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Drift rates, emergence data, harvesting	**Indicator**:
Parameter: Drift rates of benthic invertebrates, fishing yields, biomass of emerging insects	**Parameter**:

Important related indices

Property: Frequency

Variable	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Point/plot measurement	

Property: Base Units

Mandatory meta data

Location, plot/area size that this measurement is representative for, frequency of observations, biotope description	

Method applied (key words)

Drift rates: drift netting	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.19   M_other state variables ⇨ 1ˢᵗ level: / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	**Indicator**:
Parameter:	**Parameter**:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.2.20   M_+C5efficiency measures ⇨ 1ˢᵗ level: / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	**Indicator**:
Parameter:	**Parameter**:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.21 W_input ⇨ 1ˢᵗ level: Precipitation, discharge beginning / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Precipitation, discharge beginning	**Indicator**:
Parameter: Precipitation, discharge beginning	**Parameter**:

Important related indices

Property: Frequency

Ideal resolution: daily or higher measuring frequency	

Property: Time scale (incl. seasonality), temporal resolution

All year	

Property: Basic spatial scale

Site	

Property: Base Units

Mandatory meta data

location, plot/area size that this measurement is representative for, frequency of observations, biotope description	

Method applied (key words)

Devices	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.22   W_storage ⇨ 1ˢᵗ level: Water retention, storage / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Water retention, storage	**Indicator**:
Parameter: Water velocity (multiplied with section length and morphology, residence time and retention can be calculated)	**Parameter**:

Important related indices

Property: Frequency

Daily	

Property: Time scale (incl. seasonality), temporal resolution

All year	

Property: Basic spatial scale

Site	

Property: Base Units

Mandatory meta data

location, plot/area size that this measurement is representative for, frequency of observations, biotope description	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.23   **W_output ⇨ 1ˢᵗ level: Discharge end point / 2ⁿᵈ level:**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Discharge end point	**Indicator**:
Parameter: Discharge end point	**Parameter**:

Important related indices

Property: Frequency

Ideal resolution: daily or higher measuring frequency	

Property: Time scale (incl. seasonality), temporal resolution

All year	

Property: Basic spatial scale

Site	

Property: Base Units

Mandatory meta data

location, plot/area size that this measurement is representative for, frequency of observations, biotope description	

Method applied (key words)

Devices	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.24   W_other state variables ⇨ 1ˢᵗ level: / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	**Indicator**:
Parameter:	**Parameter**:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

RIVER SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.2.25   W_efficiency measures ⇨ 1ˢᵗ level: / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	**Indicator**:
Parameter:	**Parameter**:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

8.3   Lake Systems

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.1 Flora Diversity ⇨ 1ˢᵗ level: Diversity indices (taxonomic and/or functional) on primary producers / 2ⁿᵈ level: Phenology/seasonality of primary producers; %blue-green algae

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Diversity indices (taxonomic and/or functional) on primary producers	**Indicator**: Phenology/seasonality of primary producers; %blue-green algae
Parameter: Species coverages, densities or biomass/biovolume (depending on taxonomic group), e.g. macrophyte coverages,	**Parameter**: Same taxonomic groups as 1. level parameters
biovolumes of Cyanobacteria (particularly bloom-forming species; N2-fixers), Bacillariophyceae, Chlorophytes, Dinoflagellates, picopytoplankton	

Important related indices

See species richness measures in Base units column; Shannon	

Property: Frequency

Monthly /fortnightly (depending on taxonomic group), e.g macrophyte coverages (yearly during the growth season), Phytoplankton (monthly or fortnightly), Microphytobenthos (monthly or fortnightly).	Weekly

Property: Time scale (incl. seasonality), temporal resolution

All	Same as 1. level parameters

Property: Basic spatial scale

Single point (small lakes); Large lakes: several sampling points to cover within-lake heterogeneities	Same as 1. level parameters

Property: Base Units

Species richness: no. of species/lake	Same as 1. level parameters
Species density: number of species/m2 km2 or m3	
Rarefied species richness: e.g. number of species/100 or 1000 sampled individuals	
% of biomass (% abundance of particular phytoplankton taxa)	
mg/m3 (biomass of particular phytoplankton taxa)	

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	Same as 1. level parameters

Method applied (key words)

Vegetation relevees; Water column sampling, different levels (depths);	
Consider collection with a pipe of integrated water sample from epilimnion/euphotic zone	

Method references: specific to sites, not internationally applied

Bernatowicz S. & Wolny P. (1969). Botanika rybacka, Państwowe Wydawnictwo Rolnicze i Leśne, Warszawa, 421 str.;	Bernatowicz S. & Wolny P. (1969). Botanika rybacka, Państwowe Wydawnictwo Rolnicze i Leśne, Warszawa, 421 str.;
Ozimek T.& Kowalczewski A. (1984). Long-term changes of the submerged macrophytes in eutrophic lake Mikołajskie (North Poland). Aquatic Botany 19 (1-2): 1-11.;	Ozimek T.& Kowalczewski A. (1984). Long-term changes of the submerged macrophytes in eutrophic lake Mikołajskie (North Poland). Aquatic Botany 19 (1-2): 1-11.;
Wellburn A.R. (1994). J. Plant Physiol. 144: 307-313.;	Wellburn A.R. (1994). J. Plant Physiol. 144: 307-313.;
http://www.ysi.com/parametersdetail.php?Chlorophyll-6;	http://www.ysi.com/parametersdetail.php?Chlorophyll-6;
http://icts.ebd.csic.es/CambiarIdiomaAction.do;jsessionid=DC4D0AC18742FC6CC3A2740B92181DD2.icts_A?idioma=ingles	http://icts.ebd.csic.es/CambiarIdiomaAction.do;jsessionid=DC4D0AC18742FC6CC3A2740B92181DD2.icts_A?idioma=ingles

Method references: established, internationally applied

MacIsaac EA & Stockner JG (1993). Enumeration of Phototrophic Picoplankton by Autofluorescence Microscopy. – In: Kemp, PF, Sherr BF, Sherr EB, Cole JJ(Eds): Handbook of methods in aquatic microbial ecology, Lewis Publishers, Boca Raton, Ann Arbor, London, Tokyo: pp. 187-197; http://www.mountain-lakes.org/molar/	MacIsaac EA & Stockner JG (1993). Enumeration of Phototrophic Picoplankton by Autofluorescence Microscopy. – In: Kemp, PF, Sherr BF, Sherr EB, Cole JJ(Eds): Handbook of methods in aquatic microbial ecology, Lewis Publishers, Boca Raton, Ann Arbor, London, Tokyo: pp. 187-197; http://www.mountain-lakes.org/molar/
Wetzel & Likens (1991). Limnological analyses pp. 147-156	Wetzel & Likens (1991). Limnological analyses

EN 15204:2006 Water quality - Guidance standard on the enumeration of phytoplankton using inverted microscopy (Utermöhl technique) (describes a general procedure for the estimation of abundance and taxonomic composition of marine and freshwater phytoplankton by using inverted light microscopy and sedimentation chambers) See: www.cen.eu/cen/Sectors/TechnicalCommitteesWorkshops/CENTechnicalCommittees/Pages/Standards.aspx?param=6211&title=CEN/TC 230 EN 15460:2007. Water quality - Guidance standard for the surveying of macrophytes in lakes (The information provided by this method includes the composition and abundance of the aquatic macrophyte flora. For a complete assessment of ecological status, other elements of biological quality should also be assessed. The general principle of the approach described in this European Standard may also form the basis for the monitoring and assessment of macrophytes in lakes, for example, for conservation purposes.) See: http://www.cen.eu/cen/Sectors/TechnicalCommitteesWorkshops/CENTechnicalCommittees/Pages/Standards.aspx?param=6211&title=CEN/TC%20230	pp. 147-156 EN 15204:2006 Water quality - Guidance standard on the enumeration of phytoplankton using inverted microscopy (Utermöhl technique) (describes a general procedure for the estimation of abundance and taxonomic composition of marine and freshwater phytoplankton by using inverted light microscopy and sedimentation chambers) See: www.cen.eu/cen/Sectors/TechnicalCommitteesWorkshops/CENTechnicalCommittees/Pages/Standards.aspx?param=6211&title=CEN/TC 230 EN 15460:2007. Water quality - Guidance standard for the surveying of macrophytes in lakes (The information provided by this method includes the composition and abundance of the aquatic macrophyte flora. For a complete assessment of ecological status, other elements of biological quality should also be assessed. The general principle of the approach described in this European Standard may also form the basis for the monitoring and assessment of macrophytes in lakes, for example, for conservation purposes.) See: http://www.cen.eu/cen/Sectors/TechnicalCommitteesWorkshops/CENTechnicalCommittees/Pages/Standards.aspx?param=6211&title=CEN/TC%20230

