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Initial Characterisation of Lakes Prespa, Ohrid and Shkodra/Skadar

Implementing the EU Water Framework Directive in South-Eastern Europe

In cooperation with

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MINISTRIA E MJEDISIT

REPUBLIKA E SHQIPËRISË
MINISTRIA E BUJQËSISË, ZHVILLIMIT RURAL DHE ADMINISTRIMIT TË UJRAVE

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Disclaimer

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Acronyms and Abbreviations

AA	Annual Average (concentration of priority substances in water)
AAS	Atomic Absorption Spectroscopy
Al	Albania
APHA	American Public Health Association
AQEM/STAR	Assessment system for the ecological Quality of streams and rivers throughout Europe using benthic Macroinvertebrates / STAndardisation of River classifications: framework method for calibrating different biological survey results against ecological quality classifications
ASPT	Average Score Per Taxon
BMWP	Biological Monitoring Working Party
BOD_5	Biochemical Oxygen Demand (measured over a 5-day period)
Cd	Cadmium
CEED	Centre for Entrepreneurship and Economic Development
CIS	Common Implementation Strategy (for the implementation of the WFD)
Co	Cobalt
COD	Chemical Oxygen Demand
Cu	Copper
Cr	Chromium
CSBL	Conservation and Sustainable Use of Biodiversity at Lakes Prespa, Ohrid and Shkodra/Skadar
DCM	Decision of Council of Ministers (Albania)
DDD	Dichlorodiphenyldichloroethane (a metabolite of DDD)
DDE	Dichlorodiphenyldichloroethylene (a metabolite of DDT)
DDT	Dichlorodiphenyltrichloroethane (organochlorine insecticide, now banned for agricultural use)
DO	Dissolved Oxygen
EC	European Commission/Community
EN	EuropeaN (an EN document is a regional standard for use in the European Union)
EPA	Environmental Protection Agency
EQR	Ecological Quality Ratio
EQS	Environmental Quality Standard
EU	European Union
FMO	Fisheries Management Organization
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HBIO	Hydrobiological Institute Ohrid (Macedonia)
HCH	Hexachlorocyclohexane
IBA	Important Bird Area
IBI	Irish Biotic Index
ICM	Inter Calibration Metric of the Central-Baltic Ecoregion
ICPDR	International Commission for the Protection of the Danube River
IHMS	Institute of Hydrometeorology and Seismology (Montenegro)
IPA	Important Plant Area
IPA	Instrument for Pre-accession Assistance of the European Union
IPIKS	Institute for Political and Intercultural Studies (Macedonia)
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature
KAP	Kombinat Aluminijuma Podgorica (former aluminium plant in Montenegro)
LPMP	Lake Prespa Management Plan
MAB	Man And the Biosphere
masl	metres above sea level

MAV	Maximum Approved Value (concentration of priority substances in water)
MBI	Macroinvertebrate Biotic Index
MI	Macrophyte Index
MK	Macedonia
MMG	Multi Mesh Gillnetting
MNE	Montenegro
Ni	Nickel
NIVA	Norwegian Institute for Water Research
NEA	National Environmental Agency (Albania)
N:P ratio	Ratio of nitrogen to phosphorus concentrations (usually in water)
N-taxa	Number of taxa
NWC	(Albanian) National Water Council
OCP	OrganoChlorine Pesticide
OECD	Organization for Economic Cooperation and Development
OG	Official Gazette (of Macedonia)
OJ	Official Journal (of Albania)
PAH	PolyAromatic Hydrocarbon
Pb	Lead
PCB	PolyChlorinated Biphenyl
POP	Persistent Organic Pollutant
RBD	River Basin District
RBMP	River Basin Management Plan
SL	Shkodra/Skadar Lake
SPA	Special Protection Area
STPP	Sodiumtripolyphosphate
TN	Total nitrogen
$TN_{Kjeldahl}$	Total nitrogen (Kjeldahl method)
TP	Total phosphorus
TSI	Trophic State Index (calculated alternatively from chlorophyll-*a* [TSI-Chl-*a*] or phosporus [TSI-P] concentrations or from water turbidity measured with Secchi disks [TSI-SD])
TWG	Technical Working Group
UK	United Kingdom of Great Britain and Northern Ireland
UKTAG	United Kingdom Technical Advisory Group on the Water Framework Directive
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USB	Universal Serial Bus (a computer connector/connection)
UWWT	Urban Waste Water Treatment
WB	Water Body
WFD	Water Framework Directive
WHO	World Health Organization
WISER	Water Bodies in Europe: Integrative Systems to Assess Ecological Status and Recovery
WMP	Watershed Management Plan
WWTP	Waste Water Treatment Plant
Zn	Zinc

Foreword

The initial characterization of surface water bodies is an important step in the implementation of the EU Water Framework Directive (WFD), which our countries have transposed into their national laws. However, it is not a merely national affair when it comes to transboundary waters such as Lakes Prespa, Ohrid and Shkodra/Skadar. Their management requires close collaboration among riparian countries on all levels: technical, administrative and political. It is therefore with great pleasure that we see an Initial Characterization Report (ICR) published that emanates from a joint effort of competent authorities, experts and stakeholders from all of our countries.

The report provides testimony to our commitment to adopt and implement EU standards in a harmonized and transboundary fashion. It arises from a process started in 2012 with the support of GIZ that has involved a broad range of expertise from Albania, Macedonia and Montenegro. It reflects a high level of collaboration and understanding, illustrating the benefits of harmonizing methodologies across borders to comply with common legislation.

The ICR proposes a delineation of water bodies within the three lakes and provides information on the biological and chemical quality of these waters. It is an important document that paves the way towards and demonstrates the importance of international cooperation in river basin management planning. The technical and scientific knowledge contained herein is also an important contribution to our national environmental information systems.

This publication presents an essential technical document primarily for water managers, but also for interested institutions, actors and stakeholders, within and outside national borders, including those involved in decision-making. It shows that full WFD implementation will continue to be challenging, but continued collaboration will allow us to manage our water more sustainably than in the past, for the good of us all.

The ICR underlines the consensus of our countries to continue to work together on the new challenges and additional requirements of transboundary cooperation as foreseen in the WFD. We are delighted to have been invited to write this foreword and congratulate all of its collaborators/authors. We commend its use to those who wish to gain further insight into the management and status of this shared resource.

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1 Introduction

Lakes Prespa, Ohrid and Shkodra (Skadarsko in Montenegrin language[1]) are situated along the Drin and Buna/Bojana Rivers, like pearls on a string. Each of these transboundary lakes has unique features unrivalled by any other lake in Europe. Prespa stands out for its rich birdlife including Europe's largest breeding colony of the Dalmatian pelican, Ohrid for its diverse endemic fauna (evolved over four million years of geographic isolation), and Shkodra/Skadar for its wooded wetlands, extending over vast areas. The lakes are not only biodiversity hotspots of global importance, but also important cultural heritage sites, comprising stilt houses, ancient monuments and numerous churches and monasteries.

As signatories to the Convention on Biological Diversity and European Union (EU) candidate countries, Albania, FYR Macedonia[2] and Montenegro are committed to improve the ecological status of these lakes and to protect their biodiversity. The legal and strategic frameworks are set by the EU Water Framework Directive (WFD), EU nature conservation legislation (Birds and Habitats Directives) and the EU Biodiversity Strategy. Implementing these frameworks jointly requires close transboundary cooperation. The CSBL project of the *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) on behalf of the German Federal Ministry of Economic Cooperation and Development supports the three countries to this end.

The purpose of the WFD is to establish a framework for the protection of all inland and coastal surface waters and groundwater in EU member states, with the aim of achieving 'good status'. For the first time in EU water legislation, aquatic biology – and not just (physico-) chemistry – is at the centre of water quality assessment. Even though the WFD makes no explicit reference to biodiversity conservation, it is *de facto* geared towards it because it aims to preserve or restore natural or near-natural fauna and flora.

1 The names Shkodra and Skadar are used together or interchangably.
2 Henceforth the name Macedonia is used.

Guidance on the WFD and water quality assessment is given in information boxes distributed throughout this document. These are recommended particularly for readers that are not familiar with the WFD.

The three countries have transposed the WFD into national laws, but its implementation remains a challenge for all of them. Full-fledged river basin management plans and programmes of measures have been drafted for some national river basin districts or sub-basins already, usually with donor support and oftentimes resulting from desk studies and expert judgement rather than systematic procedures foreseen in the WFD. For others, not even physico-chemical elements have been adequately monitored, let alone fauna and flora to assess ecological status. In view of this, and to pursue a systematic approach, CSBL and its partners strictly followed procedures stipulated in the WFD to conduct an initial characterisation of the three lakes presented in this report.

This report does not fully cover all aspects of characterisation in terms (see Box 1). Nevertheless, it informs future monitoring programmes and the selection of measures to protect and/or improve status. The various tasks fit into a 6-year water management planning cycle as shown in Fig. 1-1. The contents mark an important milestone on the long road to river basin management planning. It will be refined over the coming years as data gaps are gradually filled and available data consolidated. The lake sub-basins serve as pilots in which transboundary cooperation is stressed.

The report informs competent authorities, decision-makers, practitioners and experts in water resources management about biological and physico-chemical characteristics of the three lakes. It enables them to make proactive decisions to improve the monitoring and management of the lakes. This is important since ongoing or new developments such as urban encroachment may have immediate negative effects on the lakes' ecological status.

BOX 1. WHAT FULL WFD CHARACTERISATION INVOLVES

The information presented in this document covers status assessment, pressures, impacts, identification of protected areas and the risk of water bodies failing to meet environmental objectives. However, the report does not identify or cover all water bodies within the Drin River Basin; instead, it focuses on the three major lakes in the basin and their main tributaries. No information on groundwater, transitional or coastal water bodies, or peatlands/wetlands is included, and neither are boundaries presented for a WFD classification scheme, since type-specific reference conditions have not been established. However, available information on WFD biological, chemical and physico-chemical quality elements, as well as hydromorphology, abstraction and flow regulation is included.

Full WFD characterisation requires very large amounts of data. It is based on the precedent that good management requires good information. It sets the scene for river basin management, showing where water resources are located and how they are connected. It then groups them into types and provides an understanding of how they are impacted by human activities. The purpose of this is to develop mitigation measures to protect and/or restore water bodies that are at risk of not being in (at least) good ecological status, or good ecological potential for heavily modified/artificial water bodies.

Full characterisation, involves the following tasks:

- Development of water body physical typologies – surface and groundwaters
- Identification of type-specific reference conditions
- Pressure-impact analyses, including diffuse and point source pollution sources, water abstraction and flow augmentation, alien species assessments and morphological alterations
- Identification of artificial and heavily modified water bodies
- Risk assessment criteria for water bodies (surface waters, ground waters and peatlands/wetlands)
- Economic analysis of water use. This identifies important uses of water bodies, considers the options for recovering management costs from users (the 'polluter pays' principle); and ensure that the costs of measures (to achieve good environmental status/potential) are not disproportionate.
- Identification of 'Protected Areas', encompassing:
    - Waters used for the abstraction of drinking water (replacement for the system of drinking water protection originally provided by the Surface Water Abstraction Directive [75/440/EEC]), but also incorporating groundwaters
    - Areas designated to protect economically significant aquatic species (established under earlier EC directives aimed at protecting shellfish [79/923/EEC] and freshwater fish [78/659/EEC])
    - Recreational Waters (areas originally designated under the Bathing Water Directive [76/160/EEC])
    - Nutrient Sensitive Areas (covering areas designated as Nitrate Vulnerable Zones under the Nitrates Directive [91/676/EEC] and Sensitive Areas under the Urban Waste Water Treatment Directive [91/271/EEC])
    - Areas designated for the protection of habitats or species (under the Birds and Habitats Directives [79/409/EEC and 92/43/EEC, respectively]).

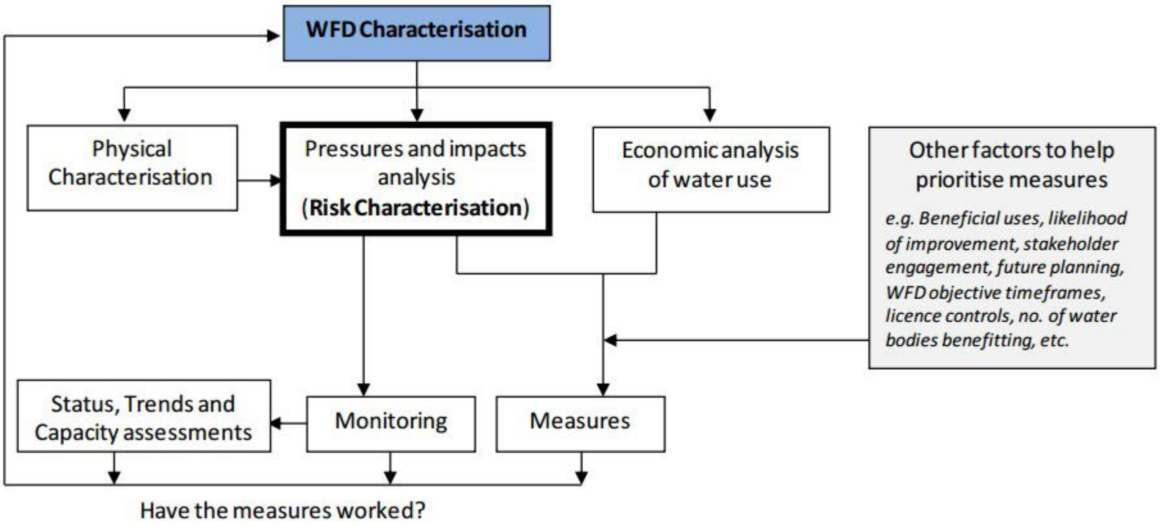

Figure 1-1 Characterisation in the WFD framework (Irish Environmental Protection Agency 2015)

The assessments presented in this document are based on results from state and donor-funded monitoring conducted over the last five years. The scope and scale of these investigations have been defined by the regional Technical Working Group (TWG) on the Water Framework Directive. The TWG is composed of representatives of ministries and competent authorities in charge of water management (permanent members), as well as experts and institutions invited on an *ad hoc* basic to provide advice on specific technical issues (non-permanent members). The TWG not only plans investigations and agrees on common methodologies but also oversees proper implementation of the agreed study and monitoring programmes. As a transboundary group, it enables cross-border dialogue, information and data exchange and provides a forum for transboundary river basin management planning in the longer term.

Even though implementation of the WFD is primarily a national task and water bodies, which are the core units of management under the WFD, are delineated at national level, it is important to coordinate actions with neighbouring countries early on in the implementation process if international river basins districts such as the extended Drin River Basin are involved. Therefore, the initial characterisation results are presented by lake rather than by country. The report summarizes main results and findings from investigations of physico-chemical, some chemical and all biological elements, conducts initial risk assessments for all water bodies of the three lakes and proposes monitoring programmes to be put into place before developing programmes of measures and drafting river basins management plans. Original monitoring data – collected with the support of CSBL – are partly annexed to the ICR in the form of summary tables and are supplied in digital form (USB flat card) in a separate Volume of Annexes. This Volume contains original reports from experts and research institutions involved in the fieldwork. It is intended for readers interested in technical details of the investigations and concrete data.

Further data will be needed to refine and consolidate the preliminary characterisation of the three lakes presented in this report. As such and in the best sense of technical reporting, the ICR should be understood as a working document with a short lifetime. With new data and information becoming available, water bodies may be merged or further divided, monitoring efforts for biological elements reduced or increased, and risk assessments repealed or confirmed. The authors would be very pleased to see that happening, since it would be a clear indication that countries are further progressing towards river basin management according to the WFD.

2 Description of the Drin River Basin

The Drin River Basin (Albanian: Drin, Macedonian: Drim) covers a geographical area of about 19,000 km^2 in the south-western Balkans; it extends through Albania, Macedonia, Montenegro, Kosovo and Greece. About 1.5 million people rely on the water resources of the basin for a range of uses, such as drinking water supply, tourism, agriculture, fisheries, industry and hydropower. The Drin River Basin is an interconnected hydrological system comprising the transboundary sub-basins of:

- Lake Prespa
- Lake Ohrid
- Lake Shkodra/Skadar
- Drin River, including its tributaries, the Black Drin and White Drin
- Morača River
- Buna/Bojana River (outflow of Lake Shkodra/Skadar to the Adriatic Sea)

A canal with sluice gates (reconstructed in 2004) connects the Macro and Micro Prespa Lakes. Water from Lake Prespa flows through underground karstic formations to the lower Lake Ohrid (springs in Buçimas and St. Naum). The regulated outflow of Lake Ohrid at Struga is the origin of the Crn (Black) Drin River. The sources of the Beli (White) Drin are located in the western part of Kosovo[3]. The confluence of the Black and White Drin is near Kukës in Albania.

The structure and flow of the river has been changed by construction of the following dams and reservoirs:

- Macedonia: Globochica, Debar (Debarsko Ezero)
- Albania: Fierzë (Liqeni i Fierzës), Koman (Liqeni i Komanit), Vau-Deja (Liqeni i Vaut të Dejës)

Flowing through Albania, the main arm of the Drin (Drin i Madh) joins the Buna/Bojana River (a watercourse which drains Lake Shkodra/Skadar and, shared between Albania and Montenegro forms part of their border before finally flowing into the Adriatic Sea) near the city of Shkodra. The smaller arm (Drin i Lezhës) drains directly into the Adriatic Sea, south of Shkodra, near the city of Lezhë. The Morača River originates in northern Montenegro, at the base of Rzača Mountain, and flows southwards before discharging into Lake Shkodra/Skadar.

The CSBL Project covers the Lake Prespa, Ohrid and Shkodra/Skadar sub-basins in the territories of Albania, Macedonia and Montenegro.

3 Water Framework Directive – National Legislation

3.1 Albania

Law № 111/2012 on the integrated management of water resources has transposed the Water Framework Directive (WFD). Its implementation started in December 2013, pursuant to which a package of bylaws was enacted by Decision of the Council of Ministers (DCM):

- DCM № 267, dated 7 May 2014, on adoption of a priority substances list for water resources
- DCM № 246, dated 30 April 2014, on environmental norms for surface waters
- DCM № 1189, dated 18 November 2009, on rules and procedures for the design and implementation of a national environmental monitoring programme

According to the law and following institutional reform, several competencies were transferred from the Ministry of Environment (MoE) to the Ministry of Agriculture, Rural Development and Water Administration[4] (MARDWA). The MARDWA is now responsible for the protection of water quality and for the sustainable use of water resources. The MoE remains the responsible body for the monitoring of water quality. Notwithstanding the above changes, the law[5] recognizes the following bodies as being responsible for the administration of water resources at a national level:

- The Council of Ministers is responsible *inter alia* for: (i) the improvement and adoption of the legal framework related to the integrated water resources management; (ii) the designation of water basin hydrographic borders within Albania; and (iii) the adoption of a national strategy for water management and water management plans.

3 Territory under Resolution UN 1244

4 Decision of Council of Ministers № 92, dated 4 February 2014

5 This law will very soon be object of new legal changes.

- The Ministry (MARDWA) is responsible for developing and implementing integrated water resources management policies, strategies, programmes and projects. The responsible Directorate of Water Administration is still at an early stage of development, since its functions remain to be elaborated and its number of staff is small (four persons).

- The National Water Council (NWC) is a decision-making body responsible for the administration and management of water resources and chaired by the Prime Minister, with all ministers responsible for water administration as members. NWC competencies include water management in inter-regional and national plans and projects in agriculture, urban planning and industrial and territorial development.

- The Technical Secretariat of the NWC[6], the executive body of the National Water Council is based at the Prime Ministry and responsible *inter alia* for drafting and monitoring the implementation of River Basin Management Plans. Its responsibilities cover: (i) implementation of international agreements and conventions on national water resources and transboundary waters to which the Republic of Albania is a party; and (ii) the coordination and control of local water management bodies.

Administration of water resources is part of the responsibility of local institutions, as follows:

- The Council of Water Basins (CWB) – subordinate to the NWC Technical Secretariat – is responsible for the identification and management of protected areas (see Box 1). CWB members represent bodies responsible for water issues such as drainage boards, businesses related to water use, etc.

- River Basin Agencies (RBAs) – subordinate to the MARDWA – responsible for drafting the inventory of water resources and other water issues, according to Law № 111/2012. However, the recent "Regulation of the Technical Secretariat of Water", adopted by Decision № 1 of the NWC, dated 9 July 2014, transfers the competencies of RBAs to the NWC Technical Secretariat.

Law № 10 431 on environmental protection was endorsed in 2011 by the Assembly. According to this law and pursuant to a decision of the Council of Ministers (№ 1189/2009) on rules and procedures for the design and implementation of a national environmental monitoring programme, the National Environmental Agency (NEA) is largely responsible for environmental status monitoring, with individual monitoring laboratories selected on a competitive basis. The NEA has 12 regional branches and – according to Decision of Council of Ministers № 47/2014 on the organisation and functioning of the National Environmental Agency – is responsible for establishing/managing the National Environmental Information System. However, management and monitoring of fisheries is undertaken by the MARDWA.

A state monitoring programme which fulfills the requirements of the WFD does not yet exist, and neither has a competent authority been appointed to manage/implement the WFD in Albania. Further bylaws and regulations to support/enforce existing water legislation and future river basin management plans are expected to be drafted and adopted to continue the process of structural and institutional reform.

3.2 Macedonia

The Ministry of Environment and Physical Planning (MEPP) is responsible for implementation of the WFD in Macedonia. Four river basins have been delineated within the country. Water management responsibilities are divided between six ministries dealing with:

- Environment and physical planning
- Agriculture, forestry and water economy
- Economy
- Transport and communications
- Education and science
- Public health

Within these institutions, there are departments, units, inspectorates and directorates with defined responsibilities for water management. Individual departments in the MEPP deal with:

- River basin management planning and implementation (including characterisation and development of programmes of measures)

- Protection of the water from pollution; preparation and updating of polluters cadastre

- Establishing and updating the register of protected areas

6 Decision of Council of Ministers № 230, dated 23 April 2014

- Monitoring – collection of water quality/ quantity data, and related research
- Regulation of operators (drinking water supply utilities, irrigation operators, industry water suppliers, etc.)
- Flood defence

The 2008 Law on Water provides the basis of the regulatory framework, the implementation of which has required a series of amendments to be made, notably Official Gazette [OG] 51/11, 44/12 and 23/13. A series of bylaws and ordinances have also been produced specifically to implement the WFD and subsidiary EC water legislation:

- Ordinance on categorization of watercourses, lakes and reservoirs (OG 18/99)
- Ordinance on water classification (OG 18/99)
- Decision on river basins delineation (OG 107/12)
- Regulation on content and methodology for preparation of RBMPs (OG 148/09)
- Regulation on methodology for evaluation of river basins (OG 148/09)
- Regulation on the content and methodology for the preparation of programmes of measures (OG 148/09)
- Regulation on content and methodology for preparation of information for mapping of monitoring activities (OG 148/09)
- Decision of Water Council (OG 122/12)
- Regulation on criteria for the determination of sensitive areas related to urban waste water discharges (OG 130/11)
- List of polluting matters and substances (OG 122/11)
- Regulation on criteria for the designation of nitrate-vulnerable zones (OG 131/11)

3.3 Montenegro

The Ministry of Agriculture and Rural Development is largely responsible for implementing the WFD in Montenegro, supported by the Ministry of Sustainable Development and Tourism.

The Water Act (Official Gazette of Montenegro [OGM] № 48/15) provides the legal basis for implementation of the WFD. Several regulations, decrees, and guidelines support the enforcement of the Water Act:

- Regulation on the classification and categorization of surface and groundwater (OGM № 2/07 of 29 October 2007)
- Regulation on the content and manner of preparation of management plans in the water area of the river basin district (see Box 2) or part thereof (OGM № 39/09 of 17 June 2009)
- Regulation on the method of determining the boundaries of the water area (OGM № 25/12 of 11 May 2012)
- Regulation on the form, detailed content and method of keeping water books (OGM № 81/08 of 26 December 2008)
- Regulation on detailed content and keeping water cadastre (OGM № 81/08 of 26 December 2008)
- Regulation on the content and management of water information systems (OGM № 33/08 of 27 May 2008)
- Regulations on the conditions for measuring the amount(s) of waste water discharged into surface waters (OGM № 24/10 of 30 April 2010)
- Regulations on the procedure for measuring amount(s) of water abstracted (OGM № 24/10 of 30 April 2010)
- Decision on the establishment of a Council for Water (OGM № 9/07 of 30 November 2007)

BOX 2. RIVER BASIN DISTRICTS AND RIVER BASIN MANAGEMENT PLANNING

What is a river basin district?

Under Article 2 of the WFD, a river basin district (RBD) is defined as "the area of land and sea, made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters, which is identified under Article 3(1) as the main unit for management of river basins."

River basin management planning

Thus, RBDs consist of water bodies and their catchment areas, for which River Basin Management Plans (RBMPs) are developed. RBMPs set statutory objectives for river, lake, groundwater, transitional and coastal water bodies, and summarise the measures needed to achieve them. Because water drains from land, carrying land-derived pollutants with it, RBMPs also inform decisions on land-use planning. Annex VII of the WFD states that RBMPs should contain the following:

- A general description of the characteristics of the river basin district (see Box 1)
- A summary of pressures and impacts of human activity on the status of waters (see Box 1)
- Maps of Protected Areas (see Box 1)
- Maps of monitoring networks and status results (see Box 1) for:
    - Surface water (ecological and chemical)
    - Groundwater (chemical and quantitative – water level monitoring)
    - Protected areas
- A list of the environmental objectives for surface waters, groundwaters and protected areas (see Box 10)
- A summary of the economic analysis of water use (see Box 1)
- Details of all programme(s) of measures
- A summary of the public information and consultation measures taken, their results and changes to the RBMP made as a consequence
- A list of competent authorities, contact points and procedures for obtaining background information.

- Decisions on determining the importance of water in Montenegro (OGM №s 9/ 08 of 8 February 2008, 28/09 of 16 April 2009 and 31/09 of 5 May 2009)
- Decision on determining the sources intended for regional and public water supply and fixing of their boundaries (OGM № 36/08 of 10 June 2008)
- Decree on categorization and categories of water facilities and their management and maintenance (OGM № 15/08 of 5 March 2008)
- Ordinance on the content of the request, the documentation for the Water Acts, methods and conditions for compulsory advertisement in determining water requirements and water content of the documents (OGM № 7/08 of 1 February 2008)
- Ordinance on the manner of determining the guaranteed minimum (OGM № 22/08 of 2 April 2008)
- Ordinances on the quality and sanitary and technical requirements for waste water discharge into the recipient and the public sewerage system method and procedure for waste water quality testing, the minimum number of tests and the contents of the report on the established quality of waste water (OGM №s 45/08 of 31 July 2008, 9/10 of 19 February 2010, 26/12 of 24 May 2012, 52/12 of 12 October 2012, and 59/13 of 26 December 2013)
- Ordinance establishing and maintaining zones of sanitary protection of sources and limits of these zones (OGM № 66/09 of 2 October 2009)

- Ordinance on the composition and content of the water infrastructure (OGM № 11/11 of 18 February 2011)

- Rules on the conditions to be fulfilled by the company for the exploitation of river sediment (OGM № 51/12 of 9 October 2012)

- Rules on the conditions to be met by legal entities that carry out water quality testing (OGM № 66/12 of 31 December 2012)

The Law on Water Management Financing (OGM № 65/08), establishes the "polluter pays principle", defines funding routes for water management, together with methods for the calculation and collection of fees for the protection and use of water resources. Discharge fees are based on an assessment of the degree of pollution caused, with the method for determining this presented in OGM № 29/09 of 24 April 2009.

4 Lake Water Status – Requirements and Procedures According to the WFD

The WFD classification scheme for surface water body (Box 3) quality includes five ecological (high, good, moderate, poor and bad) and two chemical (good vs. failing to achieve good, i.e. pass/fail) status classes. Generally, EU member states should aim to achieve the objective of at least good status of all water bodies (see Box 10). According to Article 4 of the WFD, the status of surface waters must not deteriorate (non-deterioration clause). It is thus not acceptable if the status of any water body (see Box 1) deteriorates from high to good (or good to moderate, etc.), but environmental objectives would be satisfied if a water body is enhanced from moderate to good status. The WFD classification scheme for water body status is outlined in Box 4.

BOX 3. WHAT IS A WATER BODY?

A water body is defined by the European Environment Agency as "any mass of water having definite hydrological, physical, chemical and biological characteristics and which can be employed for one or several purposes". Thus, it is a discrete and significant accumulation of water, either on or below the surface of the ground, which is distinct from any adjacent water bodies to which it may be attached.

The water body is the basic unit of/for water management under the WFD.

Types of water body

The WFD recognises four types of surface waters: lakes, rivers, transitional, coastal, which may be considered: (i) pristine/lightly modified; (ii) heavily modified; or (iii) artificial. It also recognises groundwaters and groundwater-dependent terrestrial ecosystems (more commonly known as peatlands or wetlands, although the latter term is rarely used in this context to avoid confusion with surface water littoral wetlands). The water bodies are divided into types, depending on hydromorphological factors such as drainage basin geology, altitude, tidal range, substrate type, depth, catchment size, etc.

Water body size

Pragmatism dictates that water bodies need to be of a minimum size; otherwise, every puddle and pond would need to be classified and monitored.

The WFD sets out two systems for differentiating water bodies into types: Systems A and B. Of these, only the former specifies minimum sizes for rivers (10–100 km^2 catchment area) and lakes (0.5–1 km^2 surface area); no minimum sizes are given for small transitional or coastal waters. Any smaller lake or river water bodies than this are presumably designated on the grounds of protected area status (see Box 1). In contrast, very large rivers can drain catchment areas of >10,000 km^2 and large lakes can be >100 km^2 in size. However, in a similar way to which rivers can be divided up into numerous river water bodies, where chemical status, biological status, flow, catchment geology, etc. differ, lakes can also be divided into two or more water bodies, e.g. where nutrient concentration or phytoplankton biomass/chlorophyll-*a* concentration varies between sub-basins of the same lake.

High status is defined as the biological, chemical and morphological conditions associated with no or very low human pressure. This is also called the reference condition, as it is the best status achievable – the benchmark. These reference conditions are type-specific, so they are different for different types of rivers, lakes or coastal waters, and may differ for the same type of water body in different ecological regions (since some different invertebrates, plants, etc. live 'naturally' in the Balkans to those living in Western Europe, e.g., in France, Ireland or the UK). The WFD recognises 25 ecoregions for rivers and lakes, but only 6 for transitional and coastal waters.

BOX 4. THE WATER FRAMEWORK DIRECTIVE (WFD) STATUS ASSESSMENT SCHEME

The WFD requires the ecological status of all surface water bodies (rivers, lakes, transitional and coastal waters) to be classified in a 5-level scheme (high, good, moderate, poor and bad) which incorporates four different types of assessment, as indicated by different quality elements. These are:

- An assessment of status indicated by biological quality elements
- An assessment of physico-chemical conditions that support the biological quality elements, such as dissolved oxygen and nutrients. Individual parameters are reported against a 5-class scheme, as for the biological quality elements. In addition, a pass or fail assessment against standards for other specific Annex VIII pollutants is made.
- An assessment of compliance with environmental quality standards for priority substances (chemical quality element). For these, a simple pass or fail system is applied.

And in determining high status only:

- A series of tests to ensure that hydromorphology is largely undisturbed. For these another 'pass or fail' system is applied.

For all quality elements (biological, physico-chemical, chemical and hydromorphological), the 'one out, all out' principle is applied. This means that the lowest classification for any constituent of each quality element (e.g. fish as a constituent of the biological quality element, or any individual priority substance as a constituent of the chemical priority element) applies to the entire quality element, and the lowest class of either the physico-chemical quality element or the biological quality element applies to each surface water body. Thus, any surface water body can achieve or fail to meet its environmental objectives based on biological quality elements, chemical priority pollutants, physico-chemical general conditions or physico-chemical specific pollutants (see Fig. B4-1, below and Box 10 for further information). For presentation of results, however, only maps of ecological status and chemical status (compliance with priority substance standards) will be presented.

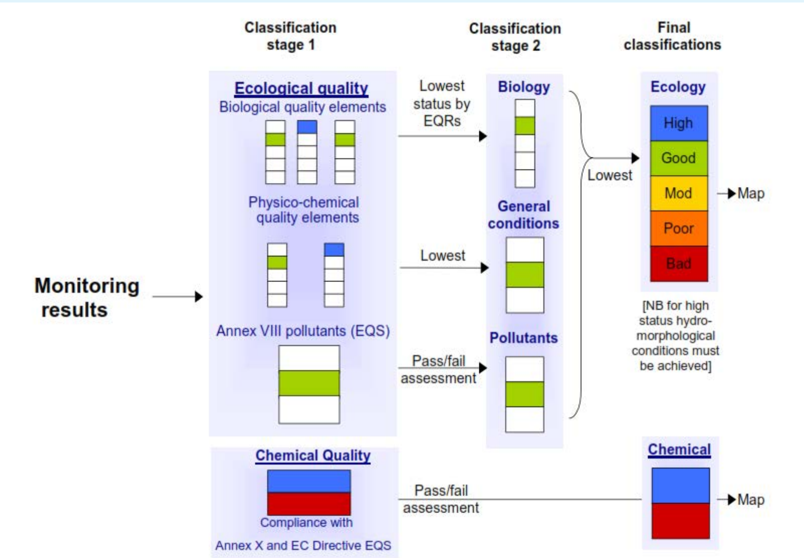

Figure B4-1 Classification of surface water bodies under the WFD (adapted from UKTAG 2005)

Assessment of quality is based on the extent of deviation from these reference conditions, following the definitions in the Directive. Good status means slight deviation, moderate status means moderate deviation, and so on. The definition of ecological status takes into account specific aspects of the biological quality elements, for example, the composition and abundance of aquatic flora or the composition, abundance and age structure of fish fauna.

Monitoring programmes for all sub-basins are established based on the results of the initial characterisation. These in turn provide the basis for devising programmes of measures and river basin management plans. Successful implementation of the programmes of measures should eventually lead to good status of all water bodies. River basin management plans and programmes of measures, respectively, are reviewed and updated every six years following the first six-year implementation period (Fig. 4-1).

lie in Montenegro and one third in Albania. The catchment covers an area of 5,490 km^2 (Lasca et al. 1981; 19% in Albania and 81% in Montenegro). The sub-basin has a shore length of 168 km, of which 110.5 km is Montenegrin and 57.5 km Albanian. The average depth is 5.9 m, with a maximum of 8.3 m and a volume of about 1,891 x 10^6 m^3 (CEED 2006). The largest tributary is the Morača River (Montenegro), providing more than 62 % of the lake's water, while the Buna/Bojana River (Montenegro and Albania) flows out from the south and drains into the Adriatic Sea. Lake Shkodra/Skadar lies in the sub-Mediterranean climate zone and has relatively high summer air temperatures, reaching 40 °C, with mild winter air temperatures (always above 0 °C).

Since 1983, 40,000 ha of the Montenegrin part of the lake has been designated as a National Park (IUCN management category II), containing an ornithological reserve of 812 ha territory (CEED 2006).

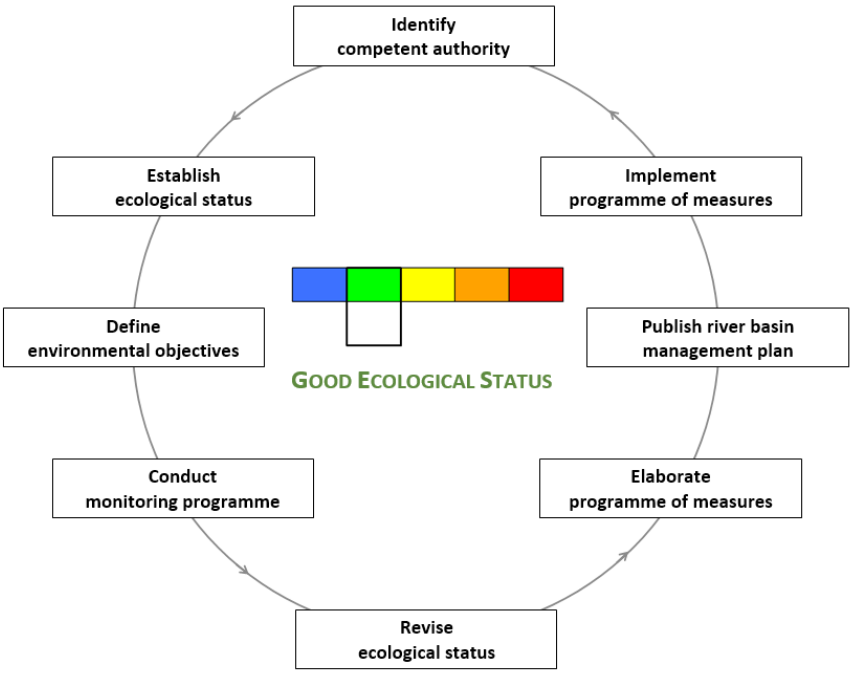

Figure 4-1 River basin management cycle of the Water Framework Directive (after H. Densky)

5 Lake Shkodra/Skadar Sub-Basin

5.1 Characteristics

Lake Shkodra/Skadar is situated in the Zeta-Skadar Basin, located on the border between Montenegro and Albania, and is the largest lake on the Balkan Peninsula, with an average surface area of 475 km^2. The surface area varies between *ca.* 350 km^2 and 570 km^2, depending on season and rainfall. At high water level, about two thirds of the water surface

5.2 Types of Surface Water Bodies – Lake and Main Tributaries

WFD System A (Annex II, Section 1.2) was used to determine/delineate individual water bodies. Central criteria are:

- Altitude
- Catchment area size (for rivers)
- Surface area size (for lakes)
- Geology
- Depth (for lakes)

In addition, specifies values (e.g. differing status/pressures, etc.) of adjacent water bodies in the same water body type) have been considered, enabling adjacent water bodies to be delineated. All water bodies are in the same ecoregion, so this cannot be used for delineation purposes.

The delineation of the water bodies at Lake Shkodra/Skadar was undertaken by the Technical Working Group, following guidance presented in CIS Document № 2 (see Box 5 and Fig. 5.5.1-1).

Water bodies of Lake Shkodra/Skadar

MNE – SL001 Vučko blato
(north-western, to a large extent isolated part of the lake)

MNE – SL002 North coast
(sampling points: Plavnica and Podhum)

MNE – SL003 South-west coast
(sampling points: Virpazar and Starčevo)

MNE – SL004 Pelagic zone

AL – SL001 Lake Shkodra

5.3 Type-Specific Reference Conditions

Establishing the reference conditions for Lake Shkodra/Skadar is difficult, due to the heterogeneity of hydrological features. The whole region of the lake watershed belongs to Ecoregion 5 – Dinaric Western Balkans.

The lake is shallow, of low altitude (below 50 m) and very large, draining karst, carbonate geology. Its sediments are largely within the euphotic zone. About 165 km² of the bottom of the lake is located below sea level. It is supplied principally by surface water inflow, but also by ground water (karstic springs). The water may be clear or mixed (Secchi depth = 2–5 m) and its volume variable, with the surface water level oscillating by 4–5 m, depending on climate, hydrologic regime and human activities. The climate is sub-tropical (mean air temperature = 14.9 *°C),* resulting in a high evaporation rate.

Photo 1. Skadar Lake

BOX 5. THE COMMON IMPLEMENTATION STRATEGY

Implementation of the Water Framework Directive raises a number of shared technical issues for national stakeholders. Moreover, many European river basins are transboundary. Thus, Member States, Norway and the Commission agreed on a common approach to dealing with such challenges. This is called the Common Implementation Strategy (CIS), which also supports further policy development (Directives on groundwater, priority substances and flood risks). While the WFD was considered a complex and lengthy document at 72 pages, the current library of 34 CIS Guidance Documents approaches 3,500 pages in total. Far from being daunting, however, this is a treasure trove of information (many would argue essential), greatly simplifying implementation of the Directive:

№ 1 – Economics and the Environment – The Implementation Challenge of the Water Framework Directive
№ 2 – Identification of Water Bodies
№ 3 – Analysis of Pressures and Impacts
№ 4 – Identification and Designation of Heavily Modified and Artificial Water Bodies
№ 5 – Transitional and Coastal Waters – Typology, Reference Conditions and Classification Systems
№ 6 – Towards a Guidance on Establishment of the Intercalibration Network and the Process on the Intercalibration Exercise
№ 7 – Monitoring under the Water Framework Directive
№ 8 – Public Participation in Relation to the Water Framework Directive
№ 9 – Implementing the Geographical Information System Elements (GIS) of the Water Framework Directive
№ 10 – Rivers and Lakes – Typology, Reference Conditions and Classification Systems
№ 11 – Planning Processes
№ 12 – The Role of Wetlands in the Water Framework Directive
№ 13 – Overall Approach to the Classification of Ecological Status and Ecological Potential
№ 14 – Guidance on the Intercalibration Process (2004–2006)
№ 15 – Groundwater Monitoring (WG C)
№ 16 – Groundwater in Drinking Water Protected Areas
№ 17 – Direct and Indirect Inputs in the Light of the 2006/118/EC Directive
№ 18 – Groundwater Status and Trend Assessment
№ 19 – Surface Water Chemical Monitoring
№ 20 – Exemptions to the Environmental Objectives
№ 21 – Guidance for Reporting under the WFD
№ 22 – Updated WISE GIS guidance (Nov 2008)
№ 23 – Eutrophication Assessment in the Context of European Water Policies
№ 24 – River Basin Management in a Changing Climate
№ 25 – Chemical Monitoring of Sediment and Biota
№ 26 – Risk Assessment and the Use of Conceptual Models for Groundwater
№ 27 – Deriving Environmental Quality Standards
№ 28 – Preparation of Priority Substances Emissions Inventory
№ 29 – Reporting under the Floods Directive
№ 30 – Procedure to Fit New or Updated Classification Methods to the Results of a Completed Intercalibration Exercise
№ 31 – Ecological Flows (final version)
№ 32 – Biota Monitoring
№ 33 – Analytical Methods for Biota Monitoring
№ 34 – Water Balances Guidance (final version subject to language and format checks)

The waters are well oxygenated (mean DO concentration = 8.1 mg.l^{-1}), alkaline (pH 7.2–8.3), with conductivity of (108–340 µS.cm^{-1}), variable nutrient concentrations (total nitrogen = <2 mg.l^{-1}, total phosphorus = 4.1–42 *µg*.l^{-1}) and moderate phytoplankton abundance (chlorophyll-*a* = 3.2–6.7 µg.l^{-1}). Expert opinion is that reference conditions for nutrient and chlorophyll-*a* concentrations would be a little lower, or closer towards the lower end of the reported ranges.

Lake Shkodra consists of three systems of habitats:

- Lacustrine with two subsystem habitats: limnetic includes habitats constantly flooded of the water surfaces; and littoral with several habitats
- Palustrine: marshy surfaces created by the withdrawal of lake water in warmer seasons, occurring especially in the north, east and south-east

- Riverine with two subsystems: alternate subsystem – habitats in outlet of streams; and permanent subsystem – such as Morača, Crnojevića and the beginning of the Buna/Bojana River from the lake

During summer, the concentration of phosphorus in the lake increases substantially. During this time, the water level drops and in littoral areas of the lake and surrounding wetlands, dense populations of macrophytes flourish. These are dominated by submerged genera (*Myriophyllum, Ceratophyllum, Najas, Vallisneria, Potamogeton* and Characeae) or floating species (*Nuphar luteum*, *Nymphea alba*, *Trapa natans*). Emergent taxa (e.g. *Phragmites, Scirpus, Typha, Cyperus, Eleocharis* and *Gratiola*) predominate in lake margins and surrounding wetlands.

Regarding phytoplankton, diatoms dominate during spring, in association with chrysophytes (*Dinobryon*) and Pyrrophyta (*Ceratium*); while in autumn, diatoms (*Cyclotella, Melosira, Navicula, Synedra, Fragillaria, Nitzschia* and/or *Cymbella*) co-dominate with green algae (Chlorophyta, mainly Chlorococcales). Large and filamentous cyanobacteria (e.g. *Microcystis, Merismopedia, Anabaena* and *Oscillatoria*) may be present in surface waters, but usually not at high densities.

It is not clear what reference conditions for most biological quality elements would be, but the assumption is that the pelagic sampling station (Water Body 4, Montenegro; Section 5.5.1), with lower levels of nutrients and organic enrichment than littoral sites, provide the best insight to defining these for phytoplankton and physico-chemistry, at least.

5.4 Identification of Pressures

5.4.1 Methods

Generally, pressures such as pollution, water abstraction or morphological alterations of water bodies are identified based on official data from state administrations. Point sources of pollution such as direct discharges from waste water treatment plants must be monitored. Data from compulsory self-monitoring and monitoring under state control provide a sound basis for the assessment of pollutant loads in lakes and rivers.

The assessment of pressures and quantification of loads from diffuse sources is more complex. Apart from discharges and run-off from agriculture, mining or other activities within the catchment, pollutants may enter lake systems through other pathways, including groundwater and atmospheric deposition. Pollutant inputs from these sources must therefore be measured as well upon evidence of risk.

5.4.2 Existing Data and Gaps

Pressures, especially significant point sources have been identified by IHMS in Montenegro and NEA in Albania. A complete state cadastre of all discharges either direct or into the sewer does not exist in either Montenegro or Albania. Pressures from diffuse sources have been estimated by studies. Official figures are not available.

Photo 2. Preparing for fishing

5.4.3 Significant Point Sources of Pollution

5.4.3.1 Albania

The majority of the sub-catchment population, around 180,000 habitants, live in Shkodra and Koplik municipalities, notably in Rrethina, Gruemirë, Kastrat and Qendër. Shkodra municipality is the main regional economic centre of north Albania. In the 1990s, much of the industry developed during the communist era collapsed.

In the city of Shkodra, waste water is collected in the sewer system and discharged untreated into the lake. It is the main point source in the watershed on the Albanian side of the lake. However, because wastewater is discharged near to the outflow of the lake, pollution of the lake water body at large is somewhat limited. This situation changes during periods of high water level of River Drin when its floodwaters may hamper the outflow of lake water or even push backwater into the lake. Exact figures about the connected households and pollution are not available yet.

5.4.3.2 Montenegro

The main industries and much of the population of Montenegro are located in the watershed. Therefore, the anthropogenic pressure on Lake Skadar ecosystem is significant.

The main emission source at the catchment area causing the biggest impact on the lake ecosystem is the discharge of untreated or insufficiently treated communal and industrial waste water. Point sources are the inlets of the municipal sewage systems. Most houses in the municipality of Podgorica (approx. 185,000 inhabitants) are connected to sewer. The WWTP employs mechanical and biological treatment processes. Storm water is discharged directly into the Morača River.

The waste water of Nikšić (approx. 58,000 inhabitants) is collected by a central sewerage system and discharged untreated to the Zeta River which is the main tributary of the Morača River. Waste water from the Cetinje municipality (approx. 16,000 inhabitants) is only partly collected by sewer. The collected untreated waste water is discharged into the Crnojevića River. Communal waste water of Rijeka Crnojevića settlement are also collected and discharged untreated into the Crnojevića River, a tributary of Skadar Lake.

