STRATEGIC PLAN OF PSI HYDROBIOLOGICAL INSTITUTE, OHRID (2019-2023)

PONT | PRESPA OHRID NATURE TRUST

PSI HYDROBIOLOGICAL INSTITUTE

OHRID

Ohrid, 2019

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INTRODUCTION

This Strategic Plan of the PSIHydrobiological Institute Ohrid concerns the contribution by the PSI Hydrobiological Institute, Ohrid(PSIHIO) to conservation and sustainable management of biological diversity, natural processes and ecosystem services in Prespa and its wider area for the period 2019-2023. It was developed through a planning grant from PONT and is in accordance with the Institute's mission and vision, defines and directs the activities of this scientific institution, i.e.establishes the methods to achieve, realize and implement the goals set, while taking into account all the priorities, needs, possibilities and specifics of both the protected areas and the institute itself.

The aim of this Strategic Plan is to identify the opportunities and organize and employ the resources of the PSIHIO to provide scientific evidence and technical advice concerning the priority conservation actions identified in the management plans for the protected areas in North Macedonia and other funding priorities identified by PONT.

The Prespa Ohrid Nature Trust (PONT) is a foundation established under the German Law, supporting Protected Areas (PAs) and Environmental Actors (EAs) in the Wider Prespa Area (WPA) in North Macedonia, Greece and Albania, with the mission to "provide long term financing for the conservation and sustainable management of biological diversity, natural processes and ecosystem services in Prespa and its wider area for the benefit of nature and people in the region." The WPA includes the basin of Prespa Lakes and the areas outside it that are within the boundaries of Galichica and Pelister national parks. The EAs include non-governmental organizations (NGOs) with conservation focus in WPA, municipalities, scientific, research and academic institutions.PONT implements its mission through two main grant programs: (1) co-financing operational costs of Protected Areas, and (2) co-financing the work of Environmental Actors.

In 2017, in close cooperation with PAs, EAs and national authorities responsible for managing PAs, PONT has identified a set of 40 priority actions to be addressed by the EAs over the period from 2018 to 2027, that complement the actions included in the Management Plans for the PAs and together constitute the Strategic Framework that informs PONT's financing decisions. The priorities are grouped into 5 Focus Areas: 1) capacity development; 2) improved PA & forest management; 3) sustainable use of PAs (incl. recreation; traditional grazing; Non-Timber Forest Products); 4) conservation of species; and 5) conservation of habitats & landscapes. The actions under the last four Focus Areas are classified as related to either (1) applied research, studies and experimentation directly linked to real measures; or (2) real measures/implementation of conservation actions.

While the 2017 PONT Funding Priorities[1] lists two actions that are specifically related to the PSI HIO, many more relevant actions are included in the management plans for the protected areas in the WPA in North Macedonia. The goals in the Strategic Plan were defined over a number of meetings held with PONT's strategic partners for the protected areas: Municipality of Resen, PI NP Galichica and PI NP Pelister, as well as the Ministry of Environment and Physical Planning of the Republic of North Macedonia.Meetings were also

[1]These include "Population trends of endemic fish species and the potential impacts of invasive fish species" and "Preparation of action plans for rare wildlife species at basin level." PONT 2017 Funding Priorities can be downloaded at: http://pont.org/wp-content/uploads/2016/06/2017-PONT-Funding-Priorities.pdf.

held with relevant stakeholders in the Republic of North Macedonia (PE Strezevo - Bitola and Institute for Accreditation of Republic of North Macedonia) and Republic of Albania (Department of Biology and Chemistry at the Agricultural University, Tirana and Water Treatment Plant, Pogradec).

The strategic goals and research activities to achieve them were defined through an analysis of the Management Plans for the above mentioned protected areas that had been developed by relevant institutions: Nature Monument Lake Prespa Management Plan (2018-2028), Ezerani Nature Park - Management Plan (2012-2021), NP GalichicaManagement Plan (2010-2020), NP Pelister Management Plan (2006). The strategy concerns the aquatic ecosystems in these protected areas, including rivers, lakes (littoral and pelagic zone), wetlandand specific habitats as: reed beds, springs, temporary watercourses (wet phase), lime-rich oligotrophic vegetation of fast-flowing streams, C1.21 Benthic communities of mesotrophic water bodies, C1.23 Rooted submerged vegetation of mesotrophic waterbodies, C1.231 Large pondweed beds (*Potamogetonperfoliatus*), C1.232 Small pondweed communities (*Potamogeton* spp.), C1.24 Rooted floating vegetation of mesotrophic waterbodies, C1.27 Plankton communities of mesotrophic standing waters, C2.3 Permanent slow-flowing watercourses without estuaries, C2.32 Metapotamal and hypopotamal (middle-reach and lower-reach) streams, C2.33 Mesotrophic vegetation of slow-flowing rivers, C3.2 Water-fringing reedbeds and tall helophytes (other than canes and *Arundodonax*) are included. The description of the protected areas and the activities that are relevant to the mission ofthe PSIHIO are given in Annexes I to IV.

The Strategic Planalso takes into account the results from the assessment of the organizational capacity of the PSI Hydrobiological Institute Ohrid in general, and with respect to fulfilling their mission/contribution to nature conservation in the Prespa/Ohrid region in particular, using the Civil Society Tracking Tool (CSTT). Only Environmental Actors that are based in or have an antenna office in the WPA and/or with a main purpose to strengthen local based organizationsare eligible to receive grants from PONT. They should also be financially transparent and sustainable, tax registered, **have adopted a strategic plan**, and have a clear track record of conservation work in the WPA for at least the last 3 subsequent years.This Strategic Plan was developed to fulfill eligibility criteria set by PONT. A minimum of 25% of co-financing/matching funds from EAs is required by PONT.

1. HISTORICAL OVERVIEW OF THE ESTABLISHMENT AND OPERATIONS OF PSI HYDROBIOLOGICAL INSTITUTE, OHRID

The Hydrobiological Institute in Ohrid was established in 1935 as the first scientific institution in the Balkans. The Institute was founded on the initiative of the prominent environmentalist and limnologist, the academician prof. Sinisa Stankovic. TheHydrobiological Station structured thus, grew into an Institute after the Second World War,to beentered into the register of organizations conducting scientific research activities in 1994.

The establishment of the Hydrobiological Institute stands as a turning pointin the research of the unique Lake Ohrid, creating the prerequisites to continuethe systematic study of the Lake and its abundant wildlife with endemic and relict species. It's mission was later

extended to include the other two natural lakes in North Macedonia- Lake Prespa and Lake Dojran, as well as all surface waters: reservoirs, rivers and wetlands.

The Institute also stands as the venue for conducting joint research projects that have included numerous scientists from leading institutes across Europe and the world, alongside with Institute's personnel.

Today, the PSIHIO is a modern scientific institution with an admirable number of scientists – 13PhDs, three masters and one junior assistant, organized into ten departments:

- Department ofPhysical and Chemical Research
- Department ofMicrobiology
- Department ofZooplankton
- Department ofPhytoplankton
- Department of Hydrobotany
- Department ofBenthic Fauna (macrozoobenthos)
- Department ofCyprinid Fishes
- Department ofSalmonid Fishes, Applied Fisheryand Aquaculture
- Department ofFish Diseases and
- Department ofMolecular Biology

The Organizational Structural of the Institute is presented by the organigram in Annex V, whereas a detailed description of the Departments, their equipment and activities is given in Annex VI.

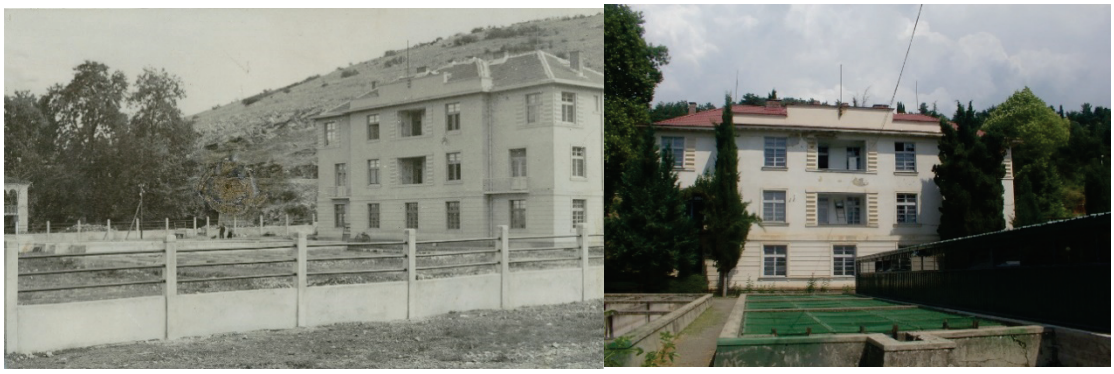
The fruitful scientific research work of the scientific staff has resulted in substantial number of scientific papers published in prestigious national and international journals. The scientific staff regularly takes part in international congresses, symposia, conferences and other scientific meetings. The Institute expands its activity through cooperation with other scientific institutions in the country and abroad and by participating in numerous national, regional and international research projects.

Apart from its principal scientific research activity, the PSIHIO has also been involved in educational activity. In this respect, it has successfully completed a cycle of postgraduate studies in Limnology, which produced the first Masters of Science in the field of limnology.

In addition, the Institute actively contributes its efforts to the mission of protecting the environment through numerous lectures and expert opinions presented by the scientific staff.

Since its establishment in 1935 to date, the Institute has been restocking the lake with artificiallyfertilized and spawnedLake Ohrid trout (*Salmo letnica*Karaman) offspring, in various development stages.

The Institute has been and will remain the cradle of internationally recognized scientists in the field of limnology and related scientific fields thus increasingly contributing to the world of science.



PSI Hydrobiological Institute Ohrid, in the past and today

2. MISSION OF PSI HYDROBIOLOGICAL INSTITUTE, OHRID

The PSIHIO is a Public Scientific Institution that performs fundamental scientific, research and educational activities in the field of biology - limnology in the Republic of North Macedonia. While performing its operations, the Institute engages in the following:

- study of hydrographic, hydrobiological, taxonomic, molecular, genetic, ecological and other features of freshwaters in North Macedonia,
- clarification of the history and evolution of the wildlife in the fresh waters of the Republic of North Macedonia - problems in and mechanisms of defining new types of organisms, the life and survival of old relic forms,
- monitoring and studying the problem of freshwater contamination in North Macedonia in order to signal, warn and protect against possible eutrophication and other forms of freshwater degradation in North Macedonia,
- improvement of research methods in limnological science,
- current scientific and professional studies of certain conditions in freshwaters in North Macedonia and relevant proposed solutions,
- artificial stocking of Lake Ohrid with Ohrid trout offspring, on condition that the latter is included in the registry of reproduction centers producing reproductive and stocking material,
- development of scientific and expert papers and reports on certain issues, as requestedby ministries and other state bodies,
- monitoring of the natural lakes in North Macedonia,
- publishing scientific papers in their own periodicals, special editions and international publications and exchange of scientific publications,
- presentation of scientific results through participation of scientific professionals from the Institute at congresses and symposia of domestic and international nature in North Macedonia and abroad.

3. VISION OF PSI HYDROBIOLOGICAL INSTITUTE, OHRID

Using itsposition of the institution with longest scientific tradition,both in the Republic of North Macedonia and in the Balkans, as a foundation for its operations,PSIHIO strives to:

1. Achieve anever-increasing level of scientific and research development through:
    - developing new, state-of-the-artresearch methods;
    - provision of new modern and sophisticated equipment and maintenance of the existing one, as well as implementation of modern monitoring, mapping and data processing programs;
    - setting higher criteria in the professional development of the scientific staff;
    - promotion of the international exchange of staff, to include the faculty, scientific professionals and associates;
    - involvement in the Erasmus scientific staff mobility program;
    - providing access to the Scopus-Elsevier electronic database or other equivalent software, thereby obtaining access to scientific and research literature;
    - achieving richer international cooperation (based on Memoranda of Cooperation signed) with institutes in related areas of activity and stakeholders;
    - promoting international visibility for our scientific profile and providing higher-level consultative and cooperative activities for the purpose ofsecuring better access to research funds, primarily on the international stage.
2. Promote the Institute's educational activity through the following:
    - renewal of the accreditation for Master degree studies in limnology, with the possibility of introducing new programs;
    - organizing summer schools, youth camps in protected areas;
    - organizing thematic practical courses for domestic and foreign students;
    - participation in the educational process at primary and secondary schools;
3. Have its laboratories and methods accreditedvia:
    - accreditation of sampling methods for different samples (water, sediment, tissue) according to the activities of each laboratory;
    - accreditation of individual accreditation methods for each laboratory
4. Improve and promoteits publishing activity through:
    - regular publication of the yearbook of PSI Hydrobiological Institute, Ohrid
    - establishing a magazine that will become a magazine of international significance in the future
5. Organizing domestic and international workshops, congresses, symposiums, conferences and other scientific meetings.

4. STRATEGIC GOALS AND EXPECTED OUTCOMES

The strategic goals presented below have been formulated by taking into account PONT 2017 Funding Priorities, the results of the analysis of management plans for the relevant protected areas in the WPA, and the discussions with their management authorities, as well as the results from the CSTT assessment. Goals I through III concern conservation issues and topics that need to be addressed through applied research and monitoring actions, whereas the remaining 4 goals relate to developing capacities and creating an enabling environment for effective cooperation with the key stakeholders.