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.2   Fauna Diversity ⇨ 1st level: Diversity indices (taxonomic and/or functional) / 2nd level: Biomass, phenology, age structure

INDICATOR FACT SHEET

LEVEL 1 Indicator   LEVEL 2 Indicator

Indicators and explicit parameters

Indicator: Diversity indices (taxonomic and/or functional)	**Indicator**: Biomass, phenology, age structure
Parameter: Species abundances, e.g. rotifers, crustacean zooplankton, copepods, benthic invertebrates …	**Parameter**: same taxonomic groups as 1. level parameters

Important related indices

E.g. % Abundance of cyprinid fish, for other indices see Base units column;	
Shannon; Species richness: no. of species/lake	
Species density: number of species/sampled area	
Rarefied species richness: e.g. number of species/100 or 1 000 sampled individuals	
Percent (%) similarity to the model community (PMA, see important indices)	
Biomass g/m2	
Percent model affinity. This index is based on model community comprising the communities of refence site i.e. the sites of pristine or near-natural conditions. Suitable for any group of organisms actually, you just need to comprise reference model community.	
Benthic Quality Index (Suitable for assessment of eutrophication and oxygen conditions of hypolimnial zone in Northern Europe.) The index is based on few profundal (deep bottom) macroinvertebrate taxa.	

Property: Frequency

Monthly/yearly, depending on group	Monthly to yearly, depending on group

Property: Time scale (incl. seasonality), temporal resolution

| All | Same as 1. level parameters |

Property: Basic spatial scale

| Single point (depending on lake size many points) | Same as 1. level parameters |

Property: Base Units

Species richness: no. of species/lake	Same as 1. level parameters
Species density: number of species/m2 or km2	
Rarefied species richness: e.g. number of species/100 or 1 000 sampled individuals	
% of biomass (% abundance of particular taxa of interest)	
mg/m3 (biomass of particular zooplankton taxa of interest)	
Catch per unit of effort in gill-net fishing:	
e.g. kg/gill-net/day or no. of ind./gill-net/day	

Mandatory meta data

| Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling | Same as 1. level parameters |

Method applied (key words)

Fish relevees; Water column sampling, different levels (depths);	Same as 1. level parameters
Consider collection with a pipe of integrated water sample from epilimnion/euphotic zone	

Method references: specific to sites, not internationally applied

Fish: Bíró et al. (2003). Hydrobiologia 506-509: 459-464	Fish: Bíró et al. (2003). Hydrobiologia 506-509: 459-464
Macroinvertebrates and zoobenthos: Specziár & Bíró (1998). Hydrobiologia 389: 203-216	Macroinvertebrates and zoobenthos: Specziár & Bíró (1998). Hydrobiologia 389: 203-216
Zooplankton: Parpala et al. (2003). Hydrobiologia 506-509: 347-351;	Zooplankton: Parpala et al. (2003). Hydrobiologia 506-509: 347-351;
BQI: Wiederholm (1980). Journal of Water Pollution Control Federation 52: 537-547	BQI: Wiederholm (1980). Journal of Water Pollution Control Federation 52: 537-547
PMA: Novak M.A. & Bode R.W. (1992). Journal of North American Benthological Society 11: 80-85	PMA: Novak M.A. & Bode R.W. (1992). Journal of North American Benthological Society 11: 80-85
Gerking, S.D. (1957). Ecology 38: 219-226.	Gerking, S.D. (1957). Ecology 38: 219-226.
Kołodziejczyk A. (1984). Occurrence of Gastropoda in the lake littoral and their role in the production and transformation of detritus. I. Snails in the littoral of Mikołajskie Lake – general	Kołodziejczyk A. (1984). Occurrence of Gastropoda in the lake littoral and their role in the production and transformation of detritus. I. Snails in the littoral of Mikołajskie Lake – general characteristics

characteristics of occurrence. Ekol. pol. 32: 441-468.; Żadin W.I. 1966. Metody badań hydrobiologicznych. Państwowe Wydawnictwo Naukowe, Warszawa, 293 str.;

Lewandowski K. & Stńczykowska A. (1975). The occurrence and role of bivalves of the family Unionidae in Mikołajskie Lake. Ekol. pol. 23: 317-334. ;

Macan T.T. (1977). A key to the British fresh- and brackish-water gastropods. Freshwater Biological Association, 17, 46 pp.;

Piechocki A. (1979). Mięczaki (Mollusca). Ślimaki (Gastropoda). Fauna Słodkowodna Polski 7, PWN, Warszawa-Poznań, 187 str.;

Piechocki A. & Dyduch-Falniowska A. (1993). Mięczaki (Mollusca). Małże (Bivalvia.) Fauna Słodkowodna Polski 7 A, Wydawnictwo Naukowe PWN, Warszawa, 204 str.;

Rybak J.I. & Błędzki L.A. (2010). Słodkowodne skorupiaki planktonowe. Klucz do oznaczania gatunków. Wydawnictwa UW, Warszawa, 366 str.;

Freshwater Biology (2009) 54, 2252–2262;

Tolonen & Hämäläinen (2010). Fundamental and Applied Limnology 176/1: 43-59. For comparison of cost efficiencies of different sampling methods used for macroinvertebrates to detect anthropogenic impacts on lake littoral zone.

http://observatoriosierranevada.iecolab.es/index.php/Trucha;

http://icts.ebd.csic.es/CambiarIdiomaAction.do;jsessionid=DC4D0AC18742FC6CC3A2740B92181DD2.icts_A?idioma=ingles

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.3   Within habitat structure ⇨ 1st level: No high priority / 2nd level: Vegetation cover, shell beds

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: No high priority	**Indicator**: Vegetation cover, shell beds
Parameter:	**Parameter**: % coverage of ground, e.g. by submerged/emergent macrophytes, mussels, …

Important related indices

Property: Frequency

	Yearly

Property: Time scale (incl. seasonality), temporal resolution

	Summer, but depending on taxonomic group

Property: Basic spatial scale

	Plot

Property: Base Units

	%

Mandatory meta data

	Survey date, location, plot/area size, frequency of observations, biotope description, method reference, design of sampling

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.4   Additional Variables ⇨ 1st level: Proportion of invasive/non-native species / 2nd level: Proportion of invasive/non-native species

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Proportion of invasive/non-native species	**Indicator**: Proportion of invasive/non-native species
Parameter: Relative species number, relative abundances in relation to native species	**Parameter**: Relative biomass in relation to native species

Important related indices

Property: Frequency

Monthly/yearly, depending on group	Monthly/yearly, depending on group

Property: Time scale (incl. seasonality), temporal resolution

All	All

Property: Basic spatial scale

Single point (depending on lake size many points)	Single point (depending on lake size many points)

Property: Base Units

%	%

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	Survey date, location, plot/area size, frequency of observations, biotope description, method reference, design of sampling

Method applied (key words)

Vegetation relevees; fish relevees; Water column sampling, different levels (depths); Consider collection with a pipe of integrated water sample from epilimnion/euphotic zone	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.5   **Soil ⇨ 1st level: Particle size distribution / 2nd level: Spatial substrate heterogeneity**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Particle size distribution	**Indicator**: Spatial substrate heterogeneity
Parameter: Granulometric fractions	**Parameter**: Variability of substrate types between plots

Important related indices

Sediment substrate composition	

Property: Frequency

Yearly; Longer intervals may be sufficient	Same as 1. level parameters

Property: Time scale (incl. seasonality), temporal resolution

Not very important	Same as 1. level parameters

Property: Basic spatial scale

Generally three replicates per station	Same as 1. level parameters

Property: Base Units

%, concentrations, …	Same as 1. level parameters

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	Same as 1. level parameters

Method applied (key words)

Box corer; Kajak-type circular corer is commonly used in lakes, at least in Nordic countries	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.6   Water ⇨ 1st level: Seasonal/annual dynamics of Temperature, Salinity, Oxygen, pH, Nutrients, conductivity/salinity, transparancy, water color, … / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Seasonal/annual dynamics of Temperature, Salinity, Oxygen, pH, Nutrients, conductivity/salinity, transparancy, water color, …	**Indicator**:
Parameter: Temperature (from surface to the bottom), Oxygen (from surface to the bottom), Nutrient concentrations (TP, TN, Si), pH, salinity/conductivity, Secchi depth, water color,…	**Parameter**: Ice cover (thickness, duration)

Important related indices

TPmix, C:P stochiometry, C:N stociometry epilimnion thickness	

Property: Frequency

Monthly /fortnightly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Point measures (for large lakes several points are necessary). The best solution is to have the information of this parameters in the same point of the biotic indicators.	