The total annual quantity of waste water discharged into the basin is estimated to be about 40 x 10^6 m^3 (Šundić and Radujković 2012). These waters contain mainly organic biodegradable materials, which are responsible for increase of trophic status of lake water.

The main industrial facilities situated in the water basin are the steel factory in Nikšić and the aluminium plant in Podgorica. Both are currently not operating, but their emission potential for toxic and hazardous substances is still high. In the past, these emissions have been responsible for the contamination (especially of the sediments) of Skadar Lake.

The food industry causes the main actual commercial waste water discharges. The main companies are brewery 'Trebjesa', drink factory 'Neksan', bread factory 'Uniprom', dairy plants 'Nika' and 'Srna', meat processing 'Goranovic' (at Nikšić); several hen and pig farms, slaughterhouses, dairy plant 'Lazine', storage facility 'Crnagoracoop' (at Danilovgrad); vineyard '13 jul' and several bakeries (at Podgorica). The composition of the waste water is similar to domestic waste water.

Leachate from Cetinje dump and previous Podgorica dump, wood processing and furniture factories have an unknown risk potential to the water status of Skadar Lake.

5.4.4 Significant Diffuse Sources of Pollution

5.4.4.1 Albania

Main diffuse sources are domestic wastewater from households not connected with the sewer system and agriculture. The five administrative units (Rrethina, Gruemirë, Qendër, Kastrat communes and Koplik municipality) have an agricultural area of about 17,189 ha of land, out of which 12,691 ha is classed as arable and 7,042 ha is cultivated. Compared to 1990, the use of macronutrients (mainly N and P) is now higher per unit area, but smaller in absolute terms. Differences in the total use of chemical fertilizers are due to a reduction (by almost 50 %) of the area now cultivated compared to the area farmed before 1990. The diffuse-source nutrient pollution load from agriculture has the potential to be larger than that from waste water. If the total agricultural land area of about 17,000 ha were to be cultivated, agriculture would become the main diffuse source of pollution with macronutrients (Çakalli et al. 2013).

The Shkodra region has an increase of economic activities especially in agriculture and the associated food processing industry. As the majority of this industry is made up of small dairies, breweries, wineries, oil mills, etc., they lack adequate facilities and practices for treatment and utilization of waste. The treatment of waste water from cleaning and residues from production processes is mostly not in accordance with EU standards. The same goes for waste disposal systems for liquid and solid wastes of the meat-processing sector. All the leftovers are dumped in illegal landfills, with leachate running into nearby rivers (Çakalli et al. 2013).

Septic tanks and other ways of treating/discharging waste waters from houses and small facilities are also important diffuse sources.

5.4.4.2 Montenegro

There are numerous and variable diffuse sources within the catchment area. Important sources of diffuse pollution, particularly pesticides, are the croplands and vast vineyards of the Zeta and Bjelopavlići plains. Other sources comprise illegal trash dumps, small and medium utilities, and tourism, associated with increasing boat traffic on the lake. Atmospheric deposition (of nitrogen) is also a diffuse source, but the contribution to pollution of the lake is very difficult to quantify.

Septic tanks and other ways of discharge of sanitary and other waste water from settlements and small facilities are also important diffuse sources. Widely scattered point sources, such as industrial solid waste dumps, may also be included in diffuse source pollution loads.

Remobilization and resuspension of heavy metals and probably other pollutants from sediments may occur during flooding in both Montenegro and Albania, which is a specific trait of Lake Skadar compared to the other lakes of the Drin Basin.

5.4.5 Water Abstraction

5.4.5.1 Albania

A cadastre of water abstraction does not exist. Furthermore, systematic studies or surveys of water abstractors are not available yet.

The main irrigation method applied in the region is surface irrigation, with furrow irrigation dominating. It is estimated that this method has an efficiency of only 50–60 % (i.e. 40–50 % of water is lost during the path from the source to the arable plot), very low compared to modern technologies (i.e. drip or spray irrigation); the efficiency of water application is also low, at about 60 % (40 % is lost from surface flow and deep infiltration). Beside the low efficiency of this method, it also may have negative impacts on the environment in general and especially for soil erosion. High loads of leachate contaminated with agricultural chemicals may be discharged into the lake.

The low uptake of water efficient irrigation technologies, such as drip emitters and the poor maintenance of irrigation infrastructure (e.g. canals) has led to inefficiencies in water use and water losses through leakages leading to an increase in water application rates per hectare irrigated.

5.4.5.2 Montenegro

According to the annual report on the total amount of water supplied to the Regional Water Supply System for the Montenegrin Coast, the amount of water delivered from the source Bolje Sestre adjacent to Skadar Lake was 6,125,636 m^3 in 2013. Bolje Sestre is a water source located in the Malo Blato wetland. It is connected with Skadar Lake through the Biševina and Katatuna Rivers, but does administratively not belong to the Skadar Lake waters (Water Directorate 2014).

According to the Environmental Impact Assessment Study of the Bolje Sestre Water Supply System, the abstracted water derives from underground water which is not part of the Skadar Lake system owing to the higher elevation of the source. Therefore, this activity has no negative impact on the quantity and quality of Skadar Lake water. The quantity of water that is predicted to be abstracted from the Bolje Sestre system does not exceed more than 50 % of the total capacity of the source (EIA 2006). The amount abstracted in 2013 was 20 % of the capacity of the source.

5.4.6 Hydromorphology and Water Flow Regulation

Specific to Skadar Lake are bottom sub-lacustrine springs (named ‘oko’, or eye) situated at the northern, north-western and south-western parts of the lake. More than 60 springs supply freshwater, contributing some 18 % of the total water inflow. The depth, surface area and water level are seasonally variable. Surface water level has fluctuated between 4.54 masl in 1952 (minimum) to 10.44 masl in 2010 (maximum). The water level affects the appearance and size of flood areas at the north coast.

5.4.6.1 Albania

Although no survey of hydromorphological status of the lake has been undertaken, the destruction of marginal wetlands endangers the ecological status.

5.4.6.2 Montenegro

A dam separates Vučko Blato from the rest of the lake. Although no survey of the hydromorphological status of the lake has been undertaken, it is obvious that settlements, industrial and recreational use have an impact, notably the destruction of wetlands.

5.4.7 Other Significant Anthropogenic Impacts

5.4.7.1 Albania

Commercial fishing is the main pressure on the fish population of the lake. However, the development of tourism and increased urbanisation surrounding the south-eastern part of the lake (the so-called meadow area) are also considered to affect fish production. This represents a key spawning area for several important species of fish, including the common carp. A dam is currently being constructed which will separate part of this area from the main lake, and may, therefore, damage the biological status of the lake.

Photo 3. Karuc, Skadar Lake

5.4.7.2 Montenegro

The biggest negative anthropogenic impact on the lake fish fauna is poaching during the fish spawning period (when fishing is legally banned), and fishing at other times with illegal fishing gear. Communal waste waters from the cities of Podgorica, Danilovgrad and Cetinje are believed to boost eutrophication. Uncontrolled fish stocking activities also represent threats since in the past such activities have introduced alien species, such as Prussian carp and perch. Alien species increase competition for space and food resources and/or may act as predators on domestic species. A decline in native species abundance is believed to have occurred.

5.5 *Water Quality Assessment*

Water quality is assessed using classification systems based on biological, hydromorphological, chemical and physico-chemical parameters (elements in WFD terminology). Assessments provide information about the impacts of substances and hydromorphological interventions on aquatic communities, as well as information about key water uses.

Classification systems need to be harmonized at the national level and between countries being part of the same river basin. Existing systems e.g. for biological or structural quality classification can be used if they comply with WFD requirements. The WFD envisages using similar methodologies among member states to determine the status of surface waters.

The overarching objective of the initial characterisation is to assess if water bodies are at risk of failing environmental objectives, especially the good status.

5.5.1 Sampling Stations

The sampling stations for water quality assessments were selected in accordance with project tasks, WFD requirements and – for physico-chemical parameters – the experience of the Institute of Hydrometeorology and Seismology of Montenegro (IHMS) and the Albanian Geological Survey (AGS) in previous investigations. Altogether, six sites were sampled in Montenegro and three sites in Albania (Tab. and Fig. 5.5.1-1).

Table 5.5.1-1 **Lake Shkodra sampling stations for physico-chemical and chemical assessment**

Montenegro	Albania
Water body 1: Vučko blato	Water body 1: Albanian part of Lake Shkodra
• MNE I Kamenik	• AL I Kaldrun
Water body 2: North	• AL II Zogaj
• MNE III Plavnica	• AL III Shiroka
• MNE IV Podhum	
Water body 3: South-west	
• MNE II Virpazar	
• MNE V Starčevo	
Water body 4: Pelagic zone	
• MNE VI Centre	

Sampling stations for biological investigations are shown in the respective sections.

5.5.2 Chemical and Physico-Chemical Elements

Ecological water quality is defined via biological and physico-chemical elements (see Boxes 6 and 7). Thus, biological assessments are supplemented with the results of general physico-chemical parameters such as dissolved oxygen and nutrients (see Box 6).

5.5.2.1 Methods

Sampling and storage

Water sampling was undertaken at all measuring stations on four occasions: April, July, October and February. Samples of water were collected using Ruttner bottle at two depths (surface and bottom). Samples for general chemical analysis were collected in 3-litre inert plastic or 1-litre polyethylene bottles. Samples were collected in Winkler bottles of 100 ml for dissolved oxygen and 250 ml for BOD_5. Samples for chlorophyll-*a* were collected in dark 1-litre glass bottles and those for microelements (heavy metals and trace metals) were collected in 1-litre polyethylene bottles. All samples were transported to laboratory in mobile fridges on the day of collection and maintained at 4 °C prior to analysis.

BOX 6. CHEMICAL AND PHYSICO-CHEMICAL QUALITY ELEMENTS

Chemical status

Chemical status is concerned with the assessment of so-called priority substances, the most recent list of which (45 in total), and their environmental quality standards (EQS, maximum allowable concentrations), is given in Directive 2013/39/EU.

Laboratory analysis of priority substances requires sophisticated analytical equipment and methods. Moreover, some of the standards challenge the concentration levels that can be analysed with existing techniques. From WFD Annex V.1 one can infer that the chemical status applies to *"Pollution by all priority substances identified as being discharged into the body of water"*. It is, however, often not easy to determine this. Complicating factors include:

- Priority substances are a heterogeneous group of chemicals, comprising of non-synthetic and synthetic substances.
- As a group, they cannot be linked to specific anthropogenic pressures; each substance has its own characteristics. Individual substances can originate from different sources and can arrive in surface water bodies via multiple pathways.

Physico-chemical status

Physico-chemical parameters are divided into two groups:

- General conditions. Those which support the biological quality elements:
  - o Transparency (including Secchi depth and turbidity)
  - o Thermal conditions (temperature, including thermal stratification)
  - o Oxygenation conditions (dissolved oxygen, but also including substances which have an unfavourable influence on the oxygen balance and can be measured using parameters such as BOD_5 and COD)
  - o Salinity (conductivity, also related to water hardness and total dissolved substances)
  - o Acidification status (primarily pH, but water hardness is also important)
  - o Nutrient conditions (nitrates, phosphates, total nitrogen and total phosphorus)
- Other specific substances/pollutants, covered in WFD Annex VIII, for which national environmental quality standards have been developed (see Annex V, Section 1.2.6), including materials in suspension, which are discharged into the water body in significant quantities

Unlike the priority substances (chemical status), there are no EU standards for physico-chemical parameters. Instead, standards are set at national level (maximum allowable concentrations for most parameters, but minimum concentrations for dissolved oxygen). However, standards from revoked EU legislation (notably the Freshwater Fisheries Directive, 2006/44/EC) may be used for some parameters for this purpose.

Analysis

All analyses were done using standard methods. Temperature of water and air, depth, Secchi depth (transparency), pH and conductivity were measured in the field. Samples for chlorophyll-*a* analysis were filtered through a 0.45 μm glass fibre filter upon entry to the laboratory, and chlorophyll-*a* extracted from the filter. Samples for dissolved oxygen were conserved with $MnCl_2$ in the field and analysis of BOD_5 was undertaken after five days using the same procedure as for dissolved oxygen. All the other parameters were analysed within specified time limits.

Photo 4. Equipment for physico-chemical measurements

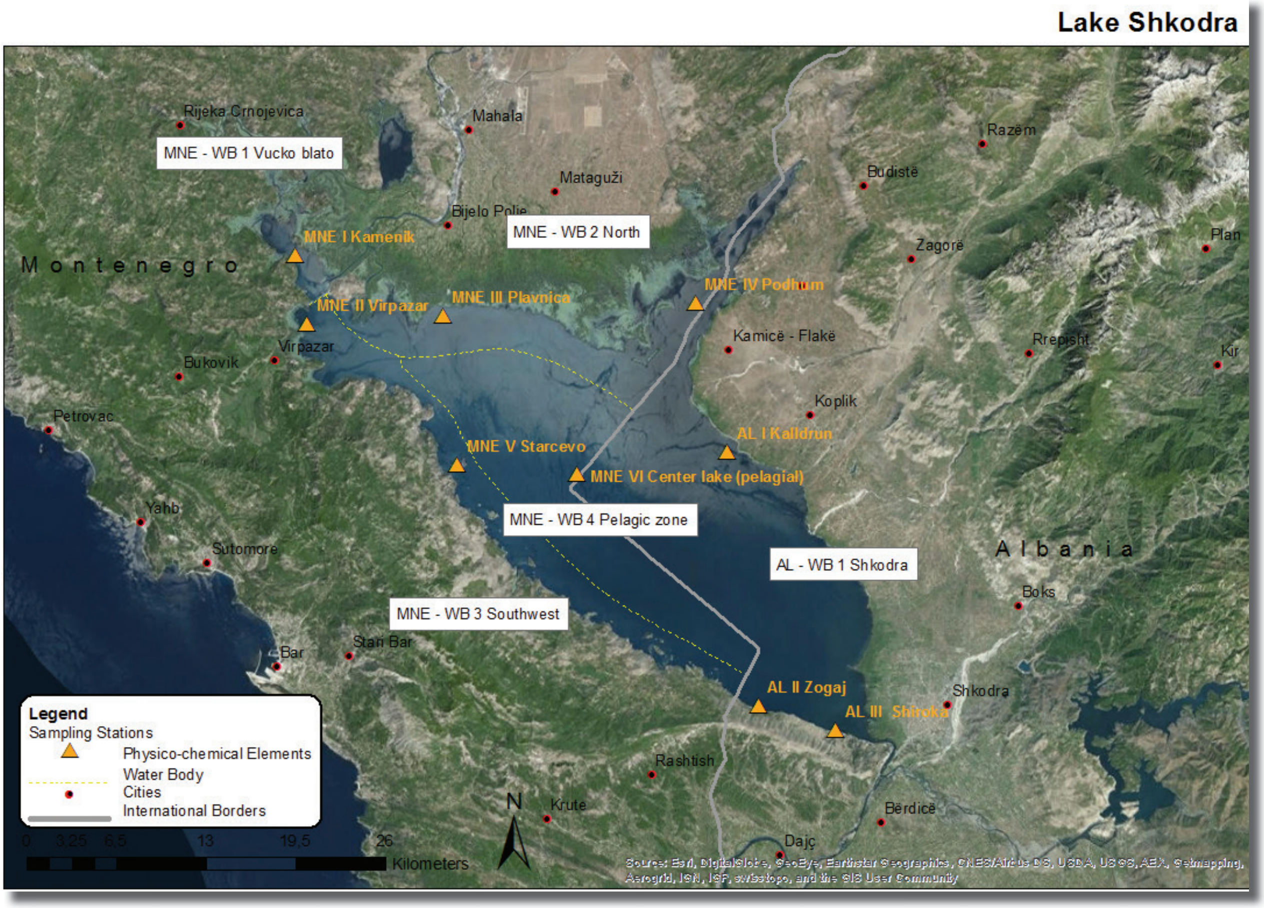

Figure 5.5.1-1 Sampling stations for chemical and physico-chemical analyses at Lake Shkodra

5.5.2.2 *Existing Data and Gaps*

Until the mid-eighties, some physico-chemical parameters were recorded under the state monitoring programme of Yugoslavia. However, the parameters monitored or the sampling procedures and/or analytical methods used do not correspond to present-day requirements of the WFD. Between the mid-eighties and today, limited monitoring was undertaken at the Montenegrin part of the lake, usually within the scope of research projects.

Only scattered and unverified physico-chemical data are available for the Albanian part of the lake. A transboundary water quality monitoring programme from 2007–2009 funded by the Research Council of Norway found total phosphorus concentrations of 1–35 µg TP.l^{-1} and total nitrogen concentrations of 200–600 µg TN.l^{-1}. This study concluded that the lake is in mesotrophic conditions despite high nutrient inputs (Skarbøvik et al. 2014).

5.5.2.3 *Results*

Results of physico-chemical investigations are summarized in Annexe 11.2. More detailed information is given in the original reports compiled in the Volume of Annexes (USB card).

5.5.2.3.1 *Albania*

Monitoring was undertaken four times from 2013–2014 (April, July, October and February) at three stations. Sampling procedures were considered suitable for most sites/parameters, but failed to follow standard methodologies fully. Bottles containing samples were transported to the laboratory by car in cool boxes, avoiding any outside influences. However, transport and storage procedures did not follow prescribed methodologies entirely.

Samples were analysed according to agreed standard methodologies, except for total phosporus. Results strongly suggested that water quality is affected by anthropogenic pressures (nutrients etc.). However, the preliminary results obtained will require validation from the proposed monitoring programme (Section 8.1).

5.5.2.3.2 *Montenegro*

Levels of conductivity were rather low (195–270 µS.cm^{-1}), considering the Karst (soluble) geology of the catchment, with Secchi depth (transparency) varying between 1.8 and 3.3 m. The maximum depth recorded (at any monitoring site and any time) was 9.5 m, indicating that macrophytes should be able to colonise most of the bottom of the lake, since the euphotic zone (the depth at which there is sufficient light available for plants to grow) is usually considered to be 2.5–3.5 times Secchi depth. As expected, chlorophyll-*a* results (a principal determinant of Secchi depth, together with [the very low] levels of suspended solids) were highly variable, with values ranging between 0.2 $\mu g.l^{-1}$ and 10.1 $\mu g.l^{-1}$. Over the course of a year, typically in lakes, maximum recorded chlorophyll-*a* levels are about 3 times the average recorded value, but more frequent monitoring than the 3-monthly programme used for this study is required to improve the certainty of obtaining maximum and mean results.

Higher values of total phosphorus generally occurred at Kamenik, Virpazar and Plavnica (3–56 $\mu g\ TP.l^{-1}$), with lower values at Starčevo and Centre (1–30 $\mu g\ TP.l^{-1}$). Inorganic nitrogen (nitrate + nitrite + ammonium) were highest in spring/winter, reflecting higher export from land (diffuse sources). In the vast majority of freshwater lakes (and Shkodra/Skadar is not an exception), phosphorus is in shorter supply than nitrogen for plant (phytoplankton) growth, so is said to be the limiting nutrient.

The lake is alkaline, reflecting the geology, with pH values typically below 8, but approaching 8.5 at the centre during autumn. Localised differences in pH are likely to reflect groundwater inputs and phytoplankton productivity.

The difference in temperature between surface and bottom waters was typically only 2 °C during all seasons, so the lake appears to be too shallow/well mixed to thermally stratify.

Dissolved oxygen levels decreased during summer due to its photosynthetic removal from the water, albeit not to levels that cause concern, with lowest values recorded at Plavnica, Starčevo and the centre (summer). Non-photosynthetic oxygen removal process also caused little concern, with low-to-moderate COD and BOD_5 values recorded. The highest recorded BOD_5 value was 4.49 $mg.l^{-1}$ at Plavnica in autumn. No investigations of diurnal patterns of dissolved oxygen were undertaken, but lower DO results would be expected at night.

5.5.3 Specific Pollutants

The chemical status of water bodies is determined on the basis of compliance with environmental quality standards for pollutants of Europe-wide importance. Therefore, the assessment of chemical status has to consider the list of priority substances for which maximum allowable concentrations are defined and priority hazardous substances whose discharge, emission or loss must cease or be phased out entirely to prevent the contamination of water (Annex X WFD). Existing evidence suggests significant discharges and/or loadings of the heavy metals lead, cadmium and aluminium, as well as organochlorine and organophosphorus pesticides. These specific pollutants as well as arsenic and mercury were therefore analysed in sediments of Montenegro within the scope of the initial characterisation. In Albania, only lead and cadmium were analysed. However, discharges into the lake of other priority substances are likely and should be analysed in future monitoring programmes.

5.5.3.1 Methods

Sampling

Sediment samples were collected in July 2013, using a van Veen grab.

Analysis

Heavy metals were analysed by inductively coupled plasma optical emission spectrometry and pesticides were measured by gas chromatography (for details, see AGS (2014) and Djurašković (2014), Volume of Annexes).

5.5.3.2 Existing Data and Gaps

Contamination of lake sediment presents a direct and lasting threat to the aquatic ecosystem, particularly the benthic flora and fauna. Many toxic and persistent pollutants become absorbed to sediments and soils and can incorporate into aquatic food webs. Data on sediments in Lake Shkodra are limited and fragmentary, but indicate the presence of trace elements, metals, PCBs, PAHs and organochlorine pesticides.

Investigations of heavy metals in lake sediments of Albania and water were conducted by the University of Tirana (Faculty of Chemistry) and the University of Shkodra (Faculty of Natural Sciences) over the last five years (e.g. Neziri and Gössler 2007). Electro thermal and flame atomic absorption spectrometry were used to determine concentrations of Pb, Cd, Co, Ni, Cu, Zn and Cr as well as their fractionation in waters and bottom sediments of Lake Shkodra. Water samples were collected at three different depths (maximum of 6 m) from a site in the pelagic zone, as well as a site close to the shore; sediment samples were taken from two sites. Concentrations of lead were 0.78–2.79 $\mu g.l^{-1}$ in water and 23.5 $mg.kg^{-1}$ in sediment, those of cadmium 0.038–0.79 $\mu g.l^{-1}$ in water – the upper level exceeding the Environmental Quality Standard (EQS) of 0.08–0.25 $\mu g.l^{-1}$ (depending on water hardness) for inland surface waters, set by Directive 2013/39/EU – and 1.2 $mg.kg^{-1}$ in sediment; and those of chromium 5.4–10.8 $\mu g.l^{-1}$ in water and 57.9 $mg.kg^{-1}$ in sediment. The nickel content in sediments was 96.65 $mg.kg^{-1}$. The high concentrations of chromium and nickel in sediments were associated with mining activities in northern Albania but also with naturally elevated levels linked to the regional geology (Shehu and Lazo 2008, Vemic et al. 2014).

Recent investigations of heavy metals in the Montenegrin part of Lake Skadar (Vemic et al. 2014) showed that the priority substances Cd, Pb and Ni were either not detected in water or lay below EQS values. However, like in Albania, concentrations of nickel in sediments were very high, ranging from 63.1–126.8 $mg.kg^{-1}$. Concentrations ≥ 22.7 $mg.kg^{-1}$ are believed to have adverse effects on sediment-dwelling organisms, though the Maximum Approved Value (MAV) according to the Dutch list is 35 $mg.kg^{-1}$ (for other heavy metals, see Table 5.5.3.3.2-1).

5.5.3.3 Results

This section summarises the main findings of chemical investigations conducted at Lake Shkodra/Skadar in 2013 and 2014. For further information, the reader is referred to AGS (2014) for Albania and Djurašković (2014) for Montenegro (Volume of Annexes) and to Annexe 11.2.

5.5.3.3.1 Albania

Results from sediment analyses showed very low heavy metal concentrations, ranging from below the detection limit to 0.03 $mg.kg^{-1}$ for Pb and 0.01 $mg.kg^{-1}$ for Cd. The upper levels lie far below the MAV according to the Dutch list (see Section 5.5.3.3.2).

5.5.3.3.2 Montenegro

Results are compared with Dutch allowable limits (see Table 5.5.3.3.2-1).

Table 5.5.3.3.2-1 Maximum approved and high risk values for selected heavy metals in soils (MvV 2000)

Metal	Maximum Approved Value ($mg.kg^{-1}$)	High Risk Value ($mg.kg^{-1}$)
Mercury	0.3	10.0
Arsenic	29.0	55.0
Lead	85.0	530 .0
Cadmium	0.8	12 .0

Contrary to Albania and the study of Vemic et al. (2014), concentrations of cadmium lay considerably above the MAV at all stations (1.5–9.1 times; Annexe 11.2). Concentrations of the other heavy metals were low. The content of mercury was 0.2–0.4 times the MAV, arsenic 0.02–0.1 times and lead 0.07–0.1 times the MAV. Aluminium, which is not on the Dutch list, was present at very high values, due partly to sediment geology, but also with a probable contribution from land-based sources, notably the former aluminium plant KAP.

The content of some metals is higher than in the 1990s (Royal Haskoning 2006), but lower than in 2005 (Šundić and Radujković 2012). Mercury was minimal at Virpazar. The other results were similar, but the maximum at Kamenik was about two times higher. Lead was increased at Kamenik, Virpazar, Podhum and Starčevo. Cadmium was present at very low levels at Kamenik, but at higher levels at Podhum and Virpazar. Aluminium concentrations were very similar at all sites.

Generally, the highest concentrations of heavy metals in sediment were found at Podhum and Kamenik. At the former site, this may be a consequence of ground waters influence, but at Kamenik, the influence of the river Crnojevića and the right branch of the river Morača, perhaps with leachate from Cetinje dump, are more likely to be sources. The lowest content of heavy metals in sediment was measured at Plavnica, away from any known sources of influence.

Organochlorine and organophosphorus pesticide concentrations were all below the limit of detection (see Annexe 11.2).

5.5.4 Biological Quality Elements

The ecological status of water bodies is assessed considering species composition, abundance, dynamics and status of selected aquatic fauna and flora (so-called biological quality elements; see Box 7) known to respond sensitively to anthropogenic pressures. The assessment uses type-specific reference conditions, i.e. natural or near-natural undisturbed conditions, as a benchmark. Depending on the degree of deviation from these reference conditions, the ecological status can be assessed. The main objective of the initial characterisation is to assess the risk of water bodies failing to achieve good ecological status. In accordance with the WFD (see Box 7), the following biological elements were investigated:

- Phytoplankton (mainly unicellular algae)
- Macrophytes (emergent, submerged or floating plants)
- Benthic invertebrates (bottom-dwellers)
- Fish

BOX 7. BIOLOGICAL QUALITY ELEMENTS

Biological status is indicated by biological quality elements. Recognising that no individual biological community can be used to monitor all (types of) water bodies equally well, the WFD requires biological monitoring to be undertaken for up to 4 biological communities (biological quality elements) in each type of water body:

Table B7.1 Biological quality elements within the WFD

Quality elements	Parameters	Rivers	Lakes	Other waters	
				transit.	coastal
Phytoplankton	*Composition, abundance and biomass*	✓	✓	✓	✓
Macrophytes and phytobenthos	*Composition and abundance*	✓	✓	✓	✓
Benthic invertebrates	*Composition and abundance*	✓	✓	✓	✓
Fish	*Composition, abundance and age structure*	✓	✓	✓	

Phytoplankton are particularly good indicators of the nutrient status of lentic (slow-flowing) waters, notably lakes (and seas – coastal waters). However, they are less good in rivers because at velocities greater than about 0.5 m/s they tend to be swept downstream faster they can multiply, preventing true river 'pelagic' phytoplankton (potamoplankton) populations from developing. Chlorophyll-*a* concentrations are often used as a surrogate for phytoplankton biomass, since in the vast majority of species this constitutes 1–2 % of dry weight. Phytoplankton community composition exhibits pronounced seasonality, with populations able to double in only a few days under ideal growing conditions. Thus, in lakes and coastal waters peak chlorophyll levels are typically 3 times annual average concentrations.

Phytobenthos are also good indicators of nutrient enrichment (and other pressures, such as acidification), and can be used to assess water quality. Diatoms are often used as a proxy for all phytobenthos, because their silica shells (frustules) make them relatively easy to identify under the microscope. They are good indicators of nutrient status and acidification, in particular. Macrophytes and phytobenthos are usually monitored as separate biological quality elements and the results integrated to form a single biological quality element. However, in this report, only macrophyte communities have been monitored/assessed; no monitoring of phytobenthos has been undertaken.

Benthic invertebrates are particularly good indicators of organic enrichment and oxygen status. A wide variety of different community composition indices/metric exist, many of which can be calculated using Asterics software.[7]

If used in isolation, fish populations are probably the least reliable biological indicators of ecological status because of historical anthropogenic management. Nevertheless, and considering the high level of endemism particularly at Lakes Prespa and Ohrid, they provide another important aspect of ecological quality when combined with the other biological quality elements.

Biological quality element results are reported as environmental quality ratios, i.e. as a proportion of the value which would have been achieved under reference (unimpacted) conditions. This explains why so much effort is focused on identifying reference conditions, particularly when these vary so much between different water body 'types' (see Box 1).

5.5.4.1 Phytoplankton

5.5.4.1.1 Methods

Water samples for phytoplankton investigations were taken at six sampling points belonging to four water bodies in Montenegro and three sampling points belonging to one water body in Albania (see table next page). The same sampling stations were used for phytoplankton and physico-chemical analyses (see Tab & Fig. 5.5.4.1-1). The same methodology was applied to all three lakes, following a protocol developed by Rakočević (2013).

7 http://www.eugris.info/displayproject.asp?Projectid=4422

Table 5.5.4.1-1 Lake Shkodra sampling stations for phytoplankton community composition and chlorophyll-*a* analysis

Montenegro	Albania
Water body 1: Vučko blato	Water body 1: Albanian part of Lake Shkodra
• MNE I Kamenik	• AL I Kaldrun
Water body 2: North	• AL II Zogaj
• MNE III Plavnica	• AL III Shiroka
• MNE IV Podhum	
Water body 3 South-west	
• MNE II Virpazar	
• MNE V Starčevo	
Water body 4: Pelagic zone	
• MNE VI Centre	

Materials

Plankton nets were used for qualitative analyses and hydrobiological sampling bottles for quantitative analyses.

Sampling campaigns

Phytoplankton samples were taken from a boat in spring (April 2013) and summer (August 2013) to reflect seasonal dynamics of community composition.

Data analysis

Phytoplankton taxa were identified using identification keys specified in Rakočević (2014, Volume of Annexes). Chlorophyll-*a* was analysed according to ISO 10260 (1992). Water transparency and chlorophyll-*a* concentration, respectively, were used to calculate the Trophic State Index (TSI) according to Carlson (1977). This index is a measure of the state of nutritional enrichment of aquatic ecosystems, reflecting pressures resulting from nutrient (nitrogen and phosphorus) inputs originating mainly from sewage and the application of

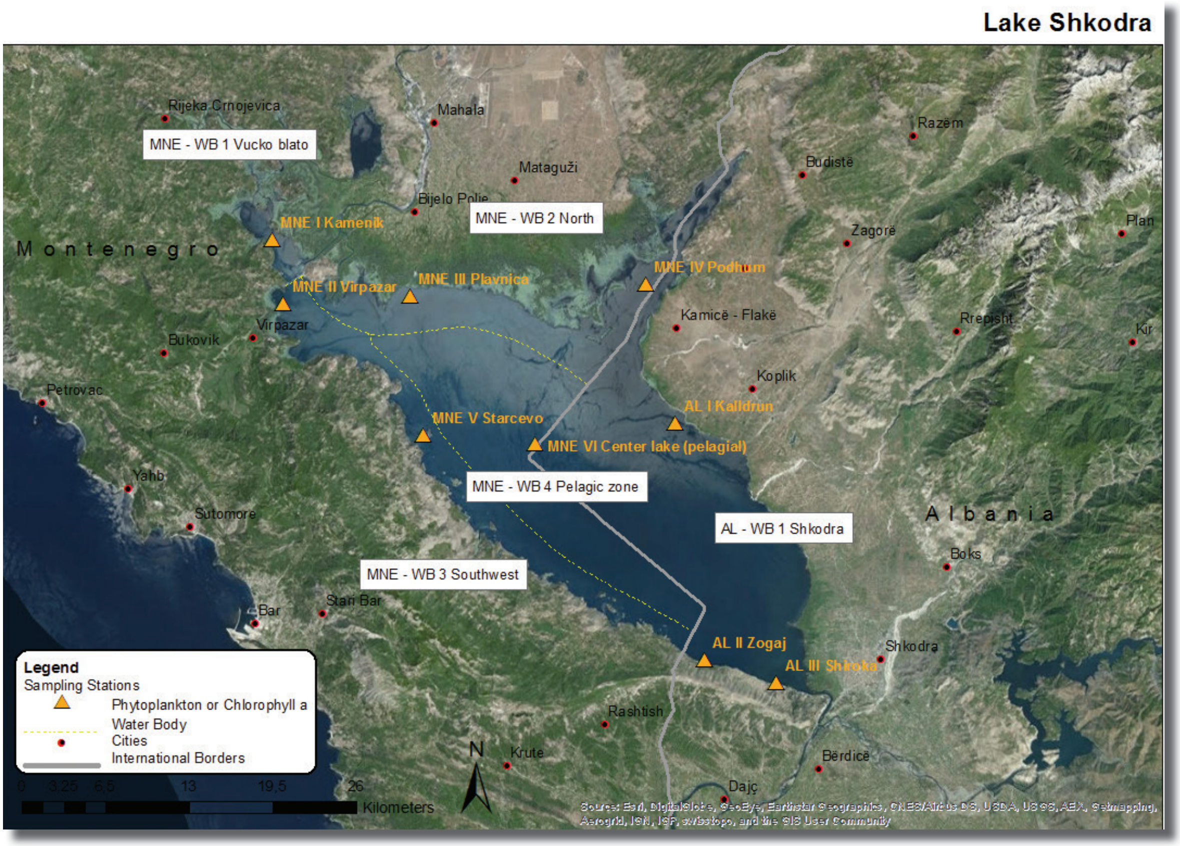

Figure 5.5.4.1-1 Sampling stations for phytoplankton at Lake Shkodra

fertilizers in agriculture. In addition, several biological indices were calculated (Rakočević 2014).

5.5.4.1.2 Existing Data and Gaps

Phytoplankton at the Montenegrin part of Lake Shkodra/Skadar was first studied at the end of fifties of the last century and then periodically until the end of the 1980s (Petković 1981). The majority of these investigations were qualitative in nature (taxonomic inventories). Quantitative analyses were done occasionally, focusing on phytoplankton abundance, although rarely covering more than one season. Data on changes in biodiversity and trophic conditions are largely missing because of the lack of continuous monitoring.

After a gap of almost three decades, investigations resumed in the first decade of the new millennium, both in Montenegro (Rakočević and Hollert 2008) and Albania (Rakaj 2008, 2010). These studies provided the first comprehensive account of the spatial and temporal dynamics of phytoplankton at Lake Shkodra/Skadar and the first profound assessment of its trophic and saprobic state.

5.5.4.1.3 Results

This section provides a synthesis of the main findings of the phytoplankton investigations conducted in 2013. For further details, the reader is referred to Rakočević (2014, Volume of Annexes).

5.5.4.1.3.1 Albania

Phytoplankton composition

The spatial distribution of phytoplankton was uniform in both seasons but differed greatly between seasons (as would be expected), with 47 species belonging to five divisions recorded in spring and 91 species belonging to 6 divisions recorded in summer. Chrysophytes (golden algae) were by far the most dominant group in spring. This group is predominantly associated with low nutrient status. In contrast in summer, diatom (Bacillariophyta) species dominated. Diatoms may be present under a wide variety of circumstances, but are, perhaps, most widely known for dense spring blooms – presumably not recorded in this instance because of timing differences – phytoplankton blooms can collapse completely within a week, so the spring samples could have been collected shortly after a diatom bloom crashed.

Abundance and trophic state

Total phytoplankton abundance ranged from 4.1×10^4 cells.l^{-1} at Sterbeq in spring to 3.4×10^5 cells.l^{-1} at Shirokë in summer. Phytoplankton abundance and the TSI (based on chlorophyll-*a*) indicated oligotrophic conditions at all three sampling points in spring but mesotrophic conditions in summer (Table 5.5.4.1.3.1-1).

Table 5.5.4.1.3.1-1 Trophic state of Lake Shkodra (Albanian part) in spring and summer 2013

Sampling station	Season	TSI	Trophic state
Sterbeq	Spring	31	Oligotrophic
	Summer	42	Mesotrophic
Zogaj	Spring	36	Oligotrophic
	Summer	41	Mesotrophic
Shirokë	Spring	33	Oligotrophic
	Summer	43	Mesotrophic

5.5.4.1.3.2 Montenegro

Phytoplankton composition

In spring 2013, 65 phytoplankton species belonging to four taxonomic divisions were recorded. In summer, species diversity was lower (56 species) though representing more divisions (6). In both seasons, species numbers were lowest in the central part of the lake where the water is deepest. Phytoplankton communities here consisted mainly of euplanktonic diatoms and golden algae while those from the shallow parts of the lake also contained littoral species of different groups including green algae (chlorophytes) which are often re-suspended from the bottom, lakeshore or macrophyte vegetation.

Abundance and trophic state

The overall abundance of phytoplankton was generally higher in Montenegro than in Albania, ranging from 5 x 10^5 cells.l^{-1} at Podhum in summer to 7 x 10^6 cells.l^{-1} at Kamenik in spring. These values are one order of magnitude higher than those found by Petković (1981) in the 1970s. The lowest phytoplankton abundance was recorded in the central part of the lake (pelagic). Contrary to Albania, the trophic state was mesotrophic at most sampling stations in spring (eutrophic at Starčevo), indicating higher nutrient loads (Table 5.5.4.1.3.2-1). In summer, the trophic state showed strong spatial variation, ranging from oligotrophic at Podhum and the pelagic site to eutrophic at Kamenik and Virpazar. The latter two sites are known to be particularly exposed to anthropogenic nutrient inputs.

Table 5.5.4.1.3.2-1 Trophic state of Lake Shkodra (Montenegrin part) in spring and summer 2013, according to the Trophic State Index (Carlson 1977)

Sampling station	Season	TSI	Trophic state
Kamenik	Spring	48	Mesotrophic
	Summer	56	Eutrophic
Virpazar	Spring	47	Mesotrophic
	Summer	51	Eutrophic
Plavnica	Spring	44	Mesotrophic
	Summer	49	Mesotrophic
Podhum	Spring	50	Mesotrophic
	Summer	37	Oligotrophic
Pelagic (central part of the lake)	Spring	40	Mesotrophic
	Summer	36	Oligotrophic
Starčevo	Spring	51	Eutrophic
	Summer	43	Mesotrophic

5.5.4.2 Macrophytes

5.5.4.2.1 Methods

Macrophyte investigations were carried out at eight sites, of which five were located in the Montenegrin and three in the Albanian part of Lake Shkodra (Tab & Fig. 5.5.4.2.1-1). The same sites were also used for physico-chemical and other biological monitoring (see Section 5.5.1).

Table 5.5.4.2.1-1 Lake Shkodra monitoring stations for macrophyte community composition and assessment

Montenegro	Albania
Water body 1: Vučko blato	Water body 1: Albanian part of Lake Shkodra
• MNE I Kamenik	• AL I Kaldrun (also known as Sterbeq)
Water body 2: North	• AL II Zogaj
• MNE III Plavnica	• AL III Shiroka
• MNE IV Podhum	
Water body 3: South-west	
• MNE II Virpazar	
• MNE V Starčevo	

Field Sampling

Macrophytes were investigated along belt transects according to methods proposed by the WISER (Water bodies in Europe: Integrative Systems to assess Ecological status and Recovery) project (WISER 2012). The fieldwork was conducted during the period of maximum growth (July–August 2013). Plants were sampled at different depths from a boat using a double-sided rake with soft rope marked by depth readings (10 samples per one meter depth zone along transects running from the shoreline to the maximum depth of plant growth). The abundance of each species was estimated on a five-point scale following Melzer (1999), ranging from 1 (very rare) to 5 (abundant or predominant). All plants sampled where identified to species level using appropriate keys.

Photo 5. Investigating macrophytes

Data analysis

A catalogue of nine so-called indicator groups of macrophyte species exhibiting different sensitivities towards nutrient enrichment was used to identify species for which indicator values have been defined (Melzer and Schneider 2001). Only these species were considered to calculate the Macrophyte Index (MI) according to Melzer (1999). The index reflects the nutrient status of lakes and was used as an indicator of ecological status.

5.5.4.2.2 Existing Data and Gaps

The earliest studies on aquatic plants of Lake Shkodra were published in the late nineteenth and early twentieth centuries (Grimburg 1871, Ascherson and Kanitz 1877, Baldacci 1901, etc.). During the First World War, some floristic studies were done by Austrian and German botanists in the area around Shkodra, including the lake, of which Janchen (1920) and Schütt (1945) provided the most comprehensive data. Later, Montenegrin and Albanian authors contributed to in-depth studies of the flora of the lake (e.g., Ristić and Vizi 1981).

More recent studies found species new to the area and established distribution patterns of rare and endangered plants. The status of the flora and fauna of Lake Shkodra was investigated from 2005 onwards within the framework of a project entitled “Biomonitoring of Lake Skadar – The Way

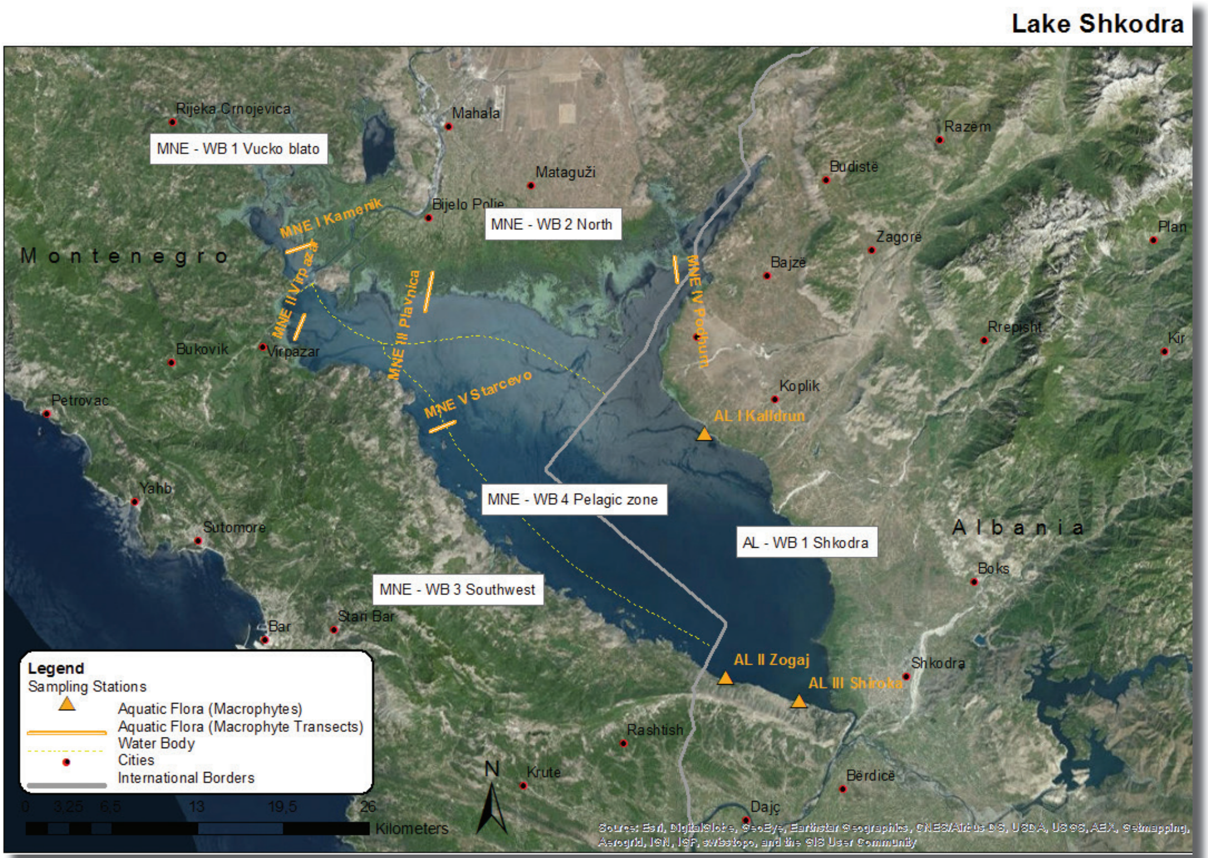

Figure 5.5.4.2.1-1 Monitoring stations for macrophyte investigations at Lake Shkodra/Skadar
Monitoring was undertaken along transects perpendicular to the shoreline. Transects shown are not to scale.

to Innovative Cross-border Monitoring". At present, however, most studies collect only qualitative data. Quantitative studies and macrophyte-based ecological assessments are almost non-existent, although a PhD study on the taxonomic composition and abundance of macrophytes in the Albanian part of the lake is in progress.

The present study uses the Macrophyte Index of Melzer (1999) originally developed for Central European lakes to assess nutrient enrichment. However, its appropriateness for Mediterranean lakes needs further scrutiny considering that indicator species may respond differently to the trophic state of lakes under sub-Mediterranean climates and that some species of mainly Mediterranean distribution have not been assigned an indicator value at all.

5.5.4.2.3 Results

This section provides a synthesis of the main findings of the macrophyte investigations conducted in 2013. For further details, the reader is referred to Kashta and Rakaj (2014, Volume of Annexes) for the Albanian part of Lake Shkodra and Hadžiablahović (2014, Volume of Annexes) for the Montenegrin part.

5.5.4.2.3.1 Albania

Macrophyte community composition

The maximum depth of macrophyte growth varied from 5.3 m at Shiroka to 6.7 m at Sterbeq. Fifteen aquatic macrophyte species were recorded at the three sites. The highest species diversity was observed at Sterbeq (14) and the lowest at Zogaj (9) while Shiroka (10) took an intermediate position. Eight of the species recorded were macrophyte indicators according to Melzer and Schneider (2001), their indicator values ranging from 2.5 (minimum) to 5.0 (maximum). Dominant species were rigid hornwort (*Ceratophyllum demersum*), perfoliate pondweed (*Potamogeton perfoliatus*) and shining pondweed (*Potamogeton lucens*). These species are associated with moderate to very high nutrient enrichment.

Nutrient enrichment and trophic state

The Macrophyte Index (MI) varied between 3.68 at Sterbeq and 4.30 at Zogaj (Tab. 5.5.4.2.3.1-1), indicating high nutrient enrichment at Sterbeq and Shiroka and very high level of nutrient enrichment at Zogaj. This corresponds to eutrophic/hypertrophic conditions at all sites.