For each strategic goal an indicative list of actions has been identified, as well as a set of expected results and outputs. The actual actions to be implemented will be selected in the preparation of grant proposals to be submitted to PONT, in consultation with the protected area authorities concerned and taking into account the available funding from PONT.

Goal I: The status and trends in key ecological processes of aquatic ecosystems withinthe protected areasin the Macedonian part of WPA are known through a well-structured and continuous monitoring of selected physicochemical and biological indicators

The monitoring constitutes a system of continued environmental surveillance in space and time. Its purpose is to collect qualitative and quantitative data on the presence and distribution of pollutants, then to monitor emissions and conditions, sources of pollution and their spatial distribution, pollutant transportation and establishment of pollutant concentrations at defined measurement points.

Generally speaking, no continuous quality water monitoring exists in any of the protected areas that are the subject of this Strategy (NM Lake Prespa, NP Ezerani, NP Galichica and NP Pelister).In order to prevent or decelerate the eutrophication processes, it is necessary to undertake measures to improve the aquatic ecosystems monitoring network: lakes (littoral and pelagic zone), rivers and groundwaters.The details of activities provided for the monitoring implementation in each of the protected areas are presented in Annexes I to IV. The monitoring will also include the following:

- calculation of nutrient balances. Nutrients are introduced into ecosystems in quantities that can accelerate the eutrophication process, i.e. aquatic ecosystem aging, and thus jeopardize both the survival of the entire ecosystem wildlife and the natural dynamic equilibrium. Additional pressure on aquatic ecosystems, especially Lake Prespa, comes from the inflow of pesticides and heavy metals, which mainly accumulate in its sediments, but also inside the consumable fish representing the peak of the food chain pyramid,and can eventually present a risk to human health. Microbiological contamination must be considered as a serious human health problem in zones wheresignificant quantities of untreated wastewater from households are discharged into the lake;
- calculation of trophic state indices (biological and chemical): aquatic ecosystem status and classification;
- monitoring of threats –identification of ecosystems pollution sources within the protected areas and the impact on wildlife.

Water quality and habitat monitoring will make it possible to produce a complete picture of the quality of protected areas environment.

The monitoring-based assessment of the situation will provide both guidance on the water quality preservation and development of measures to regulate the protected zones around the existing and planned water supply sources (springs, groundwater and surface water basins) within all protected areas.

The analysis of the nutrient balances will allow for the assessment of their impact on the Lake Prespa eutrophication, where priority will be given to the reduction of human and other types of pressure associated with the accelerated eutrophication.

The monitoring results will provide opportunities to define such measures whose implementation by the managing authority will contribute to maintaining the natural balance of ecosystems within the protected areas boundaries.

The monitoring of threats will allow for the following: mapping of hotspots – sources of pollution**; developing threat patterns; developing a cadaster of pollutants, as well as reducing or mitigating the consequences of threats.**

Goal II: The information concerning the major aquatic ecosystems and habitat types and the associated animal and plant communities is based on complex environmental researchand instrumental to addressing conservation priorities in WPA

In general, data on the distribution of plant communities, habitat types and many species within the protected areas are incomplete. Particularly insufficient are quantitative data on the status and structure of ecosystems and habitats and the processes within, i.e. population and ecology related studies to include: density of populations, numbers within populations, their spatial distribution, age structure, sex ratio insidea population, fecundity, birthrate and death rate.

The following results and outcomes are expected through the implementation of the activities related to this goal:

- mapping of important habitats of endemic species and development of habitat protection system;
- proposals for extensionof the zones of strict protection, as required;
- proposals for restriction and control of the use of certain economically beneficial species;
- design of measures for control of populations of introduced and invasive species;
- proposals for actions and measure to protect the vulnerable and endemic species of biodiversity, as well as the sites of key importance to biodiversity;
- measure to improve the conservation status of habitats and species ecosystems, their revitalization (where necessary), as well as maintaining stable populations of the species concerned;

- define a strategy for the protection of rare and important animal and plant species and habitats;
- full assessment of the natural values in the protected areas, as well as development of "national red lists".

In addition to the actions listed above, the changes in the key parameters describing the conservation status of habitats and species need to be addressed by designing and carrying out regular monitoring. Monitoring activities will include:

- monitoring of autochthonous species (endemic and endangered species);
- monitoring of allochthonous species;
- monitoring of invasive species;

  monitoring of habitats.

Goal III: Assessment of ecosystem services in protected areas provides a sound basis for management decisions:

The activities in the next 5 years concerning ecosystem services will focus on:

- Defining ecosystem services in protected areas;
- Developing maps of ecosystem services (Mind Maps) based on the Common Classification of Ecosystem Services (CICES) proposed by the European Environment Agency (EEA).

The assessment of ecosystem services in protected areas will provide for:

- ensuring the protection of biodiversity and sustainable use of natural resources and ecosystem services without posing a threat to the protected area;
- the evaluation and assessment of the ecosystem services to be an integral part of the general planning and decision-making processes at national, regional and local level.

Goal IV: Joint coordinated investigations with partner institutions on the Albanian side within transboundary protected areas enable efficient and effective use of available resources

The joint monitoring aimed at estimating the environment and biodiversity quality will provide prompt and visible environmental results, on the one hand, and strengthen the cooperation between the two countries at local and central level, on the other. To fulfill the Goal IV, PSI HIO intent to sign the Memorandum of Understanding (MoU) with each of the protected area authority concerned, especially with the stakeholders from Albanian side. The MoUs will provide opportunities for joint projects applications and activities.

The strength cooperation between PSI HIO and MoEPP will facilitate the relations with foreign ministries, agencies and institutions at national level.

Goal V: Involvement of PSI Hydrobiological Institute Ohrid in the educational programs and activities for the visitors of protected areas contributes to heightening the support for nature conservation in the WPA from stakeholders

In accordance with protected area programs and Management plans,PSI Hydrobiological Institute Ohrid can offer theoretical and practical training for different age and educational groups from the country and abroad

Environmental education and related activities, such as:Engagement of the broader community through programs such as citizen science; Expanding of teaching partnerships; Training courses,Summertime youth research camps,offer a platform for knowledge and awareness raising about the environment among some of the key stakeholders.

Goal VI: On-the-job training of the StenjeMonitoring Station personnel strengthens the management capacity of the Municipality of Resen as protected management authority

At the meeting with representatives from the Municipality of Resen, we were informed about the lack of professional staff at the station and the need to raise the Monitoring Station to a higher level by expanding the activities in terms of monitoring a large number of parameters from the physical chemical and biological aspect. For these reasons, we thought that we could participate in training existing staff, supplementing the working methodology, which would increase the number of parameters and more complex analyses for obtaining a complete picture of the state of the ecosystem - quality and biodiversity, assistance in development program of the station based on the needs of the protected area set out in their management plans. The possible joint activities will be defined with a Memorandum of Understandingand separate annexes.

Goal VII: PSIHIO has in place quality assuranceand control systems ensuring quality of the services it provides to customers and partners and improving its efficiency

Broadening the opportunities for PSI Hydrobiological Institute to apply for domestic and international projects, especially in cases when the accreditation of the laboratories or methods is one of the key requirements for application. Accreditation will provide quality of the services and intercalibration of the methods with other accredited domestic and international laboratories

- sampling methods for various samples according to the activities of each laboratory;
- individual accreditation parameters for each laboratory.

Goal VIII: The Public Scientific Institution Hydrobiological Institute Ohrid is a modern organization with the capacity to effectively plan, implement and evaluate research and educational actions contributing to biodiversity conservation.

The specific actions to achieve this goal should follow from the recommendations set out in the CSTT assessment conducted in March 2019:

1. Prepare a Strategy for development of PSIHIO for the next 3 years, which will be developed in a participatory way, involving all the employees in the Institute, and with recommendations for the vision of the Institute and by all stakeholders.
2. Find a model that will attract volunteers and young people to be actively involved in the work of PSIHIO without being expected to be permanently employed. Motivation among biologists and future laboratory assistants should be encouraged by a special program that can be assisted by the National Youth Council and the Association of Young Biologists.
3. To conduct good governance and management skills training so as to maintain sustainability in the horizontal and vertical co-operation.

4. To ensure that the documentation and work plan can be properly accredited by the Institute, from which there could be additional revenues annually and funding activities that are important for the conservation of biodiversity.
5. Enable an appropriate mentoring program to strengthen the capacity of the Hydrobiological Institute, according to this situation assessment and needs analysis.
6. To carry out training on project cycle management, which will last long-term and will have the possibility for consulting classes by an expert when applying for projects by the European Union or other international relevant institutions. To train employees how to create project goals and how the thread of the project logical framework with the accompanying budget develops.
7. Draw up a list of all stakeholders with which the Institutecooperates at this point or, according to its mission, should cooperate in the future. Such a mapping of the sector in which PSIHIO operates will be useful for strengthening long-term partnerships. If at this moment the Office cannot independently tend to a call, it can always include one of the strategic partners.

ANNEX I: MONUMENT OF NATURE LAKE PRESPA

Lake Prespa (Figure 1) (approximate surface area 17,778 ha) is classified as a Natural Monument (IUCN category III),pursuant to the Law on Nature Protection from 2004 and represents a very important part of the entirety ofIUCN-category-III protected areas in the Republic of North Macedonia, i.e. monuments of nature. Its surface area accounts for approximately 29% of the total area (61,680 ha) of all monuments of nature in North Macedonia.

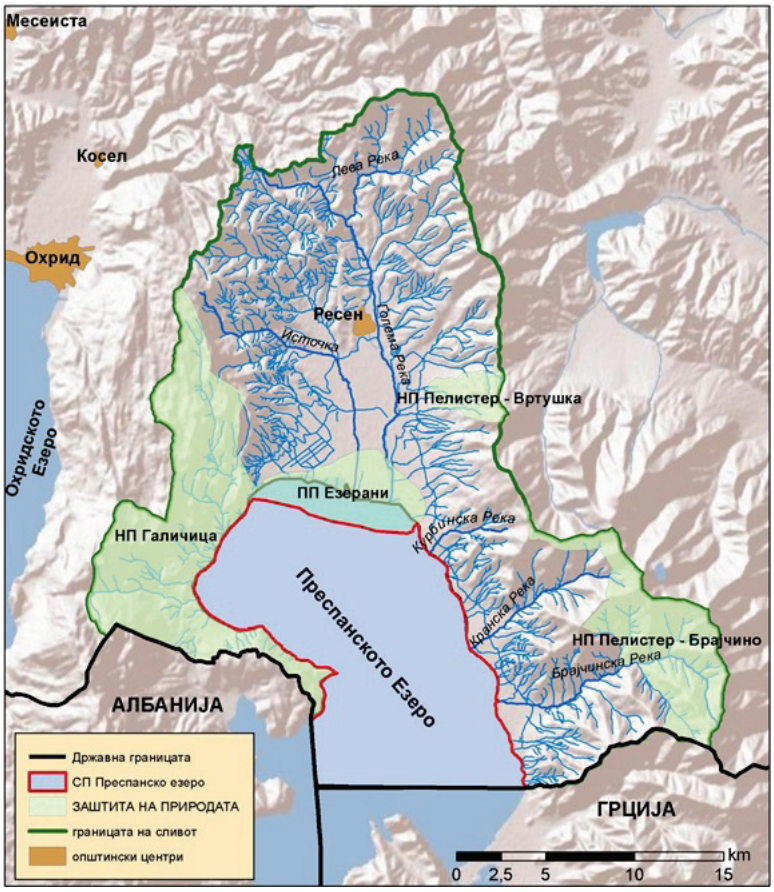


Fig. 1. Border of the Monument of Nature Lake Prespa and its watershed
(source: Monument of Nature Lake Prespa Management Plan (2018-2028))

Owing to its natural beauties, geomorphological, hydrological, hydrobiological and other scientific values, the part of the lake within the borders of the Republic of North Macedonia was proclaimed a natural monument (IUCN category III) by virtue of the Law on Proclamation of Lake Prespaasa Monument of Nature (“Official Gazette” of the Republic of North Macedonia No. 51/11, April 2011).

Lake Prespa’s added value lies within its hydrological features, as this lake is of great importance for the water regime of Lake Ohrid, and thus for the water regime ofthe River CrnDrim, which belongs to the Adriatic basin, which in turn determinesmany of the physical values in the western part of the country, as well as the protected natural values at the territory of the Republic of North Macedonia.

INTERNATIONAL SIGNIFICANCE

Lake Prespa is one of the seventeen ancient lakes on the planet and its age is estimated at more than five million years. This geological and geomorphologicalphenomenoncomprisesa large number of rare and protected plant and animal, endemic and relict species.

Lake Prespa can be found on the list of the most important ornithological sites in Europe, as well as the most important aquatic habitats in the world. It was declared a Ramsar Site on March 5, 1995 and is one of the two Ramsar Sites in North Macedonia, then a significant Emerald site (MK0000025;under Bern Convention of the Council of Europe) and animportant CORINE Biotope site (2011).

HYDROGRAPHY AND HYDROLOGY

The hydrography of the valley consists of groundwaters, springs, natural watercourses, manmade water bodies and a natural reservoir– the Lake. The total area of the hydrological basin of Prespa Valley is 1,350 km². From the geographical point of view, the basin is divided into two sub-basins: theMacro Prespa sub-basin and the Micro Prespa sub-basin.

The river network is represented by a fewmajor and many small rivers, as follows: GolemaReka, including its tributary Leva Reka, Brajcinska, Kranska, IstockaReka.All major water courses are formed at the foot of the mountains Pelister, Bigla and PlakenskaPlanina.

ECOSYSTEM TYPES

The richness and diversity of ecosystems resultsfrom the heterogeneity of natural conditions, and above all from the relief features, geological background, climate, soil, etc. The overall impact of these factors during the long geological history has led to the creation of a rich network of various relict and recent ecosystems: aquatic, wetland, meadow, forest, mountainous (subalpine and alpine), as well as human-conditioned weed and ruderal ecosystems. Key ecosystems in this region are the following:

Aquatic ecosystems. Prespa is a combination of three aquatic systems: a) lacustrine, covering the deep unpopulated parts of the lakes Macro Prespa and Micro Prespa; b) wetland, covering the area with dominant water habitat vegetation; and c) riparian, covering the river beds, defined herein as permanent watercourses or as a link between two static water bodies.

THREATS

A) Anthropogenic threats

1. Agriculture:

- agricultural activities in the Prespa region increase the physical pressure on the water bodies, especially watercourses and wetlands, but they also increase the amount of nutrients accumulating in Lake Prespa as a result of the increased supply of nutrients filtered from agricultural land

2. Animal husbandry

- poultry farms

3. Excessive forest exploitation

4. Industry

- increased anthropogenic impact due to waste matter release into lake waters

5. Inadequate treatment of household, utility and industrial wastewater, as the problem of connecting these waters to the water treatment system has not been solved

6. Illegal activities

7. Water level fluctuations:

- Water pumping - for irrigation from Lake Prespa, its tributaries and groundwater
- Natural fluctuations

8. Illegal landfills

9. Tourism

B) Global threats

1. Climate changes

- accelerated decrease of tributary volume - fresh water inflow, and therefore,lowerlakewaterleveland lower water table

PLANNED ACTIVITIES

Following are research activities within Lake Prespa Monument of Nature that are of special interest to PSI Hydrobiological Institute:

I. Input of rivers in the watershed of Lake Prespa: GolemaReka, including its tributary Leva Reka, Brajcinska, Kranska and IstockaReka.

A. Assessmentof the input of organic substances, nutrients, toxic substances and suspended solids from the rivers, which affect the eutrophication and biodiversity of Lake Prespa.

The water quality in the littoral zone of Lake Prespa is affected by the rivers that flow directly into the lake, but also by the waters drained from agricultural land and, certainly, by the household, utility and industrial waste waters, considering that the problem of connecting these waters to the water treatment system has not been solved. In view of this situation, it is necessary to establish continuous monitoringof the water quality in the littoral zone of Lake Prespa and the rivers, especially with regard tothe organic and nutrient loadcoming primarily withthe water drained from the surrounding agricultural areas. This phenomenon is especially pronounced during abundant rainfall thatdrains through agricultural land, rinses the soil and, with such quality (increased nitrogen, phosphorus, potassium and other nutrient contents) migrates directly to the aquatic ecosystems and affectswater quality.

1. Assessment of the water quality in the rivers on the basis of:
   a) physicochemical parameters:
      - basic physicochemical parameters (temperature, color, turbidity, pH, conductivity, total alkalinity, water hardness, water flow)
      - estimate of total suspended solids (organic and inorganic) and total residue after evaporation (organic and inorganic)
      - analysis of the organic load by examining the concentration of dissolved oxygen, the biochemical consumption of oxygen and organic matter, as potassium permanganate consumption,
      - nutrient load by analyzing nitrogen compounds (nitrites, nitrates, ammonia, organic nitrogen and total nitrogen) and analyzing total phosphorus and orthophosphates,
      - determination of persistent organic pollutants (organochlorine pesticides, etc.)

- determination of the presence of heavy metals

b) microbiological parameters:

- environmentally relevant parameters - presence and quantity of more important physiological groups of bacteria that indicate the specific organic pollution: heterotrophic (saprophytic, organotrophic), proteolytic, amylolytic, lipolytic, phosphate-mineralizers, phosphate mobilizers, nitrogen-fixative, cellulolytic and other bacteria
- parameters relevant to the sanitary condition of water (coliform bacteria, fecal indicators), concerning the establishment of its hygiene-epidemiological status: total number of coliform bacteria, enterococci, *Escherichia coli, Clostridium perfringens, Pseudomonas, Aeromonas*

2. Water quality estimatein the littoral and pelagic zone of Lake Prespa - The intense impact of the rivers flowing into Lake Prespa, especially observed on the lake shore, i.e. in the littoral zone, is considered to present a potential threatto the pelagic zone, primarily due to the fact that dissolved substances can be transported deeper in the lake, carried by the lake currents.

a) physical and chemical parameters:

- basic physical and chemical parameters (temperature, color, turbidity, pH, conductivity, total alkalinity, water hardness, water flow, transparency)
- estimate of total suspended solids (organic and inorganic) and total residue after evaporation (organic and inorganic)
- analysis of the organic load by examining the concentration of dissolved oxygen, the biochemical consumption of oxygen and organic matter, as potassium permanganate consumption,
- nutrient load by analyzing nitrogen compounds (nitrites, nitrates, ammonia, organic nitrogen and total nitrogen) and analyzing total phosphorus and orthophosphates,
- determination of persistent organic pollutants (organochlorine pesticides, etc.)
- determination of the presence of heavy metals

b) biological parameters:

- microbiological parameters
  - environmentally relevant parameters - presence and quantity of more important physiological groups of bacteria that indicate the specific organic pollution: heterotrophic (saprophytic, organotrophic), proteolytic, amylolytic, lipolytic, phosphate mineralizers, phosphate mobilizers, nitrogen-fixative, cellulolytic and other bacteria
  - parameters relevant to the sanitary condition of water (coliform bacteria, fecal indicators), concerning the establishment of its hygiene-epidemiological status: total number of coliform bacteria, enterococci, *Escherichia coli, Clostridium perfringens, Pseudomonas, Aeromonas*

- phytoplankton (composition and changes; chlorophyll a - indicator of trophic state ofwater; cyanobacteria - presence of toxins in the water as a risk to human health and wildlife in the water)
- zooplankton (composition, biomass, abundance, spatial and seasonal distribution, indices, bioindicators)
- benthic fauna (in accordance with the Water Framework Directive, estimate of the negative impact of lake level fluctuations on macrozoobenthos)
- macrophytes (in accordance with the Water Framework Directive; monitoring of the state of macrophytic vegetation, together with the changes in the distribution of macrophytes caused by the decrease of Lake Prespa water level)
- histological analysis of the liver tissue of barbell population (*Barbusprespensis*) which is a proper indicator of the ecological conditions in the aquatic ecosystems under research and the possible negative impact of the environment on fish populations
- identification of parasitic species in fish and establishment of the fish contamination rate in the aquatic ecosystems by seasons and localities

II. Sediments - bottom sediments are an exceptionally important element of every aquatic ecosystem

- Since the sediment is a medium which absorbs a large number of persistent organic pollutants, heavy metals, other toxic substances and nutrients (phosphorus, nitrogen), continuous inspection of the sediments is required, both in the littoral zone and in the rivers of the watershed, as well as the wetland ecosystems.
- Largest numbers of heterotrophic bacteria are present in the sediment and thereforethe latter is the sitewhere the most intenseprocesses of organic matter mineralization occur.

III. Groundwater–on account ofjeopardizedquality of groundwater used for drinking, irrigation, etc.

a) physical and chemical parameters:

- basic physical and chemical parameters (temperature, color, turbidity, pH, conductivity, total alkalinity, water hardness, water flow)
- estimate of total suspended solids (organic and inorganic) and total residue after evaporation (organic and inorganic)
- analysis of the organic load by examining the concentration of dissolved oxygen, the biochemical consumption of oxygen and organic matter, as potassium permanganate consumption,
- nutrient load by analyzing nitrogen compounds (nitrites, nitrates, ammonia, organic nitrogen and total nitrogen) and analyzing total phosphorus and orthophosphates,
- periodic determination of the presence of heavy metals

b) microbiological parameters:

- environmentally relevant parameters - presence and quantity of more important physiological groups of bacteria that indicate the specific organic pollution: heterotrophic (saprophytic, organotrophic), proteolytic, amylolytic, lipolytic, phosphate mineralizers, phosphate mobilizers, nitrogen-fixative, cellulolytic and other bacteria
- parameters relevant to the sanitary condition of water (coliform bacteria, fecal indicators), concerning the establishment of its hygiene-epidemiological status: total number of coliform bacteria, enterococci, *Escherichia coli, Clostridium perfringens, Pseudomonas, Aeromonas*

IV. Biodiversity of the main ecosystemtypes:

A) Lake ecosystem,

B) River ecosystems important in terms of biodiversity

C) Wetland ecosystems (Nakolec, Metlinec, Strbovo, Krani, StenjskoBlato) as habitats with exceptional biodiversity

These ecosystems will be explored with regard to:

- Phytoplankton (qualitative and quantitative composition, dominant species, changes depending on the trophic state)
- Invertebrate fauna (Rotifera, Copepoda, Cladocera) - qualitative composition, dominant species, enrichment of lists of species
- Macrophyte vegetation: composition, status and changes; measuring the reed belt, monitoring the condition of the reed belt and changes from the last measurements
- Bottom fauna with a special emphasis on endemic species
- Cyprinid fauna - monitoring the dynamics and ecology of ichthyopopulation; exploring the ecology of the present alochthonous species (e.g.pumpkinseed, crucian carp, etc.)
- Checking the status of endemic Prespa trout (*Salmo peristericus*) - obtaining data on the population size and age structure; comparison with previous data
- Fish parasites
- Mapping of important habitats of the barbell population (*Barbusprespensis*)

V. Functional relationships in the aquatic ecosystem food chain

Research of external impact and pressure on the aquatic ecosystem and functional relationships in the food chain (Figure 2).

- Nutrients (sources, concentration, impact)
- Phytoplankton (composition, dynamics, population density)
- Zooplankton (composition, dynamics, population density, functional characteristics)
- Fish (composition, dynamics, population density, functional characteristics)

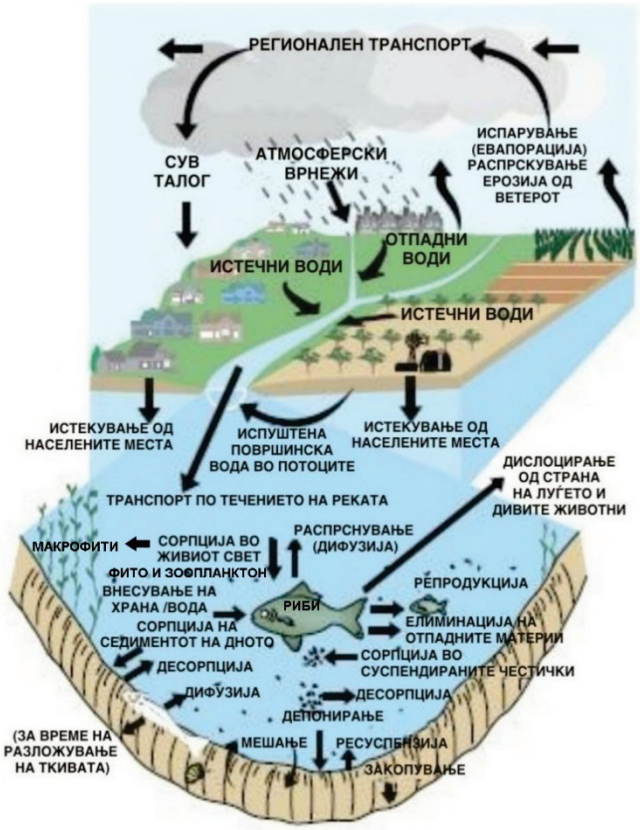


Fig. 2. External impact and pressureon aquatic ecosystem and functional relations in the food chain (modified according to Majewski and Capel, 1995)

ANNEX II: NATURE PARK EZERANI

The protected area Nature Park "Ezerani" (Figure 3) extends along the northern shore of Lake Prespa, between the village of Asamati and the settlement Sir Hahn. It is located at theelevation of 850 - 855 m above sea level. Administratively, it belongs to the municipality of Resen. The area is dominated by natural or slightly altered wetland ecosystems that cover an area of about 2,000 ha. The area of Ezerani was proclaimed a Strict Nature Reserve by the Assembly of the Republic of North Macedonia in 1996.In 2012, in accordance with the Law on Nature Protection, Ezerani was established as a Nature Park. The re-proclaimedPark's surface area covers 1,917 ha, of which 1,066 ha land area and 851 ha of water surface. The ratio of land and water surface is relative because Lake Prespa water level varies considerably in the course of the year and especially over longer periods.
Municipality of Resen has been appointed the managing authority of the nature park.

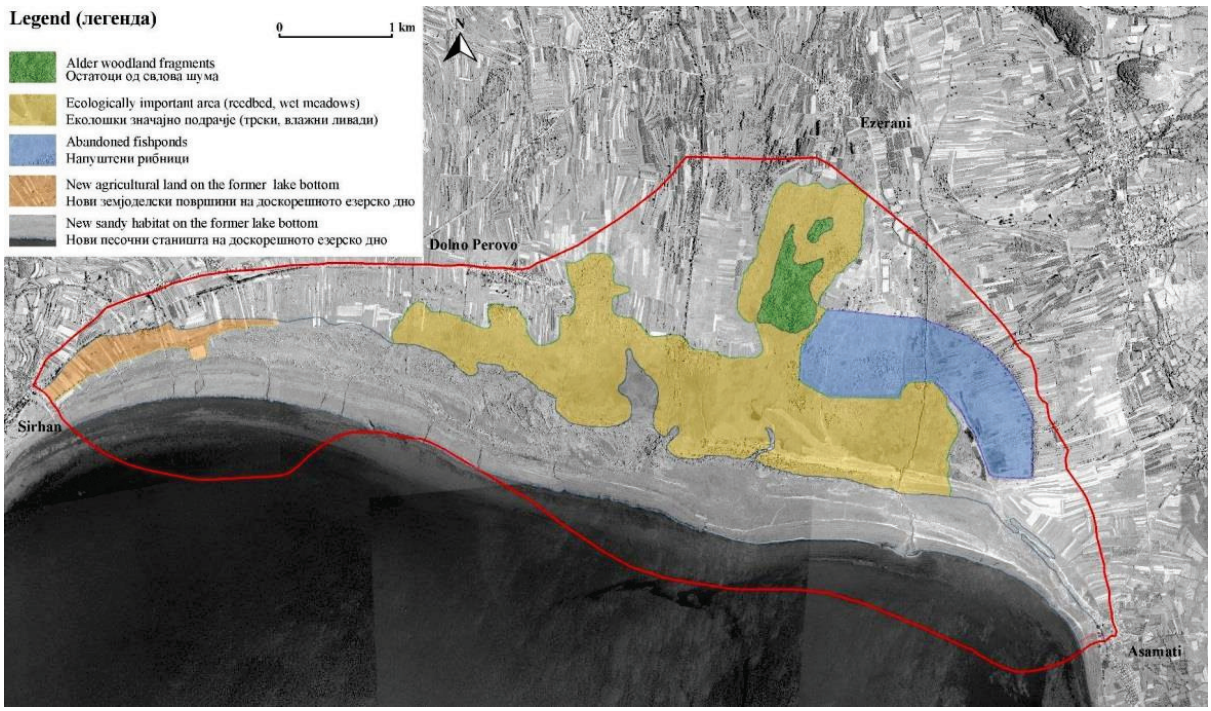


Fig. 3. Nature Park Ezerani (Source: Presentation of Prespa biosphere reserve management, 2016)

INTERNATIONAL STATUS OF NP EZERANI

NP Ezeraniisa RamsarSite as part of Lake Prespa, which was proclaimed Ramsar Site of International Importance, code 3MK001.
NP Ezerani is part of the Important Bird Area (IBA) "Lake Prespa"MK006 (Important Bird Area - IBA, according to the globally recognized Birdlife International system) (Velevski et al., 2010).
NP Ezerani is also part of the Important Plant Area (IPA) "Lake Prespa" (IPA, according to the globally recognizedPlantlife International system) (Anderson 2002; Radford and Odé (eds.); Melovski et al., 2010).
According to the latest trends in valorization of areas importantfor biodiversity and following the methodology proposed by IUCN, Prespa and the Ezerani site constitutea Key Biodiversity Area (KBA) (Melovski et al., in press).

NP Ezeranihas been identified as an Emerald site and included in the National Emerald Network (MECPP 2009), within the boundaries of the former Strict Nature Reserve.

HYDROLOGY

Two somewhat indistinct hydrological zones can be identified withinNP Ezerani. Apart from direct rainfall, the major inflow of water in Ezeraniisprovided by the rivers of GolemaReka and IstockaReka. Due to the specific hydrogeological composition of the entire region, the inflowof groundwater is also considerable. The estimated catchment area supplying water to NP Ezerani – GolemaReka, IstockaRekaand NP Ezerani's own watershed –amounts to approximately 250 km^2.

ECOSYSTEMS

The nature park "Ezerani" is characterized by the following ecosystems:

- Lake ecosystem - linked to the general importance of NP Ezerani, with the littoral being the most important habitat of the entire ecosystem, followed by the sandy shores.
- River ecosystems - very important in terms of biodiversity (aquatic organism's sanctuary, decomposition of detritus from leaves for food, etc.).
- Wetland ecosystems - developed as a result of the depth and consistency of surface and ground water. These ecosystems are highly endangered and gradually disappear or their surface area decreases.
- Grassland ecosystems
- Forest ecosystems
- Agro ecosystems

THREATS

1. ANTHROPOGENIC THREATS
   A) Agricultural activities:
   - loss, fragmentation and degradation of habitats and their destruction (wet meadows) through transformation into agricultural ecosystems
   - soil contamination - pesticides, fertilizers and pollution of lake water with pesticides and heavy metals
   - irrigation
   B) Wildfires –caused by arson to gain new arable land
   C) Destruction of embankments of former fisheries that are important habitats of many species
   D) Drainage of aquatic habitats in order to gain new arable land
   I) Unsustainable/illegal fishing
   F) Illegal logging in spruce and willow forests
   G) Pollution by waste matter (chemical and solid)
   - phosphorus input into the lake
   - disposal of rotten apples and solid waste into the riverbed of GolemaReka
   H) Sand excavation
   I) Low awareness level
   J) Absence of monitoring
2. NATURAL THREATS
   A) Lake Prespa water level fluctuations:

- decrease of water level
- the loss of the littoral zone and the biological communities associated with it
- threats to the belts of reeds, aldrovanda, pondweed and valisneria

B) Ecological succession - gradual change in the qualitative composition of a habitat biocenosis

C) Geological and climate changes:
- disruption of processes in ecosystems
- changes in biocenoses
- potential changes in species populations and loss of species

PLANNED ACTIVITIES

Following are research activities within NP Ezerani that are of special interest to PSI Hydrobiological Institute:

I. The input of the River Golema - The RiverGolema has the most important role in characterizing the hydrology of NP Ezerani, as it is the most important watercourse in the entire Lake Prespa watershed as well.

Assessment of the input of organic substances, nutrients, toxic substances and suspended solids from the River Golema that affect the eutrophication and biodiversity of NP Ezerani.

The water quality in the littoral zone of Lake Prespa is affected by the rivers that flow directly into the lake, but also by the waters drained from agricultural land and, certainly, by the household, utility and industrial waste waters, considering that the problem of connecting these waters to the water treatment system has not been solved. In view of this situation, it is necessary to establish continuous monitoring of the water quality in the littoral zone of Lake Prespa and the rivers, especially with regard to the organic and nutrient load coming primarily with the water drained from the surrounding agricultural areas. This phenomenon is especially pronounced during abundant rainfall that drains through agricultural land, rinses the soil and, with such quality (increased nitrogen, phosphorus, potassium and other nutrient contents) migrates directly to the aquatic ecosystems and affects water quality.

1. Assessment of the water quality in the rivers on the basis of:
   a) physical and chemical parameters:
      - basic physical and chemical parameters (temperature, color, turbidity, pH, conductivity, total alkalinity, water hardness, water flow)
      - estimate of total suspended solids (organic and inorganic) and total residue after evaporation (organic and inorganic)
      - analysis of the organic load by examining the concentration of dissolved oxygen, the biochemical consumption of oxygen and organic matter, as potassium permanganate consumption,
      - nutrient load by analyzing nitrogen compounds (nitrites, nitrates, ammonia, organic nitrogen and total nitrogen) and analyzing total phosphorus and orthophosphates,
      - determination of persistent organic pollutants (organochlorine pesticides, etc.)

- determination of the presence of heavy metals

b) microbiological parameters:
   - environmentally relevant parameters - presence and quantity of more important physiological groups of bacteria that indicate the specific organic pollution: heterotrophic (saprophytic, organotrophic), proteolytic, amylolytic, lipolytic, phosphate mineralizers, phosphate mobilizers, nitrogen-fixative, cellulolytic and other bacteria
   - parameters relevant to the sanitary condition of water (coliform bacteria, fecal indicators), concerning the establishment of its hygiene-epidemiological status: total number of coliform bacteria, enterococci, *Escherichia coli, Clostridium perfringens, Pseudomonas, Aeromonas*

2. Water quality estimate in the littoral zone of Lake Prespa, included within NP Ezerani boundaries, by means of the following parameters:

   a) physical and chemical parameters:

   - basic physical and chemical parameters (temperature, color, turbidity, pH, conductivity, total alkalinity, water hardness, water flow)
   - estimate of total suspended solids (organic and inorganic) and total residue after evaporation (organic and inorganic)
   - analysis of the organic load by examining the concentration of dissolved oxygen, the biochemical consumption of oxygen and organic matter, as potassium permanganate consumption,
   - nutrient load by analyzing nitrogen compounds (nitrites, nitrates, ammonia, organic nitrogen and total nitrogen) and analyzing total phosphorus and orthophosphates,
   - determination of persistent organic pollutants (organochlorine pesticides, etc.)
   - determination of the presence of heavy metals

   c) biological parameters:
   - microbiological parameters
     - environmentally relevant parameters - presence and quantity of more important physiological groups of bacteria that indicate the specific organic pollution: heterotrophic (saprophytic, organotrophic), proteolytic, amylolytic, lipolytic, phosphate mineralizers, phosphate mobilizers, nitrogen-fixative, cellulolytic and other bacteria
     - parameters relevant to the sanitary condition of water (coliform bacteria, fecal indicators), concerning the establishment of its hygiene-epidemiological status: total number of coliform bacteria, enterococci, *Escherichia coli, Clostridium perfringens, Pseudomonas, Aeromonas*
   - phytoplankton (composition, chlorophyll a - indicator of trophic state of water)

- zooplankton (composition, indices, bioindicators)
- bottom fauna (in accordance with the Water Framework Directive)
- macrophytes (in accordance with the Water Framework Directive)
- histological analyses
- fish parasites

II. Sediments - bottom sediments are an exceptionally important element of every aquatic ecosystem

- Since the sediment is a medium which absorbs a large number of persistent organic pollutants, heavy metals, other toxic substances and nutrients (phosphorus, nitrogen), continuous inspection of the sediments is required, both in the littoral zone and in the rivers of the watershed, as well as the wetland ecosystems.
- Largest numbers of heterotrophic bacteria are present in the sediment and, therefore, the latter is the site where the most intense processes of organic matter mineralization occur.

III. Groundwater –on account of jeopardized quality of groundwater used for drinking, irrigation, etc.

a) physical and chemical parameters:

- basic physical and chemical parameters (temperature, color, turbidity, pH, conductivity, total alkalinity, water hardness, water flow)
- estimate of total suspended solids (organic and inorganic) and total residue after evaporation (organic and inorganic)
- analysis of the organic load by examining the concentration of dissolved oxygen, the biochemical consumption of oxygen and organic matter, as potassium permanganate consumption,
- nutrient load by analyzing nitrogen compounds (nitrites, nitrates, ammonia, organic nitrogen and total nitrogen) and analyzing total phosphorus and orthophosphates,
- periodic determination of the presence of heavy metals

b) microbiological parameters:

- environmentally relevant parameters - presence and quantity of more important physiological groups of bacteria that indicate the specific organic pollution: heterotrophic (saprophytic, organotrophic), proteolytic, amylolytic, lipolytic, phosphate mineralizers, phosphate mobilizers, nitrogen-fixative, cellulolytic and other bacteria
- parameters relevant to the sanitary condition of water (coliform bacteria, fecal indicators), concerning the establishment of its hygiene-epidemiological status: total number of coliform bacteria, enterococci, *Escherichia coli, Clostridium perfringens, Pseudomonas, Aeromonas*

IV. Biodiversity research of the main ecosystem types:

A) Lake ecosystem,or rather its littoral part, which is within the boundary of NP Ezerani

B) River ecosystems important in terms of biodiversity

C) Wetland ecosystems as habitats with exceptional biodiversity

These ecosystems will be explored with regard to:

- Phytoplankton (qualitative and quantitative composition, dominant species, changes depending on the trophic state)
- Invertebrate fauna (Rotifera, Copepoda, Cladocera) - qualitative composition, dominant species, enrichment of lists of species
- Macrophyte vegetation: status of macrophyte vegetation and changes in the macrophyte vegetation distribution; continuous monitoring of the status of the remaining populations of *Aldrovandavesiculosa* at the site "Ezerani" and its immediate vicinity, habitat changes, as well as the threats to the survival of this species.
- Bottom fauna
- Cyprinid fauna
- Fish parasites
- Mapping of habitats important to the native and endemic fish species and developing a habitat conservation and protection system
- Ecology of the introduced species and control of their reproduction in the lake ecosystem

V. Research of habitats:

C1.21 Benthic communities of mesotrophic water bodies
C1.23 Rooted submerged vegetation of mesotrophic waterbodies
C1.231 Large pondweed beds (*Potamogetonperfoliatus*)
C1.232 Small pondweed communities (*Potamogeton* spp.)
C1.24 Rooted floating vegetation of mesotrophic waterbodies
C1.27 Plankton communities of mesotrophic standing waters
C2.3 Permanent slow-flowing watercourses without estuaries
C2.32 Metapotamal and hypopotamal(middle-reach and lower-reach) streams
C2.33 Mesotrophic vegetation of slow-flowing rivers
C3.2 Water-fringing reedbeds and tall helophytes (other than canes and *Arundodonax*)

VI. Involvement of PSI Hydrobiological Institute Ohrid in the educational programs for the visitors of NP Ezerani and in the organization of summertime, youth research camps

ANNEX III: NATIONAL PARK GALICHICA

National Park Galichica(Figure 4) was proclaimed in 1958, with the aim of preserving the flora and fauna and the natural appearance of Mount Galichica. The area covered by the Park comprises over 24,000 ha. The boundaries for the Park were defined in Article 4 of the *Law on Proclamation of part of Mountain Galichica a National Park* (Official Gazette No. 171/19).Today, the Park and its surroundings are recognized as an important biodiversity resource and cultural heritage in the region. The Park has won several international appellations including UNESCO World Heritage Site, Emerald Site, Important Plant Area, Prime Butterfly Area, while recently, in 2014, it was declared as part of the Ohird-Prespa Transboundary Biosphere Reserve (TBR), as part of the UNESCO 'Man and Biosphere' (MAB) Program.

SIGNIFICANCE

National Park Galichica is a biodiversity "hot spot" in Europe and broader. The exceptional wealth of habitats and species distinguishes the Park among other areas of similar size. At less than 25,000 ha, there are more than 35 types of habitats, 40 plant communities, about 1,600 taxa of vascular plants, over 143 species of lichenoid fungi, more than 480 species of fungi and over 3,231 fauna taxa. The rich biological diversity in the Park is of great national, European and global importance. Out of the rare or endangered habitats in Europe, the Park is home to ten types of forest vegetation, two types of shrubs, four types of grassland and two types chasmophytic vegetation. Two types of aquatic habitats and three types of habitats associated with underground geomorphological formsare also of European importance. There is truly a great number of species of global, European and national importance. In the Park, there are 4 invertebrate taxa and 13 vertebrates that are considered globally endangered. A few hundredsof rare and protected species in the park are represented by significant populations. The numerous endemic species provide the Park with a special meaning. Some of them are found only within the boundaries of the Park, including 29 algae taxa, 12 species of vascular plants, 61 taxa of invertebrates and 4 taxa of vertebrates. In addition, the park is populated bya large number of taxa found only in North Macedonia or the Balkans: 46 taxa of higher plants, 97 taxa of invertebrates and 14 taxa of vertebrates. There is a large number of species in the Park that are very attractive and easily recognizedby the visitors and the local population and, as such, theypresenta basis for tourism development.

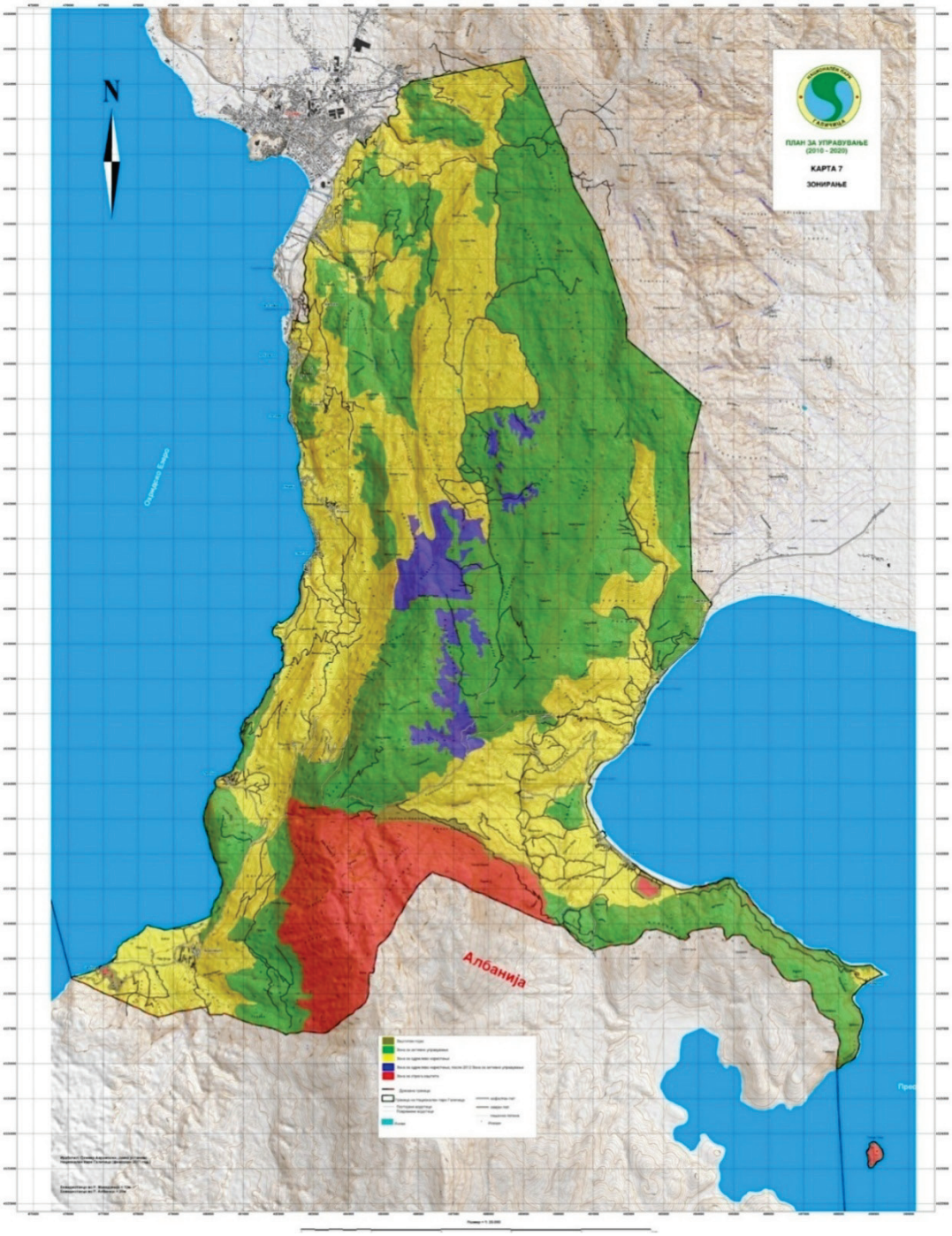


Fig. 4. NP Galichica – zoning (source: NP GalichicaManagement Plan 2010-2020)

HYDROLOGY

Galichicais among the massifs that are poorest insurface water and streamflow in the Republic of North Macedonia.The only permanent river flowing within the Park boundaries is Cherava, and only its lower reaches pass through the Park before it enters Lake Ohrid.Its sourceand the mostof the course are located in the Republic of Albania.

The large number of settlements along the slopes of Galichica and the needs of the people and numerous herds of sheep for drinking water in the past have encouraged usage of the available surface water. All the springs with a larger discharge have been adopted for water supply to the city of Ohrid and the villages in the Park. A number of small springs in the area have extremely small discharges and are typically contained in concrete reservoirs in order to secure drinking water for the settlements around the massif's slopes. This is the case with the springs at the locality of Vojtino above the village of Ljubanishta, the spring Vrshek above the village of Elshani, the spring Selishte above the village of Velestovo. The springs with the highest discharge in the locality of Letnica above the village of Ramne, have been captivated for the needs of the city of Ohrid.
The most important in the park is the spring in St. Naum, which is composed of many smaller sources that make a small pond. The water is relatively stable.
However, there are many sources on Mount Galichica and most of them are used for water supply in the populated areas of the Park, as well as for watering livestock. This is the case with the sources at the site Vojtino above the village of Ljubanishta, the spring Vrshek above the village of Elshani, the springSelishte above the village of Velestovo and, certainly, the largest and most prolific sources in the locality of Letnica above the village of Ramne, which were captured for the needs of the city of Ohrid.
The most important source within the Park is the spring in St. Naum, which is composed of multiple smaller sources that make up a small pond. The streamflow is relatively stable.

THREATS

The Park is currently exposed to a number of threats:

Urbanization: the key threat to the Park'sbiodiversity is the pressure from and for urbanization, and specifically,with regard to ensuring regional development based on tourism within the National Park Galichica. Someof the development activities along the northeast shoreline of Lake Ohrid are considered to bepotentially illegal.

Tourists: Certain parts of the National Park where tourists are granted access are facing problems (e.g. in the highlands area, and especiallyon the trails within the Zone of Strict Protection, where the tourists'numbers and behavior give rise to problems).

Wildfires;
Firewood & Forestry (legal & illegal);
Erosion: in certain areas

PLANNED ACTIVITIES

Following are research activities within NP Galichica that are of special interest to PSI Hydrobiological Institute:

I. Part of the marsh of StenjskoBlato, which belongs to the Zone of Strict Protection**.**The boundaries of this part of the zone of strict protection overlap with the boundaries of the marsh. In the past, large quantities of construction debris and solid utility waste from the village of Stenje were disposed offatStenjskoBlato, which rendereda part of this habitat completely changed. Also, Lake Prespa'swater level fluctuations, in relation to the general hydrological conditions in the Lake watershed, exert significant impact on the wetland. In the last few decades, its surface area has persistently been diminishing. The water's withdrawal has led to the expansionof the arable land at the expense of the marsh.

Taking into account its importance, but also the scarcity of relevant data, concerning this wetland ecosystem, the following research activities have been planned:

1. Assessment of the water quality on the basis of:
   c) physical and chemical parameters:
      - basic physical and chemical parameters (temperature, color, turbidity, pH, conductivity, total alkalinity, water hardness)
      - analysis of the organic load by examining the concentration of dissolved oxygen, the biochemical consumption of oxygen and organic matter, as potassium permanganate consumption,
      - nutrient load by analyzing nitrogen compounds (nitrites, nitrates, ammonia, organic nitrogen and total nitrogen) and analyzing total phosphorus and orthophosphates,

   b) biological parameters:
      - microbiological parameters
        - environmentally relevant parameters - presence and quantity of more important physiological groups of bacteria that indicate the specific organic pollution: heterotrophic (saprophytic, organotrophic), proteolytic, amylolytic, lipolytic, phosphate mineralizers, phosphate mobilizers, nitrogen-fixative, cellulolytic and other bacteria
      - phytoplankton (composition, chlorophyll a - indicator of trophic state of water)
      - zooplankton (composition, indices, bioindicators, wetland zooplankton index (WZI)determination asa useful indicator of water bodies' degradation and restoration)
      - bottom fauna (in accordance with the Water Framework Directive)
      - macrophytes (in accordance with the Water Framework Directive)

2. Sediment analyses:
   a) physical and chemical parameters:
   - pH, moisture percentage, % of organic matter (% OM), organic carbon share (% OC)

b) microbiological parameters (heterotrophic bacteria)

3. Biodiversity research
   - status of macrophyte vegetation and changes in the macrophyte vegetation distribution;
   - invertebrate fauna (Rotifera, Copepoda, Cladocera) - qualitative composition, dominant species, endemic species, enrichment of lists of species
   - benthic fauna
   - cyprinid fauna

4. Threats to biodiversity and habitat quality

II. Part St. Naum springs - (Zone of strict protection). The boundaries of this part of the zone for strict protection overlap with the boundaries of the pond formed by the shoreline and underwater sources in the karst springs including the large (southern) island. St.

Naumsprings are an exceptional, rare hydrological and ecological phenomenon in North Macedonia. Theyare the habitat of numerous endemic species. No infrastructure exists in this part of the strict protection zone. While human impact is minimal and comes down to visits to the park organized and controlled by the Park administration, the fact that the site's charm attracts a growing number of tourists should not be neglected, which poses the risk of increased anthropogenic impact on the ecosystem.

III. Part St. Naum springs - (Buffer beltaround the strict protection zone). The buffer beltextends around the entire zone of strict protection. It was established to separate the strict protection zone from the sustainable use zone, which experiences intensive tourism activities in the summer period. Enclosed within this protected area are the small (northern) island and part of the pond, formedby the shoreline and underwater sources of the karst spring around it, as well as a 100 meters wide land belt along the shoreline.

The established level of protection of St. Naum springs, as well as the potential danger of anthropogenic impact, impose the need for continuous monitoring of the ecosystem water quality, assessment of the trophic state, in order to ensure stable conditions for the populations of endemic plant and animal species.

In this respect, the following research activities have been planned:

1. Assessment of the water quality on the basis of:
    a) physical and chemical parameters:
        - basic physical and chemical parameters (temperature, color, turbidity, pH, conductivity, total alkalinity, water hardness)
        - analysis of the organic load by examining the concentration of dissolved oxygen, the biochemical consumption of oxygen and organic matter, as potassium permanganate consumption,
        - nutrient load by analyzing nitrogen compounds (nitrites, nitrates, ammonia, organic nitrogen and total nitrogen) and analyzing total phosphorus and orthophosphates,
    b) biological parameters:
        - microbiological parameters
            - environmentally relevant parameters - presence and quantity of more important physiological groups of bacteria that indicate the specific organic pollution: heterotrophic (saprophytic, organotrophic), proteolytic, amylolytic, lipolytic, phosphate mineralizers, phosphate mobilizers, nitrogen-fixative, cellulolytic and other bacteria
        - phytoplankton (composition, chlorophyll a - indicator of trophic state of water)
        - zooplankton (composition, indices, bioindicators)
        - bottom fauna (in accordance with the Water Framework Directive)
        - macrophytes (in accordance with the Water Framework Directive)

2. Biodiversity research, with particular reference to endemic species
3. Threats to biodiversity and habitatquality

IV. Habitat - ***Phragmitesaustralis*** **reed beds**(EUNIS C3.21) at the marsh ofStenjskoBlato (17 ha), at"St. Naum" springs, as well as in thePark's vicinity, along Lake Prespa shoreline, at the sectionextending from under Stenje to Carina, along Lake Ohrid shoreline, especially at the section between the autocampLjubanista and SvetiNaum.

1. Research of macrophytes

- status of macrophyte vegetation and changes in the macrophyte vegetation distribution

2. Research of invertebrate fauna (Rotifera, Copepoda, Cladocera)
   - Enrichment of the lists of meiofauna species, especially the Rotifera, Copepoda and Cladocera groups, i.e. the knowledge baseregarding biodiversity in the reed belt
3. Bottom fauna research
4. Cyprinid fauna research

V. **Temporary watercourses (wet phase)** – EUNIS 2004: C2.5and**Lime-rich oligotrophic vegetation of fast-flowing streams** – EUNIS 2004: C2.26) - types of rare or endangered habitats in Europe, as well as natural and manmade puddles.

1. Assessment of the water quality on the basis of:

d) physical and chemical parameters:

- basic physicochemical parameters (temperature, color, turbidity, pH, conductivity, total alkalinity, water hardness)
- analysis of the organic load by examining the concentration of dissolved oxygen, the biochemical consumption of oxygen and organic matter, as potassium permanganate consumption,
- nutrient load by analyzing nitrogen compounds (nitrites, nitrates, ammonia, organic nitrogen and total nitrogen) and analyzing total phosphorus and orthophosphates,
- water flow - for nutrient balance assessment

b) biological parameters:

- microbiological parameters:
  - environmentally relevant parameters - presence and quantity of more important physiological groups of bacteria that indicate the specific organic pollution: heterotrophic (saprophytic, organotrophic), proteolytic, amylolytic, lipolytic, phosphate mineralizers, phosphate mobilizers, nitrogen-fixative, cellulolytic and other bacteria
  - parameters relevant to the sanitary condition of water (coliform bacteria, fecal indicators), concerning the establishment of its hygiene-epidemiological status: total number of coliform bacteria, enterococci, *Escherichia coli, Clostridium perfringens, Pseudomonas, Aeromonas*

- phytoplankton (composition, chlorophyll a - indicator of trophic state of water)
- zooplankton (composition, indices, bioindicators)
- bottom fauna (in accordance with the Water Framework Directive)
- macrophytes (in accordance with the Water Framework Directive)

2. Biodiversity research
   - macrophyte vegetation
   - invertebrate fauna
3. Threats to biodiversity and habitat quality

VI. Determining the presence, distribution and status of fish populations represented within the National Park Galichica.

ANNEX III

In the waters that are part of or linked to NP Galichica, there are 27 fish species belonging to 5 families: Anguilide, Cyprinidae, Cobitidae, Nemacheilidae and Salmonidae.Strictly protected, endangered and endemic fish species recorded at the territory of NP Galichica are the following:

Gobioohridanus(Ohrid gudgeon) - VU
Chondrostomaohridanus(nase) - /
Barbatulasturayi- LC
Salmo letnica - DD

Research activities have been foreseen to determine the presence, distribution and status of the fish populations represented within the Park, as well as taxonomic investigations for full and complete identification of the affected and endemic species.

VII. Involvement of PSI Hydrobiological Institute Ohrid in the educational programs for the visitors of NP Galichica and in the organization of summertime, youth research camps.

ANNEX IV: NATIONAL PARK PELISTER

National Park Pelister (Figure 5) is located in the southwestern part of the Republic of North Macedonia,encompassing an area of 10,870ha on the northern side of the Baba Mountain, at elevation ranging from 900 to 2601 m. National Park Pelister was proclaimed on November 30, 1948 pursuant tothe law enacted by thePresidium of the People's Assembly of the People's Republic of North Macedonia (Official Gazette of P.R.M. 38/48).
Some of the exceptional values of National Park Pelister have been identified and evaluated earlier, the earliest case being the Park Proclamation act of 1948 (Official Gazette of R.M. 8/48), but also later, in the PhysicalPlan of 1988, as well as the Special Plans for Cultivation and Protection of the Forests withinNational Park Pelister.

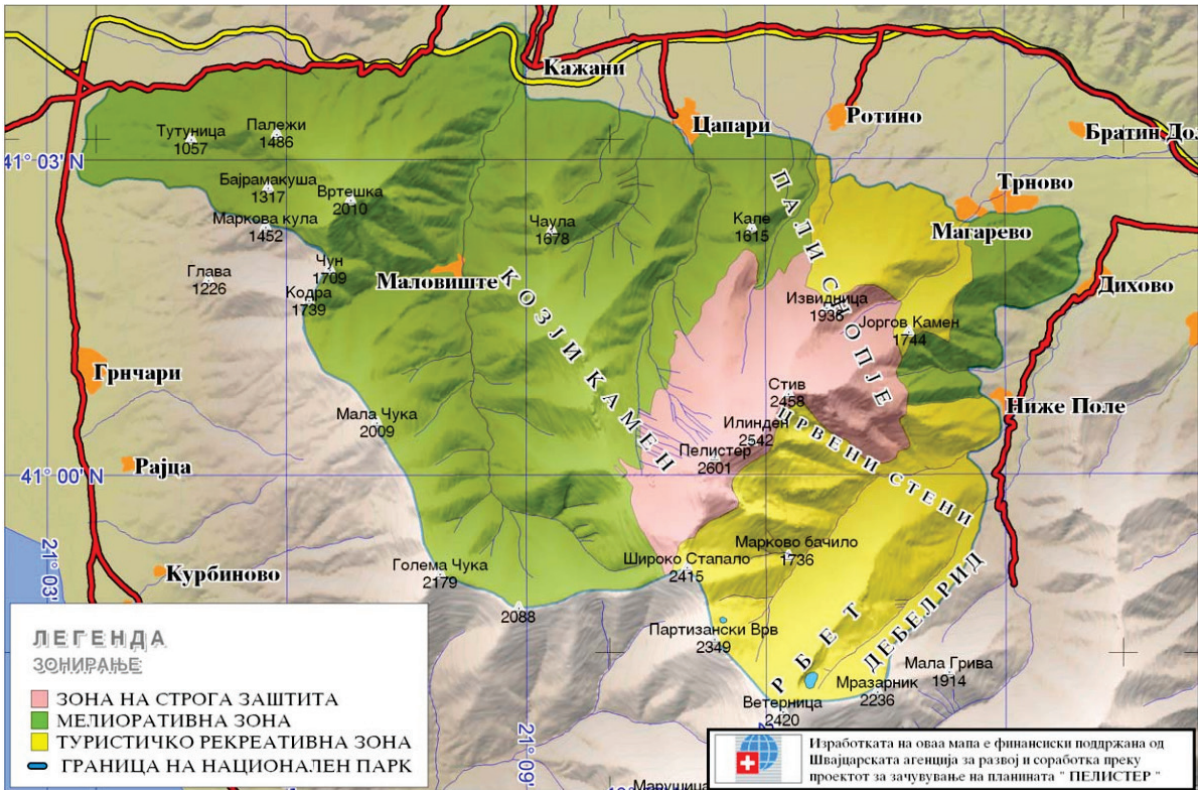


Figure.5.Present borders and zoning at National Park Pelister
(Source: Management Plan of National ParkPelister, 2006)

Within the Park's territory, there is a variety of glacial and periglacial geomorphological forms, some of which are rare in the Balkans, preserved in their original state and highly attractive to Park visitors. Thanks to the geological composition, particularities of the topography and the local mountainous climate, different habitats have developed in the Park that in turn support rich and significant biodiversity. Most prominent among these are the extensive forest of the Macedonian Pine – molika, the glacial lakes and alpine grassland communities.
There are about 26 plant communities or about 9.6% of all plant communities in North Macedonia. The Park houses more than 388 species of lower plants, which amounts to 18.4% of all lower plant species in the country, and 973 species of higher plant species or 26.3% of all higher plant species in North Macedonia. Invertebrates are represented by 587 taxa or 6.7% of all invertebrate animals in the country. Out of the total of 15 amphibian species registered in North Macedonia, 10 species are found in the Park. (66.7%). Likewise, out of the 32 registered species of reptiles, 16 (50%) are present in the Park, whilst more than 94 registered bird species represent

about 30% of all bird species in the country. The Park is also home to 41 mammal species, which represents 50% of all registered mammal species known in North Macedonia.

INTERNATIONAL IMPORTANCE

The area of National Park Pelister is included intomultiple internationally recognized categories:

- Emerald Network, as a site of special interest for protection "Pelister", under the code MK0000004,
- European Green Belt, under the code MK002,
- Transboundary Biosphere Reserve Ohrid Prespa,
- Mount Baba, across which NP Pelister extends, is consideredone of the most important butterfly areas at the international level under the code MAK-08.

HYDROLOGY

The area of National Park Pelister almost entirely belongs to the river Crna watershed and includes two glaciallakes and seven rivers: Malovishka (Shemnica), Manastirska, Caparska, Rotinska,Magarevska, Crvena and Ezerska. The longest watercourse on Pelister is Shemnica – 46 km. The Greater Glacial Lake lies at 2,218 melevation, it is elliptical inshape (3.7 ha), 223 mlong, 162 mwide and 14.5 mdeep. The Smaller Glacial Lake lies at 2,180 melevation, it is of irregular shape (0.66 ha), 97 mlong, 68 m wide and 2.6 mdeep.Groundwater in the Park feeds the numerous springs throughout its territory. There are alsofew temporary watercourses within the Park, mainly on its western slope, and they are part of Lake Prespa watershed.

ECOSYSTEMS

All major types ofecosystems, typically found inNorth Macedonia, are also present in the Park: forests, dry grassland,mountain ecosystems and water ecosystems. Within these ecosystems one can observe a variety of habitats ranging from heath andscrubs, through broadleaved deciduous (the oak and beech) and coniferous (molika pine)woodland, to dry, sub-alpine and alpine grassland communities, as well as riparian communities and aquatic habitats.
The water ecosystems in the Park, such as the glacial lakes, mountain springs, riversand streams and the associated plant communities are characterized by natural structureand spontaneous development of the processes and ecological functions.

THREATS

1. Erosion
2. Wildfires - mostly caused by negligence of visitors or local population
3. Urbanization
4. Invasive species, pests and diseases
5. Poaching
6. Unreasonableuse of water resources - impact on the quality and flow regime of watercourses
7. Construction of water abstraction stations and fountains within Park's territory
8. Construction of small hydro power plants that do not provide a biological minimum
9. Waste waters
10. No household wastewater sewage and treatment system exists and the wastewater is drained into cesspits (village ofMalovishte)
11. Wastewater discharge from hotels and otheraccommodation facilitiesin the GolemaLivada zone and the mountain hut on Greater Lake
12. Inappropriate solid waste management

13. Overharvesting of nutritive and medicinal plants
14. Tourism –largenumbers of visitors to certain sites and improper behavior
15. Global climate changes
    - variable periods with long droughts and very intense rainfall that cause soil erosion and land degradation

PLANNED ACTIVITIES

Following are research activities within NP Pelister that are of special interest to PSI Hydrobiological Institute:

Glacial lakes, mountain springs, streams and rivers

Aquatic habitats in the Park are the most sensitive ecosystems in the Park. At present, there are still pressures and threats that may bring about serious consequences for these habitats. Some of them, such as global climate changes, and probably air pollution, are a consequence of processes that occur beyond the Park boundaries. However, a significant part of the pressures results from to wastewater pollution, inappropriate visitor management and the construction of water intakes and fountains in the Park's territory. Wastewater issues are particularly pronounced in the case of the river MagarevskaReka (wastewater from Molika hotel), Shemnica (wastewater from the village of Malovishta) and Greater Lake (wastewater from the mountain hut on Greater Lake). The relatively large number of visitors at the Greater Lake and the improper behavior of some of the visitors (e.g. washing and bathing in the lake) are also a major threat to the Greater Lake ecosystem.

1. Assessment of the water quality in river ecosystems and glacial lakes on the basis of:
   a) physical and chemical parameters:
      - basic physical and chemical parameters (temperature, color, turbidity, pH, conductivity, total alkalinity, water hardness, water flow, transparency)
      - estimate of total suspended solids (organic and inorganic) and total residue after evaporation (organic and inorganic)
      - analysis of the organic load by examining the concentration of dissolved oxygen, the biochemical consumption of oxygen and organic matter, as potassium permanganate consumption,
      - nutrient load by analyzing nitrogen compounds (nitrites, nitrates, ammonia, organic nitrogen and total nitrogen) and analyzing total phosphorus and orthophosphates,

   c) biological parameters:
      - microbiological parameters
        - environmentally relevant parameters - presence and quantity of more important physiological groups of bacteria that indicate the specific organic pollution: heterotrophic (saprophytic, organotrophic), proteolytic, amylolytic, lipolytic, phosphate mineralizers, phosphate mobilizers, nitrogen-fixative, cellulolytic and other bacteria
        - parameters relevant to the sanitary condition of water (coliform bacteria, fecal indicators), concerning the establishment of its hygiene-epidemiological status: total number of coliform bacteria,

enterococci, *Escherichia coli, Clostridium perfringens, Pseudomonas, Aeromonas*

- phytoplankton (composition; chlorophyll a - indicator of trophic state of water)
- zooplankton (composition, biomass, abundance, spatial and seasonal distribution, indices, bioindicators)
- bottom fauna (in accordance with the Water Framework Directive)
- macrophytes (in accordance with the Water Framework Directive)
- health status of trout populations*Salmo pelagonicus*и *Salmo peristericus*
- identification of parasitic species in fish and establishment of the fish contamination rate in the aquatic ecosystems by seasons and localities

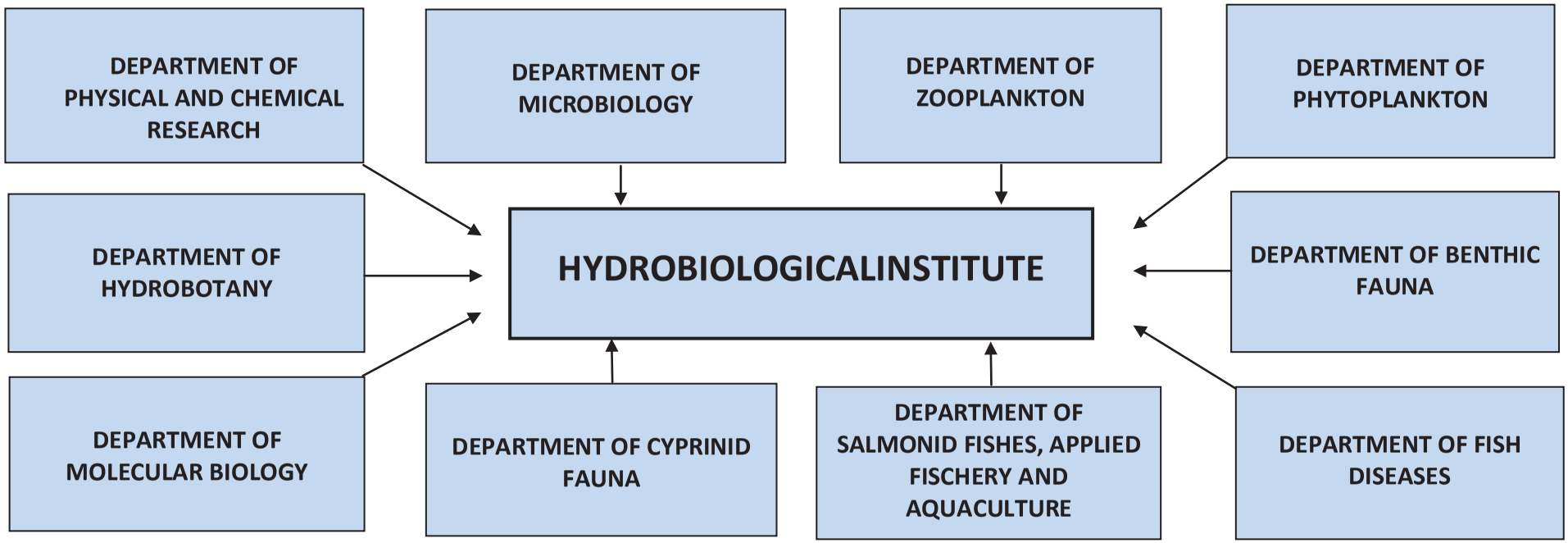
II. Biodiversity based research of the main ecosystem types: glacial lakes, mountain springs, streams and rivers, as well as the associated wetland communities(peat bogs, riverine vegetation).

Due to insufficient researchdata regarding multiple groups of invertebrates from these ecosystems, there is high certainty of the presence of other species that may be importantfor science or nature protection.

- Phytoplankton (qualitative and quantitative composition, dominant species, whereby biodiversity will be enriched with newly identified algae)
- Invertebrate fauna (Rotifera, Copepoda, Cladocera) - qualitative composition, dominant species, endemic species, enrichment of lists of species
- Preliminary research of macrophyte vegetation: determination of species
- Benthic fauna
- Checking the status of endemic Prespa trout (*Salmo peristericus*) - population status
- Thorough population and genetic research of *Salmo pelagonicus*and *Salmo peristericus*

- Involvement of PSI Hydrobiological Institute Ohrid in the educational programs for the visitors of NP Pelister and in the organization of summertime, youth research camps.

ANNEX V: ORGANIGRAM OF THE PSI HYDROBIOLOGICAL INSTITUTE, OHRID



ANNEX VI: Detailed description of the Departments at the PSI Hydrobiological Institute Ohrid

➢ DEPARTMENT OF PHYSICAL AND CHEMICAL RESEARCH






Short description of the Department and its purpose

The Department of Physical and Chemical Research studies the physical and chemical characteristics of freshwater aquatic ecosystems (natural lakes, rivers, reservoirs), fisheries, groundwater, wastewater, drinking water, etc.

- Based on physical and chemical parameters, the concentrations of total nitrogen and phosphorus, as well as organic biodegradable substances, we determine the quality of water in the littoral and pelagic zone of Ohrid, Prespa, and Dojran Lake, respectively, determining the trophic status of aquatic ecosystems.
- We determine the organic and nutrient burden of surface flows as recipients of waste industrial and communal waters, water from households, and drainage waters from the surrounding agrarian areas where these rivers migrate.
- Water quality and anthropogenic impact are assessed in the artificial reservoirs in the republic.
- Regular control of the water quality in the fish farms in the Republic of Macedonia is carried out.

Equipment available in the Department

- Spectrophotometer (UV-VIS Zeiss-Jena, Specord S-10)
- Gas chromatograph (GC / ECD GS-3800 and Varian GS / MS system, Saturn 2100)
- Atomic absorption spectroscopy Varian SpectrAA 220
- HPLC liquid chromatograph

- TOC / DOC analyzer
- Microwave oven Milestone Microwave laboratory systems (Ethos touch control)
- Four-channel auto analyser Skalar
- Analyser for nitrogen compounds in sediment (Kjeldahl - digestion) Velp
- Analytical and Technical scale
- Ultrasonic bathroom and Water bath
- Drying and grilling furnace, centrifuge
- Water meter, pH meter, conductometer, thermometer, turbidimeter
- System for ultra clean water

What scientific research and application projects can the Department perform?

Surface water and sediment represent an extremely complex system consisting of substances that have reached them naturally and as a result of anthropogenic influence. Numerous physical and chemical and biochemical processes largely influence the distribution of matter in the sediment-water system, determine the forms of their finding, behaviour, and destiny.

The sediment serves as a habitat for the benthic living world (insects, shells, shrimp, which are usually food for fish) as a source and mechanism for removing certain contaminants into and from the water ecosystem and as a carrier of contaminants in ecosystems. By analysing contaminants in sediments and aquatic life, an efficient way of detecting the presence of toxic components in the aquatic ecosystem is provided.

The high sensitivity of fish fauna to chemical substances, that evolves, it is often used as an indicator of the degree of water pollution.

Given the fact that the quality of groundwater is seriously threatened recently as a result of irrigation in the dry period and the use of water from the wells, continuous monitoring of groundwater in terms of water quality and the quantity of groundwater utilization is necessary. The monitoring involves examining the quality of groundwater based on physico-chemical and biological parameters, primarily microbiological analyses and based on the Decree on the classification of groundwater, the class in which the waters belong.

- Monitoring the status of water quality in all aquatic ecosystems in Macedonia (springs, rivers, groundwater, natural lakes, reservoirs, wetlands, etc.)
- Determination of the trophic status of aquatic ecosystems (lakes, accumulations) based on the concentration of total phosphorus and transparency by applying mathematical calculations to the Carlson trophic index.
- Quantitative and qualitative determination of persistent organic pollutants (POPs) present in different matrixes (water, sediment, plant and animal tissue)
- Determination of organic and nutrient load on aquatic ecosystems
- Determination of individual physical and chemical parameters in sample sediment collected from aquatic ecosystems (pH,% of moisture in the sediment,% of organic matter, etc.).
- Analysis of samples of atmospheric water (rainwater) based on physical and chemical parameters (basic physical-chemical parameters, nutrients, oxygen parameters, and organic biodegradable substances)

➢ DEPARTMENT OF MICROBIOLOGY



Short description of the Department and its purpose

Microbiological analyses from the sanitary and ecological aspect of all types of natural and wastewater (lakes, rivers, reservoirs, springs, fishponds, etc.)

- water for drinking
- bathing water
- for irrigation
- communal wastewater
- industrial wastewater
- Analysis of sediments
- Analysis of food and beverages, fish food, etc.
- Analysis of fish diseases

Equipment in the Department:

- dryers
- sterilizers
- Incubators for the development of microorganisms
- a filter device
- autoclave
- microscopes,
- binoculars and magnifiers for counting colonies

What scientific research and application projects can the Department perform?

Bacteria are natural components of lakes, rivers, groundwater and streams. These bacteria are numerous and varied organisms. The enormous number of these small organisms can have a major impact on the processes occurring in aquatic ecosystems, such as carbon, hydrogen, phosphorus, nitrogen and sulphur. They can also affect water quality by controlling the amount of oxygen and other elements in the water and causing disease in organisms as in humans.
Knowing the composition and dynamics of their population is a real indicator for determining and forecasting the state of aquatic ecosystems. Bacteria are a very important indicator for determining the level of purity of the analysed water. As the first indicators of eutrophication, they have primary importance within hydrobiological research.
The bottom sediments are an extremely important element of every aquatic ecosystem. In the sediment, heterotrophic bacteria occur most, and from here, this is where the processes of mineralization of organic matter take place most intensively.

• Monitoring of the conditions in all aquatic ecosystems in Macedonia (springs, rivers, groundwater, natural lakes, reservoirs, wetlands, etc.)
• All types of microbiological analyses from sanitary and environmental aspects
• Water quality analysis for any purpose (drinking, bathing, irrigation)
• Analysis of wastewater, sediment, food.

➢ DEPARTMENT OF PHYTOPLANKTON

Short description of the Department and its purpose

The Phytoplankton department explores the planktonic and other groups of algae in the lake, river, and water from accumulations. It also determines the concentration of photosynthetic pigment chlorophyll in water, which pigment is an integral part of all groups of algae. Based on this parameter, phytoplankton biomass, primary production and trophic status of water are determined. Phytoplankton Department with Decision no. 10-7004 dated December 18, 1992, issued by the Ministry of Health of the Republic of Macedonia. Macedonia is authorized by the biological aspect (phytoplankton research) to monitor the correctness of the surface waters used for water supply and processed water from the filter stations in the country, in several cities in Macedonia.

Equipment in the Department:

- Inverted microscope, truncular LW101-2 with epilmuminescence and camera, OmniVID; 8.0MP
- AlgaeTorch 10 with accessories
- Flow cytometer CytoBuoy
- Ultrasonic bathBranson 2510 Merck- Photosynthetic Active Radiation Analyzer (PAR)

What scientific research and application projects can the Department perform?

ANNEX VI

Phytoplankton forms the basis of many chains of nutrition in the lakes. It consists of many different taxa that respond to physical and chemical influences and certain types of cyanobacteria that form a flower that is associated with water enrichment with nutrients (nutrients).
The analysis of phytoplankton uses the principle that the increase in nutrients (especially phosphorus) leads to an increase in the biomass of phytoplankton and a change in the taxonomic composition, which often leads to an increased occurrence of cyanobacteria (blue-green algae). Due to their short life cycle, planktonic algae quickly respond to environmental changes and are therefore an important indicator of water quality.
According to the Water Framework Directive (WFD), phytoplankton has been identified as a key biological quality element (BQE) to be used in assessing the ecological quality of the lake.
Chlorophyll is a green pigment in phytoplankton that allows for photosynthesis. The concentration of chlorophyll is an indicator of the phytoplankton biomass and its concentration is proportional to the total amount of phytoplankton. In addition, the concentration of chlorophyll is one of the most characteristic parameters of the trophic state of the water.

- Qualitative and quantitative composition of phytoplankton
- Determination of the concentration of chlorophyll in water from lakes and rivers
- Determination of phytoplankton biomass
- Determination of primary production
- Determination of the dependence of the phytoplankton composition and abundance in relation to the concentration of nutrients in the water and their ratio.
- Determine the trophic status index based on the concentration of chlorophyll
- Determination of phytoplankton groups and a number of organic and inorganic particles in the water with a flow cytometer.
- Determination of turbidity.

➢ DEPARTMENT OF ZOOPLANKTON

Short description of the Department and its purpose

In the Department of zooplankton, the invertebrate fauna Rotifera, Crustacea (Cladocera, Copepoda) of freshwater in the Republic of North Macedonia is studied, ie their taxonomy, ecology, reproduction, daily-night migrations, seasonal periodicity and distribution of natural and artificial reservoirs in the country. In terms of fundamental research, the Department is responsible for monitoring the conditions in all aquatic ecosystems in the North Macedonia (natural lakes, reservoirs, springs, rivers, underground waters, wetlands, etc.):

- Qualitative and quantitative research of Rotifera, Crustacea (Cladocera, Copepoda) representatives
- determination of the Saprobity index based on the representatives of Rotifera, Crustacea (Cladocera, Copepoda)
- monitoring the biomass of the representatives of the zooplankton community
- monitoring of daily-night and seasonal periodicity-migrations of zooplankton representatives

The Department of zooplankton with Decision no. 10-7004(December 18, 1992) issued by the Ministry of Health of the Republic of North Macedonia is authorized to monitor (by biological aspect - zooplankton research)the quality of the surface waters used for water supply and processed water from the filter stations in the country.

Equipment in the Department:

- Inverted microscope Hydro Bios
- Inverted microscopeLeica DM IRB with Dino–Eye AM7023CT USB camera, and data processing software
- Compound microscopeOlympus BX43 with digital camera Olympus UC30 и and data processing software
- Plankton nets Hydro–Bios Kiel

What scientific research and application projects can the Department perform?

Freshwater zooplankton has an important and strategic position in the trophic food chain in the aquatic ecosystem and is highly sensitive to anthropogenic impacts. As an integrated and inextricable part of the food chain, located between phytoplankton as its nutritional resource and fish as a predator, it reflects the changes occurring at lower and higher trophic levels.Changes in water quality, but also climate change, reflect the density and biomass of zooplankton, as well as the occurrence or absence of particular species, parameters that can be used as an effective indicator of the trophic state and the ecological status of surface waters.

- Monitoring of the quality and conditions in surface water ecosystems (natural lakes, rivers and reservoirs) on the basis of the recorded species of Rotifera, Crustacea (Cladocera, Copepoda) and changes in zooplankton communities that occur as a result of human activities
- Determining the functional and taxonomic diversity of zooplankton in all water bodies
- Enrichment of the list of species from the meiofauna, especially the groups Rotifera, Copepoda and Cladocera, ie the knowledge about biodiversity in aquatic ecosystems
- Determination of the Zooplankton Wetlands Index (WZI) as a useful indicator for degradation of water surfaces and their restoration
- Determination of the biological efficiency of the treatment plants that in North Macedonia uses surface waters for water supply
- the cultivation of certain zooplankton representatives that can be used for feeding fish offspring
- biodiversity and ecology of the invertebrate fauna Rotifera, Crustacea (Cladocera, Copepoda)

➢ DEPARTMENT OF BENTHIC FAUNA

Short description of the Department and its purpose

Qualitative and quantitative research at the bottom fauna department includes the following 8 groups of macrozoobenthos: TURBELLARIA, OLIGOCHAETA, HIRUDINEA, BIVALVIA, GASTROPODA, AMPHIPODA, ISOPODA and INSECTA. These animal species, both by diversity and by number, are most present in the fauna that inhabits the bottom of lakes and coastal waters.

Equipment in the Department:

- Van Veen's Bottom Sampler with a surface area of 225 cm2 (15 x 15 cm)
- Binocular Wild Heerburgg

Microscope TechnikRocthenow with Sony color video camera

What scientific research and application projects can the Department perform?

Macrozoobenthic communities are often used as indicators of the trophic state of aquatic ecosystems, as many species are vulnerable to pollution and sudden changes in their environment. Community characteristics - such as abundancy, diversity, equilibrium, and community composition - can be monitored to determine if the community changes over time due to natural or human influences.

- Environmental research by determining the ecological status of the waters by applying the WFD,
- Taxonomic research,
- Saprobiological research,
- Protection and conservation research

➢ DEPARTMENT OF CYPRINID FAUNA


Short description of the Department and its purpose

The Department of cyprinid fauna is organized in two laboratories

1. Laboratory for fish taxonomy and ecology

This laboratory carries out taxonomic and ecological research of fish populations, determining the systematic affiliation of fish individuals as well as the ecology of fish populations.

2. Laboratory for fish physiology

This laboratory examines the physiological state of the cyprinid fish from freshwater ecosystems, and connects it with the ecotoxicological state of the ecosystems themselves.

Equipment in the Department

- stereo microscope ZEISSStemi 305
- microscope ZEISSPrimoStar
- inverted microscope ZEISSPrimoVert
- laboratory oven,
- digital scale,
- analog scale,
- digital caliper,
- centrifuge DLAB
- microplate reader METERTECH

What scientific research and application projects can the Department perform?

The department performs measurements and calculations that determine the state of the populations of fish species in lake and river ecosystems. This is done by determining the length composition of the populations, weight composition, sex composition and age composition, growth of the individuals (length and weight), tempo, constant, velocity and coefficient of length and weight growth, length-length and length-weight ratio , nutrition of fish, coefficients of food intake, dietary index of fish populations according to Fulton and according to Clark, gastro intestinal index, gonadosatomic ratio, index of maturity of gonads, absolute and relative fertility, heavy metals in the organs and tissues of cyprinid fish.Measurements of different morphometric and meristic parameters for fish species determination and comparison. Determination of the physiological status of the fish through: Condition factors, determination of the total energy content of the fish (gross energy content), determining the hematological status of the fish (total number of erythrocytes, hematocrit, hemoglobin concentration, MCH, MCHC , MCV, total number of leucocytes), and numerous biochemical parameters.

➢ DEPARTMENT OF HYDROBOTANY

Short description of the Department and its purpose

The Hydrobotany Laboratory was founded in 1955, and its primary activity is research on macrophytic vegetation in aquatic ecosystems in the Republic of Macedonia (lakes, rivers, reservoirs and wetland ecosystems)

Equipment in the Department:

- Van Veen grab Sampler 225 cm^2 for collecting aquatic plants
- Grab for collectingaquatic plants
- Binocular and microscope for the determination of aquatic plant species

What scientific research and application projects can the Department perform?

• Monitoring the state of macrophytic vegetation, and changes in the distribution of macrophytes
• Ecological, taxonomic, saprobiological, protection and conservation research
• Research on the content of mineral substances, especially heavy metals (N, P, K, Na, Ca, Mg, Fe, Mn, Zn, Cu, Pb, Cd) in the biomass of macrophytic aquatic plants.
• For the research of mineral substances, the equipment from the Department for physical and chemical research at the Hydrobiological Institute from Ohrid is used.

➢ DEPARTMENT OF DISEASES OF FISH

Short description of the Department and its purpose

The activities of the Department of Diseases of Fish are aimed at studying the diseases of fish and other aquatic animals, and especially the parasites of fish. So far, over 100 species of parasites have been found in fish from Macedonia and wider, and some of them cause significant damage to fisheries, while others are prominent with their faunistic significance, since they have been found and described for the first time in science.

Equipment in the Department

- Stereomicroscopes ZEISSPrimovetandZEISSPrimostar
- Light microscope ZEISSStemi 305

What scientific research and application projects can the Department perform?

Parasites of fish appear as direct causative agents of certain diseases or as factors that lead to disturbance or reduction of fish resistance.
The analysis of the parasites offers useful, economical, simpler monitoring of the state of the environment.
The Department of Fish Diseases at the Hydrobiological Institute - Ohrid can give:

- expertise on fish and other aquatic organisms and their products from the veterinary-sanitary aspect;
- determining the dynamics of fish contamination from aquatic ecosystems by seasons and localities;

In cooperation with the other departments of the Hydrobiological Institute in Ohrid, he is involved in expert cooperation with fish farms and other subjects in solving certain problems related to the pathology of fish.

➢ DEPARTMENT OF SALMONID FAUNA, APPLIED FISHERY AND AQUACULTURE (DAFA)



Short description of the Department and its purpose

Since the establishment of the Institute the Department of salmonid fauna, applied fishery and aquaculture (DAFA) is dedicated to investigation of salmonid fauna (trouts) regarding their endemism, speciation, biology and fishery. Salmonid hatchery and nursery with capacity of 5 millions of eggs, alevins or fingerlings of one of the endemic Lake Ohrid trout species (*Salmo letnica*, Karaman 1924) is active since 1935 in sense of aquaculture of the endemic salmonids for restocking purposes. During the eight decades of development of tools for freshwater species conservation and restoration the number of collected fertilized eggs and released fries was varying till number of 16 million in average at annual level. In certain periods this number was even bigger – exceeding 20 million. The most important moment till 2004 is that all the caught spawners in average of 25 tons were going at the fish market. From 2005 the stocking is with 2,5 million fingerlings at age of 9 months after fertilization, all the spawnerscaughtare returned into the lake waters – "catch and release" method, with proof of their future survival confirmed by different taggig techniques.

Regarding the developing processes of "artificial spawning" of the native population of Lake Ohrid trout (*Salmo letnica*, Karaman 1924) various techniques were implemented like: sperm cryopreservation, laser treatment of the spermatozoids and fertilized and non-fertilized eggs, crossbreeding etc. Also, cultivation of the outmost endemic salmonid Lake Ohridbelvica*(Salmo ohridana*, Steind.1892) has been developed, but from biodiversity conservation aspect this isn't implemented like standard process for lake's restocking program.

Besides the hatchery activities other responsibilities of the Department of Applied Fishery and Aquaculture (DAFA) are fish population ecology, human impact (habitat changes and restoration in lakes and rivers; pollution impact – heavy metals, POPs; fishery impact), genetic radiation, hybridization – natural and induced for farming purposes, species conservation, fish and fisheries monitoring, fishery management plans and strategies etc.

DAFA is representing the essential unit of official registered reproduction center for wild freshwater fish species for the R. North Macedonia. From other hand Hydrobiological institute in Ohrid is the Authorized Institution for fisheries, which includes any kind of fishing in the national open waters (lakes, rivers and reservoirs) as well as fish farms control and supervision.

The aquaculture facilities are covering 1200 m^2 under fish hatchery, nursery and breeding ponds and 500 m^2 experimental aquaculture earth ponds.

Research vessel – 12 m research boat, fully equipped is used for the realization of the artificial spawning (collecting fish eggs and fertilization in situ).

Equipment in the Department:

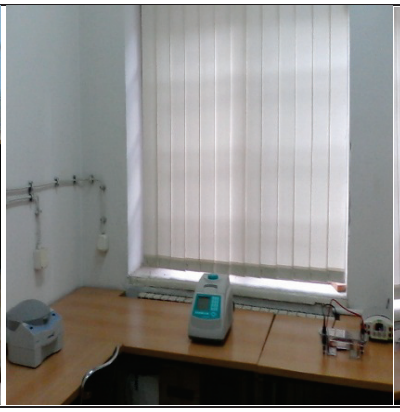
Microscopes, binocular microscopes, echosounder, portable probes for temperature, pH, oxygen, conductivity and concentration of cyanophyte algae. GPS devices, laser distance-meters, binoculars, field

balances, static and portable oxygen tanks with regulators and aerators, as well as tanks for transferring live fish. Fish tagging equipment, electrofisher for standing and running waters, fishing nets of different type and size from knot to knot, EN 14575 fishing tools, dissection tools and biometric fish measurements equipment.
Hatchery, breeding and experimental aquaculture installations. Vessels - boat, speedboat, boats with outboard motors.

What scientific research and application projects can the Department perform?

– Lake Ohrid Annual Restocking Program of endemic trout species national and transboundary (since 1935).
– Conservation and restoration of endemic and endangered trout species (S*. ohridana, S. typicus, S. aphelios, S. peristericus, S. macedonicus*, etc.)
– Cryopreservation and laser induction
– PoP'sand heavy metals in fish tissues
– Fishery master plans (protection and utilization) of the fish stocks in Macedonian running waters and lakes: determining TAC (total allowable catch) quotas, minimum allowable catch size per species, determining mitigation measures,
– Fish conservation and protection on transboundary level
– Ecosystem approach on fishery
– Fish and fisheries monitoring
- Aquaculture – knowledge transfer
- Education

➢ DEPARTMENT OF MOLECULAR BIOLOGY


Short description on the Laboratory and her purpose

Department of molecular biology in PSI Hydrobiological Institute- Ohrid is consists of two Laboratories:
- **Laboratory of molecular biology**
-Laboratory of histology

- Laboratory of molecular biology - the use of molecular-biological methods works on population-genetic

determination on several fish species which inhabit rivers and lakes in R. Macedonia.

- Laboratory of histology - there is made evaluation of environmental impact on health condition at fish populations. Through the process of histological preparations and there analysis it is an estimate on eventual lesions in internal fishes organs and on the axes on obtained date is determinate environmental impact and water quality to fishes health.

Also, in Laboratory of histology is made analysis on the Red-Ox enzyme system, like Superoxid dismutase (SOD) and Catalase (CAT) in blood and liver from fish specimens, which is marker for acute changes in water quality and environmental conditions.

The Equipment it has Laboratory

Laboratory of molecular biology
- Ultracentrifuge,
- Thermal cycler,
- Apparatus for electrophoresis,
- UV transiluminator

Laboratory of histology
- Thermostat,
- Microtome,
- Tubes for histological dyeing,
- microscope,
- spectrophotometer

What scientific research and application projects can the Department perform?

Laboratory of molecular biology can to made population-genetically investigations on fish populations in water in R. Macedonia, in sense of determining what fishes species are inhabit rivers and lakes in our country, also hybrids determination or presence of the non-autochthonous fish species.

Laboratory of histology can to made histological and enzymatic analysis in term to provide different ecological projects. In principle, the enzymes are marker to acute change in environmental conditions and water quality, while histopathological lesions display long-lasting unfavourable impacts and presence of different xenobiotics in water, that have an adverse effect on the health on fishes populations. These markers can be an indicator of environmental condition on water ecosystems and to give instructions to their more effective protection.