Property: Base Units

Oxygen saturation: % of the maximum Oxygen concentration: mg/l Nutrient concentrations: µg/l or mg/l	

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Water column sampling/ different levels (depths)	

Method references: specific to sites, not internationally applied

http://www.idrolab.ise.cnr.it/index.php?option=com_content&view=article&id=71&Itemid=59&lang=en	http://www.idrolab.ise.cnr.it/index.php?option=com_content&view=article&id=71&Itemid=59&lang=en

Method references: established, internationally applied

APAT IRSA -CNR (2003), Metodi analitici per le acque. Manuali e linee guida 29/2003;	APAT IRSA -CNR (2003), Metodi analitici per le acque. Manuali e linee guida 29/2003;
Standard Methods for the Examination of Water and Wastewater, 20th Edition;	Standard Methods for the Examination of Water and Wastewater, 20th Edition;
Goltermann, H.L., R. S. Clymo & M. A. M. Ohnstad. 1978. Method for physical and chemical analysis of fresh waters. I.B.P. N. 8. Blackwell Scientific Publications, Oxford: 214 pp.	Goltermann, H.L., R. S. Clymo & M. A. M. Ohnstad. 1978. Method for physical and chemical analysis of fresh waters. I.B.P. N. 8. Blackwell Scientific Publications, Oxford: 214 pp.
Greenberg et al. (1992)	Greenberg et al. (1992)
Pęczuła et al. (2003). Factors controlling hydrochemical and trophic state variables in 86 shallow lakes in Europe Hydrobiologia 506-509 (1): 51-58.	Pęczuła et al. (2003). Factors controlling hydrochemical and trophic state variables in 86 shallow lakes in Europe Hydrobiologia 506-509 (1): 51-58.
EN ISO 6878:2004. Water quality - Determination of phosphorus - Ammonium molybdate spectrometric method (ISO 6878:2004). (specifies methods for the determination of orthophosphate, orthophosphate after solvent extraction, hydrolysable phosphate plus orthophosphate, and total phosphorus after decomposition. The methods are applicable to all kinds of water including seawater and effluents.)	EN ISO 6878:2004. Water quality - Determination of phosphorus - Ammonium molybdate spectrometric method (ISO 6878:2004). (specifies methods for the determination of orthophosphate, orthophosphate after solvent extraction, hydrolysable phosphate plus orthophosphate, and total phosphorus after decomposition. The methods are applicable to all kinds of water including seawater and effluents.)
EN ISO 15681-1:2004. Water quality - Determination of orthophosphate and total phosphorus contents by flow analysis (FIA and CFA) - Part 1: Method by flow injection analysis (FIA) (ISO 15681-1:2003). (specifies flow injection analysis (FIA) methods for the determination of orthophosphate in the mass concentration range from 0,01 mg/l to 1,0 mg/l (P), and total phosphorus by manual digestion for the mass concentration range from 0,1 mg/l to 10 mg/l (P). ISO 15681-1:2003 is applicable to various types of	EN ISO 15681-1:2004. Water quality - Determination of orthophosphate and total phosphorus contents by flow analysis (FIA and CFA) - Part 1: Method by flow injection analysis (FIA) (ISO 15681-1:2003). (specifies flow injection analysis (FIA) methods for the determination of orthophosphate in the mass concentration range from 0,01 mg/l to 1,0 mg/l (P), and total phosphorus by manual digestion for the mass concentration range from 0,1 mg/l

water (such as ground, drinking, surface, leachate and waste waters)).

EN ISO 11905-1:1998. Water quality - Determination of nitrogen - Part 1: Method using oxidative digestion with peroxodisulfate (ISO 11905-1:1997). (This international/European standard specifies a method for the determination of nitrogen present in water, in the form of free ammonia, ammonium, nitrite, nitrate and organic nitrogen compounds capable of conversion to nitrate under the oxidative conditions described.)

EN ISO 11732:2005. Water quality - Determination of ammonium nitrogen - Method by flow analysis (CFA and FIA) and spectrometric detection (ISO 11732:2005). (specifies methods suitable for the determination of ammonium nitrogen in various types of waters (such as ground, drinking, surface, and waste waters) in mass concentrations ranging from 0,1 mg/l to 10 mg/l applying either FIA or CFA.)

EN ISO 13395:1996. Water quality - Determination of nitrite nitrogen and nitrate nitrogen and the sum of both by flow analysis (CFA and FIA) and spectrometric detection (ISO 13395:1996). (According to the methods specified in this document nitrite and nitrate by be determined in large sample series and a high analysis frequency)

EN 25813:1992. Water quality - Determination of dissolved oxygen - Iodometric method (ISO 5813:1983). (Specifies the so-called Winkler procedure modified in order to make allowance for certain interferences. It is the reference procedure and applicable to all types of water having concentrations greater than 0,2 mg/l, up to double saturation, which are free from interfering substances.)

EN 25814:1992. Water quality - Determination of dissolved oxygen - Electrotechnical probe method (ISO 5814:1990). Includes a procedure by means of an electrochemical cell which is isolated from the sample by a gas permeable membrane. (Depending on the type of probe employed measurement can be made either as concentration of oxygen, percentage saturation or both. The procedure is suitable for measurements made in the field and for continuous monitoring and in the laboratory. It is the preferred procedure for highly coloured and turbid waters. It is suitable for natural, waste and saline waters.); water color: Nõges, P., Nõges, T., Tuvikene, L., Smal, H., Ligęza,

to 10 mg/l (P). ISO 15681-1:2003 is applicable to various types of water (such as ground, drinking, surface, leachate and waste waters)).

EN ISO 11905-1:1998. Water quality - Determination of nitrogen - Part 1: Method using oxidative digestion with peroxodisulfate (ISO 11905-1:1997). (This international/European standard specifies a method for the determination of nitrogen present in water, in the form of free ammonia, ammonium, nitrite, nitrate and organic nitrogen compounds capable of conversion to nitrate under the oxidative conditions described.)

EN ISO 11732:2005. Water quality - Determination of ammonium nitrogen - Method by flow analysis (CFA and FIA) and spectrometric detection (ISO 11732:2005). (specifies methods suitable for the determination of ammonium nitrogen in various types of waters (such as ground, drinking, surface, and waste waters) in mass concentrations ranging from 0,1 mg/l to 10 mg/l applying either FIA or CFA.)

EN ISO 13395:1996. Water quality - Determination of nitrite nitrogen and nitrate nitrogen and the sum of both by flow analysis (CFA and FIA) and spectrometric detection (ISO 13395:1996). (According to the methods specified in this document nitrite and nitrate by be determined in large sample series and a high analysis frequency)

EN 25813:1992. Water quality - Determination of dissolved oxygen - Iodometric method (ISO 5813:1983). (Specifies the so-called Winkler procedure modified in order to make allowance for certain interferences. It is the reference procedure and applicable to all types of water having concentrations greater than 0,2 mg/l, up to double saturation, which are free from interfering substances.)

EN 25814:1992. Water quality - Determination of dissolved oxygen - Electrotechnical probe method (ISO 5814:1990). Includes a procedure by means of an electrochemical cell which is isolated from the sample by a gas permeable membrane. (Depending on the type of probe employed measurement can be made either as concentration of oxygen, percentage saturation or both. The procedure is suitable for measurements made in the field and for continuous monitoring and in the laboratory. It is

S., Kornijów,	the preferred procedure for highly coloured and turbid waters. It is suitable for natural, waste and saline waters.); water color: Nõges, P., Nõges, T., Tuvikene, L., Smal, H., Ligęza, S., Kornijów,

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.7   Air ⇨ 1st level: Basic climate of the site (ranges, interannual variability, extremes, etc.) / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator

Indicators and explicit parameters

Indicator: Basic climate of the site (ranges, interannual variability, extremes, etc.) **Parameter**: Temperature, wind direction, wind speed, precipitation	**Indicator**: **Parameter**:

Important related indices

Wind fetch	

Property: Frequency

Continuous/daily, for analysis these data can be used to calculate monthly/seasonal/annual means…	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Site	

Property: Base Units

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Automatic sampling devices	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied	

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.8 **Habitat ⇨ 1ˢᵗ level: Transparency, thermoclines and other "clines" / 2ⁿᵈ level:**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Transparency, thermoclines and other "clines"	**Indicator**:
Parameter: Secchi depth, colour (concentration of humic substances) and turbidity; Light extinction coefficient, oxygen	**Parameter**:

Important related indices

Schmidt stability, euphotic depth	

Property: Frequency

Monthly /fortnightly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Single point	

Property: Base Units

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Underwater measurement of photosynthetically actice radiation; Secchi disk visibility or photometer	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

EN ISO 7027:1999. Water quality - Determination of turbidity (ISO 7027:1999).	EN ISO 7027:1999. Water quality - Determination of turbidity (ISO 7027:1999).

Method references: specific to sites, not internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.9   Habitat ⇨ 1ˢᵗ level: Habitat type diversity / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Habitat type diversity	**Indicator**:
Parameter: Coverage of different microhabitat types (e.g. %proportion of littoral habitat types of the shoreline like stony, sandy, soft-organic bottom, vegetated)	**Parameter**:

Important related indices

Shannon, spatial diversity indices	

Property: Frequency

Annually	

Property: Time scale (incl. seasonality), temporal resolution

Annual, together with biotic sampling	

Property: Basic spatial scale

Plot/whole lake	

Property: Base Units

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures* ⇨ *Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.3.10   Additional Variables ⇨ 1ˢᵗ level: Catchment land use / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Catchment land use	**Indicator**:
Parameter: % coverage of land use classes of CORINE land cover	**Parameter**:

Important related indices

Property: Frequency

Annual	

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.11   E_input ⇨ 1ˢᵗ level: Radiation: Total irradiance, PAR;

8.3.12   Temperature: heat fluxes / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Radiation: Total irradiance, PAR; Temperature: heat fluxes **Parameter**: Air / water Temperature; Total irradience, PAR	**Indicator**: **Parameter**:

Important related indices

Temperature: daily/monthly/seasonal/annual means, maxima, minima, amplitudes	

Property: Frequency

Daily	

Property: Time scale (incl. seasonality), temporal resolution

All year (temperature) summer (chl a)	

Property: Basic spatial scale

Site	

Property: Base Units

°C, etc.	

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Temperature loggers, Remote sensing	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

WMO - World Meteorological Organization => http://www.wmo.int/pages/prog/www/IMOP/IMOP-home.html	WMO - World Meteorological Organization => http://www.wmo.int/pages/prog/www/IMOP/IMOP-home.html
IPC IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en	IPC IM => http://www.ymparisto.fi/default.asp?node=6412&lan=en
IPC Forests => http://icp-forests.net/page/icp-forests-manual	IPC Forests => http://icp-forests.net/page/icp-forests-manual

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.13   E_storage ⇨ 1ˢᵗ level: Energy storage / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Energy storage	**Indicator**:
Parameter: Clorophyll a, Phytoplankton (etc.) biomass estimated from cell volume and abundance	**Parameter**:

Important related indices

Property: Frequency

Monthly /fortnightly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Station	

Property: Base Units

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Water column sampling, different levels (depths)	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.14 E_storage ⇨ 1ˢᵗ level: Chlorophyll a, phytoplankton biomass, zooplankton biomass, planktivorous fish biomass, piscivorous fish biomass, profundal macroinvertebrate biomass (focus on pelagic system). Macrophyte biomass, periphyton biomass, littoral macroinvertebrate biomass, lit / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   LEVEL 2 Indicator

Indicators and explicit parameters

Indicator: Chlorophyll a, phytoplankton biomass, zooplankton biomass, planktivorous fish biomass, piscivorous fish biomass, profundal macroinvertebrate biomass (focus on pelagic system). Macrophyte biomass, periphyton biomass, littoral macroinvertebrate biomass, lit	**Indicator**:
Parameter: Total system throughput, overhead on imports, overhead on exports, Average mutual information, Ascendency, capacity, Dissipative overhead, Redundancy, Finn cycling index	**Parameter**:

Important related indices

Averaged values	

Property: Frequency

Monthly /fortnightly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Station	

Property: Base Units

C budgets	

Mandatory meta data

Survey date, location (latitude, longitude and	

| depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling | |

Method applied (key words)

| | |

Method references: specific to sites, not internationally applied

| Bondavalli C. et al. (2006). Detecting stress at the whole ecosystem level. The case of a mountain lake: Lake Santo (Italy). Ecosystems 9: 768-787. | Bondavalli C. et al. (2006). Detecting stress at the whole ecosystem level. The case of a mountain lake: Lake Santo (Italy). Ecosystems 9: 768-787. |

Method references: established, internationally applied

| | |

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.3.15   E_output ⇨ 1ˢᵗ level: Heat fluxes, light reflection / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Heat fluxes, light reflection	**Indicator**:
Parameter:	**Parameter**:

Important related indices

Property: Frequency

Yearly	

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Basin scale	

Property: Base Units

Mandatory meta data

Method applied (key words)

Model	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

**8.3.16	E_other state variables ⇨ 1st level: / 2nd level:**

INDICATOR FACT SHEET

LEVEL 1 Indicator							**LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	Indicator:
Parameter:	Parameter:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.17   E_efficiency measures ⇨ 1ˢᵗ level: Radiation balance / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Radiation balance	**Indicator**:
Parameter:	**Parameter**:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.18   M_input ⇨ 1ˢᵗ level: Nutrient inputs via precipitation, run-off, ... / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Nutrient inputs via precipitation, run-off, ... **Parameter**: DOC, POC, Total N, Total P, soluble reactive phosphorus (SPR), NO3-N, NH4-N	**Indicator**: **Parameter**:

Important related indices

Stoichiometric ratios	

Property: Frequency

Monthly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Point/plot measurement	

Property: Base Units

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Water column sampling, different levels (depths)	

Method references: specific to sites, not internationally applied

http://www.idrolab.ise.cnr.it/index.php?option=com_content&view=article&id=71&Itemid=59&lang=	http://www.idrolab.ise.cnr.it/index.php?option=com_content&view=article&id=71&Itemid=59&lang=

en	en

Method references: established, internationally applied

APAT IRSA -CNR (2003), Metodi analitici per le acque. Manuali e linee guida 29/2003;	APAT IRSA -CNR (2003), Metodi analitici per le acque. Manuali e linee guida 29/2003;
Standard Methods for the Examination of Water and Wastewater, 20th Edition;	Standard Methods for the Examination of Water and Wastewater, 20th Edition;
Goltermann, H.L., R. S. Clymo & M. A. M. Ohnstad. 1978. Method for physical and chemical analysis of fresh waters. I.B.P. N. 8. Blackwell Scientific Publications, Oxford: 214 pp.	Goltermann, H.L., R. S. Clymo & M. A. M. Ohnstad. 1978. Method for physical and chemical analysis of fresh waters. I.B.P. N. 8. Blackwell Scientific Publications, Oxford: 214 pp.
Greenberg et al. (1992)	Greenberg et al. (1992)

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.19   M_storage ⇨ 1ˢᵗ level: Living biomass, biologically available carbon, nitrogen, phosphorus in water and sediments / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Living biomass, biologically available carbon, nitrogen, phosphorus in water and sediments	**Indicator**:
Parameter: Biomass, DOC, POC, Total N, Total P, soluble reactive phosphorus (SPR), NO3-N, NH4-N	**Parameter**:

Important related indices

Average POC	

Property: Frequency

Monthly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Point/plot measurement	

Property: Base Units

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Water column sampling, different levels (depths)	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied	

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.20   M_output ⇨ 1st level: Sedimentation, harvesting, outflow / 2nd level: Mass emergence of insects, sediment removal, other losses

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator

Indicators and explicit parameters

Indicator: Sedimentation, harvesting, outflow **Parameter**: Sediment mass and contents; DOC, POC etc in outflow, Fishing yields	**Indicator**: Mass emergence of insects, sediment removal, other losses **Parameter**:

Important related indices

Sedimentation rate	

Property: Frequency

Yearly integrated	

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Point / plot / whole lake	

Property: Base Units

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Sediment traps integrated measure for unit area	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.3.21   M_other state variables ⇨ 1st level: / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	**Indicator**:
Parameter:	**Parameter**:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.22   M_+C5efficiency measures ⇨ 1st level: Trophic transfer efficency, matter breakdown rates / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Trophic transfer efficency, matter breakdown rates	**Indicator**:
Parameter: Ratios of consumers' production or biomass to that of next lower trophic level	**Parameter**:
e.g. Production of primary consumers (kg C/ha/year)/Primary production (kg C/ha/year)	
or Production of secondary consumers/Production of primary consumers	
or Carbon biomass	

Important related indices

Property: Frequency

Yearly integrated	

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Plot	

Property: Base Units

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Method references: specific to sites, not internationally applied	
Method references: established, internationally applied	

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.3.23   M_+C5efficiency measures ⇨ 1ˢᵗ level: Production / biomass ratio / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Production / biomass ratio	**Indicator**:
Parameter: Ratios of primanry production (kg C/ha/year) / Total living biomass (kg C/ha)	**Parameter**:

Important related indices

Property: Frequency

Yearly integrated	

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Plot	

Property: Base Units

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.24   W_input ⇨ 1ˢᵗ level: Catchment input, precipitation / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Catchment input, precipitation	**Indicator**:
Parameter: Precipitation, Discharge of inflowing streams, Groundwater inflow	**Parameter**:

Important related indices

Property: Frequency

Daily	

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Basin scale	

Property: Base Units

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.25 W_storage ⇨ 1ˢᵗ level: Water level / 2ⁿᵈ level: Water volume

INDICATOR FACT SHEET

LEVEL 1 Indicator   LEVEL 2 Indicator

Indicators and explicit parameters

Indicator: Water level	**Indicator**: Water volume
Parameter: Water level	**Parameter**: Water level (calculated when basin morphology is known)

Important related indices

Property: Frequency

Daily/weekly	Same as 1. level parameters

Property: Time scale (incl. seasonality), temporal resolution

All	Same as 1. level parameters

Property: Basic spatial scale

Basin scale	Same as 1. level parameters

Property: Base Units

cm	Same as 1. level parameters

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	Same as 1. level parameters

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.26   W_output ⇨ 1st level: Evaporation, outflow / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Evaporation, outflow **Parameter**: Discharge of outflowing stream, Evaporation	**Indicator**: **Parameter**:

Important related indices

Annual outflow, residence time	

Property: Frequency

Daily/weekly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Basin scale	

Property: Base Units

Mandatory meta data

Survey date, location (latitude, longitude and depth), plot/area size, frequency of observations, biotope description, method reference, design of sampling	

Method applied (key words)

Measurement/ model	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.3.27   W_other state variables ⇨ 1st level: / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	Indicator:
Parameter:	Parameter:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

LAKE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Water Budget*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.3.28   W_efficiency measures ⇨ **1ˢᵗ level: / 2ⁿᵈ level:**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	**Indicator**:
Parameter:	**Parameter**:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

8.4 Marine Systems

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.1   **Flora Diversity ⇨ 1ˢᵗ level: List of species, absolute and relative abundance, diversity index. / 2ⁿᵈ level: Phytoplankton: cell size, alien species, harmful species.**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: List of species, absolute and relative abundance, diversity index.	**Indicator**: Phytoplankton: cell size, alien species, harmful species.
Parameter: Phytoplankton and microphytobenthos: species richness, total and % abundance and biomass of Bacillariophyceae, Prymnesiophyceae, Dinoflagellates, Nanoflagellates and Cyanobacteria. Macrophyte composition and biomass	**Parameter**: Presence, absence, % abundance, cell size measurements

Important related indices

Shannon, Hulburt, Margalef, Menhinick.	Phytoplankton: presence/absence, % abundance, size

Property: Frequency

Phytoplankton: monthly/fortnightly; Macrophytes and microphytobenthos: "seasonal", i.e. 3 times the year, late winter, spring and summer.	Phytoplankton: monthly.

Property: Time scale (incl. seasonality), temporal resolution

All	All

Property: Basic spatial scale

One single sampling station for phytoplankton, considering the best fit with vertical (water column) and horizontal (site gradients) variability; - HS: transects for macrophytes, for microphytobenthos habitat structure must be taken into account	Phytoplankton: one single sampling station, considering the best fit with vertical (water column) and horizontal (site gradients) variability

Property: Base Units

Phytoplankton: cells l-1 (abundance), g C m-3 (biomass). Microphytobenthos abundance is related to unit of the substrate (either surface or weight of the macrophyte or of the sediment sampled to which the microphytobenthos is associated)	Phytoplankton: cells ml-1 (abundance), mm (Equivalent Spherical Diameter: cell size)

Mandatory meta data

Phytoplankton: survey date and time, location, site depth, sampling depths, frequency of observations, method reference.	Phytoplankton: survey date and time, location, site depth, sampling depths, frequency of observations, method reference. Cell size: number of cells enumerated, biovolume estimation method and Carbon transformation method.

Method applied (key words)

Water column sampling (Niskin bottles), different levels (depths) for phytoplankton; Net samples collected at the same dates; Macrophytes: transect mapping, for microphytobenthos selected sites along the transect, representative for the respective substrate available at the depth stages	Phytoplankton: water column sampling (Niskin bottles), different levels (depths)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

UNESCO (2010). Microscopic and molecular methods for quantitative phytoplankton analysis. UNESCO and IOC (Intergovernmental Oceanographic Commision). Manuals and Guides 55	UNESCO (2010). Microscopic and molecular methods for quantitative phytoplankton analysis. UNESCO and IOC (Intergovernmental Oceanographic Commision). Manuals and Guides 55

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.2   Flora Diversity ⇨ 1st level: Seagrasses: number of species and abundance. For macro and microphytobenthos epiphytes: list and abundance of species / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Seagrasses: number of species and abundance. For macro and microphytobenthos epiphytes: list and abundance of species	**Indicator**:
Parameter: Seagrasses: presence, cover, shoot density, genetic diversity.	**Parameter**:
Macro and microphytobenthos: presence and cover of Rhodophyta, Ochrophyta, Chlorophyta, R/O, Diatoms, morpho-functional groups.	

Important related indices

Seagrasses: density classes and G/N for genetic diversity.	
Epiphytes: Shannon-Wiener, R/O	

Property: Frequency

Seagrass density: once in a year	
Seasonal for the other parameters	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Several sampling stations according to the depth gradient	

Property: Base Units

Seagrass: density = no. of shoots m-2	
Macroepiphytes: cover = % of leaf area.	
Diatoms: no. of cells in 1.25 mm².	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	

Method applied (key words)

Seagrasses: shoot density. 10 shoot counts are performed by trained operators each within 1600cm2 quadrats; mean value is reported to 1 squre meter. Macroalgal epiphytes: 20 shoots are sampled in areas of the meadow with homogeneous characteristics. The covering of individual species or of groups of species is assessed in terms of leaf area covered by the orthogonal projection of the alga onto the leaf. Microepiphytes: 5 shoots are sampled, 3 fragments of 1 cm2 in the basal, central and distal part of the blade are selected and a total surface of 1.25 mm2 is observed by SEM. Genomic DNA is extracted from each single shoot	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

Buia et al. (2004). Mazzella et al. (1994). Migliaccio et al. (2005).	Buia et al. (2004). Mazzella et al. (1994). Migliaccio et al. (2005).

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.3   Fauna Diversity ⇨ 1ˢᵗ level: List of species, abundance, diversity index / 2ⁿᵈ level: Mesozooplankton: alien species, organisms size; Zoobenthos composition and biomass; Zooplankton seasonality

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

LEVEL 1 Indicator	**LEVEL 2 Indicator**
Indicator: List of species, abundance, diversity index	**Indicator**: Mesozooplankton: alien species, organisms size; Zoobenthos composition and biomass; Zooplankton seasonality
Parameter: Micro and mesozooplankton: species richness, % abundance of at least of the major classes	**Parameter**: Mesozooplankton: presence, absence, % abundance, organisms size measurements, ratio of juveniles to adults (for reproductive index)

Important related indices

Shannon, Margalef, Pielou, Simpson	Zooplankton: presence/absence, % abundance, size Reproductive index as a sign of persistency and success of zooplankton populations

Property: Frequency

Zooplankton: monthly / fortnightly As above for macrozoobenthos, Nekton needs to be investigated by a different approach, it cannot be taken at "points" and recruitement as well as population age structure must be taken into account	Zooplankton: monthly

Property: Time scale (incl. seasonality), temporal resolution

All	All

Property: Basic spatial scale

One single sampling station for zooplankton, considering the best fit with vertical (water column) and horizontal (site gradients) variability	Zooplankton: one single sampling station, considering the best fit with vertical (water column) and horizontal (site gradients) variability

Property: Base Units

Zooplankton: ind m-3	Mesozooplankton: ind m-3 (abundance), mm (cell

size)

Mandatory meta data

Zooplankton: survey date and time, location, site depth, sampling depths, frequency of observations, method reference	Zooplankton: survey date and time, location, site depth, sampling depths, frequency of observations, method reference

Method applied (key words)

Mesozooplankton: integrated water column net sampling; Microzooplankton: discrete sampling	Zooplankton: water column sampling (Niskin bottles for microzooplankton; net-samplin for mesozooplankton), different depths for microzooplankton, different depths or water column integrated sampling for mesozooplankton.

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

Harris et al. (2000)	Harris et al. (2000)

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.4   Fauna Diversity ⇨ 1st level: List of species, abundance, diversity index / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   LEVEL 2 Indicator

Indicators and explicit parameters

Indicator: List of species, abundance, diversity index	**Indicator**:
Parameter: Identity and abundance of selected groups of Annelida, Molluscs, Crustaceans	**Parameter**:

Important related indices

Shannon-Wiener, Equitability, Index of Borers (IB)	

Property: Frequency

Seasonal	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Several sampling stations along the depth gradient of the seagrass bed	

Property: Base Units

Ind m-2	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	

Method applied (key words)

The sampling of the motile macro-invertebrates is conducted with a quantitative method: a suction device (air lift) in a fixed standardized area (1m2). A semi-quantitative method is represented by the	

| hand-towed net but it has to be used on largewr areas. | |

Method references: specific to sites, not internationally applied

| | |

Method references: established, internationally applied

| Buia et al. (2004). | Buia et al. (2004). |

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.5   **Within Habitat Structure ⇨ 1ˢᵗ level: / 2ⁿᵈ level: PVI; community composition, epiphyte cover**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicator:	**Indicator**: PVI; community composition, epiphyte cover
Parameter:	**Parameter**: Percentage volume infested by macrophytes (PVI); Seasonality of phytoplankton

Important related indices

	Recent maximum depth versus "historical depth"

Property: Frequency

	Annual

Property: Time scale (incl. seasonality), temporal resolution

	Spring/summer

Property: Basic spatial scale

	Transect

Property: Base Units

	Maximum depth of selected "indicator species"

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Krause-Jensen et al. 2008; Steinhardt et al. 2009	Krause-Jensen et al. 2008; Steinhardt et al. 2009

Method references: established, internationally applied

Orfanidis et al. (2001) - but inapplicable for the Baltic Sea	Orfanidis et al. (2001) - but inapplicable for the Baltic Sea

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.6   Within Habitat Structure ⇨ 1ˢᵗ level: Abundance, biomass, phenology / 2ⁿᵈ level: Presence of macroalgal invasive species

INDICATOR FACT SHEET

LEVEL 1 Indicator   LEVEL 2 Indicator

Indicators and explicit parameters

Indicator: Abundance, biomass, phenology	**Indicator**: Presence of macroalgal invasive species
Parameter: Shoot density, plant biomass, leaf standing crop, leaf formation and senescence, flowering	**Parameter**: Presence, absence

Important related indices

Density classes, plastochrone intervals, Co A	

Property: Frequency

Annual, seasonal and monthly	Annual

Property: Time scale (incl. seasonality), temporal resolution

All	all

Property: Basic spatial scale

Shoot density: ten random replicates for each sampling depth. Plant biomass and phenology: 20 random replicates for sampling depth.	Shallow and deep beds

Property: Base Units

No. of shoots m-2 for density; grams per m-2 for LSC	Presence, absence

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	Survey date and time, location, site depth,

Method applied (key words)

Density: 10 shoot counts are performed by trained operators each within 1600cm2 quadrats; the mean value is reported to 1 m².	

LSC: 20 shoots are collected, dried and weighed to gram, the mean dw per shoot is multiplied for the mean density m-2.	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

Buia et al. (2004)	Buia et al. (2004)

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.7   Additional Variables ⇨ 1st level: Abundance, biomass, functional diversity / 2nd level: Dominancy of "alien species"

INDICATOR FACT SHEET

LEVEL 1 Indicator   LEVEL 2 Indicator

Indicators and explicit parameters

Indicator: Abundance, biomass, functional diversity	**Indicator**: Dominancy of "alien species"
Parameter: Structure of the whole plankton compartment: totale and % abundance and biomass of each plankton compartment	**Parameter**:

Important related indices

Autotrophic/heterotrophic ratio	

Property: Frequency

Monthly/fortnightly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

One single sampling station, considering the best fit with vertical (water column) and horizontal (site gradients) variability	

Property: Base Units

Cells l-1 (abundance), g C m-3 (biomass).	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	

Method applied (key words)

Water column sampling (Niskin bottles), different levels (depths)	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied	

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Biotic Diversity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.8   Additional Variables ⇨ 1ˢᵗ level: Seagrass: shoot density and plant production / 2ⁿᵈ level:

INDICATOR FACT SHEET

<div style="text-align:center">LEVEL 1 Indicator   LEVEL 2 Indicator</div>

Indicators and explicit parameters

Indicator: Seagrass: shoot density and plant production	**Indicator**:
Parameter: Number of shoots, annual rhizome production and elongation, annual leaf production	**Parameter**:

Important related indices

Property: Frequency

Annual	

Property: Time scale (incl. seasonality), temporal resolution

Annual	

Property: Basic spatial scale

Shoot density: ten random replicates for each sampling depth.	

Property: Base Units

No. of shoots per m-2, mg/rh/y, mm/rh/y, no. of leaves/sh/y	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	

Method applied (key words)

Annual Plant production is evaluated by the lepidochronological method, based on the cyclical variation in thickness of the leaf scales.Starting from the date of sampling, the rhizome can be back-dated and thus its production can be assessed for the lepidochronological years	

identified.	

<div align="center">

Method references: specific to sites, not internationally applied

</div>

<div align="center">

Method references: established, internationally applied

</div>

Lopex et al. (2010);	Lopex et al. (2010);
Buia et al. (2004).	Buia et al. (2004).

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.9 **Soil ⇨ 1ˢᵗ level: Sediment characterization (by observation and instrumental analyses) / 2ⁿᵈ level:**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Sediment characterization (by observation and instrumental analyses)	**Indicator**:
Parameter: Porosity (water contents), density, granulometric fractions (% in weigth of each grain size fraction), colour of the sediments compared with "Munsell soil colors charts"	**Parameter**:

Important related indices

Granulometry	

Property: Frequency

Yearly	

Property: Time scale (incl. seasonality), temporal resolution

One	

Property: Basic spatial scale

Generally two replicates per station	

Property: Base Units

% in weigth of each grain size fraction (measured in phi)	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	

Method applied (key words)

Corer or just a box-corer in case of sandy bottom, for hard bottom mapping is necessary anyway	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied	

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.10   Soil ⇨ 1st level: Sediment characterization (by observation and instrumental analyses) / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Sediment characterization (by observation and instrumental analyses)	**Indicator**:
Parameter: Granulometric fractions (% in weigth of each grain size fraction)	**Parameter**:

Important related indices

Granulometry	

Property: Frequency

Yearly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Generally 3 replicates per sampling site	

Property: Base Units

% in weigth of each grain size fraction (measured in phi)	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	

Method applied (key words)

Hand corers	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

Lorenti & De Falco (2004)	Lorenti & De Falco (2004)

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures* ⇨ *Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.4.11 **Water ⇨ 1st level: Temperature, Salinity, Transparency, Oxygen, pH / 2nd level:**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Temperature, Salinity, Transparency, Oxygen, pH	**Indicator**:
Parameter:	**Parameter**:

Important related indices

Water density, Brunt-Vasala frequency, Oxygen % saturation	

Property: Frequency

Monthly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

One single sampling station , considering the best fit with vertical (water column) and horizontal (site gradients) variability	

Property: Base Units

International Standard Units	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	

Method applied (key words)

Water column sampling (Niskin bottles), different levels (depths) and or CTD probes	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied	
Hansen (1999);	Hansen (1999);
Hansen H.P. & Koroleff F. (1999);	Hansen H.P. & Koroleff F. (1999);
Strickland J.D. & Parsons T.T. (1972)	Strickland J.D. & Parsons T.T. (1972)

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.12   Water ⇨ 1st level: Light quantity and quality / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Light quantity and quality	**Indicator**:
Parameter: Secchi depth, light extinction coefficient, euphotic depth	**Parameter**:

Important related indices

Property: Frequency

Fortnightly / weekly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Single point	

Property: Base Units

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	

Method applied (key words)

Underwater measurement of photosynthetically active radiation; Secchi disk visibility or photometer	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

EN ISO 7027: 1999. Water quality - Determination of turbidity (ISO 7027:1999).	EN ISO 7027: 1999. Water quality - Determination of turbidity (ISO 7027:1999).

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures* ⇨ *Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.4.13   Water ⇨ 1st level: Temperature, salinity, transparency, light, pH / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Temperature, salinity, transparency, light, pH **Parameter**: Light extinction coefficient	**Indicator**: **Parameter**:

Important related indices

Property: Frequency

Seasonal	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Along the depth gradient	

Property: Base Units

International Standard Units	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	

Method applied (key words)

CTD probes, temperature loggers, quantameter, pH meter	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

| Lorenti & De Falco (2004) | Lorenti & De Falco (2004) |

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures* ⇨ *Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.4.14   Air ⇨ 1ˢᵗ level: Basic climate of the site (ranges, interannual variability, extremes, etc.) / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Basic climate of the site (ranges, interannual variability, extremes, etc.) **Parameter**: Air temperature, pressure, humidity, wind speed and direction, solar irradiation	**Indicator**: **Parameter**:

Important related indices

Temperature wind speed	

Property: Frequency

Continuous/daily	

Property: Time scale (incl. seasonality), temporal resolution

Continuous/daily	

Property: Basic spatial scale

Site	

Property: Base Units

International Standard Units	

Mandatory meta data

Date, Time, location, elevation, method reference	

Method applied (key words)

Meteo stations	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.15   Habitat ⇨ 1st level: Water column structurre: Temp, Salinity, Transparency, Oxygen, pH. / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Water column structurre: Temp, Salinity, Transparency, Oxygen, pH. **Parameter**:	**Indicator**: **Parameter**:

Important related indices

Water density, Brunt-Vasala frequency, Oxygen % saturation	

Property: Frequency

Monthly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

One single sampling station, considering the best fit with vertical (water column) and horizontal (site gradients) variability	

Property: Base Units

International Standard Units	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	???

Method applied (key words)

Water column sampling (Niskin bottles), different levels (depths) and or CTD probes	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied	
Hansen H. I (1999);	Hansen H. I (1999);
Hansen H.P. & Koroleff F. (1999);	Hansen H.P. & Koroleff F. (1999);
Strickland J.D. & Parsons T.T. (1972)	Strickland J.D. & Parsons T.T. (1972)

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *Ecosystem Structures ⇨ Abiotic Heterogeneity*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.16   Additional Variables ⇨ 1ˢᵗ level: / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	Indicator:
Parameter:	Parameter:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.4.17   **E_input ⇨ 1ˢᵗ level: Total irradiance, PAR, heat fluxes / 2ⁿᵈ level: PP intensity and sink / source character of the system**

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: Total irradiance, PAR, heat fluxes	**Indicator**: PP intensity and sink / source character of the system
Parameter: Total irradiance, PAR, Temperature	**Parameter**:
Important related indices	
Surface Irradiance/depth irradiance	
Property: Frequency	
Continuous/daily	Seasonal
Property: Time scale (incl. seasonality), temporal resolution	
All	
Property: Basic spatial scale	
Basin scale	Plot
Property: Base Units	
International Standard Units	
Mandatory meta data	
Date, Time, location, elevation, method reference	???
Method applied (key words)	
Meteo stations and in situ automatic continuous measurements	
Method references: specific to sites, not internationally applied	
Method references: established, internationally applied	

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.18   E_input ⇨ 1ˢᵗ level: Carbon assimilation / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Carbon assimilation	**Indicator**:
Parameter: Carbon assimilation or oxygen production rates	**Parameter**:

Important related indices

Property: Frequency

Seasonal	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

One single sampling station, considering the best fit with vertical (water column) and horizontal (site gradients) variability	

Property: Base Units

g C m-3 h-1	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.19   E_input ⇨ 1ˢᵗ level: Plant production, PAR and LAI / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Plant production, PAR and LAI	**Indicator**:
Parameter: Leaf elongation, leaf production, photosinthetically leaf area, P/E relationships	**Parameter**:

Important related indices

LAI	

Property: Frequency

Monthly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Local	

Property: Base Units

mm/shoot/day, mg/shoot/day, m2/m2	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	

Method applied (key words)

Leaf punching method has been used to valuate the plant production.	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

Buia et al. (2004)	Buia et al. (2004)

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.20   E_storage ⇨ 1ˢᵗ level: Clorophyll a, DOM, POM, / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Clorophyll a, DOM, POM,	**Indicator**:
Parameter: Clorophyll a, phytoplankton biomass, zooplankton biomass, DOM and POM	**Parameter**:

Important related indices

Property: Frequency

Monthly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

One single sampling station, considering the best fit with vertical (water column) and horizontal (site gradients) variability	

Property: Base Units

mg C m-3, g Chl m-3	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	

Method applied (key words)

Water column sampling , different levels (depths)	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.21   E_storage ⇨ 1ˢᵗ level: / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	**Indicator**:
Parameter: Leaf biomass, rhizome biomass, epiphyte biomass, leaf N content	**Parameter**:

Important related indices

Property: Frequency

Monthly and seasonal	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Local	

Property: Base Units

Gram per shoot, mg per shoot; Nitrogen content: percent of dry weight of leaf tissue	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	

Method applied (key words)

Shoot are sampled at different depths, freeze-dried and ground to fine powder in an analytical mill. Subsamplesof 2–3 mg were analyzed for total N.	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied	
Lorenti & De Falco (2004).	Lorenti & De Falco (2004).

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.22   E_output ⇨ 1st level: Heat fluxes, respiration, PCP (Prokaryotic Carbon production) / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Heat fluxes, respiration, PCP (Prokaryotic Carbon production)	**Indicator**:
Parameter: Temperature, oxygen consumption rates, bacterial carbon production	**Parameter**:

Important related indices

Property: Frequency

Seasonal	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

One single sampling station, considering the best fit with vertical (water column) and horizontal (site gradients) variability	

Property: Base Units

g C m-3 h-1	

Mandatory meta data

Date, Time, location, elevation, method reference	

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

Steeman & Nielsen (1952)	Steeman & Nielsen (1952)

Winkler et al. (1980)	Winkler et al. (1980)
Kirchman et al. (1985)	Kirchman et al. (1985)
Carpenter (1965)	Carpenter (1965)
Robinson & Williams (2005)	Robinson & Williams (2005)

Winkler et al. (1980)

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.23   E_other state variables ⇨ 1st level: Wind speed and direction, currents and waves / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Wind speed and direction, currents and waves	**Indicator**:
Parameter: Wind speed, wind directions, wave height, current speed and direction	**Parameter**:

Important related indices

Property: Frequency

Continuous/daily	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Point close to the site	

Property: Base Units

International Standard Units	

Mandatory meta data

Date, Time, location, elevation, water depth, method reference	???

Method applied (key words)

Meteo stations and in situ automatic continuous measurements	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Energy Budget*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.4.24 E_efficiency measures ⇨ 1st level: Production/Chlorophyll, Production/PAR Production/Respiration / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Production/Chlorophyll, Production/PAR Production/Respiration	**Indicator**:
Parameter: Primary production, respiration and plankton biomass	**Parameter**:

Important related indices

Property: Frequency

Seasonal	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

One single sampling station, considering the best fit with vertical (water column) and horizontal (site gradients) variability	

Property: Base Units

P/B ratios	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	???

Method applied (key words)

See basic parameters methods	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.25 M_input ⇨ 1ˢᵗ level: Nutrients (N, P, Si) input fluxes (rivers/atmospheric deposition) / 2ⁿᵈ level:

INDICATOR FACT SHEET

<table>
<tr><td>LEVEL 1 Indicator</td><td>LEVEL 2 Indicator</td></tr>
<tr><td colspan="2" align="center">Indicators and explicit parameters</td></tr>
<tr><td>Indicator: Nutrients (N, P, Si) input fluxes (rivers/atmospheric deposition)

Parameter: Dissolved macronutrient concentration in rivers/deposition</td><td>Indicator:

Parameter:</td></tr>
<tr><td colspan="2" align="center">Important related indices</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2" align="center">Property: Frequency</td></tr>
<tr><td>Monthly</td><td></td></tr>
<tr><td colspan="2" align="center">Property: Time scale (incl. seasonality), temporal resolution</td></tr>
<tr><td>All</td><td></td></tr>
<tr><td colspan="2" align="center">Property: Basic spatial scale</td></tr>
<tr><td>One single sampling station, representative of the loads actually coming from the watershed to the ecosystem</td><td></td></tr>
<tr><td colspan="2" align="center">Property: Base Units</td></tr>
<tr><td>tons/years</td><td></td></tr>
<tr><td colspan="2" align="center">Mandatory meta data</td></tr>
<tr><td>Survey date and time, location, site depth, sampling depths, frequency of observations, method reference</td><td>???</td></tr>
<tr><td colspan="2" align="center">Method applied (key words)</td></tr>
<tr><td>Water sampling devices (e.g Niskin bottles); Deposimeter</td><td></td></tr>
<tr><td colspan="2" align="center">Method references: specific to sites, not internationally applied</td></tr>
</table>

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator* ⇨ *recommended level 1 / level 2 indicator*

8.4.26   M_storage ⇨ 1ˢᵗ level: POC, Chlorophyll, DOC / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: POC, Chlorophyll, DOC	**Indicator**:
Parameter: POC, Chlorophyll, DOC	**Parameter**:

Important related indices

Property: Frequency

Monthly	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

One single sampling station, considering the best fit with vertical (water column) and horizontal (site gradients) variability	

Property: Base Units

mg C m-3, mg Chl m-3	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	???

Method applied (key words)

Water column sampling (Niskin bottles), different levels (depths)	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.27   M_output ⇨ 1st level: Total Carbon Flux / 2nd level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Total Carbon Flux	**Indicator**:
Parameter: POC, DOC	**Parameter**:

Important related indices

Property: Frequency

Yearly integrated	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

One single sampling station, considering the best fit with vertical (water column) and horizontal (site gradients) variability	

Property: Base Units

mg C m-2 d-1	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	???

Method applied (key words)

Sedimentation traps (for vertical fluxes and outputs), geostrophic currents for advection estimates	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes* ⇨ *Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.28   M_other state variables ⇨ 1ˢᵗ level: / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	**Indicator**:
Parameter:	**Parameter**:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Matter Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.29 **M_+C5efficiency measures ⇨ 1ˢᵗ level: Sedimentation/Accumulation rates in sediments / 2ⁿᵈ level:**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Sedimentation/Accumulation rates in sediments	**Indicator**:
Parameter: Cm of sediments accumulated per year or gr of sediments accumulated per year per cm2	**Parameter**:

Important related indices

Property: Frequency

Yearly integrated	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Single point	

Property: Base Units

cm/y g/cm2xy	

Mandatory meta data

Survey date and time, location, site depth, sampling depths, frequency of observations, method reference	???

Method applied (key words)

Sediment core isotopic analysis (expensive, to discuss for budget allocation)	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.30   W_input ⇨ 1ˢᵗ level: River discharge, currents / 2ⁿᵈ level: Water circulation

INDICATOR FACT SHEET

LEVEL 1 Indicator	LEVEL 2 Indicator
Indicators and explicit parameters	
Indicator: River discharge, currents	**Indicator**: Water circulation
Parameter: River discharge, currents	**Parameter**:
Important related indices	
Property: Frequency	
Continuous/daily	Seasonally
Property: Time scale (incl. seasonality), temporal resolution	
All	
Property: Basic spatial scale	
Basin scale	Basin scale
Property: Base Units	
m3 s-1, m s-1	
Mandatory meta data	
Date, Time, location, method reference	???
Method applied (key words)	
Instrumental	Model
Method references: specific to sites, not internationally applied	
Method references: established, internationally applied	

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.31   W_storage ⇨ 1ˢᵗ level: Residence time / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Residence time	**Indicator**:
Parameter: Currents	**Parameter**:

Important related indices

Property: Frequency

Seasonal	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Basin scale	

Property: Base Units

days	

Mandatory meta data

Date, Time, location, model reference	???

Method applied (key words)

Instrumental and modelling	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.32 **W_output ⇨ 1ˢᵗ level: Advection and outflow / 2ⁿᵈ level:**

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator: Advection and outflow	**Indicator**:
Parameter: Currents	**Parameter**:

Important related indices

Property: Frequency

Seasonal	

Property: Time scale (incl. seasonality), temporal resolution

All	

Property: Basic spatial scale

Basin scale	

Property: Base Units

m3 s-1	

Mandatory meta data

Date, Time, location, instrument and model reference	???

Method applied (key words)

Instrumental and modelling	

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.33 W_other state variables ⇨ 1ˢᵗ level: / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	Indicator:
Parameter:	Parameter:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied

MARINE SYSTEMS

Components of Ecological Integrity (see table 1): *ecosystem processes ⇨ Water Budget*

Explanation to following heading: *Ecological Integrity Indicator ⇨ recommended level 1 / level 2 indicator*

8.4.34   W_efficiency measures ⇨ 1ˢᵗ level: / 2ⁿᵈ level:

INDICATOR FACT SHEET

LEVEL 1 Indicator   **LEVEL 2 Indicator**

Indicators and explicit parameters

Indicator:	Indicator:
Parameter:	Parameter:

Important related indices

Property: Frequency

Property: Time scale (incl. seasonality), temporal resolution

Property: Basic spatial scale

Property: Base Units

Mandatory meta data

Method applied (key words)

Method references: specific to sites, not internationally applied

Method references: established, internationally applied