Table 5.5.4.2.3.1-1 Macrophyte Index (MI) score and inferred levels of nutrient enrichment and trophic state at Lake Shkodra/Skadar (Albanian part), summer 2013

Sampling station	MI score	Nutrient enrichment	Trophic state
Sterbeq	3.68	High	Eutrophic (level 2)
Zogaj	4.30	Very high	Hypertrophic/polytrophic (level 3)
Shirokë	3.86	High	Eutrophic (level 2)

5.5.4.2.3.2 Montenegro

Macrophyte community composition

The maximum depth of plant growth recorded in Montenegro was 4.3 m. A total of 34 species of macrophytes were identified, the majority of them sedges and other wetland species as well as water lilies, which are not included in macrophyte index calculations. Species diversity was highest at Virpazar (19), Plavnica (18) and Podhum (16). Eleven species were recorded at Kamenik and only 4 at Starčevo. Owing to the predominance of wetland species, the number of truly aquatic macrophyte indicators according to Melzer and Schneider (2001) was relatively low (6 altogether). As in Albania, these species became dominant in deeper waters. Rigid hornwort (indicator value 5.0) was most abundant at Starčevo (west shore) while shining pondweed (indicator value 3.5) was predominant at Podhum (north-east shore).

Nutrient enrichment and trophic state

The Macrophyte Index varied between 3.5 at Podhum and 5.0 at Starčevo, indicating high nutrient enrichment at Podhum and very high nutrient enrichment at all other sites (Tab. 5.5.4.2.3.2-1). With the exception of Podhum (level 1 = eutrophic), the overall degree of eutrophication was generally higher in Montenegro than in Albania (level 3 = hypertrophic/polytrophic for the remaining four sampling stations).

Table 5.5.4.2.3.2-1 Macrophyte Index (MI) score, with inferred levels of nutrient enrichment and trophic state of Lake Shkodra/Skadar (Montenegrin part), summer 2013

Sampling station	MI score	Nutrient enrichment	Trophic state
Kamenik	4.98	Very high	Hypertrophic/polytrophic (level 3)
Virpazar	4.72	Very high	Hypertrophic/polytrophic (level 3)
Plavnica	4.99	Very high	Hypertrophic/polytrophic (level 3)
Podhum	3.50	High	Eutrophic (level 2)
Starčevo	5.00	Very high	Hypertrophic/polytrophic (level 3)

5.5.4.3 Macroinvertebrates

5.5.4.3.1 Methods

Benthic macroinvertebrates were sampled in autumn (September 2013) and spring (April–May 2014) at each of the three stations from different water depth (referred to hereafter as littoral, sublittoral and profundal part of the lake). Sampling points in Montenegro were:

- Plavnica
- Starčevo
- Virpazar

These sites (Fig. 5.5.4.3.1-1) are located in areas with different degrees of anthropogenic pressure (woodlands, agriculture, fishery, transport system, semi-urban areas, and industrial activities). During each sampling period, a rapid evaluation protocol to assess the ecological conditions was applied at each sampling station. Some ecological aspects such as land use (human influence, erosion, presence and maintenance of riparian vegetation), features (canopy cover, substrate type and particle size, etc.), water characteristics (transparency, siltation, discharge etc.), and the presence of aquatic macrophytes were evaluated.

Sampling campaigns

Macroinvertebrate communities were sampled using a multihabitat transect method (ISO: EN 27828:1994, AQEM/STAR). The first macroinvertebrate sampling exercise was conducted during September 2013, but did not include the littoral part of lake. The second exercise was undertaken during April/May 2014 and covered the littoral part of lake. Three replicate samples were collected at each station from different depths (littoral, sublittoral and profundal) using a van Veen grab (250 cm^2). The samples were stored in plastic bags and fixed in 4 % formalin solution[8]. In the laboratory, they were washed, sieved and sorted under a binocular stereomicroscope.

8 While the use of formalin/formaldehyde as a preservative for biological samples used to be widely practiced, its use for this purpose is now frowned upon, if not forbidden within EC Member States, due to its carcinogenic properties.

Species identification and community metrics

Specimens of macroinvertebrate samples were identified to the lowest possible taxonomic level, aiming for species, but genera and family level were also recorded, depending on the indices to be assessed.

Annex V of the WFD specifically outlines benthic invertebrate fauna composition and abundance, the ratio of sensitive taxa to insensitive taxa and the diversity of invertebrate communities as criteria that need to be defined for type-specific ecological assessments of lakes.

The structure of benthic invertebrate communities at each sampling point was evaluated using a range of metrics:

- Shannon-Wiener, Simpson's and Margalef diversity indices (each displaying different facets of community diversity)
- Species richness
- Relative abundance
- Number of taxa (N-taxa)
- Biological Monitoring Working Party (BMWP) score
- Average Score per Taxon (ASPT)
- Relative abundance of invertebrates in each functional feeding group (collector-gatherers, predators, collector-filterers, shredders, and scrapers)
- Ephemeroptera, Plecoptera and Trichoptera (EPT) Index (the total number of families in these three pollution-sensitive orders)
- Macroinvertebrate Biotic Index (MBI).

Individual metrics provide different insights to the overall quality of a community, in a similar way to which different (physico-) chemical parameters (e.g. nutrients, dissolved oxygen status, heavy metals, organic pollutants, etc.) represent different facets of overall water quality. In general terms, the more metrics that are used, the more reliable an assessment of 'status' will be. Thus, the better the understanding of the overall health of a community based on a small sub-sample of it; and the greater the confidence in the results.

5.5.4.3.2 Existing Data and Gaps

Benthic macroinvertebrates in Montenegro are poorly investigated and consequently the literature about them is deficient, with some taxa (e.g. Oligochaeta, Gastropoda, Coleoptera, Odonata) being more intensively monitored than others. As such, the use of historic data to establish reference conditions may not be practical, even though the lake had hardly been affected by pollutants from municipal, agricultural and industrial sources prior to 1980 (but see Karaman and Beeton 1981).

During more recent decades, the basin has experienced increasing pollution, resulting in reduced biodiversity; a threat to fisheries, public health and tourism. Industrial pollution and untreated waste water discharges from cities and towns close to the Morača River are obvious pollution sources. However, chemical pollution is not the only pressure: the impact of water level fluctuations, which are expected to increase due to climate change, are poorly understood.

While valuable data have undoubtedly been produced for this report, an increased number of sampling stations is required to establish threshold values between human-impacted and unimpacted sites. Understanding natural distribution patterns of littoral invertebrates remains a significant challenge.

Data covering at least a five or six year period (i.e. covering a WFD river basin planning cycle) should ideally be used to assess environmental quality. Fluctuations in weather patterns (rainfall, temperature, etc.) occur naturally from year-to year, with resultant changes in pollutant export from diffuse sources (including sewer overflows), waste dumps, etc. Likewise, the relatively constant pollution load from point sources (notably waste water treatment plants) is subject to varying degrees of dilution.

5.5.4.3.3 Results

5.5.4.3.3.1 Albania

No monitoring of macroinvertebrate communities was undertaken in the Albanian part of Lake Shkodra.

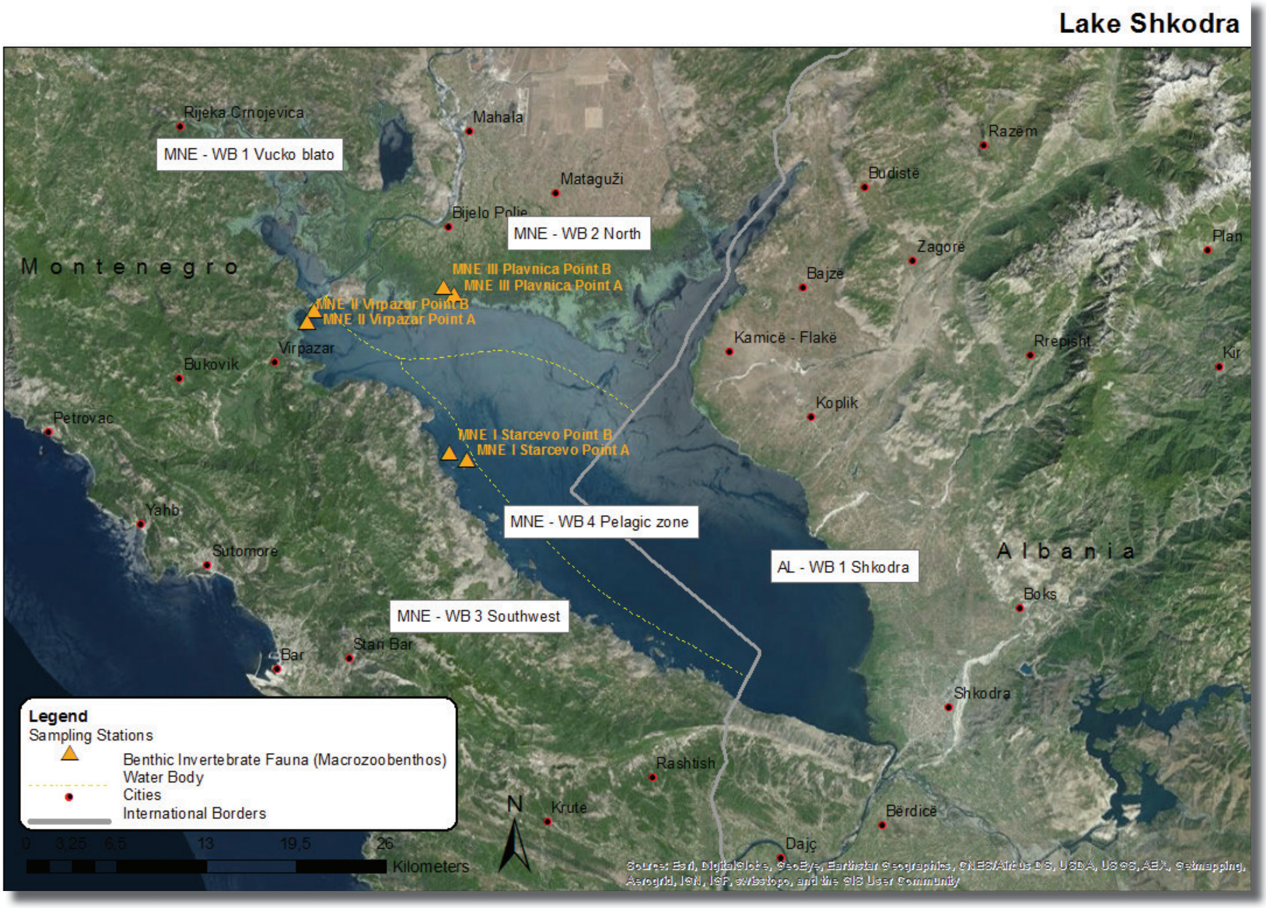

Figure 5.5.4.3.1-1 Benthic invertebrate sampling stations in Lake Shkodra/Skadar

5.5.4.3.3.2 Montenegro

Overall, results of the three diversity indices suggest that macroinvertebrate diversity is highest at Virpazar and lowest at Plavnica. Results from Starčevo fall between those from the other two sites. Taxa (species) richness results suggest high levels of organic enrichment at Virpazar, Plavnica and Starčevo. Results vary between the spring and autumn samples, illustrating why samples need to be collected during both seasons.

Autumn BMWP scores of 26.5 and 22.1 in Starčevo and Virpazar, respectively, indicate polluted and impacted status, albeit better than Plavnica (BMWP score = 8.9) which is a heavily polluted site. An ASPT result of 3.3 (very poor water quality) was obtained for Starčevo, while Virpazar and Plavnica results indicate moderate (fair) status/quality (5.5.4.3.3.2-1). Spring BMWP scores of 12.4–29.6 indicate polluted/impacted water, a conclusion supported by ASPT results of 3.0–4.1, indicating poor or very poor status.

MBI scores ranged from 8.4-10.0, indicating very poor water quality and a high degree of organic pollution at all sites.

Table 5.5.4.3.3.2-1 Ecological status of the littoral zone of the Montenegrin part of Lake Shkodra/Skadar based on the Average Score per Taxon (ASPT) index

Sampling station	Season	ASPT	Ecological status
Starčevo	Autumn	3.3	Very poor
	Spring	3.6	Poor
Virpazar	Autumn	4.4	Moderate
	Spring	3.0	Very poor
Plavnica	Autumn	4.4	Moderate
	Spring	4.1	Poor

ASPT ≤ 3.6 indicates bad status.
ASPT > 4.8 indicates good status (not achieved at any site)

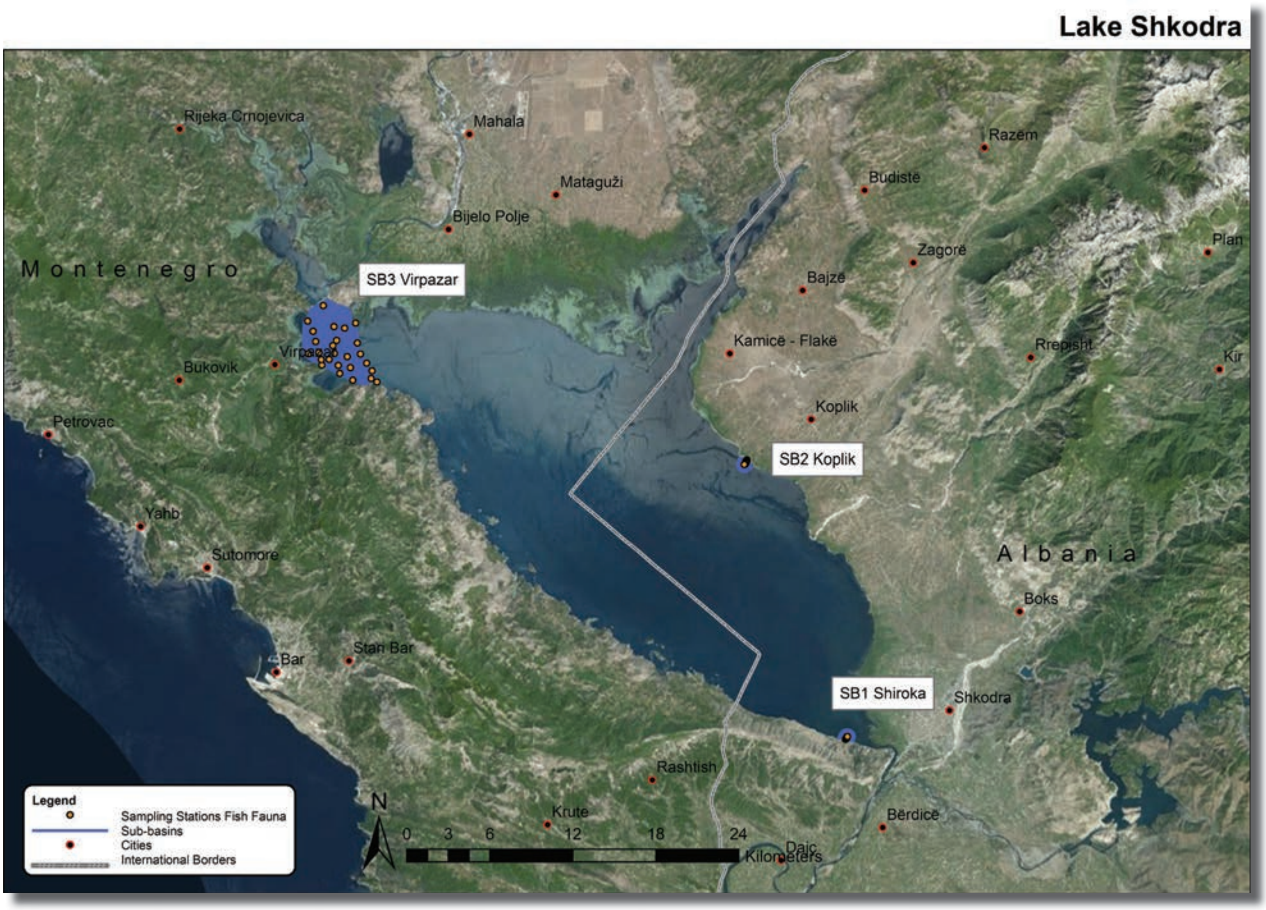

Figure 5.5.4.4.1-1 Fish sampling stations in Albania and Montenegro for multimesh gillnetting in 2013
Circles demarcate the sub-basins sampled. The sampling stations were clustered in Albania but more widely dispersed in Montenegro. Sampling stations in 2014 covered larger sub-basins in both countries.

Photo 6. Fishing on lake Shkodra

Collector-gatherers were the most abundant trophic group, suggesting a high input of allochthonous (externally derived) organic matter. The second most abundant were collector-filterers, implying elevated levels of phytoplankton. The number of predators recorded in this study was low, and they were completely absent at Plavnica. The presence of four of the five functional groups at Starčevo and Virpazar suggests a relatively balanced (but organically enriched) invertebrate community at these sites, albeit with a different, more unstable community at Plavnica. Generalists, such as collector-filterers and collector-gatherers, which were well represented in this study, have a broader range of acceptable food materials than specialists have, and thus are more tolerant to pollution that might alter the availability of certain food types.

5.5.4.4 Fish

5.5.4.4.1 Methods

The assessment of Lake Shkodra's fish fauna was based on two multimesh sampling campaigns. Multimesh gillnetting (MMG) took place in autumn of both 2013 and 2014. The standard EN 14757:2006 (now replaced by SS-EN 14757:2015) was modified according to the lake's characteristics resulting in MMG sampling of three sub-basins per year (Fig. 5.5.4.4.1-1). In 2013, a total of 24 benthic nets were set on the Montenegrin side and 72 on the Albanian side of the lake. In 2014, 36 (Montenegro) and 72 (Albania) nets, respectively, were employed. In Montenegro, electrofishing transects were sampled in addition to MMG (not shown in the map).

Photo 7. Removing fish from multimesh gillnets

Further details on sampling, data collection and analysis are given in the lake reports on fish and fisheries in the Volume of Annexes.

5.5.4.4.2 Existing data and gaps

Information on the fish fauna of Lake Skadar and its development can be found in the scientific literature. To date, approximately 50 species have been detected, of which 37 are native and 13 are introduced species (Marić and Milošević 2011). The fish fauna comprises both warmwater and coldwater species. As well, the lake is inhabited by several endemic species of the families Salmonidae, Cyprinidae, Gobiidae and Cobitidae, and is temporal habitat (e.g., spawning ground) for many migratory (e.g. *Alosa falax*, *Anguilla anguilla, Acipenser* sp.) and marine (*Mugil cephalus*, *Dicentrarchus labrax*, *Platichthys flesus flesus*) fishes. One of the greatest challenges related to identification of Shkodra lake fishes, however, is the uncertain taxonomic position of several species, which in the past caused misidentifications resulting in some degree of uncertainty in terms of data reliability.

Photo 8. Measuring fishes

A precise commercial catch statistic for both the Montenegrin as well as the Albanian part of Skadar Lake is missing for decades. Due to the engagement of the Fisheries Management Organisation (FMO) Shkodra this situation, however, has recently improved on the Albanian side.

In conclusion, essential elements (e.g. the selection of metrics indicating different kinds of anthropogenic pressures on the fish assemblage, class boundaries for ecological status, calculation of EQRs) to assess the ecological status of Lake Shkodra/Skadar using the biological quality element fish are still lacking at present. Further information, such as the composition of a reference and present fish assemblage list including abundance and age structure, does exist in fragments, but still needs to be completed.

5.5.4.4.3 Results

5.5.4.4.3.1 Albania

In the two sub-basins sampled with multimesh gillnets, a total of 13 species was found. Dominant taxa in these areas of the lake were *Rutilus, Alburnus* and *Pseudorasbora*, which represented about 80 % of all caught individuals. For further information, see Tab. 5.5.4.4.3.1-1 and the Lake Shkodra report on fish and fisheries (Mrdak et al. 2014, Volume of Annexes).

5.5.4.4.3.2 Montenegro

Multimesh gillnetting in the northern part of Shkodra Lake resulted in a catch comprising 16 fish species. *Alburnus scoranza*, *Rutilus prespensis* and the invasive *Perca fluviatilis* were the dominant fishes in terms of biomass and abundance. In 2014, the rare marble trout was caught again for the first time in many years. For further information, see Tab. 5.5.4.4.3.1-1 and the Lake Shkodra/Skadar report on fish and fisheries (Mrdak et al. 2014, Volume of Annexes).

Table 5.5.4.4.3.1-1 Relative abundance (RA) of fish species sampled in 2013 and 2014

(Data from both countries pooled)

Native Species	RA		Introduced Species	RA	
	2013	2014		2013	2014
Cyprinidae			Cyprinidae		
Bleak (*Alburnus scoranza*)	3	3	Prussian carp (*Carassius gibelio*)	1	1
Ohrid nase (*Chondrostoma ohridanus*)	1	1	Percidae		
Carp (*Cyprinus carpio*)	1	1	Perch (*Perca fluviatilis*)	3	3
Ohrid spirlin (*Alburnoides ohridanus*)	1	0			
Spotted roach (*Pachychilon pictum*)	2	1			
Stone moroko (*Pseudorasbora parva*)	2	1			
Bitterling (*Rhodeus amarus*)	1	1			
White roach (*Rutilus albus*)	1	1			
Roach (*R.* prespensis)	3	3			
Roach (*R. rubilio*)	1	0			
Chub (*Squalius platyceps*)	1	1			
Skadar rudd (*Scardinius knezevici*)	1	3			
Rudd (*S. erythrophthalmus*)	1	0			
Cobitidae					
Prespa spined loach (*Cobitis meridionalis*)	1	0			
Salmonidae					
Marble trout (*Salmo marmoratus*)	0	1			
Marine/brackish					
Clupeidae					
Twait shad (*Alosa fallax*)	1	1			
Blenniidae					
Freshwater blenny (*Blennius fluviatilis*)	0	1			
Mugilidae					
Grey mullet (*Mugil cephalus*)	1	0			

0 = absent; 1 = rare; 2 = frequent; 3 = abundant.

5.6 *Impact and Risk of Water Bodies Failing to Meet Environmental Objectives*

The assessment of the risk of water bodies failing to meet the environmental objectives set was done by the Technical Working Group – WFD. It used information from previous studies and data from the current project, as well as expert knowledge and background information on prevailing impacts and pressures in the respective sub-basins. An overview of the elements used to assess the ecological status of surface water bodies is shown in Fig. 5.6-1.

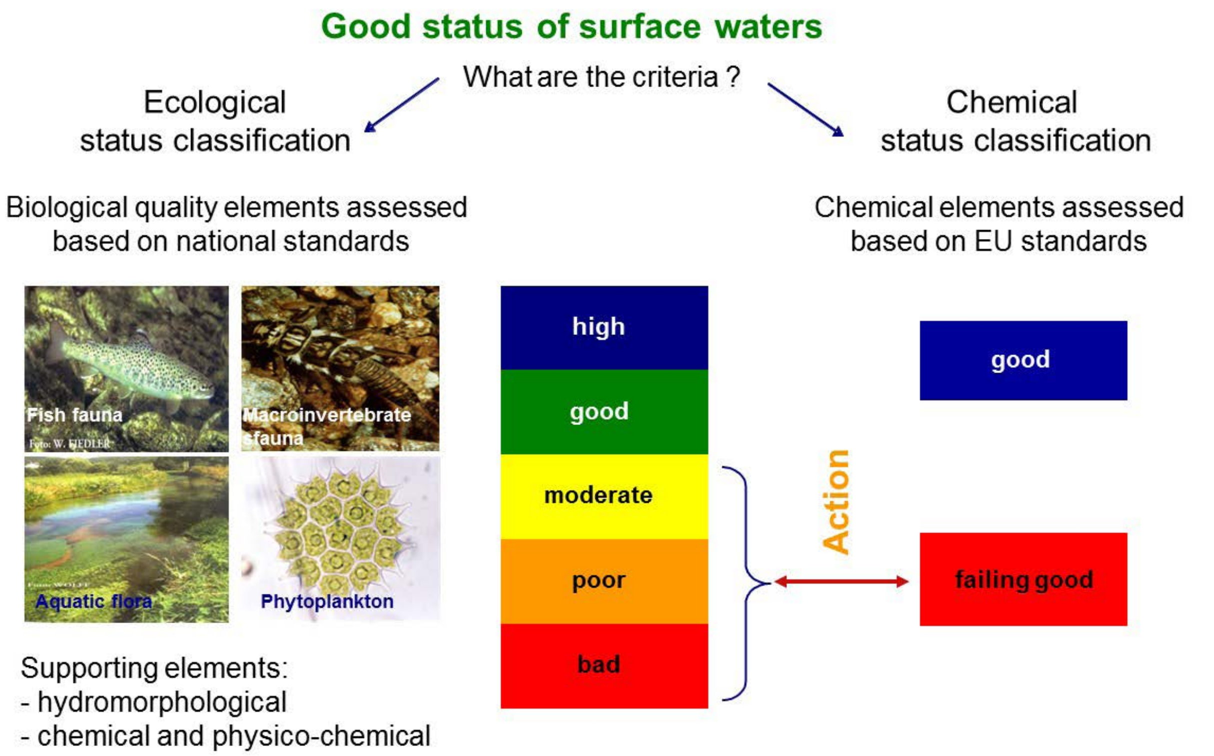

Figure 5.6-1 Elements used to assess the ecological status of surface water bodies (after H. Densky).
Action is required if any of the quality elements indicates less than good status.

5.6.1 Chemical and Physico-Chemical Elements

5.6.1.1 Albania

Because of problems related to sampling and laboratory procedures, the results of the sampling campaigns need to be validated by comparison with future monitoring results. However, it is obvious that high nutrient concentrations, as well as high values for BOD_5 and COD are caused by the discharge of untreated waste water especially from the municipality of Shkodra.

5.6.1.2 Montenegro

The total phosporus results in particular show that the lake (and all Montenegrin water bodies within it) are highly impacted. While there is no doubt that both point and diffuse sources are to blame, no nutrient source apportionment modelling is known to have been undertaken (for either the Albanian or Montenegrin sub-catchments), and this is a pre-requisite of any nutrient control programme, in order to identify the primary sources and most cost-effective solutions. All water bodies (especially around Vučko blato and Virpazar bay) are under pressure. The main pollution and nutrient load enters the lake via Rivers Crnojevića and Morača, together with the Virpazar channel as an extension of River Orahovštica.

5.6.2 Biological Elements

5.6.2.1 Albania

Phytoplankton abundance, chlorophyll-*a* concentration and Trophic State Index (TSI) results suggest mesotrophic conditions, although a large amount of caution should be exercised over this conclusion because of the very small amount of data and limited timespan over which those data were collected. Macrophyte results, however, indicate a higher level of eutrophication. Macroinvertebrate results also suggest a relatively high level of organic enrichment at all sites. Fish are probably the most uncertain biological quality element to assess the status of lake quality and no attempt has been made as yet to produce a classification scheme based on the results observed. Thus, fish have effectively been excluded from the ecological status assessment. The recent finding of a sensitive salmonid species, although very rare in the lake, suggests that ecological status may not be quite as bad as other biological quality elements suggest.

Even though type-specific reference conditions remain to be defined, it is evident that the composition and abundance of phytoplankton and macrophyte communities differ significantly from undisturbed conditions, and that the Albanian part of Lake Shkodra is likely to fail the environmental objective of achieving good ecological status (Tab. 5.6.2.1-1).

richness, low abundance and a degraded population structure. However, species composition of the shallow-water (littoral) lake community reflects slightly better environmental quality conditions than the deep-water (profundal) communities. Macrophyte Index results shows that the status of the lake as a whole is not satisfactory, even though the lake has a high self-purification capacity due to its short nominal residence time (3–4 months). Nutrient enrichment is inferred as being very high at four sampling stations, and high at a further sampling station.

As with the Albanian part of the lake, even though type-specific reference conditions remain to be defined, it is likely that the environmental objective of achieving good ecological status would not be achieved in any Montenegrin water body (Tab. 5.6.2.1-1).

Table 5.6.2.1-1 Risk of Lake Shkodra/Skadar water bodies failing to achieve good ecological status

Water body	Individual assessment				Overall assessment
	Phytoplankton	Macrophytes	Macroinvertebrates	Fish	
MNE – SL001 Vučko blato	🟡	🔴	🔴	⚫	At risk
MNE – SL002 North coast	🟡	🔴	🔴	⚫	At risk
MNE – SL003 South–west coast	🟡	🔴	🔴	⚫	At risk
MNE – SL004 Pelagic	🟡	Not assessed	Not assessed	Not assessed	At risk †
AL – SL001 Lake Shkodra	🟡	🔴	Not assessed	⚫	At risk

Yellow = probably at risk (but only limited data), red = at risk, black = assessment not possible (significant data deficiencies); AL = Albanian water body, MNE = Montenegrin water bodies.
† Precautionary principle applied.
"Probably at risk" is not a risk assessment category foreseen in the WFD but has been used on an interim basis in countries such as the UK if data were considered insufficient to draw firm conclusions.
All water bodies are **at risk** of failing to meet their environmental objectives.

5.6.2.2 Montenegro

As in Albania, no definite conclusions can be drawn from the phytoplankton community data because the monitoring undertaken was too infrequent and the dataset too short-lived. However, the limited number of Cyanophyta suggests that the lake may not be as highly nutrient-enriched as inferred from the macroinvertebrate results, which may be due to its short renewal time. The macroinvertebrate community is characterised by relatively low species

5.6.3 Hydromorphological Elements

Hydromorphological quality elements are outlined in Box 8. The watershed of Skadar Lake is mainly composed of calcareous rocks and dolomite less, while at the plain it is mainly built with limestone rocks, less dolomite and quaternary deposits.

The lake is characterised by two types of lakeside: high lakeside of erosion nature and low lakeside of accumulative nature. The western lakeside is an erosion one, while the east, north and south zones are characterised by the low accumulative side. The low lakesides of the northern area are wide and shallow. The south and east sides consist of alluvial fields formed by the continuous accumulation of solid matter brought from small streams. Moreover, there are many lagoons especially in the north.

Hydromorphological monitoring/mapping is not yet undertaken, in either Albania or Montenegro.

should be the environmental objective for all water bodies of the lake.

5.7 *Protected Areas*

The register of Protected Areas (Box 1) includes the following sites designated for the protection of habitats or species, but does not yet include areas designated for drinking water abstraction or recreational (bathing) waters. Neither the Urban Waste Water Treatment (UWWT) nor the Nitrates Directives have been implemented in Albania or Montenegro, so no nutrient sensitive areas are included in the following sections.

BOX 8. HYDROMORPHOLOGICAL QUALITY ELEMENTS

Hydromorphology is a mixture of hydrological and morphological assessments, but with one very important addition: water continuity. Thus, whilst the other monitoring elements (biological, chemical and physico-chemical) are concerned primarily with the quality of the aquatic environment, hydromorphology is concerned primarily with the physical nature of the aquatic environment.

For all types of water bodies, hydromorphology is concerned with the physical characteristics of sediment/substrates, and thus with the proportions of water body bottoms (benthic habitats) that consist of bedrock, boulders, cobbles, pebbles, sand, silt, mud, organic debris, etc.

Thus in all surface water bodies it is concerned with the physical size of the water body itself and the shore/riparian zone – depth variations, surface area (lakes), substrate composition, water inflow (and velocities in rivers), abstractions/discharges, outflow, residence time and water level. Connections to groundwater, water level regulatory structures (dams and weirs) and other obstructions/impedances to flow (e.g. flood defence structures) should all be considered in terms of their impacts on ecological status.

In coastal waters, hydromorphology is also concerned with the tidal regime (height), wave exposure, longshore/rim currents and the structure and condition of intertidal zones and, in transitional waters, the quantity of freshwater inflow.

For classification purposes, a water body can only be considered to be of high ecological status if there are no or very limited hydromorphological alterations from its reference status.

5.6.4 Surface Water Status and Environmental Objectives Assessment

Even though reference conditions have not been defined, there is sufficient evidence available to state with a high degree of certainty that the environmental status of the lake has changed considerably in recent decades, compared to its pre-1980 status (for the latter, see Karaman and Beeton 1981). The degree of nutrient and organic enrichment is considerably elevated all over the lake and the biological quality element results display this clearly. The impact of pressures, notably untreated and insufficiently treated waste water (from Podgorica, Shkodra, Virpazar etc.) on the composition and abundance of biological elements is obvious. A considerable proportion of non-native fish species underlines the high anthropogenic pressure on lake ecology. Nevertheless, with improved waste water treatment and more sustainable practices in agriculture and fisheries, good ecological status can be achieved and

5.7.1 Albania

Shkodra district (total surface of 52,192 ha) has protected area status (IUCN classified). In particular, Theth has the status of a National Park, Buna River–Velipoja is a protected landscape (V IUCN category) and the lake is a Managed Natural Reserve. Beside the protected areas, dozens of natural monuments are scattered around Shkodra district, from the city up to the most remote mountainous areas.

The Managed Nature Reserve of Lake Shkodra and the surrounding areas cover a total surface of 26,535 ha out of which 15,719 ha are water surface. Land uses include forestry, arable land and livestock farming, together with urban areas.

5.7.2 Montenegro

The Montenegrin side of the lake (two-thirds of the total surface area) has been designated as a National Park (II IUCN category) since 1983, covering 40,000 ha altogether. In 1995, the lake was designated as a Wetland of International Importance under the Ramsar convention, due to the richness and diversity of its bird life (20,000 ha on the Montenegrin side and 49,562 ha on the Albanian side, including River Bojana/Buna).

The area of Skadar Lake is also included in the list of Important Plant Areas (IPA) due to the presence of representative habitats that are of European and global importance. In addition, it is recognized as an Important Bird Area (IBA) for breeding, wintering and passage of water birds, holding more than 20,000 individuals throughout the year.

Seventeen Emerald habitats are also recognized in the lake region, according to the Bern Convention. This corresponds to its recognition as a potential Natura 2000 site, although a full designation is still to be completed for the lake.

6 Sub-Basin Lake Ohrid

6.1 Characteristics

Lake Ohrid is an ancient ecosystem, isolated by surrounding hills and mountains that have enabled a unique collection of plants and animals to evolve into new species, and some of them to survive under unchanged conditions in the lake. These include a number of relic species, or 'living fossils', and many endemic species, found only in Lake Ohrid. For example, 10 of the 17 fish species in Lake Ohrid are endemic, as are many of the lake's snails, worms, and sponges. Because of its high biodiversity and endemism, as well as its unique cultural heritage, Lake Ohrid and its surroundings are not only of local, but international significance.

Water inputs include surface tributaries and underground springs, while balancing losses include evaporation, the outflow into the river Crin Drin and relatively minor levels of abstraction. Around 50 % of the water comes from its tributaries, mainly from the Macedonian rivers Sateska and Koselska. Inputs from the Albanian Pogradec and Verdova Rivers are smaller. The remaining inflow comes from springs that flow into the southern part of the lake, at St. Naum, Drilon and Tushemisht. These springs are fed by water flowing out of the porous karst mountains to the east, Galichica and Mali i Thatë. Over thousands of years, holes and channels have formed within the mountain rock. These channels carry water that originates in the Prespa watershed to Lake Ohrid. Because Lake Prespa sits about 150 m higher, its waters run 'downhill' to Lake Ohrid through channels in the karst.

The watershed covers approx. 3,921 km² of which 1,402 km² belongs to the Lake Ohrid sub-watershed and 2,519 km² to the Prespa Lakes sub-watershed. Lake Ohrid occupies an area of 358 km² and has an 87.5 km-long shoreline. The average depth of the lake is 164 m, its maximum depth is 289 m and it has a nominal retention time of about 70 years.

Photo 9. Morning fog rising over Lake Ohrid

About 106,000 residents live in the Macedonian sub-watershed and about 61,000 residents in the Albanian one. This population is 5 or 6 times as large as it was at the end of World War II. Most residents live in several large towns but there are also many small villages and communities scattered throughout the watershed.

In the Albanian part of the watershed, only 2,500 ha is arable land, compared to 53,303 ha in Macedonia. In Albania, fruit (orchards and vineyards), wheat, corn and vegetables are the primary agricultural products. The pastureland is used for a variety of livestock, most importantly sheep, goats, and cattle. In Macedonia, about 12 % of GDP is agriculture-derived. Sixty percent of the arable land is used to grow wheat and corn, and about 25 % for orchards and vineyards. The remainder is used for vegetable, tobacco and other crops.

6.2 Types of Surface Water Bodies – Lake and Main Tributaries

WFD System A (Annex II, Section 1.2) was used to determine/delineate individual water bodies. Central criteria were:

- Altitude
- Catchment area (for rivers)
- Surface area (for lakes)
- Geology
- Depth (for lakes)

In addition, specifies values (e.g. differing status/ pressures, etc.) of adjacent water bodies in the same water body type) have also been considered, enabling adjacent water bodies to be delineated. All water bodies are in the same eco-region, so this cannot be used for delineation purposes.

An initial delineation of water bodies at Lake Ohrid was undertaken by the Technical Working Group – WFD, following advice laid down in CIS document Guidance Document No 2 – Identification of Water Bodies (see Box 5):

Photo 10. Meeting of Technical Working Group - WFD

Water bodies of Lake Ohrid

MK – OL001 Lake Ohrid
AL – OL001 Lake Ohrid

Water bodies of the main tributaries

MK – RS001 Upper River Sateska
MK – RS002 Lower River Sateska
MK – RK001 River Koselska
MK – RC001 River Cherava

These are shown in Fig. 6.5.1-1, Section 6.5.1.

6.3 Type-Specific Reference Conditions

Hydromorphologically, Lake Ohrid represents a single water body. Administratively, however, it is divided into two water bodies separated by the Albanian-Macedonian border. The lake is mountainous, located above 600 masl, large (surface >100 km^2), drains a catchment of carbonate/calcareous geology and deep (>15m). It is a very large water body with a stable water volume (small oscillation of water level). The climate is typically subtropical highland, and the lake comprises a large limnetic and a narrow littoral zone.

Waters are well oxygenated (DO >7 mg.l^{-1}), alkaline in character (pH >7), and highly transparent (Secchi depth >10 m). The lake is phosphorus-limited (N:P ratio >25:1) and naturally oligotrophic (total phosphorus = 4.0–4.5 µg.l^{-1}). Consequently, phytoplankton abundance is low (chlorophyll-*a* concentration <3µg.l^{-1}). Phytoplankton community composition is typical for oligotrophic lakes, with Chlorophyta, Chrysophyta and Pyrrophyta dominating in the top 10 m of the water column, and small forms of Cyanophyta taking over between 10 and 30 m. However, the lake harbours highly specialised forms of pelagic diatoms (e.g., *Cyclotella fottii*) which occur between 20 and 50 m depth and become dominant between 40 and 150 m (Patceva 2001, 2005, Kalff 2002, Mitic 1985). The latter depth range would usually be considered to be below the euphotic zone (see Section 5.5.2.3.2).

6.4 Identification of Pressures

6.4.1 Methods

The most significant pressures and their likely impacts on achieving the environmental objectives of the WFD are analysed considering:

- Point source pollution
- Diffuse source pollution
- Water abstraction and flow regulation
- Physical modifications
- Other man-made pressures (e.g. alien species).

The first three groups of pressures (at least) are quantified using official data of state administrations. Point sources as direct discharges from WWTP are monitored. The measurements of state supervision and compulsory self-monitoring are the base for the calculation of point source pollution loads into lakes and rivers.

The assessment of pressures from diffuse sources is more difficult to determine, but many can be modelled/estimated from other information (e.g. agricultural census data). Information on possible polluters to other media (air, soil, groundwater etc.) have, therefore, been collated and assessed, but no formal modelling studies have been undertaken, and no GIS maps of pressures have been produced.

6.4.2 Existing Data and Gaps

Pressures have been identified by the Hydrobiological Institute Ohrid (HBIO) in Macedonia and the National Environment Agency (NEA) in Albania. However, a complete inventory of all discharges, either direct or into the sewer, does not exist in either Macedonia or Albania. Pressures from diffuse sources have been estimated from relevant studies. Official figures were not available at the time of writing.

6.4.3 Significant Point Sources of Pollution

6.4.3.1 Albania

The most significant point source is the discharge (4,500–5,000 $m^3.day^{-1}$) from Pogradec WWTP, designed to cater for a population equivalent of 40,000. The BOD_5 removal efficiency is 90 % (outflow concentration = 15 $mg.l^{-1}$), and 87 % for COD (outflow concentration = 40 $mg.l^{-1}$). The treatment plant cleans an estimated 70 % of the waste water produced in Pogradec. Other point sources are discharges of untreated waste water from villages (Lin Udemisht, Mëmëlisht, etc.) and settlements which are not connected to a central sewerage system.

6.4.3.2 Macedonia

The impact of point source pollution (Fig. 6.4.3.2.-1) has probably decreased as the majority (*ca.* 80 %) of the settlements in the watershed of the lake are now connected to sewerage systems and treatment plants. Nonetheless, the main point sources of pollution in the watershed of Lake Ohrid include: (i) storm-water outfalls from sewerage systems not connected to treatment plants; (ii) sparsely built-up areas; and (iii) direct industrial discharges.

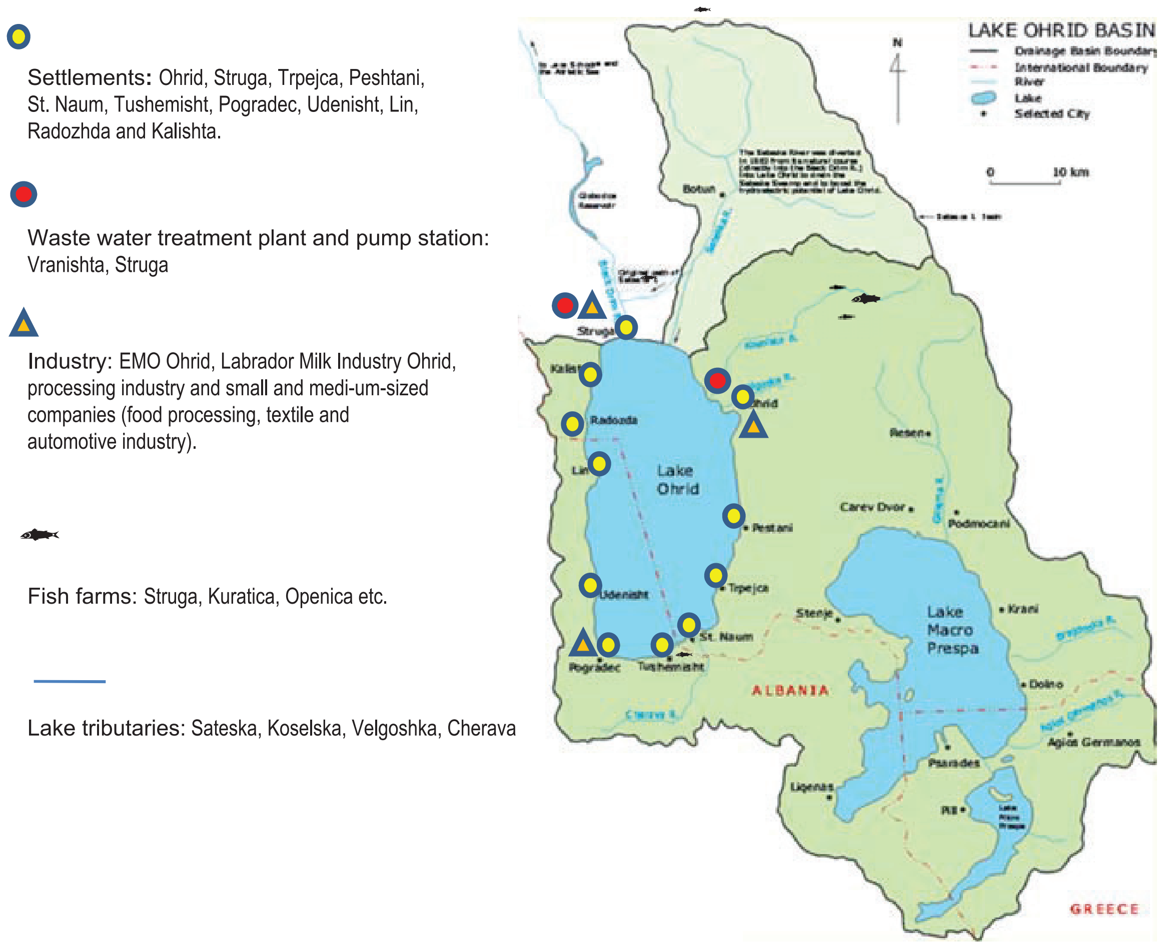

Figure 6.4.3.2-1 Major point sources of pollution in the watershed of Lake Ohrid

Industrial pollution of the lake and the water bodies originates from several small to mid-sized enterprises, dealing mainly with food processing, civil construction, chemicals etc. (Watzin et al. 2002). However, 2002 was a long time ago in water management terms, and a revised inventory of pollution sources and activities is required.

6.4.4 Significant Diffuse Sources of Pollution

6.4.4.1 Albania

Water quality of Lake Ohrid is affected by agriculture and industrial activities, especially the metallurgical, chemical and mining industries. Several mines are located close to the lake (2.5 km), whereas four other coalmines (Alarup, Petrush, Vërdovë and Dardhas) can be found within a distance of 10 km from the lakeshore. Other threatening factors for water quality are chromium mining and naturally occurring serpentine soil from around Pojskë (Pogradec). The latter is potentially toxic due to its high content of heavy metals and high nickel availability.

Agricultural land use in the immediate proximity of the lake has decreased from 460 ha to 130 ha.

About 10 % of waste waters are directly discharged into the lake without being treated due to constructions distributed along the shore without any planning, especially touristic buildings (hotels and restaurants). In the villages along the lake shore there is no sewage system except for Lin village which discharges the sewage into a wetland located north of it.

Furthermore, illegal landfills and dumps are potential sources of diffuse pollution. Especially Çerrava landfill has an elevated risk potential.

6.4.4.2 Macedonia

Agriculture is concentrated in the plains north of the lake and along the watersheds of its main tributaries. Fertilizers, soil particles and pesticides are washed with the erosion processes. The pollution load in the rivers represents a potential pressure on the lake. The diverted River Sateska and other tributaries (rivers and springs) passing through cropland are significant sources of organic and chemical pollution and discharge high sediment loads into the lake.

6.4.5 Water Abstraction

6.4.5.1 Albania

Water is abstracted for the irrigation of cropland south-west and south of the lake, and for domestic purposes in rural areas. The volume of water abstraction is higher during summer owing to increased consumption by tourist facilities. Official figures, however, are not available.

6.4.5.2 Macedonia

Ground water abstraction in Ohrid-Struga region

This area is located in the western part of Macedonia and encompasses Ohrid-Struga valley and a fringe of mountains (Jablanica, Galichica, Karaorman and others). Main urban centres are Ohrid and Struga. Main recipients for surface waters Lake Ohrid and the Black Drin River. The rivers Koselska and Sateska, tributaries of Lake Ohrid, are also important.

In the Black Drin sub-catchment, seven springs are abstracted for water supply. The largest are St. Naum, (>10 $m^3.s^{-1}$), Vevchani (1.5 $m^3.s^{-1}$), Sum (1 $m^3.s^{-1}$), Biljaniniizvori (0.2–1 $m^3.s^{-1}$), Beli Vodi (0.3 $m^3.s^{-1}$) and Bel Bunar (0.04–0.1 $m^3.s^{-1}$). Groundwater is used for public water supply in Ohrid and Struga, with boreholes supplying individual dwellings in rural areas.

Agricultural water use

The total area of arable land in Macedonia is approximately 667,000 ha, about 60 % of which is currently (or planned to be) under irrigation. Sprinkler irrigation is the predominant technique, covering 61 % of the irrigated area. Other types of surface irrigation are applied to the remainder of the land.

It is estimated that 15,205 ha of arable land in the Ohrid-Prespa region will be irrigated by 2020, accounting for 75 % of the total water demand (Tab. 6.4.5.2-1).

Table 6.4.5.2-1. Estimated water demand in the Ohrid-Prespa region by 2020 ($10^3 m^3$)
Source: Spatial plan of Ohrid-Prespa region (2005-2020)

Water management region	Population	Tourists	Industry	Irrigation	Total
Ohrid-Struga	17,837	6,791	5,740	58,480	88,848
Prespa	2,336	924	1,435	30,889	35,584
Total	20,173	7,715	7,175	89,369	124,432

Lake Prespa – treated here because of its importance for the hydrology of Lake Ohrid – has been used as a source of water for both irrigation and municipal water supply since the late 1950s. Two pumping stations, one in Asamati and the other one in Sirhan, have been used to supply irrigation systems east and west of Lake Prespa on Macedonian territory. Presently, Lake Prespa and its tributaries, as well as groundwater resources, are all abstracted for irrigation purposes. Wells combined with drip-irrigation systems have become the predominant method of irrigation in the region due to the unreliability of channel irrigation systems. Some 8,000 to 10,000 wells have been drilled, covering an area of at least 3,000 ha. Besides wells, a number of irrigation water intakes exist in rivers in the watershed. Some of them use remnants of old irrigation systems but a significant number are newly constructed systems of low efficiency, with high water losses. These systems are largely unregulated and beyond the control of water authorities and may have negative effects on groundwater and lake quality.

6.4.6 Hydromorphology and Water Flow Regulation

6.4.6.1 Albania

No flow regulations or other significant interventions affecting the hydrological regime have taken place at the Albanian part of the lake.

Within the assessment of the ecological status of water bodies, hydrological and morphological quality elements must be taken into account. Although systematic investigations of the hydromorphological status of the lake are lacking, it is obvious that urban encroachment as well as industrial and recreational facilities do have a harmful impact on hydromorphological structures of Lake Ohrid. The ecological status of the lake is particularly at risk from the continued destruction of wetlands and uncontrolled building and infrastructure development at the shoreline.

6.4.6.2 Macedonia

Ground and surface water inputs are approximately equal, but prior to 1962 river inputs were much lower. At this time, the River Sateska – a former tributary of the Black Drin – was diverted into the lake to: (i) reduce siltation of the Globocica reservoir, the first of a cascade of reservoirs along the Drin Basin; (ii) drain the Struga marshland (now used for farming); and (ii) ensure continuous flow of Lake Ohrid water for hydroelectric power generation. The diversion of the Sateska increased the size of the Lake Ohrid sub-catchment. This drains about 2,500 ha and regulates the course and slope of the Black Drin River through the town of Struga, as well as the agricultural area around the town. An overflow structure that controls the flow of water out of Lake Ohrid and into the Black Drin River was constructed in Struga, and water flows are regulated for hydroelectric generation in Macedonia.

Sand and gravel extraction from the riverbed is uncontrolled, influencing water flow and sediment load, with substantial erosion of the riverbed. When the Sateska was diverted, anti-erosion measures intended to reduce sediment suspension in the river and the input of sediment into Lake Ohrid were put in place. These preventive measures were later discontinued. As a result, sediment has since accumulated in the constructed riverbed, the channel has degraded and shoreline vegetation has been lost. The suspended matter load into Lake Ohrid is large and a delta has formed in the receiving waters. The load also includes a lot of organic material, the decomposition of which has reduced dissolved oxygen concentrations in the receiving waters (see Box 9) and changed the distribution of flora and fauna in this section of the lake.

Photo 11. Outflow of sediment-rich Sateska River into Lake Ohrid

BOX 9. OXYGEN BALANCE IN LAKES

The dissolved oxygen concentration in lakes (and other surface waters) is probably the single most important quality-defining factor, since this not only determines what fauna can live in the water, but also determines the concentrations of numerous other chemical substances (e.g. the ratios of ammonia, nitrate and nitrite). The oxygen status of lakes also has a major impact on the release of substances, such as phosphate, manganese and iron from the sediment into the water column (and *vice versa*).

Oxygen enters lakes by dissolving into the water column across the air/water interface at the surface of the lake and via photosynthesis during the day within the lake (by phytoplankton and submerged aquatic vegetation). Oxygen is continuously removed from the water column by respiration (phytoplankton and submerged vegetation), but with a net export of oxygen into the water column during the day and net uptake (by plants) during the night. This pattern of higher dissolved oxygen levels during the day (due to photosynthesis) and lower dissolved oxygen levels at night is usually referred to as being 'diurnal' in nature.

However, respiration by bacteria (as they break down organic material) is the primary route of oxygen removal (and its conversion to carbon dioxide). This organic matter is present in the water column and in the sediment. Thus, surface waters remain well oxygenated (often to >100 % sat during the day in many lakes) while bottom waters are less well oxygenated, due to sediment oxygen demand (bacteria in the sediment).

This difference in oxygen status between surface and lower waters is often exacerbated by thermal stratification: sunlight heats the surface water, which because of the rise in temperature becomes less dense and so 'floats' above the cooler water beneath. This situation continues until the input of solar energy diminishes (usually in autumn) and there is sufficient mixing of the water (by wind) to mix the upper and lower layers together. During thermal stratification two discrete layers of water form – an upper layer (epilimnion) and a lower layer (hypolimnion), separated by a narrow band of water (thermocline) in which temperature changes very rapidly with depth. To a large extent, the epilimnion and hypolimnion remain separated from each other and there is little transfer of oxygen across the thermocline. The longer the period of stratification, the greater the difference in oxygen status between the upper and lower layers.

The two main metrics for estimating how much oxygen will be stripped from the water column are: (i) biochemical oxygen demand (BOD), a measure of bacterial activity as they break down organic matter – usually measured over a 5-day period (hence BOD_5); and (ii) chemical oxygen demand (COD). COD measures everything that can be chemically oxidised, and is rather less specific than BOD_5, so in environmental samples, COD results are typically about double those of BOD_5 results. Unusually high COD:BOD_5 ratios are indicative of industrial pollution.

Dissolved oxygen can be measured either in terms of percentage saturation (% sat) or as an absolute concentration (mg.l^{-1}). For aquatic fauna which use dissolved oxygen for their oxygen supply, the latter is the most important. There is widespread agreement that water containing less than 4 mg.l^{-1} dissolved oxygen (DO) is unsuitable for sensitive fish, such as salmonids (e.g. salmon and trout), and water containing less than 2 mg.l^{-1} DO is unsuitable for less-sensitive fish, such as carp. As temperature increases the solubility of oxygen decreases, so water at 15°C and 90 % saturation will contain more DO than water at 30°C and 90 % saturation. However, this relationship between oxygen concentration and temperature in lakes is made more complex by the fact that bacterial activity increases with temperature. For this reason, BOD_5 analysis is undertaken at a standard temperature (20°C).

6.4.7 Other Significant Anthropogenic Impacts

6.4.7.1 Albania

Commercial fishing is the main pressure on Lake Ohrid fish communities. However, some other anthropogenic factors also affect species composition and biomass of fish stocks. The construction of hydroelectric dams on the River Drin during the 1960s and 1970s closed the natural route of eel migration and recruitment of elvers. Today, the eel yield in the lake is inestimable, but believed to be very small.

The development of tourism and intensified urbanization of the lake in the western part (Pojske – Mëmëlisht) and on the other hand the poor water quality or drying and drainage of the effluent, have damaged spawning areas, resulting in a drastic fall in fish production.

Despite the operation of a waste water treatment plant in the southern part of the lake (City of Pogradec), there remains a problem with the waste water collecting system along the western part of the lake, from Lin to Mëmëlisht. The reactivation of mines in this part of the lake – which is currently under discussion – would be an additional pressure and may become an important issue.

6.4.7.2 Macedonia

Besides fishing, tourism, intensified urbanisation of the lake's surroundings, increased numbers of recreational and speed boats, as well as nutrient loads, are issues affecting fish ecology. Fishery status, fish yield and water quality are all impacted. Mining in Albania might become an issue also in Macedonia, as is the continued sediment input from River Sateska.

Five alien – or neozootic – fish species have already become established in the lake. They might compete in particular with native littoral species for food and habitat and thereby become a threat to the lake's natural biodiversity.

Unregulated and illegal fishery is also suggested to affect the composition, abundance and age structure of fish assemblages and needs to be considered as a potential risk for the achievement of good ecological status.

6.5 Water Quality Assessment

6.5.1 Sampling Stations

The sampling stations for water quality measurements were selected in accordance with project tasks, WFD requirements as well as experience of the implementing research institutes from previous monitoring. In Macedonia, they comprised both lake and river sites; in Albania, they comprised only lake sites (see Tab. & Fig. 6.5.1-1).

Table 6.5.1-1 Lake Ohrid sampling stations for physico-chemical assessment

Macedonia	**Albania**
Water body 1: Macedonian part of Lake Ohrid • MK I Kalishta • MK II Grashnica • MK III Veli Dab • MK IV St. Naum • MK V Pelagic zone Tributaries of Lake Ohrid in Macedonia: • Sat I River Sateska before redirection • Sat II River Sateska middle course • Sat III River Sateska inlet • Kos I River Koselska • Che I River Cherava inlet	Water body 1: Albanian part of Lake Ohrid • AL I Lin • AL II Memlisht • AL III Pogradec

The sampling stations for biological investigations are shown in the respective sections.

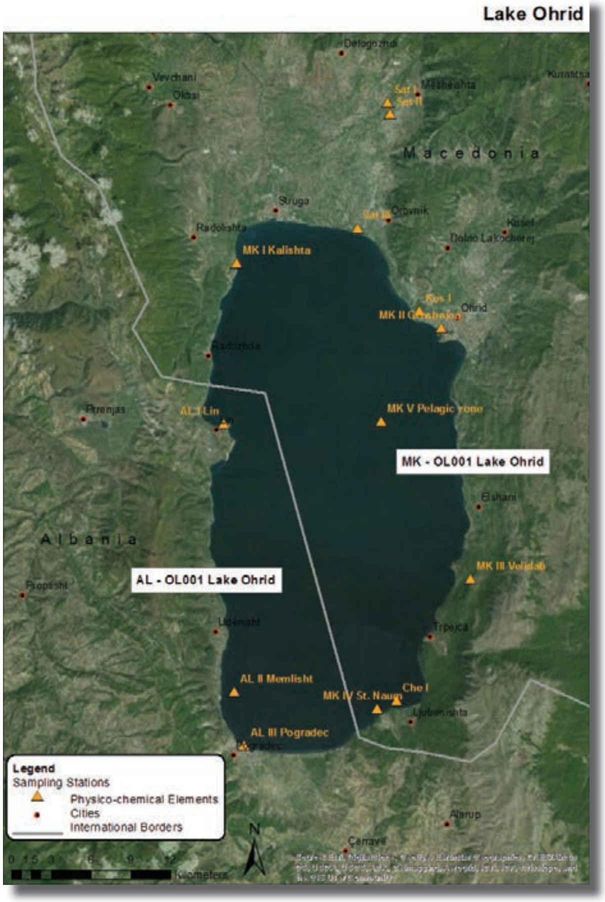

Figure 6.5.1-1 Sampling stations for chemical and physico-chemical analyses at Lake Ohrid
Upon a decision of the Technical Working Group WFD, the lake was tentatively divided into only two water bodies, corresponding to the national lake territories of the two countries.

6.5.2 Chemical and Physico-Chemical Elements

6.5.2.1 Methods

Albania

Monitoring was undertaken four times from 2013 to 2014 (April, July, October and February) at three stations. Sampling procedures were considered suitable for most sites/parameters, but failed to follow standard methodologies fully.

Bottles containing samples were transported to the laboratory in cool boxes. However, transport and storage procedures did not follow prescribed methodologies fully. As a result, biochemical or physico-chemical processes might have been triggered in some samples, leading to flawed results. Samples were analysed according to standard methodologies agreed by the TWG. However, owing to the above-mentioned problem, the results obtained will require validation by comparison against available data and results from the proposed monitoring programme (Section 8.2).

Macedonia

Monitoring was undertaken four times at five stations in Lake Ohrid and stations in the main tributaries. Sampling procedures fulfilled standard methodologies. Samples were transported to the laboratory in cool boxes, avoiding any outside influences. Transport, storage and analytical procedures were in full compliance with standard methodologies. Details are given in Veljanoska-Sarafiloska (2014; Volume of Annexes).

6.5.2.2 Existing data and gaps

Albania

Between 1998 and 2004, the Hydrometeorological Institute carried out regular monitoring at three stations in the lake, in addition to tributaries that feed into the lake, with a frequency of six times per year. The scope was then reduced to four times per year at one station (in the pelagic zone) and in tributaries. In 2008, the monitoring programme was reduced further to cover only basic physical and chemical parameters (e.g., temperature, pH, conductivity, transparency, dissolved oxygen, ammonia, nitrites, nitrates, phosphates, total phosphorus). After 2008, selected parameters such as phosphorus were analysed along with certain biological elements (Sections 6.5.4.2 and 6.5.4.3) in collaboration with the Norwegian Institute for Water Research (NIVA; e.g. Schneider et al. 2014).

Macedonia

From 1998 to 2004, monitoring was undertaken of major Macedonian tributaries (Rivers Velgoshka, Koselska, Sateska and Cherava), and springs in St. Naum area. Further monitoring was undertaken in littoral and pelagic zones of the lake. Pelagic monitoring was undertaken at only one station, but down a vertical profile, at depths of 1–200 m. This monitoring was supported by a range of programmes between 2000 and 2012, concerned

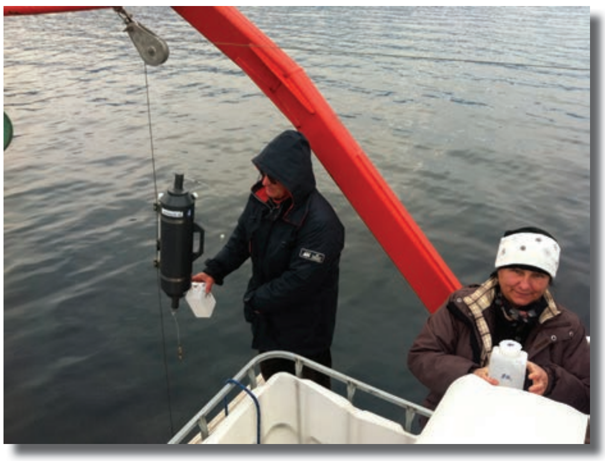

Photo 12. Taking water samples for physico-chemical analyses

primarily with monitoring trophic status and wider anthropogenic influences, funded largely from ministerial sources. Further work on pollutant loads of lake tributaries was carried out between 2009 and 2011. These studies indicated substantial impacts of Rivers Velgoshka and Cherava on the wider littoral zones adjacent to the inflows.

Earlier investigations showed reference values for nutrients of <10 µg $TP.l^{-1}$ and <1 mg $TN.l^{-1}$. Based on these results and more recent investigations of chlorophyll-*a* and Secchi depth, and despite a more than threefold increase of phosphorus concentrations in lake sediments over the past century (Matzinger et al. 2007), Lake Ohrid is considered to be in a stable oligotrophic condition (Patceva et al. 2009, Novevska and Tasevska 2009).

The above-mentioned NIVA study comprised up to 30 monitoring stations in Macedonia and Albania for selected physico-chemical parameters, phytobenthos (benthic diatoms), macrophyte community composition and macroinvertebrates (Christiansen et al. 2013, Schneider et al. 2014). For physico-chemical parameters, samples were collected four times per year. Whilst these results generally concur with earlier findings (oligotrophic nature of the lake), some littoral areas (Grashnica, Daljan, inflow of Sateska River, Cherava) now show an increased anthropogenic influence. This is particularly the case at Grashnica, where the water is mesotrophic/eutrophic in character. The increased number of tourists in summer also contributes to seasonal eutrophication in some areas.

6.5.2.3 Results

Results of physico-chemical investigations are summarized in Annexe 11.2. More detailed information is given in the original reports compiled in the Volume of Annexes (USB card).

6.5.2.3.1 Albania

Results show that water quality is adversely affected by anthropogenic pressures (nutrient inputs in particular; see Section 6.5.4.1). However, the results are tentative in nature and need to be validated and verified by comparison with results from the planned monitoring programme (Section 8.2) to determine whether the trend of increasing littoral anthropogenic influence is continuing.

6.5.2.3.2 Macedonia

Increased nutrient concentrations prevail in the littoral zone during the summer period (Annex 11.2). According to both Carlson's Trophic State Index (TSI) and the fixed boundary OECD classification scheme (Vollenweider and Kerekes 1982), calculated based on total phosphorus, Lake Ohrid is predominantly oligotrophic. However, TSI values for the littoral zone exhibit seasonal and spatial variability. Littoral sites at Kalishta and Veli Dab are oligotrophic, but at Grashnica during spring and summer, the water becomes mesotrophic. During summer, the TSI for St. Naum also indicated mesotrophic conditions. The most alarming results, however, were for the Cherava River inlet, which is eutrophic. The TSI value for this site was about 70. The river has a relatively small water flow (presumably due to abstraction) and passes through mining areas in Albania and croplands in Macedonia.

6.5.3 Specific Pollutants

The chemical status of water bodies is determined based on compliance with Environmental Quality Standards (EQS) for pollutants of Europe-wide importance. Therefore, the assessment of chemical status considers the list of priority substances (Directive 2013/39/EU). Lead and cadmium originating from former mining activities in Albania could reach biologically relevant concentrations in the lake environment, particularly in sediments. Further investigations will be necessary within future monitoring programmes to address this risk. Specific pollutants of concern in Macedonia were organochlorine pesticides, which showed elevated concentrations in sediments in previous investigations (Section 6.5.3.2).

6.5.3.1 Methods

Sampling

Sediments were collected using a Van Veen grab sampler with a volume of 440 cm^3. They were stored at 4 °C for a maximum duration of seven days prior to the analysis.

Analysis

In Albania, heavy metals were analysed using Atomic Absorption Spectrometry (AAS). Determination of cadmium was undertaken by traditional flame AAS, while lead was analysed using a graphite furnace AAS. In Macedonia, samples for organochlorine pesticide analysis were dried at 40–50 °C, homogenised by grinding (< 0.5 mm) and stored in a refrigerator. Wet digestion by acid mixture of HNO_3+$HClO_4$+HF was used. Organochlorine pesticides were analysed by gas chromatography, using an Electron Capture Detector (ECD) and nitrogen as carrier gas.

6.5.3.2 Existing Data and Gaps

Albania

Heavy metal contents of sediments and water had been analysed within the framework of the Lake Ohrid Conservation Project. The level of pollution varied from moderate at Pogradec to severe at Hudenisht. Iron concentrations in the water column varied from 9.3 to 54.6 µg.l^{-1} and chromium concentrations from 1.0 to 17.9 µg.l^{-1}. Nickel concentrations ranged from 4.9 to 12.3 µg.l^{-1}, which is less than the Maximum Allowable Concentration (MAC)-EQS set by Directive 2013/39/EU (34 µg.l^{-1}) but higher than the Annual Average (AA)-EQS of 4 µg.l^{-1}.

Soluble, reduced (ferrous) iron released from deep sediments (anaerobic conditions) into the water column is oxidised to ferric iron. This is particulate and has a greater density than water, so sinks. Thus, elevated levels of dissolved iron occur, as would be expected, at greater depth rather than in surface waters. Concentrations of Ni and Cr are not significantly dependent on the depth of the water column.

Concentrations of heavy metals in sediments were found to be below Maximum Approved Values (MAV) of the Dutch list (see Tab. 5.5.3.3.2-1) for most elements (Malaj et al. 2012). However, chromium exceeded the MAV of 100 mg.kg^{-1} at some sampling sites (range: 2–576 mg.kg^{-1}) as well as nickel (MAV = 35 mg.kg^{-1}; range 10–1501 mg.kg^{-1}). Iron showed very high concentrations of 9.6–23.0 g.kg^{-1} (no MAV value defined for iron).

Macedonia

In Macedonia, studies of specific pollutants focused on a range of organochlorine pesticides in water, sediment and fish in the Macedonian part of Lake Ohrid and its larger tributaries (e.g., Veljanoska-Sarafiloska et al. 2011). The results obtained give an overview of the contamination levels of these problematic pesticide compounds: (i) at their potential sources in the river mouths; (ii) in the potentially affected, species-rich littoral section of the lake; and (iii) in the muscle tissue of Greek barbel (*Barbus peloponnesius*), collected from close to river deltas to investigate bio-accumulation.

The organochlorine pesticides measured in all three matrixes were gamma-HCH (γ-HCH), Σ HCH (sum of α-isomer, β-isomer and δ-isomer), endosulfan (total of α and β-endosulfan), and DDT metabolites (p,p'–DDE, p,p'–DDD and p,p'–DDT). Observed concentrations for p,p'–DDT ranged between 0.006 µg.l^{-1} in water samples from Daljan and St. Naum and 0.036 µg.l^{-1} in the water sample from Koselska River. The latter concentration exceeds the EU Environmental Quality Standard – Annual Average (EQS–AA) in Directive 2013/39/EU (0.01 µg p,p'–DDT.l^{-1}). The p,p'–DDT content of dry sediment ranged from 0.121 µg.kg^{-1} at St. Naum to 1.8 µg.kg^{-1} in the Velgoshka River. Pesticide residues in wet fish biomass were 0.553 µg.kg^{-1} for endosulfan and 5.982 µg.kg^{-1} for p,p'–DDE.

The existence of organochlorine pesticides in water, sediment and the muscle tissue of Greek barbel is mainly due to the chemical stability of these compounds, their high lipid solubility and the bioaccumulation of this group of persistent organic pollutants (POPs) – rather than their current use.

6.5.3.3 Results

This section summarized the main findings of the chemical and physico-chemical investigations conducted at Lake Ohrid in 2013 and 2014. For further information, the reader is referred to AGS (2014) for Albania and Veljanoska-Sarafiloska (2014) for Macedonia (Volume of Annexes) and to Annexe 11.2.

6.5.3.3.1 Albania

Heavy metal concentrations in lake sediments were ≤ 0.01 mg.kg^{-1} for lead and ≤ 0.001 mg.kg^{-1} for cadmium. These values lie far below the Maximum Approved Values (MAV) of the Dutch list (MvV 2000; see Tab. 5.5.3.3.2-1).

6.5.3.3.2 Macedonia

DDT metabolites (breakdown products) were the most frequent organochlorine pesticides, i.e. *p,p*'-DDT, *p,p*'-DDE and *p,p*'-DDD. For the sediment sample collected from St Naum, lindane (γ-HCH) was below the limit of detection, but total HCH was present at 0.42 µg.kg^{-1} dry sediment, endosulfan at 0.49 µg.kg^{-1} dry sediment and total DDT at 1.39 µg.kg^{-1} dry sediment. The principal metabolic form of DDT in St. Naum sediment was p,p'-DDE (0.67 µg.kg^{-1} dry sediment).

For the sediment sample collected from Grashnica, organochlorine pesticide concentrations were higher than in St. Naum. The concentration of lindane was 0.29 µg.kg^{-1} dry sediment, total HCH was 1.02 µg.kg^{-1} dry sediment, endosulfan was 0.85 µg.kg^{-1} dry sediment and total DDT was present at 2.43 µg.kg^{-1} dry sediment. The principal metabolic form of DDT was p,p'-DDE (1.72 µg.kg^{-1} dry sediment).

The existence of organochlorine pesticides in the sediment is due to the chemical stability of these compounds, rather than their current widespread/intensive use. Sediment acts as the memory of water for chemicals which degrade slowly. In rivers particularly, pesticide concentrations may peak during the first heavy rainfall event following application, leaving no trace in the water column a few days later, but sediments may contain residues for years to come. The same is true, but to a lesser extent, in lakes, since the same water that carried the contaminant load into the lake, remains in the lake for a longer time than it usually does in rivers. However, since Directive 2013/39/EU does not contain environmental quality standards for chlorinated pesticides in sediment, only in water, it would be advisable to focus future monitoring efforts on the analysis of water samples.

6.5.4 Biological Elements

The ecological status of water bodies is assessed considering species composition, abundance, dynamics and status of selected aquatic fauna and flora (so-called biological elements) known to respond sensitively to anthropogenic pressures. The assessment uses type-specific reference conditions, i.e. natural or near-natural undisturbed conditions, as a benchmark. Depending on the degree of deviation from these reference conditions, the ecological status can be assessed. The main objective of the initial characterisation is to assess the risk of water bodies failing to achieve good ecological status.

Lake Ohrid has been intensively investigated over the past decade. The most recent study, yielding extensive data relevant to the initial characterisation, focused on macrophytes, benthic invertebrates, chlorophyll-*a* and nutrients, particularly phosphorus (Christiansen et al. 2013, Schneider et al. 2014). Investigations under the current project therefore covered only the following biological elements:

- Phytoplankton biomass (estimated from chlorophyll-*a* concentrations in the littoral zone of Albania and the pelagic zone in Macedonia)
- Benthic invertebrate fauna (Macedonian tributaries)
- Fish (both countries)

6.5.4.1 Phytoplankton

6.5.4.1.1 Methods

Sampling

Phytoplankton samples were taken in April and July 2013, respectively. The two sampling campaigns were coordinated by the two countries to ensure comparability of data. In Albania, a third sampling campaign was conducted in February 2014.

The Albanian sampling points were located in the littoral zone at Lin, Memlisht and Pogradec (Fig. 6.5.4.1.1-1). Samples were taken only from the upper depth stratum (0.5 m). Samples for chlorophyll-*a* analyses in Macedonia were taken at 9 depths in the pelagic zone of the lake (Fig. 6.5.4.1.1-1), at 0.5, 10, 20, 30, 40, 50, 75, 100 and 150 metres depth.

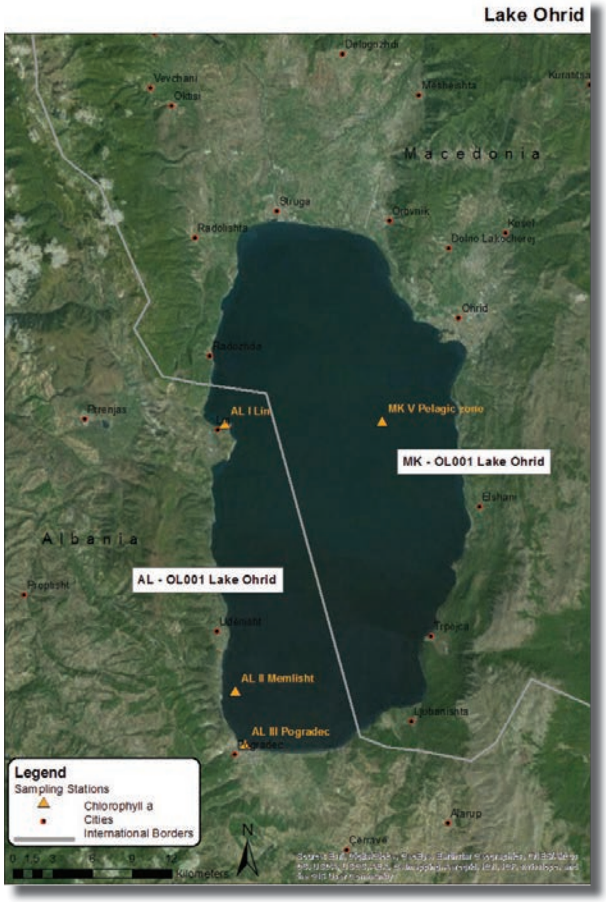

Figure 6.5.4.1.1-1 Sampling stations for chlorophyll-*a* analysis in Lake Ohrid
In Macedonia, samples were taken at one pelagic station from 9 depth strata. In Albania, samples were taken at three littoral stations from the upper depth stratum.

Water samples were collected at each depth using Niskin bottles. The bottles were stored according to standard procedures. Sub-samples for chlorophyll-*a* analysis were transferred into 1 litre polyethylene bottles and transported to the laboratory in cool boxes.

Chlorophyll-*a* analysis

Chlorophyll-*a* was extracted with 90 % ethanol and analysed spectrophotometrically, according to ISO 10260 (1992). The Trophic State Index (TSI) was calculated using chlorophyll-*a* results, according to Carlson (1977).

6.5.4.1.2 Existing Data and Gaps

Recent studies in the littoral zone of Lake Ohrid in Macedonia using phytoplankton composition and chlorophyll-*a* concentration as biological indicators showed a negative influence of lake tributaries on the trophic state of the lake (for details, see Patceva

2014, Volume of Annexes). According to these studies, the Grashnica region at the inflow of River Velgoshka has the worst trophic state, followed by Cherava, Sateska and Koselska.

In the last few decades, negative effects gradually extended from the littoral into the pelagic zone of the oligotrophic lake. The latest investigations of phytoplankton in the pelagic zone were carried out within the scope of two projects, "Biodiversity and ecology of plankton communities in Lake Ohrid (Macedonia) and Plitvice Lakes (Croatia)" (2007–2009) and "Spatial and temporal changes in planktonic community – carrier of the Lake Ohrid trophic state (2009–2011)". These studies, however, provided no evidence of eutrophication and concluded that the lake is in a stable oligotrophic state despite minor changes in dominance structure of algal communities. Phytoplankton biomass had not increased compared to previous studies. To the contrary, a slight decrease was observed especially during the summer period.

The phytoplankton composition and distribution of Lake Ohrid is typical of oligotrophic lakes, showing a considerable proportion of Chrysophyta and Chlorophyta. Cyanophyta and Bacillariophyta comprise approximately 65 % of the total biomass. Over a three-year observation period, Cyanophyta abundance decreased from 29 % in 2001 to 12 % in 2003 while Bacillariophyta increased from 35 % to 50 % and Chrysophyta from 6 % to 19 % (Patceva 2005). Average annual chlorophyll-*a* concentrations ranged between 0.52 $\mu g.l^{-1}$ in 2003 and 0.97 $\mu g.l^{-1}$ in 2001, and average summer concentrations between 0.59 $\mu g.l^{-1}$ in 2003 and 1.21 $\mu g.l^{-1}$ in 2001, indicating oligotrophic conditions. Phosphorus is the limiting nutrient and the main cause of eutrophication (Patceva et al. 2009).

With the exception of benthic diatoms (Schneider et al. 2014), no further phytoplankton studies have been conducted since 2011 to assess the current trophic state of Lake Ohrid, despite increasing anthropogenic pressures in both Albania and Macedonia.

6.5.4.1.3 Results

This section provides a synthesis of chlorophyll-*a* analyses as a proxy for algal biomass conducted in 2013 and 2014. For further details, the reader is referred to Baku (2014) and Patceva (2014) in the Volume of Annexes.

6.5.4.1.3.1 Albania

Trophic state

Chlorophyll-*a* concentrations varied between 0.48 $\mu g.l^{-1}$ at Pogradec and 1.91 $\mu g.l^{-1}$ at Lin. Trophic state index (TSI) results for most sampling stations and seasons were ≤ 30, indicating oligotrophic conditions (Table 6.5.4.1.3.1-1).

Table 6.5.4.1.3.1-1 Trophic state of Lake Ohrid (Albanian part) in summer (July), autumn (October) 2013 and in winter (February) 2014, according to the Trophic State Index (Carlson 1977)

Sampling station	Season	TSI	Trophic state
	Summer	37	Oligotrophic
Lin	Autumn	30	Oligotrophic
	Winter	25	Oligotrophic
	Summer	23	Oligotrophic
Mëmëlisht	Autumn	27	Oligotrophic
	Winter	26	Oligotrophic
	Summer	23	Oligotrophic
Pogradec	Autumn	26	Oligotrophic
	Winter	30	Oligotrophic

6.5.4.1.3.2 Macedonia

Trophic state

Chlorophyll-*a* concentrations varied between 0.08 $\mu g.l^{-1}$ at 150 m and 2.83 $\mu g.l^{-1}$ at 20 m depth, corresponding to oligotrophic and mesotrophic conditions, respectively (Fig. 6.5.4.1.3.2-1). The vertical distribution pattern differed among seasons, the highest concentrations being recorded in the 10-30 m layer in spring (April) and in the 20-50 m layer in summer (July). Average concentrations of both seasons were < 1.0 $\mu g.l^{-1}$ at surface level and below 40 m depth.

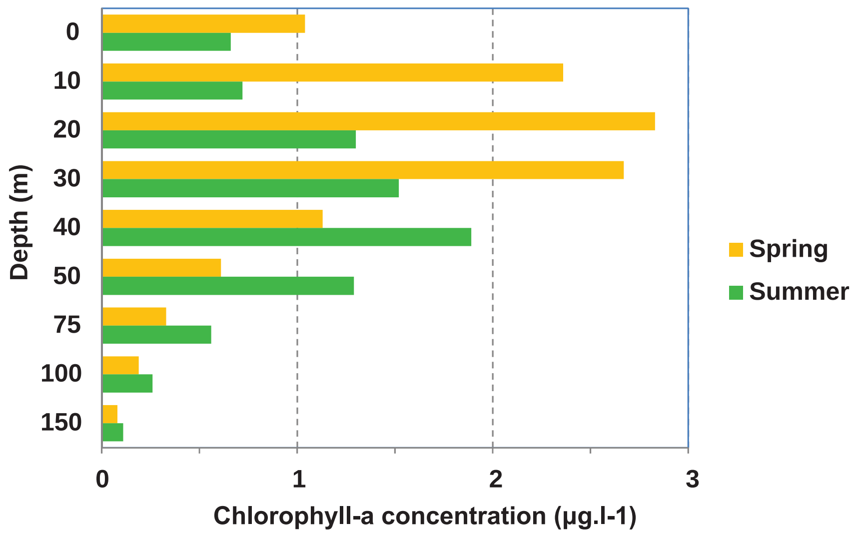

Figure 6.5.4.1.3.2-1 Chlorophyll-*a* concentrations at different depth strata of the pelagic zone of Lake Ohrid in spring and summer 2013

Average trophic state index (TSI) values (mean of all depth strata) of 31 in spring and 26 in summer designate Lake Ohrid as oligotrophic Table 6.5.4.1.3.2-1.

Table 6.5.4.1.3.2-1 Mean TSI of the pelagic zone of Lake Ohrid (Macedonian part) in spring and summer 2013, according to the Trophic State Index (Carlson 1977)

Sampling site	Season	TSI	Trophic state
Pelagic (central part of the lake)	Spring	31	Oligotrophic
	Summer	26	Oligotrophic

6.5.4.2 Macrophytes

6.5.4.2.1 Methods

Macrophyte investigations under the present project were restricted to the Lake Ohrid tributaries Sateska, Koselska and Cherava Rivers in Macedonia since the lake littoral had already been studied in a recent transboundary research project in collaboration with the Norwegian Institute for Water Research (NIVA). Some results of these studies are presented in Section 6.5.4.2.3. No samples were taken in Albania.

Field sampling

Tributaries. Macrophytes were sampled at five sites (Fig. 6.5.4.2.1-1) in summer 2013 according to Wetzel and Likens (2000) and Schneider and Melzer (2003). Plants were collected by hand in shallow water and using a rake in deeper water. The abundance was estimated using a five-point scale (Melzer 1999): 1 = very rare, 2 = infrequent, 3 = common, 4 = frequent, 5 = predominant.

Lake littoral (NIVA study). The study was conducted from 2009 to 2011, comprising 28 sampling stations in Albania and Macedonia (Schneider et al. 2014). Submerged macrophytes as well as the macroscopic filamentous blanketweed *Cladophora glomerata* were surveyed in belt transects of approximately 10 m width – perpendicularly to the shoreline – from the upper littoral to the lower vegetation limit. Each transect was divided into depth zones: 0-2 m, 2-4 m, 4-10 m, and >10 m depth. Plants were collected manually by snorkelling in shallow water and with a Van Veen grab in deeper water.

Data analysis

Tributaries. The analysis was done qualitatively based on the relative abundance of indicator species. Specimens were identified using assorted keys. For further details, see Talevska and Trajanovska (2014, Volume of Annexes).

Lake littoral (NIVA study). The macrophyte index (MI) was chosen as a metric because it reflects phosphorus supply, is applicable to calcareous lakes, and most macrophyte species observed in Lake Ohrid are included in the list of indicators (Schneider et al. 2014). The index was calculated according to the formula described by Melzer (1999), but with updated indicator values and class boundaries as described in Melzer and Schneider (2001). The MI ranges from 1 to 5, with high values indicating nutrient pollution.

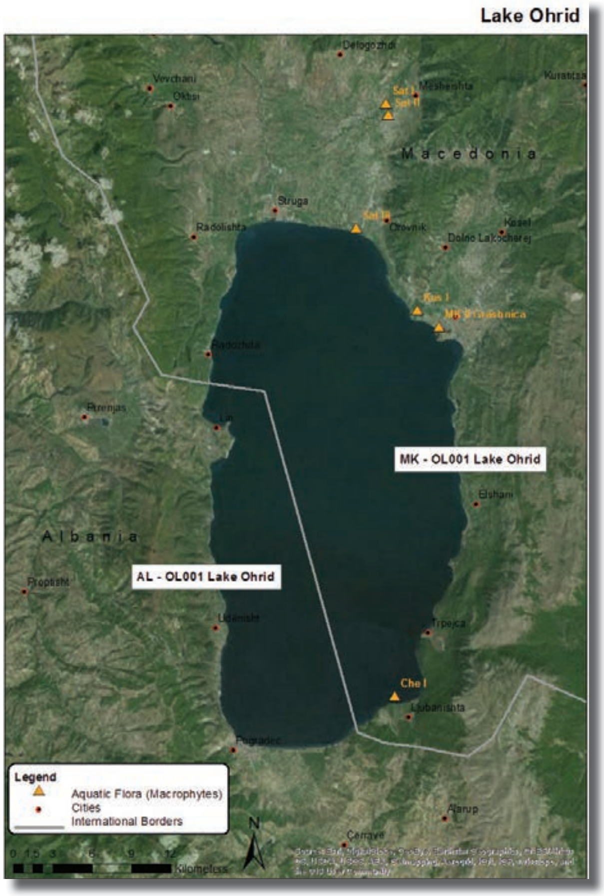

Figure 6.5.4.2.1-1 Sampling stations for macrophyte investigations at Lake Ohrid tributaries in Macedonia.
All rivers were sampled at the inflow into the lake and River Sateska was also sampled upstream. No samples were collected from the Albanian part of the lake.

6.5.4.2.2 Existing Data and Gaps

Studies conducted between 1960 and 2004 revealed a distinct pattern of the littoral macrophyte vegetation of Lake Ohrid, starting with reed belts (*Phragmites*) at the littoral part and followed by stretches of greenweed (*Cladophora*), pondweed (*Potamogeton*) and charophyte meadows with increasing depth (e.g. Stankovich 1960, Talevska 1996, Talevska and Trajanovska 2004).

The data base has greatly improved thanks to the recent NIVA study (Christiansen et al. 2013, Schneider et al. 2014) which included up to 30 sampling stations and found 29 macrophyte species in 9 families, of which 17 species are included in the list of indicators of Melzer and Schneider (2001). However, in future studies it is recommended to revise and amend the list of indicators and respective indicator values in order to better reflect the specific composition and ecology of macrophyte communities of Lake Ohrid.

6.5.4.2.3 Results

This section provides a synthesis of the main findings of macrophyte investigations conducted at selected lake tributaries under the present project and the lake littoral under the NIVA project. For details, the reader is referred to Talevska and Trajanovska (2014, Volume of Annexes) for lake tributaries and to Christiansen et al. (2013) and Schneider et al. (2014) for the lake littoral.

6.5.4.2.3.1 Albania

The macrophyte indices found on the west shore of the lake indicated oligotrophic to oligo-mesotrophic conditions with the exception of a site near to the peninsular village of Lin where conditions were mesotrophic (Fig. 6.5.4.2.3.1-1). The trophic state was even more elevated (mesotrophic to meso-eutrophic) along the more urbanized south shore of the lake.

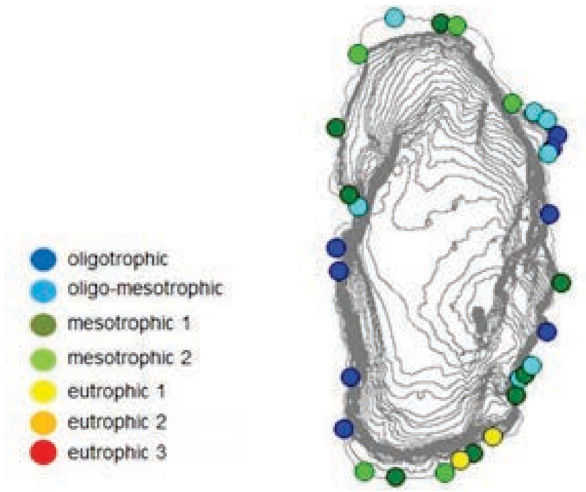

Figure 6.5.4.2.3.1-1 Trophic state of the littoral zone of Lake Ohrid, based on the macrophyte index of Melzer (1999) and Melzer and Schneider (2001)
Areas with low population density generally show oligotrophic to oligo-mesotrophic conditions while the more densely populated areas on the south and north shores show mesotrophic to meso-eutrophic conditions. Source: Christiansen et al. (2013).

With reference to Fig. 6.5.4.2.3.1-1 and interpretation/classification using Melzer's macrophyte index, it will be necessary to reset the class boundaries if the index is to be used for WFD purposes, since a 5-class system is required. The OECD (Vollenweider and Kerekes 1982) fixed boundary classification system has 5 classes (ultra-oligotrophic, oligotrophic, mesotrophic, eutrophic and hypertrophic) and uses terminology that is understood by all workers in the field. Whether or not the original class boundaries will prove to be correct for WFD purposes will depend on the definition(s) of reference conditions and the class boundaries used by other countries in the intercalibration exercises.

6.5.4.2.3.2 Macedonia

Lake tributaries

Twenty macrophyte species were recorded at the three rivers. Sixteen of these species belonged to vascular macrophytes, two to the taxonomic group of charophytes and one to the group of mosses. Abundances ranged from very rare to common. Indicators of eutrophication such as Canadian pondweed (*Elodea canadensis*) and duckweed (*Lemna minor*) were very rare except for the middle course of River Sateska. The presence of the endemic species *Chara ohridana* as well as dark stonewort (*Nitella opaca*) and starry stonewort (*Nitellopsis obtusa*) at the river inlets indicated that the water is still of high quality.

Lake littoral

Twenty-nine macrophyte species were found within the scope of the NIVA project (Schneider et al. 2014). The average macrophyte index was MI = 3.2, indicating mesotrophic to slightly eutrophic conditions in the lake littoral (average of 28 sites from both Albania and Macedonia). As in Albania, macrophyte indices were generally higher along the more densely populated shores (Fig. 6.5.4.2.3.1-1). The abundance of the ubiquitous, filamentous blanketweed (*Cladophora glomerata*) at sites with elevated phosphorus load was another indication of local eutrophication. Nutrient enrichment was moderate to elevated in shallow water but very low in deeper water. Overall, the littoral zone of Lake Ohrid was found to be oligotrophic and oligo-mesotrophic in about equal shares.

6.5.4.3 Macroinvertebrates

Lake tributaries play an important role in the water balance and ecological status of lakes. In Lake Ohrid, a deterioration of water and habitat quality resulting from industrial development of the Macedonian lake catchment has become increasingly evident since the early 1970s. However, Lake Ohrid tributaries have so far been paid little attention in terms of biological monitoring.

6.5.4.3.1 Methods

Benthic macroinvertebrate investigations under the present project were restricted to the Lake Ohrid tributaries Sateska, Koselska and Cherava Rivers in Macedonia since the lake littoral had already been extensively studied under the above-mentioned NIVA project (Christiansen et al. 2013, Schneider et al. 2014). No samples were taken in Albania, except for Cherava upstream, since the country contains no large tributaries; only a network of small creeks with large seasonal flow variations (Matzinger et al. 2007).

Field sampling

Tributaries. Three sites were sampled at River Sateska, the longest of the three tributaries, reflecting differences in anthropogenic pressures along the river course (Fig. 6.5.4.3.1-1). One site was located upstream (near natural conditions) and the second one at the middle course (rural and urban conditions). The third one was located at the inflow into the lake. The other two, relatively short tributaries were only sampled at the inflow. Macroinvertebrates were collected in spring (May) and autumn (October) 2013, using the kick-and-sweep method. A standard D-shaped net (ISO: EN 27828:1994, AQEM/STAR-lakes) with a metal frame holding a mesh bag of 400-µm mesh size was employed. This net is suitable for sampling on sandy, gravelly and mixed bottom covered by macrophytic vegetation. The sampling time was 5 minutes. Transects were run at approximately 0.5 m depth. Samples were sieved, preserved in 70 % ethanol and transported to the laboratory for further examination.

Lake littoral (NIVA study). The study was conducted from 2009 to 2011, comprising up to 30 sampling stations in Albania and Macedonia (Christiansen et al. 2013). The methodology was principally the same as for the tributaries since the study focused on the shallow parts of the littoral zone at 0.5 m depth (Schneider et al. 2014).

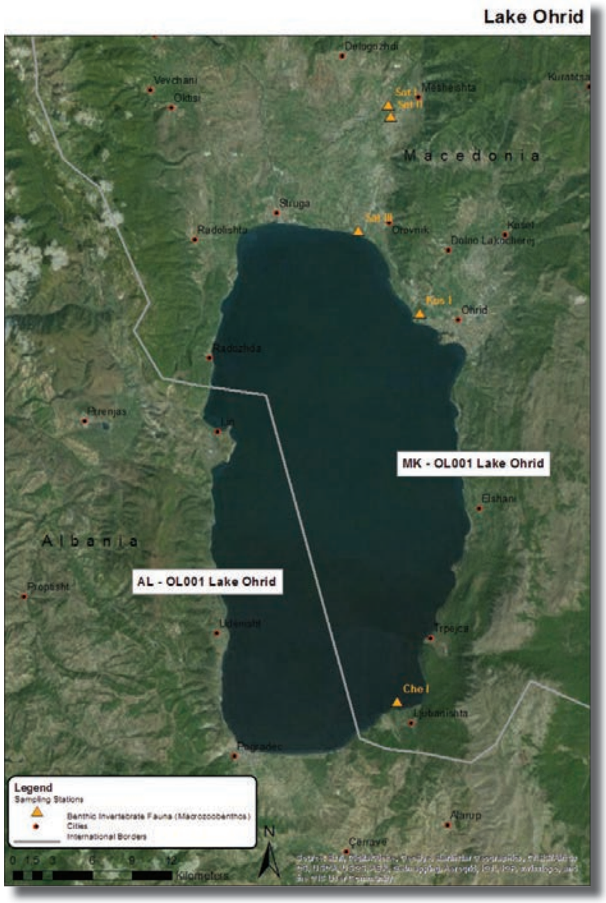

Figure 6.5.4.3.1-1 Sampling stations for macroinvertebrate investigations at Lake Ohrid tributaries in Macedonia. *All rivers were sampled at the inflow into the lake while River Sateska was also sampled upstream. No samples were taken from the Albanian part of the lake.*

Data analysis

Tributaries. Different metrics were used to describe river macroinvertebrate communities, including diversity, species richness and evenness indices (for details, see Trajanovski 2014, Volume of Annexes). As a practical metric for ecological status assessments based on tolerances of macroinvertebrates to pollution, the Irish Biotic Index (IBI) was calculated. The IBI ranges from 1 (bad ecological status) to 5 (high ecological status).

Lake littoral (NIVA study). The NIVA study used the lake macroinvertebrate intercalibration metric for the Central-Baltic Ecoregion (ICM). This index was specifically developed for lakes and includes species composition and abundances as well as functional indicators (Schneider et al. 2014). The ICM ranges from 0 (bad ecological status) to 1 (high ecological status).

6.5.4.3.2 Existing Data and Gaps

Research on the fauna of Lake Ohrid, including benthic invertebrates, has a long tradition in Macedonia. The beginnings are related to the works of Stankovich (1960) who reviewed the density and vertical distribution of specific groups of the benthic fauna of Lake Ohrid. Since then, the research interest has focused on taxonomy (description of new species, studies on speciation and endemism) and ecology (structure-density, dynamics, diversity of benthic communities). Due to the high percentage of endemics and the nonexistence of saprobic index systems for most species, water quality assessments using the benthic invertebrate fauna has been given little attention.

The first ever attempt to assess the ecological status of the lake according to the WFD using macroinvertebrates was done under the NIVA project mentioned in the previous section (Christiansen et al. 2013, Schneider et al. 2014). The project entitled "Developing Biological Tools According to the Water Framework Directive in Lake Ohrid" studied up to 30 sites along the littoral zone of the entire lake (Fig. 6.5.4.3.3.1-1). Most of the sites anticipated to represent reference conditions (i.e. good or high ecological status) turned out to be in a far worse state than expected (see next section). More research is needed to consolidate these preliminary findings.

Contrary to the lake, the benthic fauna of the tributaries has never been subjected to comprehensive research. The few studies done so far deal mainly with Lake Ohrid endemics and their distribution in adjacent waters.

Notable gaps regarding macroinvertebrate monitoring include:

- Long-term continuous datasets, as they do for all quality elements
- Knowledge regarding macroinvertebrate ecology of the profundal zone, which occupies almost two thirds of the lake bottom
- Derivation of indicator values for Lake Ohrid taxa to enable more accurate macroinvertebrate status assessments to be made, using metrics used within the EU.

6.5.4.3.3 Results

This section provides a synthesis of the main findings of macroinvertebrate investigations conducted at selected lake tributaries under the present project and the lake littoral under the NIVA project. For details, see Trajanovski (2014, Volume of Annexes) for the Macedonian lake tributaries, and Christiansen et al. (2013) and Schneider et al. (2014) for the lake littoral zone.

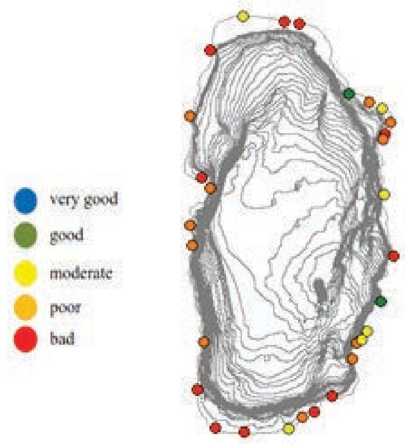

Figure 6.5.4.3.3.1-1 Ecological status of the littoral zone of Lake Ohrid based on the Intercalibration Common Metric (ICM) for the Central-Baltic Ecoregion.
The majority of the sites in Albania along the west and south shores showed poor to bad conditions. Moderate to good conditions were found only along the east and north shores, i.e. mainly in Macedonia (Christiansen et al. 2013).

6.5.4.3.3.1 Albania

The vast majority of the Albanian sampling stations of the lake littoral showed poor or even bad ecological status (Fig. 6.5.4.3.3.1-1). The average ICM for the entire lake was 0.22 (range: 0.06 – 0.52), indicating poor conditions (Schneider et al. 2014). However, these findings need to be interpreted with caution because of limited applicability of the ICM to Lake Ohrid which is dominated by endemic macroinvertebrate species whose sensitivities to pollution and other environmental pressures are not known yet. Furthermore, the assessment was limited to the shallow part (0.5 m depth) of the littoral zone, which is more vulnerable to anthropogenic disturbances than deeper parts.

6.5.4.3.3.2 Macedonia

Lake tributaries

River Sateska. Species diversity was highest in spring in the upper course, comprising 21 taxa, of which 90

% insects. In autumn, the same number of taxa was recorded in the middle course, of which 76 % were insects. IBI values decreased from 5 (indicating high ecological status) at the upper course in both seasons to 3 (spring: moderate status) and 2 (autumn: bad status) at the inflow into the lake, with the middle course taking an intermediate position (3–4, moderate status in both seasons). The deterioration of ecological status reflects increasing anthropogenic pressures. In the upper part, these are almost non-existent. On its course to the lake, the river passes through populated and agricultural areas, receiving waste water from households, sediments and pollutants (mostly pesticides and phosphorus). Seasonal water level fluctuations as well as riverbed morphology also affect the structure of macrozoobenthos communities.

River Koselska. Species diversity at the inflow was low in both seasons. Nine taxa were recorded in spring and seven in autumn. Total abundance was very low in both seasons. These findings along with low IBI values (≤ 2) indicated bad ecological status. The predominance of the dipteran larva *Chironomus plumosus* in both seasons was indicative of strong organic pollution.

River Cherava. The macrozoobenthos fauna was represented by seven and five taxa in spring and autumn, respectively. The fauna was dominated by leeches and insects in spring, with *Chironomus plumosus* being most abundant. Species identified in autumn belonged to amphipods and insects. Total abundance of macroinvertebrates was lower in autumn than in spring while the IBI values were similar (2), indicating bad ecological status in both seasons.

In conclusion, only the upper part of River Sateska had high biodiversity, indicating high ecological status. The lower reaches of River Sateska and the mouths of all tributaries had poor or bad status, depending on season. The tributaries are known to carry pollutants and sediments (originating from a range of human activities) into the lake.

Lake littoral

The macroinvertebrate fauna at the Macedonian part of Lake Ohrid indicated good ecological status at two sites only (west of Ohrid town and north of Trpejca). Like in Albania, the status of the majority of the sites was moderate, poor or bad (Fig. 6.5.4.3.3.1-1). While these findings should be considered tentative because of the argument put forward in the previous section, they are in full agreement with the findings from the lake mouths of the lake tributaries. It can be concluded that benthic invertebrates living in the shallow littoral zone are negatively affected by pollution and probably other factors such as sediment loads and low habitat structural diversity. These stressors are likely to diminish with increasing depth.

6.5.4.4 Fish

6.5.4.4.1 Methods

The assessment of Lake Ohrid's fish fauna was based on a first execution of a multimesh gillnet sampling campaign according to a European standard (EN 14757 2005).

Multimesh gillnetting (MMG) was conducted in autumn 2013.[9] The standard was modified according to the lake's characteristics resulting in sampling of seven sub-basins (Fig. 6.5.4.4.3-1). In total, 135 nets were set at both parts of the Lake, 64 in Macedonia and 72 in Albania. For further details, see Spirkovski et al. (2014, Volume of Annexes).

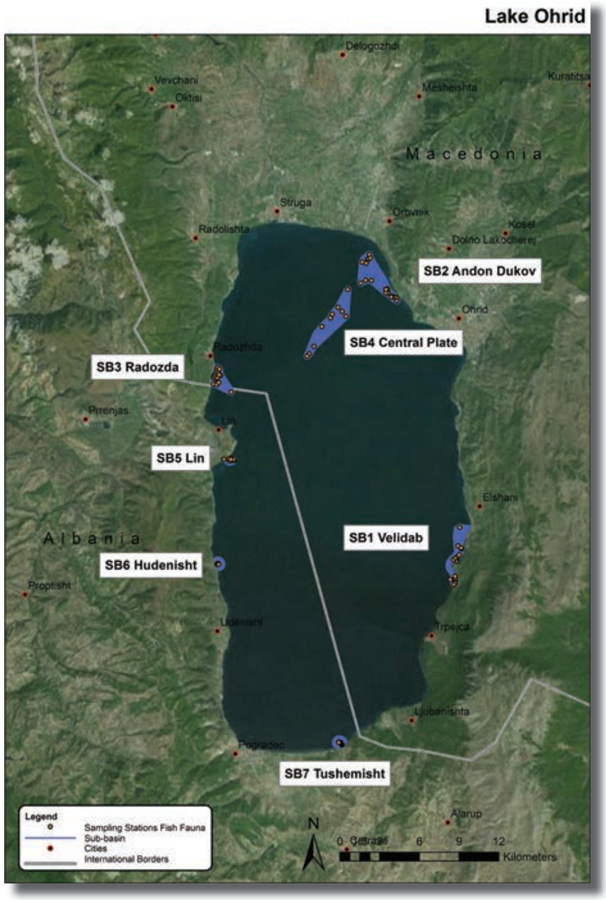

Figure 6.5.4.4.1-1 Fish sampling stations in Albania and Macedonia for multimesh gillnetting in 2013. *Circles demarcate the areas sampled. Sampling stations were clustered in Albania but more widely dispersed in Macedonia.*

6.5.4.4.2 Existing Data and Gaps

Despite the unique ecologic and high economic value of Lake Ohrid, there is not much information available on the lake's fishes as both detailed inventories and fish stock assessments have not been performed on Lake Ohrid fish since the early nineties. Similar to other intensively exploited water bodies most of the research was dedicated to commercially valuable species, mainly Lake Ohrid trout, Lake Ohrid belvica, eel, carp and bleak. In consequence,

9 Sampling was resumed in 2015 to cover at least another two seasons.

available information on fish assemblages of Lake Ohrid is primarily based on data derived from catch statistics and occasional samplings. Catch statistics, however, is available only for the period from 1969 to 2001 while data from more recent years are missing.

Ichthyologic investigations conducted so far addressed to reproduction of native species, their forage behaviour, and competitive interactions between cyprinid and salmonid species. Current data suggest that Lake Ohrid's fish community consists of 17 native and (at least) 6 alien species. Again, abundance, stock development, and ecologic effects of alien species, in particular, have never been studied in detail.

Recently performed multimesh gillnet sampling added information, in particular, on the presence and relative abundance as well as age structure of small sized species. Nonetheless, this method is known to be highly selective and, therefore, needs to be repeatedly applied as well as combined with other fishing methods in order to obtain a full picture about the state of Lake Ohrid's fish stocks.

In summary, further information is needed to derive index-based conclusions on the ecological state of Lake Ohrid using the biological quality element fish. Specifically, selection of metrics indicating different kinds of anthropogenic pressures on the fish assemblage of this lake, class boundaries for ecological status, and calculation of EQR are still lacking at present.

6.5.4.4.3 Results

6.5.4.4.3.1 Albania

In the Albanian part of Lake Ohrid, 14 species were caught (Tab. 6.5.4.4.3.1-1). In terms of numbers and/or biomass, the most dominant species in the catches were bleak, roach, Ohrid minnow (*Pachychilon*) and spirlin, all of which are of low commercial value. On the contrary, the endemic Ohrid belvica (which is typically sold for a high price) appeared in the catches with only a few individuals.

For further information, see Tab. 6.5.4.4.3.1-1 and the Lake Ohrid report on fish and fisheries in the Volume of Annexes (Spirkovski et al. 2014).

6.5.4.4.3.2 Macedonia

During the 2013 MMG fishing campaign, 14 species were found at the Macedonian sampling stations. Similar to the Albanian part of the lake, bleak, roach, and spirlin dominated the catch in terms of biomass. The alien species stone moroko and bitterling were also very abundant, representing up to 30 % of the total catch in some sub-basins. Endemic Ohrid trout and Ohrid nase were not caught at all. Together, the data suggest that substantial changes in the lake's ecology have occurred.

For further information, see Tab. 6.5.5.4.3.1-1 and Spirkovski et al (2014, Volume of Annexes).

Table 6.5.5.4.3.1-1 Relative abundance (RA) of fish species sampled in 2013

(Data from both countries pooled)

Native Species	RA	Introduced Species	RA
Cyprinidae		Cyprinidae	
Bleak (*Alburnus scoranza*)	3	Stone moroko (*Pseudorasbora parva*)	3
Ohrid spirlin (*Alburnoides ohridanus*)	3	Bitterling (*Rhodeus amarus*)	2
Barbel (*Barbus rebeli*)	1		
Carp (*Cyprinus carpio*)	1		
Ohrid gudgeon (*Gobio ohridanus*)	2		
Albanian roach (*Pachychilon pictum*)	3		
Ohrid minnow (*Pelasgus minutus*)	2		
Minnow (*Phoxinus lumaireul*)	1		
Ohrid roach (*Rutilus ohridanus*)	3		
Rudd (*Scardinius knezevici*)	2		
Ohrid chub (*Squalius squalus*)	1		
Nemacheilidae			
Stone loach (*Barbatula sturanyi*)	1		
Cobitidae			
Spined loach (*Cobitis ohridana*)	2		
Salmonidae			
Ohrid belvica (*Salmo ohridana*)	1		

0 = absent; 1 = rare; 2 = frequent; 3 = abundant.

6.6 *Impact and Risk of Water Bodies Failing to Meet Environmental Objectives*

The assessment of the risk of water bodies failing to meet their environmental objectives (see Box 10) set was done by the Technical Working Group – WFD. It used available data emerging from previous studies and those conducted under the current project as well as expert knowledge and background information on prevailing impacts and pressures in the respective sub-basins.

6.6.1 Chemical and Physico-Chemical Elements

6.6.1.1 Albania

Higher concentrations of nutrients, BOD_5 and COD are caused by the discharge of untreated or insufficiently treated waste water into the lake and its tributaries.

While the results of the monitoring undertaken specifically for characterisation purposes are currently considered representative, there will be a need to validate them against future monitoring programme results (Section 8.2), due to upgrading of the waste water treatment plant at Pogradec.

BOX 10. ENVIRONMENTAL OBJECTIVES

Environmental objectives are defined in Article 4 of the WFD.

Surface waters

The WFD general objective of good ecological status should be achieved in surface water bodies by 2015. The Directive also utilises the 'no deterioration' principle, so no waterbody should be allowed to fall from high to good status. However, exemptions to this general objective are allowed, permitting less stringent objectives or extension of the deadline beyond completion of the first river basin management planning cycle, provided a set of conditions are fulfilled (see CIS Guidance Document 20, Box 5).

In the river basin characterisation process, artificial and heavily modified water bodies need to be designated, in addition to protected areas (see Box 1).

For a water body to be described as artificial, it must be located where previously there was no water (e.g. a pumped storage reservoir or man-made canal), whereas a heavily modified water body is one where water was originally present at the site, e.g. a dammed river valley. In terms of environmental objectives, pristine/lightly modified water bodies [there is no requirement to differentiate between the two types] have to achieve at least good ecological *status*, while both heavily modified and artificial water bodies have to achieve the less stringent objective of good environmental *potential*. All water bodies have to achieve good chemical status.

Protected areas (see Box 1) may have more stringent environmental objectives than other surface waters. Objectives that are more rigorous are often introduced for physico-chemical status and/or hydromorphological conditions in protected areas designated for the protection of habitats or species.

Groundwaters

Groundwater bodies need to achieve good chemical and quantity status. The WFD sets out the following environmental objectives for these:

- To implement measures to prevent or limit the input of pollutants into groundwater and to prevent deterioration
- To ensure a balance between abstraction and recharge of groundwater, with the aim of achieving 'good groundwater status' within 15 years of the Directive coming into force, except under certain special circumstances (see CIS Guidance Document 20, Box 5)
- To reverse any significant and sustained upward trend in the concentration of any anthropogenic pollutant and progressively reduce pollution
- To ensure compliance with the relevant standards and objectives for protected areas within 15 years of Directive implementation (for groundwater bodies from which abstraction for human consumption exceeds 10 $m^3.d^{-1}$ or serves greater than 50 persons).

6.6.1.2 Macedonia

Carlson's Trophic State Index summarises the results of Secchi depth, total phosphorus and chlorophyll-*a* concentrations within a single trophic status metric, according to which the pelagic site is ultra-oligotrophic, while according to the OECD fixed boundary classification scheme (Vollenweider and Kerekes 1982) the site is oligotrophic. The fact that different indices can produce different results hints at why the WFD appears to be so data-hungry in terms of its requirements.

The impact of elevated nutrient levels varies greatly depending on the type of water body, and hence the reason for developing water body typologies. Lakes tend to be impacted more heavily (e.g. have higher chlorophyll-*a* concentrations and more dense growth of rooted vegetation) than rivers with the same nutrient concentrations. As expected, the tributaries of Lake Ohrid were more nutrient-enriched than the lake itself.

The Sateska River, before redirection at the middle course and at the inlet were subject to moderate nutrient-enrichment, as was the Koselska River inlet. The Grashnica littoral was mesotrophic or eutrophic (based on total phosphorus concentration), while Kalishta, Veli Dab and St. Naum sites were oligotrophic.

6.6.2 Biological Elements

6.6.2.1 Albania

Owing to its large water volume, Lake Ohrid offers some resilience towards anthropogenic pressures such as eutrophication, siltation and pollution. According to phytoplankton and chlorophyll-*a* analyses, the lake is mostly in its natural oligotrophic state, particularly in the pelagic zone. Moreover, its largely endemic benthic invertebrate fauna seems to be in stable condition. The same holds for the fish fauna, which is dominated by native species (74 % of 23 species). In view of this, and following a weight-of-evidence approach, Lake Ohrid is likely to meet the environmental objective of good ecological status.

However, results for more sessile biota (aquatic flora and benthic invertebrate fauna) suggest that the objective might not be met for parts of the littoral zone where moderate to bad status was diagnosed, particularly at the mouths of Lake Ohrid tributaries. Results of the fish assessments also give reason for concern, in particular the scarcity of endemic species of economic importance such as Ohrid trout and Ohrid belvica, probably indicating a significant shift in community composition and abundance from reference conditions. The overall assessment, therefore, concludes a possible risk of failing to achieve good ecological status at least for the littoral zone (Tab. 6.6.2.1-1). Further monitoring is needed to corroborate this preliminary assessment.

Table 6.6.2.1-1 Risk of water bodies of Lake Ohrid of failing to meet the objective of good ecological status, based on four biological quality elements

Water body	Individual assessment				Overall assessment
	Phytoplankton	Aquatic flora	Benthic fauna	Fish fauna	
AL – WB1	● (green)	● (yellow)	● (yellow)	● (yellow)	Probably at risk
MK – WB1	● (green)	● (yellow)	● (yellow)	● (yellow)	Probably at risk

Green = not at risk, yellow = probably and/or locally at risk, red = at risk;
AL – WB1 = Albanian water body, MK – WB1 = Macedonian water body.
"Probably at risk" is not a risk assessment category foreseen in the WFD but has been used on an interim basis in countries such as the UK if data were considered insufficient to draw firm conclusions.

6.6.2.2 *Macedonia*

The preliminary risk assessment for the Albanian part of Lake Ohrid presented in Section 6.6.2.1 also holds for the Macedonian part of the lake (MK – WB1, Tab. 6.6.2.1-1).

6.6.3 Hydromorphological Elements

Within the CSBL project, a characterisation of hydromorphological conditions of the lake structure has not taken place. Hydromorphological field mapping does not yet exist in either Albania or Macedonia.

6.6.4 Surface Water Status and Environmental Objectives Assessment

Self-purification processes and the recent modernization of the sewer system in Ohrid and Struga have reduced the nutrient and pollution load of the lake. The status of its pelagic zone, therefore, is considered good at least in Macedonia. However, this assessment neither holds for the littoral zone of the lake where aquatic flora and benthic invertebrate fauna indicate organic pollution (Section 6.6.1) and other anthropogenic pressures such as changes in hydromorphology, nor for the Albanian part. There, untreated waste water from settlements and effluents from the waste water treatment plant at Pogradec affect both the littoral and pelagic zones of the lake. Furthermore, the impact of abandoned and active mining as well as the recent deposition of road construction materials into the lake on water status have not yet been assessed. Therefore, both Albanian and Macedonian water bodies are at risk of failing to achieve good status.

Photo 13. Outflow of St Naum springs

6.7 *Protected Areas*

According to the WFD, a register of protected areas must be kept, which includes areas designated:

- For the abstraction of drinking water
- For the protection of economically significant aquatic species
- As recreational waters
- As nutrient-sensitive areas
- For the protection of habitats or species according to EU Nature Protection Legislation

6.7.1 Albania

According to law № 111/2012, dated 15 December 2012 on the integrated management of water resources, the competent ministry should define protected areas with the aim of water and aquatic ecosystem protection, which are declared later on through a regulation of the Council of Ministers. It is the duty of the NWC and the ministry to draft, manage and update an inventory of protected areas as part of the management plan of them. The latest should be included in the management plan of the respective water basin.

However, information from the ministry with regard to these protected areas is still missing since important secondary legislation is in the process of being drafted. The only available information pertains to areas designated for the protection of habitats or species including Emerald and/or Natura 2000 sites.

Lake Ohrid has been declared a Protected Landscape (Category V of IUCN) through decision № 80 of February 1999. In 12 June 2014, the UNESCO MAB programme declared the Ohrid-Prespa catchment as a Transboundary Biosphere Reserve.

6.7.2 Macedonia

The Galichica National Park extends along the biggest part of the east shoreline of Lake Ohrid as well as the north-west part of the Prespa shoreline in Macedonia. It hosts 35 habitat types, a large number of which are protected under the Bern Convention and the EU Habitats Directive. The Park has also been designated as an Emerald Site, Prime Butterfly Area, Important Bird Area and Important Plant Area. Moreover, the Macedonian side of the lake was proclaimed a Natural Monument (to be re-evaluated and re-proclaimed in accordance to the new Law on Nature Protection.)

The Natural and Cultural Heritage of the Ohrid Region (UNESCO site) covers an area of about 830 km^2, partially overlapping with the municipalities of Ohrid, Debarca and Struga. As mentioned in the previous section, the transboundary Ohrid-Prespa Biosphere Reserve has recently been proclaimed within the UNESCO MAB programme.

7 Lake Prespa Sub-Basin

7.1 Characteristics

Lake Prespa (*ca.* 850 masl) drains a high-altitude sub-basin of the River Drin. It consists of two inter-linked lakes: Micro Prespa (*ca.* 47 km^2) and Macro Prespa (*ca.* 259 km^2), with a maximum depth of 55 m. Water from Micro Prespa flows into Macro Prespa via a weir, which is used to artificially control its surface water level. The catchment is shared between Macedonia, Albania and Greece. The lakes, along with the surrounding forested mountain slopes of Pelister, Galichica, Mali i Thatë, Varnountas and Triklario, cover a total area of 1,386 km^2. The gradient of the terrain in the Macedonian part of the basin, in particular, is steep. It can be divided into Prespa valley and the surrounding mountains of Baba, Ilinska and Galichica.

The water resources in the Prespa valley are used for different purposes: water supply for populated regions in the valley, industrial use and irrigation of agricultural regions in all three countries. In addition to agriculture, tourism and fisheries are of economic importance in the lake basin.

Supply systems, using water abstracted from Macro Prespa Lake, are present in the Macedonian village of Stenje, and the summer camps of Carina and Oteshevo, as well as 18 Greek villages and 12 villages in Albania. Agricultural irrigation systems in Macedonia use water from Macro Prespa Lake. Pumping stations in Asamati and Sirhan provide water to fields around the villages. Greece uses water from Micro Prespa Lake to provide irrigation for agricultural areas in the Billis-Corca valley. In Albania, water from the same lake is transferred through the artificial channel of Canyon Grlo, again for agricultural irrigation.

7.2 Types of Surface Water Bodies – Lake and Main Tributaries

WFD System A (Annex II, Section 1.2) was used to determine/delineate individual water bodies. Central criteria were:

- Altitude
- Catchment area (for rivers)
- Surface area (for lakes)
- Geology
- Depth (for lakes)

In addition, specific traits (e.g. status, pressures, etc.) of water bodies of the same type have been taken into consideration, enabling adjacent water bodies to be delineated. The initial delineation of water bodies at Lake Prespa was undertaken by the TWG – WFD, following advice laid down in CIS Guidance Document № 2 – Identification of Water Bodies (see Box 5). The

Photo 14. Lake Prespa

delineation differs from the one proposed in the Prespa Lakes Watershed Management Plan (WMP) for the Macedonian part of Macro Prespa, which recognizes only a single water body (UNDP 2012):

Water bodies of Lake Macro Prespa

MK – PL001 Ezerani (northern part and wetlands)

MK – PL002 Pelagic zone

AL – PL001 Lake Prespa

Water bodies of the main tributary

MK – RG001 River Golema

These are shown in Fig. 7.5.1-1, Section 7.5.1.

7.3 Type-Specific Reference Conditions

Establishing reference conditions for Lake Prespa is difficult because the lake cannot be compared for its reference parameters to any other lake (not even to Lake Ohrid to which Lake Prespa is the major water source). Lake Prespa and its whole catchment lie within Ecoregion 6 – *Hellenic Western Balkans*. The lake is characterised as being mountainous, located above 800 m altitude, large (with a surface area of >100 km^2), overlying silicate/carbonate geology, and deep (>15 m). It is well mixed by numerous sub-lacustrine springs, and lies within a subtropical highland climatic region. The surface water level oscillates by up to 4.5 m, depending on meteorology and abstraction rates/volumes.

The Lake Macro Prespa sub-basin contains lacustrine habitats – with limnetic (constantly flooded) and littoral sub-habitats – as well as riverine habitats, such as Istočka, Brajčinska, Golema River etc.

Waters are relatively well-oxygenated (DO 6–7 $mg.l^{-1}$), alkaline in character (pH >7), reasonably transparent (Secchi depth >5 m), with moderate nutrient levels (total phosphorus = 15–25 $\mu g.l^{-1}$; total nitrogen = <3 $mg.l^{-1}$), and a moderate to high abundance of phytoplankton, (chlorophyll-*a* = >3.8 $\mu g.l^{-1}$). Phytoplankton is the most characteristic feature of the pelagic zone of the lake, while macrophytes are characteristic of the littoral zone.

The planktonic diatom flora is surprisingly uniform and very rich in taxa (Levkov at al. 2006). Predominant species are *Cyclotella ocellata, Stephanodiscus rotula, Diploneis maule* and *Camplylodiscus noricus*. However, as with the vast majority of lakes, the overall composition of the phytoplankton community changes on a seasonal basis. High densities of large and filamentous microalgae (*Anabaena, Microcystis*) occur in surface water during summer, indicating an ecosystem enriched with nutrients.

7.4 Identification of Pressures

7.4.1 Methods

The most significant pressures and their likely impacts on achieving the Directive's aims are analysed in terms of:

- Point source pollution
- Diffuse source pollution
- Water abstraction and flow regulation
- Physical modifications
- Other man-made pressures
(e.g., introduction of alien species).

The first three types of pressures are quantified using official data of state administrations. Point sources, such as direct discharges from WWTPs, are monitored. The measurements of state and compulsory self-supervision are the base for the calculation of point source pollution loads into lakes and rivers.

Pressures from diffuse sources are more difficult to assess, but can be modelled or estimated from other information (e.g., agricultural census data). Information on possible polluters of various environmental compartments (air, soil, groundwater etc.) have, therefore, been collated and assessed, although no formal modelling studies have been undertaken, nor have GIS maps of pressures been produced.

7.4.2 Existing Data and Gaps

Pressures, especially significant point sources have been identified by HBIO in Macedonia and NEA in Albania. An appropriate state cadastre of discharges, either direct or into the sewer, does not exist in either Macedonia or Albania, so pressures have been identified using expert knowledge. Pressures from diffuse sources have been derived from scientific literature. Official figures are not available. However, the Prespa Lakes WMP (UNDP 2012) provides sample information about land use and pressures at the Macedonian sub-basins.

7.4.3 Significant Point Sources of Pollution

7.4.3.1 Albania

No significant point sources of pollution exist in the Albanian part of the Lake Prespa catchment.

7.4.3.2 *Macedonia*

Ezerani WWTP represents a significant point source of pollution to Lake Prespa. Insufficiently treated waste water and storm water outfalls from separate and combined sewerage systems have an obvious harmful impact on water quality, even though marginal wetlands around the lake have a buffering and filtering function.

The waste water pressure comes from 16,825 residents living in 44 locations in the watershed. This number swells during the summer, when approximately 4,000 tourists stay in the catchment, accommodated in private houses, hotels and holiday camp facilities (see Fig. 7.4.3.2-1). Industrial pollution arises from several small-to-medium sized enterprises, dealing with food processing, poultry farming, textiles, metal processing, wood processing, civil construction, ceramics and chemicals. Only 25 % of the storm water network has been completed.

7.4.4 Significant Diffuse Sources of Pollution

7.4.4.1 *Albania*

Water quality of Lake Prespa is affected by agriculture and untreated waste water from settlements, especially from the villages of Kollmas, Gorica, Gollomboc and Pustec (Liqenas). The pollution load is approximately 230 kg COD.d^{-1}.

Extensive agriculture has a less harmful impact on the lake. Farmers use very little inorganic fertilizers (only for wheat), relying primarily on livestock manure. Considering the high soil erosion factor of 31.7 tonnes ha^{-1}.yr^{-1} and the low absorptive capacity of the soil, up to 50 % of the agrochemicals used may be transferred to the lake and its sediments.

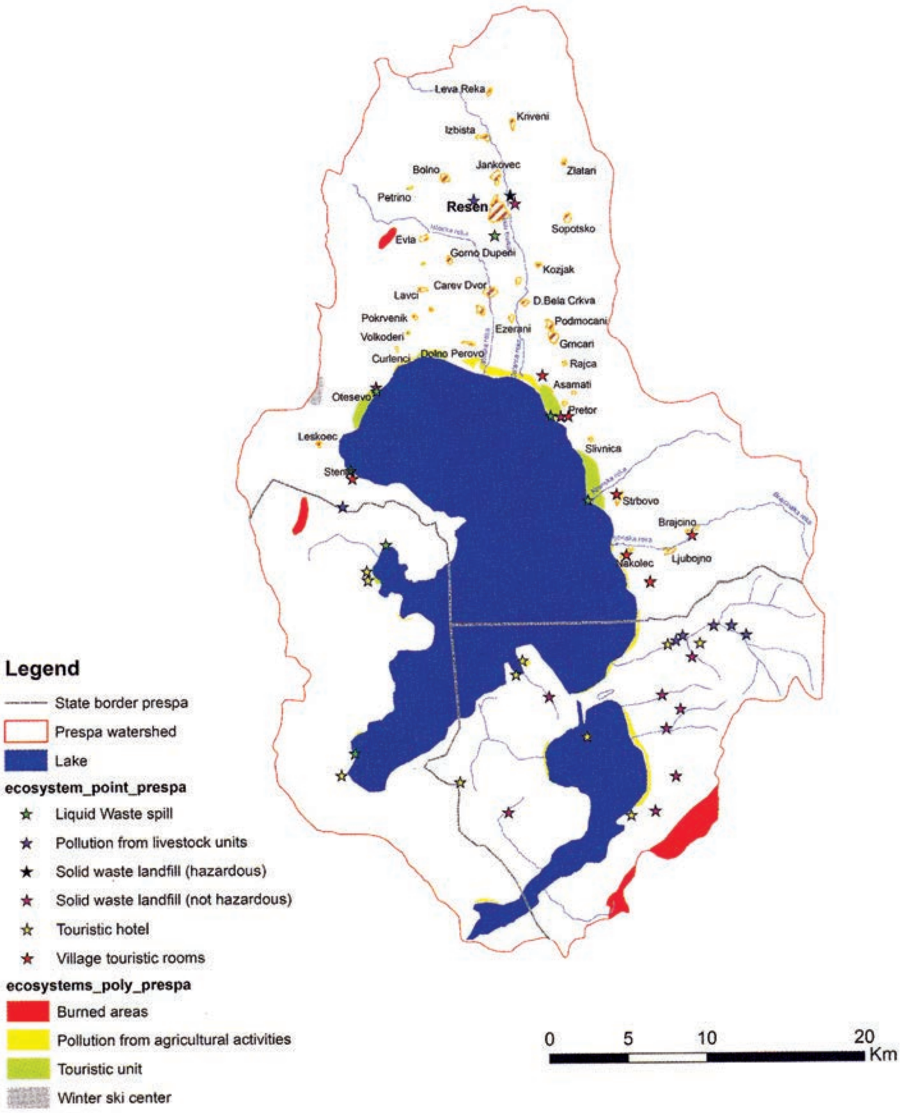

Figure 7.4.3.2-1 Major point and diffuse sources of pollution in the watershed of Lake Prespa (adapted from UNDP 2012).

Furthermore, illegal landfills and dumps in the villages especially near the shoreline are potential sources for diffuse pollution.

7.4.4.2 Macedonia

Agricultural activities result in higher diffuse source nutrient loading to Prespa Lake. In total, some 920 tonnes of nitrogen and 477 tonnes of phosphorus are applied each year in the Macedonian watershed of Lake Prespa (UNDP 2012). Typically, 15–30 % of nitrogen applied as fertilizer is exported to surface and groundwaters, depending on geology, soil type, land slope and vegetation. Likewise, 1–5% of phosphorus is exported to surface waters, depending principally on land slope, drainage density and vegetation.

In total, it is estimated that around 64 tonnes of pesticides are used each year. Significant quantities of mainly organic waste (waste apples and yard waste) and hazardous solid waste generated by agricultural activities (pesticide packaging) are disposed of in the river channel and riparian corridor. This has a significant negative impact on surface water bodies, groundwaters and soil, and especially on the Golema Reka water ecosystem (UNDP 2012).

Besides agricultural activities, coastal and other villages in the watershed (Stenje, Krani, Ljubojno, Dolno Dupeni) also contribute to the overall load of diffuse source-derived pollution. Most villages, especially those in River Golema sub-catchment are not connected to the sewerage system and represent significant diffuse source pollution. Some of these (Konjsko, Stenje, Brajchino) have high tourist capacities, so are thought to represent relatively important diffuse sources of pollution.

7.4.5 Water Abstraction

7.4.5.1 Albania

Around of the Prespa Lake shoreline are placed five villages that use lake water for irrigation and domestic purposes. These villages have a population of about 3,500 inhabitants, mostly farmers, corresponding to about 700 $m^3.day^{-1}$ total for personal use or a maximum abstraction rate of approx. 20 $m^3.d^{-1}$ per family (including irrigation). Regular state monitoring and proper documentation of water extraction from the lake does not exist. The amount of abstracted water is smaller in winter when a substantial proportion of the population moves away from the villages to other locations.

7.4.5.2 Macedonia

In the northern part of the Prespa basin, numerous artesian wells have been drilled to depths of 15–200 m, with maximum flow rates of 6 $l.s^{-1}$.

For water supply, the town of Resen uses water from 2 karst springs at Krushje locality (Bigla Mountain), providing a flow rate of 35–160 $l.s^{-1}$ and three production wells (alluvial aquifer at Carev Dvor village), each 30 m deep, with total capacity of 50 $l.s^{-1}$. Numerous wells and springs are used for water supply by surrounding villages (UNDP 2012). For further information on water abstraction at Lake Prespa, see Section 6.4.5.2.

7.4.6 Hydromorphology and Water Flow Regulation

As Macro Prespa Lake is relatively shallow compared to its large surface area, wind and convective mixing lead to complete destratification of the entire water column from September to April/May and consequently, dissolved substances are homogenized annually. A canal with sluice gates (reconstructed in 2004) connects Macro and Micro Prespa Lakes.

7.4.6.1 Albania

Micro Prespa, which is not covered by the CSBL project, is shared by Albania and Greece. It is located within the Prespa Lake river sub-basin. The management of Micro Prespa affects the water level of Macro Prespa. Increased water extraction in the Greek part of Micro Prespa over the last decades may have negatively affected the water status of Lake Prespa. However, this impact has not yet been quantified.

7.4.6.2 Macedonia

No flow regulating structures are present in the Macedonian part of the lake or its tributaries.

7.4.7 Other Significant Anthropogenic Impacts

Agriculture, notably fruit production, is the major economic activity in the catchment. Livestock farming, particularly of small ruminants, is also widely practiced, but the majority of the farms use outdated technologies and equipment, usually without proper waste management practices.

The tourism sector is small but growing. Lake-based tourism is more highly developed (although in need of improved organisation) whilst mountain-based tourism is in its infancy (IPIKS 2010). Improved management will be required to minimise impact as this sector expands.

7.4.7.1 Albania

Endemic fish species are threatened by several anthropogenic activities and factors:

- Water pollution, including eutrophication
- Poorly integrated management approaches/practices
- Unregulated fishery practices and illegal fishing
- Alien fish species
- Destruction of spawning grounds

Between 1972 and 2000, a reduction of water volume in Lake Macro Prespa exacerbated the impacts of pollution and increased pressure on the littoral fish community.

7.4.7.2 Macedonia

Agriculture, fishing, and water abstraction are issues that have affected the lake`s fish community in various ways. The introduction of alien fish species has led to the current situation where nearly half of the species (12 of 25) are non-native, although five of these have not been recorded recently. Nevertheless, at least seven species are competing with native littoral fish for food and habitat. This may also affect other elements of the wider biological community.

Unregulated and illegal fishing also affects the composition, abundance and age structure of the lake's fish assemblage.

7.5 Water Quality Assessment

7.5.1 Sampling Stations

The sampling stations for water quality measurements were selected in accordance with WFD requirements, based on the experience and knowledge of contributing specialists. In Macedonia, they comprised both lake and river sites, while in Albania they comprised only lake sites (Tab & Fig. 7.5.1-1).

Table 7.5.1-1 Lake Prespa sampling stations for physico-chemical and chemical assessment

Macedonia	Albania
Water body 1: Ezerani (northern part of Lake Prespa) • MK II NW (North-west) littoral of Ezerani • MK III Ezerani littoral • MK IV NE (North-east) littoral of Ezerani • MK V Oteshevo Water body 2: Pelagic zone (eastern part of Lake Prespa) • MK VI Pelagic point Tributaries of Lake Prespa in Macedonia • Golema I • Golema II • MK I WWTP (Waste Water Treatment Plant Ezerani)	Water body 1: Albanian part of Lake Prespa (south-western part of Lake Prespa) • AL I Gollomboc • AL II Pustec (Liqenas)

The sampling stations for biological investigations are shown in the respective sections.

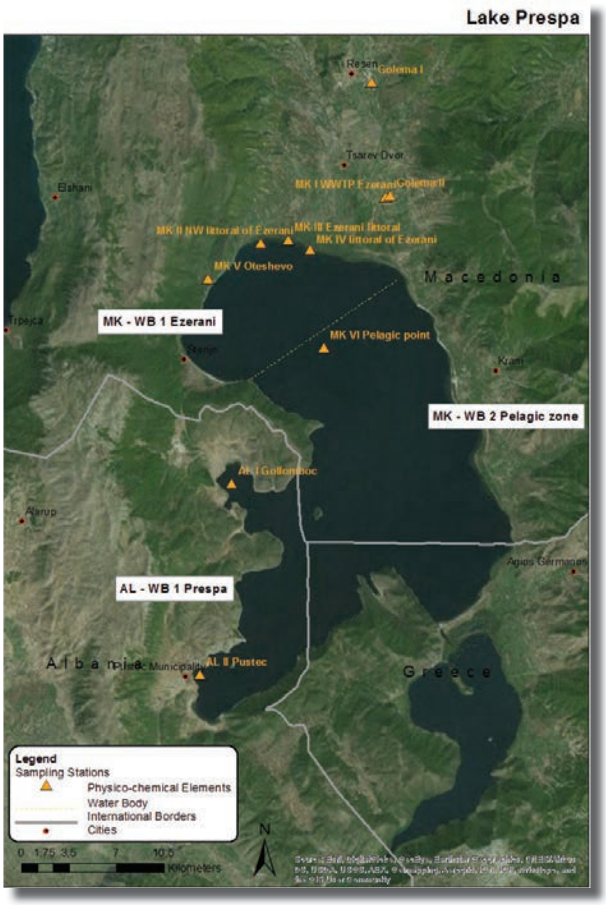

Figure 7.5.1-1 Sampling stations for chemical and physico-chemical analyses at Lake Prespa
The Technical Working Group – WFD tentatively divided Macro Prespa into three water bodies: two in Macedonia and one in Albania.

7.5.2 Chemical and Physico-Chemical Elements

7.5.2.1 Methods

Albania

Monitoring was undertaken four times in 2013–2014 (April, July, October and February) at three stations. Sampling procedures were considered suitable for some sites/parameters, but failed to follow standard methodologies fully. Bottles containing samples were transported to the laboratory in cool boxes. However, transport and storage procedures did not follow prescribed methodologies fully. Therefore, biochemical or physico-chemical processes might have been triggered in some samples, leading to flawed results. Samples were analysed according to standard methodologies agreed by the TWG. However, owing to the above-mentioned problem, the results obtained require validation by comparison with available data and results from the proposed monitoring programme (Section 8.3).

Macedonia

Monitoring was undertaken on four occasions, during April, July, October and February, 2013–2014. A Niskin bottle (5 litre) was used for collecting water samples from littoral and pelagic sites (two depths: 1 and 15 m). Sediment samples were collected using a van Veen grab from the two sampling points Oteshevo littoral and Ezerani littoral. All sampling was done according to standard procedures. Samples were transported as soon as possible to the laboratory at low temperature, avoiding outside influences. Upon arrival, they were transferred to a refrigerator and stored at 4 °C prior to analysis.

7.5.2.2 Existing Data and Gaps

Until 2008, the Hydrometeorological Institute carried out regular physico-chemical monitoring (temperature, pH, conductivity, transparency, dissolved oxygen, ammonia, nitrites, nitrates, phosphates and total phosphorus) at a single station in Lake Prespa, but since then no state monitoring has been undertaken. Very few data exist for the Albanian part of the lake.

7.5.2.3 Results

Results of physico-chemical investigations are summarized in Annexe 11.2. More detailed information is given in the original reports compiled in the Volume of Annexs (USB card).

7.5.2.3.1 Albania

Analysis shows that water quality is affected by anthropogenic pressures (nutrient inputs in particular; see Annex 11.2 and Section 7.5.4.1). However, the results have to be validated and verified by comparison with results from the monitoring programme proposed in Section 8.3.

7.5.2.3.2 Macedonia

All the investigated parameters indicate that Lake Prespa is in the process of eutrophication. Changes in the volume of the lake also appear to be having a direct effect on the concentrations of dissolved nutrients within it, since there is less water to dilute the loads from both external sources and releases from the sediment. At present, however, it is the shallow, littoral areas which appear to be most highly impacted.

For phosphorus, it is well known that anaerobic conditions above the sediment surface can strongly stimulate its release from the sediment. However, the only place where dissolved oxygen levels fell to worryingly low levels was at Ezerani WWTP (where phosphorus levels were extremely high. In contrast to the suspicion of eutrophic/hypertrophic lakes suffering low dissolved oxygen levels, there are many results from the lake where dissolved oxygen is >100 % saturation. Confusingly, however, this is also a symptom of eutrophication.

Both Carlson's Trophic State Index results (calculated on basis of total phosphorus concentration and Secchi depth) and the OECD fixed boundary scheme (Vollenweider and Kerekes 1982) classify Lake Prespa as being mesotrophic.

7.5.3 Specific Pollutants

The chemical status of water bodies is determined pursuant to Environmental Quality Standards (EQS) for pollutants of Europe-wide importance. Therefore, the assessment of chemical status considers the list of priority substances (Directive 2013/39/EU). The pollutants analysed were lead and cadmium in Albania (rather as a routine during the 2013 national sampling campaign than based on evidence) and organochlorine pesticides in Macedonia, which showed elevated concentrations in previous assessments (see Section 7.5.3.2). Persistent organic pollutants (POPs), including organochlorine pesticides, are of global concern because of their toxicity, resistance to degradation, potential for long-term transport and their tendency to accumulate in fatty tissues. The latter renders them likely to bioaccumulate through the food chain.

7.5.3.1 Methods

Sampling

Sampling methods in Albania were similar to those practiced at Lake Ohrid (Section 6.5.3.1). Sediment samples in Macedonia were collected using a van Veen grab at two sampling points only (Oteshevo littoral and Ezerani littoral). Samples were transported and stored (for a maximum of seven days) at 4 °C prior to analysis.

Analysis

In Albania, heavy metals were analysed using Atomic Absorption Spectrometry (AAS). Determination of cadmium was undertaken by traditional flame AAS, while lead was analysed using a graphite furnace AAS. In Macedonia, organochlorine pesticide analysis of sediment samples was conducted by gas chromatography, following solvent extraction. The organochlorine pesticides measured were: gamma-HCH (γ-HCH), Σ-HCH (sum of α-isomer, β-isomer and δ-isomer, endosulfan (total of α and β-endosulfan), DDT and its metabolites (p,p'–DDE, p,p'–DDD and p,p'-DDT).

7.5.3.2 Existing Data and Gaps

Albania

No analyses for specific pollutants in either water or sediment are known to have been undertaken in Albania.

Macedonia

During a three-year period (2000–2002), heavy metals (Cu, Ni, Cr, Fe, Cd, Pb and Mn) were analysed in samples from the following sites:

- River Brajčinska – Concentrations of heavy metals were very low.
- River Kranska – Heavy metal concentrations were very low except for cadmium (during October 2001), which showed elevated yet moderate levels.
- River Golema – Similar results to those obtained for River Kranska, i.e. most metals were present at low concentrations, but with elevated concentrations of Cd, albeit not massively.

DDT derivatives have been identified in the tissue of lake fish. The total DDT content of analysed muscle samples ranged from 11.67 to 13.58 $\mu g.kg^{-1}$ fresh tissue. The average total DDT content of sediment samples was within the range of 2.32 to 4.17 $\mu g.kg^{-1}$ of dry sediment. Higher DDT concentrations were found in tributary sediment samples than in samples from the littoral zone. Unsurprisingly, lowest average total concentrations of DDTs were recorded in water samples and ranged between 0.036 and 0.057 $\mu g.l^{-1}$. However, these concentrations exceed the Environmental Quality Standard (EQS) in Directive 2013/39/EU (annual average total DDT = 0.025 $\mu g.l^{-1}$), so should be of concern.

Greece

A recent assessment of sediment quality in both Micro and Macro Prespa in Greece concluded that heavy metal concentrations were generally within the range of values that are found in non-polluted sites (Maliaka and Smolders 2013). Heavy metals do hence not appear to pose a risk to achieving good chemical status in the southern part of Macro Prespa. The major concern there is eutrophication, which is aggravated by the inflow of nutrient-rich water from Micro Prespa and may locally lead to toxic algal blooms.

7.5.3.3 Results

7.5.3.3.1 Albania

Similar to Lake Ohrid, heavy metal concentrations in lake sediments were ≤ 0.01 $mg.kg^{-1}$ for lead and ≤ 0.001 $mg.kg^{-1}$ for cadmium. These values lie far below the Maximum Approved Values (MAV) of the Dutch list (MvV 2000; see Tab. 5.5.3.3.2-1) and corroborate the results from Greece that heavy metals do not pose a risk to the chemical status of Lake Prespa.

7.5.3.3.2 Macedonia

The content of total DDT in sediment from Ezerani (3.01 µg.kg^{-1} dry sediment) was higher than that estimated for Oteshevo (1.824 µg.kg^{-1} dry sediment). Mean values for the content of total organochlorine pesticides in sediment were 7.860 µg.kg^{-1} dry sediment for Ezerani and 5.646 µg.kg^{-1} dry sediment for Oteshevo. Unfortunately, Directive 2013/39/EU does not contain EQSs for either total DDT or total organochlorine pesticides in sediment, but the results discussed in Section 7.5.3.2 are a cause for concern.

Photo 15. Processing samples for phytoplankton analysis

7.5.4 Biological Elements

The ecological status of water bodies is assessed considering species composition, abundance, dynamics and status of selected aquatic fauna and flora (so-called biological elements) known to respond sensitively to anthropogenic pressures. The assessment uses type-specific reference conditions, i.e. natural or near-natural (undisturbed) conditions, as a benchmark. Depending on the degree of deviation from these reference conditions, the ecological status can be assessed. The main objective of the initial characterisation is to assess the risk of water bodies failing to achieve good ecological status.

Despite extensive investigations of the Macedonian watershed of Lake Prespa in recent years (UNDP 2012), comprehensive transboundary data on the status of the lake itself were missing. Therefore, all four biological elements have been investigated under the current project, notably:

- Phytoplankton
- Other aquatic flora (macrophytes)
- Benthic invertebrate fauna
- Fish fauna

In addition to ordinary phytoplankton analysis, a novel chemotaxonomic method was employed in Albania to assess phytoplankton biomass and composition based on different phytoplankton pigment concentrations and ratios (results shown in Bacu 2014, Volume of Annexes).

7.5.4.1 Phytoplankton

7.5.4.1.1 Methods

Sampling

Samples for phytoplankton investigations and chlorophyll-*a* (and/or other pigments) analyses were taken at four littoral and two pelagic sites in the Macedonian part of Lake Prespa, and at two littoral sites in the Albanian part (Fig. 7.5.4.1.1-1). At all sites, samples were taken from the upper depth stratum (0.5 m), using Niskin water samplers. Samples were preserved immediately upon sampling by the addition of 4 % formaldehyde. At the pelagic site, another sample was collected from 15 m deep.

In Macedonia, samples for phytoplankton and chlorophyll-*a* analysis were collected during July 2013 and April 2014. The second sampling campaign was coordinated between the two countries to ensure comparability of data.

In Albania, chlorophyll-*a* and other pigments were analysed four times (during July and October 2013, February and April 2014). Full phytoplankton analysis there was undertaken only in April 2014.

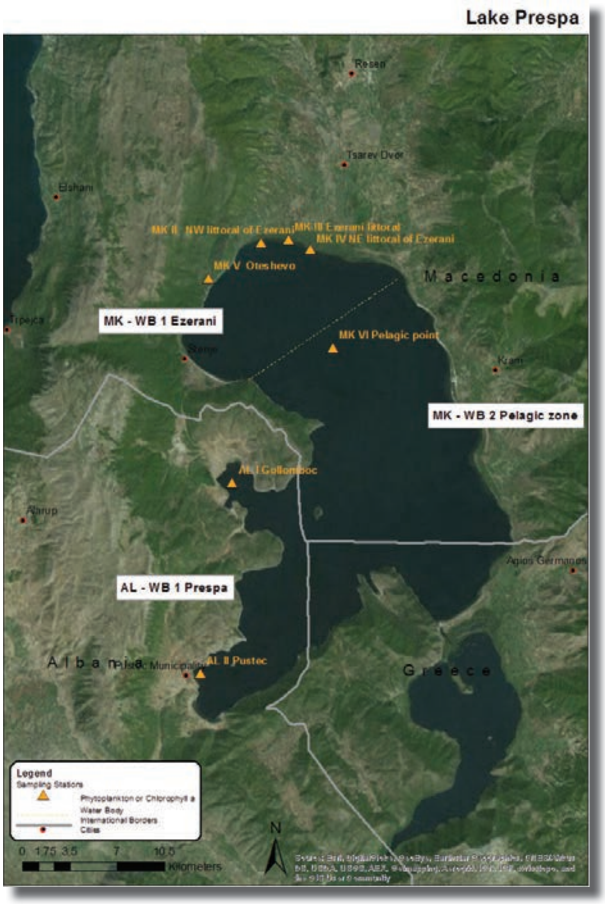

Figure 7.5.4.1.1-1 Sampling stations for phytoplankton and chlorophyll-*a* at Lake Prespa

Analyses

Phytoplankton taxa were identified and quantified according to Utermöhl (1958) using an inverted microscope. For each sample, one low magnification whole chamber count, two intermediate magnification transect counts and 50–100 field of view counts at high magnification (400x) were performed.

Following extraction with 90 % ethanol, chlorophyll-*a* was analysed according to ISO 10260 (ISO 1992). Trophic State Index (TSI) results were calculated according to Carlson (1977).

7.5.4.1.2 Existing Data and Gaps

Phytoplankton investigations started in the early twentieth century and continued irregularly in the second half of the century (e.g. Kozarov 1960, 1972; Mitic 1996, Mitic et al. 1997). The majority of those studies were qualitative in nature, focusing on the production of taxonomic lists, especially of diatoms, rather than abundance.

Pelagic zone

Phytoplankton assemblages of the pelagic zone are rich in species number and surprisingly homogeneous (Levkov et al. 2006). Dominant species in winter and spring are *Cyclotella ocellata, Diploneis mauleri, Stephanodiscus rotula, Camplylodiscus noricus* and *Nitzschia subacicularis* while *Navicula rotunda, N. subrotundata* and species of *Pseudostaurosira* predominate in summer. Long-term comparative analyses of phytoplankton communities and the trophic state of Lakes Ohrid and Prespa were conducted after the turn of the millennium (Patceva 2005). These studies included qualitative and quantitative analyses of the taxonomic composition of phytoplankton communities and chlorophyll-*a* content in the pelagic zone, as well as the correlation of these parameters with nutrient concentrations (phosphorus and nitrogen). They found significant changes in phytoplankton composition owing to eutrophication (Patceva and Mitic 2006).

Littoral zone

In-depth analyses of phytoplankton assemblages of the littoral zone, which is particularly prone to eutrophication, are still lacking. Diatoms such as *Cavinula scutelloides*, *Navicula rotunda, N. subrotundata, Cymatopleura elliptica* and *Amphora pediculus* are frequent in the littoral benthic communities, while *Cyclotella ocellata* and *Diploneis mauleri* are dominant at deeper strata. The occurrence of species of *Aulacoseira* in lake sediments indicates a significant increase of nutrients in the ecosystem.

Two cyanobacteria (*Anabaena affinis* and *A. contorta*), may cause algal blooms between May and September when they become dominant particularly over diatoms of the genus *Cyclotella*. Overall, the diversity of phytoplankton assemblages is high and indicative of mesotrophic conditions.

7.5.4.1.3 Results

This section provides a synthesis of the main findings of phytoplankton and chlorophyll-*a* investigations conducted in Albania (2013 and 2014) and Macedonia (2013), respectively. For further details, see Bacu (2014), Patceva (2014) and Rakaj (2014) in the Volume of Annexes.

7.5.4.1.3.1 Albania

Phytoplankton abundance and composition

In spring 2014, diatoms were by far the most abundant and species-rich group, comprising about 57 % of all algal cells and 60 % of the 30 species identified. Dinophytes (dinoflagellates) and chrysophytes (golden algae) were the second and third most abundant groups, respectively. *Cyclotella ocellata* and *Gymnodinium mirabile* were the most abundant species, comprising 80 % of all algal cells. However, overall abundance was low, ranging from 2.3×10^4 to 2.7×10^4 cells.l^{-1} at Gollomboc and Pustec, respectively.

Trophic state

The TSI (based on chlorophyll-*a*) indicated oligotrophic to mesotrophic conditions at Gollomboc and predominantly mesotrophic conditions at Pustec (Tab. 7.5.4.1.3.1-1). At both sampling stations, TSI values were highest in autumn, i.e. after the peak of the growing season, and lowest in spring. The predominance of mesotrophic conditions was also supported by TSI (based on transparency) values of >40 (Rakaj 2014, Volume of Annexes).

7.5.4.1.3.2 Macedonia

Results obtained for the Macedonian part of the lake – though based on a more limited temporal sampling scheme for chlorophyll-*a* – largely confirm those for Albania (see Patceva 2014, Volume of Annexes, for details).

Phytoplankton abundance and composition

Phytoplankton species identified during the spring and summer sampling campaigns belonged to six divisions: Cyanophyta, Bacillariophyta, Chlorophyta, Chrysophyta, Pyrrophyta and Euglenophyta. The overall composition as well as spatial and temporal distribution was typical of mesotrophic lakes. The number of species was highest at Ezerani littoral in July and lowest in the pelagic zone and at Ezerani

Table 7.5.4.1.3.1-1 **Trophic state of Lake Prespa (Albanian part) in July/October 2013 and February/April 2014, according to the Trophic State Index** (Carlson 1977)

Sampling station	Season	TSI	Trophic state
Gollomboc	Summer	39	Oligotrophic
	Autumn	47	Mesotrophic
	Winter	41	Mesotrophic
	Spring	34	Oligotrophic
Pustec	Summer	42	Mesotrophic
	Autumn	48	Mesotrophic
	Winter	41	Mesotrophic
	Spring	35	Oligotrophic

NW in April. Phytoplankton of the pelagic zone at 15 m depth showed low species diversity owing to the predominance of *Cyclotella ocellata,* which accounted for 98 % of the total abundance.

Trophic state

Chlorophyll-*a* concentrations were generally higher in summer than in spring except for the 15 m depth layer where the reverse was true. Concentrations ranged between 2.32 and 5.43 $\mu g.l^{-1}$. The observed seasonal pattern is typical of mesotrophic lakes from the temperate zone. Differences in chlorophyll-*a* concentration among the littoral and the pelagic zones were low. TSI results (based on chlorophyll-*a*) indicated predominantly mesotrophic conditions at all sites and during all seasons (Tab. 7.5.4.1.3.2-1).

Table 7.5.4.1.3.2-1 **Trophic state of the littoral and pelagic zones of Lake Prespa (Macedonian part) in April and July 2013**

Sampling site	Season	TSI	Trophic state
Littoral zone			
Ezerani NE	Spring	43	Mesotrophic
	Summer	46	Mesotrophic
Ezerani littoral	Spring	41	Mesotrophic
	Summer	44	Mesotrophic
Ezerani NW	Spring	39	Oligotrophic
	Summer	47	Mesotrophic
Oteshevo	Spring	39	Oligotrophic
	Summer	44	Mesotrophic
Pelagic zone			
Surface level (0.5 m depth)	Spring	41	Mesotrophic
	Summer	47	Mesotrophic
15 m depth	Spring	47	Mesotrophic
	Summer	39	Oligotrophic

Samples were generally taken at surface level. However, the pelagic zone was also sampled at 15 m depth.

7.5.4.2 *Macrophytes*

The macrophyte vegetation of lakes shows a distinct vertical zonation. Emergent and floating plants grow in shallow water close to the shore while submerged macrophytes grow at greater depth. Over recent decades, the water level of Lake Prespa has declined by several metres owing to anthropogenic pressures. This has had a dramatic effect on the distribution and composition of macrophyte communities and on the trophic state of the lake.

7.5.4.2.1 Methods

Macrophyte investigations and sampling was carried out at six sites, four in the Macedonian and two in the Albanian part of the lake (Tab & Fig. 7.5.4.2.1-1). The sites corresponded to the littoral sampling stations for chemical and other biological analyses (Section 7.5.1). In Macedonia, an additional site was established at the inlet of River Golema (not shown on the map) for comparative purposes.

Table 7.5.4.2.1-1 Lake Prespa monitoring stations for macrophyte community composition and assessment

Macedonia	Albania
Water body 1: Ezerani (northern part of the lake)	Water body 1: Albanian part of the lake
• MK II NW (North-west) Ezerani littoral	• AL I Gollomboc
• MK III Ezerani littoral	• AL II Pustec (Liqenas)
• MK IV NE (North-east) Ezerani	
• MK V Oteshevo	

Field Sampling

Macrophytes were sampled during the period of maximum growth (July–August 2013) along belt transects according to the WISER method (WISER 2012). Specimens were collected using a double-sided rake attached to a rope marked with depth readings. Ten samples were taken at each one-meter depth stratum from the shoreline to the maximum depth of plant growth. The abundance was estimated using a five-point scale (Melzer 1999) ranging from 1 (very rare) to 5 (abundant or predominant). Site characteristics such as vegetation structure or the type of sediments were recorded at each sampling point.

Data analysis

All macrophytes were identified to species level using appropriate keys. The catalogue of indicator groups of Melzer and Schneider (2001) was consulted to derive indicator values for identified species and to calculate the Macrophyte Index (MI) according to Melzer (1999). The index reflects the nutrient status of lakes and was used as an indicator of ecological status. Only species listed by Melzer and Schneider were considered.

River Golema

Macrophyte sampling and analytical methods for River Golema are explained in Talevska and Trajanovska (2014, Volume of Annexes).

7.5.4.2.2 Existing Data and Gaps

The first studies of vegetation in Lake Prespa were conducted at the beginning of the 20th century (Petkoff 1910, Doflein 1921). However, only few data were collected over the remainder of the century. Micevski (1969) provided the first comprehensive overview of floating and submerged aquatic flora. This study forms the basis for subsequent comparative studies, which were done mainly in the new millennium (e.g., Matevski 2006, 2009; Talevska 2001, 2013). Some monitoring was performed within the framework of Technical Assistance projects such as the pilot application of the "Transboundary Monitoring System for the Prespa Park" which took place in 2010, focusing among others on aquatic vegetation. The present study is the first systematic attempt to use macrophytes as a biological element to assess the ecological status of Lake Prespa in both Albania and Macedonia.

For the calculation of the Macrophyte Index (MI), the indicator groups described by Melzer and Schneider (2001) for central European lakes are used in the present study. However, several species recorded at Lake Prespa are not included in this list, i.e. no indicator values have been assigned to them yet. An amended list should be prepared in the future to include species of Lake Prespa and other lakes of the Western Balkans that are relevant as indicators of trophic state. The overall number of transects studied so far may be to too small to draw representative conclusions for the entire lake. More research will be needed to validate and consolidate preliminary results from the present study.

7.5.4.2.3 Results

This chapter provides a synthesis of the main findings of the macrophyte investigations conducted in 2013. For further details, the reader is referred to Kashta and Rakaj (2014, Volume of Annexes) for the Albanian part of Lake Prespa and Talevska and Trajanovska (2014, Volume of Annexes) for the Macedonian part.

7.5.4.2.3.1 Albania

Macrophyte community composition

Twenty-eight macrophyte species were recorded at the two sampling stations, 20 in Gollomboc and 23 in Pustec. Of these, twelve are listed as macrophyte indicators according to Melzer and Schneider (2001). These species were used to calculate the MI. The most commonly encountered ones were rigid hornwort (*Ceratophyllum demersum*), an indicator of eutrophic conditions, and Eurasian water milfoil (*Myriophyllum spicatum*), an indicator of mesotrophic conditions. These species had an abundance value of 3 (common). The maximum depth of plant growth recorded at both sites was 5.8 m.

Nutrient enrichment and trophic state

The MI (average of all depth strata) was 3.85 at Gollomboc and 3.90 at Pustec, indicating high to very high nutrient enrichment and eutrophic conditions at both sites (Table 7.5.4.2.3.1-1).

Table 7.5.4.2.3.1-1 **Macrophyte Index (MI) and corresponding levels of nutrient enrichment and trophic state at Lake Prespa (Albanian part) in summer 2013**

Sampling station	MI score	Nutrient enrichment	Trophic state
Gollomboc	3.85	High	Eutrophic (level 2)
Pustec	3.90	Very high	Eutrophic (level 3)

Values are the mean of different depth strata. The threshold for very high nutrient enrichment is MI ≥ 3.90.

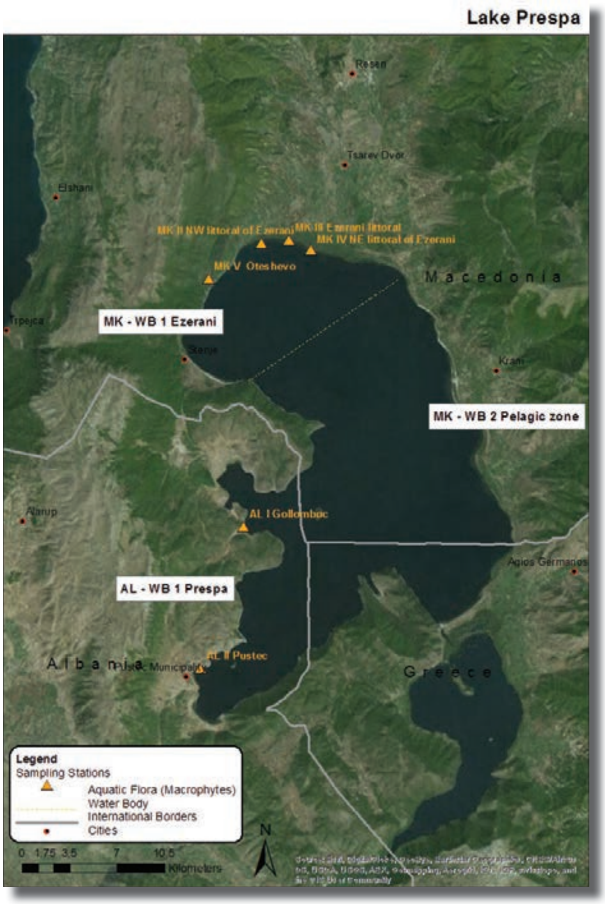

Figure 7.5.4.2.1-1 Sampling stations for macrophyte investigations at Lake Prespa
Samples were taken along transects perpendicular to the shoreline.

7.5.4.2.3.2 Macedonia

Macrophyte community composition

Twenty-one macrophyte species were found in the littoral zone of Lake Prespa and the River Golema inlet. Species indicating eutrophication such as rigid hornwort or fan-leaved water-crowfoot (*Ranunculus circinatus*) were common, as well as various pondweed (*Potamogeton*) species. Contrary to Albania, charophytes, which are associated mainly with clear waters, were not found.

Nutrient enrichment and trophic state

The mean MI for the littoral sites varied between 3.39 and 3.46 (Table 7.5.4.2.3.2-1). These levels were lower than those found in Albania, but still indicative of eutrophic conditions (level 1). The highest individual MIs were recorded at 4–5 m depth, ranging from 3.49 (Ezerani) to 4.26 (Oteshevo).

Table 7.5.4.2.3.2-1 **Macrophyte Index (MI) score, with corresponding levels of nutrient enrichment and trophic state at Lake Prespa (Macedonian part) in summer 2013**

Sampling station	MI score	Nutrient enrichment	Trophic state
NW Ezerani	3.39	Elevated	Eutrophic (level 1)
Ezerani	3.45	Elevated	Eutrophic (level 1)
NE Ezerani	3.45	Elevated	Eutrophic (level 1)
Oteshevo	3.46	Elevated	Eutrophic (level 1)

7.5.4.3 Macroinvertebrates

7.5.4.3.1 Methods

Macroinvertebrates were studied at four littoral sites in Macedonia and two littoral sites in Albania (Tab & Fig. 7.5.4.3.1-1). Another two sites were sampled at River Golema, the main tributary of Lake Prespa in Macedonia.

Field Sampling

Macroinvertebrates in Macedonia were sampled in May 2013 (spring) and again in October 2013 (autumn). Corresponding sampling periods in Albania were October 2013 and May 2014[10]. A multi-habitat transect-line method was applied to collect macroinvertebrates in the littoral zone, using a van Veen grab. At least three replicate samples were taken at each sampling point and depth. Each transect comprised between three and five different depths, depending on the depth limit of macrophyte growth. Transects were oriented perpendicular to the shoreline, with sampling starting from the shore towards deeper water. Shallow parts (0.5 m depth) were sampled according to hand-net sampling guideline EN 27828: 1994.

The River Golema was sampled using an ISO kick-and-sweep method. For further details, see Trajanovski (2014, Volume of Annexes).

10 Results not available at the time of printing.

Data analysis

The Average Score per Taxon (ASPT) was used as a metric to assess the status of the lake with regard to organic pollution. The ASPT is based on the BMWP index/score, a procedure for measuring water quality using macroinvertebrate sensitivities (tolerance scores) to pollutants, ranging from 1.0 (low sensitivity, e.g. some leeches) to 10.0 (highly sensitive stoneflies and mayflies). The ASPT equals the average of the tolerance scores of all macroinvertebrate families found at a given site.

For the lake tributary, the Biotic Index (or modified Irish Biotic Index (IBI) according to [Cheshmedziev 2011]) was calculated. The IBI is widely used in Europe. It is calculated by assigning pollution tolerance scores to different types of macroinvertebrates, ranging from 1.0 (bad) to 5.0 (high) water quality.

Table 7.5.4.3.1-1 **Lake Prespa monitoring stations for macroinvertebrate community composition and assessment**

Macedonia	Albania
Water body 1: Ezerani (northern part of the lake) • MK II NW (North-west) Ezerani littoral • MK III Ezerani littoral • MK IV NE (North-east) Ezerani • MK V Oteshevo River Golema • Golema I (upstream) • Golema II (downstream)	Water body 1: Albanian part of the lake • AL I Gollomboc • AL II Pustec (Liqenas)

Photo 16. Sampling macroinvertebrates

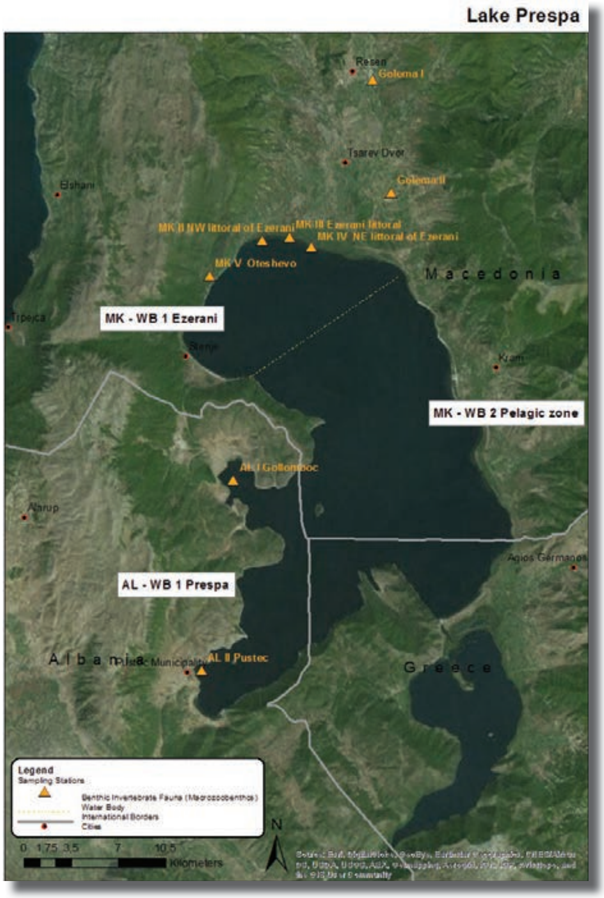

Figure 7.5.4.3.1-1 Sampling stations for macroinvertebrate investigations at Lake Prespa

7.5.4.3.2 Existing Data and Gaps

Unlike Lake Ohrid, the benthic fauna of Lake Prespa has not been subjected to in-depth research yet. Most data were collected in the 1960s, focusing on individual taxa rather than the entire macroinvertebrate fauna. The earliest research dates back to the 1930s, focusing on leeches (Augener 1929) and aquatic worms (Hrabe 1941). Comprehensive studies of macroinvertebrate communities were first published by Tocko (1971) and later by Angelovski et al. (1994). A more recent study focused on aquatic gastropods (Stanković-Jovanović and Stojkoska 2001). This study confirmed the existence of seven endemic species in Lake Prespa.

The benthic fauna was also considered in the Country State Report for the Biodiversity of the Republic of Macedonia (2006) and the National Fishery Plan for Lake Prespa prepared by the Hydrobiological Institute Ohrid in 2008. Extensive research was conducted specifically for WFD implementation in the framework of the Integrated Ecosystem Management in the Prespa Lake Basin project implemented by UNDP. The main outcome of this project was the initial characterisation of the Macedonian watershed and a full-fledged watershed management plan (UNDP 2012). However, the focus of the monitoring and management was on the lake tributaries, which have been divided into 16 separate water bodies, while the Macedonian territory of Macro Prespa was considered as one single water body. The study concluded mainly bad to moderate ecological status for rivers and moderate status for Lake Prespa.

However, these preliminary status assessments need to be corroborated and validated through longer-term monitoring of macroinvertebrates and possibly other biological elements. Monitoring should be extended from the littoral to the sub-littoral and profundal zone. Furthermore, indicator values of endemic species must be defined to derive more accurate organic enrichment metrics and to define reference conditions for macroinvertebrates. To get a more realistic picture of the ecological status, the number of sampling stations from different parts of the lake including Albania should be increased and anthropogenic pressures as well as lake hydromorphology established since macroinvertebrates are known to respond very sensitively not only to pollution but also to hydromorphological modifications.

7.5.4.3.3 Results

This section provides a synthesis of the main findings of macroinvertebrate investigations conducted at selected lake tributaries and the lake under the present project. For further information on the Albanian or the Macedonian part of the lake, see Sajmir (2014) and Trajanovski (2014) in the Volume of Annexes.

7.5.4.3.3.1 Albania

During autumn 2013, both Albanian sites of the lake littoral showed bad ecological status (Tab. 7.5.4.3.3.1-1). ASPT values amounted to 3.6 and 3.4, respectively, for Gollomboc and Pustec. Species richness and abundance were also low, indicating stressed conditions. The results suggest that macrozoobenthos at Lake Prespa is adversely affected by anoxic conditions resulting from eutrophication. Preliminary results from the spring sampling campaign in 2014 showed a slight recovery during winter (Sajmir 2014, Volume of Annexes). However, overall conditions remained poor or bad, depending on water depth.

Table 7.5.4.3.3.1-1 Ecological status of the littoral zone of the Albanian part of Lake Prespa based on the Average Score per Taxon (ASPT) metric

Sampling site	Season	ASPT	Ecological status
Gollomboc	Autumn	3.6	Bad
Pustec	Autumn	3.4	Bad

ASPT ≤ 3.6 indicates bad status. ASPT > 4.8 indicates good status (not achieved at any site)

7.5.4.3.3.2 Macedonia

River Golema

Only three pollution-tolerant invertebrate species were registered at the middle course of River Golema, two dipterans (chironomids) and one aquatic worm (oligochaetes). The IBI varied between 1.0 (spring) and 2.0 (autumn), indicating bad and poor ecological status, respectively. Species diversity was higher at the inflow into the lake (8 species in total), with midges (*Chironomus plumosus*) dominating in spring and aquatic worms (*Pothamothryx hammoniensis*) dominating in autumn. Similar to the middle course, the IBI ranged between 1.0 and 2.0 in spring and autumn, respectively, which corresponds to bad and poor ecological status.

Littoral zone

Species numbers ranged between 6 at Oteshevo in spring and 13 at the same location in autumn. The Balkan endemic mussel *Dreissena presbensis* was the most abundant species at Oteshevo and north-western Ezerani, while pollution-tolerant midges and oligochaetes dominated at Ezerani. The latter were also abundant at north-eastern Ezerani, though at lower densities. This site was characterised by a predominance of *Dreissena presbensis* and an elevated diversity of snails (gastropods).

The ASPT index ranged between 2.6 at Ezerani and 3.8 at Oteshevo in spring (Tab. 7.5.4.3.3.2-1). ASPT values of 3.6 or less generally indicate very poor conditions with regards to organic pollution (bad in WFD terminology). Oteshevo was the only site scoring slightly better (poor), though only in spring. Overall, and despite the reference status remaining to be defined, there was overwhelming evidence of seriously degraded ecological status of the littoral zone of the Macedonian part of Lake Prespa during both seasons.

7.5.4.4 Fish

7.5.4.4.1 Methods

The assessment of the Lake Prespa fish fauna is based on two multimesh sampling campaigns according to European standard EN 14757:2006 (now replaced by SS-EN 14757:2015).

Multimesh gillnetting (MMG) was conducted in autumn 2013 and 2014. The standard was modified according to the lake's characteristics, resulting in the sampling of 6 (2013) and 7 (2014) sub-basins, respectively (Fig. 7.5.4.4.1-1). In autumn of 2013, a total of 128 benthic nets were set (i.e. 64 per country), while in the following year 64 nets were used in the Albanian part of the lake and 136 nets (120 benthic plus 16 pelagic) were set on the Macedonian side.

7.5.4.4.2 Existing data and gaps

In the literature, there is some information on fish species residing in the Prespa lakes. Currently, there are 13 native and 7 alien species present. In addition, the introduction of another five non-native species

Photo 17. Multimesh gillnetting

Table 7.5.4.3.3.2-1 **Ecological status of the littoral zone of the Macedonian part of Lake Prespa based on the Average Score per Taxon (ASPT) index**

Sampling station	Season	ASPT	Ecological status
Oteshevo	Spring	3.8	Poor
	Autumn	3.0	Bad
Ezerani NW	Spring	3.0	Bad
	Autumn	2.8	Bad
Ezerani	Spring	2.6	Bad
	Autumn	3.4	Bad
Ezerani NE	Spring	3.2	Bad
	Autumn	3.1	Bad

ASPT ≤ 3.6 indicates bad status. ASPT > 4.8 indicates good status (not achieved at any site) has been reported but those species seem not to have established self-sustaining stocks in the lake. Out of 14 fish species known, 8 are endemic: Prespa spirlin, Prespa bleak, Prespa barbel, Prespa nase, Prespa minnow, Prespa roach, Prespa trout and Prespa chub. According to Crivelli et al. (1997), however, the taxonomic position of a number of fish species from lake Prespa is doubtful. Two of the endemic species (Prespa barbel, Prespa trout) are classified as vulnerable on the IUCN Red List of threatened animals.

The basic biology, physiological and habitat requirements of the respective species, as well as general population threats are known (Spirkovski et al. 2012). Information on fish stock developments in the Albanian and/or Macedonian lake territories can be derived for some species from samplings and catch statistics up to the year 2006. However, more recent data on fish stock developments are missing. Just a few data from a recent sampling campaign are available for the Greek part of the lake.

Further information is needed to derive index-based conclusions on the ecological state of Prespa Lake using the biological quality element fish. Specifically, selection of metrics indicating different kinds of anthropogenic pressures on the fish community of the lake, class boundaries for ecological status, and derivation of Ecological Quality Ratios (EQRs) are still lacking.

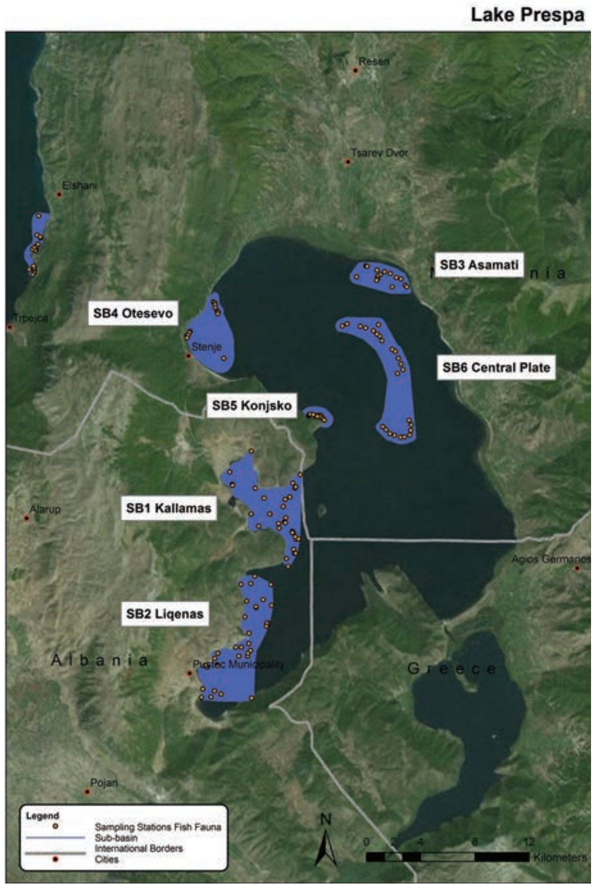

Figure 7.5.4.4.1-1 Fish sampling sites in Lake Prespa during 2013
Circles show the sites sampled. Sampling sites in 2014 (not shown on map) covered larger areas in both countries.

7.5.4.4.3 Results

7.5.4.4.3.1 Albania

In the Albanian part of Lake Prespa, a total of 15 species were caught (Tab. 7.5.4.4.3.1-1). In terms of numbers, the most abundant species in the catches were bitterling (*R. amarus*) and stone moroko (*P. parva*), both of which are non-indigenous fish. Together with the non-indigenous pumpkinseed (*L. gibbosus*), these three neozoa constitute a significant part in terms of biomass indicating a substantial change in the lake's ecological state. For further information, see Tab. 7.5.4.4.3.1-1 and Ilik-Boeva and Shumka (2014, Volume of Annexes).

Table 7.5.4.4.3.1-1 Relative abundance (RA) of fish species sampled in 2013 and 2014

(Data from both countries pooled)

Native Species	RA 2013	RA 2014	Introduced Species	RA 2013	RA 2014
Cyprinidae			Cyprinidae		
Prespa bleak (*Alburnus belvica*)	2	3	Prussian carp (*Carassius gibelio*)	1	1
Prespa spirlin (*Alburnoides prespensis*)	2	3	Stone moroko (*Pseudorasbora parva*)	3	3
Prespa barbel (*Barbus prespensis*)	1	1	Bitterling (*Rhodeus armarus*)	3	3
Carp (*Cyprinus carpio*)	1	1	Tench (*Tinca tinca*)	1	1
Prespa nase (*Chondrostoma prespensis*)	1	1	Centrarchidae		
Prespa minnow (*Pelasgus prespensis*)	1	1	Pumpkinseed (*Lepomis gibbosus*)	1	1
Prespa chub (*Squalius prespensis*)	1	1			
Prespa roach (*Rutilus prespensis*)	2	2			
Salmonidae					
Prespa trout (*Salmo peristericus*)	1	0			
Cobitidae					
Prespa spined loach (*Cobitis meridionalis*)	1	1			

0 = absent; 1 = rare; 2 = frequent; 3 = abundant

7.5.4.4.3.2 Macedonia

During the multimesh gillnet sampling campaign, 13 fish species were caught at the Macedonian part of Lake Prespa, of which 4 are introduced. In terms of both abundance and biomass, neozoic fish constituted a significant part (up to over 60 %) of the catch, though differences in species composition existed between years. For further information, see Tab. 7.5.4.4.3.1-1 and Ilik-Boeva and Shumka (2014, Volume of Annexes).

7.6 Impact and Risk of Water Bodies Failing to Meet Environmental Objectives

The assessment of the risk of water bodies failing to meet the environmental objectives set was jointly conducted by the Technical Working Group – WFD. It used available data emerging from previous studies and those conducted under the current project as well as expert knowledge and background information on prevailing impacts and pressures in the respective sub-basins. An overview of the elements used to assess the ecological status of surface water bodies is given in Fig. 5.6-1 (Section 5.6).

7.6.1 Chemical and Physico-Chemical Elements

7.6.1.1 Albania

Higher concentrations of nutrients, BOD_5 and COD are thought to be caused mainly by the discharge of untreated or insufficiently treated waste water into the lake and its tributaries from the Macedonian sub-catchment. However, no source apportionment modelling of these pollutants has been undertaken, so firm conclusions cannot be drawn. A higher degree of littoral nutrient/organic enrichment than that experienced in the deeper central part of the lake is usually an indicator of the pollution originating from more localised sources.

The results of the monitoring undertaken need to be validated by comparison with future monitoring results.

7.6.1.2 Macedonia

All parameters investigated indicate that Lake Prespa is undergoing eutrophication. Besides the increased phosphorus levels, the water level has lowered. Changes in the volume of the lake have a direct effect on the concentration of dissolved nutrients, since there is a reduced level of dilution for the loads entering the lake. The influence of river inflows (most notably the River Golema), expressed in the lake littoral, are a danger to waters of the pelagic zone as well, but these are not as heavily impacted, yet. Nutrient enrichment as a result of the River Golema input results in mesotrophic-eutrophic conditions in the receiving littoral area.

During the summer period at 15 m depth (the bottom of the lake) the concentration of dissolved oxygen was extremely low (anoxia), and the concentration of phosphorus was so high (>87 mg $TP.l^{-1}$) that it suggests contamination of the sample by particulate matter resuspended from the sediment. Generally, more values for concentration of total phosphorus during the investigated period belong to mesotrophic state: Ezerani littoral, Ezerani littoral NW, Ezerani littoral NE, Oteshevo littoral, pelagic zone 0.5 and 15 m depth (according to the OECD fixed boundary lake classification scheme).

According to Carlson's Trophic State Index (TSI) values, calculated from total phosphorus and Secchi depth results, the pelagic zone is mesotrophic, veering towards eutrophic.

The TSI for the littoral zone of Lake Prespa indicate meso-eutrophic conditions. According to OECD classification of water, values for TP belong to meso-eutrophic state and hyper-eutrophic state for water from WWTP and River Golema middle course.

The detected concentrations for organochlorine pesticides at sediment samples are a cause for concern.

7.6.2 Biological Elements

7.6.2.1 Albania

The phytoplankton community suggests oligo-trophic to mesotrophic conditions. This may not be so far from reference conditions. However, the presence of large and filamentous forms of phytoplankton as well as high Macrophyte Index values leave no doubt that eutrophication has widely taken place beyond natural levels owing to anthropogenic inputs of organic matter and nutrients. The poor status of benthic macroinvertebrates in the littoral zone, which are negatively affected by low oxygen status in summer, indicates that the objective of good ecological status (Tab. 7.6.2.1-1) is likely to fail to be achieved for this quality element as well. This conclusion was further corroborated by results for the biological element fish, which revealed the abundance and predominance of non-native species in both countries.

Table 7.6.2.1-1 **Risk of water bodies of Lake Prespa of failing to meet the objective of good ecological status, based on four biological quality elements**

Water body	Individual assessment				Overall assessment
	Phytoplankton	Macrophytes	Benthic fauna	Fish fauna	
AL – WB1	● (yellow)	● (red)	● (red)	● (yellow)	At risk
MK – WB1	● (yellow)	● (red)	● (red)	● (yellow)	At risk
MK – WB2	● (yellow)	Not assessed	Not assessed	● (yellow)	Probably at risk

Green = not at risk, yellow = probably and/or locally at risk, red = at risk.
AL – WB1 = Albanian water body, MK – WB1 and WB2 = Macedonian water body.
'Probably at risk' is not a risk assessment category foreseen in the WFD but has been used in ountries such as the UK if available data were considered insufficient to draw firm or final conclusions.

7.6.2.2 Macedonia

The achievement of good ecological status of WB2 in the Macedonian part of the lake is thought to be 'probably at risk' (Tab. 7.6.2.1-1), even though the biological element macrophytes in WB1 indicated a slightly lower degree of nutrient enrichment in Macedonia than in Albania (see Tab. 7.5.4.2.3.1-1 vs. Tab. 7.5.4.2.3.2-1).

Both Macedonian Prespa Lake water bodies are at risk of failing to meet their (ecological) environmental objectives – 'probably' for the pelagic water body (WB2), since no assessment was made of macrophyte/macroinvertebrate communities; but with a more 'definite' risk associated with the littoral (WB1) water body, for which assessments of both macroinvertebrate and macrophyte communities have been made. Even though reference conditions have not been defined, there can be little doubt that marginal areas of the lake are in a degraded state.

A similar conclusion can be reached for the River Golema, which showed bad to poor ecological status according to the biological element macroinvertebrates. This finding confirms results from previous investigations reported by UNDP (2012) and GIZ (2010).

7.6.3 Hydromorphological Elements

No assessment of hydromorphological quality has been undertaken yet. Also, no information is available from earlier investigations.

7.6.4 Surface Water Status and Environmental Objectives Assessment

The degree of nutrient enrichment of Lake Prespa is very high not only in the littoral but also in the pelagic zone. Insufficient sewer systems and waste water treatment, together with intensive agriculture, particularly on the Macedonian side of the border (including vast apple growing areas), lead to eutrophication of the lake. Algal blooms may cause anoxic conditions and death of benthic fauna. Even though type-specific reference conditions remain to be established, it is evident that aquatic flora and fauna deviate considerably from good ecological status (Section 7.6.2). The abundance of non-native species of fish, for example, may be the result of eutrophication, structural degradation of habitats as well as weak fisheries management.

There is no evidence from previous studies that environmental quality standards for priority substances and certain other pollutants set by the WFD are exceeded. However, further investigations are needed regarding the chemical status of Lake Prespa.

While all water bodies of Lake Prespa are at risk of failing to meet the environmental objective of good ecological status, re-establishment of good status seems feasible for most biological elements if nutrient/organic pollution was effectively reduced. Hence, good status should be the environmental objective for all water bodies of the lake.

7.7 Protected Areas

7.7.1 Albania

According to Law № 111/2012 on the integrated management of water resources, the ministry should define protected areas with the aim of water and aquatic ecosystem protection, which are declared later on through a regulation of the Council of Ministers. It is the duty of the NWC and the ministry to draft, manage and update the inventory of protected areas as part of the management plan of them. The latest should be included in the management plan of the respective water basin.

So far, information has not been provided by the ministry but it is believed that conservation-based protected areas are under consideration. The only information obtained refers to areas designated for the protection of habitats or species including Emerald and/or Natura 2000 sites.

Through Decision № 80, Lake Prespa has been declared a National Park, Category II of IUCN. In 2013, through Decision № 489, Macro and Micro Prespa and their surroundings have been declared as a Special Protection Area (SPA) and have been included in the Ramsar list of Wetlands of International Importance. In June 2014, Prespa Lake was declared part of the Transboundary Biosphere Reserve Ohrid-Prespa.

7.7.2 Macedonia

The major part of the Prespa watershed and lakes are currently under protected area status. The National Park of Prespa in Albania, the National Park of Galichica in Macedonia and the National Prespa Park in Greece are geographically linked to form a unified protected area system. However, the management, protection measures, and their enforcement differ in the three countries. Hence, the level of protection differs.

Lake Macro Prespa and the Ezerani Nature Reserve were together designated as a Natural Monument (1997) and Wetland of International Importance (1995) under the Ramsar Convention. The lake has also been designated as an Important Bird Area (IBA); and the shore areas are recognised as Important Plant Areas (IPA).

The Ezerani Nature Reserve (19.16 km^2; Ceroni 2013) was established in 1996. It is a natural wetland extending from the northern shoreline of Lake Prespa, hosting important riparian forest and wet meadows. The area has also been designated as an Emerald site. Through a highly participatory process, an Ezerani Nature Park was designated, with the Municipality of Resen responsible for its management.

The National Park of Pelister is located at the east of Lake Macro Prespa – bordering the Greek National Prespa Park and including part of the Baba Mountain. It currently covers approx. 171 km^2, of which about 64 km^2 falls within the Prespa Lake sub-basin. The park is designated as an Emerald site, Important Plant Area (IPA 029) and Prime Butterfly Area.

The Galichica National Park extends over an area of approx. 250 km^2. About one third of the territory of the park falls within the boundaries of the Prespa sub-basin.

8 Proposed Programmes for the Monitoring of Water Status

According to Article 8 of the WFD, as well national water laws in Albania, Macedonia and Montenegro, water monitoring programmes must be developed and implemented for all river basins. The development of national monitoring programmes is part of the river basin management planning process which requires transboundary cooperation (see Box 11), so there is – as close as possible – a seamless transition between the monitoring undertaken by adjacent countries.

BOX 11. TRANSBOUNDARY COOPERATION UNDER THE WATER FRAMEWORK DIRECTIVE

River basin management planning should be coordinated to the widest possible extent by countries which share common river basins, but this does not necessarily imply that all countries have to employ identical approaches/methodologies. Indeed, the information/data used for river basin characterisation is likely to vary considerably between different countries in the same RBD, e.g. in terms of assessing pressures, impacts and status, as well as estimating costs for economic analyses. Despite this, intercalibration exercises ensure all Member States share a common understanding of 'good ecological status' in qualitative and quantitative terms, which is consistent with the definitions of the WFD. A common understanding of 'good chemical status' is assured by all countries complying with the same environmental quality standards for priority substances and certain other pollutants (Directive 2008/105/EC).

All programmes of measures should be coordinated for the whole of the RBD, where it lies fully within the EU. However, for river basins extending beyond the boundaries of the Community, Member States should endeavour to ensure appropriate coordination with relevant non-Member States.

Of all Community RBDs, the Danube has presented perhaps the greatest challenge in terms of scale (10 % of Continental Europe, covering over 800,000 km^2) and complexity (the most international river basin in the world). The International Commission for the Protection of the Danube River (ICPDR) was originally established in 1998 to implement the Danube River Protection Convention (signed in 1994 by the majority of parties), and comprises the 14 countries sharing over 2,000 km^2 of the Danube RBD[11], together with the European Union. However, in 2000 the contracting parties also nominated the organisation to be the platform for implementation of all transboundary aspects of the WFD, including negotiated measures to enable good status to be reached in all water bodies. At present, 11 of the 19 countries which have territory in the Danube RBD are full EU Member States.

11 Albania and Macedonia, along with Italy, Poland and Switzerland also include relatively small areas of the Danube RBD and cooperate with the ICPDR, though they are not members of the ICPDR itself.

The WFD recognises three major types of monitoring programmes: surveillance, operational and investigative (see below), in addition to groundwater level monitoring and Special Areas monitoring, although the latter can be divided between the surveillance and operational programmes. The three main surface water quality monitoring programmes are outlined below for the lakes and their tributaries, but the importance of water quantity monitoring (not only in terms of groundwater level, but also in terms of river flow as a hydromorphological quality component) need to be considered. The assessment and management of pollutant pressures on lake (and coastal) water body status is usually undertaken in terms of loads, rather than concentrations, for which continuous monitoring of input flows is required.

Water bodies are classified applying a two-category classification scheme for chemical status assessments (good vs. failed) and a five-class scheme for ecological status assessments (Box 4). Monitoring sites and parameters are selected to enable the monitoring of water status at an acceptable level of confidence and precision. Monitoring programmes should be designed in a cost-effective and well-targeted manner.

Surveillance monitoring

Surveillance monitoring provides an assessment of the overall water status within each catchment and sub-catchment within a given river basin district. More specifically, it provides information for:

- supplementing and validating impact assessment procedures
- assessing natural and/or anthropogenic long-term changes

Under surveillance monitoring, hydromorphological and physico-chemical quality elements as well as relevant biological elements are monitored over a period of at least one year. Priority substances according to WFD at risk of being discharged into the river basin or sub-basins must be monitored as well.

Operational monitoring

Operational monitoring serves to establish or confirm the status of water bodies found to be at risk of failing to meet environmental objectives (following initial characterisation). It focuses on parameters or biological elements that are most sensitive to the pressures to which the water bodies are subject. It is undertaken for all water bodies identified as being at risk. The number of monitoring sites needs to be sufficient to assess the magnitude and impact of specified pressures.

Investigative monitoring

If the reasons for failure to meet environmental objectives cannot be elucidated by operational

Photo 18. Launching the ICR in Albania

monitoring, more intensive or additional monitoring may be required. Investigative monitoring is also used to ascertain the magnitude and impacts of accidental pollution. It may also include alarm or early warning monitoring, for example to protect drinking water intakes against accidental pollution.

8.1 Lake Shkodra/Skadar

8.1.1 Surveillance Monitoring

Lake Shkodra/Skadar is a highly vulnerable ecosystem affected by different kinds of anthropogenic pressures, in particular organic pollution from municipal waste water and nutrient inputs from agriculture. Natural changes of the water balance and the dynamics of water exchange are significant characteristics of the lake to be reflected in the design of surveillance monitoring.

Taking the results of the initial characterisation into account, a tentative surveillance monitoring scheme is proposed in Tab. 8.1.1-1. Sampling frequencies and the type of biological elements to be monitored remain to be identified.

It is not foreseen to monitor priority substances and other pollutants under the surveillance monitoring scheme.

Analysis of hydromorphological features is an essential part of surveillance monitoring. Representative sections of the shoreline should be characterised to this end based on recognized and proven typologies.

8.1.2 Operational Monitoring

Additional investigations are necessary to assess the impact of point discharges from waste water treatment plants (mainly Shkodra and Podgorica) and industries (e.g. steel works in Nikšić and aluminium plant in Podgorica) and pollution from diffuse sources (mainly untreated waste water and intensive agriculture). A tentative operational monitoring scheme is proposed in Tab. 8.1.2-1. It encompasses sampling points near the confluences of the main tributaries of the lake in Montenegro and a sampling point for the monitoring of waste water discharges near to the city of Shkodra (which requires a new sampling station AL V_{new}). As with surveillance monitoring, sampling frequencies and the type of biological elements to be monitored remain to be identified.

Table 8.1.1-1 Proposed scheme for surveillance monitoring at Lake Shkodra/Skadar

Proposed sampling station (from inflow to outflow)		Quality element		
Station code	**Station name, WB code and name**	**Biological**	**Physico-chemical**	**Chemical**
MNE Mor_{new}	River Morača (new)	x	x	
MNE I	Kamenik (littoral), WB SL1: Vučko Blato	x	x	
MNE V	Starčevo (littoral), WB SL3: Southwest	x	x	
MNE VI	Centre (pelagic), WB SL4: Pelagic zone	x	x	
AL IV_{new}	Centre (pelagic), WB SL1: AL part of LS	x	x	
AL III	Shiroka (littoral), WB SL1: AL part of LS	x	x	

For the location of already established sampling stations, see Fig. 5.5.1-1.

Table 8.1.2-1 Proposed scheme for operational monitoring at Lake Shkodra/Skadar

Proposed sampling station (from inflow to outflow)		Quality element		
Station code	**Station name, WB code and name**	**Biological**	**Physico-chemical**	**Chemical**
MNE Mor_{new}	River Morača (new)			x
MNE II	Virpazar (littoral), WB SL3: Southwest	x	x	
MNE IV	Podhum (littoral), WB SL2: North	x	x	
AL I	Kaldrun (littoral), WB SL1: AL part of LS	x	x	
AL V_{new}	Shkodra (littoral), WB SL1: AL part of LS	x	x	

For the location of already established sampling stations, see Fig. 5.5.1-1.
At the outlet of the Morača River, sediment samples should be taken for the analysis of phosphorus and specific pollutants.

8.1.3 Investigative Monitoring

Results from the initial characterisation gave no indication for the need to conduct investigative monitoring.

8.2 Lake Ohrid

8.2.1 Surveillance Monitoring

Lake Ohrid is a popular and densely populated tourist destination. The cities of Ohrid, Struga and Pogradec are the social and economic centres of the lake. Owing to its large surface and great depth, the lake has special physical and biological characteristics. The lake is stratified into two distinct layers, the hydrologically dynamic epilimnion (upper layer) and the more static, voluminous hypolimnion (lower layer). The latter forms a sink for mineral and organic matter originating from the catchment area.

The surveillance monitoring scheme proposed for Lake Ohrid (Tab. 8.2.1-1) reflects results of the initial characterisation, the above mentioned peculiarities as well as experiences from other deep lakes in Europe, e.g. Lakes Constance, Leman or Lomond. It includes one site at the main tributary Sateska River and lake sites in the pelagic zone or the littoral near to the outflow.

Water samples should be monitored for organochlorine pesticides. Initially it is proposed that all water bodies be sampled for OCPs rather than just the site where DDT levels exceeded the EU EQS because of the transient nature of aquatic pesticide concentrations.

Analysis of hydromorphological features is an essential part of surveillance monitoring. Representative sections of the shoreline should be characterised to this end, based on recognized and proven typologies.

8.2.2 Operational Monitoring

Additional investigations are necessary to assess the impact of waste water discharges at Pogradec, diffuse pollution resulting from human activities such as tourism, agriculture and – in Albania – mining. In Macedonia, the monitoring should also include the Sateska River, which was diverted to Lake Ohrid in the 1960s, thereby increasing the sediment load. The proposed operational monitoring scheme is summarized in Tab. 8.2.2-1.

Table 8.2.1-1 Proposed scheme for surveillance monitoring at Lake Ohrid

Proposed sampling station		Quality element		
Station code	**Station name, WB code and name**	**Biological**	**Physico-chemical**	**Chemical**
Sat II	River Sateska, mid. course, RS2: Low. Riv. Sat.	x	x	x
MK I	Kalishta (littoral), WB OL1: MK part of LO	x	x	x
MK V	Centre (pelagic), WB OL1: MK part of LO	x	x	x
AL IV$_{new}$	Centre (pelagic), WB OL1: AL part of LO		x	x

For the location of already established sampling stations, see Fig. 6.5.1-1.

Table 8.2.2-1 Proposed scheme for operational monitoring at Lake Ohrid

Proposed sampling station		Quality element		
Station code	**Station name, WB code and name**	**Biological**	**Physico-chemical**	**Chemical**
SAT III	River Sateska, low. course, WB RS1: Low. Riv. Sat.		x	x
MK II	Grashnica (littoral), WB OL1: MK part of LO	x	x	x
MK III	Veli Dab (littoral), WB OL1: MK part of LO	x	x	x
MK V	Centre (pelagic), WB OL1: MK part of LO	x	x	x
AL I	Lin (littoral), WB OL1: AL part of LO		x	x
AL II	Memlisht (littoral), WB OL1: AL part of LO		x	x
AL III	Pogradec (littoral), WB OL1: AL part of LO		x	x
AL V$_{new}$	Outlet Pogradec WWTP, WB OL1: AL part of LO		x	x

For the location of already established sampling stations, see Fig. 6.5.1.-1.

At the south-western part of the lake in Albania, sediment samples should be taken for analysis of specific pollutants from the mining industry. Monitoring of water samples should also be undertaken for organochlorine pesticides.

8.2.3 Investigative Monitoring

Results from the initial characterisation gave no indication for the need to conduct investigative monitoring.

8.3 Lake Prespa

8.3.1 Surveillance Monitoring

Lake Prespa has undergone a dramatic change from oligotrophic to mesotrophic and – in some parts – even eutrophic status. The lake is affected by a range of anthropogenic pressures such as organic waste water, agriculture or water extraction and has seen strong natural changes in the water balance. The surveillance monitoring must be adapted to these traits. Furthermore, the monitoring programme should consider the situation in the Greek part of the lake, including the interaction with Lake Micro Prespa. The proposed surveillance monitoring scheme is depicted in Tab. 8.3.1-1. It includes among others one site at the main tributary River Golema and another one located near to the underground drainage into Lake Ohrid (Oteshevo). It also foresees a new site in the pelagic zone of the Albanian part of the lake.

Sampling stations and parameters should be aligned with those established by the Lake Prespa Restoration Project implemented by UNDP in Macedonia to avoid redundancies and reduce sampling effort.

Analysis of hydromorphological features is an essential part of surveillance monitoring. Representative sections of the shoreline should be characterised to this end based on recognized and proven typologies.

It is not foreseen to monitor priority substances and other pollutants under the surveillance monitoring scheme.

8.3.2 Operational Monitoring

Additional investigations are necessary to assess the impact of point discharges of the waste water treatment plant Ezerani as well as diffuse pollution particularly from discharges of untreated waste water and intensive agriculture. Tab. 8.3.2-1 shows the proposed operational monitoring scheme. Most sampling stations are located at the shallow part of the lake to the North and North-west. As outlined in the previous section, the scheme should be aligned with the sampling scheme of the GEF-UNDP Lake Prespa Restoration Project.

Table 8.3.1-1 Proposed scheme for surveillance monitoring at Lake Prespa

Proposed sampling station		Quality element		
Station code	**Station name, WB code and name**	**Biological**	**Physico-Chemical**	**Chemical**
Golema II	River Golema, WB RG1: River Golema	x		
MK V	Oteshevo (littoral), WB PL1: Ezerani	x	x	
MK VI	Centre (pelagic), WB PL2: Pelagic zone	x	x	
AL I	Gollomboc (littoral), WB PL1: AL part of LP	x	x	
AL III$_{new}$	Centre (pelagic), WB PL1: AL part of LP	x	x	

For the location of already established sampling stations, see Fig. 7.5.1-1.

Table 8.3.2-1 Proposed scheme for operational monitoring at Lake Prespa

Sampling station		Quality element		
Station code	**Station name, WB code and name**	**Biological**	**Physico-Chemical**	**Chemical**
MK III	Ezerani (littoral), WB PL1: Ezerani	x	x	x
MK IV	Northeast (littoral), WB PL1: Ezerani	x	x	x
AL II	Pustec (littoral), WB PL1: AL part of LP	x	x	x

Sampling station locations are shown in Fig. 7.5.1.-1.

Organochlorine pesticide concentrations in the water column should be monitored under the operational monitoring scheme. Sampling/monitoring should also be undertaken to help quantify 'internal' nutrient loads from historically enriched sediments. Notwithstanding the importance of classical organochlorine pesticides such as DDT, analytical capacities should be developed to analyse current use pesticides as well, focusing on active ingredients widely used in Macedonian fruit crops.

8.3.3 Investigative Monitoring

Results from the initial characterisation gave no indication for the need to conduct investigative monitoring.

8.4 Monitoring Frequencies

8.4.1 Biological Quality Elements

The WFD specifies monitoring frequencies of between 6 months and 3 years for individual biological quality elements (Tab. 8.4.1-1).

Macroinvertebrates are usually monitored in spring and autumn, since results from these times of year may be significantly different, and the results combined to increase their certainty.

Macrophytes, however, need to be monitored only once during each monitoring year (often summer when plants are easiest to identify), and always at the same time of year (to reduce variability in abundance).

Monitoring of fish populations depends largely upon the seasonality of migratory fish movements, but the age structure of fish populations is usually assessed in terms of whole years to remove the effects of seasonality from statistical results.

Table 8.4.1-1 Monitoring frequencies for biological quality elements in surface waters according to the WFD

Biological quality element	Rivers	Lakes	Transitional waters	Coastal waters
Phytoplankton	6 monthly	6 monthly	6 monthly	6 monthly
Macrophytes/phytobenthos	3 yearly	3 yearly	3 yearly	3 yearly
Macroinvertebrates	3 yearly	3 yearly	3 yearly	3 yearly
Fish	3 yearly	3 yearly	3 yearly	

However, the high variability in phytoplankton biomass (and chlorophyll-*a* concentration) means that in reality this needs to be monitored more frequently (monthly as a minimum), particularly if trend analysis is to be undertaken on chlorophyll-*a* results. Funding such frequent monitoring is a big commitment, but one which is not required at all sites, nor at all depths. Monitoring should be restricted to the upper layers of the lakes, using either a composite sample from throughout the euphotic zone or a sample from close to the surface. One or two sites per lake should suffice, preferably from the pelagic zone. Data from the high frequency pelagic monitoring sites should be supported by 3-monthly sampling from littoral sites.

For other biological elements, two years is a safer monitoring frequency (than the three stated in the Directive), since this allows for one unusual or erroneous result to occur in each 6-year WFD management cycle, with two more 'natural' results to act as a counterbalance.

8.4.2 Chemical and Physico-Chemical Quality Elements

The WFD requires monthly sampling and analysis of priority substances, which implies considerable effort (see Tab. 8.4.2-1). Nevertheless, this frequency should be endeavoured at selected sites for one year of surveillance monitoring, if possible. A frequency of once per two months (six samples per year) would be a reasonable compromise when resources are limiting. Sampling and analysis of priority substances once per 3 months should be considered a minimum upon evidence of significant sources of pollution.

On the other hand, a monitoring frequency for general conditions of once per 3 months might be too low to capture seasonal variations in water temperature, dissolved oxygen and nutrient concentrations. Higher frequencies would be beneficial, for example, two monthly or, even better, monthly.

Generally, more frequent sampling may be required to determine long-term trends or estimate pollution loads with acceptable levels of confidence and precision.

Table 8.4.2-1 **Monitoring frequencies for chemical and physico-chemical quality elements in surface waters according to the WFD**

Parameter	Rivers	Lakes	Transitional waters	Coastal waters
Thermal conditions	3 monthly	3 monthly	3 monthly	3 monthly
Oxygenation	3 monthly	3 monthly	3 monthly	3 monthly
Salinity	3 monthly	3 monthly	3 monthly	
Nutrient status	3 monthly	3 monthly	3 monthly	3 monthly
Acidification status	3 monthly	3 monthly		
Priority substances	Monthly	Monthly	Monthly	Monthly
Other pollutants	3 monthly	3 monthly	3 monthly	3 monthly

8.4.3 Hydromorphological Quality Elements

With the exception of river flow (which is monitored continuously), hydromorphological assessments need only be made once in every 6-year river basin management planning cycle (Tab. 8.4.3-1). However, monitoring of shallow macroinvertebrate communities as a biological quality element (possibly also aquatic vegetation) will usually involve an assessment of substrate type(s) to ensure that different habitats are monitored on a proportional basis.

8.5 Uncertainty and the Risk of Mis-Classification

Vollenweider and Kerekes (1982) presented alternative trophic status classification systems to those usually referred to as the OECD (fixed boundary) classification scheme, based on the probability of a lake belonging to each trophic status class. Of the three middle classes (oligotrophic, mesotrophic and eutrophic), the maximum probability of any water body being placed in the 'correct' class is 60-70 % (Fig. 8.5-1), whether the classification scheme is based on chlorophyll-*a* or total phosphorus concentration. In the same OECD report, a simple model/linear correlation linking total phosphorus and chlorophyll-*a* concentrations was presented (as has been done by numerous other workers – see Carvalho et al. [2006]), but in the OECD report the confidence limits presented are an order of magnitude apart. This illustrates why there is so much uncertainty in classifying water bodies. The aim of classification is to identify the most probable class for each waterbody in terms of ecology, physico-chemistry and chemistry, but what is actually produced by the classification process is a face-value class (see UK TAG 2013).

The consequences of misclassification under the WFD may be very costly in terms of unnecessary measures having to be implemented or, *vice versa*, in terms of waterbodies failing to be given the level of protection required.

The greater the number of parameters/metrics used to classify a water body, the greater the chance of that water body being classified correctly. This risk of misclassification is understood in the WFD, since it requires that 'estimates of the level of confidence and precision of the results provided by the monitoring programmes' be given in river basin management plans (Annex V, Paragraph 1.3). This has not been attempted for any of the waterbodies covered in this report – there are much more immediate challenges in terms of developing methods and expanding the proposed monitoring programmes to cover all fresh and tidal water bodies in each of the three countries – but this subject will need to be tackled in the future.

Table 8.4.3-1 **Monitoring frequencies for hydromorphological quality elements in surface waters, according to the WFD**

Parameter	Rivers	Lakes	Transitional waters	Coastal waters
Continuity	6 yearly			
Hydrology	Continuously	Monthly		
Morphology	6 yearly	6 yearly	6 yearly	6 yearly

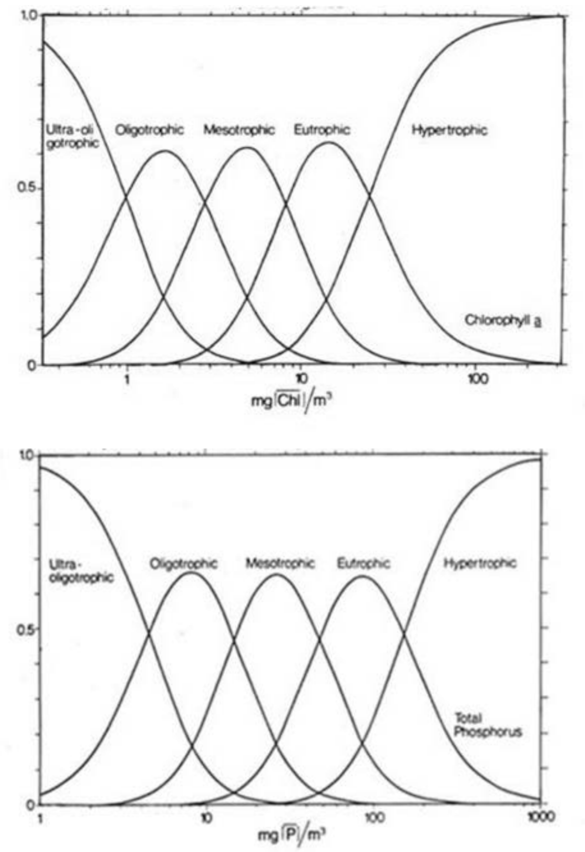

Figure 8.5-1 Probability distribution for trophic categories based on chlorophyll-*a* and total phosphorus concentrations, according to the OECD classification scheme *(Vollenweider and Kerekes 1982)*

9 Summary and Outlook

9.1 Summary

The WFD requires anthropogenic pressures on the water environment to be assessed and managed in an integrated way across all waters. The Directive sets out a planning cycle, which consists of the characterisation of river basin districts, the implementation of environmental monitoring programmes, the setting of environmental objectives and the elaboration of a river basin management plan, including a programme of measures to achieve the environmental objectives (e.g. Irish EPA 2005)

The Drin River Basin extends through Greece, Albania, Macedonia, Kosovo and Montenegro. About 1.5 million people rely on the water resources of the basin for a range of uses, such as drinking water supply, tourism, agriculture, fisheries, industry and hydropower. The Drin River Basin is an interconnected hydrological system comprising the transboundary sub-basins of:

- Lake Prespa
- Lake Ohrid
- Lake Shkodra/Skadar
- Drin River, including its tributaries, the Black Drin and White Drin
- Morača River
- Buna/Bojana River (outflow of Lake Shkodra/Skadar to the Adriatic Sea)

Within the CSBL project, the sub-basins of Lakes Prespa, Ohrid and Shkodra/Skadar have been characterised according to the requirements of Annex II of the WFD. The initial characterisation has been restricted to surface water bodies of the three lakes and the major tributaries of Lakes Prespa and Ohrid.

On the base of former research and current monitoring programmes, the TWG incorporated biological, physico-chemical and chemical quality elements, to develop a robust WFD-aware programme. Sampling and analytical methods, as well as evaluation procedures were refined and harmonized during transboundary workshops of the TWG to meet the requirements of the WFD.

Supported by experts from universities, research institutions and administrative bodies of all three countries, the TWG divided the lakes and their tributaries into water bodies based on their physical characteristics. Based on the monitoring results obtained, the TWG assessed the pressures and impacts on the water bodies.

To be able to manage and report on the water environment, Lake Prespa has been divided into three, Lake Ohrid into two and Lake Shkodra/Skadar into five water bodies. Furthermore, water-related protected areas (usually designated under other European Directives) have been identified, to ensure they are managed in a way that meets their needs.

A main part of the initial characterisation has been the assessment of pressures and impacts on the water environment. The assessment identified water bodies at risk of failing the environmental objectives set out in the Directive. The results will be used to inform future environmental monitoring and identify those water bodies for which greater protection may be required.

The following point source pressures were examined for their impacts in the three sub-basins:

- Waste water treatment plant at Resen (Lake Prespa, Macedonia)
- Waste water treatment plant at Pogradec (Lake Ohrid, Albania)
- Untreated waste water discharged from Podgorica (Montenegro) into the Morača river as the main tributary of lake Shkodra/Skadar
- Untreated waste water from the city of Shkodra (Albania)

- Smaller point sources of untreated waste and storm water discharges (all countries)

Significant industrial point sources remain to be identified. The main part of industrial waste water is discharged into the public sewer system. Potential sources are landfill sites (solid and sludge waste) and industrial waste disposal sites (steelworks, mines etc.).

Agriculture in the catchment area is the main diffuse source of pollution, especially concerning the use of fertilizers and pesticides. The steeply sloping land in parts of the sub-catchments increases land erosion and causes the discharge of nutrients applied as fertilizer into the lakes. The artificial estuary of the Sateska River (Macedonia) has been responsible for the discharge of nutrient-rich sediments into Lake Ohrid for the last five decades. Furthermore, nutrient loads from housing and touristic sites without sewer system are part of the diffuse pollution.

All of the lakes appear to be suffering to some extent and in some parts at least from eutrophication. While it makes sense that the focus of nutrient control measures from urban areas should be the maintenance and upgrading of the waste water treatment system, alternative solutions should also be looked at. These include the banning of high-phosphorus (STPP-based) detergents. In some European countries, these may contribute up to 40 % of the phosphorus load to sewer.

9.2 Results of the Initial Characterisation

The investigations of the biological quality elements 'phytoplankton' (mainly unicellular algae), 'macrophytes' (emergent, submerged or floating plants) and 'benthic macroinvertebrates' (bottom-dwellers) has shown the harmful impact of excess nutrient supply to all three lakes. Only one water body of Lake Ohrid and Lake Prespa are probably not at risk of failing their environmental objectives. All other water bodies are at risk.

The results of the physico-chemical investigations have confirmed the correlation between the discharge of nutrients (especially phosphorus) and eutrophication especially in Lake Prespa, but also in Lake Shkodra/Skadar.

Further information is needed to derive index-based conclusions on the ecological state of the lakes using the biological quality element fish. It has therefore only tentatively been considered in the assessment of the initial characterization.

Hydromorphological mapping of the lakeshores has never been done in any of the lake riparian countries and could not, hence, be considered in the assessment. Generally, wetland loss and degradation enhance the vulnerability of aquatic ecosystems to adverse impacts such as inputs of nutrients and organic pollutants from surrounding land. Therefore, changes to the shoreline (especially of Lakes Ohrid and Shkodra/Skadar) should be taken into account in future assessments.

An essential conclusion of the initial characterisation is that environmental pressures may be national in origin, yet have a transboundary impact on water status. Transboundary cooperation between national competent authorities and research institutions has improved, joint monitoring programmes have been agreed and information/knowledge swapped. The process also informed the Drin Core Group with which the TWG shares members and expertise.

9.3 Next Steps

Within the CSBL project, it is planned to determine hydromorphological conditions of the lakes. The current state monitoring programmes in the three countries should be supported by and aligned with activities of other donors, such as UNDP[12] and NIVA[13]. Based on existing studies (contaminated land, landfills, industrial sites etc.), specific pollutants and priority substances have to be investigated in water as well as in sediments. Moreover, an economic analysis of all relevant water uses in the sub-basins is necessary.

Establishing type-specific reference conditions for the three lakes remains one of the major challenges to be addressed. This requires a thorough review and assessment of available data, including historic surveys and inventories.

The results of the investigations undertaken for the initial characterisation should be transferred into national data management systems. Cooperation with the IPA (Instrument for Pre-Accession Assistence) project[14] in Macedonia and the Worldbank project[15] in Albania has to be strengthened. Furthermore, the results are essential for the development of the river basin management plan for the wider Drin River Basin, as envisaged by GEF[16].

Finally, a programme of measures as the operational component of the river basin management plan has to be elaborated in each country. Within this process, active involvement of the public is necessary to increase the acceptance of the measures and ensure the achievement of good water status in all three lakes.

12 Restoration of Prespa Lake Ecosystem.
13 Assessment of Ecological Status According to the Water Framework Directive – Intercalibration among Western-Balkan Countries.
14 Technical Assistance for Strengthening the Institutional Capacities for Approximation and Implementation of Environmental Legislation in the Area of Water Management.
15 Water Cadastre in Albania.
16 Enabling Transboundary Cooperation and Integrated Water Resources Management in the Extended Drin River Basin.

10 References

Angelovski P, Sapkarev J, Karaman B, Smiljkov S (1994) Qualitative composition and quantitative relations of the macrozoobenthos from Lake Prespa. Ann Biol Skopje 47: 5–21

Ascherson P, Kanitz A (1877) Catalogus cormophytorum et anthophytorum Serbiae, Bosniae, Hercegovinae, Montis Scodri, Albaniae hucusque cognitorum. Claudiopoli, Typ Nic K Papp, p 108

Augener H (1929) Fauna hirudinea Ohridskog i Prespanskog jezera. Limnoloska ispitivawa Balkanskog poluostrva. Glas SKA 137: 185–186

Baldacci A (1901) Rivista della collezione botanica fatta nel 1897 nell' Albania settentrionale. Mem Accad sci Isti Bologna, ser V t IX

Çakalli M, Bushati D, Ulqini D, Doçaj E (2012) Impact of agricultural activities and related industries on Shkodra/Skadar Lake's pollution. IPA Cross-Border Programme Albania-Montenegro, 2007–2013. Final Report, Tirana

Carlson RE (1977) A trophic state index for lakes. Limnology and Oceanography 22(2): 361–369

Carvalho L, Phillips G, Maberly SC, Clarke R (2006) Chlorophyll and phosphorus classifications for UK lakes. http://nora.nerc.ac.uk/3305/1/WFD38_WP2_Final_report_e_version.pdf. Accessed 13 October 2015

CEED (2006) Social assessment for Skadar Lake. In: Shkoder/Skadar Lake integrated ecosystem management. Centre for Entrepreneurship and Economic Development, University of Montenegro: 41–81

Ceroni M (2013) The economic case for long-term protection of the Ezerani Nature Park. Report for the Integrated Ecosystem Management in the Prespa Lakes Basin project, United National Development Programme, Skopje

Cheshmedjiev S, Soufi R, Vidinova Y, Tyufekchieva V, Yaneva I, Uzunov Y, Varadinova E (2011) Multi-habitat sampling method for benthic macroinvertebrate communities in different river types in Bulgaria. Water Research and Management 1(3): 55–58

Christiansen A, Wathne BM, Schneider SC (2013) Lake Ohrid ENSIS database – Technical Report. Norwegian Institute for Water Research. Report № 6535

Crivelli A, Catsadorakis G, Malakou M, Rosecchi E (1997) Fish and fisheries of the Prespa lakes. Hydrobiologia 351: 107-125.

Doflein F (1921) Mazedonien. Erlebnisse und Beobachtungen eines Naturforschers im Gefolge des Deutschen Heeres. Gustav Fischer Verlag, Jena

EIA (2006) EIA for Montenegrin coastal regional water supply system from Bolje Sestre spring. ITSC Ltd. Montenegro

EIONET GEMET Thesaurus (2012) Water body definition of the European Environmental Agency. http://www.eionet.europa.eu/gemet/concept?cp=9151&langcode=en Accessed 4 September 2015

GIZ (2010) Assessment of the present ecological state of Lake Macro Prespa. Hydrobiological Institute Ohrid, Macedonia

Grimburg CG (1871) Beiträge zur Flora Albaniens. Verhandlungen d.k. Zoologisch-Botanischen Gesellschaft in Wien, Band XXI: 1345–1352

Hrabe S (1941) Zur Kenntnis der Oligochaeten aus der Donau. Acta Societatis Scientarium Naturalium Moraviceae [Moravo-Silesiae] 13(12): 1–36

Irish Environmental Protection Agency (2015) An approach to characterisation as part of implementation of the Water Framework Directive. Version 2, revised

http://www.epa.ie/pubs/reports/water/other/WFD %20Characterisation %20Approach %20 %28May %202015 %29.pdf Accessed June 22 2015 Accessed 22 October 2015

ISO (1992) Water quality – Measurement of biochemical parameters. Spectrometric determination of the chlorophyll-*a* concentration. ISO 10260: 1992

Janchen E (1920) Vorarbeiten zu einer Flora der Umgebung von Škodra in Nord-Albanien. Österr Bot Zeitschr 69(11): 230–261

Kalff J (2002) Limnology: Inland Water Ecosystems. Prentice Hall, Upper Saddle River

Karaman G, Beeton AM (eds) (1981) The biota and limnology of Lake Skadar. Prosveta, Beograd

Kozarov G (1960) Triennial studies of the phytoplankton of Lake Prespa. University St. Kliment Ohridski Bitola, PSI Hydrobiological Institute Ohrid. Review Vol. VIII 4(49): 1–52

Kozarov G (1972) La rapport correlatif entre la lumiere et la repartition du phytoplankton dans lac de Prespa. Verch Inter Verein Limnol 18: 489–493.

Lasca NP, Radulović V, Ristić RJ, Cherkauer DS (1981) Geology, hydrology, climate and bathymetry of Lake Skadar. In: Karaman G, Beeton AM (eds) The biota and limnology of Lake Skadar. Prosveta, Beograd, p 17–38

Levkov Z, Krstic S, Metzeltin D, Nakov T (2006) Diatoms of Lakes Prespa and Ohrid (Macedonia). Iconographia Diatomologica 16. Gantner Verlag, Rugell, Lichtenstein

Malaj E, Rousseau DPL, Du Laing G, Lens PNL (2012) Near-shore distribution of heavy metals in the Albanian part of Lake Ohrid. Environ Monit Assess 184 (4): 1823–1839

Maliaka V, Smolders AJP (2013) Water and sediment quality Prespa Lakes (Greece). B-Ware Research Centre, The Netherlands

Marić D, Milošević D (2011) Catalog of freshwater fishes (Osteichthyes) of Montenegro. Montenegrin Academy of Sciences and Arts. Volume 5, Book 4, Podgorica

Matzinger A, Schmid M, Veljanoska-Sarafiloska E, Patceva S, Guseska D, Wagner B, Müller B, Sturm, M, Wüst

A (2007) Eutrophication of ancient Lake Ohrid: Global warming amplifies detrimental effects of increased nutrient inputs. Limnology and Oceanography 52(1): 338–353

Melzer A (1999) Aquatic macrophytes as tools for lake management. Hydrobiologia 396: 181–190

Melzer A, Schneider S (2001) Submerse Makrophyten als Indikatoren der Nährstoffbelastung in Seen. In: Steinberg C, Calmano W, Klapper H, Wilken R-D (eds) Handbuch angewandte Limnologie. Ecomed Verlagsgesellschaft, Landsberg, Kap VIII-1.2.1: 1–13

Micevski K (1969) Aquatic Vegetation of the Ohrid and Prespa Lake. Acta Museum of Natural History, Skopje, T XI, No 4: 61-80

Mitic V (1985) Influence of the anthropogenic factor on the phytoplankton changes in Lake Ohrid. MASA, Skopje Vol. VI (1-2): 51–54

Mitic V (1993) Seasonal and spatial distribution of the phytoplankton in the pelagic zone of Lake Ohrid. Ecology and Environmental Protection 1(1-2): 7–10

Mitic V (1996) Yearlong investigations of the phytoplankton in the pelagic zone of Lake Prespa. First Conference of Macedonian Biologists, Ohrid

Mitic V, Novevska V, Lokoska L, Naumoski T (1997): Pelagic phytoplankton and primary productivity of Prespa Lake. In: Proceedings Internat Symp "Towards Integrated Conservation and Sustainable Development of Transboundary Macro and Micro Prespa Lake", Korçë, Albania, p 97

MvV (2000) Circular on target values and intervention values for soil remediation. Dutch Target and Intervention Values, 2000 (the New Dutch List). Annexes. Ministerie van Volkshulsvesting, Ruimtelijke Ordeningen Milieubeheer

http://www.esdat.net/Environmental%20Standards/Dutch/annexS_I2000Dutch%20Environmental%20Standards.pdf Accessed 8 April 2015

Neziri A, Gössler W (2006) Determination of heavy metals in water and sediments of Drini river, Buna River and Lake Shkodra. In: International Conference on Water Observation and Information System for Decision Support, Ohrid, Republic of Macedonia

Novevska V, Tasevska O (2009) Preliminary Investigations of mutual relations between the Rotifera and organotrophic Bacteria in Lake Ohrid. BALWOIS 2010

OECD (1982) Eutrophication of waters. Monitoring, assessment and control. Organization for Economic Co-operation and Development, Paris

Patceva S (2001) The phytoplankton and the chlorophyll-*a* as indicators of the trophic state of the water in the littoral and pelagic region of Lake Ohrid. Master Thesis, University St. Kiril and Methodius Skopje, Macedonia (in Macedonian)

Patceva S (2005) Comparative analysis of the phytoplankton community and the trophic state of Lakes Ohrid and Prespa. PhD thesis, University St. Kiril and Methodius, Skopje, Macedonia

Patceva S, Mitic V (2006) Phytoplankton composition of Lake Prespa and its response to eutrophication in the last fifty years. Collection of Papers Devoted to Academic Kiril Micevski: 299–309

Patceva S, Mitic V, Jordanoski M, Veljanoska-Sarafiloska E (2009) Trophic state of Lake Ohrid. J Int Environmental Application and Science 4(3): 310–316

Petcović S (1981) Phytoplankton. In: Karaman G, Beeton AM (eds) The biota and limnology of Lake Skadar. Prosveta, Beograd, p 163–189

Petkoff S (1910) La flore aquatique et algologique de la Macedoine du S.-O. Philippoli. Imprimerie Christo Danoff, Plovdiv

Rakaj M (2008) Phytoplankton and periphyton communities as indicators of trophic state of Lake Shkodra. In: Proceeding of the International Conference on Biological and Environmental Sciences, 26–28 September, FNS, Tirana, Albania, p 568

Rakaj M (2010) Biological water quality of Lake Shkodra based on the diatoms and Cyanobacteria bioindicator species. In: Proceedings of the 4th International Scientific Conference BALWOIS. Ecohydrology and Hydrobiology. Ohrid, Republic of Macedonia, 25–29 May, p 286

Rakočević J (2013) Phytoplankton Protocol – Transboundary Monitoring Program. GIZ CSBL Project (see USB card)

Rakočević-Nedović J, Hollert H (2005) Phytoplankton community and chlorophyll-*a* as trophic state indices of Lake Skadar. Environ Sci Pollut Res 12(3): 146–152

Ristić J, Vizi O (1981) Synoptic survey of the dominant macrophytes in Lake Skadar. In: Karaman G, Beeton AM (eds) The biota and limnology of Lake Skadar. Prosveta, Beograd, p 117–124

Royal Haskoning (2006) Lake Shkoder transboundary diagnostics analysis. Final Report commissioned by the World Bank

Schneider SC, Cara M, Eriksen TE, Goreska BB, Imeri A, Kupe L, Lokoska T, Patceva S, Trajanovska S, Trajanovski S, Talevska M, Veljanoska-Sarafiloska E (2014) Eutrophication impacts littoral biota in Lake Ohrid while water phosphorus concentrations are low. Limnologica (44): 90–97

Schneider S, Melzer A (2003) The trophic index of macrophytes (TIM) – A new tool for indicating trophic state of running waters. International Review of Hydrobiology 88: 49–67

Schütt B (1945) Die Pflanzenwelt von Nordalbanien, des westlichen Montenegro und der westlichen Šar. Manuskript, Übersee-Museum, Bremen

Shehu A, Lazo P (2008) Distribution of heavy metals in different fractions of waters and sediments of Shkodra Lake using electrothermal atomic absorption spectrometry. [Full reference not available during time of printing]

Skarbøvik E, Perovic A, Shumka S, Nagothu US (2014) Nutrient inputs, trophic status and water management challenges in the transbundary lake Skadar/Shkodra, Western Balkans. Arch Biol Sci, Belgrade, 66 (2): 667–681

Spirkovski Z, Ilic-Boeva D, Talevski T, Palluci A, Kapedani E (2012) The fish of Prespa. National and University Library St. Kliment Ohridski, Skopje

Stanković S (1960) The Balkan Lake Ohrid and its living world. W Junk, Den Haag, Monogr Biol 9

Stanković-Jovanović S, Stojkoska E (2001) Diversity of aquatic snail fauna (Gastropoda, Mollusca) in the Republic of Macedonia from the bibliographic date of the hitherto taxonomic investigations. In: 75 years Maced Mus Nat His, Skopje: 125–136

Šundić D, Radujković B (2012) Study on freshwater oligochaeta of Montenegro and their use as indicators in water quality assessment. Natura Montenegrina 11: 117–383

Talevska M (1996) Characters of macrophytic vegetation of Lake Ohrid. Protection from pollution in Lake Ohrid. Unpublished study supported by the Friedrich Ebert Stiftung

Talevska M (2001) Qualitative composition of macrophytic vegetation from Lake Prespa. In: 30th Annual Conference of the Yugoslav Water Pollution Control Society "Water pollution control 2001". Arangelovac, SR Jugoslavija: 213–218

Talevska M (2013) Preliminary researches of aquatic vegetation in reed beds from Lakes Prespa. In: Abstracts of the 5th International Symposium of the Ecologists of the Republic of Montenegro (ISEM5). Tivat, Montenegro: 146–147

Talevska M, Trajanovska S (2004) Lake Ohrid macrophyte vegetation. In: Lakes Ohrid and Prespa monitoring program. 3rd Report, Hydrobiological Institute, Ohrid, Macedonia: 61–69

Tocko M (1971) Makrozoobentosot i ciprinidite na Ohridskoto i Prespanskoto Ezero. Studija za hidrobioloskite karakteristiki na Ohridsko-Prespanskiot region. Hidrobioloski zavod, Ohrid

Trajanovska S, Melovski L, Hristovski S (2004) Determination of biomass in the stoneworts (*Chara* spp.) belt of the Lake Ohrid. In: Proceedings of the II Congress of Ecologists of the Republic of Macedonia with International Participation, Ohrid, Macedonia, 25–29 October 2003. Macedonian Ecological Society, Skopje, Macedonia: 262–267

UKTAG (2005) Classification schemes in river basin planning: an overview. UK Technical Advisory Group on the Water Framework Directive

http://www.wfduk.org/sites/default/files/Media/Characterisation %20of %20the %20water %20environment/Overview %20of %20classification %20schemes %20in %20river %20basin %20planning %20_Final_010705.pdf Accessed 17 May 2015

UKTAG (2007) Recommendations on surface water classification schemes for the purposes of the Water Framework Directive (alien species list updated Oct 2008, Nov 2008, June 2009). UK Technical Advisory Group on the Water Framework Directive http://www.wfduk.org/resources%20/recommendations-surface-water-classification-schemes Accessed 10 September 2015

UKTAG (2013) Method statement for the classification of surface water bodies, v3. (2012 classification release) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/290506/LIT_5769_ed4e2b.pdf Accessed 10 September 2015

UNDP (2008) Economic analysis – Prespa Park Project. Draft Report

UNDP (2012) Prespa Lake watershed management plan. United Nations Development Program, Skopje, Macedonia Accessed 17 May 2015

UNDP (2013) Breaking new grounds in conservation in the Republic of Macedonia: The economic case for long-term protection of the Ezerani Nature Park. Ceroni M

Utermöhl H (1958) Zur Vervollkommnung des quantitativen Phytoplankton – Methodik. Mitteil Int Ver Limnologie: 1–38

Vemic A, Malenovic A, Rakic T, Kostic N, Jancic Stojanovic B (2014) Chemometrical tools in the study of the retention behavior of azole antifungals. Journal of Chromatographic Science 52(2): 95–102. doi: 10.1093

Vemic M, Rousseau D, Du Laing G, Lens P (2014) Distribution and fate of metals in the Montenegrin part of Lake Skadar. Intern J Sediment Res 29: 357–367

Veljanoska-Sarafiloska E, Jordanoski M, Stafilov T, Stefova M (2011) Study of organochlorine pesticide residues in water, sediment and fish tissue in Lake Ohrid (Macedonia/Albania). Macedonian Journal of Chemistry and Chemical Engineering 30(2): –163–179

Veljanoska-Sarafiloska E, Stafilov T (2012) Comparison of the presence of DDT metabolites in sediments and fish from Lakes Ohrid, Prespa and Dojran. Acta zool bulg, Suppl 4: 211–218

Vollenweider RA, Kerekes J (1982) Eutrophication of waters. Monitoring, assessment and control. OECD Cooperative programme on monitoring of inland waters (Eutrophication control), Environment Directorate, OECD, Paris

Watzin M, Puka V, Naumoski T (eds) (2002) Lake Ohrid and its watershed – State of the environment report. Lake Ohrid Conservation Project, Tirana, Albania and Ohrid, Macedonia

Wetzel RG, Likens GE (2000) Limnological analyses. 3rd edn, Springer, New York

WISER (2012) Overview and comparison of macrophyte survey methods used in European countries and a proposal of harmonized common sampling protocol to be used for WISER uncertainty exercise including a relevant common species list. http://www.wiser.eu/results/deliverables Accessed 10 October 2014

11 Annexes

11.1 List of national contributing specialists

Name	E-mail address	Main area(s) of contribution
Albania		
Adhami, Emirjeta	emi_adhami@hotmail.com	Physico-chemistry
Bacu, Ariola	ariolabacu@yahoo.com	Chlorophyll-*a* analysis
Beqiraj, Sajmir	s_beqiraj@yahoo.com	Macroinvertebrates
Kashta, Lefter	leka.kashta@yahoo.com	Macrophytes
Koçu (Deçka), Ermira	ermira.kocu@giz.de	Water legislation
Palluqi, Arian	arian.palluqi57@yahoo.com	Fish and fisheries
Pambuku, Arben	urtesi2001@yahoo.com	Physico-chemistry
Rakaj, Marash	marashrakaj@yahoo.com	Phytoplankton
Saliaga, Vjola	vjola.saliaga@stkku.gov.al	Water administration
Shumka, Spase	sprespa@yahoo.co.uk	Fish and fisheries
Macedonia		
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Ivanovski, Aleksandar	ivanovskia@yahoo.com	Protected areas
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Lokoska, Lence	lokoskalence@yahoo.com	Microbiology
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Trajanovska, Sonja	sonjat@hio.edu.mk	Macrophytes
Trajanovski, Sasho	trajsa@hio.edu.mk	Macroinvertebrates
Veljanoska-Sarafiloska, Elizabeta	elizabetasarafiloska@yahoo.com	Physico-chemistry
Montenegro		
Djuranović, Zorica	zorica.djuranovic@mpr.gov.me	Water legislation and administr.
Djurašković, Pavle	pavle.djuraskovic@meteo.co.me	Physico-chemistry
Hadžiablahović, Sead	seadh@t-com.me	Macrophytes
Mrdak, Danilo	danilomrdak@gmail.com	Fish and fisheries
Pavićević, Ana	ana.pavicevic@mrt.gov.me	Macroinvertebrates
Peruničić, Jelena	jelena.perunicic@giz.de	Water abstraction, tourism
Rakočević, Jelena	mina.hidrobios@gmail.com	Phytoplankton

11.2 Monitoring results

Lake Shkodra – Albania. CSBL Analysis 2013–2014

Physico-chemical elements	Medium		Unit	AL I Kalldrun (Bejza)								AL II Zogaj							
Date	Water	Sediment		27/04/2013	27/04/2013	18/07/2013	18/07/2013	09/10/2013	09/10/2013	10/02/2014	10/02/2014	27/04/2013	27/04/2013	18/07/2013	18/07/2013	09/10/2013	09/10/2013	10/02/2014	10/02/2014
Water depth	x		m	5	10	5	5	5	5	4	4	5	5	6	6	6	6	7	7
Sampling depth	x		m	2	9.5	0	4	0	4	0	4	0	5	0	6	0	4	0	7
Temperature	x		^0C	19.4		28.1	16.2	20.4	14.1			20.2		27.8	17	20	17.7		
Transparency (Secchi depth)	x		m			4.0	4.0	2.5	2.5	1.5	1.5			3.0	3.0	2.2	2.2	3.0	3.0
Conductivity	x		$\mu S.cm^{-1}$	251	251	221	253	225	226	267	282	250	249	226	226	222	223	266	268
pH	x			8.0	7.7	8.2	8.0	8.1	8.1	8.2	8.3	7.9	7.9	8.4	8.3	8.5	8.5	8.3	8.3
Alkalinity as phenolphthalein	x		ml HCl	130	130	118	133	113	115	140	140	133	133	125	123	113	113	138	135
Total suspended solids	x		$mg.l^{-1}$	9.20	9.10	3.30	12.20	<0.1	<0.1	<0.1	<0.1	0.40	2.80	4.40	15.40	1.80	1.80	<0.01	<0.01
Dissolved oxygen	x		$mg.l^{-1}$	8.77		7.64	7.54	7.69	7.57			9.18		7.92	7.42	7.70	7.52		
Chemical oxygen demand	x		$mg.l^{-1}$	0.52	0.32	0.80	0.80	0.84	0.84	0.76	0.60	0.24	0.32	0.52	0.52	0.68	0.52	0.56	0.60
BOD_5	x		$mg.l^{-1}$	1.72		2.52	2.75	2.44	2.63			2.21		2.24	2.67	2.50	2.62		
NH_3-N	x		$mg.l^{-1}$	0.01	ND	ND	ND	0.02	0.02	0.03	0.06	ND	ND	ND	ND	0.02	0.02	0.05	0.08
NO_3-N	x		$mg.l^{-1}$	1.64	1.31	0.18	0.18	0.09	0.06	0.37	0.37	0.25	0.82	0.54	0.18	0.20	0.07	0.30	0.29
NO_2-N	x		$mg.l^{-1}$	0.140		ND	ND	<0.01	<0.01	<0.01	<0.01	0.010	0.130	ND	ND	0.010	<0.01	<0.01	<0.01
Total nitrogen	x		$mg.l^{-1}$			0.33		0.21	0.24	0.34	0.46	0.66		0.22	0.19	0.20	0.18	0.30	0.36
Ortho-phosphorus	x		$\mu g.l^{-1}$					30	20	29	26							31	15
Total phosphorus*	x		$\mu g.l^{-1}$	150	150	10	10	10	10	10	10	100	100	10	10	10	10	10	10
Total organic carbon	x		$mg.l^{-1}$					3.62	4.46	3.58	4.54		0.22			3.67	3.45	3.76	4.48
Chloride	x		$mg.l^{-1}$	3.55	3.55	3.55	8.88	5.33	3.55	2.27	2.27	3.55	5.32	3.55	3.55	5.33	5.33	2.23	2.70
Sulphate	x		$mg.l^{-1}$	2.80	2.46	7.00	6.58	7.65	7.23	2.49	2.89	3.76	3.70	4.53	4.53	2.88	2.47	2.43	2.46
Fluoride	x		$mg.l^{-1}$																
Specific pollutants																			
Mercury		x	$\mu g.kg^{-1}$																
Arsenic		x	$mg.kg^{-1}$																
Lead		x	$mg.kg^{-1}$	ND		ND	ND	<0.01		0.01		ND	0.04	ND	ND	<0.01		0.03	
Cadmium		x	$mg.kg^{-1}$	0.01		ND	ND	0.00		0.00		0.00		0.00	0.00	0.00		0.00	
Aluminium		x	$g.kg^{-1}$	ND	ND							ND	0.00						

*The similarity of figures between sampling sites and campaigns ra ises concern as to the accuracy of some of the data. It is recommended to consider the data reported as indicative rather than conclusive. Further analyses will be needed to corroborate tentative findings.

Legend

(Ultra-)Oligotrophic

Mesotrophic

Eutrophic

Hypertrophic

ND Not detected

Lake Shkodra – Albania. CSBL Analysis 2013–2014 (continued)

Physico-chemical elements	Medium			**AL III Shiroka**							
Date	Water	Sediment	Unit	27/04/2013	27/04/2013	18/07/2013	18/07/2013	09/10/2013	09/10/2013	10/02/2014	10/02/2014
Water depth	x		m	5	4	4	4	4	4	4	4
Sampling depth	x		m	4.5	4	0	4	0	4	0	4
Temperature	x		^{0}C	20		28.3	27.5	21	16.5		
Transparency	x		m		4.0	3.0	3.5	2.7	2.7	3.5	3.5
Conductivity	x		µS.cm^{-1}	252	255	224	226	226	226	262	271
pH	x			7.8	7.8	8.4	7.3	8.5	8.3	8.3	6.9
Alkalinity as phenolphthalein	x		ml HCl	128	130	125	123	114	115	140	140
Total suspended solids	x		mg.l^{-1}	7.20	4.80	3.40	1.00	3.70	3.10	0.80	<0.10
Dissolved oxygen	x		mg.l^{-1}	8.95		7.79	7.22	7.81	7.61		
Chemical oxygen demand	x		mg.l^{-1}	0.45	0.40	0.48	0.48	0.72	0.64	0.60	1.72
BOD_5	x		mg.l^{-1}	2.42		2.38	2.89	2.41	2.74		
NH_3-N	x		mg.l^{-1}	0.01	0.01	ND	ND	0.01	0.01	0.04	<0.001
NO_3-N	x		mg.l^{-1}	1.15	1.15	0.45	0.18	0.41	0.16	0.27	0.28
NO_2-N	x		mg.l^{-1}	0.200	0.010	ND	ND	<0.01	<0.01	<0.01	<0.01
Total nitrogen	x		mg.l^{-1}			0.18	0.22	0.20	0.21	0.31	0.35
Ortho-phosphorus	x		µg.l^{-1}							4	4
Total phosphorus*	x		µg.l^{-1}	130	120	10	10	10	20		
Total organic carbon	x		mg.l^{-1}		0.19			3.5	3.61	3.87	10.2
Chloride	x		mg.l^{-1}	3.55	7.10	3.55	3.55	5.33	3.55	2.01	2.20
Sulphate	x		mg.l^{-1}	3.29	2.88	6.58	6.58	7.65	2.06	2.29	2.38
Fluoride	x		mg.l^{-1}								
Specific pollutants											
Mercury		x	µg.kg^{-1}								
Arsenic		x	mg.kg^{-1}								
Lead		x	mg.kg^{-1}	ND	0.01	ND	ND	<0.01		0.00	
Cadmium		x	mg.kg^{-1}	ND	ND	0.01	ND	0.00		0.03	
Aluminium		x	g.kg^{-1}	ND	0.01						

*See comment on previous page.

Legend

Oligotrophic

Mesotrophic

Hyperrophic

ND Not detected

Lake Skadar – Montenegro. CSBL Analysis 2013–2014

Physico-chemical elements			**Unit**	**MNE I Kamenik**								**MNE II Virpazar**							
Date	Water	Sediment		18/04/2013	18/04/2013	19/07/2013	19/07/2013	23/10/2013	23/10/2013	07/02/2014	07/02/2014	18/04/2013	18/04/2013	19/07/2013	19/07/2013	23/10/2013	23/10/2013	07/02/2014	07/02/2014
Water depth	x		m	-	5.5	-	4.3		6		6	-	4.75	-	3		3.8		5
Sampling depth	x		m	-	6.6	0.5	3.5	0.5	5	0.5	5	-	5.75	-	2	0.5	2.8	0.5	4
Temperature	x		^{0}C	16	13	20.4	20.5	15.8	12	9.6	9.4	15	13	26.1	24.3	13.8	12.4	9.6	9
Transparency	x		m	-	3.8	2.4	-	3.4		3.3	3.3	-	2.8	1.9		2.6		1.8	1.8
Conductivity	x		µS.cm^{-1}	222	224	252	244	261	260	235	249	231	226	225	248	266	263	270	273
pH	x			8.1	8.2	7.98	8.01	7.7	7.8	7.8	7.7	8.1	8.1	8.2	8.0	7.9	7.9	7.9	7.9
Alkalinity as phenolphthalein	x		ml HCl	3.05	2.75	2.60	2.65	3.1		2.71	2.87	2.8	2.8	2.7	2.35	3.22		2.83	3.1
Total suspended solids	x		mg.l^{-1}	<LOD	<LOD	0.2	45.6	0.20	2.60	1.00	0.10	<LOD	<LOD	0.30	10.00	0.20	1.20	0.60	2.10
Dissolved oxygen	x		mg.l^{-1}	10.96	12.29	9.1	10.0	9.11	9.62	11.80	11.20	12.08	11.75	10.40	9.80	9.55	10.15	12.20	11.90
Chemical oxygen demand	x		mg.l^{-1}	1.37	1.19	2.9	1.6	2.27	1.74	1.20	1.40	1.35	1.18	1.90	2.50	2.70	1.94	2.70	1.94
BOD_5	x		mg.l^{-1}	1.95	3.80	2.10	2.00	2.42	2.14	2.00	1.50	3.28	2.64	2.90	1.40	3.59	1.98	2.3	0.7
NH_3-N	x		mg.l^{-1}	0.06	0.04	0.05	0.01	<0.01	0.03	0.06	0.02	0.12	0.15	0.05	0.06	0.05	0.03	0.07	0.03
NO_3-N	x		mg.l^{-1}	0.11	0.34	0.018	0.014	0.24	0.57	0.13	0.14	0.23	0.48	<LOD	<LOD	0.32	0.58	0.17	0.19
NO_2-N	x		mg.l^{-1}	0.003	0.002	<LOD	0.001	0.007	0.008	0.003	0.001	0.002	<LOD	<LOD	0.001	0.006	0.009	0.003	0.002
Total nitrogen	x		mg.l^{-1}					0.51	0.71	0.25	0.18					0.50	0.69	0.30	0.24
Ortho-phosphorus	x		µg.l^{-1}	4	10	10	3	12	16	16	<10	10	16	13	20	15	16	13	13
Total phosphorus	x		µg.l^{-1}	18	11	43	30	16	19	17	10	22	24	13	30	17	19	23	33
Total organic carbon	x		mg.l^{-1}					2.32	1.19	1.45	1.06					1.88	1.31	1.52	1.18
Chloride	x		mg.l^{-1}	2.10	2.10	4.20	3.90	3.44	1.90	4.10	2.30	3.10	3.00	3.50	4.00	3.14	1.65	3.50	3.90
Sulphate	x		mg.l^{-1}	4.40	4.90	4.50	5.00	6.00	6.00	3.50	4.40	4.50	4.80	4.50	4.10	5.50	5.40	4.70	5.90
Fluoride	x		mg.l^{-1}					1.78	0.07	0.05	0.05					1.68	1.86	0.04	0.04
Specific pollutants																			
Mercury		x	µg.kg^{-1}				116.95								52.25				
Arsenic		x	mg.kg^{-1}				0.56								0.49				
Lead		x	mg.kg^{-1}				9.26								9.45				
Cadmium		x	mg.kg^{-1}				1.20								6.40				
Aluminium		x	g.kg^{-1}				17.68								12.99				

Legend

Oligotrophic

Mesotrophic

Eutrophic

ND Not detected

Lake Skadar – Montenegro. CSBL Analysis 2013–2014 (continued)

Physico-chemical elements	Medium		Unit	MNE III Plavnica								MNE IV Podhum							
Date	Water	Sediment		18/04/2013	18/04/2013	19/07/2013	19/07/2013	22/10/2013	22/10/2013	07/02/2014	07/02/2014	17/04/2013	17/04/2013	18/07/2013	18/07/2013	22/10/2013	22/10/2013	07/02/2014	07/02/2014
Water depth	x		m	-	4	-	2.6		2.8		4	-	4.5		3		5		5
Sampling depth	x		m	-	4.8	-	1.5	0.5	2	0.5	3	-	5.5	-	2.5	0.5	4	0.5	4
Temperature	x		^0C	16.4	15	26.1	25.9	18	17.2	8.6	8.5	16.1	14.9	27	26.2	18.8	12.2	10	9.8
Transparency	x		m	-	3.6	2.0		2.8		2.2	2.2	-	5.5	2.7		3.4		3.1	3.1
Conductivity	x		$\mu S.cm^{-1}$	255	239	221	217	204	205	255	264	230	227	210	211	199	227	267	264
pH	x			8.2	8.1	8.2	8.4	8.1	8.1	7.6	7.7	8.1	8.0	8.2	8.2	8.4	7.9	7.9	7.9
Alkalinity as phenolphthalein	x		ml HCl	3.3.	2.75	2.5	2.4	2.49		2.85	2.83	2.8	2.4	2.3	2.15	2.52		3.15	2.95
Total suspended solids	x		$mg.l^{-1}$	<LOD	<LOD	0.40	14.20	0.40	0.90	1.90	3.00	<LOD	<LOD	0.30	0.40	0.30	1.10	0.40	2.50
Dissolved oxygen	x		$mg.l^{-1}$	10.77	9.80	9.00	8.70	11.67	9.69	12.10	11.30	10.55	11.19	9.50	9.60	9.90	10.60	12.60	12.50
Chemical oxygen demand	x		$mg.l^{-1}$	2.14	1.22	2.50	1.70	2.88	1.98	2.10	2.10	0.91	1.33	2.60	2.50	2.58	1.21	1.20	1.40
BOD_5	x		$mg.l^{-1}$	3.08	3.76	1.50	1.30	4.49	2.41	3.70	1.60	1.46	2.23	2.40	2.50	2.00	1.69	1.90	0.90
NH_3-N	x		$mg.l^{-1}$	0.11	0.07	<LOD	0.01	0.02	<0,01	0.04	0.02	0.20	< 0.01	0.03	0.04	<0.01	<0.01	0.02	0.02
NO_3-N	x		$mg.l^{-1}$	0.10	0.16	0.02	<LOD	0.01	0.05	0.29	0.33	0.35	0.45	0.13	<LOD	0.12	0.71	0.59	0.76
NO_2-N	x		$mg.l^{-1}$	0.003	0.003	<LOD	<LOD	0.003	0.004	0.005	0.005	0.002	0.002	0.002	0.001	0.002	0.007	0.003	0.002
Total nitrogen	x		$mg.l^{-1}$					0.08	0.01	0.57	0.43					0.17	0.88	1.02	0.73
Ortho-phosphorus	x		$\mu g.l^{-1}$	14	20	17	<LOD	14	10	10	43	12	2	<LOD	<LOD	14	14	8	17
Total phosphorus	x		$\mu g.l^{-1}$	18	25	23	3	15	29	17	56	15	17	23	20	22	16	13	17
Total organic carbon	x		$mg.l^{-1}$					2.33	2.64	1.92	2.16					1.92	1.05	1.68	1.06
Chloride	x		$mg.l^{-1}$	3.90	3.60	5.80	4.40	3.79	3.49	4.30	3.80	2.70	2.40	4.00	3.40	4.04	3.94	3.10	2.90
Sulphate	x		$mg.l^{-1}$	5.60	6.10	4.90	5.00	5.30	5.50	7.20	7.50	4.80	4.10	4.10	3.50	5.80	0.90	4.70	5.00
Fluoride	x		$mg.l^{-1}$					1.71	1.93	0.07	0.07					1.94	1.85	0.11	0.04
Specific pollutants																			
Mercury		x	$\mu g.kg^{-1}$				58.24								58.00				
Arsenic		x	$mg.kg^{-1}$				0.56								3.71				
Lead		x	$mg.kg^{-1}$				6.14								9.00				
Cadmium		x	$mg.kg^{-1}$				3.49								7.31				
Aluminium		x	$g.kg^{-1}$				10.56								15.98				

Legend

(Ultra-)Oligotrophic

Mesotrophic

Eutrophic

<LOD Less than the limit of detection

Lake Skadar – Montenegro. CSBL Analysis 2013–2014 (continued)

Physico-chemical elements	Medium		Unit	MNE V Starcevo								MNE VI Centre lake							
Date	Water	Sediment		17/04/2013	17/04/2013	18/07/2013	18/07/2013	22/10/2013	22/10/2013	07/02/2014	07/02/2014	17/04/2013	17/04/2013	18/07/2013	18/07/2013	22/10/2013	22/10/2013	07/02/2014	07/02/2014
Water depth	x		m		7.5	-	5		7.5		5	-	8	-	7		8		7.5
Sampling depth	x		m	-	8.5	-	5.8	0.5	6.5	0.5	4	-	9	-	8	0.5	7	0.5	6.5
Temperature	x		^0C	15.1	14.9	26.9	25.6	17.4	14	10	9.8	14.9	12.6	27	25.6	18.8	17.4	9.2	9
Transparency	x		m	-	3.7	2.5	-	3.3		3.1	3.1	-	6.1	2.0	-	3.6		2.4	2.4
Conductivity	x		$\mu S.cm^{-1}$	231	232	207	209	198	242	267	264	223	229	205	207	195	199	248	246
pH	x			8.3	8.2	8.2	8.3	8.3	8.3	7.9	7.9	8.2	8.1	8.2	8.3	8.4	8.5	8.0	7.9
Alkalinity as phenolphthalein	x		ml HCl	2.7	3.25	2.6	2.45	2.34		3.15	2.95	2.8	2.6	2.4	2.35	2.43		2.76	2.62
Total suspended solids	x		$mg.l^{-1}$	<LOD	<LOD	<LOD	0.20	0.20	2.50	0.40	2.50	<LOD	<LOD	<LOD	2.60	0.20	2.40	1.90	2.30
Dissolved oxygen	x		$mg.l^{-1}$	11.06	10.68	8.90	8.70	10.33	10.27	12.60	12.50	10.63	9.84	8.20	7.90	10.88	10.63	12.60	12.60
Chemical oxygen demand	x		$mg.l^{-1}$	0.92	1.16	1.90	2.20	1.75	1.58	1.20	1.40	0.95	1.18	1.40	0.80	1.54	1.34	1.50	1.00
BOD_5	x		$mg.l^{-1}$	2.09	1.86	1.00	1.00	2.47	1.71	1.90	0.90	1.84	0.76	2.00	1.80	2.31	1.37	2.30	1.60
NH_3-N	x		$mg.l^{-1}$	0.06	0.10	0.02	0.04	0.02	0.03	0.02	0.02	0.08	0.10	0.02	0.03	0.02	<0.01	0.03	0.04
NO_3-N	x		$mg.l^{-1}$	0.23	0.23	<LOD	<LOD	0.02	0.46	0.59	0.76	0.30	0.25	<LOD	<LOD	<0.01	<0.01	0.37	0.29
NO_2-N	x		$mg.l^{-1}$	0.002	0.001	<LOD	0.001	0.003	0.004	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.002	0.002
Total nitrogen	x		$mg.l^{-1}$					0.17	0.57	1.02	0.73					0.07	0.02	0.58	0.62
Ortho-phosphorus	x		$\mu g.l^{-1}$	8	9	<LOD	<LOD	16	19	8	17	10	17	7	<LOD	11	14	17	26
Total phosphorus	x		$\mu g.l^{-1}$	6	9	23	<LOD	17	20	13	17	11	28	13	30	14	19	20	26
Total organic carbon	x		$mg.l^{-1}$					2.17	1.57	1.68	1.06					2.34	1.86	1.48	1.77
Chloride	x		$mg.l^{-1}$	2.70	2.90	3.30	3.80	3.44	3.64	3.10	2.90	2.80	3.00	3.20	3.10	3.00	4.09	2.80	2.60
Sulphate	x		$mg.l^{-1}$	5.20	4.70	2.40	4.30	4.50	5.00	4.70	5.00	5.10	4.00	4.30	3.80	3.60	4.00	5.40	4.70
Fluoride	x		$mg.l^{-1}$					0.13	1.48	0.11	0.04					0.09	1.65	0.04	0.04
Specific pollutants																			
Mercury		x	$\mu g.kg^{-1}$												74.81				
Arsenic		x	$mg.kg^{-1}$												0.69				
Lead		x	$mg.kg^{-1}$												6.53				
Cadmium		x	$mg.kg^{-1}$												3.86				
Aluminium		x	$g.kg^{-1}$												16.78				

Legend

(Ultra-)Oligotrophic (green)

Mesotrophic (yellow)

<LOD Less than the limit of detection

Lake Ohrid – Macedonia. CSBL Analysis 2013–2014

Physico-chemical elements	Medium		Unit	**MK I Kalishta**				**MK II Grashnica**				**MK III Velidab**				**MK IV St. Naum**			
Date	water	sediment		16/04/2013	22/07/2013	21/10/2013	22/01/2014	16/04/2013	22/07/2013	21/10/2013	22/01/2014	16/04/2013	22/07/2013	21/10/2013	22/01/2014	16/04/2013	22/07/2013	21/10/2013	22/01/2014
Temperature	x		^0C	9.8	21.7	17	8.5	8	22.8	16.5	9	8.3	23.8	17.2	8.9	11.2	23.2	16.2	10
Transparency	x		m																
Conductivity	x		$\mu S.cm^{-1}$	208	216	140	172	103	280	191	208	197	226	129	162	212	223	187	188
pH	x			8.1	8.7	8.4	8.3	7.8	8.1	8.6	8.3	8.1	8.7	8.7	8.5	8.1	8.6	8.6	8.3
Alkalinity as phenolphthalein	x		$mg.l^{-1}$	123	112	110	179	130	131	115	118	115	114	121	114	120	118	120	130
Suspended and dissolved inorganic and organic matter	x		$mg.l^{-1}$		0.02	0.02	0.03		0.03	0.02	0.03		0.01	0.01	0.02		0.03	0.01	0.03
Dissolved oxygen	x		$mg.l^{-1}$	12.29	9.62	9.90	10.39	11.61	6.83	9.44	10.99	12.18	8.75	9.69	11.27	11.57	8.33	9.15	25.14
Chemical oxygen demand	x		$mg.l^{-1}$	4.08	4.40	4.93	5.76	4.55	7.54	3.39	6.26	3.77	3.64	2.16	6.26	3.61	4.43	2.16	5.27
BOD_5	x		$mg.l^{-1}$	2.24	1.21	0.98	1.45	1.20	4.77	0.84	1.71	1.63	1.41	0.42	1.64	1.73	1.15	0.46	0.93
NH_3-N	x		$mg.l^{-1}$	<LOD	<LOD	<LOD	<LOD	0.04	<LOD	0.04	0.06	0.04		<LOD	<LOD	0.01	<LOD	<LOD	<LOD
NO_3-N	x		$mg.l^{-1}$	0.11	0.05	0.01	0.18	0.20	0.06	0.02	0.30	0.41	0.02	0.12	0.17	0.08	0.02	0.04	0.21
NO_2-N	x		$mg.l^{-1}$	0.002		0.002	0.002	0.001	<LOD	0.002	0.002	0.010		0.002	0.001	0.001		0.001	0.001
Total nitrogen	x		$\mu g.l^{-1}$	444	887	508	381	571	334	860	805	913	560	343	379	564	341	298	463
Kjeldahl nitrogen (organic nitrogen)	x		$\mu g.l^{-1}$	332	838	497	199	369	276	840	499	488	541	343	210	488	325	260	256
Total phosphorus	x		$\mu g.l^{-1}$	12	10	10	6	23	65	8	6	4	9	5	4	10	24	6	8
Total organic carbon	x		$mg.l^{-1}$	13.14	26.28	23.87	18.65	38.52	42.54	44.21	36.55	18.96	24.58	22.47	19.85	22.98	27.89	25.14	24.18
Chloride	x		$mg.l^{-1}$	50	55	48	41	54	49	47	45	48	51	41	34	43	47	39	33
Specific pollutants																			
Lead		x	$mg.kg^{-1}$																
Cadmium		x	$mg.kg^{-1}$																

Legend

(Ultra-)Oligotrophic

Mesotrophic

Eutrophic

<LOD Less than the limit of detection

Lake Ohrid – Macedonia. CSBL Analysis 2013–2014 (continued)

Physico-chemical elements	Medium		Unit	**MK V Pelagic point**				**Sat 1**				**Sat 2**				**Sat 3**			
Date	water	sediment		18/04/2013	24/07/2013	24/10/2013	24/01/2014	16/04/2013	22/07/2013	21/10/2013	22/01/2014	16/04/2013	22/07/2013	21/10/2013	22/01/2014	16/04/2013	22/07/2013	21/10/2013	22/01/2014
Temperature	x		^{0}C	10	23.6	16.8	8.6	6.1	13.1	8.7	6.9	6.1	14.3	9.1	7.1	6.2	15.9	9.7	7.3
Transparency	x		m		16.8	21.0	15.3												
Conductivity	x		µS.cm^{-1}	164	206	189	159	188	367	291	210	182	361	287	285	186	353	285	216
pH	x			8.5	8.6	8.9	8.3	7.7	8.2	8.3	8.2	7.7	8.4	8.4	8.2	7.7	8.7	8.5	8.4
Alkalinity as phenolphthalein	x		mg.l^{-1}	118	116	106	110	122	191	194	146	117	186	159	141	120	187	189	140
Suspended and dissolved inorganic and organic matter	x		mg.l^{-1}						0.03	0.02	0.05		0.03	0.02	0.05		0.02	0.02	0.05
Dissolved oxygen	x		mg.l^{-1}	12.28	8.58	10.32	10.50	12.35	10.49	11.43	11.38	12.50	11.09	12.31	11.68	12.01	11.44	12.32	12.00
Chemical Oxygen Demand	x		mg.l^{-1}	3.32	3.12	3.66	4.48	5.34	3.93	7.14	8.40	2.83	3.61	6.82	9.22	5.02	5.02	7.47	8.56
BOD_5	x		mg.l^{-1}	1.06	0.83	1.16	3.92	1.89	2.33	1.42	1.61	2.46	2.58	1.57	3.17	1.79	2.41	1.44	3.08
NH_3-N	x		mg.l^{-1}	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.01
NO_3-N	x		mg.l^{-1}	0.06	0.02	0.01	0.03	0.16	0.39	0.19	0.35	0.17	0.48	0.19	0.35	0.15	0.41	0.19	0.33
NO_2-N	x		mg.l^{-1}			<LOD	<LOD		0.002	0.001	0.002	0.002	0.001	0.002	0.001	0.001	0.002	0.002	0.003
Total nitrogen	x		µg.l^{-1}	775	397	365	267	475	713	435	1110	432	940	430	907	452	1000	309	805
Kjeldahl nitrogen (organic nitrogen)	x		µg.l^{-1}	717	377	360	236	315	323	435	758	256	460	430	554	299	587	309	469
Total phosphorus	x		µg.l^{-1}	3	5	5	4	23	19	6	38	20	12	11	22	20	25	8	19
Total organic carbon	x		mg.l^{-1}	23.19	24.68	21.08	22.35												
Chloride	x		mg.l^{-1}	44	46	49	23	47	51	46	35	56	56	45	34	55	58	37	44
Specific pollutants																			
Lead		x	mg.kg^{-1}																
Cadmium		x	mg.kg^{-1}																

Legend

(Ultra-)Oligotrophic

Mesotrophic

Eutrophic

<LOD Less than the limit of detection

Note: Trophic state colour code also applied to tributaries for comparison even though not normally valid for rivers

Lake Ohrid – Macedonia. CSBL Analysis 2013–2014 (continued)

Physico-chemical elements	Medium		Unit	**Kos 1**				**Che 1**			
Date	water	sediment		16/04/2013	22/07/2013	21/10/2013	22/01/2014	16/04/2013	22/07/2013	21/10/2013	22/01/2014
Temperature	x		^{0}C	8.5	15.2	11.2	9.8	10.8	19.2	12.8	7.3
Transparency	x		m								
Conductivity	x		$\mu S.cm^{-1}$	225	387	311	289	326	429	439	360
pH	x			7.6	7.9	7.8	7.9	8.5	8.3	8.6	8.9
Alkalinity as phenolphthalein	x		$mg.l^{-1}$	140	178	190	179	163	188	208	182
Suspended and dissolved inorganic and organic matter	x		$mg.l^{-1}$		0.22	0.18	0.15		0.26	0.02	0.08
Dissolved oxygen	x		$mg.l^{-1}$	11.33	9.45	10.74	11.81	10.40	7.38	9.61	12.35
Chemical Oxygen Demand	x		$mg.l^{-1}$	3.14	3.93	3.57	5.10	9.11	12.49	18.01	18.44
BOD_5	x		$mg.l^{-1}$	0.85	1.08	0.35	1.16	1.40	1.87	1.28	3.56
NH_3-N	x		$mg.l^{-1}$	<LOD	<LOD	0.02	<LOD	<LOD	0.04	<LOD	0.02
NO_3-N	x		$mg.l^{-1}$	0.12	0.67	0.26	0.67	0.13	0.00	0.06	1.74
NO_2-N	x		$mg.l^{-1}$	0.001	0.004	0.002	0.003	0.002		0.053	0.017
Total nitrogen	x		$\mu g.l^{-1}$	412	1194	614	1058	692	489	626	24176
Kjeldahl nitrogen (organic nitrogen)	x		$\mu g.l^{-1}$	294	523	614	384	560	485	626	675
Total phosphorus	x		$\mu g.l^{-1}$	21	12	8	5	15	25	9	99
Total organic carbon	x		$mg.l^{-1}$								
Chloride	x		$mg.l^{-1}$	52	39	49	45	49	51	72	45
Specific pollutants											
Lead		x	$mg.l^{-1}$								
Cadmium		x	$mg.l^{-1}$								

Legend

Oligotrophic

Mesotrophic

Eutrophic

Note: Trophic state colour code also applied to tributaries for comparison even though not normally valid for rivers

Lake Ohrid – Albania. CSBL Analysis 2013–2014

Physico-chemical elements	Medium		Unit	**AL I Lin**				**AL II Memlist**				**AL III Pogradec**			
Date	water	sediment		01/05/2013	24/07/2013	08/10/2013	02/04/2014	01/05/2013	24/07/2013	08/10/2013	02/04/2014	01/05/2013	24/07/2013	08/10/2013	04/02/2014
Temperature	x		^{0}C		21	20			25.4	17.7			25	17.6	
Transparency	x		m		5.0	4.5			5.0	5.2	8.0		6.0	4.3	4.0
Conductivity	x		$\mu S.cm^{-1}$	249	231	229	234	234	236	230	232	246	235	232	234
pH	x			8.0	8.6	8.7	8.3	8.0	8.6	8.7	8.4	7.9	8.6	8.7	8.4
Alkalinity as phenolphthalein	x		$mg.l^{-1}$	135	118	105	113	120	118	110	113	123	120	110	113
Suspended and dissolved inorganic and organic matter	x		$mg.l^{-1}$	0.40	<LOD	<0.1	<0.1	0.40	<LOD	<0.01	<0.01	0.40	7.00	<0.10	<0.10
Dissolved oxygen	x		$mg.l^{-1}$		8.81	8.74			8.20	9.83			8.10	9.48	
Chemical oxygen demand	x		$mg.l^{-1}$												
BOD_5	x		$mg.l^{-1}$		1.02	0.48			1.25	0.52			1.30	0.58	
NH_3-N	x		$mg.l^{-1}$	<LOD	<LOD	<0.01	0.02	<LOD	<LOD	<0.01	0.01	<LOD	<LOD	<0.01	0.02
NO_3-N	x		$mg.l^{-1}$	2.30	1.80	1.14	0.04	0.82	0.18	0.17	0.05	2.38	0.18	0.11	0.04
NO_2-N	x		$mg.l^{-1}$	0.010	<LOD	<0.01	0.010	0.010	<LOD	<0.01	0.010	0.010	<LOD	<0.01	0.010
Total nitrogen	x		$\mu g.l^{-1}$		0	0	0		0	0	0		0	0	0
Kjeldahl nitrogen (organic nitrogen)	x		$\mu g.l^{-1}$												
Total phosphorus*	x		$\mu g.l^{-1}$	10	20	10	10	20	20	20	10	50	30	20	10
Total organic carbon	x		$mg.l^{-1}$		1.68	3.45	3.04		0.31	3.34	3.55		4.61	3.67	3.18
Chloride	x		$mg.l^{-1}$	7	5	5	3	7	5	4	3	7	5	5	3
Specific pollutants															
Lead		x	$mg.kg^{-1}$												
Cadmium		x	$mg.kg^{-1}$												

*The similarity of values between sampling sites and campaigns rais es concern as to the accuracy of some of the data. It is recommended to consider the data reported as indicative rather than conclusive. Further analyses will be needed to corroborate tentative findings.

Legend

Oligotrophic	(green)
Mesotrophic	(yellow)
Eutrophic	(orange)
<LOD	Less than the limit of detection

Lake Prespa – Macedonia. CSBL Analysis 2013–2014

Physico-chemical elements	Medium		Unit	MK I WWTP Ezerani				MK II NW littoral of Ezerani				MK III Ezerani littoral				MK IV NE littoral of Ezerani			
Date	water	sediment		25/04/2013	29/07/2013	30/10/2013	26/01/2014	25/04/2013	29/07/2013	30/10/2013	26/01/2014	25/04/2013	29/07/2013	30/10/2013	26/01/2014	25/04/2013	29/07/2013	30/10/2013	26/01/2014
Temperature	x		^0C	11.6	19.2	15.2	6.9	16.1	25.6	15.9	4.1	14.7	25.6	15.7	5.4	14.2	25.4	15.7	5.5
Transparency (Secchi depth)	x		m																
Conductivity	x		$\mu S.cm^{-1}$	433	607	420	323	199	232	176	226	194	216	175	242	199	226	178	233
pH	x			6.7	7.4	7.3	7.1	7.9	8.8	8.3	8.2	7.9	8.5	8.2	8.2	8.0	8.5	8.3	8.2
Alkalinity as phenolphthalein	x		$mg.l^{-1}$	163	239	205	147	105	102	105	116	107	102	106	112	106	103	107	113
Suspended and dissolved inorganic and organic matter	x		$mg.l^{-1}$		0.10	0.05	0.04		0.03	0.02	0.01		0.02	0.01	0.01		0.03	0.02	0.02
Dissolved oxygen	x		$mg.l^{-1}$	10.81	3.05	2.42	3.91	11.17	9.06	9.91	10.73	12.39	8.85	10.78	9.32	11.67	8.47	9.45	10.40
Chemical oxygen demand	x		$mg.l^{-1}$	12.87	14.13	18.30	9.51	10.05	13.03	11.77	5.61	10.68	9.73	12.57	8.89	10.36	11.15	12.25	7.64
BOD_5	x		$mg.l^{-1}$	2.10	3.05	7.27	2.67	1.97	3.80	3.44	0.79	3.45	2.70	4.48	0.81	2.31	3.23	3.02	0.67
NH_3-N	x		$mg.l^{-1}$	2.117	3.842	7.08	<LOD	<LOD	<LOD	<LOD	<LOD	0.147	<LOD	0.143	<LOD	<LOD	<LOD	<LOD	<LOD
NO_3-N	x		$mg.l^{-1}$	0.696	0.072	0.139	1.536	0.009	0.005	0.01	0.022	0.145	<LOD	0.098	0.022	0.003	<LOD	0.001	0.024
NO_2-N	x		$mg.l^{-1}$	0.170	0.022	0.112	0.001	<LOD	0.001	0.001	0.001	0.001	<LOD	0.001	<LOD	<LOD	<LOD	<LOD	0.001
Kjeldahl nitrogen (organic nitrogen)	x		$\mu g.l^{-1}$	971	4433	8773	631	503	776	322	1	973	378	389	438	827	303	231	387
Total nitrogen	x		$\mu g.l^{-1}$	1836.57	4526.66	8772.88	2169.34	512.16	782.15	321.86	1.04	1119.21	378.31	389.07	461.22	830.29	303.43	230.81	410.37
Total phosphorus	x		$\mu g.l^{-1}$	252	1113	703	696	35	40	41	32	33	24	30	34	11	25	37	38
Chloride	x		$mg.l^{-1}$	60	61	61	56	51	55	47	43	49	58	58	39	40	51	40	38
Total organic carbon	x		$mg.l^{-1}$					27.15	19.53		30.58	24.33	21.58		28.55	29.57	24.32		33.05
Specific pollutants																			
Cadmium		x	$mg.kg^{-1}$																
Lead		x	$mg.kg^{-1}$																

Legend

- Oligotrophic
- Mesotrophic
- Eutrophic
- Hypertrophic
- <LOD Less than the limit of detection

Note: Trophic state colour code also applied to tributaries for comparison even though not normally valid for rivers

Lake Prespa – Macedonia. CSBL Analysis 2013–2014 (continued)

Physico-chemical elements	Medium		Unit	**MK V Otesevo**				**MK VI Pelagic point**				**Golema 1**				**Golema 2**			
Date	water	sediment		25/04/2013	29/07/2013	30/10/2013	26/01/2014	25/04/2013	29/07/2013	30/10/2013	26/01/2014	25/04/2013	29/07/2013	30/10/2013	26/01/2014	25/04/2013	29/07/2013	30/10/2013	26/01/2014
Temperature	x		^{0}C	16.5	25.5	16.7	4.9	13.9	25.2	16.1	5.8	11	25	12.5	0.35	11	18.2	10.5	0.34
Transparency (Secchi depth)	x		m					5.2	4.2	2.7	3.0								
Conductivity	x		μS.cm^{-1}	217	220	177	227	196	205	175	230	167	416	175	143	148	382	238	154
pH	x			7.7	8.9	8.6	8.5	8.1	8.9	8.7	8.2	7.6	7.8	7.2	7.4	7.1	7.2	7.5	7.3
Alkalinity as phenolphthalein	x		mg.l^{-1}	113	98	102	109	116	103	106	109	87	182	153	82	82	144	150	82
Suspended and dissolved inorganic and organic matter	x		mg.l^{-1}		0.02	0.02	0.02				0.02		0.02	0.12	0.03		0.02	0.04	0.07
Dissolved oxygen	x		mg.l^{-1}	11.43	10.44	10.99	10.78	11.26	9.47	9.63	10.70	10.87	5.57	4.69	10.10	10.93	7.70	5.98	9.85
Chemical oxygen demand	x		mg.l^{-1}	7.69	12.72	10.82	6.24	9.73	9.42	11.78	12.32	7.43	24.81	190.92	44.18	7.07	6.44	17.02	14.03
BOD_5	x		mg.l^{-1}	2.54	3.42	3.65	1.37	1.84	3.50	1.78	1.24	2.58	5.57	4.05	9.63	2.84	1.22	4.18	6.98
NH_3-N	x		mg.l^{-1}	<LOD	<LOD	<LOD	<LOD	0.020	<LOD	<LOD	<LOD	36.42	3.724	0.068	0.268	0.078	0.309	0.108	0.061
NO_3-N	x		mg.l^{-1}	0.019	<LOD	0.001	0.026	0.016	0.002	0.034	0.048	195.66	0.049	0.036	0.321	0.173	0.055	0.001	0.357
NO_2-N	x		mg.l^{-1}	<LOD	<LOD	<LOD	0.001	<LOD	<LOD	0.001	0.001	0.195	0.007	0.05	0.035	0.005	0.006	0.002	0.007
Kjeldahl nitrogen (organic nitrogen)	x		μg.l^{-1}	792	283	385	968	470	549	250	443	482	4217	632	993	407	473	385	597
Total nitrogen	x		μg.l^{-1}	811.28	282.75	385.30	994.34	486.00	568.74	250.10	491.44	680.43	4272.57	631.83	1314.54	178.28	533.46	385.30	963.86
Total phosphorus	x		μg.l^{-1}	37	18	30	45	6	30	41	43	30	440	100	139	54	34	59	89
Chloride	x		mg.l^{-1}	52	56	40	37	49	44	43	43	49	66	61	39	46	66	55	38
Total organic carbon	x		mg.l^{-1}	10.83	9.07		21.52	20.56	18.67		26.78								
Specific pollutants																			
Cadmium		x	mg.kg^{-1}																
Lead		x	mg.kg^{-1}																

Legend

Oligorophic

Mesotrophic

Eutrophic

Hypertrophic

<LOD Less than the limit of detection

Note: Trophic state colour code also applied to tributaries for comparison even though not normally valid for rivers

Lake Prespa – Albania. CSBL Analysis 2013–2014

Physico-chemical elements	Medium		Unit	**AL I Gollomboc**				**AL II Liqenas**			
Date	water	sediment		01/05/2013	24/07/2013	09/10/2013	05/02/2014	01/05/2013	24/07/2013	09/10/2013	05/02/2014
Temperature	x		^{0}C		27						
Transparency (Secchi depth)	x		m		3.5		3.5		3.5		2.5
Conductivity	x		µS.cm^{-1}	232	216	277	242	240	209	225	241
pH	x			8.3	8.8	8.4	8.1	7.8	8.6	8.5	8.3
Alkalinity as phenolphthalein	x		mg.l^{-1}	103	98	98	105	110	93	98	110
Suspended and dissolved inorganic and organic matter	x		mg.l^{-1}	0.40	3.70	0.50	<0.10	0.40	5.00	<0.01	<0.01
Dissolved oxygen	x		mg.l^{-1}		7.50				7.71		
Chemical oxygen demand	x		mg.l^{-1}	1.07	1.80	1.20	1.52	1.28	1.80	1.12	1.20
BOD_5	x		mg.l^{-1}		2.37	0.42			1.92	0.38	0.03
NH_3-N	x		mg.l^{-1}	<LOD	<LOD	0.02	0.01	<LOD	<LOD	0.01	0.02
NO_3-N	x		mg.l^{-1}	1.36	0.14	0.09	0.01	1.28	0.72	0.74	
NO_2-N	x		mg.l^{-1}	<LOD	<LOD	<0.01	<0.01	<LOD	<LOD	<0.01	<0.01
Kjeldahl nitrogen (organic nitrogen)	x		µg.l^{-1}								
Total nitrogen	x		µg.l^{-1}		0.45	0.39	0.34		0.46	0.83	0.36
Total phosphorus*	x		µg.l^{-1}	110	20	30	30	120	20	30	30
Chloride	x		mg.l^{-1}	7	9	7	5	9	7	9	5
Total organic carbon	x		mg.l^{-1}		4.64	6.04	5.57			5.95	5.84
Specific pollutants											
Cadmium		x	mg.kg^{-1}	<LOD			<0.001	<LOD	<LOD		<0.001
Lead		x	mg.kg^{-1}	0.007			<0.01	0.008			<0.01

*The similarity of values between sampling sites and campaigns raises concern as to the accuracy of some of the data. It is recommended to consider the data reported as indicative rather than conclusive. Further analyses will be needed to corroborate tentative findings.

Legend

Oligotrophic

Mesotrophic

Hypertrophic

<LOD Less than the limit of detection

11.3 *List of Orginal Reports Compiled in the Volume of Annexes*

Lake Shkodra/Skadar Sub-Basin

- **Chemical and physico-chemical quality elements**

  AGS (2014) Joint integrated monitoring programme in three lakes. Final report for Albania.

  Djuraskovic P (2013) Report of physical-chemical and microbiological investigations of Skadar Lake water and sediment quality. Final Report for Montenegro.

- **Biological quality elements**

– **Phytoplankton**

  Rakočević J and Rakaj M (2014) Phytoplankton of Skadar Lake. Final Report.

– **Macrophytes**

  Hadžiablahović S (2014) Macrophytes of Skadar Lake. Final Report for Montenegro.

  Kashta L and Rakaj M (2014) Macrophytes of lakes Prespa and Shkodra. Final Report for Albania.

– **Macroinvertebrates**

  Pavićević A (2014) Macrozoobenthos of Skadar Lake - Report for Montenegro

– **Fish**

  Mrdak D and Milošević D (2004) Fish Monitoring and Fisheries: Skadar/Shkodra Lake. Final Report.

Lake Ohrid Sub-Basin

- **Chemical and physico-chemical quality elements**

  AGS (2014) Joint integrated monitoring programme in three lakes. Final Report for Albania.

  Veljanoska-Sarafiloska E (2014a) Physico-chemical investigations of the water of Lake Ohrid and main tributaries. Final Report for Macedonia.

- **Biological quality elements**

– **Phytoplankton**

  Bacu A (2013) Preliminary report on quantitative chlorophyll-*a* evaluation at the lakes of Prespa and Ohrid during the campain of July 2013. Report for Albania.

  Bacu A (2013) Report on quantitative evaluation of chlorophyll-*a* and trophic state at the lakes of Prespa and Ohrid during the campaign of October 2013. Report for Albania.

  Bacu A (2014) Comprehensive report on phytoplankton analysis based on pigment content and tentative assesments of water quality sampling campaigns of 2013-2014 for Lakes Ohrid and Prespa. Report for Albania.

  Patceva S (2014a) Chlorophyll-*a* of Lake Ohrid. Final Report for Macedonia.

- **Macrophytes**

  Talevska M and Trajanovska S (2014) Final report for Macedonia by the Department of Hydrobotany.

– **Macroinvertebrates**

  Trajanovski S (2014) Macroinvertebrates investigations. Final Report for Macedonia.

– **Fish**

  Spirkovski Z, Ilik-Boeva D, Kapedani E, Flloko A, Palluqi A, Talevski T (2014) Fish Monitoring and Fisheries: Lake Ohrid. Final Report.

Lake Prespa Sub-Basin

- **Chemical and physico-chemical quality elements**

  AGS (2014) Joint integrated monitoring programme in three lakes. Final Report for Albania.

  Veljanoska-Sarafiloska E (2014b) Physico-chemical investigations of the water of Lake Prespa and River Golema. Final Report for Macedonia.

- **Biological quality elements**

– **Phytoplankton**

Bacu A (2013) preliminary report on quantitative chlorophyll-*a* evaluation at the lakes of Prespa and Ohrid during the campain of July 2013. Report for Albania.

Bacu A (2013) Report on quantitative evaluation of chlorophyll-*a* and trophic state at the lakes of Prespa and Ohrid during the campaign of October 2013. Report for Albania

Bacu A (2014) Report on quantitative evaluation of chlorophyll-*a*, trophic state determination and chemotaxonomy at the Lake Prespa during the campaign of April 2014. Report for Albania.

Bacu A (2014) Comprehensive report on phytoplankton analysis based on pigment content and tentative assesments of water quality sampling campaigns of 2013-2014 for Lakes Ohrid and Prespa. Report for Albania.

Patceva S (2014b) Phytoplankton of Lake Prespa. Final Report for Macedonia.

Rakaj M (2014) Phytoplankton of Macro Prespa Lake. Report for Albania.

– **Macrophytes**

Kashta L and Rakaj M (2014) Macrophytes of lakes Prespa and Shkodra. Final Report for Albania.

Talevska M and Trajanovska S (2014) Final report for Macedonia by the Department of Hydrobotany.

– **Macroinvertebrates**

Beqiraj S (2014) Benthic intervertebrate fauna Lake Prespa. Final Report for Albania.

Trajanovski S (2014) Macroinvertebrates investigations. Final Report for Macedonia.

– **Fish**

Ilik-Boeva D, Spirkovski Z, Talevski T, Shumka S, Aleksi P, Duma O (2014) Fish Monitoring and Fisheries: Lake Prespa. Final Report.

OTHER REPORTS

LAKE OHRID SUB-BASIN

Lokoska L (2014) Microbiological Investigation of the Water of Lake Ohrid and Tributaries: River Sateska, River Koselska and River Cherava. Final Report for Macedonia.

LAKE PRESPA SUB-BASIN

Kostoski G, Guseska D, Tasevska O (2014) Zooplankton of Lake Prespa. Final Report for Macedonia.

Lokoska L (2014) Microbiological Investigations of the Water of Lake Prespa and River Golema. Final Report for Macedonia.

11.4 List of Technical Working Group and other WFD Meetings

Technical Working Group – WFD Meetings		
20–21 September 2012	1st Meeting	Tirana
6 November 2012	2nd Meeting	Tirana
19–20 March 2013	3rd Meeting	Tirana
15 May 2013	4th Meeting	Tirana
9–10 October 2013	5th Meeting	Skopje
19–20 November 2013	6th Meeting jointly with TWG on Fisheries	Tirana
18–19 February 2014	7th Meeting	Tirana
18–19 June 2014	8th Meeting	Tirana
13 November 2014	Launching the Initial Characterization Report	Podgorica
18 November 2014	Launching the Initial Characterization Report	Skopje
19 November 2014	Launching the Initial Characterization Report	Tirana
19–20 November 2014	9th Meeting including Planning Workshop	Tirana
13–14 May 2015	10th Meeting	Tirana
29–30 October 2015	11th Meeting	Tirana

Other events		
17–18 July 2013	Joined sampling for physico-chemical analysis	Shkodra/Skadar Lake
4–5 February 2013	Calibration workshop on harmonization of methods and standards regarding sampling, transport and analysis	Podgorica
March 2014	Joined sampling for physico-chemical analyses	Ohrid Lake
March 2013	National expert meeting Albania: Defining responsible institutions for monitoring of parameters and indicators	Tirana
13–14 May 2013	National expert meeting Macedonia and Montenegro: Exchanging on analysis of phytoplankton, chlorophyll-*a* and physico-chemical parameters	Ohrid
7 February 2014	Regional expert meeting on macrophytes	Tirana
7 April 2014	Regional expert meeting on macrozoobenthos	Tirana
25–27 April 2014	Regional expert meeting on harmonization of methods for macrozoobenthos monitoring	Podgorica