Department of Biology
Josip Juraj Strossmayer University of Osijek

Curriculum of the Graduate University Study Programme in Nature and Environmental Protection

accredited by the Ministry of Science, Education and Sports of the Republic of Croatia on 18 August 2014

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1. INTRODUCTION	
1.1. General information	Josip Juraj Strossmayer University of Osijek **Department of Biology** Address: Cara Hadrijana 8A, HR-31000 Osijek, Croatia Phone: +385 31 399 900 Fax: +385 31 399 939 e-mail: info@biologija.unios.hr web: http://biologija.unios.hr/

2. INSTITUTIONAL PRECONDITIONS	
2.1. Study programme title	Nature and Environmental Protection
2.2. Study programme provider	Department of Biology, Josip Juraj Strossmayer University of Osijek
2.3. Study programme type	University study programme
2.4. Level	Graduate study programme
2.5. Scientific or artistic area	1. Natural sciences; 8. Interdisciplinary field of science
2.6. Scientific or artistic field	1.05. Biology; 1.07. Interdisciplinary natural sciences; 8.03. Integrative bioethics
2.7. Scientific or artistic branch	1.05.05. Ecology; 1.05.07. General biology; 1.07.03. Environmental science
2.8. Enrolment criteria	Study programme can be enrolled by bachelors who have completed university undergraduate studies (with 180 ECTS) in the following areas: ▪ natural sciences ▪ interdisciplinary sciences ▪ biotechnical sciences ▪ biomedical sciences
2.9. Study programme duration (in semesters)	Graduate University Study Programme in Nature and Environmental Protection lasts for 2 academic years, i.e. 4 semesters. Students shall complete the study upon successful defence of their master theses. Study programme is delivered on a full-time basis.
2.10. Total number of ECTS	Students are obliged to obtain 120 ECTS by passing exams within 15 obligatory courses (87 ECTS) and 7 elective courses (21 ECTS). Upon completion of the research practice, students obtain 4 ECTS, and by preparation and defence of the master thesis students acquire 8 ECTS.
2.11. Academic title awarded after completion of the study programme	Master of Environmental Protection (Croatian abbreviation *mag. prot. nat. et amb*.)
2.12. Document of accredited undergraduate study programme in the scientific field of biology	The Department of Biology delivers the Undergraduate University Study Programme of Biology, upon completion of which the graduates can proceed with enrolment to the graduate study *Nature and Environmental Protection* (Annex II – Document on the accredited undergraduate university study programme).

2.13. Analysis of compliance of the study programme with the strategic objectives of the higher education institution	Establishment of the study programme is in line with the strategic objectives of Josip Juraj Strossmayer University in Osijek (as defined in the Strategy of Josip Juraj Strossmayer University of Osijek for the period 2011-2020; III1.5.1. Reorganisation of study programmes and establishment of new study programmes). Implementation of graduate study *Nature and Environmental Protection* is determined as an objective of the Department of Biology, as defined by the Strategy of the Department of Biology for the period 2012-2017. According to the Strategy of Josip Juraj Strossmayer University of Osijek, there is a defined need to reorganise study programmes to follow European trends in higher education and to define new academic profiles. Strategy of Josip Juraj Strossmayer University of Osijek available at: http://www.unios.hr/index.php?g=4&i=5 Strategy of the Department of Biology available at: http://biologija.unios.hr/webbio/kvaliteta.
2.14. Competences developed after completion of the study programme	Within the university graduate study programme *Nature and Environmental Protection*, students shall learn about principles of natural resource management, sustainable development and fundamentals of environmental economics. **Competences** that students will acquire upon completion of this study programme are the following: ▪ knowledge of issues related to nature and environmental protection at national and international level, ▪ skills required for preparation of environmental studies, ▪ planning and management of ecosystems of protected natural objects, ▪ analysis and assessment of an area, ▪ integrated protection of protected natural objects, ▪ ecological monitoring, ▪ management and protection of soil and water, ▪ restoration of degraded habitats, ▪ management of animal species, ▪ preparation of studies and basis for management of protected natural objects and urban ecosystems, ▪ readiness for continuous scientific and professional trainings within courses and postgraduate studies. **Job qualifications**: ▪ skills to perform the most complex tasks in various organisations dealing with protected natural objects (strict nature reserves, national parks, special reserves, nature parks, natural monuments, natural landscapes, parks and park architecture monument), in state, county and city governments, including advisory services and inspections, ▪ skills to perform jobs in horticultural companies and community services, ▪ skills to work as an expert associate and leader in scientific institutions in the area of environmental protection, ▪ skills to work as a professional manager and supervisor in the area of nature and environmental protection, and as a teacher in vocational secondary schools and other similar schools, ▪ skills to perform jobs and tasks related to publications and media dealing with nature and environmental protection, ▪ qualification for participation in the development and implementation of environmental impact assessment studies for ecological networks, strategic assessment of studies and risks for nature and environment. By acquiring interdisciplinary knowledge of biological, geological and geographical aspects of the protection of biological and landscape

	diversity, students being awarded the qualification of masters of nature and environmental protection are representing professionals that are sought by institutions involved in nature protection and spatial planning, management of national parks, water management and similar. After completing the study programme, masters of nature and environmental protection can continue their formal education at the postgraduate level by enrolling a postgraduate study in natural sciences, primarily the postgraduate interdisciplinary university study programme Nature and Environmental Protection offered by the University of Osijek.
2.15. Mechanism of vertical mobility of students in national and international higher education area	The study programme is fully applying the principles of the Bologna Declaration, by supporting the objective of student mobility at all levels of education. For this reason, this study programme is suitable for all forms of student exchanges that can be organised with similar national and international institutions of higher education. The proposed study programme provides horizontal and vertical mobility of students, since it is modelled on some European study programmes, and it is also compatible with similar study programmes delivered in the Republic of Croatia. The national mobility will be provided through the choice of elective courses offered by other similar study programmes in Croatia. Many elective courses enable the upgrading of the obligatory part of the study programme through facilitating the enrolment of postgraduate studies delivered by Croatian universities. The international mobility of students is based on the bilateral university agreements. The Department of Biology also supports the mobility of students that is organised within international exchange programmes and networks (Erasmus+, CEEPUS, COST, etc.).
2.16. Relation with the basic and modern skills and profession	The graduate study programme *Nature and Environmental Protection* is organised with the purpose to educate future experts in interdisciplinary area, so that they shall be able to conduct scientific research. The study programme follows the lifelong learning concept of education and as such, it facilitates further education within advanced master studies, professional and postgraduate study programmes. This graduate programme is based on competitive scientific research and competences required for the development of knowledge-based society. In Croatia, there is a demand for professionals and scientists skilled in the field of environmental protection. Therefore, this study programme represents a significant contribution to the development of young scientific and expert staff resources and will have direct effects on interdisciplinary, regional and local development even during its implementation. Apart from provision of students with basic knowledge of biology and ecology, the study programme *Nature and Environmental Protection* also teaches students how to apply this knowledge in responsible management of natural resources, and how to interlink ideas and knowledge of these issues with other professions and scientific fields, such as climatology, urban planning, economics, civil engineering and agriculture. In addition to the fundamental knowledge, students also acquire expert knowledge and skills to apply various methods of monitoring and environmental assessments, mathematical modelling, spatial modelling, statistical analysis and programmes, radiobiology, environmental economics.

2.17. Connection to the needs of the local community	The graduate study programme Nature and Environmental Protection is proposed to meet the needs of the local community as it educates professionals to perform jobs in the related area and to encourage the development and progress of this region, both on practical and on scientific level. The proposed study programme supports academic and practical work, which will directly improve the scientific potential of our country, and also contribute to the education of highly professional workforce able to develop the local, but also Croatian and European economy. In modern Croatian society, there are many institutions and companies in the public and private sector that are in demand of qualified experts in the field of nature and environmental protection. Organisation of the university graduate study programme in *Nature and Environmental Protection* arises from the growing need to understand the complex processes in the environment and to apply the knowledge from various scientific fields and disciplines in assessment of environmental conditions, in optimal environmental management and sustainable development planning. Advancements in technology and knowledge development requires the academic community to follow the newest insights and trends on the labour market, and to suggest new study programmes accordingly. It is particularly important to comply with the concept of lifelong learning. In this sense, students who complete this university graduate study programme will be able to continue their education at postgraduate level (e.g. at the University doctoral or specialist study programmes of Nature and Environmental Protection, as well as some other postgraduate study programmes in Croatia or in Europe. The Department of Biology of Josip Juraj Strossmayer University of Osijek is situated in the proximity of several protected natural areas (Nature Park Kopački Rit, Nature Park Papuk, Regional Park Mura-Drava) and the Danube River, which provides for the local community multiple benefits resulting from the cooperation of the Department of Biology with various institutions.
2.18. Analysis of employability	Upon completion of the proposed study programme, graduates will gain knowledge and skills necessary to perform complex tasks aimed at protection of nature and environment. Potential employers are small and medium-sized enterprises, as well as large companies that seek for qualified and trained staff. Despite the relatively high level of unemployment, the membership in the European Union will increase the need for knowledge of European business regulations. It is expected that the students who complete this study programme will be easily employable also at the international level, because of the competences acquired through the study.
2.19. Comparison with the accredited programmes abroad	In Croatia, there is no equivalent to the proposed programme of the university graduate study programme Nature and Environmental Protection, and therefore, this study programme is innovative and unique on the national scale. There are study programmes abroad that are similar to the proposed graduate study programme. The programme of the proposed graduate study programme Nature and Environmental Protection can be compared with: Master Program Environmental Protection and Management, The University of Edinburgh: http://www.ed.ac.uk/schools-departments/geosciences/postgraduate/masters- programme/taught-masters/environment-protection/degree-structure

	Master of Environmental Management, The Yale School of Forestry & Environmental Studies: http://environment.yale.edu/academics/degrees/mem/#mem-curriculum This graduate study programme enables the mobility of students and staff of similar study programmes, while at the same time maintaining the specific characteristics that will make it unique.
2.20. Previous experience in delivering the same or similar university study programmes	For the time being, University Department of Biology carries out one undergraduate study programme of Biology and two graduate study programmes (Graduate University Study Programme in Biological Sciences, and Graduate University Study Programme in Biology and Chemistry Teacher Education), as well as three postgraduate study programmes (Postgraduate university interdisciplinary doctoral study programme in Nature and Environmental Protection, Postgraduate advanced interdisciplinary master study Nature and Environmental Protection, and Postgraduate university interdisciplinary doctoral study programme in Molecular Biosciences).
2.21. Partners outside the higher education system who will participate in the proposed study programme	In the education of students enrolled at the proposed study programme of *Nature and Environmental Protection,* there will be several partner institutions involved in organisation of field work, professional practices and master theses preparation. These partner institutions are: ▪ public institutions dealing with nature protection, e.g. Nature Park Kopački Rit, Nature Park Papuk, Public Institution for Management of Protected Natural Values of the Osijek-Baranja County; ▪ scientific institutions, e.g. Ruđer Bošković Institute, Agricultural Institute of Osijek; ▪ state institutions, e.g. Community water supply company Vodovod, Institute of Public Health Osijek, Institute for Soil Osijek.
2.22. Development of international cooperation	One of the Bologna process objectives is the development of higher education system within three cycles (undergraduate, graduate and postgraduate study cycle) with recognisable diplomas and credit transfer system (ECTS), which contributes to the overall development and promotion of the mobility of students, teaching, research and administrative staff and supports the European network of interuniversity cooperation at all levels of education. The Department of Biology of Josip Juraj Strossmayer University of Osijek is organised similar to all European universities, which allows for easy international mobility. Numerous activities performed by the Department of Biology contribute to the development of international relations with partner institutions in the world, encouraging the mobility of students, teachers and non-teaching staff and participation in international programmes and projects in higher education. As of the strategy of the Department of Biology, scientific research activity is aimed to increase the quality of scientific work through establishing cooperation with other Croatian and international universities and scientific institutions, and to participate in joint projects with the European partners. The international cooperation of Josip Juraj Strossmayer University of Osijek and of the Department of Biology is realised within the framework of bilateral and multilateral agreements, international university networks and associations, international scientific and professional projects, and through cooperation with faculties, institutes and individual members of the academic community and of students' associations.

3. STUDY PROGRAMME DESCRIPTION	
3.1. The list of obligatory and elective courses with corresponding number of teaching hours and ECTS credits (***to be find below - Table 1, Table 2***)	

Table 1. The list of obligatory and elective courses with corresponding number of teaching hours and ECTS credits

LIST OF OBLIGATORY COURSES						
Study year: 1						
Semester: I						
COURSE	COURSE TEACHER	**L**	**P**	**S**	ECTS	STATUS[1]
Biogeochemistry (ZPIO-O01)	Assoc. Prof. Dr. Mirna Velki Assist. Prof. Dr. Goran Palijan	30	-	30	6	O
Terrestrial Ecology (ZPIO-O02)	Prof. Dr. Oleg Antonić Assoc. Prof. Dr. Davorka Hackenberger Kutuzović	30	30	-	6	O
Aquatic Ecology (ZPIO-O03)	Assist. Prof. Dr. Filip Stević Assoc. Prof. Dr. Dubravka Čerba	30	15	15	6	O
Quantitative Ecology (ZPIO-O04)	Prof. Dr. Branimir K. Hackenberger	30	30	-	6	O
Ecophysiology (ZPIO-O05)	Prof. Dr. Branimir K. Hackenberger Prof. Dr. Janja Horvatić	30	-	30	6	O

LIST OF OBLIGATORY COURSES						
Study year: 1						
Semester: II						
COURSE	COURSE TEACHER	**L**	**P**	**S**	ECTS	STATUS
Ecotoxicology (ZPIO-O06)	Prof. Dr. Branimir Kutuzović Hackenberger	30	30		6	O
Environmental Engineering (ZPIO-O07)	Assist. Prof. Dr. Goran Palijan Assist. Prof. Dr. Filip Stević	30		15	4	O
Geoinformation Science in Nature and Environmental Protection (ZPIO-O08)	Prof. Dr. Oleg Antonić	30	30		6	O
Inventory of Biological Diversity (ZPIO-O09)	Prof. Dr. Stjepan Krčmar Assoc. Prof. Dr. Davorka K. Hackenberger	15	30		4	O
Scientific Research Practice (ZPIO-O10)			30		4	O
LIST OF ELECTIVE COURSES						
Biomonitoring (ZPIO-I01)	Assoc. Prof. Dr. Sandra Ečimović	15		15	3	E
Radiobiology (ZPIO-I02)	Assoc. Prof. Dr. Valentina Pavić	15		15	3	E
Soil Ecology (ZPIO-I03)	Assoc. Prof. Dr. Davorka Hackenberger Kutuzović	15	15		3	E
Urban Ecology (ZPIO-I04)	Assoc. Prof. Dr. Dubravka Čerba	15		15	3	E
Vector Ecology (ZPIO--05)	Prof. Dr. Stjepan Krčmar Assist. Prof. Dr. Mirta Sudarić Bogojević	15		15	3	E
Environmental Microbiology (ZPIO-I06)	Assist. Prof. Dr. Goran Palijan	15	15		3	E
Herpetology	Assist. Prof. Dr. Olga Jovanović Glavaš	15	15		2	E

[1] **IMPORTANT:** Obligatory course is marked with O, and elective course is marked with E.
* From the list of elective courses, students have to select minimum two elective courses, so that they can obtain a total of 6 ECTS within elective courses in order to achieve a minimum of 30 ECTS per one semester.

L – lectures; P – practices; S – seminars

LIST OF OBLIGATORY COURSES						
Study year: 2						
Semester: III						
COURSE	COURSE TEACHER	**L**	**P**	**S**	ECTS	STATUS
Environmental and Natural Resources (ZPIO-O12)	Prof. Dr. Oleg Antonić Assoc. Prof. Dr. Dubravka Čerba	45		45	9	O
Ecological Modelling and Prediction (ZPIO-O13)	Prof. Dr. Branimir K. Hackenberger	30	30		6	O
Environmental Economics (ZPIO-O14)	Assist. Prof. Dr. Željka Lončarić	30	30		6	O
LIST OF ELECTIVE COURSES						
Invasive Species (ZPIO-I07)	Assist. Prof. Dr. Mirta Sudarić Bogojević	15	15		3	E
Energy Sources and the Environment (ZPIO-I08)	Assoc. Prof. Dr. Sandra Ečimović	15		15	3	E
Protected Areas (ZPIO-I09)	Assist. Prof. Dr. Dubravka Špoljarić Maronić	15		15	3	E
Natura 2000 in Croatia (ZPIO-I10)	Assist. Prof. Dr. Nataša Turić	15		15	3	E
Landscape Ecology (ZPIO-I14)	Assoc. Prof. Dr. Ljiljana Krstin	15	15		3	E
Structural Ecology and Ecological Networks (ZPIO-I15)	Assoc. Prof. Dr. Davorka Hackenberger Kutuzović	15		15	3	E
Ecological Projects (ZPIO-I)	Assoc. Prof. Dr. Melita Mihaljević	15		15	3	E
Algae as Biological Indicators	Assist. Prof. Dr. Dubravka Špoljarić Maronić	15	15		2	E
Biofilms	Assist. Prof. Dr. Goran Palijan	15		15	2	E
Socially Useful Learning	Assist. Prof. Dr. Anita Galir Balkić	3		27	2	E
Ecological Immunology	Assist. Prof. Dr. Senka Blažetić Assist. Prof. Dr. Irena Labak	15		15	2	E
Microphytes in Fouling Development	Assoc. Prof. Dr. Tanja Žuna Pfeiffer	15	15		2	E
Application of Algae and Cyanobacteria	Assist. Prof. Dr. Filip Stević	15		15	2	E
Introduction to Scientific Research Methodology	Assist. Prof. Dr. Lidija Begović	15	15		2	E

*From the list of elective courses, students have to select minimum three elective courses, so that they can obtain a total of 9 ECTS within elective courses in order to achieve a minimum of 30 ECTS per one semester.

L – lectures; P – practices; S – seminars

LIST OF OBLIGATORY COURSES						
Study year: 2						
Semester: IV						
COURSE	COURSE TEACHER	**L**	**P**	**S**	ECTS	STATUS
Environmental Impact Assessment (ZPIO-O15)	Prof. Dr. Oleg Antonić	45	-	30	8	O
Conservation Biology (ZPIO-O11)	Assoc. Prof. Dr. Dubravka Čerba Assist. Prof. Dr. Alma Mikuška	30	-	15	4	O
Human Ecology (ZPIO-O16)	Prof. Dr. Enrih Merdić	30	-	15	4	O

LIST OF ELECTIVE COURSES						
Eutrophication (ZPIO-I11)	Prof. Dr. Janja Horvatić Assist. Prof. Dr. Filip Stević	15	15	-	3	E
Biological Collections (ZPIO-I12)	Assist. Prof. Dr. Goran Vignjević	15	15	-	3	E
Agriculture and Environment (ZPIO-I13)	Assoc. Prof. Dr. Mirna Velki	15	-	15	3	E
Lichens as Biomonitors (ZPIO-I17)	Assist. Prof. Dr. Filip Stević	15	-	15	3	E
Nature and Environment Protection in Education (ZPIO-I18)	Assist. Prof. Dr. Irena Labak	15	-	15	3	E
Preparation of Master Thesis					4	
Defence of Master Thesis					4	

* From the list of elective courses, students have to select minimum two elective courses, so that they can obtain a total of 6 ECTS within elective courses in order to achieve a minimum of 30 ECTS per one semester.

L – lectures; P – practices; S – seminars

Course teachers and associates are assigned to courses as of the academic year 2021/2022

Obligatory courses

Course title	**Aquatic Ecology**
Code	ZPIO-O03
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	I semester
Workload/ECTS credits	6
Course status	Obligatory
Course teacher	Assist. Prof. Dr. Filip Stević Assoc. Prof. Dr. Dubravka Čerba
Associate teachers	Assist. Prof. Dr. Goran Palijan Assist. Prof. Dr. Dubravka Špoljarić Maronić Assoc. Prof. Dr. Tanja Žuna Pfeiffer
Course entry requirements (Preceding courses)	
Course objective	To introduce students to the functioning of aquatic ecosystems and living communities and to enable them to critically assess the impact of humans on aquatic ecosystems for the purpose of their protection. To develop students' natural science literacy and skills needed for independent work related to water research and protection.
Learning outcomes	1. Ability to compare the living communities of marine and freshwater ecosystems and their characteristics. 2. Knowledge about the functioning of aquatic ecosystems. 3. Ability to analyse the relations between habitat type, living conditions, flora and fauna. 4. Awareness of the importance of monitoring and assessing the status, management and protection of aquatic ecosystems. 5. Skills in selecting appropriate techniques and methods for independent field work.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-4	1	Lecture	Critical conversation and discussion	Records related to active and independent participation in conversations and discussions	10	15
1-4	1	Seminar	Independent preparation and presentation of seminar paper	Records related to active and independent preparation of seminar paper with provision of feedback	10	15
5	0.5	Practices	Written report about results and	Records related to students' activities within	5	10

				conclusions of performed analyses	practices, evaluation of the report		
	1-5	1.5	Written exam	Preparation for written exam	Written exam	15	25
	1-5	2	Oral exam	Preparation for oral exam	Oral exam	20	35
	Total	**6**				**60**	**100**
	Final grade: **60-70 points: grade 2 (sufficient)** **71-80 points: grade 3 (good)** **81-90 points: grade 4 (very good)** **91-100 points: grade 5 (excellent)**						

Consultation hours	As agreed with students		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	30	15	15

Course content / teaching units

Lectures:

- Basic terms and concepts in aquatic ecology
- Physical and chemical water properties – importance and interdependence of water parameters, influences on the flora and fauna, differences and similarities between marine and freshwater ecosystems (oxygen, temperature, dissolved gases, salinity/conductivity, micro- and macroelements, density, stratification)
- Nutrients
- Trophic state and water quality assessment – indicators and classifications
- Primary and secondary production
- Trophic levels and food network
- Biological communities in aquatic habitats and their characteristics
- Distribution, ecological classification, horizontal and vertical distribution of aquatic organisms
- Adaptations of organisms to environmental conditions
- Invasive species
- Species as indicators of environmental changes

Seminars:

- The importance of wetlands
- Anthropogenic influence on aquatic ecosystems
- Relations between the alternative energy sources and water
- Monitoring, assessment, management and protection of the aquatic ecosystems
- The legal framework for water protection – national and international conventions
- Protection and management of the aquatic ecosystems

Practices:

- Field work in selected habitat sites - sampling of water, sediments and biocenoses
- Determination of physical and chemical water properties
- Analyses of collected samples
- Grouping, systematisation and basic interpretation of collected data
- Application of modelling techniques in water quality assessment

Recommended reading

Dobson M., Frid C. (2009) Ecology of Aquatic Systems. Oxford University Press.
Habdija I., Primc B. (2019) Limnologija - Ekologija slatkih voda. Alfa, Zagreb.
Wetzel R.G. (2001). Limnology. Academic Press.

Optional reading	Bakran-Petricioli T. (2007) Morska staništa. Priručnik za inventarizaciju i praćenje stanja. Državni zavod za zaštitu prirode, Zagreb. Castro P., Huber M.E. (2005) Marine biology. Global Coastal Strategies. Engelhardt W. (2003) Was lebt im Tümpel, Bach und Weiher? Kosmos, Stuttgart. Hauer F.R., Resh V.H. (2006) Methods in stream ecology. Elsevier. Purger J.J. (ed.) (2007) Priručnik za istraživanje bioraznolikosti duž rijeke Drave, Sveučilište u Pečuhu. Streble H., Krauter D. (2002) Das Leben im Wassertropfen. Mikroflora und Mikrofauna des Suswassers. Kosmos, Stuttgart.
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.
Exam passing procedure	Students' performance is assessed during lectures and practices, and within written and oral exam. Each student prepares and presents a seminar paper, for which there are certain number of points awarded according to determined criteria.
Main language of instruction; other languages	Croatian language
Method of monitoring the quality and efficiency of teaching	Evaluation form

Course title	**Biogeochemistry**
Code	ZPIO-O01

Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	I semester
Workload/ECTS credits	6
Course status	Obligatory
Course teacher	Assoc. Prof. Dr. Mirna Velki Assist. Prof. Dr. Goran Palijan
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To enable students to understand the key concepts of biogeochemistry, basic methodology in biogeochemical research and the most important physical and chemical processes in the environment. To raise students' awareness of the importance of biogeochemical cycles in the global environment and to make them understand the influences of humans and of global changes on the biogeochemical cycles and ecological systems.
Learning outcomes	1. Knowledge about the basic biogeochemical principles, the origin and evolution of biogeochemical systems on Earth and the interactions among lithosphere, hydrosphere, atmosphere and biosphere. 2. Ability to explain the cycle of nitrogen, carbon, water, phosphorus and sulphur, and to analyse the anthropogenic effect on the balance of biogeochemical cycles. 3. Ability to analyse the effects of anthropogenic changes in natural cycles leading to ecosystem degradation. 4. Ability to estimate the consequences of global, regional and local human influence on the environment. 5. Ability to critically interpret scientific papers referring to the issue of human influence and global change on Earth.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	1	Lecture	Critical conversation and discussion	Records related to active participation in conversations and discussions	5	10
1-5	1.5	Seminars	Interpretation of scientific papers	Monitoring of students' performance at interpretations	10	20
1-5	1.5	Written exam	Preparation for written exam	Written exam	15	30
1-5	2	Oral exam	Preparation for oral exam	Oral exam	30	40
Total	**6**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)

<table>
<tr><td></td><td colspan="3">91-100 points: grade 5 (excellent)</td></tr>
<tr><td>Consultation hours</td><td colspan="3">As agreed with students</td></tr>
<tr><td>Teaching</td><td>Lectures</td><td>Seminars</td><td>Practices</td></tr>
<tr><td>Hours - total</td><td>30</td><td>30</td><td>0</td></tr>
<tr><td>Course content / teaching units</td><td colspan="3">Lectures:
Origin of elements and metabolic processes; basic principles of physical and chemical processes in the environment (ionic interactions, dissolution, precipitation, oxidation and reduction processes, photochemical processes, adsorption, ion exchange, diffusion, filtration)
Global water cycle
Global carbon cycle
Global nitrogen cycle
Global phosphorus cycle
Global sulphur cycle
Biogeochemistry of mercury and other heavy metals
Research into biogeochemistry by isotope analysis
Anthropogenic influences on natural biogeochemical cycles, such as nutrients, water, heavy metals and other pollutants
Anthropogenic changes in natural cycles leading to degradation of ecological systems
Atmospheric biogeochemistry
Lithosphere biogeochemistry
Ocean biogeochemistry
Biogeochemistry of the terrestrial environment
Biogeochemistry of rivers and lakes
Radionuclides in the environment
Seminars:
Biogeochemical modelling
Biogeochemistry and human health
Drought biogeochemistry
Polar ice and its impact on ocean biogeochemistry
Anthropogenic effects on global climate change
Biogeochemistry of extreme environment
Biogeochemistry of wetlands
Aeolian erosion and impact on biogeochemistry
Dust in the Earth's system: biogeochemical connection of land, air and sea
Influence of Saharan sand and dust on the Mediterranean region (biogeochemical cycles of the Mediterranean Sea, lakes and reservoirs in the Mediterranean region, and influence on human health)
Biogeochemistry and bioremediation of uranium and other radionuclides
Heterogeneous interactions of C, N, and S cycles in the atmosphere: the role of aerosols and clouds</td></tr>
<tr><td>Recommended reading</td><td colspan="3">Bashkin V.N., Howarth R.W. (2003) Modern biogeochemistry. Kluwer Academic Publishers, Boston.
Filipović-Vinceković N., Dutour-Sikirić M., Tomašić V. (2004) Fizičko-kemijski procesi u okolišu. Interna skripta za studente poslijediplomskog sveučilišnog interdisciplinarnog znanstvenog studija Zaštita prirode i okoliša u Osijeku.
Schlesinger W.H., Bernhardt E.S. (2013) Biogeochemistry: an analysis of global change. Elsevier.</td></tr>
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Optional reading	Scientific papers and review articles
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.
Exam passing procedure	Prior to taking oral exam, students are obliged to prepare seminar papers and to pass the written exam. The final grade is determined according to the number of points that students obtain for the seminar paper and at the written and oral exams.
Main language of instruction; other languages	Croatian language
Method of monitoring the quality and efficiency of teaching	Student survey, possibility to make oral or written remarks after lectures. Monitoring of students' success at exams.

Course title	**Ecophysiology**
Code	ZPIO-O05
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	I semester
Workload/ECTS credits	6
Course status	Obligatory
Course teacher	Prof. Dr. Branimir K. Hackenberger Prof. Dr. Janja Horvatić
Associate teachers	Assoc. Prof. Dr. Sandra Ečimović Assist. Prof. Dr. Vesna Peršić Martina Varga, Ph.D.
Course entry requirements (Preceding courses)	
Course objective	To enable students to understand basic physiological processes of plant and animal organisms that depend on environmental factors. To explain ecophysiological phenomena at all levels of biological organisation and the principles of adaptation to different environmental conditions in the aquatic and terrestrial environment, their fluctuation and various extreme conditions (high altitudes, deserts, etc.).
Learning outcomes	1. Knowledge about basic concepts in ecophysiology. 2. Ability to analyse the basic physiological processes of plant and animal organisms, as well as environmental influence on these processes. 3. Ability to connect the interactions between the environment and living organisms and to understand and explain the principles of acclimatization and adaptation to different environmental conditions. 4. Ability to assess and analyse how changes in abiotic and biotic factors will affect physiological processes in organisms. 5. Skills to correlate acquired knowledge with interactions at different levels of biological organisation by using case studies.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	1	Lecture	Lecture attendance and active participation	Records on lecture attendance and student activity	10	20
3-5	2	Seminars	Attendance of seminars, active participation, presentation of a seminar paper	Records on Attendance and student activity, evaluation of seminar paper	20	30
1-5	2	Exam (Written exam)	Preparation for written exam	Written exam	20	30
1-5	1	Oral exam	Preparation for oral exam	Oral exam	10	20
Total	**6**				**60**	**100**

	Final grade: **60-70 points: grade 2 (sufficient)** **71-80 points: grade 3 (good)** **81-90 points: grade 4 (very good)** **91-100 points: grade 5 (excellent)**		
Consultation hours	By appointment.		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	30	30	0
Course content / teaching units	Lectures: • Introduction to ecophysiology • Homeostasis • Stress and stressors • Acclimatisation, adaptation and natural selection • Ecophysiology of plants • Photosynthesis - the interaction of the endogenous and exogenous factors in determining photosynthetic efficiency. • Respiration (endogenous and exogenous factors of respiration, photorespiration). • Control of growth and development. • Functional role of inorganic elements in plants with respect to growth, proliferation and survival in different environments. • Adaptations and acclimatisation of plants to the climate changes (increased concentration of CO2, extreme temperatures, drought, UV radiation). • Adaptation and acclimatisation of plants to unfavourable soil conditions (deficiency and toxicity of the mineral nutrients, salinity, acidity, alkalinity, drought, heavy metals). • Genetic and molecular mechanisms involved in the adaptation and acclimatisation to abiotic stress. • Interaction of soil and plants (processes in the rhizosphere). • Biotic interactions. • Physiology of anthropogenic impacts on plants • Animal ecophysiology • Thermal physiology • Physiological adaptations to life in deserts and dry savannas • Physiological adaptations to life in the polar regions • Hibernation and torpor • Orientation and navigation in animals • Functional anatomy and physiology of movement • Physiology of animal flight • Physiology of diving of birds and mammals; biological clocks; physiology of anthropogenic impacts on animals Seminars: • Physiology of plants and animals in the extreme conditions, extraterrestrial and artificial environments – case studies and relevant scientific literature		
Recommended reading	Randall D., Burggen W., French K. (2002) Eckert Animal Physiology – Mechanisms and Adaptation. W. H. Freeman and Company, New York. Teiz L., Zeiger E. (2002) Plant Physiology. Sinauer Assoc. Inc., Sunderland, Massachusetts. Willmer P., Stone G., Johnston I. (2004) Environmental Physiology of Animals, Wiley-Blackwell.		
Optional reading	Bradshaw D. (2003) Vertebrate Ecophysiology: An Introduction to its Principles and Applications. Cambridge University Press. Lambers H., Chapin III F.S., Pons T. L. (2008) Plant Physiological Ecology, Springer. Larcher W. (2003) Physiological Plant Ecology. Springer.		

Conditions for obtaining teacher's signature	Regular attendance of lectures and practices
Exam passing procedure	During the course, the teacher monitors and evaluates the activities of each student. Student activity, preparation and presentation of seminar paper refer to 30% of the final grade. Passing of written exam refers to 30% of the final grade, while passing of oral exam refers to the remaining 40% of the final grade.
Main language of instruction; other languages	Croatian language, English language
Method of monitoring the quality and efficiency of teaching	Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams.

Course title	**Human Ecology**
Code	ZPIO-O16
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	IV semester
Workload/ECTS credits	4
Course status	Obligatory
Course teacher	Prof. Dr. Enrih Merdić
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To teach students about the basic principles of quality living and about the self-caused threats.
Learning outcomes	1. Knowledge about the negative influences that humans cause to themselves. 2. Ability to analyse the effect of some chemicals on humans. 3. Ability to explain the reasons for food contamination. 4. Skills in interpreting health through lifestyles and notion on correlation between pharmaceutical industry and health. 5. Developed attitude about healthy lifestyle.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	1	Lecture	Critical conversation and discussion	Records related to active participation in discussions	10	20
1-5	1.5	Seminar	Independent work on seminars assignments	Presentation of seminar assignments and of seminar paper	25	40
1-5	1.5	Oral exam	Preparation for oral exam	Oral exam	25	40
Total	**4**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment.		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	30	15	0
Course content / teaching units	• Genetic physiological and social adaptation to the environment and to changes in the environment • Relations between human development (economic) and the loss of biodiversity		

	• Humans as an invasive species • Analysis of the basis of life; energy, breathing, food and movement • Influences on life: radiation, environment, personal choice, impact of industrialisation, distancing from nature • Negative impact of mass food production: mass food production, chemicals in food, reasons for intake of these chemicals, residues of pesticides and drugs in food and contamination of stored food • Natural food: organic food production, varieties and ways of food preparation • Chemicals around us and their impact on humans: chemicals for general use and chemicals in the environment • Health: definition of health, state of the organism: health vs. disease, health institutions, medicines, pharmaceutical industry • How to live in a modern society • Education in the function of quality living: modern and traditional
Recommended reading	Foster J. (2003). Between economics and ecology: Some historical and philosophical considerations for modelers of natural capital. Environmental Monitoring and Assessment 86:63–74. doi:10.1023/A:1024002617932 Marten G. (1992) Human Ecology: basic concept for susteinable development. Easthscan. Young G.L. (1974) Human ecology as an interdisciplinary concept: A critical inquiry. Advances in Ecological Research 8: 1–105. doi:10.1016/S0065-2504(08)60277-9
Optional reading	Holmgren D. (2002) Permaculture: Principles and Pathways beyond sustainbility. Holmgren Design Services. Kushi M. (2010) Makrobiotika: put zdravlja sreće i mira. Planetopija.Williams, L., Roberts, R., Mcintosh A. (2012) Radical Human Ecology: Intercultural and indigenous approaches. Ashgate Publishing, e-book.
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively.
Exam passing procedure	Grading of students will be carried out by evaluation of their activities within lectures and their performance at preparation of a seminar paper. At the end of the course, students shall take the oral exam. During the oral exam, the teacher asks questions that are related to learning outcomes. The final grade is determined according to the number of points awarded for oral exam and the number of points gained during lectures.
Main language of instruction; other languages	Croatian language, English language
Method of monitoring the quality and efficiency of teaching	Periodic evaluation of students and teachers is planned to be carried out in order to assure and continuously improve the quality of teaching and of the study programme. Within the last lecture, there will be an anonymous student survey carried out to evaluate the overall quality of the course. Student success at exams will be also monitored.

Course title	**Ecological Modelling and Prediction**
Code	ZPIO-O13
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	6
Course status	Obligatory
Course teacher	Prof. Dr. Branimir Kutuzović Hackenberger
Associate teachers	Assist. Prof. Dr. Željka Lončarić
Course entry requirements (Preceding courses)	
Course objective	To acquaint students with the principles of mathematical modelling of ecological processes, types of mathematical models and their application in ecology, nature protection and environmental management. Students will learn how to model the basic changes of biotic and abiotic environmental factors, and how to apply commercial models in the forecasting of changes and conditions.
Learning outcomes	1. Knowledge about the basic types and division of mathematical models used in ecology, nature protection and environmental management. 2. Skills in applying commercial models independently. 3. Skills in implementing, testing and analysing simple models. 4. Ability to apply commercial models for the purpose of forecasting changes in environment. 5. Ability to critically review the literature in the field of ecological modelling.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	2	Lectures	Critical conversation and discussion	Records related to active participation in conversations and discussions	5	10
1-5	2	Practices	Solving of tasks, independent set up of a model	Monitoring of student performance at solving of tasks	10	20
1-5	1	Written exam	Preparation for written exam	Written exam	20	30
1-5	1	Oral exam	Preparation for oral exam	Oral exam	25	40
Total	**6**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment

Teaching	Lectures	Seminars	Practices
Hours - total	30	0	30
Course content / teaching units	Lectures: • Introduction - an overview of the existing models in ecology, basic model types (discrete, continuous, deterministic and stochastic models) and their characteristics • The single-species population models • Malthusian Growth Model • Intraspecific competition - Verhulst model • The emergence of chaos in discrete mathematical models • Allee effect • Modelling of age-structured populations: Leslie and Lefkovitch model • The analysis of population dynamics – basic eigenanalyses • Metapopulation models: Levin's model, MacArthur and Wilson's equilibrium model, Source-sink model, the rescue effect. Models of two populations: Lotka-Volterra model. Basic epidemiological models • Modelling of ecological systems (introduction to the basic models - Whole Ecosystem Models, Minimum Realistic Models, Dynamic System Models, ESAM) • Growth models • Models of matter cycles • Hydrologic models • Models and forecasting of water levels • Models and forecasting of ice-melting Practices: • Introduction to the basic mathematical models in ecology and nature conservation, and their construction, testing and analysis by using MS Office Excel and the R software		
Recommended reading	Edelstein-Keshet L. (2005) Mathematical Models in Biology. SIAM. Rockwood L.L. (2006) Introduction to Population Ecology. Blackwell Publishing.		
Optional reading	de Vries G., Hillen T., Lewis M., Müller J., Schönfisch B. (2006) A Course in Mathematical Biology: Quantitative Modeling with Mathematical & Computational Methods. Society for Industrial and Applied Mathematics, Philadelphia. Jopp F., Reuter H., Breckling B. (2011) Modelling Complex Ecological Dynamics: An Introduction into Ecological Modelling for Students. Teachers & Scientists, 1st ed. Springer.		
Conditions for obtaining teacher's signature	Regular attendance at lectures, successfully completed practices		
Exam passing procedure	During lectures, the teacher monitors and evaluates performance of each student, which refers to 30% of the final grade. Passing of written exam refers to 30% of the final grade, and passing of oral exam refers to the remaining 40% of the final grade.		
Main language of instruction; other languages	Croatian language, English language		
Method of monitoring the quality and efficiency of teaching	Student survey to evaluate the overall quality of the course. Analysis of student success at the exams.		

Course title	**Environmental Economics**
Code	ZPIO-014
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	6
Course status	Obligatory
Course teacher	Assist. Prof. Dr. Željka Lončarić
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To acquaint students with the basic economic concepts and analytical tools needed to understand and evaluate the relations between the environment and the economy. Problems of environmental pollution will be considered in the context of competitive economics, and students will learn about the basics of cost-benefit analysis (CBA), non-market methods of environmental evaluation, and assessment of economic efficiency in implementing environmental policy (pollution standards, taxes, subsidies, marketable permits). Students will be introduced to the basics of environmental policy of the Republic of Croatia.
Learning outcomes	1. Ability to critically evaluate the basic economic concepts needed to understand and evaluate the relations between the environment and the economy. 2. Ability to apply economic theory to environmental sustainability and sustainable development. 3. Skills in reviewing the basic principles of the conflict between the market and the environment integrity. 4. Development of a critical understanding of how economic decisions, market forces, and governmental policies affect the environment. 5. Skills in applying basic cost-benefit analyses and basic non-market methods of environmental evaluation. 6. Ability to valorise the economic efficiency of environmental policy implementation.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-6	2	Lectures	Lecture attendance and active participation	Records related to active participation in conversations and discussions	5	10
1-6	2	Practices	Practical classes attendance and active participation	Monitoring of student performance at solving of tasks	10	20
1-6	1	Written exam	Preparation for written exam	Written exam	20	30
1-6	1	Oral exam	Preparation for oral exam	Oral exam	25	40
Total	**6**				**60**	**100**

	Final grade: **60-70 points: grade 2 (sufficient)** **71-80 points: grade 3 (good)** **81-90 points: grade 4 (very good)** **91-100 points: grade 5 (excellent)**		
Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	30	0	30
Course content / teaching units	Lectures: • Introduction to environment economics (definition and basic concepts; establishing property rights on the environment; issues of economic sustainability and the environment; social capital, PPF (Production Possibilities Frontier), CIC (Community Indifference Curves); Meadows's model - limits to growth; Environmental Kuznets curve (EKC). • The relationship between economy and environment (the first and the second law of thermodynamics, pollution processes, classification of contaminants, pollution trends in Croatia). Competitive Market Model (Demand curves; CS - Consumer Surplus; Offer curves; PS - Producer Surplus; Market Equilibrium). • Social efficiency and market failure (social welfare (SW); SEM (Social Efficiency Model); competitive markets; external costs; external costs of consumption; external profit). • Economics of environmental pollution (external production costs; external costs of consumption; MD (Marginal Damage curve); MAC (Marginal Abatement Cost curve); acceptable levels of pollution according to the model of competitive market. • Cost-Benefit Analysis - introduction; NPV (Net Present Value); effects of the discount rate, the choice of discount rate. The value of ecosystem services; DRM (Dose-Response Method); PEM (Preventative Expenditure Method); HPM (Hedonic Pricing Method); Indirect methods – TCM (Travel Cost Method); CVM (Contingent Valuation Method); BTM (Benefit Transfer Method). Estimation of the costs of pollution (Economic Impact Analysis (EIA), economic impacts of pollution reduction). • The evaluation criteria of environmental policy (efficiency and effectiveness). • Environmental policy, legal framework and the right of ownership (legislation liability for environmental damage; the right of ownership and cost-effectiveness, evaluation criteria for the determination of the rights of ownership; moral suasion - evaluation criteria, standards - emissions to the environment, technology standards; taxes and subsidies - evaluation criteria for determining the incentive to reduce pollution; tradable permits - evaluation criteria). • Environmental policy of the Republic of Croatia. Practices: • Introduction to the cost-benefit analysis and non-market methods of environmental value assessment		
Recommended reading	Field B., Olewiler N. (2011) Environmental Economics, 3rd Canadian ed. McGraw-Hill Ryerson. Kolstad C.D. (2010) Environmental Economics, 2nd ed. Oxford University Press**.**		
Optional reading	Daly H.E., Farley J. (2010) Ecological economics: principles and applications. 2nd ed. Island Press. Hussen A.M. (2004) Principles of Environmental Economics, 2nd ed. Routledge, New York.		
Conditions for obtaining teacher's signature:	Regular attendance at lectures, successfully completed practices		

Exam passing procedure	During lectures, the teacher monitors and evaluates performance of each student, which refers to 30% of the final grade. Passing of written exam refers to 30% of the final grade, and passing of oral exam refers to the remaining 40% of the final grade.
Main language of instruction; other languages	Croatian language
Method of monitoring the quality and efficiency of teaching	Student survey to evaluate the overall quality of the course. Analysis of student success at the exams.

Course title	**Ecotoxicology**
Code	ZPIO-006
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	II semester
Workload/ECTS credits	6
Course status	Obligatory
Course teacher	Prof. Dr. Branimir Kutuzović Hackenberger
Associate teachers	Assoc. Prof. Dr. Sandra Ečimović Assoc. Prof. Dr. Davorka Kutuzović Hackenberger
Course entry requirements (Preceding courses)	
Course objective	To enable students to understand the basic principles of ecotoxicology and modern approaches to the issue of pollutant influence on various structural parts of ecological system, as well as on the entire biosphere. To acquaint students with the basic concepts in ecotoxicology, the basic groups of pollutants and its effects in the environment and the mechanisms of action of pollutants at different levels of the ecological system. To enable students to analyse the interactions of biological structures and pollutants within the ecological systems.
Learning outcomes	1. Knowledge about the basic concepts in ecotoxicology, and skills in analysing the effects of pollutants in the environment and the mechanisms of action on the components of environment. 2. Ability to connect the interactions between pollutants and different components of environment. 3. Ability to assess the effects of individual pollutants on the ecological system through the relevant scientific literature 4. Ability to select and apply appropriate methods in environmental risk assessment and management. 5. Ability to apply standard methods to assess the effects of pollutants at different levels of biological organisation.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-4	1.5	Lecture	Active participation in lectures and discussions	Records related to active participation in conversations and discussions	5	10
4-5	2	Practices	Work on the experimental task and interpretation of scientific papers	Monitoring of student performance	10	15
1-5	1.5	Written exam	Preparation for written exam	Written exam	15	25

	1-5	1	Oral exam	Preparation for oral exam	Oral exam	10	20
	Total	**6**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	30	0	30

Course content / teaching units

Lectures:

- Introduction to and history of ecotoxicology
- Definition of basic concepts of ecotoxicology
- Basic groups of pollutants
- Anthropogenic and non-anthropogenic sources of pollution
- Pollutants in the environment
- Biomagnification, bioaccumulation and bioconcentration
- Bioavailability
- Response of the individual, population, community and the ecological system to pollutants (at molecular, physiological and behavioural level)
- Lethal and sub-lethal effects
- Stress
- Biomonitoring and biomarkers of pollution
- Principle of concentration dependence in ecotoxicology
- Effect of pollutants on the stability and dynamics of populations
- Mechanisms of disturbing the stability of interactions between populations of pollutants
- Pollution and population stability and population genetics
- Stability of biocenoses under continuous and discontinuous pollutant burden
- Effects of pollutants on individual organisms
- Predicting the environmental impact of pollutants
- Interactions among pollutants
- Circulation of pollutants in the biosphere
- Degradation of pollutants in the environment
- Pesticides in the ecological system
- Quantification and measurement of ecotoxicological effects
- Biotests
- Risk and danger
- Ecotoxicological risk assessment
- Ecotoxicological risk management
- Field probing and screening
- Sampling design
- Selection of experimental organisms and monitoring organisms
- Microcosm
- Mesocosm
- Conservation and primary processing of samples
- Multilayer biomonitoring design
- Determination of pollution sources in the field
- Gradient of pollution in aquatic and terrestrial environment
- Air pollution gradient

	• Determination of critical points in an area Practices: • Sampling design • Sampling methods • Methods of exposing organisms to xenobiotics • Measuring the effects of pollutants • Biomarkers at different levels of biological organisation • Processing and interpretation of research results • Case studies in ecotoxicology and review of relevant scientific literature
Recommended reading	Hoffman D.J., Rattner B.A., Burton G.A., Cairns J. (2003) Handbook of ecotoxicology. CRC Press LLC. Newman M.C., Clements W.H. (2008) Ecotoxicology. A comprehensive treatment. CRC Press, Taylor & Francis Group. Newman M.C. (2009) Fundamentals of Ecotoxicology. CRC Press.
Optional reading	Mumtaz M. (2010) Principles and practice of mixtures toxicology. WILEY-VHC. Robinson L., Thorn I. (2005) Toxicology and Ecotoxicology in Chemical Safety Assessment. Blackwell Publishing Ltd.
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.
Exam passing procedure	Before taking oral exam, students are obliged to pass written exam. Points gained at written and oral exam are added to the points gathered up to the final exam, thus making a total number of points to be converted to final grade.
Main language of instruction; other languages	Croatian language, English language
Method of monitoring the quality and efficiency of teaching	Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams.

Course title	**Geoinformation Science in Nature and Environmental Protection**
Code	ZPIO-008
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	II semester
Workload/ECTS credits	6
Course status	Obligatory
Course teacher	Prof. Dr. Oleg Antonić
Associate teachers	Assoc. Prof. Dr. Davorka Kutuzović Hackenberger Assist. Prof. Dr. Željka Lončarić
Course entry requirements (Preceding courses)	
Course objective	To introduce students to the geoinformation science and the role of geoinformation technologies in nature and environmental protection. Students will learn how to perform basic operations on spatial data, spatial analysis and digital cartography, and get an insight into the possibilities of commercial and free software packages.
Learning outcomes	1. Skills in designing the organisation of spatial data relevant to nature and environmental protection. 2. Skills in preparing digital spatial backgrounds and integrate them into the geoinformation system. 3. Ability to review the physical foundations and fundamental principles of remote research. 4. Ability to determine efficiency of geoinformation technologies on various practical examples. 5. Skills to independently create a cartographic presentation by using digital cartography methods.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1 - 5	1	Lecture	Participation in discussions during lectures	Records related to attendance and participation in discussions	10	15
2, 5	2	Practices	Performance at solving of tasks	Assessment of performance during practices	20	30
1-5	2	Written exam	Preparation for written exam	Written exam	20	30
1-5	1	Oral exam	Preparation for oral exam	Oral exam	10	25
Total	**6**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)

	91-100 points: grade 5 (excellent)		
Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	30	0	30
Course content / teaching units	Lectures: • Definition and the scope of geoinformation science • Organisation and presentation of spatial data • Geographic Information System (GIS) • Projections and spatial transformations • Digitalisation, scanning, vectorisation • Georeferencing • Raster and vector GIS • Thematic layers • Attribute tables • Operations on raster and vector themes • Digital relief model and geomorphometric derivatives • Spatial interpolations • Spatial modelling • Physical bases of remote research • Photogrammetry and photointerpretation • Orthophotograph • Multispectral scanners • Spectral signature of the Earth's surface • Passive and active sensors • The most important satellite platforms • Spatial, temporal, spectral and thematic resolution • Subjective interpretation and delineation • The importance of geoinformation technologies in biological research shown on practical examples • Overview of commercial and free geoinformation software packages. • Usage of a GPS device • Independent creation of a digital thematic map Practices: • Basic operations on vector and raster spatial data. Usage of a GPS device • Independent creation of a digital thematic map • Application of basic geostatistical methods, geomorphometric analysis and data processing obtained by remote researching in the context of biological studies		
Recommended reading	Barret E.C., Curtis L.F. (1999) Environmental Remote Sensing. Burrough P.A., McDonnell R.A. (1998) Principles of geographical information systems. Hengl T., Reuter H.I. (2009) Geomorphometry: Concepts, Software, Applications. Elsevier, Amsterdam, London, New York.		
Optional reading	Bernhardsen T. (2002) Geographic Information System, An Introduction, 3rd ed. John Willey and Sons, Toronto. Frančula N. (2003) Digitalna kartografija. Hengl T. (2004) Geografski informacijski sustavi u inventarizaciji prirodnih resursa. Sveučilište u Osijeku, Osijek. Oluić M. (2001) Snimanje i istraživanje Zemlje iz Svemira: sateliti, senzori, primjena.		
Conditions for obtaining teacher's signature	Attendance at lectures and practices, and gaining of minimum 30 points.		

Exam passing procedure	During the course, the teacher monitors and evaluates the activities of each student. After the course, students pass the written exam with a minimum of 20 points. After having passed the written exam, students take the oral exam and pass it with a minimum of 10 points.
Main language of instruction; other languages	Croatian language, English language
Method of monitoring the quality and efficiency of teaching	Evaluation form

Course title	**Inventory of Biological Diversity**
Code	ZPIO-O09
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	II semester
Workload/ECTS credits	4
Course status	Obligatory
Course teacher	Prof. Dr. Stjepan Krčmar Assoc. Prof. Dr. Davorka Kutuzović Hackenberger
Associate teachers	Assist. Prof. Dr. Nataša Turić Aleksandra Kočić, Ph.D. Dragan Prlić, assistant
Course entry requirements (Preceding courses)	
Course objective	To enable students to understand the concept of biodiversity, and the biodiversity inventory option in the selected area as a basis for nature and environmental protection. To enable students to organise and participate in projects related to inventory and monitoring of habitats, flora and fauna in Croatia. To develop students' critical thinking skills in the processes needed to design and perform a credible and reliable inventory of different plant and animal taxa.
Learning outcomes	1. Ability to critically evaluate the procedures required for the inventory of flora, fauna, and habitats, especially on the Croatian territory. 2. Ability to distinguish between endemic, rare and endangered plant and animal species, and to assess the influence of non-native species on flora and fauna. Ability to understand the principle of determining the vulnerability of a taxon. 3. Skills in using methods for flora and fauna inventory (direct and indirect), monitoring methods, geocoding and cartographic networks, biodiversity research databases. 4. Ability to select an option suitable for making of a biodiversity inventory of certain habitat types, and to determine the characteristics of individual terrestrial habitats in accordance with the EU Habitats Directive. 5. Skills in using the geoinformation systems in inventorying or monitoring of biodiversity.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	0.5	Lecture	Lecture attendance and active participation	Records, evaluation	5	15
1-5	1	Practices	Practical classes attendance and active participation	Records, evaluation	15	25
1-5	1	Knowledge assessment (written exam)	Preparation for written exam	Written exam	15	25

	1-5	1.5	Exam (oral exam)	Preparation for final exam	Oral exam	25	35
	Total	**4**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	Regular consultation hours will be scheduled after being agreed with students.		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	0	30

Course content / teaching units

Lectures:

- Biodiversity (concept, benefits and ecological values)
- Biodiversity of fauna and flora of Croatia (endemicity, endangerment and reasons for endangerment, endangered habitats, rare and endangered species, areas of special protection), selection of options for the implementation of biodiversity inventory procedures
- Characteristics of individual terrestrial habitats in Croatia according to the EU Habitats Directive
- Reasons, selection and application of flora and fauna inventory methods, monitoring methods
- Geocoding of data, use of GIS, remote researching and cartographic networks, biodiversity databases, spatial data analysis
- Overview of suitable options for biodiversity inventory of certain habitat types in accordance with the EU Habitats Directive

Practices:

- Preparation for inventorying (cartographic preparation, database review, selection of inventory methods, number and schedule of sampling)
- Inventory of fauna and flora of different habitat types (forest, wetland, meadow and anthropogenic), sampling
- Field data processing, geocoding, methods of population density estimation

Recommended reading

Henderson P.A. (2003) Practical methods in ecology. Blackwell, UK.
Leveque C., Mounolou J.C. (2003) Biodiversity. John Wiley & Sons, Ltd.
Southwood T.R.E., Henderson P.A. (2000) Ecological methods. Blackwell, UK.
Topić J., Vukelić J. (2009) Priručnik za određivanje kopnenih staništa u Hrvatskoj prema direktivi o staništima EU. Državni zavod za zaštitu prirode, RH.

Optional reading

Bohn U., Gollub G., Hettwer C. (ed.) (2000) Map of the natural vegetation of Europe. Federal agency for nature conservation.
Brown R.W., Lawrence M.J., Pope J. (2009) Animals – tracks, trails and signs. Bounty Books, Octopus publishing Group Ltd, London.
Evans K.M. (2006) Endangered species, protecting biodiversity. Thomson Gale.
Hawksworth D.L., Bull A.T. (2007) Plant conservation and biodiversity. Springer.
Nikolić T., Bukovec D., Šopf J., Jelaska S.D. (1998) Kartiranje flore Hrvatske – mogućnosti i standardi. Nat. Croat. 7, Suppl. 1: 1-62.
Radović J., Čivić K., Topić R., Posavec Vukelić V. (2009) Biološka raznolikost Hrvatske, Drugo izmjenjeno izdanje. DZZP. Zagreb.
Vukelić A., Mikac S., Baričević D., Bakšić D., Rosavec R. (2008) Šumska staništa i šumske zajednice u Hrvatskoj. DZZP. Zagreb.
Državni zavod za zaštitu prirode Republike Hrvatske: Crvena knjiga vretenaca Hrvatske, Crvena knjiga danjih leptira Hrvatske, Crvena knjiga slatkovodnih riba Hrvatske, Crvena knjiga morskih riba Hrvatske, Crvena knjiga vodozemaca i gmazova Hrvatske, Crvena knjiga

	sisavaca Hrvatske, Crvena knjiga špiljske faune Hrvatske, Crvena knjiga vaskularne flore Hrvatske.
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.
Exam passing procedure	During the course, the teacher monitors and evaluates the activities of each students, which makes up to 40% of the final grade (report on preparation of an inventory after attended practices), passing of written exam contributes to the final grade with 25%, while passing of oral exam refers to 35% of the final grade.
Main language of instruction; other languages	Croatian language
Method of monitoring the quality and efficiency of teaching	Evaluation form

Course title	**Scientific Research Practice**
Code	ZPIO-O10
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	II semester
Workload/ECTS credits	4
Course status	Obligatory
Course teacher	Assigned mentor
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To introduce students to the modern principles and methods of research work by enabling their active participation in researches performed by research teams under direct supervision of an assigned mentor.
Learning outcomes	1. Knowledge about the methods applied in research work in a laboratory. 2. Skills in practical application of previously acquired theoretical knowledge in research work. 3. Skills required to carry out independently one part of scientific research. 4. Gained self-confidence in scientific research work.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-4	4		Independent research work in a research team	Evaluation		
Total	**4**					

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	0	0	30
Course content / teaching units	Scope of a field work: • Preparation for field work (appropriate clothing and footwear, safety measures, keeping of a field work diary) • Field work: application of sampling methods, making sample collection, conservation and labelling of samples		

	• Measurements performed on field Work in the laboratory: • Introduction to laboratory routines • Keeping of a laboratory diary • Learning how to apply laboratory techniques • Participation in the laboratory procedures • Independent completion of selected assignments
Recommended reading	
Optional reading	
Conditions for obtaining teacher's signature	Successfully completed scientific research practice and submission of the practice diary approved by the appointed mentor.
Exam passing procedure	
Main language of instruction; other languages	Croatian language, English language
Method of monitoring the quality and efficiency of teaching	Student survey to evaluate the overall quality of the course.

Course title	**Conservation Biology**
Code	ZPIO-O11
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	IV semester
Workload/ECTS credits	4
Course status	Obligatory
Course teacher	Assoc. Prof. Dr. Dubravka Čerba Assist. Prof. Dr. Alma Mikuška
Associate teachers	Assist. Prof. Dr. Nataša Turić
Course entry requirements (Preceding courses)	
Course objective	To enable students to become responsible members of the local and global community by strengthening their knowledge about conservation biology and raising their awareness of natural, social, economic and cultural aspects of the protection of taxa and habitats.
Learning outcomes	1. Ability to perform self-evaluation of knowledge and skills regarding responsible behaviour for biodiversity conservation. 2. Ability to critically evaluate methods and activities aimed at protection of animal and plant taxa. 3. Ability to review scientific and professional research in the field of conservation biology. 4. Ability to critically evaluate efficiency of national and international legislative frameworks referring to nature and environmental protection. 5. Ability to identify and rank anthropogenic influences on the conservation of biological diversity of aquatic and terrestrial ecosystems.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	1	Lecture	Critical conversation and discussion, flipped classroom	Monitoring of students' activity during lectures	15	20
1-5	2	Seminars	Writing of an academic essay	Analysis of student essay by giving a feedback on student's progress in the learning process	20	30
1-5	0.5	Written exam	Preparation for written exam	Written exam	15	25
1-5	0.5	Oral exam	Preparation for oral exam	Oral exam	10	25
Total	**4**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)

	71-80 points: grade 3 (good) **81-90 points: grade 4 (very good)** **91-100 points: grade 5 (excellent)**		
Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	30	15	0
Course content / teaching units	• Introduction to conservation biology • Biodiversity - the importance of species in conservation biology • Genetic diversity: bottleneck effect, founder effect, genetic drift, inbreeding, outbreeding, genetics and species conservation: the role of conservation genetics • The concept of metapopulation • Key species (flagship, umbrella, indicator, ecosystem engineers) and their importance in biodiversity protection • Conservation of migratory species • Ethics and attitudes towards biodiversity values • Biodiversity endangerment: anthropogenic effects leading to habitat degradation, fragmentation and extinction, anthropogenic influence on changes within ecosystems • Imported and invasive species and their impact on biodiversity • Conservation of species *in situ* and *ex situ* • The IUCN protection criteria • Reintroduction of species • Protected areas (natural, social, economic and cultural aspects) • Ecological restoration • Conservation of species and habitats in practice, examples of conservation of species and habitats at the global and local level (special reference to the conservation of aquatic and terrestrial invertebrates, and terrestrial vertebrates). Relation between evolution and conservation biology. Relation between landscape ecology and environmental protection.		
Recommended reading	Primack R.B. (2014) Essentials of Conservation Biology. Sinauer. Pullin S.A. (2007) Conservation Biology. Cambridge University Press, New York.		
Optional reading	Antolović J., Frković A., Grubešić M., Holcer D., Vuković M., Flajšman E., Grgurev M., Hamidović D., Pavlinić I., Tvrtković N. (2006) Crvena knjiga sisavaca Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode, Zagreb. Belančić A., Bogdanović T., Franković M., Ljuština M., Mihoković N., Vitas B. (2008) Crvena knjiga vretenaca Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode, Zagreb. Hunter M.L. JR., Gibbs J. (2007) Fundamentals of Conservation Biology. 3rd ed. Blackwell Publishing, UK. Jardas I., Pallaoro A., Vrgoč N., Jukić-Peladić S., Dadić V. (2008) Crvena knjiga morskih riba Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode, Zagreb. Jelić D., Kuljerić M., Koren T., Treer D., Šalamon D., Lončar M., Podnar-Lešić M., Janev-Hutinec Lj., Bogdanović T., Mekinić S., Jelić K. (2013) Crvena knjiga vodozemaca i gmazova Hrvatska. Ministarstvo zaštite prirode i okoliša i Državni zavod za zaštitu prirode, Zagreb. Maczulak A. (2010) Biodiversity. Conserving Endangered Species. Facts On File. USA. Magurran A.E. (2010) Measuring Biological Diversity. Blackwell Publishing, UK. Mrakovčić M., Brigić A., Buj I., Ćaleta M., Mustafić P., Zanella D. (2006) Crvena knjiga slatkovodnih riba Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode, Zagreb. Ozimec R., Bedek J., Gottstein S., Jalžić B., Slapnik R., Štamol V., Bilandžija H., Dražina T., Kletečki E., Komerički A., Lukić M., Pavlek M. (2009) Crvena knjiga špiljske faune Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode, Zagreb Tutiš V., Kralj J., Čiković D., Barišić S. (2013) Crvena knjiga ptica Hrvatske. Ministarstvo zaštite prirode i okoliša i Državni zavod za zaštitu prirode, Zagreb.		

	Williams D.R., Pople R.G., Showler D.A., Dicks L.V., Child M.F., zu Ermgassen E.K.H.J., Sutherland W.J. (2012) Bird Conservation: Global evidence for the effects of interventions. Exeter, Pelagic Publishing.
Conditions for obtaining teacher's signature	Active participation in the teaching process and fulfilment of all assignments.
Exam passing procedure	The teacher evaluates the activities of students by awarding points according to determined criteria. In this way, students can assess and improve their learning progress and advance their own professional development. At the end of the course, students are required to write an essay. During the oral exam, the teacher asks questions that are related to learning outcomes.
Main language of instruction; other languages	Croatian language
Method of monitoring the quality and efficiency of teaching	The teacher continuously monitors the learning process and student achievements, thus determining and adapting his/her teaching. After the course, the teacher and students analyse the efficiency of the teaching process and carry out a survey to evaluate students' subjective impression about the teaching quality, all with the aim to improve future teaching.

Course title	**Quantitative Ecology**
Code	ZPIO-004
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	I semester
Workload/ECTS credits	6
Course status	Obligatory
Course teacher	Prof. Dr. Branimir Kutuzović Hackenberger
Associate teachers	Assist. Prof. Dr. Željka Lončarić
Course entry requirements (Preceding courses)	
Course objective	To acquaint students with numerical methods that are used in analysis of complex environmental data and to teach them about proper use of these methods in order to obtain the required answers. Within practices, students will be able to apply theoretical knowledge about the methods on examples processed by appropriate software tools. Students will be taught how to design an ecological experiment, how to monitor environmental conditions, and how to interpret obtained results.
Learning outcomes	1. Ability to critically evaluate basic scientific methods, including the logic of experimental design and hypothesis testing. 2. Skills to use the R programming language independently. 3. Skills to set up a hypothesis, to design an experiment independently, and to select appropriate methods for analysing the data obtained in the experiment. 4. Ability to perform basic spatial analysis of ecological data. 5. Ability to critically review the literature dealing with environmental and statistical issues.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	2	Lectures	Critical conversation and discussion	Records related to active participation in conversations and discussions	5	10
1-5	2	Practices	Independent analysis of experimental data	Monitoring of student performance at solving of tasks	10	20
1-5	1	Written exam	Preparation for written exam	Written exam	20	30
1-5	1	Oral exam	Preparation for oral exam	Oral exam	25	40
Total	**6**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	30	0	30
Course content / teaching units	Lectures: • Introduction • Experiment design: basic principles and guidelines • Sampling design and determination of the sample size • Grouping, systematisation and basic data processing • Distribution testing. Aggregation measures and matrices (Q and R mode) • An overview of numerical methods • Regression, General linear models (logistic and Poisson regression), Mixed effect models, multivariate methods. Visualisation of multivariate methods • Swarm models (hierarchical, non-hierarchical, fuzzy, cophenetic correlation, k-mean values, medoids, Kendall's coefficient of concordance, data forms). Comparative application of biodiversity indicators and assessors • Free sorting (multidimensional data spaces, principal component analysis, stacking analysis, principal coordinate analysis, non-metric multidimensional scaling) • Canonical classification (redundancy analysis, canonical analysis of agreement, rectilinear discriminant analysis, canonical correlation analysis, coinertial analysis, multifactor analysis) • Spatial analysis of ecological data (spatial structures, spatial dependence and autocorrelation, spatial correlogram, trend-surface analysis, eigenvector and spatial modelling, MEM) Practices: • Introduction to the R programming language; data acquisition and preparation • Data types, descriptive statistics, graphical representation and data analysis • Probabilities, confidence interval, hypothesis testing, two-sample testing • Testing of differences between multiple samples • Correlation, regression. Power analysis and determination of the number of samples • Swarm model, MANOVA, coordinate methods • Basics of spatial statistics • Modelling of the simple population dynamics • Modelling of dynamics of several populations in interaction • Analytical dynamics of complex populations		
Recommended reading	Gotelli N.J., Ellison A.M. (2004) A primer of ecological statistics, Sinauer. McGarigal K. et al. (2000) Multivariate statistics for wildlife and ecology research, Springer.		
Optional reading	Borcard D., Gillet F., Legendre P. (2011) Numerical Ecology with R, first edition, Springer. Crawley M.J. (2007) The R book. Wiley, UK. Legendre P., Legendre L. (1998) Numerical ecology. Elsevier, Amsterdam. Quinn G., Keough M. (2002) Experimental Design and Data Analysis for Biologists, Oxford press. Zuur A.F., Leno E.N., Meesters E.H.W.G. (2009) A beginner's guide to ., Springer.		
Conditions for obtaining teacher's signature	Regular attendance of lectures, successfully completed practices.		
Exam passing procedure	During lectures, the teacher monitors and evaluates performance of each student, which refers to 30% of the final grade. Passing of written exam refers to 30% of the final grade, and passing of oral exam refers to the remaining 40% of the final grade.		
Main language of instruction;	Croatian language, English language		

other languages	
Method of monitoring the quality and efficiency of teaching	Student survey to evaluate the overall quality of the course. Analysis of student success at the exams.

Course title	**Environmental and Natural Resources**
Code	ZPIO-012
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	9
Course status	Obligatory
Course teacher	Prof. Dr. Oleg Antonić Assoc. Prof. Dr. Dubravka Čerba
Associate teachers	Assist. Prof. Dr. Filip Stević Assoc. Prof. Dr. Tanja Žuna Pfeiffer Assist. Prof. Dr. Vesna Peršić
Course entry requirements (Preceding courses)	
Course objective	To present to students a scientific approach to the issue of renewable and non-renewable natural resources and their optimal management. To develop natural science literacy of students, to teach them about the impact of global climate change and environmental pollution on natural resources, and to raise students' awareness of the importance of renewable energy sources and the rational use of the non-renewable sources.
Learning outcomes	1. Ability to critically assess potentials and limitations in exploitation of natural resources available at a particular area and to identify conflicts associated with interests in the use of available natural resources. 2. Ability to evaluate and classify the priorities of local policies related to exploitation of natural resources by cooperating with local community representatives and other stakeholders (especially in issues related to nature and environmental protection). 3. Ability to self-evaluate the knowledge and skills required for developing various resource management studies, as well as nature and environmental protection studies. 4. Skills required to raise awareness of the wider community about usage of renewable energy sources, about sustainable management of renewable natural resources, and about rational use of non-renewable natural resources.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1 - 4	2	Lecture	Participation in discussions during lectures	Records related to attendance and participation in discussions	5	10
1 - 4	3	Seminars	Preparation and presentation of a seminar paper	Assessment of the seminar paper content and presentation	5	10
1-4	2	Written exam	Preparation for written exam	Written exam	25	40

	1-4	2	Oral exam	Preparation for oral exam	Oral exam	25	40
	Total	**9**				**60**	**100**
	Final grade: **60-70 points: grade 2 (sufficient)** **71-80 points: grade 3 (good)** **81-90 points: grade 4 (very good)** **91-100 points: grade 5 (excellent)**						
Consultation hours	By appointment						
Teaching	**Lectures**		**Seminars**		**Practices**		
Hours/week total	45		45		0		
Course content / teaching units	• Typology of environmental and natural resources • Water as a fundamental resource • Water pollution and water regime disbalance • Fishery and aquaculture • Criteria, methods and procedures for sustainable management of water resources • Soil as a fundamental resource for plant production • Pollution and the loss of usable soil • Criteria, methods and procedures for sustainable management of soil resources • Agroforestry • Extensive, intensive and organic agriculture • Genetic impoverishment and contamination • Integrated river basin management • Air as a fundamental resource • Air pollution • Mineral resources • Renewable and non-renewable energy sources • Carbon balance and global climate changes • Space as a fundamental resource • Conflicts in natural and environmental resources utilization regarding available space • Criteria, methods and procedures for sustainable management of space • Principals of spatial planning at state, regional and local level • Participants in space utilisation • Resource users' cooperation and involvement in decision-making process						
Recommended reading	Hackett S.C. (2006) Environmental and natural resources economics: theory, policy, and the sustainable society. M.E. Sharpe. McPherson G.R., DeStefano S. (2003) Applied Ecology and Natural Resource Management. Cambridge University Press. Newman E.I. (2000) Applied ecology & Environmental management. Blackwell Science Ltd a Blackwell Publishing company.						
Optional reading	Anderson D.A. (2010) Environmental economics and natural resource management, Taylor & Francis Mitchell B. (2002) Resource and Environmental Management. Pearson Education Limited. Newson M. (2008) Land, Water and Development. Sustainable and adaptive management of rivers. Taylor & Francis.						
Conditions for obtaining teacher's signature	Attendance at lectures and seminars, and acquisition of minimum 10 points.						

Exam passing procedure	During the course, the teacher monitors and evaluates the activities of each student. After the course, students pass the written exam with a minimum of 25 points. After having passed the written exam, students take the oral exam and pass it with a minimum of 25 points.
Main language of instruction; other languages	Croatian language
Method of monitoring the quality and efficiency of teaching	Evaluation form

Course title	**Environmental Engineering**
Code	ZPIO-007
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	II semester
Workload/ECTS credits	4
Course status	Obligatory
Course teacher	Assist. Prof. Dr. Goran Palijan Assist. Prof. Dr. Filip Stević
Associate teachers	Assoc. Prof. Dr. Tanja Žuna Pfeiffer Assist. Prof. Dr. Anita Galir Balkić
Course entry requirements (Preceding courses)	
Course objective	To enable students to understand the key concepts of environmental engineering and basic research methodology, as well as to comprehend the importance of environmental engineering in solving of environmental issues caused by anthropogenic activity.
Learning outcomes	1. Ability to assess the appropriate environmental engineering methods for solving of environmental issues. 2. Ability to recommend preventive actions to be undertaken in the environment to reduce negative impacts. 3. Ability to assess interventions made in the environment. 4. Ability to critically review professional and scientific literature.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-3	1	Lecture	Critical conversation and discussion	Records related to active participation in conversations and discussions	5	10
1-4	1	Seminar	Interpretation of scientific papers and application of obtained results at concepts learned within lectures	Monitoring of students' performance at interpretations and tasks	5	10
1-4	1	Written exam	Preparation for written exam	Written exam	20	30
1-4	1	Oral exam	Preparation for oral exam	Oral exam	30	50
Total	**4**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment

Teaching	Lectures	Seminars	Practices
Hours/week total	30	15	0
Course content / teaching units	Lectures: • Environmental engineering – definition and application • Principles of environmental engineering • Environmental impact assessment – from global to local level • Classification and quantification of various negative impacts on the environment • Technologies (methods) for predicting, preventing and reducing of negative environmental impacts • Removing the consequences and optimisation of environment • Source emission reduction and prevention of environmental pollution • Development of new procedures and methods (technologies) to reduce the impact on the environment • Use of natural and semi-natural ecosystems to solve environmental problems • Biological barriers • Construction of ecosystems – imitation of nature • Constructed wetlands – types and use (application) • The construction and working principle of the artificial wetlands • Phytoremediation • Bioremediation • Wastewater treatment processes • Disposal of waste sludge • Prevention of desertification • Environmental nanotechnology Seminars: • Sustainable development and environmental management • Environmental protection and natural resource management • Modelling in the environmental protection systems		
Recommended reading	Jørgensen SV. (2009) Applications in ecological engineering. Elsevier. Amsterdam. Kangas PC. (2004) Ecological engeneering – principles and practice. CRC Press, London.		
Optional reading	Kiely G. (1998) Environmental Engineering. McGraw-Hill, New York. Liu D, Liptak B. (1997) Environmental Engineering's Handbook. Lewis Publishers, London.		
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.		
Exam passing procedure	Prior to taking oral exam, students are obliged to prepare and present seminar papers, and to pass the written exam.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams.		

Course title	**Environmental Impact Assessment**
Code	ZPIO-015
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	IV semester
Workload/ECTS credits	8
Course status	Obligatory
Course teacher	Prof. Dr. Oleg Antonić
Associate teachers	Assist. Prof. Dr. Nataša Turić Assist. Prof. Dr. Željka Lončarić
Course entry requirements (Preceding courses)	Passed all exams related to the courses of the semester II of the 1st study year (Module: Quantitative Aspects of Nature and Environment). Attended course Environmental and Natural Resources.
Course objective	To introduce students to the assessment of anthropogenic impacts on nature and environment, and to explain the normative aspects of this area as defined by legal regulations.
Learning outcomes	1. Ability to identify possible anthropogenic impacts on nature and environment for a particular type of intervention in space. 2. Ability to review the principles and methods used in assessment of the type and level of anthropogenic impacts on nature and environment. 3. Knowledge of legislative framework for nature and environmental protection 4. Knowledge of the elements and stages of the Environmental Impact Assessment (EIA) process. 5. Knowledge of the elements and procedure of the Assessment of acceptability of plans, programmes and interventions for the ecological network Natura2000 (AAPPIEN).

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1 - 5	2	Lecture	Participation in discussions during lectures	Records related to attendance and participation in discussions	15	25
4 and 5	2	Seminars	Preparation and presentation of seminar paper	Assessment of contents and presentation of seminar paper	15	25
1-5	2	Written exam	Preparation for written exam	Written exam	20	30
1-5	2	Oral exam	Preparation for oral exam	Oral exam	10	20
Total	**8**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	45	30	0
Course content / teaching units	• Repetition of types of anthropogenic impacts on nature and environment (sea, inland waters, soil, air, organisms, biodiversity and ecological systems) • Legislative framework for nature and environmental protection in Croatia, Europe and the world • Environmental Impact Assessment in a broader sense: typical phases of assessment (an overview of characteristics of planned interventions, plans and programmes; measurement and observation; modelling and forecasting; quantification of the impacts; consideration of the possibilities of avoiding/reducing/controlling the adverse impacts; cost-benefit analysis; selection of the best solution; protective measures and mitigation) with an overview of methods according to their influence on different environmental segments • Standard impact assessment within the legal framework • Elements and stages of the Environmental Impact Assessment (EIA) process • Elements and stages of the procedure Assessment of acceptability of plans, programmes and interventions for the ecological network Natura 2000 (AAPPIEN) • Analysis of typical examples of spatial interventions: linear infrastructure facility (roads, railways, power transmission line, gas pipeline), industrial plants, power plants (thermal power plants, nuclear power plants, hydroelectric power plants with a water reservoir and derivative channel, flow hydropower, wind power, solar power), animal farms (cattle, poultry farm), fish farms, marina, waste water, hydro regulation		
Recommended reading	Glasson, J., Therivel R., Chadwick A. (2005) Introduction to Environmental Impact Assessment. Routledge. Morris P., Therivel R. (2009) Methods of Environmental Impact Assessment. Routledge.		
Optional reading	Anderson D.A. (2010) Environmental economics and natural resource management. Taylor & Francis. Hackett S.C. (2006) Environmental and natural resources economics: theory, policy, and the sustainable society. M.E. Sharpe. McPherson G.R., DeStefano S. (2003) Applied Ecology and Natural Resource Management. Cambridge University Press. Newson M. (2008) Land, Water and Development. Sustainable and adaptive management of rivers. Taylor & Francis.		
Conditions for obtaining teacher's signature	Attendance of lectures and seminars, and acquisition of minimum 30 points.		
Exam passing procedure	During the course, the teacher monitors and evaluates the activities of each student. After the course, students pass the written exam with a minimum of 20 points. After having passed the written exam, students take the oral exam and pass it with a minimum of 10 points.		
Main language of instruction; other languages	Croatian language, English language		
Method of monitoring the quality and efficiency of teaching	Evaluation form		

Course title	**Terrestrial Ecology**
Code	ZPIO-002
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	I semester
Workload/ECTS credits	6
Course status	Obligatory
Course teacher	Prof. Dr. Oleg Antonić Assoc. Prof. Dr. Davorka Kutuzović Hackenberger
Associate teachers	Assist. Prof. Dr. Goran Palijan Assist. Prof. Dr. Olga Jovanović Glavaš
Course entry requirements (Preceding courses)	
Course objective	To enable students to understand the spatial variability of terrestrial habitats on Earth and in Croatia, their biological diversity and connection with environmental processes and factors that influence the emergence, survival and extinction of these habitats. Students will be given synthetic approach to terrestrial ecology by linking relevant information on climate, soil, relief, flora and vegetation, fauna and other components of terrestrial ecosystems.
Learning outcomes	1. Knowledge about parallel development of soil and vegetation in different ecological conditions. 2. Ability to connect the spatial distribution of macroclimatic factors on a global level with the spatial distribution of bioclimatic zones. 3. Ability to identify typical life strategies and adaptations of organisms in terrestrial habitats. 4. Ability to distinguish between the types of terrestrial habitats in Croatia and to assess their characteristic ecological conditions. 5. Ability to analyse the structure and dynamics of selected habitat types by applying appropriate methods.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-4	1	Lecture	Participation in discussions during lectures	Records related to attendance and participation in discussions	15	20
3-5	2	Practices	Performance at solving of tasks	Assessment of performance during practices	15	20
1-5	2	Written exam	Preparation for written exam	Written exam	20	40
1-5	1	Oral exam	Preparation for oral exam	Oral exam	10	20
Total	**6**				**60**	**100**

	Final grade: **60-70 points: grade 2 (sufficient)** **71-80 points: grade 3 (good)** **81-90 points: grade 4 (very good)** **91-100 points: grade 5 (excellent)**		
Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	30	0	30
Course content / teaching units	Lectures: • What is a terrestrial habitat and what kind of organisms live there • Ecological factors that influence life of the organisms in a terrestrial habitat • Solar energy on the Earth surface • Global atmospheric circulation • Macroclimate – parameters, their spatial and temporal variability • Water cycle • Lithology and relief as the environmental factors • Topoclimate • Soil as a precondition for the terrestrial habitat formation and maintenance • Pedosphere, pedogenesis, pedosystematics – basic terms • Biotic factors • Life strategies of the terrestrial organisms • Matter and energy cycles in a terrestrial habitat • Basic types of the terrestrial habitats (biomes) and their correlation with the macroclimate • Spatial distribution of the biomes on the Earth and their dynamics in time (global paleoecological aspect) • Bioclimatic zones of Europe and Croatia • Edaphic factors and biogeocoenosis differentiation within the bioclimatic zones • Spatial and temporal relation between the soil and vegetation • Classification of the terrestrial habitats • Overview of the particular habitat types (on the global, regional and local level): 1) dominant abiotic factors, 2) soil and vegetation, 3) typical organism representatives and their adaptations to the habitat and interactions with the habitat, 4) genesis and ecological stability, 5) anthropogenic influence • Terrestrial habitat boundaries • Environmental gradients and gradual transition between the terrestrial habitats and between the terrestrial and marine/freshwater habitats • Anthropogenic terrestrial habitats • Levels of bioecological details in the terrestrial habitat research • Overview of the research themes and methods. Practical examples Practices: • Recognition of the major types of the terrestrial habitats on the global level (biomes) • Recognition of the terrestrial habitats in Croatia • Determination of the expected habitat type for the set environmental factors (and vice versa) • Overview of the different sampling methods for the particular organism groups in different habitats, qualitative and quantitative field data analysis		
Recommended reading	Chapin F.S. III, Matson P., Mooney H.A., Chapin M.C. (2002) Principles of Terrestrial Ecosystem Ecology. Springer-Verlag, New York.		
Optional reading	Archibold O.W. (1995) Ecology of World Vegetation. Chapman & Hall, London, New York. Bailey R.G. (2009) Ecosystem Geography: From Ecoregions to Sites. Springer-Verlag, New York, Dordrecht, Heidelberg, London.		

	Ćirić M. (1986) Pedologija. Svjetlost, Sarajevo. Gobat J.-M., Aragno M.,Matthey W. (2004) The Living Soil – Fundamentals of Soil Science and Soil Biology. Science Publishers Inc., Endfield USA, Plymouth UK. Herak M. (1990) Geologija. Školska knjiga, Zagreb. Oldeman R.A.A. (1990) Forests: Elements of Silvology. Springer-Verlag, Berlin. Penzar I. i Penzar B. (1989) Agroklimatologija. Školska knjiga, Zagreb. Topić J., Vukelić J. (2009) Priručnik za određivanje kopnenih staništa u Hrvatskoj prema Direktivi o staništima EU. Državni zavod za zaštitu prirode, Zagreb. Vukelić J., Mikac S., Baričević D., Bakšić D., Rosavec R. (2009) Šumska staništa i šumske zajednice u Hrvatskoj. Državni zavod za zaštitu prirode, Zagreb.
Conditions for obtaining teacher's signature	Attendance at lectures and practices, and gaining of minimum 30 points.
Exam passing procedure	During the course, the teacher monitors and evaluates the activities of each student. After the course, students pass the written exam with a minimum of 20 points. After having passed the written exam, students take the oral exam and pass it with a minimum of 10 points.
Main language of instruction; other languages	Croatian language, English language
Method of monitoring the quality and efficiency of teaching	Evaluation form

Elective Courses

Course title	**Algae as Biological Indicators**
Code	
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	2
Course status	Elective
Course teacher	Assist. Prof. Dr. Dubravka Špoljarić Maronić
Associate teachers	Assist. Prof. Dr. Filip Stević Assoc. Prof. Dr. Tanja Žuna Pfeiffer Nikolina Bek, assistant
Course entry requirements (Preceding courses)	
Course objective	To enable students to understand the role and importance of algae as indicators of environmental changes and to develop students' skills in applying methods for assessment of ecosystem conditions.
Learning outcomes	1. Ability to assess the role of algae as biological indicators of environmental changes. 2. Skills in sampling and analysing different algae in order to determine their structure, differences and adjustments to particular ecological conditions. 3. Skills in using professional and scientific literature and keys for determination of algae. 4. Ability to assess ecological conditions of an aquatic biotope by using defined methodology and regulations. 5. Ability to compare various approaches and methodologies for assessment of aquatic ecosystem status. 6. Ability to critically review and implement legal documents referring to water protection.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1 , 4-6	0.5	Lecture	Critical conversation and discussion	Records related to active participation in conversations and discussions	5	10
1-6	1	Practices	Field research, work on the experimental task	Field work report, Monitoring of student performance	25	40
1-6	0.25	Written exam	Preparation for written exam	Written exam	15	25
1-6	0.25	Oral exam	Preparation for oral exam	Oral exam	15	25
Total	**2**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)

	71-80 points: grade 3 (good) **81-90 points: grade 4 (very good)** **91-100 points: grade 5 (excellent)**		
Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	0	15
Course content / teaching units	Lectures: • Algae within the monitoring of water, soil and air quality • Algal biomarkers - biomolecular, biochemical, physiological • Monitoring of the community composition and metabolism - indicators and methods • Analysis of population - indicator species, invasive species, growth potential, indices • Algae as indicators of ecological status of waters - comparison of taxonomic approach and functional classifications • Algae - indicators in paleolimnological research and forensic limnology Practices: • Methods of sampling of algae (water, sediment, aerophytic communities) and monitoring of basic physical and chemical indicators • Taxonomic analysis and functional classifications • Calculation and application of relevant indexes for evaluation of ecological conditions • Determination of basic algal biomarkers		
Recommended reading	Bellinger E.G., Sigee D.C. (2010) Freshwater algae: Identification and use as bioindicators. John Wiley & Sons, Ltd, Chichester, West Sussex, UK. Hrvatske vode (2016) Metodologija uzorkovanja, laboratorijskih analiza i određivanja omjera ekološke kakvoće bioloških elemenata kakvoće (https://www.voda.hr/hr/metodologije).		
Optional reading	Stoermer E.F., Smol J.P. (2004) The Diatoms: Applications for the Environmental and Earth Sciences. Cambridge University Press, Cambridge, UK. Keys for determination of algae, recent scientific publications (scientific papers and review articles) and legal acts related to course topics.		
Conditions for obtaining teacher's signature	Active participation in lectures and fulfilment of all assignments within the course.		
Exam passing procedure	During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After lectures and practices, students shall pass the written exam, as well as oral exam. The final grade is determined according to the number of points gained during lectures and practices and the number of points achieved at written and oral exam.		
Main language of instruction; other languages	Croatian language, English language		
Method of monitoring the quality and efficiency of teaching	Making reviews during lectures; Carrying out of a student survey to obtain remarks and comments referring to organisation and realisation of teaching after the course; Monitoring of students' success at exams.		

Course title	**Biofilms**
Code	
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	2
Course status	Elective
Course teacher	Assist. Prof. Dr. Goran Palijan
Associate teachers	
Course entry requirements (Preceding courses)	Microbiology
Course objective	To teach students about the structure and function of biofilms.
Learning outcomes	1. Obtained knowledge about the role of biofilms in the environment. 2. Ability to valorise the interaction of biofilms and environment. 3. Ability to predict the changes in biofilm populations in the environment depending on environmental effects and species interactions. 4. Skills in reviewing professional literature.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-3	0.5	Lecture	Critical conversation and discussion	Records related to active participation in conversations and discussions	5	10
1-4	0.5	Seminar	Interpretation of scientific papers and application of obtained results at concepts learned within lectures	Monitoring of students' performance at interpretations and tasks	10	15
1-4	0.5	Written exam	Preparation for written exam	Written exam	20	32,5
	0.5	Oral exam	Preparation for oral exam	Oral exam	25	42,5
Total	**2**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**

Hours - total	15	15	0
Course content / teaching units	Lectures: • Physical and chemical factors that influence the biofilm microorganism • Competitive strategies of microorganisms in biofilms • Interactions between microorganisms in biofilm • Soil biofilms • Biofilms of the sea and ocean • Inland water biofilms • Extreme habitats Practices: • Within seminars, students will present and discuss the topics related to individual teaching units • Students shall independently prepare and present the seminar paper		
Recommended reading	Costerton JW. (2007) The Biofilm Primer. Springer, Berlin. Ghannoum M, Parsek M, Whiteley M, Mukherjee PK. (2015) Microbial Biofilms. ASM Press, Washington DC.		
Optional reading	Brown AE. (2009) Benson's Microbiological Applications – Laboratory Manual in General Microbiology. McGraw-Hill, Boston. Barton LL, Northup DE. (2011) Microbial Ecology. Wiley-Blackwell, New Jersey.		
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.		
Exam passing procedure	Before taking oral exam, students are obliged to pass written exam.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams.		

Course title	**Biomonitoring**
Code	ZPIO-I01
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	II semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assoc. Prof. Dr. Sandra Ečimović
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To enable students to acquire knowledge of biomonitoring and its application in environmental control, in pollution monitoring and environmental risk assessment. Students will learn about basic types of biomonitoring, methods and ways of their implementation, and interpretation of the obtained results. They will also acquire knowledge about biomarkers applied in the process of biomonitoring and environmental risk assessment, and learn how to assess ecological systems and to design biomonitoring studies.
Learning outcomes	1. Knowledge about biomonitoring definition and its types. 2. Ability to identify the purpose of biomonitoring in environmental risk assessment, to apply biomarkers in biomonitoring and methods in conducting biomonitoring. 3. Ability to assess the conditions of ecosystems, to design a biomonitoring study, and to independently interpret the results of biomonitoring.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-3	0.5	Lecture	Lecture attendance and active participation	Records, evaluation	5	10
1-3	0.5	Seminars	Attendance of seminars and active participation	Records, evaluation	20	35
1-3	1	Knowledge assessment (written exam)	Preparation for written exam	Written exam	20	35
1-3	1	Final exam	Preparation for final exam	Oral exam	15	20
Total	**3**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment.

Teaching	Lectures	Seminars	Practices
Hours - total	15	15	0
Course content / teaching units	Lectures: • Introduction into biomonitoring • Types of biomonitoring • Basic ecotoxicological concepts in the context of biomonitoring and ecological risk assessment • Definitions and division of biomarkers • Population biomarkers • Systematic biomarkers • Bioindicator species • Organic biomarkers • Cellular and molecular biomarkers • Research methods • Sampling design, sampling methods • Measurements, interferences, data interpretation • Remote research and application of geographic information system Seminars: • Biomonitoring of aquatic ecosystem pollution • Biomonitoring of terrestrial ecosystem pollution • Biomonitoring of soil pollution • Assessment of aquatic and terrestrial ecosystem condition • Design of biomonitoring studies • Case study analysis		
Recommended reading	Hoffman D.J., Rattner B.A., Burton G.A., Cairns J. (2003) Handbook of ecotoxicology, CRC Press LLC. Markert B.A., Breure A.M., Zechmeister H.G. (2003) Bioindicators & Biomonitors: Principles, Concepts, and Applications, Elsevier Science Ltd., UK. Zhang C. (2007) Fundamentals of environmental sampling and analysis. John Wiley & Sons, Inc.		
Optional reading	Lauwerys R.R., Hoet P. (2001) Industrial Chemical Exposure: Guidelines for Biological Monitoring. CRC Press. U.S. EPA. (1998) Guidelines for Ecological Risk Assessment. U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC, EPA/630/R095/002F. Walker C.H., Hopkin S.P., Sibly R.M., Peakall D.B. (2001) Principles of ecotoxicology, Taylor & Francis, USA.		
Conditions for obtaining teacher's signature	Regular attendance of lectures and seminars.		
Exam passing procedure	The teacher evaluates the activities of students during the course and their achievements at final exam. During the course, the teacher monitors and evaluates performance of each student, which refers to 25% of the final grade. If attending the lectures regularly, students will be entitled to obtain teacher's signature and to take the written exam. Passing of written exam refers to 35% of the final grade, and passing of oral exam refers to 40% of the final grade.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	Student survey to evaluate the overall quality of the course. Analysis of student success at exams.		

Course title	**Socially Useful Learning**
Code	
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	2
Course status	Elective
Course teacher	Assist. Prof. Dr. Anita Galir Balkić
Associate teachers	Assoc. Prof. Dr. Tanja Žuna Pfeiffer Assist. Prof. Dr. Dubravka Špoljarić Maronić Nikolina Bek, assistant
Course entry requirements (Preceding courses)	
Course objective	To enable students to acquire knowledge and develop skills that are useful in solving of issues related to nature and environment protection in local community. Within the selected project, students will be engaged in an association or society in order to find solutions to current problems.
Learning outcomes	1. Supported cooperation of students and the local community with the aim to identify needs, find solutions and contribution to the community. 2. Skills in dealing with current issues and challenges related to nature and environment protection. 3. Ability to self-assess one's own management skills and engagement in a project team while dealing with actual problems. 4. Ability to make critical assessment of methods and solutions of similar problems at a local level or in a wider community.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-4	0.2	Lectures	Active participation in critical discussion and in teaching	Records, evaluation	5	10
1-3	0.8	Seminars	Active participation in all project activities	Records, assessment of participation in project activities	25	35
1-4	0.5	Written exam	Keeping a work diary about the socially useful learning experience	Assessment of work diary	15	25
3-4	0.5	Oral exam	Final oral presentation	Oral exam	15	25
Total	**2**				**60**	**95**

	Final grade: **60-68 points: grade 2 (sufficient)** **69-77 points: grade 3 (good)** **78-86 points: grade 4 (very good)** **87-95 points: grade 5 (excellent)**		
Consultation hours	By appointment.		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	3	27	0
Course content / teaching units	Lectures: • Socially useful learning in higher education - definition and purpose • Forms of socially useful learning • Socially useful learning procedure - project planning (project goal, project duration, distribution of activities, end-user function), determination of project teams, project management and implementation of project activities) • Assessment of achieved project results and experiences. Seminars: • Examples of good practice • Developing a project with a local community partner in order to solve specific problems of a local community target group • Project report - activities, sustainability, knowledge transfer, description of measurable and objective indicators of success of certain activities		
Recommended reading	Mikelić Preradović N. (2009) Učenjem do društva znanja. Zavod za informacijske studije Odsjeka za informacijske znanosti Filozofskog fakulteta Sveučilišta u Zagrebu, Zagreb.		
Optional reading	Begić J., Berbić K. E., Brajković L., Matanović D., Mileusnić M., Paraga S., Tomasić I., Zec K. (2019) Od realizacije do promjene: Vodič za pokretanje programa društveno korisnog učenja. Institut za razvoj obrazovanja, Zagreb. Brubaker D.C., Ostraff J.H. (eds.) (2006) Life, learning, and community: Concepts and models for service-learning in biology. Sterling, VA: Stylus Publishing, LLC. Kazmer M.M. (2005) Community-Embedded Learning. The Library Quarterly, 75: 190-212. Original scientific and professional papers related to course subject area.		
Conditions for obtaining teacher's signature	Regular attendance of lectures and active participation in project-related tasks.		
Exam passing procedure	The teacher evaluates the activities of students during the course and their achievements at final exam. Active participation in lectures refers to 10% of the final grade, and active participation in project activities and keeping of work diary refers to 70% of the final grade. Final oral presentation refers to 20% of the final grade.		
Main language of instruction; other languages	Croatian language, English language		
Method of monitoring the quality and efficiency of teaching	Communication with students during lectures, continuous guidance, giving possibility to students to make oral or written remarks, monitoring of the implementation of all project phases, evaluation of the final project report.		

Course title	**Soil Ecology**
Code	ZPIO-I03
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	II semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assoc. Prof. Dr. Davorka Kutuzović Hackenberger
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To train students for an integrative approach to the studying of soil, of biodiversity and biogeochemical processes, and to perform analysis of the most common causes of soil degradation and the impact of environmental factors on condition of soil.
Learning outcomes	1. Knowledge about the relations among soil structure, soil circulation and basic physical, chemical and thermodynamic processes in soil. 2. Ability to apply an integrative approach to the analysis of the most important groups of organisms in the soil. 3. Ability to examine the basic interactions of organisms in the soil. 4. Ability to analyse the most common causes of soil degradation and the impact of environmental factors on soil condition. 5. Skills in designing and applying basic pedological-ecological experiments.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-4	0.5	Lecture	Lecture attendance and active participation	Records related to attendance and activity	5	10
5	1	Practices	Practical classes attendance and active participation	Records related to attendance and activity	15	30
1-5	1	Written exam	Preparation for written exam	Written exam	20	40
1-5	0.5	Oral exam	Preparation for oral exam	Oral exam	10	20
Total	**3**				**50**	**100**

Final grade:
50.1-62.5 points: grade 2 (sufficient)
62.6-75 points: grade 3 (good)
75.1-87.5 points: grade 4 (very good)
87.6-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	0	15
Course content / teaching units	Lectures: • Structure, formation, microclimate, and biogenic structures of soil • Soil circulation and thermodynamic equilibrium of soil and basic physical, chemical and thermodynamic processes in soil • Characteristics and diversity of soil life (biology, ecology, research methods), and interactions of organisms and soil processes • Soil degradation, and the impact of climate change on soil • Examples of pedological and ecological experiments and their design Practices • Soil sampling methods, soil fauna, measurement of soil enzymatic activity, micro- and mesocosmic terrestrial experiments		
Recommended reading	Bardgett R.D. (2005) The biology of soil – a community and ecosystem approach. Oxford University Press, New York. Coleman D.C., Crossley Jr. D.A., Hendrix P.F. (2004) Fundamentals of soil ecology. Elsevier, USA. Jeffery S., Gardi C., Jones A., Montanarella L., Marmo L., Miko L., Ritz K., Peres G., Römbke J., van der Putten W.H. (eds.) (2010) European Atlas of Soil Biodiversity. European Commission, Publications Office ofthe European Union, Luxembourg.		
Optional reading	European commission DG ENV (2010) Soil biodiversity: functions, threats and tools for policy makers - final report. Lavelle P., Spain A.V. (2002) Soil ecology. Springer, New York. Paul E.A. (2007) Soil microbiology and biochemistry. Elsevier.		
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.		
Exam passing procedure	Before taking oral exam, students are obliged to pass written exam. Points gained at written and oral exam are added to the points gathered up to the final exam, thus making a total number of points to be converted to final grade.		
Main language of instruction; other languages	Croatian language, English language		
Method of monitoring the quality and efficiency of teaching	Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams.		

Course title	**Vector Ecology**
Code	ZPIO-I05
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	II semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Prof. Dr. Stjepan Krčmar Assist. Prof. Dr. Mirta Sudarić Bogojević
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To teach students about the main groups of vectors, and to enable them to understand and compare their ecological characteristics and distribution. To increase students' interest in learning about the vector role and epidemiological significance of individual groups of vectors, of pathogens that they transmit, and about modes of their transmission. To develop students' skills required for selection of appropriate methods of sampling and determination, in order to regulate the abundance of individual groups of vectors.
Learning outcomes	1. Ability to determine the olfactory senses and vision in the hematophagous insects and mites and their role in host finding. 2. Ability to rank the hematophagous groups of mites and insects with respect to their vector role and epidemiological significance. 3. Skills in selecting methods and procedures for sampling and regulation of abundance of individual groups of vectors (mites and hematophagous families of insects). 4. Ability to identify the main groups of vectors, the prevalence of vectors, pathogens that they transmit, and disease symptoms. 5. Developed writing skills within preparation of seminar paper by using relevant scientific literature.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-4	0.5	Lecture	Lecture attendance and active participation	Records, evaluation	10	20
5	0.5	Independent work of students (seminar)	Independent search for and critical revision of scientific references used in preparation of a seminar paper, and presentation of a seminar paper	Records and evaluation of the presented seminars paper	10	20

	1-5	1	Knowledge assessment (written exam)	Preparation for written exam	Written exam	20	30
	1-5	1	Final exam (oral exam)	Preparation for oral exam	Oral exam	20	30
	Total	**3**				**60**	**100**
	Final grade: **60-70 points: grade 2 (sufficient)** **71-80 points: grade 3 (good)** **81-90 points: grade 4 (very good)** **91-100 points: grade 5 (excellent)**						
Consultation hours	Regular consultation hours will be scheduled after being agreed with students.						
Teaching	**Lectures**		**Seminars**		**Practices**		
Hours - total	15		15		0		
Course content / teaching units	Lectures: • Systematics and ecological characteristics of the main groups of vectors • The olfactory senses and vision in the hematophagous insects and mites and their role in host finding • Vector role and epidemiological significance of hematophagous groups of insects and mites • Sampling methods and procedures in the regulation of abundance of individual groups of vectors • Prevalence of vectors and biological characteristics of pathogens that they transmit, and symptoms of diseases Seminars: • Presentation of selected topics: vectors and climate change, and similar topics						
Recommended reading	Atkinson P. (2010) Vector Biology, Ecology and Control. Springer. Gratz N.G. (2006) The vector- and rodent-borne diseases of Europe and North America: their distribution and public health burden. Cambridge University Press. Takken W., Knols B.G.J. (2007) Emerging pests and vector-borne diseases in Europe. Wageningen Academic Publishers.						
Optional reading	Bowman A.S., Nuttal A.P. (2009) Ticks Biology, Disease and Control. Cambridge University Press. Friend M. (2006) Disease Emergence and Resurgence: The Wildlife-Human Connection: Reston, Va., U.S. Geological Survey, Circular 1285. Lehane M.J. (1991) Biology of blood - sucking insects. Harper Collins Academic.London. Takken W., Knols B.G.J. (2010) Olfaction in vector-host interactions. Wageningen Academic Publishers.						
Conditions for obtaining teacher's signature	Students are obliged to attend and actively participate in lectures, and to complete all tasks related to the preparation of a seminar paper.						
Exam passing procedure	During the course, the teacher monitors and evaluates the activities of each student, which makes up to 40% of the final grade. Passing of written exam and passing of oral exam contribute with 30% to the final grade, respectively.						
Main language of instruction; other languages	Croatian language						

Method of monitoring the quality and efficiency of teaching	Evaluation form

Course title	**Ecological Immunology**
Code	
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	2
Course status	Elective
Course teacher	Assist. Prof. Dr. Senka Blažetić Assist. Prof. Dr. Irena Labak
Associate teachers	
Course entry requirements (Preceding courses)	Ecology (attended), Biochemistry 3 (attended)
Course objective	To enable students to understand the natural variations in the body's immune response, by putting emphasis on the influence of biotic and abiotic factors and their consequences.
Learning outcomes	1. Ability to compare the diversity and complexity of the immune system of different groups of organisms. 2. Knowledge about the causes and consequences of the immune system diversity in the context of evolution and ecology. 3. Ability to analyse the relations between environmental factors and the immune response. 4. Ability to determine the consequences that ecosystem disorders have on the immune response.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-4	0.5	Lecture	Critical conversation and discussion	Records related to student performance during lectures	10	20
1-4	0.75	Seminar	Working on a case study	Assessment of presentation and interpretation of obtained results with provision of feedback	35	50
1-4	0.25	Written exam	Preparation for written exam	Written exam	5	10
1-4	0.5	Oral exam	Preparation for oral exam	Oral exam	10	20
Total	**2**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	15	0
Course content / teaching units	• Evolutionary development of the immune response • Mechanisms of interaction between the host and the pathogen • Intraspecific selective limitations • Influence of environmental factors on the diversity of the immune response • Integration of the immune response and collective immunity within community • Mechanisms for development of tolerance and resistance		
Recommended reading	Demas G., Nelson R. (2011) Ecoimmunology 1st Edition, Oxford University Press. Malagol D., Ottaviani E. (2014) Eco-immunology: Evolutive Aspects and Future. Springer, Dordrecht.		
Optional reading	Elling Ulvestad (2007). Defending Life: The Nature of Host-Parasite Relations. Springer.		
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.		
Exam passing procedure	During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After the course, students take a written exam and then oral exam.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	During the course, the teacher continuously evaluates student achievement, and gives students the opportunity to make oral or written comments. After the course, students are given a survey in which they give their subjective opinion about quality and organisation of teaching, all with the aim to improve future teaching.		

Course title	**Ecological Projects**
Code	ZPIO-I
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assoc. Prof. Dr. Melita Mihaljević
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To enable students to develop, implement and manage scientific and professional projects related to the nature and environment protection.
Learning outcomes	1. Skills needed for project management, from its preparation, through implementation and final evaluation. 2. Ability to assess environmental studies and projects. 3. Ability to determine environmental protection issues, to find solutions for problems, and to prepare a project proposal independently.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-3	0.5	Lectures	Lecture attendance and active participation	Records, evaluation	10	15
1-3	0.5	Seminar	Attendance at the seminar, prepared seminar paper containing results and conclusions of the performed analyses	Records, evaluation of seminar paper	15	20
1-3	1	Written exam	Preparation for written preliminary exam	Written exam	15	20
1-3	1	Final exam	Exam preparation	Oral exam	20	**45**
Total	**3**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	15	0
Course content / teaching units	• Scientific research projects, development projects - planning, specifics, application procedure, project management and implementation. • European Union funds, financial programs and calls for proposals • Application of projects for financial support from European Union and national funds • Preparation of project documentation and project application process • Proposal evaluation procedure • The role of individuals, non-governmental organisations, scientific community and authorised institutions in the application and implementation of projects • Legal framework. • Independent preparation of project documentation		
Recommended reading	Kerzner H. (2003) Project management, A systems Approach to Planning, Scheduling and Controlling. John Wiley & Sons, Inc. Martinić I. (2010) Upravljanje zaštićenim područjima prirode - planiranje, razvoj i održivost. Šumarski fakultet, Sveučilište u Zagrebu.		
Optional reading	McCarthy S. (2013) How to Write a Competitive Proposal for Horizon 2020. Seán McCarthy Hyperion Ltd. McCarthy S. (2008) How to Write a Competitive Proposal for Framework 7. Seán McCarthy Hyperion Ltd.		
Conditions for obtaining teacher's signature	Attendance at lectures and seminars by obtaining minimum 25 points and by achieving at least 40% of the total number of points at the preliminary exam. A report written in the form of a scientific project application is a prerequisite for proceeding with the written exam.		
Exam passing procedure	The teacher evaluates the activities of students during the course and their achievements at final exam. The final grade consists of preparation of a written report by a share of 30%, of written exam by a share of 40%, and of oral exam by a share of 30%.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	Periodic evaluation of students and teachers is planned to be carried out in order to assure and continuously improve the quality of teaching and of the study programme. During the last week of lectures, an anonymous student survey will be carried out to evaluate the overall quality of the course. The analysis of students' success at exams will be carried out.		

Course title	**Eutrophication**
Code	ZPIO-I11
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	IV semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Prof. Dr. Janja Horvatić Assist. Prof. Dr. Filip Stević
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To teach students about causes, consequences and problems of eutrophication and to enable them to differentiate the changes caused by human activity and by normal natural processes. To develop students' critical thinking skills and ability to independently work on the studying of eutrophication, revitalisation and environmental protection.
Learning outcomes	1. Ability to assess the impact of eutrophication on habitat, flora and fauna. 2. Ability to identify and control the anthropogenic sources that supply the environment with nitrogen and phosphorus. 3. Knowledge about advantages and disadvantages of different methods used in prevention of anthropogenic eutrophication. 4. Ability to identify living organisms in the assessment of the trophic state of an ecological system. 5. Ability to analyse the positive and negative consequences of eutrophication processes and on ecological systems and on the primary and secondary ecosystem production.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	0.5	Lecture	Critical conversation and discussion	Records related to active and independent participation in conversations and discussions	10	15
3-5	0.5	Practices	Written report on the results and conclusions about performed analyses	Records related to students' activities within practices, evaluation of the report	10	15
1-5	1	Written exam	Preparation for written exam	Written exam	20	30
1-5	1	Oral exam	Preparation for oral exam	Oral exam	20	40
Total	**3**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)

	71-80 points: grade 3 (good) **81-90 points: grade 4 (very good)** **91-100 points: grade 5 (excellent)**		
Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	0	15
Course content / teaching units	Lectures: • The causes, consequences and control of eutrophication • The process of eutrophication - nature vs. man • Main effects of eutrophication on the changes in the environment – influence on habitat, flora and fauna • Indicators of eutrophication in an ecosystem • Assessment of the trophic status of the selected aquatic ecosystems • Examples of aquatic ecosystems according to the trophic level (from oligotrophic to eutrophic) • Sources of pollution • Nutrients • Management of natural resources with respect to eutrophication of an area • Management of contamination/pollution to reduce the eutrophication • Restoration of the natural areas – methods of the water restoration Practices: • Examples of eutrophication in Croatia and in the world • Visit to several sites with different trophic level • Possibilities for revitalisation of an ecosystem with respect to its current state • Application of modelling techniques to assess the state of aquatic ecosystems		
Recommended reading	Ansari A. A., Singh Gill G.S. (2014) Eutrophication: causes, consequences and control (Volume II), Springer. Ansari A.A., Singh Gill G.S., Lanza G.R., Rast W. (2011) Eutrophication: causes, consequences and control (Volume I), Springer. Wetzel R.G. (2001) Limnology - Lake and River Ecosystems. 3rd ed. Academic Press, San Diego.		
Optional reading	Butusov M., Jernelöv A. (2013) Phosphorus. An Element that could have been called Lucifer. Springer. Scheffer M. (2001) Ecology of Shallow Lakes. Kluwer Academic Publishers, Dordrecht, Boston, London. Shen Z., Niu J., Wang Y., Wang H., Zhao X. (2013) Distribution and Transformation of Nutrients and Eutrophication in Large-scale Lakes and Reservoirs. Springer. Smith V.H., Tilman G.D., Nekola J.C. (1999) Eutrophication: impacts of excess nutrient inputs on freshwater, marine, and terrestrial ecosystems. Environmental Pollution 100: 179-196.		
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.		
Exam passing procedure	Students' performance is assessed during lectures and practices, and within written and oral exam.		
Main language of instruction; other languages	Croatian language		

Method of monitoring the quality and efficiency of teaching	Periodic evaluation of students and teachers is planned to be carried out in order to assure and continuously improve the quality of teaching and of the study programme. During the last week of lectures, an anonymous student survey will be carried out to evaluate the overall quality of the course. Student success at exams will be also monitored.

Course title	**Herpetology**
Code	
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	II semester
Workload/ECTS credits	2
Course status	Elective
Course teacher	Assist. Prof. Dr. Olga Jovanović Glavaš
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To teach students about the biology of amphibians and reptiles and their systematics, anatomy, morphology, distribution and causes of endangerment.
Learning outcomes	1. Knowledge about the anatomy and morphology of amphibians and reptiles and different ways of their reproduction. 2. Ability to predict distribution of amphibians and reptiles based on the acquired knowledge. 3. Ability to define the reasons for the endangerment of amphibians and reptiles. 4. Ability to select appropriate methods for researching amphibians and reptiles. 5. Knowledge about the fauna of amphibians and reptiles of Croatia. 6. Skills in searching databases of amphibians and reptiles.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	0.5	Lectures	Lecture attendance and active participation	Student attendance	5	10
1-6	0.5	Practices	Practical classes attendance and active participation, written report containing obtained results	Records, evaluation	10	15
1-6	0.5	Knowledge assessment (written exam)	Preparation for written exam	Written exam	20	40
1-6	0.5	Final exam	Preparation for oral exam	Oral exam	25	35
Total	**2**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment.		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	0	15
Course content / teaching units	Lectures: • Introduction to herpetology • Taxonomy of amphibians • Anatomy and morphology of amphibians • Reproduction of amphibians • Distribution of amphibians • Systematics of reptiles • Anatomy and morphology of reptiles • Reproduction of reptiles • Distribution of reptiles • Endangerment of herpetofauna • Methods of researching herpetofauna • Herpetofauna of Croatia Practices: • Introduction to keys for identification of amphibian and reptile species • Anatomy and morphology of amphibians • Sounds of the Anura order • Identification of Croatian amphibians • Anatomy and morphology of reptiles • Identification of Croatian reptiles • Methods of researching herpetofauna • Collection and processing of data on the distribution of certain species of amphibians and reptiles • International databases of amphibians and reptiles		
Recommended reading	Arnold N., Ovenden D. (2002) Reptiles and Amphibians of Britain and Europe. Collins. Vitt L.J., Caldwell J.P. (2013) Herpetology: An Introductory Biology of Amphibians and Reptiles 4th ed. Academic Press.		
Optional reading	Duellman W.E., Trueb L. (1994) Biology of Amphibians. Johns Hopkins University Press.		
Conditions for obtaining teacher's signature	Regular attendance at lectures, successfully completed practices.		
Exam passing procedure	During the course, the teacher monitors and evaluates the performance of each student, which makes up to 30% of the final grade. Written exam contributes with 40% to the final grade, while oral exam takes up to 30% of the final grade.		
Main language of instruction; other languages	Croatian language, English language		
Method of monitoring the quality and efficiency of teaching	Student survey to evaluate the overall quality of the course. Analysis of student success at the exams.		

Course title	**Invasive Species**
Code	ZPIO-IO7
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assist. Prof. Dr. Mirta Sudarić Bogojević
Associate teachers	Dragan Prlić, assistant
Course entry requirements (Preceding courses)	
Course objective	To teach students about the negative impact of invasive alien plant and animal species on the environment, on human health and the economy, and to raise students' awareness of the importance of responsible behaviour of individuals and communities in the prevention, monitoring and control of invasive alien species.
Learning outcomes	1. Knowledge about the classification of invasive alien species in Croatia and Europe. 2. Ability to determine the entry routes of (potentially) invasive alien species. 3. Ability to analyse the mechanism of biological invasions. 4. Ability to assess the alien species invasiveness by analysing the effects of alien species on biodiversity, human health and economy. 5. Contribution to the expertise development by critical interpretation of relevant scientific papers / environmental studies. 6. Ability to suggest preventive actions and methods of monitoring and control of invasive alien species.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-6	0.5	Lecture	Attendance of lectures	Records related to active participation in discussions and conversations	5	10
1-6	1	Practices, tasks and continuous assessment of knowledge	Practical classes attendance and active participation, guided discussion, presentation of obtained results	Records and evaluation of student activities	15	30
1-6	1	Written exam	Preparation for written exam	Written exam	20	30
1-6	0.5	Oral exam	Preparation for oral exam	Oral exam	20	30
Total	**3**				**60**	**100**

	Final grade: **60-70 points: grade 2 (sufficient)** **71-80 points: grade 3 (good)** **81-90 points: grade 4 (very good)** **91-100 points: grade 5 (excellent)**		
Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	0	15
Course content / teaching units	• Domestic and foreign species • Mechanism of biological invasion • Resistance of the ecological system to invasions • Biological characteristics of invasive alien species • Impact of invasive alien species on biodiversity, human health and economy • Risk assessment • Entry routes of alien species • Timely detection of presence of potentially invasive alien species • Methods of control of invasive alien species • National and international legislation referring to invasive alien species • Overview of invasive plant and animal species in Croatia and Europe/world		
Recommended reading	DAISIE (2009) Handbook of alien species in Europe. Springer. Keller R.P., Lodge D.M., Lewis M.A., Shogren J.F. (2009) Bioeconomics of invasive species. Oxford University Press, New York. Wilcox C.P., Turpin R.B. (2009). Invasive species. Detection, impact and control. Nova Science Publishers, Inc. New York.		
Optional reading	Clout M.N., Williams P.A. (2009) Invasive species management. Oxford University press, New York. Lockwood J.L., Hoopes M.F., Marchetti M.P. (2013) Invasion Ecology, Wiley-Blackwell. Nikolić T., Mitić B. (2009)Invazivne biljke prijetnja bioraznolikosti, Coast. Scientific and professional pepers.		
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.		
Exam passing procedure	The teacher monitors and evaluates the activities of students during the course and at the final exam. Before taking oral exam, students are obliged to pass written exam by completing project assignments. The final grade is determined according to the number of points that students collect during the course and the points they achieve at the written and oral exam.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	The teacher continuously monitors the learning process and student achievement, thus determining and adapting his/her teaching. At the end of the course, the teacher and students analyse the teaching process efficiency, and there is an anonymous survey among students carried out to determine their subjective experience of teaching quality, the results of which are to be used in improvement of future teaching.		

Course title	**Energy Sources and the Environment**
Code	ZPIO-I08
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assoc. Prof. Dr. Sandra Ečimović
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To enable students to acquire knowledge about different ways of energy production and their impacts on environment, by putting an emphasis on the environmental and economic effects of energy production (cost benefit analysis of environmental pollution, pollution control costs, and profit).
Learning outcomes	1. Knowledge about the basic concepts related to energy and environment. 2. Ability to compare and describe forms of energy, its conversion and importance for life. 3. Ability to discuss the problems of energy production, transmission and storage 4. Ability to critically assess the impacts of different ways of energy production on the environment. 5. Knowledge about advantages and disadvantages of particular energy sources.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	0.5	Lecture	Lecture attendance and active participation	Records, evaluation	5	10
1-5	0.5	Seminars	Attendance of seminars, active participation	Records, evaluation	10	15
1-5	1	Knowledge assessment (written exam)	Preparation for written exam	Written exam	20	35
1-5	1	Final exam	Exam preparation	Oral exam	25	40
Total	**3**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**

Hours - total	15	15	0
Course content / teaching units	Lectures: • Energy and environment (basic terms, an overview of global energy demand and energy consumption); • Thermodynamic principles of energy conversion (basic forms of energy, thermodynamic properties, efficiency of energy conversion); • Problems of production, transmission and storage of energy; • Fossil fuel power plants (determination of major impacts on the environment, the problems of cooling, control of emissions – incomplete combustion, CO, particulate matter, sulphur, nitrogen oxides, toxic emissions, waste management problems), cogeneration plants; • Nuclear power plants (nuclear energy, nuclear reactors; determination of the basic environmental impacts –radioactivity, cooling problems, biological effects of radiation, radiation protection standards); • Renewable energy and determination of its environmental effects (hydroelectric power plants, biomass, geothermal energy, solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, capital costs of renewable energy sources) Seminars: • Environmental effects of fossil fuels burning (air and water pollution, global warming, global warming potential of individual greenhouse gases – CO2 equivalents, methods of controlling CO2 emission) • The future of energy sources usage, alternative energy sources and energetic optimisation		
Recommended reading	De Oliveira S. Jr. (2013) Exergy: Production, Cost and Renewability. London: Springer-Verlag. O'Keefe P., O'Brien G., Pearsall N. (2010) The Future of Energy Use. Earthscan. Sørensen B. (2004) Renewable Energy: Its physics, engineering, use, environmental impacts, economy and planning aspects, 3rd ed. Elsevier Science.		
Optional reading	Fay J.A., Golomb D.S. (2002) Energy and the Environment. Oxford University Press, New York.		
Conditions for obtaining teacher's signature	Regular attendance of lectures and seminars.		
Exam passing procedure	During the course, the teacher monitors and evaluates performance of each student, which refers to 10% of the final grade. Prior to taking written exam, student is obliged to prepare and present a seminar paper, which contributes 20% to the final grade. Passing of written exam refers to 30% of the final grade, and passing of oral exam refers to the remaining 40% of the final grade.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	Student survey to evaluate the overall quality of the course. Analysis of student success at exams.		
Method of monitoring the quality and efficiency of teaching	Evaluation form		

Course title	**Landscape Ecology**
Code	ZPIO-I14
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assoc. Prof. Dr. Ljiljana Krstin
Associate teachers	Assist. Prof. Dr. Zorana Katanić
Course entry requirements (Preceding courses)	
Course objective	To enable students to understand the spatial structure of the landscape and its ecological consequences, as well as to comprehend the importance of monitoring, planned landscape management and conservation of landscape diversity.
Learning outcomes	1. Knowledge about the structure, function and ecology of the landscape. 2. Ability to assess the main pressures that affect specific landscape types. 3. Knowledge about geometric features of the landscape structure. 4. Ability to review the role of geoinformation science and remote research.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-3	0.5	Lecture	Critical conversation and discussion	Records related to active participation in conversations and discussions	10	20
3, 4	1	Practices	Work on the experimental task	Monitoring of student performance	20	30
1-4	1	Written exam	Preparation for written exam	Written exam	20	30
1-4	0.5	Oral exam	Preparation for oral exam	Oral exam	10	20
Total	**3**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment.		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	0	15
Course content / teaching units	Lectures: • The subjective experience of the landscape in everyday life • The objectification of the landscape issues		

	• Definitions and theories of the landscape • Structure, function and changes of the landscape • Geometric features of the structure of the landscape • Layers, corridors and matrixes • Landscape discretisation • Ecotones • Scaling and fractals • Relations between biological species and their areals • Animal migration in time and space • The theory of metapopulation • Fragmentation, separation and isolation • Ecological aspects of fragmentation • Defragmentation and networking • Models of habitats • The role of geoinformation science and remote research in landscape ecology • Parameters of spatial-structural characteristics of landscape within GIS: surface, boundaries, core analysis, shape, fractal dimension compactness, diversity, homogeneity • The relationship between the neighbourhood and proximity • Grading of landscape characteristics in the function of planned modelling • Variation, scenarios and simulations • Network analysis and optimisation • Landscape monitoring and analysis of changes Practices: • Practical application of theoretical concepts learned within the lectures
Recommended reading	Farina A. (2006) Principles and Methods in Landscape Ecology: Towards a Science of the Landscape. Springer. Gergel S.E., Turner M.G. (2017) Learning Landscape Ecology: A Practical Guide to Concepts and Techniques. 2nd ed. Springer. Haines-Young R., Green D.R., Cousins S.H. (2003) Landscape Ecology and Geographical Information Systems. CRC Press.
Optional reading	Collinge S.K. (2009) Ecology of Fragmented Landscapes. Baltimore: Johns Hopkins University Press. Coulson R.N., Tchakerian M.D. (2010) Basic Landscape Ecology. KEL Partners Incorporated. Millington A.C., Walsh S.J., Osborne P.E. (2012) Gis and Remote Sensing Applications in Biogeography and Ecology. Springer. Turner M.G., Gardner R.H., O'Neill R.V. (2003) Landscape Ecology in Theory and Practice: Pattern and Process. Springer.
Conditions for obtaining teacher's signature	
Exam passing procedure	During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After having attended lectures and practices, students proceed with the written and oral exam. Points achieved at written and oral exam are added to the points that students collected up to the final exam, thus making a total number of points to be converted to final grade.
Main language of instruction; other languages	Croatian language

Method of monitoring the quality and efficiency of teaching	After the course, an anonymous survey will be carried out among students to evaluate their subjective impression about the organisation and quality of teaching; during the lectures, students will have opportunity to make written or oral remarks; monitoring of students' success at exams.

Course title	**Lichens as Biomonitors**
Code	ZPIO-I17
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	IV semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assist. Prof. Dr. Filip Stević
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To teach students about unique characteristics of lichens that make them ideal organisms for biomonitoring of terrestrial ecosystems and to explain to students the importance of the alliance of *Lobarion pulmonariae* with other epiphytic lichen flora in the management and protection of forest ecosystems.
Learning outcomes	1. Knowledge about biological characteristics and ecological adaptations of lichens as ideal and reliable bioindicators of air pollution. 2. Ability to assess the degree of air pollution by analysing lichen flora according to indicator values and life forms and to apply the scale of lichens according to their resistance to air pollution. 3. Knowledge about the characteristics of lichens, which make them suitable in monitoring of terrestrial ecosystems by assessing the air quality, climate and biodiversity. 4. Skills required to perform research into lichens on field and in laboratory. 5. Ability to estimate the importance of the *Lobarion pulmonariae* alliance for the forest ecosystem.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1, 2, 4, 5	0.5	Lecture	Critical conversation and discussion	Records related to active and independent participation in conversations and discussions	5	10
3	1	Seminar	Independent preparation of seminar paper	Records related to active and independent preparation of seminar paper with provision of feedback	15	30
1-5	1	Written exam	Preparation for written exam	Written exam	20	30
1-5	0.5	Oral exam	Preparation for oral exam	Oral exam	20	30
Total	**3**				**60**	**100**
Final grade:						

	60-70 points: grade 2 (sufficient) **71-80 points: grade 3 (good)** **81-90 points: grade 4 (very good)** **91-100 points: grade 5 (excellent)**		
Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	15	0
Course content / teaching units	• Biological characteristics and ecological adaptations of lichens making them the indicator species • Bioindicators of the air quality - sensitive and tolerant bioindicator species to air pollution • Lichen research (field research, laboratory research and determination of lichens, usage the keys for determination of lichens) • Ecological features of lichen flora according to the indicator values and the life forms • Lichen flora mapping and assessment of pollution according to the composition of lichens – scales of lichens according to resistance to pollution • Criteria of selecting lichens for biomonitoring • The role of lichens as biomonitors in monitoring of the terrestrial ecosystems • The secondary metabolites of lichens as indicators of air quality and of pollution in the ecosystem • The importance of lichens as biomonitors in the management and protection of forest ecosystems • Factors of impoverishment of the alliance of *Lobarion Pulmonariae* with other epiphytic lichens		
Recommended reading	Brodo I. M., Duran Sharnoff S., Sharnoff S. (2001) Lichens of North America, Published by Yale University Press. Shukla V., Upreti D.K., Bajpai R. (2014) Lichens to Biomonitor the Environment. Springer.		
Optional reading	Partl A. (2009) Lišajevi. Priručnik za inventarizaciju i praćenje stanja. Državni zavod za zaštitu prirode, Zagreb. Richardson D.H.S. (1992) Pollution monitoring with lichens. Richmond Pub. Co. Stolte K.W., Stroh Huckaby L., Tonnessen K.A. (1993) Lichens as bioindicators of air quality. Rocky Mountain Forest and Range Experiment Station. Forest Service, U.S. Dept. of Agriculture.		
Conditions for obtaining teacher's signature	Students are obliged to attend and actively participate in lectures and seminars.		
Exam passing procedure	Student's performance within the course is evaluated during lectures, and at the written and oral exam. Each student prepares and presents a seminar paper, for which there are certain number of points awarded according to determined criteria.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	Student survey after the course; reviews during the course and possibility to give oral or written remarks after lectures; monitoring of student success at exams.		

Course title	**Environmental Microbiology**
Code	ZPIO-I06
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	II semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assist. Prof. Dr. Goran Palijan
Associate teachers	Assist. Prof. Dr. Anita Galir Balkić
Course entry requirements (Preceding courses)	Microbiology
Course objective	To explain to students anthropogenic influences on microorganisms in the environment.
Learning outcomes	1. Knowledge about the role of microorganisms in the environment. 2. Ability to evaluate the interaction between microorganisms and the environment. 3. Ability to estimate the changes in populations of microorganisms in the environment depending on anthropogenic influences. 4. Skills required to determine anthropogenic influences on samples of environmental microorganisms.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-3	0.5	Lecture	Critical conversation and discussion	Records related to active participation in conversations and discussions	5	10
1-4	0.5	Practices	Interpretation of scientific papers and application of obtained results at concepts learned within lectures	Monitoring of students' performance at interpretations and tasks	10	15
1-4	1	Written exam	Preparation for written exam	Written exam	20	32,5
1-4	1	Oral exam	Preparation for oral exam	Oral exam	25	42,5
Total	**3**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours/week total	15	0	15
Course content / teaching units	Lectures: • Physical and chemical factors that influence the microorganisms in environment • Competitive strategies of microorganisms • Interactions between microorganisms • Life of microorganisms at low nutrient concentrations • Biofilms • Soil biofilms • Biofilms of the sea and ocean • Inland water biofilms • Extreme habitats Practices: • Interactions between microorganisms • Life of microorganisms at low nutrient concentrations • Biofilms of soil and inland waters		
Recommended reading	Barton L.L., Northup D.E. (2011) Microbial Ecology. Wiley-Blackwell, New Jersey. Pepper I.L., Gerba C.P. (2005) Environmental Microbiology. Elsevier, Amsterdam.		
Optional reading	Brown A.E. (2009) Benson's Microbiological Applications – Laboratory Manual in General Microbiology. McGraw-Hill, Boston. Ghannoum M., O'Toole G.A. (2004) Microbial Biofilms. ASM Press, Washington DC. Varnam A.H., Evans M.G. (2000) Environmental Microbiology. Manson Publishing Ltd, London.		
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.		
Exam passing procedure	Before taking oral exam, students are obliged to pass written exam.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams.		

Course title	**Microphytes in Fouling Development**
Code	
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	2
Course status	Elective
Course teacher	Assoc. Prof. Dr. Tanja Žuna Pfeiffer
Associate teachers	Assist. Prof. Dr. Dubravka Špoljarić Maronić Assist. Prof. Dr. Filip Stević Nikolina Bek, assistant
Course entry requirements (Preceding courses)	Algae, Fungi and Lichens
Course objective	To teach students about the importance and role of microphytes in aquatic ecosystems.
Learning outcomes	1. Ability to select a representative substrate for the analysis of microphytes in fouling of an aquatic biotope. 2. Ability to compare the structure of different microphytic communities on fresh and permanent microscopic preparations prepared by students 3. Ability to correlate development of microphytic communities and abiotic and biotic factors in an aquatic biotope. 4. Ability to use literature references for microphyte determination and to review professional and scientific research. 5. Ability to critically assess the importance of microphytes in fouling in assessing water condition and quality.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	0.5	Lecture	Critical conversation and discussion	Records related to active and independent participation in conversations and discussions	5	10
1-5	1	Practices	Independent production of microscopic preparations, determination of microphytes, comparison of microphytes on various substrates, analysis of water condition	Records related to students' activities within practices with provision of feedback	25	40
1-5	0.25	Written exam	Preparation for written exam	Written exam	15	25
1-5	0.25	Oral exam	Preparation for oral exam	Oral exam	15	25
Total	**2**				**60**	**100**

	Final grade: **60-70 points: grade 2 (sufficient)** **71-80 points: grade 3 (good)** **81-90 points: grade 4 (very good)** **91-100 points: grade 5 (excellent)**		
Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	0	15
Course content / teaching units	Lectures: • Fouling – definition and basic characteristics • Adaptations of microphytes to life in fouling communities • Fouling communities - structure and seasonal dynamics in different types of ecological systems • Influence of abiotic and biotic factors on fouling development and microphyte structure • Interactions between phytoplankton and microphytes in fouling development • Microphytes in fouling communities as indicators of aquatic ecosystem condition • Application of microphytic communities Practices: • Qualitative and quantitative analysis of microphytes in fouling on sediment and on different types of natural and artificial substrates in different aquatic ecosystems • Fouling biomass analysis • Analysis of chlorophyll-a, -b and -c contents in fouling samples • Using of analysis results in the assessment of aquatic ecosystem condition		
Recommended reading	Azim M.S., Verdegem M., van Dam A., Beveridge M. C. M. (eds.) (2005) Periphyton: Ecology, Exploitation and Management. Cabi Publishing. Stevenson R., Bothwel M., Lowe R., Thorp J. (eds.) (1996) Algal Ecology: Freshwater Benthic Ecosystem. Academic Press.		
Optional reading	Yonghong W. (2016) Periphyton: Functions and Application in Environmental Remediation. Elsevier Inc. Original scientific papers referring to the subject area.		
Conditions for obtaining teacher's signature	Students are obliged to attend and actively participate in lectures and practices.		
Exam passing procedure	During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After lectures and practices, students shall pass the written exam, as well as oral exam. The final grade is determined according to the number of points gained during lectures and practices and the number of points achieved at written and oral exam.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	During the course, the teacher continuously monitors the learning process and student achievement, thus determining and adapting his/her teaching. After each lecture, students have the opportunity to make oral or written remarks. During the last week of lectures, students are given an anonymous survey to evaluate the overall quality of the course. The teacher monitors the success of students at the exams.		

Course title	**Natura 2000 in Croatia**
Code	ZPIO-I10
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assist. Prof. Dr. Nataša Turić
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To explain to students the basic principles of the European law on nature protection and the role of scientific research in the creation of Natura 2000 areas.
Learning outcomes	1. Ability to critically determine the importance of Natura 2000 ecological network and its implementation in the EU and Croatia. 2. Knowledge about the procedures for selecting Natura 2000 areas and the legislative framework used for determination of valuable ecological areas. 3. Developed opinion on scientific criteria applied in selecting of areas for the ecological network in Croatia. 4. Ability to review the management models of Natura 2000 areas and international obligations of each EU member state regarding the implementation of European directives. 5. Raised awareness of the value of biodiversity conservation by establishing cooperation of all EU members, and of the importance to monitor the conservation status of species and habitat types.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	1	Lecture	Critical conversation and discussion	Records related to active participation in conversations and discussions	15	20
1-5	1.5	Seminar	Preparation for seminar paper	Written exam	25	50
1-5	0.5	Oral exam	Preparation for oral exam	Oral exam	20	30
Total	**3**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	Wednesdays, from 10.00-12.00 a.m.		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	15	0

Course content / teaching units	Lectures: • Natura 2000 - idea and concept. The Habitats Directive (92/43/EEC) and directive's annexes, The Birds Directive (79/409/EEC) and its annexes • Implementation of the ecological network in Croatia. Biogeographical regions in Croatia • Selection of the Natura 2000 areas • Natura 2000 and economic activities of Croatia (agriculture, forestry, water management and eco-tourism) • Natura 2000 and rules on the assessment of acceptability of impacts and interventions on nature in Croatia • Natura 2000 and non-governmental organisations • Natura 2000 area management in Croatia • Obligations to monitor the situation and to report at the EU level • Natura 2000 species in Croatia • Natura 2000 areas in Croatia divided by biogeographical regions Seminars: • Within the seminar, each student will choose one of the lecture topics to elaborate it and present to the class independently, while being supervised by the teacher. There will be course-related video material presented to the class
Recommended reading	Peternel H., Roth P., Antonić O., Mesić Z., Mazija M. (2011) Priručnik za Ocjenu prihvatljivosti zahvata za ekološku mrežu. Topić J., Ilijanić LJ., Tvrtković N., Nikolić T. (2006) Staništa-Priručnik za invertarizaciju, kartiranje i praćenje stanja. DZZP, Zagreb. Holcer D., Pavlinić I. (2008) Fauna- Priručnik za invertarizaciju i praćenje stanja. DZZP, Zagreb.
Optional reading	Bakran-Petricoli T. (2007) Morska staništa- Priručnik za invertarizaciju i praćenje stanja. DZZP, Zagreb. Gottstein S. (2010) Priručnik za određivanje podzemnih staništa u Hrvatskoj prema Direktivi o staništima EU. Državnog zavoda za zaštitu prirode, Zagreb. Holcer D., Pavlinić I. (2008) Fauna- Priručnik za invertarizaciju i praćenje stanja. DZZP, Zagreb. Topić J., Vukelić J. (2009) Priručnik za određivanje kopnenih staništa u Hrvatskoj prema Direktivi o staništima EU Državnog zavoda za zaštitu prirode, Zagreb. Nikolić T. (2006) Flora- Priručnik za invertarizaciju i praćenje stanja. DZZP, Zagreb. Temunović M., Turić N. (2011) Praćenje vrste Graphoderus bilineatus (De Geer, 1774) na važnim područjima za očuvanje vrste u RH i rezultati istraživanja na potencijalnim novim nalazištima vrste u kontinentalnoj Hrvatskoj. Konačni izvještaj. Udruga za biološka istraživanja - BIOM. Zagreb. Temunović M., Turić N. (2013) Program praćenja na biogeografskoj razini sa smjernicama za ocjenu stanja očuvanosti vrste *Graphoderus bilineatus*. Udruga BIOM, Zagreb, 28 pp.
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.
Exam passing procedure	Students shall deliver an oral presentation about the topic of their choice. Presentations are evaluated according to criteria valid for the assessment of seminar papers.
Main language of instruction; other languages	Croatian language
Method of monitoring the quality and efficiency of teaching	Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams.

Course title	**Agriculture and Environment**
Code	ZPIO-I13
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	IV semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assoc. Prof. Dr. Mirna Velki
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To teach students about the basics of agricultural production by pointing out negative impacts of conventional agriculture on the environment and to enable students to understand the importance of sustainable agricultural production for the purpose of lowering the burden put on the environment.
Learning outcomes	1. Knowledge about the basics of agricultural production. 2. Ability to analyse the negative impacts of conventional agricultural production on the environment. 3. Ability to determine interactions between agricultural and natural ecosystems. 4. Awareness of the importance of environmentally friendly principles used in the plant production and protection. 5. Ability to critically interpret scientific papers related to the course topics.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	1	Lecture	Critical conversation and discussion	Records related to active participation in conversations and discussions	5	10
1-5	1	Seminar	Interpretation of scientific papers dealing with course topics	Monitoring of students' performance at interpretations	15	30
1-5	0.5	Written exam	Preparation for written exam	Written exam	20	30
1-5	0.5	Oral exam	Preparation for oral exam	Oral exam	20	30
Total	**3**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	Mondays, 10.00 – 11.00 a.m.		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	15	0
Course content / teaching units	Lectures: • Basics of plant and livestock production • Interactions between agricultural and natural ecosystems • Principles and problems of conventional agricultural production • Ecological problems of fertilisation and application of plant protection products • Irrigation and drainage of agricultural land • Genetically modified plants and animals • Impact of extensive agricultural production on terrestrial and aquatic ecosystems, climate change, habitat conservation and biodiversity • Comparison between conventional and organic agriculture • Links between biodiversity conservation and organic agriculture • Ecological potentials of production of biofuel, bioethanol and biomass Seminars: • Independent analysis and interpretation of scientific papers related to the course topics		
Recommended reading	Lichtfouse E. (2010) Sociology, Organic Farming, Climate Change and Soil Science. Springer. Martin K., Sauerborn J. (2013) Agroecology. Springer. Villalobos F.J., Fereres E. (2016) Principles of Agronomy for Sustainable Agriculture. Springer.		
Optional reading	Scientific papers and review articles		
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.		
Exam passing procedure	Before taking oral exam, students are obliged to pass written exam that can be substituted by a preparation of a seminar paper. The final grade refers to the points achieved on written and oral exam and the points obtained during lectures.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	Student survey, possibility to make oral or written remarks after lectures. Monitoring of students' success at exams.		

Course title	**Application of Algae and Cyanobacteria**
Code	
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	2
Course status	Elective
Course teacher	Assist. Prof. Dr. Filip Stević
Associate teachers	Assist. Prof. Dr. Dubravka Špoljarić Maronić Assoc. Prof. Dr. Tanja Žuna Pfeiffer
Course entry requirements (Preceding courses)	
Course objective	To teach students about the importance and multiple possibilities of using algae and cyanobacteria in various areas of human activities.
Learning outcomes	1. Knowledge about general characteristics of algae and cyanobacteria. 2. Ability to understand how lifestyle affects algal and cyanobacterial adaptations. 3. Ability to assess the importance of algae and cyanobacteria in the context of global climate change. 4. Ability to estimate the success of algae and cyanobacteria application in various areas of human activities.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-4	0.5	Lecture	Critical conversation and discussion	Records related to active and independent participation in conversations and discussions	10	20
3-4	0.5	Seminar	Independent preparation of seminar paper	Records related to active and independent preparation of seminar paper with provision of feedback	15	25
1-4	0.5	Written exam	Preparation for written exam	Written exam	15	25
1-4	0.5	Oral exam	Preparation for oral exam	Oral exam	20	30
Total	**2**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	15	0
Course content / teaching units	• Habitats of algae and cyanobacteria • Lifestyle • Significance of algae and cyanobacteria • Adaptations to different environmental conditions • Primary producers, heterotrophs and mixotrophs • Bioactive substances • Biotechnology • Application of algae and cyanobacteria: basic indicators of water quality, medical and pharmaceutical industry, water purifiers, energy sources (photobioreactors, biofuels), paleolimnology, cosmetic industry (cosmetics, cosmeceutics), nutrition - primitive food, macro and microelements, sources of vitamins, proteins, minerals and fatty acids • The most common types of algae and cyanobacteria in wide application • UV protection • Connection to global climate change		
Recommended reading	Lee R.E. (2008) Phycology. Cambridge University Press, New York. Reynolds C.S. (2006) The Ecology of Phytoplankton. Cambridge University Press, Cambridge. Relevant scientific papers referring to the subject area.		
Optional reading	Cardozo K.H.M., Guaratini T., Barros M.P., Falcão V.R., Tonon A.P., Lopes N.P., Campos S., Torres M.A., Souza A.O., Colepicolo P., Pinto E. (2007) Metabolites from algae with economical impact. Comp Biochem Physiol 146: 60-78. Goswami G. (2015) Diverse apllications of algae. Int J Adv Res Sci Eng Technol 4: 1102-1109.		
Conditions for obtaining teacher's signature	Students are obliged to attend and actively participate in lectures and practices.		
Exam passing procedure	Student's performance within the course is evaluated during lectures, and at the written and oral exam. Each student prepares and presents a seminar paper, for which there are certain number of points awarded according to determined criteria.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	An anonymous student survey will be carried out to evaluate the overall quality of the course. Analysis of student success at the exams.		

Course title	**Biological Collections**
Code	ZPIO-I12
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	IV semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assist. Prof. Dr. Goran Vignjević
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To make students aware of the importance and value of biological collections. Students will be introduced to different types of biological collections, and to the possibilities of growing exemplary organisms in aquariums, terrariums, gardens, etc. Students will acquire basic knowledge of and develop skills for creating biological collections by applying appropriate breeding grounds and habitats. Within the field work, students will be presented several biological collections kept in museums.
Learning outcomes	Developed skills in collecting different biological samples by using appropriate tools. Skills in preparation and stuffing of different biological materials by using appropriate taxidermy techniques. Acquired knowledge and skills to select the most suitable technique for stuffing of certain group of animals. Skills to independently make breeding media for growing of protozoa. Skills to independently create biological collection.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	0.5	Lecture	Critical conversation and discussion; collaborative learning by analysing possibilities of stuffing of biological material	Records related to active participation in discussions and analysis	5	10
1-5	0.5	Field-based teaching	Practical application of methods in sampling of biological material, selection of suitable biological material within field classes	Records related to active engagement in the field-based learning	5	10

	1-5	1	Practices	Independent preparation of biological collection	Analysis of stuffed material with provision of feedback, preparation of a small collection	10	20
	1-5	1	Oral practice-based exam	Prepared student's own biological collection	Control of methods applied for taxidermy, determination and storage of collection	40	60
	Total	**3**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	0	15

Course content / teaching units

Within the course, students develop their skills of independent creation of biological collections.
Lectures:

- Different types of biological collections (botanical, zoological, paleontological, petrographic, mineralogical)
- Modern collections (cell and tissue cultures, DNA banks, other "molecular preparations")
- Virtual records of collections
- Methods of making collections, methods and recipes for preparing materials for collections
- Labelling of the collection parts
- Access to collections and information - the cooperation between scientific institutions, museums and the public
- Protected plant and animal species

Practices:

- Creation of various biological collections (herbarium, entomological collection, bone collection...)
- Production of permanent and semi-permanent preparations
- Making of an aquarium, terrarium or a living corner

Visit to natural history museums

Recommended reading

Chinery M.(1989) 1000 ideja za prirodoslovca. Svjetlost, Sarajevo.
Durrell G. (1990) Svijet prirode, GZH, Zagreb.
Various authors (2015) Taxidermy Vol. 9 Bones and Skeletons - The Collection, Preparation and Mounting of Bones, Sigaud Press

Optional reading

Conditions for obtaining

Students are obliged to participate in lectures actively and to fulfil all assignments within the course.

teacher's signature	
Exam passing procedure	During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. In this way, the teacher provides continuous feedback, which students use to assess their learning progress and to create their own biological collection. After having prepared their biological collection, students take the oral exam. During the oral exam, the teacher checks the applied methods that are related to learning outcomes. The final grade is determined according to the number of points gained during the course and at the oral exam, as well as for preparation of biological collection.
Main language of instruction; other languages	Croatian language
Method of monitoring the quality and efficiency of teaching	During the course, the teacher performs evaluation for learning by continuous monitoring of the learning process and student achievement, thus determining and adapting his/her teaching. After the course, the teacher conducts a survey among students to evaluate their subjective impression about the teaching quality, all with the aim to improve future teaching.

Course title	**Radiobiology**
Code	ZPIO-I02
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	II semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assoc. Prof. Dr. Valentina Pavić
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To teach students about the sources, types and properties of radiation and about biological effects of ionizing and non-ionizing radiation. To introduce students to the methods of detecting harmful effects of radiation, and to enable them to apply appropriate radiation protection measures.
Learning outcomes	1. Ability to predict radiation sources. 2. Ability to classify ionizing and non-ionizing radiation. 3. Ability to interpret radiation in medical and laboratory diagnostics. 4. Ability to determine the interactions between ionizing radiation and the biological system. 5. Knowledge about methods used in detection of harmful effects of radiation. 6. Ability to propose protection measures against ionizing radiation. 7. Knowledge about the factors that determine the intensity of biological damage caused by radiation. 8. Ability to assess potentially harmful effects and existing ones, and to plan the prevention of additional harmful effects of radiation.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-8	0.5	Lecture	Critical conversation and discussion	Records related to active participation in conversations and discussions	5	10
1-8	1.5	Seminar	Interpretation of scientific papers and application of obtained results at concepts learned within lectures	Monitoring of students' performance at interpretations and tasks	35	60
1-8	1	Final exam	Preparation for oral exam	Oral exam	20	30
Total	**3**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)

	81-90 points: grade 4 (very good) **91-100 points: grade 5 (excellent)**		
Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	15	0
Course content / teaching units	Lecture: • Overview of the most important scientific findings. Types and division of radiation • Radioactivity and sources of radioactivity in the environment • Exposure to radiation: external and internal • Application of radiation sources in medical diagnostics and therapy • Radiotherapy and radiological diagnostics • Measurement of ionizing radiation • Interaction of radiation with biological macromolecules • Radiation absorption • Mechanisms of DNA damage and repair • Cell sensitivity to radiation • Tissue radiosensitivity • Effects of radiation on the body Seminar: • Somatic and genetic effects • Acute and chronic effects • Effects of radiation on fetus • Biological effects of optical spectrum radiation • Radiofrequency - microwave radiation, ultrasound • Principles of protection against ionizing radiation • Possible consequences of exposure to ionizing radiation • Measurement of radiation damage • Radioprotectors and radiosensibilisators		
Recommended reading	Down S.B., Tilson E.R. (2003) Practical Radiation Protection and Applied Radiobiology, 2nd ed. Saunder WB. Company, Toronto, Canada. Polk C., Postow E. (1996) Biological Effects of Electromagnetic Fields. CRC Press, USA.		
Optional reading	Fenech M. (2006) Cytokinesis-block micronucleus assay evolves into a "cytome" assay of chromosomal instability, mitotic disfunction and cell death. Mutation Research 600: 58-66. Natarajan A.T. (2002) Chromosome aberrations: past, present and future. Mutation Research 504:3-16.		
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.		
Exam passing procedure	Prior to taking oral exam, students are obliged to prepare and present the seminar paper. The final grade consists of points achieved at oral exam and of points obtained during the course.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams.		

Course title	**Structural Ecology and Ecological Networks**
Code	ZPIO-I15
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assoc. Prof. Dr. Davorka Hackenberger Kutuzović
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To introduce students to the structure of ecological systems and ecological networks, and to develop their skills in using methods to create and analyse ecological networks.
Learning outcomes	1. Knowledge about structural ecology, ecological networks and their characteristics. 2. Ability to develop and analyse ecological networks. 3. Ability to apply methods for creation of ecological networks in scientific and professional work. 4. Ability to perform analysis of structures of existing ecological systems. 5. Ability to assess the effect of ecological network structure on properties of the studied ecological system.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	0.5	Lecture	Active participation in discussion	Records related to student attendance and activity	10	20
3-5	1	Seminar	Interpretation of scientific papers and application of obtained results at concepts learned within lectures	Monitoring of students' performance at interpretations and tasks	20	30
1-5	1	Written exam	Preparation for written exam	Written exam	20	30
1-5	0.5	Oral exam	Preparation for oral exam	Oral exam	10	20
Total	**3**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	15	0
Course content / teaching units	Lectures: • Introduction to the concept of structural ecology and the concept of ecological networks • Properties of ecological networks (complexity, connectivity, clustering, compartmentation) • Stability of ecological networks • Trophic ecological networks • Non-trophic ecological networks • Characterisation of interspecific interactions • Importance of interspecific interactions • Identification of key species • Dynamics of ecological networks • Application of ecological networks Seminars: • Within the seminar, students will elaborate concrete examples from research, create ecological networks, and explain specific examples available from scientific publications		
Recommended reading	Bascompte J., Jordano, P. (2013) Mutualistic Networks. Princeton University Press. Képès F. (ed.) (2007) Biological networks. World Scientific, Singapore.		
Optional reading	Bascompte J. (2007) Networks in ecology. Basic Appl. Ecol. 8: 485-490. Fath B.D., Scharler U.M., Ulanowicz R.E., Hannon B. (2007) Ecological network analysis: network construction. Ecol. Model. 208: 49-55. Montoya J.M., Pimm S.L., Sole R.V. (2006) Ecological networks and their fragility. Nature 442: 259-264.		
Conditions for obtaining teacher's signature	Regular attendance of lectures, submitted and presented seminar paper.		
Exam passing procedure	Attendance of lectures, and prepared and presented seminar paper contribute to the final grade with a share of 40%, and entitles students to proceed with the written exam. Passing of written exam refers to 30% of the final grade, and passing of oral exam refers also to the remaining 30% of the final grade.		
Main language of instruction; other languages	Croatian language, English language		
Method of monitoring the quality and efficiency of teaching	Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams.		

Course title	**Urban Ecology**
Code	ZPIO-I04
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	II semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assoc. Prof. Dr. Dubravka Čerba
Associate teachers	Barbara Vlaičević, Ph.D.
Course entry requirements (Preceding courses)	
Course objective	To introduce students to the concepts of urban ecology and to raise their awareness of the importance of planning and monitoring the anthropogenic influence on the environment and on living communities when expanding urban areas. To introduce students to the characteristics of urban areas as specific ecosystems.
Learning outcomes	1. Knowledge about basic concepts of urban ecology and ability to explain the importance of urban ecology by using examples. 2. Knowledge about functioning of urban areas as specific ecosystems and ability to determine important plant and animal species in urban areas. 3. Ability to determine issues related to ecology and protection of anthropologically changed areas, and to propose nature protection measures in urban areas. 4. Ability to self-assess knowledge and skills of responsible social behaviour with respect to preservation of biodiversity of urban areas despite the strong anthropogenic impact.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-4	0.5	Lecture	Critical conversation and discussion	Records related to active participation in conversations and discussions	5	10
1-4	1	Seminar	Flipped classroom, independent work and group work	Monitoring of students' performance at interpretations and assessment of seminar paper	15	20
1-4	1	Written exam	Preparation for written exam	Written exam	20	35
1-4	0.5	Oral exam	Preparation for oral exam	Oral exam	20	35
Total	**3**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)

	81-90 points: grade 4 (very good) **91-100 points: grade 5 (excellent)**		
Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	15	0
Course content / teaching units	• Urban ecology - definition, historical development and present significance. Urban planning and development strategies • The city as a specific ecosystem. Habitat ecology in urban areas. Pattern, dynamics and ecological effects of urbanisation • Biodiversity of plant and animal communities in urban areas. Adventive species • Risk assessment of floods and climate change in urban areas • Environmental impact studies. Flood protection. Construction of collectors and sewerage networks • Pollution monitoring. Methods of monitoring air, water and soil quality, environmental protection measures • Connecting culture and nature in cities. Parks and green areas • Megacities		
Recommended reading	Marzluff J.M., Shulenberger E., Endlicher W., Alberti M., Bradley G., Ryan C., ZumBrunnen C., Richter M., Weiland U. (2012) Applied urban ecology: a global framework. Blackwell Publishing Ltd. Simon U. (2008) Urban Ecology: An International Perspective on the Interaction Between Humans and Nature. Springer.		
Optional reading	Purger J.J. (2007) Priručnik za istraživanje bioraznolikosti duž rijeke Drave. Sveučilište u Pečuhu. WWF (2002) Waterway Transport on Europe's Lifeline, the Danube.		
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course. Attendance of lectures and seminars, and preparation of a seminar paper are obligatory.		
Exam passing procedure	The teacher evaluates the activities of students during the course and their achievements at final exam. Regular attendance of lectures entitles the students to obtain the teacher's signature for the course attendance. Upon successful preparation and presentation of the seminar paper, student proceeds with the written exam. Students' knowledge is assessed within written and oral exam.		
Main language of instruction; other languages	Croatian language		
Method of monitoring the quality and efficiency of teaching	The teacher continuously monitors the learning process and student achievement, thus determining and adapting his/her teaching. After the course, the teacher and students analyse the efficiency of the teaching process and carry out a survey to evaluate students' subjective impression about the teaching quality, all with the aim to improve future teaching.		

Course title	**Introduction to Scientific Research Methodology**
Code	
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	2
Course status	Elective
Course teacher	Assist. Prof. Dr. Lidija Begović
Associate teachers	Assist. Prof. Dr. Selma Mlinarić
Course entry requirements (Preceding courses)	
Course objective	To enable students to understand the basic concepts of scientific research work and to develop their skills required for independent preparation of a research paper.
Learning outcomes	1. Ability to determine the relation between research methodology and research results. 2. Ability to critically evaluate the importance of experimental design and application of statistical methods. 3. Ability to select appropriate methods and techniques to research a selected problem and to test the hypotheses. 4. Ability to assess and critically analyse scientific articles. 5. Skills in searching the bibliographic databases and in using reference management software.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	0.5	Lecture	Critical conversation and discussion	Records related to active participation in conversations and discussions	15	20
2-5	0.5	Practices	Work on the experimental task	Monitoring of student performance within experimental assignment	20	30
1-5	0.5	Written exam	Preparation for written exam	Written exam	10	20
1-5	0.5	Oral exam	Preparation for oral exam	Oral exam	15	30
Total	**2**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	0	15
Course content / teaching units	Lectures: • What is a hypothesis? The role of hypothesis in scientific research • How to design an experiment: what is a replica (technical, biological), experiment replication, control, variability • Experiments in controlled conditions, field experiments, field research. • Ethics and codes of ethics in research on humans and animals • Types of publications, bibliographic databases of scientific and professional papers, WOS, SCImago (SRJ), JCR • Citation, reference management software Practices: • Experiment design • Rules for preparation of master theses • Writing of scientific articles: styles, grammar • Presentation of research results: tables, graphs, figures • Working with reference management software (EndNote, Ref Manager, Mendeley), creating citation databases, searching of databases • Presentation of research at scientific conferences: oral presentation, poster		
Recommended reading	Quinn G.P., Keough M.J. (2002) Experimental Design and Data Analysis for Biologists. Cambridge University Press, Cambridge, UK. Silobrčić V. (2003) Kako sastaviti, objaviti i ocijeniti znanstveno djelo. Medicinska naklada, Zagreb.		
Optional reading	Glass D.J. (2014) Experimental Design for Biologists. 2nd ed. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY. Optional reading list will be selected from the latest scientific publications referring to the topics of students' interest.		
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.		
Exam passing procedure	During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After lectures and practices, students take a written exam and then an oral exam. Points gained at written and oral exam are added to the points gathered up to the final exam, thus making a total number of points to be converted to final grade.		
Main language of instruction; other languages	Croatian language, English language		
Method of monitoring the quality and efficiency of teaching	Survey on the subjective impression about the organisation of the course will be carried out after the course; during the course, students will be given an opportunity to make oral or written remarks; the teacher monitors students' success at exams.		

Course title	**Protected Areas**
Code	ZPIO-I09
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	III semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assist. Prof. Dr. Dubravka Špoljarić Maronić
Associate teachers	Assist. Prof. Dr. Filip Stević
Course entry requirements (Preceding courses)	
Course objective	To enable students to understand the concept of protected areas within sustainable management and preservation of natural and cultural heritage, so that they can form their own solutions to current problems and challenges in nature and environmental protection.
Learning outcomes	1. Knowledge about the concept of protected areas and their management for the purpose of long-term nature and ecosystem conservation. 2. Knowledge about international and national categories of protection, and management structure of protected areas. 3. Skills required for cooperation and communication with experts and other stakeholders dealing with nature and environmental protection. 4. Ability to critically analyse professional and scientific papers, different approaches, legal regulations and documents related to nature protection.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-3	0.5	Lecture	Critical conversation and discussion	Records related to active participation in conversations and discussions	5	10
1-4	1.5	Seminars	Case studies and group discussion	Monitoring of student performance	25	40
1-4	0.5	Written exam	Preparation for written exam	Written exam	15	25
1-4	0.5	Oral exam	Preparation for oral exam	Oral exam	15	25
Total	**3**				**60**	**100**

Final grade:
60-70 points: grade 2 (sufficient)
71-80 points: grade 3 (good)
81-90 points: grade 4 (very good)
91-100 points: grade 5 (excellent)

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**

Hours - total	15	15	0
Course content / teaching units	Lectures: • The concept of protected areas - origin and development • The role and importance of protected areas - fundamental phenomena of protection • Protected areas in Croatia • IUCN categories and international proclamations • Development of protection measures in protected areas • Monitoring and research in protected areas • Visiting and recreational activities in protected areas • Protection of plant and animal species in protected areas • Protected areas and local communities - sustainable development of the area Seminars: • National parks, nature parks and internationally protected areas in Croatia • Protected areas in the world - an overview and basic characteristics • Analysis of the structure, organisation and management of protected areas on the examples of nature parks of Kopački Rit and Papuk		
Recommended reading	Dudley N. (2008) Guidelines for Applying Protected Area Management Categories. IUCN, