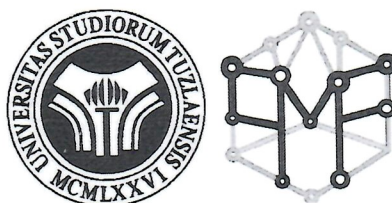


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UNIVERSITY OF TUZLA
FACULTY OF NATURAL SCIENCES AND MATHEMATICS

SECOND CYCLE OF STUDIES

**FEASIBILITY STUDY ON THE SOCIO-ECONOMIC JUSTIFICATION
OF ESTABLISHING A NEW STUDY PROGRAM**

"ECOLOGICAL MONITORING AND AQUATIC BIOASSESSMENT"

Tuzla, March 2021



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1. INTRODUCTION

1.1 Basic information about the University and the organizational unit where the study program is to be established

The University of Tuzla was institutionally founded in 1976. The establishment of the University was preceded by the creation of the Association of Higher Education and Scientific Research Institutions in the Northeastern Bosnia region in 1972 and the Consortium for the Development of high and higher education and scientific research in Tuzla. By the decision of the Tuzla Municipality Assembly on April 15th 1975, the Initiative Committee for the establishment of the University of Tuzla was appointed with 104 members and academician Ismet Mujezinović as its president. The agreement on amalgamating the University was signed on November 18, 1976 in Sarajevo, and the opening ceremony was held on December 18, 1976 in Tuzla.

The University bodies consist of the Management board, being the managing body, the Senate, being the highest elected academic body, and the Rector, as the executive body. The University of Tuzla now unites twelve faculties and one academy of dramatic arts. The interconnection of the University's sectors is shown in Figure 1.



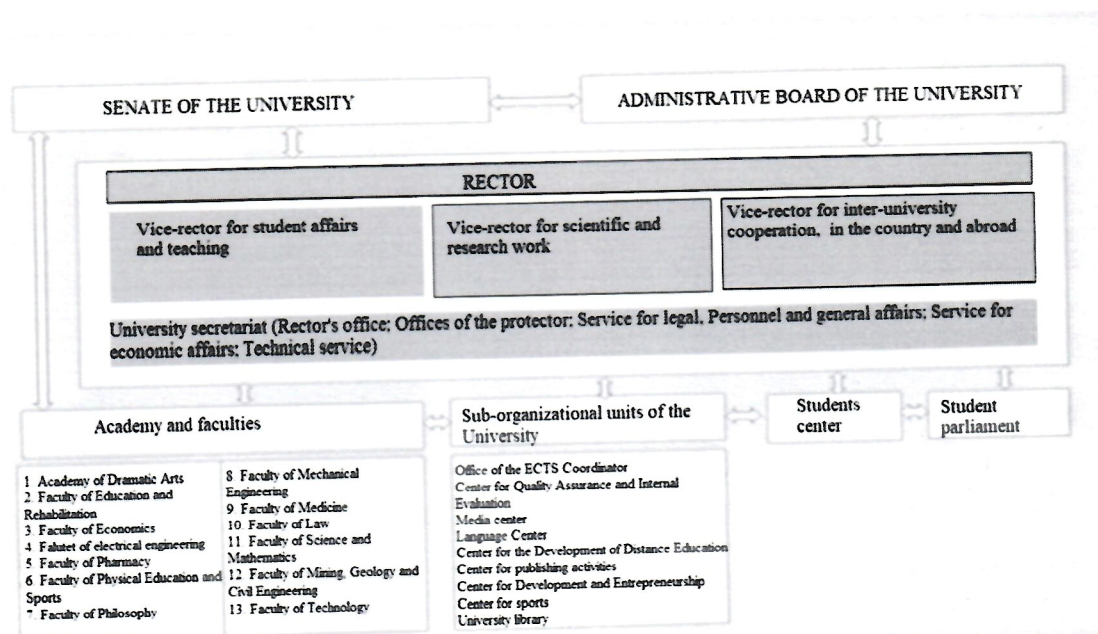


Figure 1. Organizational structure of the University of Tuzla, 2020

In total, 124 study programs are taught at the University of Tuzla, including 52 study programs of the first cycle, 58 study programs of the second cycle, 2 integrated first- and second-cycle study programs, and 14 study programs of the third cycle of studies.

1.1.1 The Faculty of Natural Sciences and Mathematics

The Faculty of Natural Science and Mathematics of Tuzla was founded in 2002 by the Law on Amending to the Law of the University of Tuzla, approved by the Assembly of Tuzla Canton ("Official Gazette of Tuzla Canton", number 2/02). The faculty was founded as a higher educational institution created by separating the study departments of natural sciences and mathematics from the Faculty of Philosophy in Tuzla. Teaching at the Faculty is organized for full-time students, and is conducted within the study departments: Biology, Physics, Geography, Chemistry and Mathematics.

Before the establishment of the Faculty of Natural Sciences and Mathematics, these study departments had developed professional staff within the framework of two-subject, four-year study departments at the Faculty of Philosophy. The transformation of two-subject four-year study departments into single-subject departments at the Faculty of Philosophy was carried out in the academic years 1999/2000. Three two-subject study departments: Mathematics-Physics, Biology-Chemistry and History-Geography were then transformed into six single-subject study departments, five of which became part of the newly founded Faculty of Natural Sciences and Mathematics, as following below:



- Department: Biology
- Department: Physics
- Department: Geography
- Department: Chemistry
- Department: Mathematics

After its foundation, the Faculty of Natural Sciences and Mathematics was located in the renovated building of the former "Enver Šiljak" student dormitory, with address Univerzitetska no. 4 (today Urfeta Vejzagića no. 4), starting in 2002. In this way, the Faculty became one of the organizational units of the University of Tuzla.

Since the establishment of the Faculty, undergraduate studies have been organized for full-time students and conducted within each study department. Undergraduate or first cycle studies last for four years according to the 4+1 system.

Since 2003, when the Bologna system was introduced, as well as the ECTS system, curricula and programs have been innovated with the aim of improving basic education, increasing the efficiency of studies and harmonizing with the general goals of the reform of university education. In this regard, curricula and programs of every department of the Faculty have been designed on the principle of compulsory and elective subjects, and all subjects became one-semester. Since 2003, the curricula have been innovated several times.

The first cycle of studies in all study programs of the Faculty of Natural Sciences and Mathematics has 240 ECTS points, and upon completion of studies in all study departments of the Faculty, an academic title is obtained, i.e., a professional title: Bachelor of a specific field.

From 2012/2013 until the academic year 2018/2019 a total of nine study programs in five departments were active at the Faculty of Natural Sciences and Mathematics. Thus, in the first cycle of studies at the Department of Biology, the academic or professional title is obtained: Bachelor of Biology and Bachelor of Applied Biology, at the Department of Physics: Bachelor of Physics and Bachelor of Applied Physics, at the Department of Chemistry: Bachelor of Chemistry and Bachelor of Applied Chemistry, at the Department of Mathematics: Bachelor of Mathematics and Bachelor of Applied Mathematics. At the mentioned departments, the study programs last four years, and the first two years are common for all profiles. At the Department of Geography, the study lasts four years, and the academic or professional title of Bachelor of Geography is obtained.

Since the academic year 2018/2019, the new study programs of the first cycle were introduced: Biology, Physics, Chemistry, Mathematics and Tourism, while the Geography study program remained unchanged. With this change, upon completion of studies in the mentioned study programs of the Faculty, the academic title is acquired, i.e., the professional title of Bachelor of Biology, Bachelor of Chemistry, Bachelor of Geography, Bachelor of Mathematics, Bachelor of Physics and Bachelor of Tourism.



The second cycle of studies at the Faculty of Natural Sciences has been active since the academic year 2001/2002, firstly through a two-year postgraduate study at the study departments of Physics and Geography, while starting from academic year 2004/2005 two-year postgraduate courses were organized in all study departments of the Faculty. Since the academic year 2011/2012 a one-year teaching process is carried out at the Faculty in the second cycle of study in all study departments, which results in a total of 60 ECTS points.

Since the academic year 2012/2013, the third study cycle has been organized at every study department of the Faculty of Natural Sciences and Mathematics. After the completion of the third cycle of studies in all study departments of the Faculty, an academic title is acquired, i.e., the academic title of Doctor of Natural Sciences of the specific field.

The Department of Biology of the Faculty of Natural Sciences and Mathematics, as the proposer of the new study program of the second cycle, performs curricula according to the programs recommended by the Bologna Declaration (according to the ETCS scoring system), which are similar (comparable) to the study programs of several well-known universities that have accepted this process and are compatible with European higher education systems that enable further education abroad.

Currently, two study programs of the second cycle are active at the Department of Biology: study program Applied Biology with six specializations and the study program Education in Biology. Upon completion of studies, students of the second cycle acquire the title of Master of Biology and Master of Applied Biology, referring to a specific focus in the degree.

1.2 Introduction to discipline and qualification

Freshwater ecosystems are under major anthropogenic pressures, such as pollution, nutrient enrichment, damming and overexploitation. Monitoring of the impact of various stressors is necessary for their early detection, monitoring and alarming, and assessment of the condition of water bodies and analysis of stressors are crucial for the development of adequate water management strategies. Management of water resources and monitoring of the ecological status of water bodies has been a very important issue of environmental protection in Europe during the previous decades, during which the development of monitoring methodology has developed significantly, whereby the monitoring system, in addition to chemical and hydrological, also generates a biological assessment of water ecosystems. The European Community is constantly working to improve the quality and strives to establish a good state of all water bodies. The entry into force of the Water Framework Directive of the European Union, which aims to achieve at least a good status of water bodies, and which is followed by the harmonization of the legislation of Bosnia and Herzegovina with the European guidelines for water management, brought with it the requirements for the education of staff in terms of ecological monitoring and



biological monitoring of water. According to the EU Water Framework Directive, the assessment of the ecological state of rivers and lakes is based on biological elements, such as aquatic macrophytes, phytobenthos, benthic macroinvertebrates, phytoplankton and fish, all supported by hydro morphological characteristics and physical-chemical parameters of water quality. Capacity building in the field of higher education and the field of ecological monitoring of water is a key prerequisite for the management of water resources in Bosnia and Herzegovina.

The study program Ecological monitoring and aquatic bioassessment with the degree title Master of Biology is adapted to the European educational space and is in accordance with the concept of the Bologna Declaration and market needs in the field of biological monitoring and water resource management. The main goal of the master program in the second cycle of studies is to build capacity in higher education as a necessary step towards the application of European principles in the field of environmental protection and requirements in the processes of monitoring and water management in Bosnia and Herzegovina. The study program will achieve its goals through the application of new methods and technologies in educational and research work, especially in the areas of inland water ecology, field sampling techniques, application of classification protocols in biomonitoring, mastering the techniques of ecotoxicological tests, microbiological testing of water, detailed identification of aquatic organisms, application of modern technique of using environmental DNA in monitoring, remote detection in ecological monitoring, conservation ecology, riparian ecology, forensic and numerical ecology. Such a study program will enable the upgrading of knowledge from the first cycle of education and orientation in the field of ecological water monitoring in accordance with the necessary skills and competencies in this field.

1.3 Reasons to start the studies - the justification for carrying out the study program

Current education on biomonitoring of water bodies and biological assessment of the ecological status of waters in Bosnia and Herzegovina does not fully meet the requirements of the Water Framework Directive of the European Union and European legislation and policy in ecological water monitoring. The existing legislation in the area of the Law on Water of the Federation of Bosnia and Herzegovina and the Republic of Srpska foresees the use of biological quality elements in the monitoring process, while the European legislation focuses on a holistic approach to water monitoring. These requirements mandate the education of experts who will use their competences and skills to respond to the modern requirements of ecological monitoring and biological assessment of water. The master's study program Ecological monitoring and aquatic bioassessment will, through the application of modern learning methods, the integration of theoretical, practical, independent and team work of students, supported by the use of modern equipment, respond to the demands and needs of



society and institutions for continuous ecological monitoring and appropriate management of bodies of water.

The second cycle of studies - the master studies in Ecological monitoring and aquatic bioassessment is a continuation of the first cycle of education of the Biology program of study at the Faculty of Natural Sciences and Mathematics of the University of Tuzla in accordance with the Bologna Declaration.

The master's degree course will be taught by the staff of the Department of Biology of the Faculty of Science, preferring a multidisciplinary approach with the participation of teachers from the Department of Geography, Chemistry and Mathematics.

The justification for the realization of the study program is stated in the following theses:

- Rational use of water resources;
- Management and ecological monitoring of water bodies based on professional and scientific basis;
- Mastering the knowledge of ecological monitoring of water bodies with a focus on national and European legislation;
- Mastering the knowledge and improvement of skills in the processes of preservation, protection and restoration of freshwater ecosystems;
- Application of new techniques and modern knowledge in the field of ecology, especially in the field of using environmental DNA and remote detection in ecological monitoring;
- Promotion of scientific and research work in the University through the engagement of master students in projects and publications of scientific works;
- Formation of experts with adopted skills, competences and knowledge in the field of ecological water monitoring, environmental impact assessment, protection and preservation of aquatic ecosystems;
- Continuous education according to the Bologna system and transition from the main study program and the first cycle of studies to the second cycle of studies;
- The possibility of more successful employment of students who have completed the second cycle.

In addition to the above-mentioned real needs for educating this staff, additional reasons for starting this master program stem from the participation of the University of Tuzla with the organizational unit of the Faculty of Natural Sciences and Mathematics in the ERASMUS project from the field of strengthening the capacity of higher education institutions under the name "Development of master curricula in ecological monitoring and aquatic bioassessment for Western Balkans HEIs". The ECOBIAS project aims to develop and improve knowledge, skills and technical resources of higher education institutions in partner countries in the field of ecological monitoring and biological assessment of freshwater resources (EMAB) in



accordance with the national and EU water management policy and in accordance with the Bologna and national standards for accreditation.

The project is coordinated by the Faculty of Science and Mathematics of the University of Novi Sad, and the project consortium consists of a total of 11 universities from five countries. In addition to the University of Novi Sad, the consortium consists of the University of Niš (Serbia), the University of Zagreb (Croatia), the University of Duisburg-Essen (Germany), the University of Tuzla, the University of Sarajevo, the University of Mostar, the International University of Travnik, the University of East Sarajevo, University of Banja Luka (Bosnia and Herzegovina) and University of Donja Gorica (Montenegro). Water quality management in lakes and rivers has been an important issue of environmental protection in Europe during the last decades. The development and intercalibration of the ecological state assessment system at the national and regional level is a long-term process that requires comprehensive databases of regularly monitored biological and environmental properties. Therefore, the building of higher education capacity in the Western Balkans region for the field of ecological monitoring and assessment of aquatic biological assessment is a necessary and inevitable step towards the integration of the EU's environmental protection policy in the region. For this reason, the ECOBIAS project can be considered part of the pan-European process of the European way of water management.

The ECOBIAS project implements the launch of four master studies in the field of ecological water monitoring or ecological engineering in Bosnia and Herzegovina, as well as the launch of lifelong learning courses in Bosnia and Herzegovina and Montenegro. In accordance with the stated goal, the University of Tuzla plans to launch this study program for the second cycle of studies. The project also plans that the program member countries of the project (Serbia, Croatia and Germany) through the exchange of experiences in the field of monitoring and water management, will support the launch of master studies with the aim of achieving better education for students. A total of 26 new master courses are planned to be launched, of which a total of 13 are planned to be implemented at the University of Tuzla as part of the new program in the second cycle of studies. The existence of joint master courses of partner institutions in Bosnia and Herzegovina would ensure the passibility of students and their mobility, which are very important parameters for evaluating the quality of contemporary study programs. The project implements the complete equipping of the University of Tuzla laboratory in terms of strengthening the capacity of the equipment and the skills of the teachers through the exchange and networking of teaching staff with researchers from the project consortium, all with the aim of quality teaching in this study program. The total value of the project for the University of Tuzla is EUR 120,679, of which EUR 63,000 is provided for the purchase of equipment and supplies for the quality education of second-cycle students.



1.4 Assessment of the importance of studies with regard to the needs of the labor market in the public and private sector

The establishment and application of the biological monitoring system is recognized as a priority area in Bosnia and Herzegovina on the way to European integration and the implementation of the European Union Water Framework Directive.

The assessment of the importance of the study program was made on the basis of the fact that the regulations derived from the Law on Water and the Law on the Environment of the Federation of Bosnia and Herzegovina require the employment of personnel with a biological orientation in the field of hydrobiology, microbiology and ecotoxicology in the activities of registration, accreditation and work of control laboratories and institutes. The establishment of a study program that combines these skills in the second cycle of study is a real reason for the recognition of that staff on the market in terms of the necessary qualifications. On the other hand, through a range of elective subjects, students will acquire knowledge in conservation ecology, biomonitoring processes, the application of remote detection in ecological monitoring, forensic ecology and environmental DNA in ecological monitoring, which can be highly sought-after competencies in water monitoring agencies, nature protection and spatial planning institutions or scientific research centers.

Upon completion of the master study program „Ecological monitoring and aquatic bioassessment“, experts will be trained to work in:

- research institutions engaged in research in the field of ecology and environmental protection (universities, institutes, science and technology parks);
- expert and control laboratories, institutes and agencies dealing with monitoring and management of water resources;
- institutions for nature protection and biodiversity conservation (national parks, public institutions for protected areas, institutes for nature protection, departments of natural resources);
- state administration institutions and inspection services in the departments of water protection, environmental protection, spatial planning and water management;
- public enterprises of the utility and plumbing sector;
- companies in wastewater toxicity control departments;
- water management companies;
- aquaculture farms;
- consulting companies that provide services related to the preparation of studies for water management and monitoring;
- civil society organizations.



1.5 Compliance with the mission of the University and the strategy of the proposer of the study program

The mission of the University of Tuzla is: *The University of Tuzla educates students - future leaders of social and economic development in all three study cycles and within the lifelong learning program, implements and disseminates the results of fundamental, applied and developmental research, ensures and implements the mobility of students and teachers, creates motivating environment for scientific-teaching/artistic and scientific-research work, by transferring the results of educational, scientific-research, artistic-creative and professional work, contributes to the development of society; rationally uses available human, financial and material resources and applies standards of quality and excellence, thus ensuring competitiveness in the European academic area.*

Motto: *University of Science, Tradition and Knowledge*

The vision of the University of Tuzla is: *The University of Tuzla will, through a unique way of integrating students, alumni, teaching and non-teaching staff, internal resources, top education, excellence in scientific research, teaching and artistic work, internationalization and networking with partner organizations, socially responsible activities, remain a part of the European academic space and permanently maintain the position of leader in higher education in Tuzla Canton and beyond.*

Motto: *Be educated, creative and enterprising.*

The mission and vision of the Faculty of Natural Sciences and Mathematics are defined in the framework of the Strategic Development Plan of the University of Tuzla for the period 2011-2015, as well as the curricula of the University and the Faculty that are adopted for each calendar year. Research, learning, creative and critical work are the central values of the Faculty of Natural Sciences and Mathematics. The primary mission of the Faculty of Natural Science and Mathematics is to continuously transmit and develop the internationally recognized quality of scientific and professional research and higher education at the three stages of the Bologna cycle, scientific research work and lifelong education. The vision of the Faculty is to conduct reference scientific, artistic and professional research as part of the integral European higher education and research area, and to provide students of all three study cycles with top-quality education and develop fundamental scientific research from natural sciences groups based on research and international cognitive achievements. The Faculty of Natural Sciences and Mathematics realizes its vision and mission with the application of three fundamental principles:

- excellence in teaching;



- excellence in scientific research;
- excellence in inter-university cooperation.

The strategic goals of the University of Tuzla are aimed at increasing the digitalization of the University of Tuzla, raising the level of study quality and student standards, permanently encouraging excellence in scientific-research and artistic-creative work, strengthening the internationalization of the University and the mobility of students and teachers, developing the University's cooperation with the environment, improvement of infrastructure capacities, improvement of the degree of development and efficiency of the quality assurance system and construction of organizational infrastructure for the development of scientific/artistic teaching and scientific research work. The mission and vision of the University of Tuzla are focused on a unique way of integrating students, alumni, teaching and non-teaching staff, internal resources, top education, excellence in scientific research, teaching and artistic work, internationalization and networking with partner organizations, socially responsible activities and educating students- future leaders of the development of society and economy.

With all of the above, the upcoming study program of the second study cycle is directly related to and supports the strategic goals, since the study program is created as a product of cooperation between partner institutions on the European ECOBIAS ERASMUS project, it supports scientific and research work through equipping laboratories, and strengthens the institution's capacity through infrastructure and skills of its employed staff, supports the internationalization and visibility of the University and ensures conditions for quality education.

1.6 Legal basis for establishing a new study program

The legal basis for the creation and adoption of the Report on the socio-economic justification of establishing a new study program "Ecological monitoring and aquatic bioassessment" at the Department of Biology of the Faculty of Natural Sciences and Mathematics, University of Tuzla can be found in the following documents:

1. General Law on Higher Education of Bosnia and Herzegovina (<https://mon.ks.gov.ba/sites/mon.ks.gov.ba/files/59-07.pdf>);
2. Articles 26, 64 and 122 of the Law on Higher Education (Official Gazette of Tuzla Kanton, number 7/16, 10/16, 5/17 i 15/17);
3. Article 144 of the Statute of University of Tuzla 3 February 2017 (Responsibility of the Department Council);
Study Department Council;
(http://www.untz.ba/uploads/file/akti/201617/STATUT_UNTZ_i_Aneks_djelatnosti_03_02_2017.pdf);
4. Alphabetical list of occupations of the Agency for Statistics of Bosnia and Herzegovina
5. Decision on the adoption of the Basic qualification framework in Bosnia and Herzegovina (<http://www.sluzbenilist.ba/page/akt/FAaZ4BuUFtA>)



6. Standards and guidelines for quality assurance in the European area of higher education (ESG) <http://www.heg.gov.ba/Dokumenti/Bolonja/?id=6150>
7. Decision on criteria for accreditation of study programs of the first and second cycle of studies in Bosnia and Herzegovina (http://www.heg.gov.ba/Dokumenti/dokumenti_agencije/?id=7765)
8. Standards and guidelines for quality assurance in higher education in Bosnia and Herzegovina (http://www.untz.ba/uploads/file/bolonjski%20proces/6_BiH%20Standardi%20i%20smjernice%20za%20OK%20u%20VO.pdf)
9. Rulebook on the accreditation procedure of higher education institutions and study programs ("Official Gazette of Tuzla Canton" number 9/16)
10. Rulebook on the licensing procedure of study programs of the first, second and third cycle of higher education institutions in the area of Tuzla Canton, Official Gazette of Tuzla Canton 7/2017
11. Rules on taking exams and evaluating students at the University of Tuzla (Abridged text) (http://www.untz.ba/uploads/file/akti/201920/PRAVILA_o_nacinu_polaganja_ispita_i_ocjenjivanju_studenata_na_Univerzitetu_u_Tuzli_Precisceni_tekst_29_05_2020.pdf;
http://www.qa.untz.ba/web/wp-content/uploads/2010/10/Sluzbene_novine_TK_br_18_-_2013-Pravilnik-o-akreditaciji-TK-.pdf)
12. Rules on studying for the second cycle of studies at the University of Tuzla (Abridged text) dated 06 November 2013
13. Rulebook on the final master's thesis in the second cycle of studies at the University of Tuzla
(http://www.untz.ba/uploads/file/akti/Pravilnik_o_završnom_magistarskom_radu_IIciklus-06_07_2012.pdf)
14. (http://www.untz.ba/uploads/Procedure_donosenja_eval_stud_programa-april2011.pdf)
15. Rules and procedures for admission and enrollment of students in the first year of the first- and integrated first and second cycle of studies at the University of Tuzla
(http://www.untz.ba/uploads/file/akti/2016-17/PRAVILA_I_PROCEDURE_ZA_PRIJEM_I_UPIS_STUDENATA_Senat_21_04_2017.pdf)
16. Rulebook on quality assurance of the University of Tuzla dated 5 July 2017

The aforementioned acts are periodically revised and improved, which is evident from the dynamics of changes and additions to the acts (<http://www.untz.ba/index.php?page=akti>).



1.7 Comparability of the study program with other related accredited study programs in Bosnia and Herzegovina and the countries of the European Union

Within the Framework Law on Higher Education of Bosnia and Herzegovina (Official Gazette of BiH No. 59/07) it is emphasized that "Bosnia and Herzegovina accepts the strategic goals in the field of higher education expressed in the Declaration of European Ministers of Higher Education from Bologna, as well as the subsequent development of the Bologna concept. The international recognition of master students is ensured by defined learning outcomes, by innovating teaching programs, by participating in international and domestic research projects, and by teacher and student mobility programs. The international recognition of the students of the University of Tuzla is ensured by the issuance of the Diploma Supplement. The Diploma Supplement lists the professional status of graduated students, their qualifications, and all courses with scores or ECTS points.

While proposing a new study program, particular attention was paid to ensure that the program is compatible with related programs that exist in the countries of the region, as well as with programs in other European countries. In this way, recognition of the students of the University of Tuzla in the international framework is ensured. With the implementation of the ECOBIAS projects, for the first time in Bosnia and Herzegovina, master's study programs related to ecological monitoring and bioassessment (EMAB) are being established. Of course, similar programs are present in neighboring countries, and an analysis was made of the compatibility of the Master's study program Ecological monitoring and aquatic bioassessment with the study programs of licensed and accredited higher education institutions from the signatory countries of the Bologna Declaration, i.e., with the programs of accredited related study programs in Bosnia and Herzegovina and European countries of the Union.

- 1) The University of Duisburg-Essen, Germany, Faculty of Biology, is in the consortium of the Ecobias program and has developed three master's studies that are partially related to Ecological Monitoring and Bioassessment (EMAB):
 - a) Environmental Toxicology (EnviTox) with two modules (<https://www.uni-due.de/studienangebote/studiengang.php?id=40>; https://www.uni-due.de/imperia/md/content/biologie/studium/masterenvitox_modulhandbuch1920.pdf)
 - b) Transnational Ecosystem-based Water Management (TWM) with seven modules (<https://www.uni-due.de/studienangebote/studiengang.php?id=103>; https://www.uni-due.de/imperia/md/content/twm/module_handbook.pdf)
 - c) Biodiversity (together with Ruhr-University Bochum) with two modules: Aquatic Biology and Molecular Ecology (which focuses on DNA methods for bioassessment and biomonitoring). http://www.biologie.ruhr-uni-bochum.de/studium/bm/msc_b/index.html.de
- 2) At the UCC University in Ireland, a master degree in Freshwater Quality Monitoring and Assessment was organized, which by the nature of the subject shows a certain similarity



with the newly proposed master's program Ecological monitoring and aquatic bioassessment. <https://www.ucc.ie/en/ckr17/>

3. At the University of Novi Sad, the Faculty of Science and Mathematics, a master degree program in Ecology was organized, with four modules: Hydrobiology, Ecological Risk Assessment, Nature Protection and Sustainable Development, as well as Applied Botany. The common basis for the aforementioned study program at the University of Novi Sad and Ecological monitoring and aquatic bioassessment at the University of Tuzla are the subjects: Freshwater ecology, Biomarkers in ecotoxicology, Conservation and restoration of ecosystems and Statistical methods and program packages in ecology. <https://www.pmf.uns.ac.rs/en/studies/study-programs/master-of-science-in-ecology-2018/>
4. The University of Niš, Faculty of Natural Sciences and Mathematics has an organized master course "Ecology and Nature Protection". Joint subjects with the master's study "Ecological monitoring and aquatic bioassessment" are: Hydrobiology, Conservation Biology, Ecology of Microorganisms, Ecotoxicology. <https://www.ni.ac.rs/en/studies-and-admission/studies/course-catalogue/courses/category/250-ecology-and-nature-conservation>
5. At the Faculty of Natural Sciences and Mathematics, Biology Department of the University of Zagreb, the graduate university study "Ecology and Nature Protection" was organized, with which the following subjects were found to be compatible: Application of GIS in biology, Modeling, Ecotoxicology, Bacteriology of polluted waters, Fundamentals of molecular ecology, Freshwater ecology. https://www.pmf.unizg.hr/biol/studiji/preddiplomski_studij/diplomski_sveucilisni_studij_ekologija_i_zastita_prirode

In terms of the structure and focus of the studies, the new program is comparable to the study of Applied Biology, majoring in Ecology and Nature Protection at the Department of Biology, Faculty of Natural Sciences and Mathematics, University of Tuzla.

Within the framework of the ECOBIAS project, a detailed comparability was made of upcoming study programs with existing master's programs in the region and Europe. The results of that report are available in report 1.3 at the link: <https://www.ecobiaserasmus.com/wp1-preparation-uni/>.



2. BASIC CHARACTERISTICS OF THE STUDY PROGRAM

2.1 Qualification name

- a) Name of the study program: Ecological monitoring and aquatic bioassessment
- b) Study cycle: Second, regular studies
- c) Model: The study program follows the 4+1 model. Master studies last one year
- d) Degree: Academic, seventh
- e) Minimum number of ECTS credits: 60 ECTS credits
- f) Holder of the study program: Department: Biology, Faculty of Natural Sciences and Mathematics, University of Tuzla
- g) Scientific field: Natural sciences
- h) Field: Biological Sciences
- i) Field: The multidisciplinary study of the second cycle is organized primarily within the scientific field of Natural Science, and the field of Biological Science, in which a multidisciplinary approach is realized through elective courses and in other fields of Earth and Environmental Science, Chemical Science, and Computer and Information Science. Given that the study program is realized primarily through the study program Biology and the field of Biological Sciences, within that, at the third level of classification, it primarily fits into the narrow field of Ecology of plants and animals, with the existing multidisciplinary approach to the fields of other biological sciences: botany, zoology, microbiology and molecular biology.

2.2 Academic/professional title acquired upon completion of the study program

Academic title obtained upon completion of the study program: Master of Biology. After licensing, the academic title will be included in the list of titles in accordance with the Rulebook on the Use of Academic Titles and the Acquisition of Scientific and Professional Titles at Higher Education Institutions in the Tuzla Canton, issued by the Tuzla Canton Ministry of Education, Science, Culture and Sports.

Along with the obtained diploma on the completion of the II cycle of studies, attached is a supplement to the diploma containing information on the candidate's competences, skills and qualifications for work in the field of environmental monitoring, and a list of exams passed by the student with the corresponding ECTS points.



2.3 Language in which the study program is conducted

Studies are held in Bosnian, Croatian and Serbian.

2.4 Goal of the study program

The main goal of the study program is the training of professional staff and the building of competences, knowledge and skills in the field of ecological and biological water monitoring, bioindication and management of aquatic ecosystems.

The specific objectives of the program are:

- understanding the interaction of the components of aquatic ecosystems,
- developing skills for field and laboratory work in the field of ecological monitoring, bioindication and environmental protection,
- training students for the analysis and valorization of ecological data,
- improvement of students' competencies in the field of water resources management according to the standards of the Water Framework Directive,
- developing basic skills in understanding problems in the field of environmental protection and applying tools for analysis and evaluation of the state of the ecosystem.

The study program will achieve its goals through the application of new methods and technologies in educational and research work, especially in the areas of inland water ecology, field sampling techniques, application of classification protocols in ecological monitoring, mastering the techniques of ecotoxicological tests, microbiological testing of water, detailed identification of aquatic organisms, application of modern the technique of using environmental DNA and the technique of remote detection in ecological monitoring, conservation ecology, riparian ecology, forensic and numerical ecology.

2.5 Competences acquired through qualification (diploma)

After completing the study program of the second cycle of studies Ecological monitoring and aquatic bioassessment and the acquired academic title Master of Biology, the necessary knowledge, skills and competences in the educational-scientific field of natural sciences are provided. The outcome of the learning process is an expert with advanced academic education who possesses significantly expanded and deepened knowledge compared to the knowledge acquired in basic academic studies, as well as integrated knowledge necessary for understanding the scientific basis in the field of water ecology.

The purpose of the master academic studies at the Department of Biology, study program "Ecological monitoring and aquatic bioassessment", is the education of experts in the field of



biology, competent to work in professional and scientific-research biological laboratories, accredited laboratories for quality control, biotechnology laboratories, institutes for monitoring and environmental protection environments, scientific institutes, and laboratories of various industrial and agricultural branches where knowledge from this field is applicable. Also, the knowledge acquired upon completion of these studies provides competence and expertise for further education at doctoral studies.

Learning outcomes:

- ✓ Integrated theoretical and practical knowledge about the functional organization of inland water ecosystems, in addition to possessing a broader knowledge of biology and ecology and other related sciences that supports the performance of professional and scientific work and responsible action;
- ✓ Integrated knowledge of methodological approaches in the field of ecological monitoring and bioindication of aquatic ecosystems and connecting broader knowledge about physical, chemical and biological parameters important for water quality with professional and scientific knowledge in the field of water resource management;
- ✓ Successful application of the principles of good laboratory and field practice in the processes of planning, execution and management of experiments, mastered principles of planning, realization and processing of data obtained within the framework of professional and practical activities in environmental monitoring;
- ✓ Improved knowledge in the field of modern molecular methods of ecological status assessment, methods of remote detection and data processing;
- ✓ Application of acquired knowledge in solving problems in the realization of tasks and making decisions in practice in an environment with a wider, multidisciplinary context;
- ✓ Application of systematic knowledge in the field of classification protocols and systems for the assessment of the quality of water bodies and integrated knowledge of the management processes of water and wetland habitats in conservation and restoration systems;
- ✓ Independent learning and awareness of the need for lifelong learning and development of professional competencies.

Skills:

After completing the second cycle of studies, the student will be able to:

- ✓ apply their knowledge and understanding, as well as problem-solving abilities to new and unknown environments within a broader (or interdisciplinary) context related to the field of natural sciences in the broader field of inland water ecology;



- ✓ apply conceptual and abstract thinking, with a high level of ability and creativity, which enables:
 - o realization and critical assessment of current research and academic work in the field of ecology, monitoring and bioindication of terrestrial waters, independent organization and implementation of hydrobiological research;
 - o application and evaluation of different methodologies in ecology and monitoring of inland waters, formation of critical thinking and offer of alternative solutions;
- ✓ apply various techniques and technologies from the field of ecology necessary for planning, leading and managing existing and new techniques.

Competencies:

After completing the second cycle of study, the student has the following competencies:

- ✓ the ability to integrate knowledge, deal with complex problems and formulate judgments based on incomplete or limited information, but with thinking about social and ethical responsibilities related to the application of their knowledge or judgments;
- ✓ the ability to communicate their conclusions, knowledge and reasoning on which they are based, using appropriate language(s), to a non-specialist and a specialist audience, clearly and unambiguously;
- ✓ acquired interpersonal and teamwork skills, suitable for different learning and employment contexts, and demonstrates the ability to lead and/or initiate initiatives and contribute to change and development.
- ✓ the ability to work effectively and communicate in a national and international environment;
- ✓ the ability to apply the latest scientific and professional achievements in professional and scientific work;
- ✓ understanding of professional and ethical responsibility;
- ✓ the ability to conduct independent theoretical and experimental research in the field;
- ✓ the ability to learn independently and have the need for lifelong learning;
- ✓ upon completion of studies, experts are formed capable of working as managers in laboratories of various industrial branches and in institutions dealing with research, monitoring and management of water resources and nature protection.

2.6 Duration of the study program

The study program Ecological monitoring and aquatic bioassessment is carried out through classes and scientific-research work lasting one year, or two semesters, which is valued to be worth a total of 60 ECTS points, or 30 ECTS for each semester.



After completing the second cycle of studies, by defending the final master's thesis, the student earns a total of 300 ECTS points, of which 240 points are for the first cycle study and 60 ECTS points are for the second cycle study. In this way, the student fulfills the condition and acquires the right to enroll in the third cycle PhD study programs.

2.7 Procedures and conditions for enrollment in the study program

Persons who have completed basic academic studies in biology, applied biology, education in biology or ecology with 240 ECTS credits can apply for admission to the studies. Persons who have completed a four-year study of Biology in the two-subject group of the pre-Bologna system and persons who have completed a single-subject pre-Bologna four-year study of Biology or Ecology can apply for admission to the studies. Enrollment in the course is also achieved by persons who have completed related basic academic studies and have accumulated 240 ECTS, with the implementation of the procedure of determining the equivalent number of ECTS points by the Commission that conducts the enrollment of students of the second cycle of studies and compliance with the provisions of the Rules on studying in the second cycle of studies that refer to the condition's enrollment. The decision on the enrollment of candidates who have completed undergraduate studies that were not based on the ECTS credit system is made by the Faculty's Scientific and Teaching Council on the proposal of the commission.

The order of candidates in the final ranking list is determined by respecting the Provisions of the Statute of the University of Tuzla and accompanying acts for the rules of studying at the University of Tuzla.

Citizens of Bosnia and Herzegovina and foreign nationals who, after the nostrification procedure, i.e., equivalating the diploma of the previously completed cycle/degree of study, under equal conditions have the right to enroll in the second cycle of studies have been found to have completed adequate education for continuing studies in the second cycle.

A person who enrolls in a study program acquires the status of a full-time student, in accordance with the competition and the final ranking list. Full-time students can be financed at the expense of the Budget or finance their studies themselves, in accordance with the University's enrollment policy.

2.7.1 Conditions for transferring from other study programs within the same or related fields of study and the possibility of continuing studies



The student has the right to change the study program. A transfer from another university can only be done before the start of studies in the semester, as determined by the Rules of Studying for the second cycle of studies.

Passed exams of other study programs in natural sciences are recognized, if the subjects from which the exams were passed, in terms of their content and scope, correspond to the subject of the second cycle of study program by at least 80%. By recognizing the exam, the grade with which the student was evaluated and the number of points in accordance with the curriculum of the study program are also recognized. The decision on the recognition of passed exams and transfer from other study programs within the same or related fields of study is made by the Scientific and Teaching Council of the Faculty.

2.7.2 Conditions for enrollment in the next semester

A student can enroll in the following semester after completing the obligations from the previous semester on the basis of attendance of lectures/exercises, which is proven by certifying the semester at the Student Service of the Faculty for engagement in the courses from the winter semester. A student who has not completed the prescribed obligations from the enrolled courses and has not certified the semester, re-enrolls and takes the listed courses again in the following academic year. Additional enrollment conditions for the next semester accompany the Rules of Studying for the second cycle and the Statutory provisions of the University of Tuzla.

2.7.3 Conditions for continuing the studies

Students who have completed the second cycle have the right to continue their education in the third cycle of studies at the Department of the Faculty of Natural Sciences and Mathematics of the University of Tuzla, as well as in other related programs of the third cycle in natural sciences, both in the country and abroad. The provisions of the Law and the Statute of the University, which set the conditions for termination of student status, apply analogously to students of the second cycle of studies. Student's rights and obligations can be suspended for a maximum of one academic year, which is more closely regulated by the Rules on studying at the University of Tuzla.

2.8 Study organization



The study program "Ecological monitoring and aquatic bioassessment" defines the way in which ECTS points can be achieved with the goal of obtaining 60 ECTS points needed to complete the second cycle of studies, in accordance with the Law on Higher Education of the Tuzla Canton and the Statute of the University of Tuzla. The studies are organized in two semesters, which are evaluated with 30 ECTS points each.

In order for a student to complete his studies, they need to obtain a total of 60 ECTS points. A student can earn ECTS credits:

- working on the master thesis,
- passing the compulsory subjects,
- passing the elective subjects.

The student earns ECTS points by obtaining a passing grade in the course in accordance with the Statute and general acts of the University. The master thesis is mandatory and is valued with 24 ECTS points.

As part of the program, all students take compulsory courses, while elective courses are chosen from the list of elective courses provided for the first semester, guided by the guidelines of the Standards and Norms for Higher Education in the Tuzla Canton.

In addition to the subject of the study program of the second cycle of studies "Ecological monitoring and aquatic bioassessment" of the Faculty of Natural Sciences and Mathematics, University of Tuzla, the student will also be recognized for ECTS points earned within the framework of student mobility, according to the corresponding contract defining the student mobility program signed between the Faculty of Natural Sciences i.e. the University of Tuzla and host institution, in accordance with the Rulebook on International Mobility.

2.9 Implementation of the ECTS point system

Ways of implementing the ECTS points system at the University of Tuzla are defined by the Statute of the University of Tuzla, chapter X - Organization and execution of university studies, study programs, regulations on study programs of the second cycle, as well as procedures for evaluation of study programs. In Article 26, the procedure for the adoption and evaluation of study programs, the adequacy of the ECTS point system is treated in such a way that the assessment of the actual student load is carried out through a comparison of the predicted ECTS points and the actual load of students according to individual activities in the course. This position is also expressed in the aforementioned acts of the University of Tuzla.



The allocation of ECTS points was done in the phase of creating the curriculum. With the introduction of ECTS credits, the assumption was made for the harmonization of curricula in accordance with the experiences of other universities both in Bosnia and Herzegovina and beyond, as well as the mobility of students to other universities. ECTS credits are not based only on the number of hours of classes, but on the total workload that these classes require. During the year, the course activities consist of lectures, exercises, preparation of seminar papers, concretization of student projects, student independent work, exam preparation, teamwork, discussions, consultations and the exams themselves. The independent work of students per individual subject is evaluated, and depending on the number of concrete hours of lectures and exercises and the necessary number of independent hours of student work, ECTS points are assigned to the subjects.

2.10 Teaching and learning methods

The teaching and learning methods are designed to encourage students to think critically and act actively in order to meet the demands placed on them in their professional work. Students are trained to work individually and as a team. Students are trained to understand the importance of the concept of lifelong learning in order to improve knowledge, skills and competences with the application of various methods.

The methods used to transfer knowledge are mainly successful learning activities, namely: concrete experience, observation and reflection, creation of abstract concepts and active experimentation. The preferred learning styles are: visual style, auditory, verbal, logical-mathematical, social and independent. The most important learning methods are:

- lectures with the use of multimedia tools and active learning techniques, with active participation and discussions of students through independent and team work;
- laboratory and field exercises;
- case studies,
- student projects,
- workshops,
- seminar papers, assignments.

2.11 Knowledge assessment criteria and evaluation system

Students' knowledge will be assessed based on their ability to research information, analyze conditions and present arguments in a consistent manner. The knowledge assessment during the course of study is based on topics covered in lectures, exercises, seminars, workshops, projects and requires the demonstration of general skills and competencies arising from the given



subject. The methods of knowledge verification are complementary to the appropriate and expected learning outcomes and will be organized through knowledge verification in colloquiums, tests, presentation of skills in exercises and case studies, approach and work in a team and laboratory, skills in the realization of student projects and seminars and oral presentations.

The method of scoring these activities is determined in more detail by the syllabus of each subject, and the criteria for assessing knowledge are determined by the Law on Higher Education of the Tuzla Canton and the Statute of the University of Tuzla. Knowledge assessment criteria are generic and apply to all subjects. The final success of a student for a specific subject, in a specific semester, is expressed by a numerical, descriptive or letter grade, which is presented in table 1.

Table 1. Weighting factor of knowledge verification

Numerical	Descriptive	Literally	Description	Points
10	excellent	A	The student's response and activity are appropriate and provide clear evidence of full acquisition of knowledge, understanding and skills corresponding to the level of qualification. The evidence also shows that all learning outcomes and obligations for that level are met in a high manner.	95-100
9	outstanding	B	The student's response and activity are excellent and provide evidence of comprehensive knowledge, understanding and skills appropriate to the level of qualification. The evidence also shows that all learning outcomes and obligations for that level are met, and that many are met in a high manner.	85-94
8	very good	C	The student's response and activity are good and provide evidence of knowledge, understanding and skills appropriate to the level of qualification. The evidence also shows that all learning outcomes and obligations for that level are met, and that many are more than merely met.	75-84
7	good	D	The student's response and activity are acceptable and provide evidence of knowledge, understanding and skills appropriate to the level of qualification. The evidence also shows that all learning outcomes and obligations for that level are met.	65-74



6	sufficient	E	The student's response and activity are acceptable and provide evidence of the minimum knowledge, understanding and skills appropriate for that level of qualification. The evidence also shows that the majority of the learning outcomes and obligations for that level are met.	54-64
5	does not satisfy	F	The student's response and activity are unacceptable and provide little evidence of knowledge, understanding and/or skills appropriate to that level of qualification. The evidence shows that very few, if any, learning outcomes and obligations for that level are met.	0-53

The grade on the exam is based on the total number of points that the student earned by fulfilling pre-exam obligations and taking the exam, and according to the quality of acquired knowledge and skills, and contains a maximum of 100 points. In order to pass the course, the student must obtain a minimum of 54 cumulative points. If the student is not satisfied with the final grade, they can cancel the points of the final exam by following the instructions of the university's rules on canceling the grade.

2.12 Student practice

Student practice in this study program is linked to independent work and work with a mentor and research in the master's degree. Also, at the level of each subject through exercises, greater involvement of students in independent scientific and scientific-research work is achieved. In addition, students will be able to use the equipment that is acquired within the project from which this study program originates in their independent laboratory work. The student practice is organized by the candidate in cooperation with the subject professor, and the basic goal of the practice is aligned with the needs of the subjects that are studied as part of the studies, and does not represent a separate subject, but is an integral part of certain syllabuses.

2.13 Final master's thesis

The study of the second cycle ends with the passing of all exams, as well as the preparation and public defense of the final master's thesis. The concept of the content of the final master's thesis at the Department of Biology of the Faculty of Natural Sciences and Mathematics of the University of Tuzla, in its structure, corresponds to the programs recommended by the Bologna Declaration (according to the ETCS scoring system). As a rule, the master's thesis is of a



research type or professional-theoretical character, in the field of biological and ecological sciences.

According to the provisions of the Rulebook on the final master thesis in the second cycle of studies at the University of Tuzla, the master thesis is an independent work in which the student proves that they can successfully use the methodology of scientific research and professional work, conduct research, discuss research results and draw conclusions. The student works on the selected topic by applying scientific and professional methods, and proves that they have mastered the curricula, acquired the necessary knowledge and trained for its application.

The master thesis should be written in such a way that it provides a scientific and professional contribution to:

- the existing published scientific and professional knowledge;
- solving a current scientific or professional problem;
- in the application of the existing scientific and professional results in solving professional problems.

The final thesis carries a total of 24 ECTS credits.

On the basis of the student's written statement, with the consent of the proposed mentor, the Academic and Teaching Council of the Faculty issues a Decision on appointing a mentor to the candidate. The mentor for the preparation of the final thesis can be a teacher who is elected in the narrower scientific field to which belong the compulsory subjects from which the student has earned or will earn ECTS credits, or a teacher with whom the student studied an elective subject as part of this study program. The procedure for applying, preparing and defending the final master's thesis is more closely regulated by the Regulations on the final master's thesis at the second cycle of studies at the University of Tuzla, in accordance with the Statute and Rules of studying at the second cycle of studies at the University of Tuzla. The final master thesis can be submitted for evaluation and further processing after all exams have been passed and all other obligations prescribed by the study program and general acts of the University's competent bodies have been fulfilled.

2.14 Information on how to complete the studies

The second cycle of studies ends with the creation and defense of the final thesis. After the defense of the final thesis, the student will have achieved 60 ECTS credits, which in total with the first cycle amounts to 300 ECTS.



2.15 Study program curriculum

The study program is realized in two semesters during the duration of the academic year, where each semester has 15 teaching weeks. The total workload of the student is determined according to the European Credit Transfer System - ECTS credits, and consists of classes (lectures, practical or field exercises), practice, seminars, independent work, tests and final (master's) work. The courses carry 6 ECTS points each, of which students in the winter semester take two compulsory and three elective courses which they choose from the list of optional courses (Table 3), while in the summer semester they take one compulsory course (Table 2). The master's thesis is valued at 24 ECTS, which is scheduled for completion in the summer semester.

Table 2. Curriculum of the Ecological monitoring and aquatic bioassessment study program, Title: Master of Biology

Course	Winter semester				Summer semester			
	Classes			ECTS	Classes			ECTS
	L	AE	LE		L	AE	LE	
Freshwater ecology	3	0	1	6				
Field practice in aquatic monitoring	3	0	0	6				
Elective course 1	2	0	1	6				
Elective course 2	2	0	1	6				
Elective course 3	2	0	1	6				
Classification protocols and systems in ecomonitoring					3	0	1	6
Final master's thesis					0	0	0	24
Total per semester	12	0	4	30	3	0	1	30
TOTAL TEACHING CLASSES		16				4		
TOTAL	20 CLASSES OF TEACHING				60 ECTS			

L- lectures

AE - auditory exercises

LE - laboratory exercises

Table 3. List of compulsory and elective courses



List of compulsory courses						
Ord.nr. of the course	Course code	Course	P	A	L	ECTS
1.	KBIOEKPV	Freshwater ecology	3	0	1	6
2.	KBIOPEV	Field practice in aquatic monitoring	3	0	0	6
3.	KBIOKPEM	Classification protocols and systems in ecomonitoring	3	0	1	6
List of optional courses						
4.	KBIOKZEK	Conservation Ecology	2	0	1	6
5.	KBIOGISE	GIS and Remote Sensing in ecomonitoring	2	0	1	6
6.	KBIONUM E	Numerical ecology	2	0	1	6
7.	KBIOODN K	eDNA in biomonitoring	2	0	1	6
8.	KBIOAKEK	Aquatic ecotoxicology	2	0	1	6
9.	KBIOMPO V	Freshwater microbiology	2	0	1	6
10.	KBIOEVRS	Wetland and riparian ecology	2	0	1	6
11.	KBIOPREB	Practicum in ecology and botany	2	0	1	6
12.	KBIOPREZ	Practicum in ecology and zoology	2	0	1	6
13.	KBIOFZVI	Forensic essentials in aquatic insects' ecology	2	0	1	6

2.15.1 The Study program by subjects

Full name of the subject	Freshwater ecology
Abbreviated name/code of the subject	KBIOEKPV
Study cycle	second cycle
Credit value of ECTS	ECTS - 6
Status of the course	compulsory



Prerequisites for passing	completed pre-examination requirements		
Access restriction	students of the second cycle of studies		
Duration/semester	one semester/ winter		
Number of contact hours per week	Lectures	Auditory exercises	Laboratory/ practical exercises
	3	0	1
Faculty	Faculty of Natural Sciences and Mathematics		
The study program	Ecological monitoring and aquatic bioassessment		
The teacher in charge	Ph.D. Jasmina Kamberović, associate professor		
e-mail of the teacher	jasmina.kamberovic@untz.ba		
Web page	www.pmf.untz.ba		
Course objectives	Familiarity with the basic characteristics of aquatic ecosystems with a focus on physio-chemical, hydromorphological and biological elements, with a pronounced holistic approach to the study of living communities of freshwaters and the application of data in ecomonitoring		
Learning outcomes	After passing the course, students will be able to:		
	<ul style="list-style-type: none"> - master the knowledge of hydromorphology, chemistry of freshwaters and living communities of inland waters; - independently design and conduct hydrobiological research; - integrate and apply acquired knowledge in ecomonitoring of aquatic ecosystems with a focus on biological elements of quality; - apply a holistic approach to the evaluation of the conservation value of aquatic ecosystems. 		
Indicative course content	Theoretical studies:		
	Freshwater ecosystems, overview of the freshwaters in the world, springs, rivers, lakes, ponds, wetlands, artificial water bodies, canals. Light and thermal stratification as a limiting factor in the distribution of organisms.		
	Water pollution, eutrophication, compatibility, toxic pollution, ecological status.		
Physico-chemical parameters and hydromorphological parameters in the assessment of the status of rivers and lakes. Life communities of aquatic habitats and their specificities. Biomonitoring and bioindicators of the ecological status of inland waters.			
Phytoplankton in assessment of ecological status, functional groups of phytoplankton. Phytobenthos in the assessment of ecological status, diatoms as indicators of ecological status, diatom indices. Aquatic macrophytes, ecological factors and distribution in rivers and lakes, research methodology and diversity of macrophyte communities. Determining the ecological status of rivers and lakes			



	<p>using macrophytes. Macrozoobenthos in liquids and stagnant water. Community zoning, metrics.</p> <p>Ichthyofauna, possibility of use in biomonitoring, ecological groups of fish, metrics.</p> <p>Water toxicity, ecotoxicological tests. A holistic approach to assessing the status of freshwater ecosystems. SERCON conservation potential assessment. Legal frameworks for water protection.</p> <p>Practical classes:</p> <p>Hydrobiological sampling and material processing methodology. Physico-chemical and hydromorphological parameters as indicators of water quality. Analysis of samples for biological elements of water quality and example metrics. Acute toxicity test. SERCON method for assessing the conservation value of rivers and lakes.</p>
Learning methods	<p>Preferred learning styles are: verbal, group and independent. The most important learning methods in the course are:</p> <ul style="list-style-type: none"> - Lectures with the use of multimedia tools, active learning techniques and with active participation and discussions of students; - Laboratory exercises with the use of laboratory equipment and statistical application programs; - Preparation and presentation of group and individual seminar papers and presentation of project ideas.
Explanation of the knowledge test	<p>During the semester, knowledge is continuously checked through some of the following activities: passing tests, colloquiums, writing seminar papers or project assignments.</p> <p>The final exam is done in writing or orally. The student gets the final grade by adding up the individual points obtained in all forms of knowledge testing during the semester.</p>
Weighting factors of verification	<p>PRE-EXAM REQUIREMENTS</p> <p>Student project, activity and colloquium of practical classes: 20 points</p> <p>Seminar paper/essay: 20 points</p> <p>Test: 20 points</p> <p>FINAL EXAM: 40 points</p>
References	<p>Basic references:</p> <p>Radulović, S., Teodorović, I. (2010). Ekologija i monitoring kopnenih voda. Metodološki priručnik. Prirodno-matematički fakultet. Univerzitet u Novom Sadu. Novi Sad</p> <p>Đug, S. et. al. (2020): Biomonitoring akvatičnih ekosistema. Univerzitet u Sarajevu. Sarajevo.</p>



Milošević, Đ., Stojković-Piperac, M. 2018. Bioindikacije i biomonitoring -praktikum i radna sveska. Prirodno-matematički fakultet, Univerzitet u Nišu. Srbija, Niš

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Kamberović, J. (2020): Ekosistemi izvora planine Konjuh. OFF- SET, Tuzla.

Doods, K., W. (2002): Freshwater Ecology: Concepts and Environmental Applications, Division of Biology, Kansas State University, Manhattan, Kansas. Academic Press. San Diego, San Francisco, New York, Boston, London, Sydney, Tokyo

Full name of the subject	Field practice in aquatic monitoring		
Abbreviated name/code of the subject	KBIOTPEV		
Study cycle	The second cycle (II cycle)		
ECTS point value	ECTS 6		
Status of the subject	Compulsory		
Prerequisites for passing	Completed pre-exam requirements		
Access restriction	Students of the II cycle of studies		
Duration/semester	One semester/winter		
Number of contact hours per week	Lectures	Auditory exercises	Laboratory/ practical exercises
	3	0	0
Faculty	Faculty of Natural Sciences and Mathematics		
Study program	Ecological monitoring and aquatic bioassessment		
Responsible teacher	Ph.D. Elvira Hadžiahmetović Jurida, Assoc. prof.		
e-mail of the teacher	elvira.lonic@untz.ba		
Web page	www.pmf.untz.ba		
Course objectives	Field practice in water monitoring aims to develop the ability to analyze the conditions of different types of water ecosystems.		
Learning outcomes	The structure of the practicum includes a balance of classroom lectures, field-based instruction, field and laboratory exercises, and integrated group projects, with the aim of providing knowledge of final assessment tools,		



	including a full assessment of aquatic ecosystems based on the biological part of the biocenosis. Field trips are designed to give students access to a variety of aquatic ecosystems and practices.
Indicative content	<p>Teaching:</p> <p>Physical and chemical properties of water: temperature, organoleptic properties (smell and taste, color), turbidity, pH, dissolved gases, COD, BOD. Physical and chemical properties of water: total dissolved substances, alkalinity, water hardness, organic substances, nutrients, metals. Sources of water pollution: domestic waste water, washing from agricultural land, industrial wastewater. Flow dynamics and hydromorphology. Theoretical basis of sampling methodology for biological elements of quality - phytobenthos, phytoplankton, macrophytes, zoobenthos and fish. Sample preservation methodology. Water purification procedures.</p> <p>Field: Field procedures for the analysis of physical and chemical parameters. Laboratory methods of determining physical and chemical parameters. Macrozoobenthos sampling methods and procedures for analysis and evaluation of biological elements of water quality. Phytobenthos, macrophyte sampling methods and procedures for analysis and evaluation of biological and hydromorphological elements of water quality and biological elements-fish.</p>
Learning methods	<p>Preferred learning styles are: verbal, group and independent. The most important learning methods in the course are:</p> <ul style="list-style-type: none"> - Lectures with the use of multimedia tools, active learning techniques and with active participation and discussions of students; - Field exercises with the use of equipment - Preparation and presentation of group and individual seminar papers and student projects
Explanation about the knowledge test	<p>During the semester, knowledge is continuously checked through some of the following activities: taking tests, colloquiums, monitoring student activities and creating seminar papers or project assignments.</p> <p>The final exam is done in writing or orally. The student receives the final grade by adding up the individual points obtained in all forms of knowledge assessment during the semester.</p>
Weighting factors of verification	<p>PRE-EXAM REQUIREMENTS</p> <p>Student project, activity and colloquium of practical classes: 20 points</p> <p>Seminar paper/essay: 20 points</p> <p>Test: 20 points</p> <p>FINAL EXAM: 40 points</p>
References	<p>Green, W.R., Robertson, D.M., and Wilde, F.D., 2015. Lakes and reservoirs Guidelines for study design and sampling: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A10, 65p.</p> <p>Hauer, F. R., Lamberti G. A. 2007.</p>



Full name of the subject	Qualification protocols and systems in ecological water monitoring		
Abbreviated subject name/code	KBIOKPEM		
Study cycle	second cycle		
ECTS point value	ECTS 6		
Status of the course	mandatory		
Prerequisites for passing	completed pre-examination requirements		
Access restriction	students of the second cycle of studies		
Duration/semester	one semester/ summer		
Number of contact hours per week	Lectures	Auditory exercises	Laboratory/ practical exercises
	3	0	1
Faculty	Faculty of Natural Sciences and Mathematics		
Study program	Ecological monitoring and aquatic bioassessment		
Responsible teacher	Ph.D. Jasmina Kamberović, associate professor		
e-mail of the teacher	jasmina.kamberovic@untz.ba		
Web page	www.pmf.untz.ba		
Objectives of the course	<p>The aim of the course is to acquire knowledge, competences and skills in the field of protocols and systems for assessing the ecological state of water bodies. The focus of the course is on training students to apply and understand the represented metrics for chemical and biological elements of quality in the water ecomonitoring process in accordance with the Water Framework Directive and national legislation, understanding the typification of water bodies and the application of intercalibration techniques of methods in the bioassessment of water bodies.</p>		
Learning outcomes	<p>Students will be trained to:</p> <ul style="list-style-type: none"> - apply systematic knowledge in the field of classification protocols and systems for assessing the quality of water bodies; - apply knowledge, understanding and skills in the implementation of appropriate methods for water quality assessment based on biological quality elements; - understand the concept of evaluating the status and potential of a water body - apply the latest scientific and professional achievements in professional and scientific work. 		



<p>Theoretical teaching</p> <p>Indicative content of the course</p>	<p>The concept of protocols and systems in ecomonitoring.</p> <p>Concepts and definitions of biomonitoring and bioindicators of aquatic ecosystems, saprobic system, biotic indices, diversity indices, multivariate indices, multimetric indices, functional groups, new trends in ecomonitoring. Validation and accreditation of chemical analysis methods in ecomonitoring. Validation parameters and validation strategy. Documenting the validation process. Ecological status and the Water Framework Directive, determining the ecological state and reference state of water bodies and the ratio of ecological water quality. Ecological potential of water bodies. Chemical and hydromorphological status of water bodies. Biological elements of quality for the evaluation of the ecological state, phytoplankton, phytobenthos, macrozoobenthos, macrophytes and fish.</p> <p>Typology of natural, artificial and significantly changed water bodies of fresh surface water. Overview of the application of biological methods and water evaluation systems based on different biological quality elements in Europe for stagnant and liquid water. Application of methods for evaluating the ecological potential of water bodies that are not of natural origin. Intercalibration and intercalibration types.</p> <p>Approach to defining the classification protocol for certain biological elements of quality. Examples of classification protocols for creating a system for evaluating the ecological state of rivers/lakes based on certain biological elements of quality. Comparison of classification protocols and standards for natural, artificial and significantly altered water bodies.</p> <p>Practical classes: Calculation of saprobic, trophic, biotic, multimetric and diversity indices on the example of samples of biological quality elements. Determining the ecological status of water bodies based on chemical and biological quality elements.</p>
<p>Learning methods</p>	<p>Preferred learning styles are: verbal, group, independent and problem-based. The most important learning methods in the course are:</p> <ul style="list-style-type: none"> - Lectures with the use of multimedia tools, active learning techniques and with active participation and discussions of students; - Laboratory and analytical exercises using laboratory equipment and statistical application programs; - Preparation and presentation of group and individual seminar papers, literature research, testing of methods and preparation of student projects.
<p>Explanation about the knowledge test</p>	<p>During the semester, knowledge is continuously checked through some of the following activities: taking tests, colloquiums, monitoring student activities and creating seminar papers or project assignments.</p> <p>The final exam is done in writing or orally. The student receives the final grade by adding up the individual points obtained in all forms of knowledge assessment during the semester</p>
<p>Weighting factors of verification</p>	<p>PRE-EXAM REQUIREMENTS</p>



Student project, activity or colloquium of practical classes: 20 points

Seminar paper/essay: 20 points, Test: 20 points,

FINAL EXAM: 40 points

Primary references:

Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy;

Milošević, Đ., Stojković-Piperac, M. 2018. Bioindikacije i biomonitoring - praktikum i radna sveska. Prirodno-matematički fakultet, Univerzitet u Nišu. Srbija, Niš

Common Implementation Strategy for the Water Framework Directive (2000/60/EC) Guidance document N° 10 – Rivers and Lakes – Typology, Reference Conditions and Classification Systems;

References

Common Implementation Strategy for the Water Framework Directive (2000/60/EC) Guidance document N° 13 – Overall Approach to the Classification of Ecological Status and Ecological Potential

Additional references:

Birk, S., Willby, N. J., Kelly, M. G., Bonne, W., Borja, A., Poikane, S., & vande Bund, W. (2013). Intercalibrating classifications of ecological status: Europe's quest for common management objectives for aquatic ecosystems. *The Science of the Total Environment*, 454–455, 490–499. <https://doi.org/10.1016/j.scitotenv.2013.03.037>

Full name of the subject	Conservation Ecology		
Abbreviated name/code	subject KBIOKZEK		
Study cycle	second cycle		
Credit value of ECTS	ECTS 6		
Status of the course	elective		
Prerequisites for passing	pre-examination requirements completed		
Access restriction	students of the second cycle of studies		
Duration/semester	one semester/ winter		
Number of contact hours per week	Lectures	Auditory exercises	Laboratory/ practical exercises
	2	0	1



Faculty	Faculty of Natural Sciences and Mathematics
Study program	Ecological monitoring and aquatic bioassessment
Responsible teacher	Ph.D. Avdul Adrović, full professor
e-mail of the teacher	avdul.adrovic@untz.ba
Web page	www.pmf.untz.ba
Objectives of the course	The goal of the course is to familiarize students with the concept of minimally sustainable population and metapopulation organization that can help maintain species and species communities despite the deteriorating effects of anthropogenic influence and develop basic ecological skills necessary for the analysis of aquatic ecosystem communities.
Learning outcomes	Students should acquire a broad knowledge of the identification of metapopulation organization in the field and the necessary prerequisites for maintaining the metapopulation structure. In addition, they will learn about the concept of minimally sustainable population size and its application in conservation practice, especially the theory and practice of population sustainability analysis. Students will also gain knowledge about the causes of endangered species and populations and ways to preserve nature.
Indicative content of the course	<p>Theoretical teaching</p> <p>Concept of conservation ecology and biology, metapopulations, Levins model, metapopulation genetics and evolution, interaction of metapopulations and metacommunities, spatial structure of populations, metapopulation dynamics in conservation biology, quantitative conservation biology - theory and practice, analysis of population viability, biological diversity, modern evolution and impact on biodiversity, species protection and assessment of the risk of extinction, basic principles of species and area protection</p> <p>Practical classes: Two-population metapopulation model, analysis of Levins' metapopulation model, analysis of the relationship between the extinction rate of local populations and interpopulation genetic differentiation within a metapopulation, analysis of the modification of Levins' model in the case of interspecies competition, analysis of the population turnover model, analysis of cases, introduction to Population Viability Analysis (PVA)), the results of the application of PVA, census-based PVA-models independent of population density, VORTEX-metapopulation models, analysis of species and ecosystem diversity</p>
Learning methods	<p>Preferred learning styles are: verbal, group and independent. The most important learning methods in the course are:</p> <ul style="list-style-type: none"> - Lectures with the use of multimedia tools, active learning techniques and with active participation and discussions of students; - Laboratory exercises with the use of statistical application programs; <p>Preparation and presentation of group and individual seminar works and presentation of project ideas.</p>



Explanation about the knowledge test During the semester, knowledge is continuously checked through some of the following activities: taking tests, colloquiums, monitoring student activities and creating seminar papers or project assignments.
The final exam is done in writing or orally. The student receives the final grade by adding up the individual points obtained in all forms of knowledge assessment during the semester

Weighting factors of verification PRE-EXAM REQUIREMENTS
Student project, activity or colloquium of practical teaching: 20 points
Seminar paper/essay: 20 points
Tests: 20 points
FINAL EXAM: 40 points

References Primary references:
Hanski, I. 1999. *Metapopulation ecology*. Oxford Series in Ecology and Evolution. Oxford University Press., 1-21
Morris, W.F., Doak, D.F. 2002. *Quantitative conservation biology: Theory and practice of PVA*. Sinauer.
Additional references:
Beissinger, S.R., McCullough, D.R. (eds.) 2002. *Population viability analysis*. University of Chicago Press.
Crandall, K.A., Bininda-Emonds, O.R.P., Mace, G.M., Wayne, R.K. 2000. Considering evolutionary processes in conservation biology. TREE 15, 290-295.

Full name of the subject	GIS and Remote Sensing in ecomonitoring
Abbreviated name/code of the subject	KBIOGISE
Study cycle	second cycle
Credit value of ECTS	ECTS 6
Status of the course	elective
Prerequisites for passing	completed pre-examination requirements
Access restriction	students of the second cycle of studies
Duration/semester	one semester/ winter



Weekly number of contact hours	Lectures	Auditory exercises	Laboratory/ practical exercises
	2	0	1
Faculty	Faculty of Natural Sciences and Mathematics		
Study program	Ecological monitoring and aquatic bioassessment		
Responsible teacher	Ph.D. Edin Hadžimustafić, docent		
e-mail of the teacher	edin.hadzimustafic@untz.ba		
Web page	www.pmf.untz.ba		

Objectives of the course

The study goals are for students to:

- learn to differentiate and apply geographic data models (raster and vector) in biodiversity analysis and ecomonitoring of riparian areas and water ecosystems;
- collect, store, call, process, interpret and present data;
- they know how to analyze spatially interpolated data;
- learn geovisualization methods of water ecosystems and riparian areas;
- understand the physical basics of remote detection;
- learn the techniques of detection, sensors on satellites and other spacecraft;
- know the theory and practice of image data processing and analysis.

Learning outcomes

At the end of the semester/course, students will be able to:

- use GIS to process spatial data and carry out spatial analyses to solve various practical environmental problems;
- conduct field research using basic and advanced GIS and Remote Sensing technology (GPS and drones)
- collect in the field, download, link, analyze, interpret data on biodiversity and area and draw conclusions;
- geo visualize ecosystems through maps, reports, layers and disseminate the obtained information;
- find remote sensing data (satellite images, LiDAR data) on the Internet;
- differentiate the ecosystem according to the wavelengths of the electromagnetic spectrum;
- process, extract and get new information from processed images;
- integrate and process data obtained by remote sensing in GIS.



<p>Indicative content of the course</p>	<p>Theoretical classes:</p> <p>Geographic data models and the modeling process; Collection and accumulation of data on ecosystems; Cartographic basis in GIS; Analysis of vector and raster models of distribution and biodiversity data; Spatial interpolated data and their analysis; Presentation of the results of the area analysis and distribution of habitats, biocenoses and species. Principles of electromagnetic radiation; Types of sensors; Digital image processing - hardware and software; Pre-processing, enhancement, transformation and classification of recordings; Information extraction; Thematic ecosystem mapping.</p> <p>Practical/field teaching by teaching units, if it is provided for in the textbook:</p> <p>Research on ecomonitoring data structure, file types and attributes; Coordinate reference systems and data redesign; Georeferencing and digitization of data; Collection of ecosystem diversity data by GPS and drone; Geomorphological, hydrological and biogeographic modeling of space; Correlation of vegetation maps with geomorphological, pedological and geological structure of the area; Spatial analyses of ecosystem diversity; Assembling, mosaic, subset of figures of the researched area; Image correction; Extraction of data on the range of species, ecosystems and habitats by unsupervised and supervised classification; Mapping ecosystem diversity.</p>
<p>Learning methods</p>	<p>Preferred learning styles are: verbal, group and independent. The most important learning methods in the course are:</p> <ul style="list-style-type: none"> - Lectures with the use of multimedia tools, active learning techniques and with active participation and discussions of students; - Laboratory exercises using laboratory equipment and statistical application programs; <p>Preparation and presentation of group and individual seminar works and presentation of project ideas.</p>
<p>Explanation about the knowledge test</p>	<p>During the semester, knowledge is continuously checked through some of the following activities: taking tests, colloquiums, monitoring student activities, and making seminar papers or project assignments.</p> <p>The final exam is done in writing or orally. The student receives the final grade by adding up the individual points obtained in all forms of knowledge assessment during the semester</p>
<p>Check weighting factors</p>	<p>PRE-EXAM REQUIREMENTS</p> <p>Student project, activity or colloquium of practical classes: 20 points</p> <p>Seminar paper/essay: 20 points</p> <p>Test: 20 points</p> <p>FINAL EXAM: 40 points</p>



Primary references

Primary references:

Đug, S., Drešković, N., Odžak, S. (2015): Daljinska istraživanja - principi i primjena u prirodnim naukama. Univerzitet u Sarajevu Prirodno-matematički fakultet.
Horning, N. (2010): *Remote Sensing for Ecology and Conservation: A Handbook of Techniques*. Oxford University Press
Radulović, S., Teodorović, I. (2011): *Ekologija i monitoring kopnenih voda. Metodološki priručnik*. Prirodno-matematički fakultet. Novi Sad
Radulović, S., Drešković, N., Cvijanović, D., Hadžimustafić, E., Mesaroš, M., i Đug, S. (2021 in press): *Geografski informacijski sistemi i daljinska detekcija u ekomonitoringu*.

Additional references:

Peter A. Burrough, Rachael A. McDonnell, Christopher D. Lloyd (2015): *Principles of Geographical Information Systems*. Oxford University Press.
Hamlyn G. Jones, Robin A. Vaughan (2010): *Remote Sensing of Vegetation: Principles, Techniques, and Applications*. Oxford University Press.
Paul A. Longley, Michael F. Goodchildat, David J. Maguire, David W. Rhind (2015): *Geographic Information Science and Systems*. John Wiley & Sons Inc.

Full name of the subject	Numerical ecology		
Abbreviated name/code	subject	KBIONUME	
Study cycle	second cycle		
Credit value of ECTS	ECTS - 6		
Status of the course	elective		
Prerequisites for passing	completed pre-examination requirements		
Access restriction	students of the second cycle of studies		
Duration/semester	one semester/winter		
Number of contact hours per week	Lectures	Auditory exercises	Laboratory/ practical exercises
	2	0	1
Faculty	Faculty of Natural Sciences and Mathematics		
Study program	Ecological monitoring and aquatic bioassessment		
Responsible teacher	Ph.D. Vedad Pašić, Assoc. prof.		



e-mail of the teacher	vedad.pasic@untz.ba
Web page	www.pmf.untz.ba
Objectives of the course	The aim of this course is to provide skills for statistical analysis of multivariate data in ecology. The four main goals of multivariate analysis and related techniques are the same: (1) data types and their standardization; (2) classification and analysis of clusters. (3) medical practice and related methods; (4) computational approach to multivariate statistical analysis.
Learning outcomes	Students should gain a broad understanding of the various multivariate techniques in relation to the types of research and data sets appropriate for each technique in ecology. The subject is highly concentrated on learning through projects, joint work, discussions and analysis of data sets.
Indicative course content	Types of data in ecological studies; Exploratory data analysis; Matrix algebra - introduction; Dimensional analysis in ecology; Multidimensional quantitative, semi-quantitative and qualitative data; Basics of probability theory in ecology; Basics of statistical hypothesis testing; Parametric hypothesis testing; Non-parametric tests; Basics of code writing; Correlation, Regression, Multivariate Analysis - Cluster Analysis; Multivariate analysis - Ordination analysis; Canonical analysis; Analysis of the diversity of species and ecosystems.
Learning methods	Preferred learning styles are: verbal, group and independent. The most important learning methods in the course are: <ul style="list-style-type: none"> - Lectures with the use of multimedia tools, active learning techniques and with the active participation and discussion of students; - Practical exercises in the software packages for data processing - Independent and group processing of ecological data with the presentation and interpretation of the obtained results
Explanation about the knowledge test	During the semester, knowledge is continuously tested through some of the following activities: taking tests, monitoring student activities and preparing seminar papers or project assignments. <p>The final exam is done in writing or orally. The student receives the final grade by adding up the individual points obtained in all forms of knowledge assessment during the semester.</p>
Check weighting factors	PRE-EXAM REQUIREMENTS <p>Student project, activity or colloquium of practical classes: 20 points</p> <p>Seminar paper/essay: 20 points</p> <p>Test: 20 points</p> <p>FINAL EXAM: 40 points</p>
References	Legendre, P. & Legendre, L. (2012): Numerical Ecology, Elsevier. 3 rd edition.



Redžić, S. & Bašić, H. (2008): Ekološki sistemi i modeli. Prirodno-matematički fakultet. Univerzitet u Sarajevu.

Full name of the subject	Environmental DNA in biomonitoring		
Abbreviated name/code	subject	KBIOODNK	
Study cycle	second cycle		
Credit value of ECTS	ECTS 6		
Status of the course	elective		
Prerequisites for passing	completed pre-examination requirements		
Access restriction	students of the second cycle of studies		
Duration/semester	one semester/ winter		
Number of contact hours per week	Lectures	Auditory exercises	Laboratory/ practical exercises
	2	0	1
Faculty	Faculty of Natural Sciences and Mathematics		
Study program	Ecological monitoring and aquatic bioassessment		
Responsible teacher	Ph.D. Adisa Ahmić, Assoc. prof.		
e-mail of the teacher	adisa.ahmic@untz.ba		
Web page	www.pmf.untz.ba		
Objectives of the course	To acquaint students with the concept of environmental DNA (eDNA) and approaches to using eDNA in biomonitoring. To acquaint students with the necessary field, laboratory and bioinformatics disciplines for performing eDNA based on bioassessment of specific biological water quality elements (BQEs).		
Learning outcomes	<p>After passing the course, students will be able to:</p> <ul style="list-style-type: none"> -have a broad understanding of the concept of DNA based on bioassessment and monitoring, eDNA in water, origin, condition, transport, bulk DNA samples (macroinvertebrates, diatoms). - use sources of knowledge on BQE inference for data interpretation; - discuss the concept of metabarcoding, learn about reference database sources, primer design and high throughput Illumina sequencing methods 		



	<p>- acquire the necessary skills for DNA isolation, DNA extraction and sequenced data library creation, high-throughput sequencing data download and analysis in relation to targeted BQEs and environmental quality status assessments with eDNA data</p>
Indicative content of the course	<p>Theoretical teaching: Classical biomonitoring versus eDNA-based biomonitoring. PCR/metabarcoding/primer design. Basics of DNA barcoding (single samples). Metabarcoding, PCR, primer and polymerase compatibility, reading in relation to current abundance and biomass. Pattern indexing. Environmental DNA (condition/fate/origin/transport). Bioinformatics approach, taxonomic assignment).</p> <p>Practical lesson: (e) DNA extraction, quantification on agarose gel. PCR (two-step PCR). Agarose Gel PCR Validation. Librarian preparation (Illumina). Sequence data analysis by downloading stand-alone software.</p>
Learning methods	<p>The following learning styles are preferred: verbal, group and independent. The most important learning methods in the course are:</p> <ul style="list-style-type: none"> - Lectures with the use of multimedia tools, active learning techniques and with the active participation and discussion of students; - Laboratory exercises for using laboratory equipment and statistical application programs; <p>Preparation and presentation of group and individual seminar works and presentation of project ideas.</p>
Explanation about the knowledge test	<p>During the semester, knowledge is continuously checked through some of the following activities: taking tests, monitoring student activities and creating seminar papers or project assignments.</p> <p>The final exam is written or oral. The student receives the final grade by adding up the individual points obtained in all forms of knowledge assessment during the semester.</p>
Check weighting factors	<p>PRE-EXAM REQUIREMENTS</p> <p>Student project, activity or colloquium of practical classes: 20 points</p> <p>Seminar paper/essay: 20 points</p> <p>Test: 20 points</p> <p>FINAL EXAM: 40 points</p>
References	<p>Primary references:</p> <p>Taberlet et al. Environmental DNA. For Biodiversity Research and Monitoring. Oxford University Press 2018.</p> <p>Additional references:</p> <p>Creer, S., K. Deiner, S. Frey, D. Porazinska, P. Taberlet, W. K. Thomas, C. Potter and H. M. Bik (2016). "The ecologist's field guide to sequence-based identification of biodiversity." <i>Methods in Ecology and Evolution</i> 7(9): 1008-1018.</p>



Valentini, A., P. Taberlet, C. Miaud, R. Civade, J. Herder, P. F. Thomsen, E. Bellemain, A. Besnard, E. Coissac, F. Boyer, C. Gaboriaud, P. Jean, N. Poulet, N. Roset, G. H. Copp, P. Geniez, D. Pont, C. Argillier, J. M. Baudoin, T. Peroux, A. J. Crivelli, A. Olivier, M. Acqueberge, M. Le Brun, P. R. Moller, E. Willerslev and T. Dejean (2016). "Next-generation monitoring of aquatic biodiversity using environmental DNA metabarcoding." *Molecular Ecology* 25(4): 929-942.

Elbrecht, V., E. E. Vamos, K. Meissner, J. Aroviita and F. Leese (2017). "Assessing strengths and weaknesses of DNA metabarcoding-based macroinvertebrate identification for routine stream monitoring." *Methods in Ecology and Evolution* 8(10): 1265–1275.

Full name of the subject	Aquatic ecotoxicology		
Abbreviated name/code	subject	KBIOAKEK	
Study cycle	second cycle		
Credit value of ECTS	ECTS - 6		
Case status	elective		
Prerequisites for passing	completed pre-examination requirements		
Access restriction	students of the second cycle of studies		
Duration/semester	one semester/ winter		
Weekly number of contact hours	Lectures	Auditory exercises	Laboratory/ practical exercises
	2	0	1
Faculty	Faculty of Natural Sciences and Mathematics		
Study program	Ecological monitoring and aquatic bioassessment		
Responsible teacher	Ph.D. Amela Hercegovac, Assoc. prof.		
e-mail of the teacher	amela.hercegovac@untz.ba		
Web page	www.pmf.untz.ba		
Objectives of the course	Acquisition of knowledge about anthropogenic chemicals, their mode of action at all levels of biological systems, from the molecular to the ecosystem level.		
	Understanding the principles of the methods used in water toxicity testing, determining the source of toxicity and determining the fate of pollutants.		



	<p>Students will get to know some of the classical methods as well as the basic concepts used in the testing of water toxicity in situ and in vitro with special attention paid to biological markers in aquatic organisms.</p>
<p>Learning outcomes</p>	<p>After passing the subject, students will be able to:</p> <ul style="list-style-type: none"> - identify chemical substances whose presence in the environment, due to their toxic action, represents a danger to living things; - understand the ways of intake, transformation and elimination of toxic substances. - understand the mechanism of their toxic action; - detect the sources of pollution as well as the places where they are deposited in the environment; - apply the appropriate biological method for assessing the effect of pollution; - assess the environmental risk on the basis of the gathered information
<p>Indicative content of the course</p>	<p>Anthropogenic impact on the environment, basic principles of toxicology, history of toxicological research. Calculation of reference values of toxic substances MDK, KDK. Classification of harmful substances and their physical and chemical characteristics. Representatives of chemical groups of hazardous substances in industry. Inorganic and organic substances. Basic concepts of toxicity, sublethal and lethal effects. Overview of the main types of toxicants/pollutants (inorganic, organic) and mechanisms of their toxic action, definition of xenobiotics. The problem of investigating the toxic effect of chemicals present in the environment. Division of bioassays by organisms: bioassays on bacteria, bioassays on yeast fungi, bioassays on protozoa, bioassays on phytoplankton (green algae growth inhibition test, etc.), bioassays on zooplankton (Daphnia test, etc.), bioassays on higher plants (Allium test, Lemna test, germination tests, etc.). Division of bioassays according to the mechanism of toxic effect. Bioindicator species, diversity indices, biotic indices.</p> <p>Pollutant risk assessment, human risk assessment and environmental/ecotoxicological risk assessment, exposure assessment.</p> <p>Practical classes: Standard toxicological and ecotoxicological tests; Biotests. Methods and ways of determining pollution; measurement of the impact of pollution/toxicants on the environment: toxicity tests-biotests, biomonitoring, biomarkers.</p>
<p>Learning methods</p>	<p>Preferred learning styles are: verbal, group and independent. The most significant learning methods in the subject are:</p> <ul style="list-style-type: none"> - Lectures with the use of multimedia tools, active learning techniques and with the active participation and discussion of students; - Laboratory exercises for the use of laboratory equipment and statistical application programs; - Preparing and presenting group and individual seminar papers and presentation of project ideas.



Explanation about the knowledge test	<p>During the semester, knowledge is continuously tested through some of the following activities: taking tests, monitoring student activities and preparing seminar papers or project assignments.</p> <p>The final exam is done in writing or orally. The student receives the final grade by adding up the individual points obtained in all forms of knowledge assessment during the semester.</p>
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Check weighting factors	<p>PRE-EXAM REQUIREMENTS</p> <p>Student project or colloquium of practical classes: 20 points</p> <p>Seminar paper/essay: 20 points</p> <p>Test: 20 points</p> <p>FINAL EXAM: 40 points</p>
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References	<p>Primary references:</p> <ol style="list-style-type: none"> 1. Analitika okoliša (2013) Ašperger D, Babić S, Bolanča T, Darbra RM, Ferina S, Ginebreda A, Horvat AJM, Kaštelan-Macan M, Klobučar G, Macan J, Mutavdžić Pavlović D, Petrović M, Sauerborn Klobučar R, Štambuk A, Tomašić V, Ukić Š. Hinus, Zagreb, str. 294 2. Teodorović Ivana & Sonja Kaišarević: Ekotoksikologija. Univerzitet u Novom Sadu. Prirodno-matematički fakultet. Departman za biologiju i ekologiju, 2015.
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References	<ol style="list-style-type: none"> 3. Amiard-Triquet C, Amiard J-C, Mouneyrac C (2015) Aquatic Ecotoxicology: Advancing Tools for Dealing with Emerging Risks. Academic Press, Elsevier Inc., London. 4. Principles of ecotoxicology 2nd ed. (2001) Walker CH, Hopkin SP, Sibly RM, Peakall DB, Taylor & Francis 5. Environmental toxicity testing (2005) Thompson KC, Wadhia K, Loibner AP (Eds.) Blackwell Publishing Ltd.,
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Full name of the subject	Freshwater microbiology
Abbreviated name/code	KBIOMPOV
Study cycle	second cycle
Credit value of ECTS	ECTS 6
Status of the course	elective



Prerequisites for passing	completed pre-examination requirements		
Access restriction	students of the second cycle of studies		
Duration/semester	one semester/ winter		
Number of contact hours per week	Lectures	Auditory exercises	Laboratory/ practical exercises
	2	0	1
Faculty	Faculty of Natural Sciences and Mathematics		
Study program	Ecological monitoring and aquatic bioassessment		
Responsible teacher	Ph.D. Snježana Hodžić, regular professor		
e-mail of the teacher	snjezana.hodzic@untz.ba		
Web page	www.pmf.untz.ba		
Objectives of the course	The goal of this subject (course) is for students to understand the role and significance of microorganisms in different freshwater ecosystems and how the composition of the microbial community can be an indicator of the state of surface waters.		
Learning outcomes	After successfully completing the pre-exam and exam requirements, students will be able to describe the dynamic activities of freshwater microorganisms in different aquatic ecosystems; to predict the response of microorganisms to eutrophication, as well as the ecological consequences associated with the increase of nutrients, to recognize and use the most important groups of microbiological indicators in the assessment of surface water quality, to understand the role of microorganisms in surface water, to be able to practically prepare and perform microbiological analyses of surface water, to be able to process the results of the obtained microbiological analyzes and to interpret them correctly in terms of assessing the microbiological quality of surface waters.		
Indicative content of the course	Theoretical teaching arranged by teaching units:		
	Microbiological diversity in freshwater ecosystems; Influence of physico-chemical factors on MO communities;		
	Circulation of matter in freshwater ecosystems; Biodiversity and activity of algae in freshwater ecosystems; Bacteria as the main heterotrophic MO in freshwater ecosystems; Viruses in freshwater environments; The role of fungi and fungi-like organisms in aquatic ecosystems; The role of protozoa in freshwater environments; Eutrophication; Definition, strategy and principles of bioindication and environmental biomonitoring; MO as environmental indicators; MO as useful indicators for monitoring surface water conditions and risk assessment.		
	Practical teaching includes the following procedures: preparation and sterilization of microbiological media, accessories and dishes for microbiological analyses of surface waters, taking samples in the field,		



	inoculation, incubation, reading and processing of results and their interpretation in terms of quality assessment of the tested surface waters.
Learning methods	Lectures, laboratory exercises, seminar work and consultations
Explanation about the knowledge test	Tests of theoretical knowledge would take place through two colloquiums (semester tests) that would cover half of the theoretical part of the material each. The student's seminar work, which would include an independent research paper on a chosen topic, would entail the evaluation of the written text, presentation and evaluation of the defense of the seminar work in front of the teacher and a select group of students. Knowledge from the practical and theoretical part of the class would be checked by an oral examination.
Check weighting factors	<p>PRE-EXAM REQUIREMENTS</p> <p>Colloquium of practical classes: 20 points</p> <p>Seminar paper/essay: 10 points</p> <p>Test (two colloquiums): 30 points</p> <p>FINAL (oral) EXAM: 40 points</p>
References	<p>Sigee, D. (2005): Freshwater Microbiology. John Wiley and Sons Ltd. England.</p> <p>Petrović O., Gajin S., Matavulj M., Radnović D., Svirčev Z. (1998): Microbiological investigation of surface water quality. Institute of Biology, University of Novi Sad.</p>

Full name of the subject	Wetland and riparian ecology
Abbreviated name/code	KBIOEVRS
Study cycle	second cycle
Credit value of ECTS	ECTS - 6
Status of the course	elective
Prerequisites for passing	completed pre-examination requirements
Access restriction	students of the second cycle of studies



Duration/semester	one semester/ winter		
Number of contact hours per week	Lectures	Auditory exercises	Laboratory/ practical exercises
	2	0	1
Faculty	Faculty of Natural Sciences and Mathematics		
Study program	Ecological monitoring and aquatic bioassessment		
Responsible teacher	Ph.D. Sanida Bektić, Assoc. prof.		
e-mail of the teacher	sanida.osmanovic@untz.ba		
Web page	www.pmf.untz.ba		
Objectives of the course	Acquaintance of students with the basic characteristics of biological components of wet and riparian habitats and adaptations of living organisms (with special reference to the Balkan peninsula), conceptual understanding of ecosystem functions and processes of wet ecosystems, use of acquired knowledge in the processes of conservation, restoration and management of wet and riparian ecosystems.		
Learning outcomes	After passing the course, students will be able to:		
	<ul style="list-style-type: none"> - distinguish between wet and riparian habitats, identify the plant and animal species of these habitats; - differentiate between communities and habitat types; - use knowledge in the processes of management of wetland and riparian habitats; - use scientific principles to solve real problems in conservation or management of wetland and riparian habitats. 		
Indicative content subject	Wetland and riparian habitats, definition, significance, differences, ecosystem services and functions, delineation of wetland and riparian habitats; Wetland and riparian typology, classification, wetland and riparian indicators. Peatlands. Wet and riparian habitats on the Balkan Peninsula; Wet and riparian habitats in Bosnia and Herzegovina; Morphological and physiological adaptations of plants and animals, reproductive strategies, distribution, structure and abundance, biodiversity; Biotic functions of wet and wetland habitats, water and nutrient flows, production ecology, dynamics of decomposition, information flows, microclimate; Biophysical connections and function of riparian areas and wetlands (nutrient flows, energy flows and food webs); Vegetation of wetland habitats and riparian areas; Endangerment of wet and riparian ecosystems (basic categories of changes, ecological consequences of flow regulation, consequences of global climate change); Conservation of wet and riparian habitats, protected areas, international conventions and legislation; Management of wet and riparian areas, Restoration of wet and riparian ecosystems (basic principles and definitions, creation of a restoration plan); Synthesis (principles of ecological management of riparian habitats, global ecological changes). Field teaching: Methods of identification and delineation of wet and riparian habitats; Flora of wet		



	and riparian habitats; Fauna of wet and riparian habitats; Vegetation of wet habitats and riparian areas. Research methods.
Learning methods	<p>Preferred learning styles are: verbal, group and independent. The most significant learning methods in the subject are:</p> <ul style="list-style-type: none"> - Lectures with the use of multimedia tools, active learning techniques and with active participation and discussions of students; - Field and laboratory exercises using field and lab. equipment and statistical applications; - Preparation and presentation of group and individual seminar papers and presentation of project ideas.
Explanation about the knowledge test	<p>During the semester, knowledge is continuously tested through some of the following activities: taking tests, monitoring student activities and preparing seminar papers or project assignments.</p> <p>The final exam is done in writing or orally. The student receives the final grade by adding up the individual points obtained in all forms of knowledge assessment during the semester.</p>
Check weighting factors	<p>PRE-EXAM REQUIREMENTS</p> <p>Student project, activity or colloquium of practical classes: 20 points</p> <p>Seminar paper/essay: 20 points</p> <p>Test: 20 points</p> <p>FINAL EXAM: 40 points</p>
References	<p>Primary references</p> <p>Keddy, P. A. 2010. Wetland ecology: principles and conservation. Cambridge University Press.</p> <p>Lovett, S., Price, P. (Eds.), 2007. Principles for riparian lands management. Land & Water Australia, Canberra, AUS.</p> <p>Additional preferences:</p> <p>Naiman, J.R., Decamps, H., Mc Clain, E.M. 2005. Riparia-Ecology, Conservation, and Management of Streamside Communities, Elsevier Academic Press.</p>

Full name of the subject	Practicum in ecology and botany
Abbreviated name/code	KRIOPREB
Study cycle	second cycle
Credit value of ECTS	ECTS - 6
Status of the course	elective



Prerequisites for passing	completed pre-examination duties		
Access restriction	students of the second cycle of studies		
Duration/semester	one semester/ winter		
Number of contact hours per week	Lectures	Auditory exercises	Laboratory/ practical exercises
	2	0	1
Faculty	Faculty of Natural Sciences and Mathematics		
Study program	Ecological monitoring and aquatic bioassessment		
Responsible teacher	Ph.D. Samira Huseinović, Assoc. prof.		
e-mail of the teacher	samira.huseinovic@untz.ba		
Web page	www.pmf.untz.ba		
Objectives of the course	The goal of the course is to improve students' knowledge of the basic morphological and functional characteristics of plants, with a special emphasis on aquatic plants and algae used in their determination, nomenclature and classification. Acquiring knowledge about scientific collections, methods and models of sampling and working with types of botanical samples.		
Learning outcomes	After passing the subject, students will be trained:		
	<ul style="list-style-type: none"> - for work on sampling, preparation, scientific, taxonomic and systematic processing of materials, determination of plants using all types of keys, creation of scientific herbarium collections. - for work in scientific collections, gathering information from collections, work on taxonomic and phenotypic variability analysis of plants, basics of morphometry, statistical processing and presentation of results. 		
Indicative content of the course	Herbarium-organization and historical development; Types of herbarium collections, organization and functioning of herbarium; Sampling of plant material, types of samples, research plan; Determination of plant material, types of keys for determination, character, levels of character significance; Plant nomenclature, International code of nomenclature of algae, fungi and plants, typification; Preparation and preservation of material; Application of identification for the analysis of micro and macro algal samples; Specificity of determination of plants - mosses (especially aquatic); Specificity of determination of plants - especially aquatic ferns and representatives from hygrophilous habitats; Specificity of determination of plants - gymnosperms; Specificity of determination of plants - of aquatic flowering plants; sympetaly forms and dissections of flowers; Determination of plant material from herbarium samples - flower rehydration techniques; Comparative phenotypic and morphological research of plant variability - character selection; Micromorphological research of seeds, pollen grains and epidermal structures, cytological analyzes and chromosomal series; Statistical operations in processing the		



	<p>results of phenotypic and taxonomic variability; descriptive and multivariate statistics; Research project of phenotypic and taxonomic variability of plants; Method of sampling plant material; Herbarizing and conservation of plant material; Canning of micro and macroalgae; creation of microscopic preparations; Application of determination keys.</p>
Learning methods	<p>The following learning styles are preferred: verbal, group and independent. The most important learning methods in the course are:</p> <ul style="list-style-type: none"> - Lectures with the use of multimedia tools, active learning techniques and with the active participation and discussion of students; - Laboratory exercises for using laboratory equipment and statistical application programs; - Preparing and presenting group and individual seminar papers and presentation of project ideas.
Explanation about the knowledge test	<p>During the semester, knowledge is continuously checked through some of the following activities: taking tests, monitoring student activities and creating seminar papers or project assignments.</p> <p>The final exam is done in writing or orally. The student receives the final grade by adding up the individual points obtained in all forms of knowledge assessment during the semester.</p>
Check weighting factors	<p>PRE-EXAM REQUIREMENTS</p> <p>Student project, activity or colloquium of practical classes: 20 points</p> <p>Seminar paper/essay: 20 points</p> <p>Test: 20 points</p> <p>FINAL EXAM: 40 points</p>
References	<p>Primary references:</p> <p>Nikolić T. (2013): Sistematska botanika. Alfa, Zagreb.</p> <p>Boža P., Veljić M., Marin P., Anačkov G., Janačković P. (2004): Praktikum za determinaciju viših biljaka. Old Commerce, Novi Sad.</p> <p>Huseinović S., Terzić Z.,(2016): Osnove algologije sa praktikumom. Global Media, Tuzla.</p> <p>Additional references:</p> <p>Nikolić T. (1996): Herbarijski priručnik. Školska knjiga, Zagreb</p> <p>Bridson, D., Forman, L. (1999): The Herbarium Handbook, third ed. Royal Botanical Gardens, Kew.</p> <p>Stuessy T. (2009): Plant taxonomy, The Systemtic evaluation of comparative data, sec ed. Columbia UniveCantonati, Marco, Martyn G. Kelly</p>



Horst Lange - Bertalot (eds.)(2017): Freshwater Benthic Diatoms of Central Europe: Over 800 Common Species Used in Ecological Assessment. Koeltz Botanical Books. Njemačka.

Full name of the subject	Practicum in ecology and zoology		
Abbreviated name/code	subject	KBIOPREZ	
Study cycle	second cycle		
Credit value of ECTS	ECTS - 6		
Status of the course	elective		
Prerequisites for passing	completed pre-examination requirements		
Access restriction	students of the second cycle of studies		
Duration/semester	one semester/winter		
Number of contact hours per week	Lectures	Auditory exercises	Laboratory/ practical exercises
	2	0	1
Faculty	Faculty of Natural Sciences and Mathematics		
Study program	Ecological monitoring and aquatic bioassessment		
Responsible teacher	Edina Hajdarević, Ph.D., Assoc. prof.		
e-mail of the teacher	edina.hajdarevic@untz.ba		
Web page	www.pmf.untz.ba		
Objectives of the course	The aim of this course is to develop basic ecological skills in order to analyze different types of aquatic habitats and ecosystems, using different animal groups (macroinvertebrates, fish, amphibians).		
Learning outcomes	The structure of the practicum includes lectures in the classroom, field teaching, field and laboratory exercises and integrated group projects, with the aim of providing knowledge about ways to assess aquatic ecosystems, based on the zoological part of biocenosis. The field course is designed to introduce students to different types of aquatic ecosystems, management goals and practices.		
Knowledge, skills and competences	Students will acquire basic knowledge of common ecological methods. They will be trained to carry out certain analyzes of populations and communities and to calculate various indices.		
Indicative content of the course	Theoretical and practical teaching distributed by teaching units: - Methods of preservation of zoological specimens from the aquatic environment.		



	<ul style="list-style-type: none"> - Spatial arrangement of organisms in liquid and stagnant water. - Adaptations to the planktonic way of life, determination of the population density of zooplankton organisms, methods of their identification, use of literature keys. - Adaptations of macroscopic invertebrates to the speed of water flow, methods of identification of macroscopic invertebrates, determination of population density of species of macrozoobenthic organisms. - Ichthyofauna. Ecological groups of fish. Endangered species of fish. Invasive fish species. Non-native species. Interspecies competitive relations. Concept of zonation of watercourses according to ichthyofauna. Law on Freshwater Fisheries. Metrics. Application of identification keys for fish identification. Fish morphometry. Analysis of changes in the age and gender structure of the population. - Sampling methodology. Estimating the size of the closed population using Peterson's method with different hunting effort and using Schnabel's method. - Determination of species diversity and community similarity.
Learning methods	<p>Preferred learning styles are: verbal, practical, group, independent and problem-based. The most significant learning methods in the subject are:</p> <ul style="list-style-type: none"> - lectures with the use of multimedia tools, active learning techniques and with active learning and student discussion; - field and laboratory exercises with the use of equipment for work in the field and laboratory equipment; - preparation and presentation of individual and group seminar papers, literature research, testing methods in the laboratory and in the field, and preparation of student projects.
Explanation about the knowledge test	<p>During the semester, knowledge is continuously tested through some of the following activities: taking tests, monitoring student activities and preparing seminar papers or project assignments.</p> <p>The final exam is done in writing or orally. The student receives the final grade by adding up the individual points obtained in all forms of knowledge assessment during the semester.</p>
Check weighting factors	<p>PRE-EXAM REQUIREMENTS</p> <p>Colloquium of practical classes: 20 points</p> <p>Seminar work, activity or student project: 20 points</p> <p>Test: 20 points</p> <p>FINAL EXAM: 40 points</p>
References	<p>Primary references:</p> <p>Ternjej, I., Brigić, A., Gottstein, S., Ivković, M., Mihaljević, Z., Previšić, A. i Kerovec, M. (2019): Terenske i laboratorijske vježbe i statističke metode u ekologiji. Ur: Školska knjiga d.d. i Sveučilište u Zagrebu Prirodoslovno-matematički fakultet Biološki odsjek, Zagreb, str. 413.</p>



Additional preferences:

Hauer, F. R., Lamberti, G. A. (2007): Methods in stream ecology, Elsevier

Đug i sar. (2020): Biomonitoring akvatičkih ekosistema. Univerzitet u Sarajevu, Prirodno-matematički fakultet. Str. 342

Full name of the subject	Forensic essentials in aquatic insects ecology		
Abbreviated name/code	subject	KBIOFZVI	
Study cycle	second cycle		
Credit value of ECTS	ECTS - 6		
Status of the course	elective		
Prerequisites for passing	completed pre-examination requirements		
Access restriction	students of the second cycle of studies		
Duration/semester	one semester/ winter		
Number of contact hours per week	Lectures	Auditory exercises	Laboratory/ practical exercises
	2	0	1
Faculty	Faculty of Natural Sciences and Mathematics		
sdagram	Ecological monitoring and aquatic bioassessment		
Responsible teacher	Ph.D. Isat Skenderović, Assoc. prof.		
e-mail of the teacher	isat.skenderovic@untz.ba		
Web page	www.pmf.untz.ba		
Objectives of the course	The objective of this course is to provide a broad knowledge of the use of aquatic insects in determining postmortem intervals of aquatic invertebrates and vertebrates found in water after environmental stress. The aim is also to present physical, chemical, geographical and biological parameters that influence the speed of colonization of dead animals by insects.		
Learning outcomes	Course Outcome: Students should gain a broad understanding of the ecology of aquatic biota relevant to forensic science and apply it to help resolve litigation in civil and criminal cases.		
Indicative content of the course	Teaching: Introduction to forensic biology, disciplines in forensic entomology, urban entomology, entomology of stored products, medico-legal / medico-criminal entomology; Aquatic insects in forensic investigations, important groups and species diversity, biology and development and ecology; Decomposition in freshwater ecosystems,		



	<p>submerged fresh body, early floating body, floating decaying body, advanced floating decaying body, submerged body remains; Collection of insects of forensic importance, methods of collection, breeding, preservation, dissection and identification; Molecular methods for forensic entomology, extraction of DNA samples from insects, DNA amplification, Species identification based on COI; Entomotoxicology, detection of toxins in carrion-feeding insects, effect of toxins on developing insects; Morphology of insects of forensic importance, adults, larvae, water bugs, diving beetles (Ordo Dytiscidae); Aquatic dipterons, midges (Family Chironomidae), mosquitoes (family Culicidae), dung flies (Family Scathophagidae), black flies (family Simuliidae); Groups other insects, water flowers (order Ephemeroptera), stoneflies (order Plecoptera), tularides (order Trichoptera); other aquatic arthropods, water mites, crabs; cases; practical teaching; preparation of recommended sampling equipment; Immersion of a body (a dead rat) in a cage in water; Body sampling (early and late stages of body decomposition); Preservation, handling and transport of samples; PMI estimate</p>
Learning methods	<p>The following learning styles are preferred: verbal, group and independent. The most important learning methods in the course are:</p> <ul style="list-style-type: none"> - Lectures with the use of multimedia tools, active learning techniques and with active participation and discussions of students; - Laboratory exercises using laboratory equipment - Preparation and presentation of group and individual seminar works and presentation of project ideas.
Explanation about the knowledge test	<p>During the semester, knowledge is continuously tested through some of the following activities: taking tests, monitoring student activities and preparing seminar papers or project assignments.</p> <p>The final exam is done in writing or orally. The student receives the final grade by adding up the individual points obtained in all forms of knowledge assessment during the semester.</p>
Check weighting factors	<p>PRE-EXAM REQUIREMENTS</p> <p>Student project or colloquium of practical classes: 20 points</p> <p>Seminar paper/essay: 20 points</p> <p>Test: 20 points</p> <p>FINAL EXAM: 40 points</p>
References	<p>Primary references:</p> <p>Markquez-Grant N, Roberts J (2012) Forensic Ecology Handbook. From Crime Scene to Court. Wiley-Blackwell. Oxford</p> <p>Villet, M. H. (2010). Forensic Entomology: The Utility of Arthropods in Legal Investigations. JH Byrd & JL Castner (Eds.): book review. <i>African Entomology</i>, 18(2), 387.</p> <p>Additional references:</p>



Byrd, J. H., & Tomberlin, J. K. (Eds.). (2019). *Forensic entomology: the utility of arthropods in legal investigations*. CRC press.

Amendt, J., Goff, M. L., Campobasso, C. P., & Grassberger, M. (Eds.). (2010). *Current concepts in forensic entomology* (pp. 212-215). London: Springer Netherlands

2.16 Connection with external reference points on the basis of the acquired qualifications

The qualifications that represent the successful completion of the second cycle (60 ECTS points) are awarded to students who master the planned curriculum and are shown in Table 4.

Table 4. Matrix connecting the qualifications of the 2nd cycle "Ecological monitoring and aquatic bioassessment" with different descriptors of the qualification framework for higher education in Bosnia and Herzegovina.

EXTERNAL REFERENCE POINTS	Order number of the subject													
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	Master thesis
Descriptors of the frame B&H university qualification that represent the successful completion of the second cycle (60 ECTS credits) Systematic understanding and mastering of knowledge in the field of natural sciences, which is based on knowledge of biological disciplines, i.e., it is expanded and/or upgraded with the level of undergraduate studies in biology or ecology, and which represents a basis or possibility for originality in the development and/or application of ideas, usually in the context of research work in water ecology	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Application of knowledge and understanding, as well as problem-solving skills, to new and unfamiliar environments within a broader (or interdisciplinary) context related to their field of study	X	X	X	X	X	X	X	X	X	X			X	X



<p>Application of conceptual and abstract thinking, with a high level of ability and creativity, which enables:</p> <ul style="list-style-type: none"> - critical evaluation of current research and academic work at the highest level in a given discipline, - assessment of different methodologies, formation of critical thinking and offering alternative solutions 	x	x	x		x	x	x	x											x	X	
<p>Ability to integrate knowledge and deal with complex problems, and to formulate judgments based on incomplete or limited information, but with consideration of the social and ethical responsibilities associated with applying their knowledge or judgments</p>	x	x	x	x	x	x	x	x	x	x	x									x	X
<p>They can transfer their conclusions, knowledge and reasoning on which they are based, using appropriate language(s), to non-specialist and specialist audiences, clearly and unambiguously</p>	x	x	x	x							x	x	x	x	x				x	X	
<p>They can raise their knowledge to a higher level, deepen their understanding of their field of study or discipline, and continuously develop their own skills, through independent learning and development.</p>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	X	
<p>They have learning skills that allow them to continue their studies in a way that will be largely self-directed and autonomous</p>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	X	
<p>They have acquired interpersonal and teamwork skills, suitable for different contexts of learning and employment, and demonstrate the ability to lead and/or initiate initiatives and contribute to change and development</p>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	X	



3 RELEVANCE OF THE STUDY PROGRAM

3.1 Compliance of learning outcomes with contemporary requirements in the scientific field and the labor market

The aim of every university study program is to expand knowledge from certain scientific fields acquired during previous education, permanent improvement of the scientific research process, introduction and opening of study programs that are adapted to new achievements in science and educational processes in Europe and the world.

The plan for establishing and developing the proposed study program is feasible, given that it represents a new program based on market needs. The Faculty of Natural Sciences and Mathematics has its own space, equipment, infrastructure, that is, educational staff and resources necessary for the implementation of the proposed study program. The new study program is financially sustainable, i.e., there are no significant initial additional costs for the Budget of Tuzla Canton, because the necessary equipment and training of the teaching staff is provided through the Erasmus project.

Since this or similar studies do not exist in the area of Tuzla Canton, experts of this profile will be trained for:

- monitoring of aquatic organisms in water or organisms of biological quality elements (phytobenthos, phytoplankton, macrophytes, zoobenthos and fish)
- field sampling,
- evaluation of the ecological status and ecological potential of water bodies,
- microbiological monitoring of aquatic ecosystems,
- conducting ecotoxicological tests,
- monitoring and conservation of riparian and wetland habitats,
- GIS and remote sensing,
- molecular and forensic methods for monitoring aquatic ecosystems
- data processing,
- administrative tasks related to national and EU legislation and policy in the field of water quality and freshwater ecosystem conservation.

The study program Ecological monitoring and aquatic bioassessment is designed to provide second-cycle students with numerous transferable skills:

- troubleshooting,
- organization of professional and scientific activities in the field of ecology and water monitoring,



- communication,
- sequence of deadlines,
- team management,
- team work,
- making decisions,
- research skills.

Masters in biology will be trained to apply the acquired scientific knowledge in scientific and scientific-teaching institutions, state administration bodies, city and canton councils, advisory services, state inspectorates, control laboratories, ecological laboratories and research centers in the field of environmental protection, as and institutes for nature protection and national parks, in various production companies, educational institutions, and other public and private sectors that are directly related to water monitoring and management.

Future masters will play a significant role in social institutions that deal with the sustainable development of society in which water management and protection of water and the environment play a key role. Also, candidates will acquire competencies for working in various domestic and international projects that participate in solving problems by applying ecological principles in accordance with national research priorities and needs in the public and private sectors.

Upon completion of the studies, the candidate is given the opportunity to improve at the third cycle of studies - doctoral studies that deal with the issues of ecology, water management, monitoring, water protection and the environment.

The curricula of the second cycle of studies of the study program Ecological monitoring and aquatic bioassessment, Department: Biology, Faculty of Natural Sciences and Mathematics, University of Tuzla, in its structure corresponds to the programs recommended by the Bologna Declaration (according to the ETCS scoring system). The study program is compatible with European higher education systems, which enables further education abroad. This study program is organized with the aim of students acquiring new knowledge in the field of biology and ecology with an emphasis on a multidisciplinary approach, as well as competences and skills in the application of modern biological and ecological methods in scientific research.

The connection of the academic title with the occupational codebook in Bosnia and Herzegovina is primarily achieved through the basic occupational code 2131 - BIOLOGISTS, BOTANISTS, ZOOLOGISTS AND RELATED EXPERTS, and through the ecomonitoring water specification, it is also linked to the code 2133 - ENVIRONMENTAL PROTECTION EXPERTS, which fall within 2133.001 - Ecologist, 2133.002 Hydrobiologist; 2133.004 - Person in charge of water control; 2133.005 - Environmental protection advisor; 2133.006 - Expert in energy and water management. The obtained title is also in line with the research occupations of code 231 UNIVERSITY AND HIGH SCHOOL TEACHERS in the context of assistants and lecturers in biology and ecology.



3.2 Continuation of education, accessibility of studies and mobility of students

The second cycle of studies can be enrolled by a candidate who has completed the undergraduate or first cycle of studies at the Faculty of Natural Sciences and Mathematics of the University of Tuzla or at one of the same or related faculties at other universities, which enables vertical transfer.

At the end of the second cycle of studies, the student, by defending the final master's thesis, achieves a total of 300 ECTS points, 240 ECTS points of which are for the study of the first cycle and 60 ECTS points of which are for the study of the second cycle. In this way, they fulfill the requirement and acquire the right to enroll in the third cycle - doctoral studies, which also ensures vertical mobility.

The existence of joint master courses of partner institutions in Bosnia and Herzegovina, which derive from the ERASMUS ECOBIAS project, ensures the accessibility of students and mobility, which are very important parameters of the quality assessment of modern study programs.

Given that the University of Sarajevo, University of East Sarajevo, the International University of Travnik and the University of Tuzla are developing parallel study programs in the second cycle of education in Ecological Monitoring and Ecological Engineering as part of the Ecobias project, when creating curricula and programs within the project consortium, taking into account the compatibility of teaching subjects, content and goals in order to enable the smooth mobility of students. Namely, at the University of Sarajevo, a master study program is being developed within the framework of the ECOBIAS project with the planned 9 subjects. Congruence with this study program is 6 common subjects. Also, at the University of East Sarajevo, a similar study program is being developed for master studies, with a total of 9 subjects. With this study program, matching is achieved with 3 common subjects. As part of the Ecobias project, the International University in Travnik is also developing a master degree program in "Environmental Engineering", with a total of 10 subjects, of which we have 5 common subjects. With the aforementioned similarities, a realistic prerequisite for the mobility of students within the framework of master's studies between the aforementioned universities is achieved.

3.3 Criteria and methods of quality assurance

The main goal set in the process of developing the quality system at the University of Tuzla is a satisfied student through a positive experience at the faculty, from the application for admission to the faculty, through the process of learning, exams and diplomas to employment and lifelong education. The quality assurance system at the University of Tuzla is defined by the act



"Quality Assurance Policy of the University of Tuzla" adopted by the Senate of the University in March 2011. The organizational structure of quality assurance at the University level consists of the Center for Quality Assurance and Internal Evaluation and the Quality Management Committee. The Center plays a coordinating role in quality assurance.

The tasks of the Center are:

- creation of a network for quality improvement and assurance and integration of the University into the national and international network for quality improvement,
- coordinating initiatives for the implementation of development programs for the purpose of continuous quality assurance and improvement,
- monitoring of indicators defined by the document "Standards and guidelines for quality assurance in higher education",
- encouraging constant discussions about quality, spreading the culture of quality in the academic and non-academic public,
- developing internal and external evaluation procedures,
- ensuring feedback from students and directing their suggestions, proposals and criticisms,
- collection of quality information from all system users,
- encouraging the professional development of teachers, associates, management and administrative staff,
- compliance with standards and guidelines in the field of quality assurance in Bosnia and Herzegovina, as well as other documents in the field of quality assurance, which bind the University.

The Board of the University of Tuzla organizes, coordinates and implements evaluation procedures (internal and external) and develops internal mechanisms for ensuring and improving quality, especially with regard to the following elements:

- organizes, coordinates and implements internal and external evaluation procedures,
- develops and collects quality indicators,
- ensures the participation of students in monitoring the quality of studies,
- investigates the success of studying and the causes of low-quality, inefficient and too long studying,
- conducts institutional quality research,
- conducts student surveys,
- conducts a survey of UNTZ employees,
- investigates the competences of the teaching staff,
- promotes the training of university teachers (lifelong education),
- promotes the training of administrative and technical staff,



- investigates the quality of general and specific competencies achieved by the study program,
- defines and introduces standard procedures in the administrative part of the faculty/Academy.

In relation to the previously listed elements, the Committee makes recommendations to the deans of organizational units of the University to consider and take appropriate measures in relation to them, and submits a report on the subsequent activities carried out to the NNV of the faculty and, if necessary, to the Senate of the University.

The criteria for periodic evaluation of the quality of study programs, which is done once every two years at the University of Tuzla, follow the requirements for accreditation of study programs defined in the Decision on criteria for accreditation of study programs of the first and second cycle of studies in Bosnia and Herzegovina, namely:

Criterion 1 - Quality assurance policy of study programs

Criterion 2 - Creation and adoption of study programs

Criterion 3 - Student-centered learning, teaching and assessment

Criterion 4 - Enrollment and advancement of students, recognition and certification

Criterion 5 - Human resources

Criterion 6 - Resources and financing

Criterion 7 - Management of information about study programs

Criterion 8 - Informing the public about study programs

Criterion 9 - Continuous monitoring, periodic evaluation and revision of study programs

Criterion 10 - Mobility of academic staff and students

The satisfaction of students and teachers is evaluated by conducting an anonymous survey twice a year.

3.4 Human Resources

The Faculty of Natural Sciences and Mathematics employs a total of 61 teachers in various academic titles, ten associates, five laboratory workers, four administrative employees and ten members of technical/support staff. Of these, a total of 16 teachers and one associate are



employed at the Department of Biology, while practical teaching is covered by selected assistants in associate titles and prominent experts from practice.

Thus, the Faculty of Natural Sciences and Mathematics has its own teaching staff to start the new study program.

The categories of teaching staff who participate in the educational process and scientific research work at the Department of Biology, and who are also participants in the ECOBIAS project from which the new study program stems, are as follows:

1. Dr. sc. Avdul Adrović, full professor
2. Dr. sc. Snježana Hodžić, full professor
3. Dr. sc. Jasmina Kamberović, associate professor
4. Dr. sc. Adisa Ahmić, associate professor
5. Dr. sc. Isat Skenderović, associate professor
6. Dr. sc. Amela Hercegovac, associate professor
7. Dr. sc. Edina Hajdarević, associate professor
8. Dr. sc. Elvira Hadžiahmetović Jurida, associate professor
9. Dr. sc. Sanida Bektić, associate professor
10. Dr. sc. Samira Huseinović, associate professor
11. Dr. sc. Alen Bajrić, assistant professor
12. Mr. sc. Darja Husejnagić, senior assistant

Also, in the project and in the curriculum, the following teachers from other study areas of the Faculty were engaged:

1. Dr. sc. Vedad Pašić, associate professor, dean of Faculty, Department: Mathematics
2. Dr. sc. Elvis Baraković, assistant professor, Department: Mathematics
3. Dr. sc. Aldina Kesić, associate professor, Department: Chemistry
4. Dr. sc. Semir Ahmetbegović, associate professor, Department: Geography
5. Dr. sc. Edin Hadžimustafić, assistant professor, Department: Geography

The categories and number of the total teaching staff of the Department of Biology of the Faculty of Science and Mathematics who participate in the educational process and scientific research work and who may be involved in the implementation of the mentioned study program are as follows:

- Full professor – 2
- Associate Professor - 11
- Assistant professors – 3
- Senior assistant – 1
- External collaborators – 9
- Experts from practice – 10



3.5 Spatial capacities

In total, 4498.8 m² of space is currently available at the Faculty of Natural Science and Mathematics (Table 5).

Table 5. Spatial capacities of the Faculty of Science and Mathematics

Spatial capacities	m ²
The area of the faculty's classrooms	478,0
Area of faculty laboratories	537,7
Surface area of university laboratories used by Faculty of Natural Sciences and Mathematics	284,5
Area of computer rooms	66,6
Area of cabinets	859,4
Area of administrative premises	156,0
The area of the support staff premises	101,4
The area of the accompanying rooms	2015,2
TOTAL AREA:	4498,8

The Department: Biology of the Faculty of Science has the following laboratories located at the Faculty of Technology:

- Laboratory for botany and plant ecology;
- Laboratory for zoology and animal ecology;
- Laboratory for physiology;
- Laboratory for microbiology and genetics;
- Scientific research laboratory.

Students of this study program, if necessary, will be able to use the laboratories used by students of chemistry, geography and mathematics, which are:

- Chemistry and Biochemistry Laboratory (at the Faculty of Medicine);
- General and inorganic chemistry laboratory (at the Faculty of Technology);
- Laboratory for organic chemistry (at the Faculty of Technology);
- Scientific-research laboratory for chemistry (on the Tuzla University campus);
- Laboratory for geographic information system (GIS), at Faculty of Natural Sciences and Mathematics,



- Computer center, with two computer rooms (22 computers) at Faculty of Natural Sciences and Mathematics.

3.6 Equipment Capacities

The teaching process, experimental exercises and scientific research work on the study program "Ecological monitoring and aquatic bioassessment" will be carried out in classrooms and laboratories of the biology department, GIS laboratories, and the computer center, which are adequately equipped.

The laboratories of the biology department have the following equipment:

- PCR device: Labnet, Labnet International Inc., Edison USA, Model: Multigen Gradient, TC 9600-G-230V;
- PCR device: Applied biosystems, Life TechnologiesTM, Model: 2720 Thermal Cycler;
- Electrophoresis equipment (bath, charger, gel combs): Labnet, Labnet International Inc., Edison USA;
- Magnetic stirrer: BioCote, Stuart, Type: US 152, UK;
- Mini centrifuge: Heathrow Scientific, Model: SproutTM, USA (2X);
- Vortex: BioSan, Bio Vortex, Type V1 plus;
- Micropipettes: Eppendorf (fixed and variable; 0.5 μ l -10 μ l, 10 μ l -100 μ l, 100 μ l -1000 μ l, 20 μ l-200 μ l);
- Thermostat with shaker: BIOSAN, Type ES 20/60;
- Microwave oven 2x;
- Autoclave: Presoclave 75-Selecta;
- Autoclave: Witeg, Model: Vac-60;
- Dry sterilizer: Titanox art.A3-213-400 (Serie no.010163);
- Technical scale: Balance, Type: ET-1111;
- Centrifuge: Universal 320R-Hettich Scientific;
- Water baths: SELECTA, AENURER-109/1/96, Spain;
- Combined refrigerator with freezer (2X);
- Freezer: ODOOD-Banknecht Automatic;
- Micropipettes: Micropet, Digipette (fixed and variable; 0.5 μ l-10 μ l, 10 μ l-100 μ l, 100 μ l-1000 μ l, 20 μ l-200 μ l);
- Thermostat: Memmert GmbH+Co. Kg. Type BE 400;
- Device for membrane filtration: Biotech Sartorius stadium (Gottingen, Germany);
- Digester 2x;
- Apparatus for centrifugation (LC 320, "Tehnica Železnik" Slovenia);
- Annealing furnace;
- Dryer;



- Scale (Wuder Italy);
- Binocular microscopes (30 pieces);
- Orbital shaker SO1: Stuart (UK);
- Binocular microscope with camera: Motic, RedLine, type RED 200, OPTICAM PRO3, Ver 4.0, Italy;
- pH meter (Piccolo 2);

The geographic information system (GIS) laboratory at the geography department is equipped with:

- 11 computers with installed GIS software;
- server;
- smart board;

Computer centers at the Faculty of Natural Sciences and Mathematics at the Department of Mathematics are equipped with 22 computers.

Exclusively for the needs of starting a new study program, funds were provided for the purchase of equipment worth EUR 63,000 within the framework of the ECOBIAS project, in which equipment for research in the application of environmental DNA in biomonitoring, field equipment for water sampling, equipment for remote detection in ecological monitoring and research equipment for the needs of terrestrial water ecology, classification protocols in ecological monitoring and numerical ecology. Some of the more important items provided by the project are the following:

- Compact portable photometer for cuvette tests;
- Thermo block for digestion of samples;
- Digital portable three-channel multi-meter with electrodes for measuring the pH of water; conductivity and dissolved oxygen in water;
- Deionizer;
- Ion exchange resin, suitable for the deionizer from the previous item;
- Fluor-meter for determining the concentration of nucleic acids;
- Thermo-Shaker for micro-tubes and PCR plate;
- Block for thermo-shaker compatible with thermo-shaker;
- Digital scale;
- Multifunctional table centrifuge;
- Oscillating swing out rotor;
- Set for electrophoresis with adapter;
- UV trans-illuminator lamp;
- Optical microscope, transmitted light, binocular 5 pieces;
- Trinocular stereomicroscope 1 piece;
- Binocular stereomicroscope 5 pieces;
- Microscopic USB C-mount camera for trinocular stereo microscope;



- Research light microscope, trinocular with transmitted light, differential interference contrast and color microscope camera 1x;
- A system for vacuum filtering of water samples in the field for environmental DNA sampling with the possibility of installing appropriate sterile cellulose-nitrate filter funnels;
- Set of variable pipettes 4x;
- Pipettor;
- Aircraft (drone) with camera;
- Computer 5x;
- Projector;
- Boat;
- Polychloroprene suits for fishing, rubber boots, life belts;
- Excavator for sampling liquid and stagnant sediment;
- Deep water pump;
- Net for macrozoobenthos;
- Mered's trawl nets;
- Graphnel for macrophyte sampling;
- Secchi disc for evaluating water transparency;
- Power unit for fishing;
- Computers

The mentioned equipment is supplemented with accompanying accessories and reagents, which are also planned for procurement within the Ecobias project.

3.7 Library Resources

Considering the spatial dislocation of faculty facilities, the University Library is organized as part of a network of centers for supporting scientific, teaching and research work at the University of Tuzla.

By decision of the Senate and the Board of Directors of the University, the University Library was established, and a facility was designated for it on the University Campus. Work on the reconstruction of the building was not started due to a lack of funds, but an executive project was drawn up, and urban planning approval was obtained. Until the formation of the University Library, there were 7 Departments at: the Faculty of Philosophy, the Faculty of Medicine, the Faculty of Economics, the Faculty of Technology, the Faculty of Electrical Engineering, the Faculty of Science and Mathematics, and the Faculty of Law.

Departments of the University Library have the minimum conditions necessary for active work, such as space, employees and library materials. Libraries have a reading area and a storage



area. Computers and computer equipment necessary for the work of users and employees also enter into the technical conditions in the process of modernization. In this sense, some reading rooms are equipped with computers that are necessary for students in the process of creating seminar, diploma and master's theses. Through the authentication system, students are given unlimited access to the Internet (in addition to fixed Internet connections, the reading room areas are also covered by a Wi-Fi signal), from the computers located in the reading rooms or from their own computers within the University premises.

A library was established at the Faculty of Natural Science and Mathematics of the University of Tuzla, which began operating in 2007. According to its purpose and the contents of the library collection, the library is a higher education, special, scientific library, and it is organized as a library within the Faculty of Science. It serves the goals of teaching, the development of science and the improvement of practice in the field of science. The library fund consists of about 5,200 books and publications from various fields of natural sciences, divided by study departments at PMF: biology, physics, geography, chemistry, and math. The faculty library has a reading room for students.

In order to find in the libraries a sufficient number of copies of required literature for each subject in each study program, the University has such a policy of publishing textbooks and manuscripts, written by the University's teaching staff, that one of the conditions, when approving them by the Senate, is that the authors of approved textbooks and manuscripts must submit the required number of copies of approved textbooks or manuscripts for use in the University Library.

3.8 Financial resources required for establishing a study program

All the costs of the teaching process can be classified into three groups, namely:

1. Work costs (work costs of teachers, associates and supporting staff);
2. Running expenses necessary for maintaining the teaching process;
3. Investment expenses;

The opening of the proposed study program does not imply significant financial investments from the budget of the Tuzla Canton, given that the University of Tuzla has its own staff that is able to fully hold the classes provided for in the curriculum and that significant investments in equipment and accessories are secured from ERASMUS ECOBIAS project. The project also provided training for all teachers provided for in the project application in terms of upgrading existing knowledge and skills and handling modern equipment in order to more efficiently transfer the knowledge of the planned teachers in the teaching process. The project also foresees the costs of the consumption of chemicals for conducting practical classes in the first few years of study.



The funds necessary for the work costs of the teaching staff would be provided by the existing enrollment policy for second-cycle students who participate in the costs of the two-semester tuition. The planned minimum number of students for enrollment in the new study program Ecological monitoring and aquatic bioassessment is 5, with the fact that the guidelines of Standards and norms for higher education in the Tuzla Canton will be consulted during the enrollment policy.

3.9 Consulted institutions and potential partners outside the higher education system

The acquired knowledge provides the graduate student with the expertise to work in laboratories and research centers of ecological profiles, accredited laboratories for quality control, biotechnology laboratories, institutes for monitoring and environmental protection, scientific institutes and laboratories of various industrial and agricultural branches where knowledge from this field is applicable, but also the practical application of acquired knowledge in different branches of the economy. Also, the knowledge acquired upon completion of these studies provides competence and expertise for further education in doctoral studies in the aforementioned direction.

Compliance with market needs in the preparation phase of the Elaboration was done through the analysis of existing Regulations and Decisions from the water sector, with consultations with accredited laboratories, agencies and the non-governmental sector. The project analyzed the needs of the labor market in ecological monitoring and aquatic bioassessment in partner countries and Bosnia and Herzegovina. Study results at: https://www.ecobiaserasmus.com/wp-content/uploads/2020/06/ECOBIA_TASK-1_4-REPORT.pdf. The results of the analysis of employment opportunities show that the labor market has the greatest need for experts who possess knowledge and skills related to environmental engineering and water protection technologies. Then there are experts in the field of administrative affairs related to national and EU legislation and policy in the field of water quality and conservation of freshwater ecosystems, and writing project proposals, followed by the need for experts in the field of GIS and remote sensing.

After completing the studies, based on the acquired knowledge and competencies, students will be able to cooperate with the local community, especially through activism and work with civil society organizations focused on environmental protection.

3.10 Summary

The second cycle of studies - the master's study "Ecological monitoring and aquatic bioassessment" is a continuation of the first cycle of education of the biology study program at



the Faculty of Natural Sciences and Mathematics of the University of Tuzla and is in accordance with the Bologna Declaration. Educating experts who, with their competences and skills, will respond to the modern requirements of ecological monitoring and biological assessment of waters on the way from Bosnia and Herzegovina to the European Union is a huge step forward in adapting the educational system to the needs of the market for highly specialized personnel. Through the application of modern learning methods, the integration of theoretical, practical, independent and team work of students, supported by the use of modern equipment, the Master's study will respond to the demands and needs of society and institutions for continuous ecological monitoring and appropriate management of water bodies and thus justify the demands for the establishment of a more active inter-institutional cooperation and improvement of knowledge, skills and competences of students and future masters.

In Tuzla, March, 2021.

Commission for the preparation of the Report:

1. Ph.D. Vedad Pašić, Assoc. prof., dean of the Faculty of Natural Sciences and Mathematics

2. Ph.D. Smajo Sulejmanović, Assoc. prof. vice dean for teaching at the Faculty of Natural Sciences and Mathematics

3. Ph.D. Jasmina Kamberović, Assoc. prof.

4. Ph.D. Isat Skenderović, Assoc. prof.

5. Ph.D. Edina Hajdarević, Assoc. prof.



6. Ph.D. Samira Huseinović, Assoc. prof.,

7. Vedrana Piljić, student of the biology department

Attachments: Description of each subject
(Syllabi in pdf format), teacher biographies

End of translation

I hereby confirm that the translation is true to the original.

Saša Leper, Certified Court Interpreter for the English Language

Reg. no: 1/23

In Banja Luka, on 21 January 2023

Saša Leper

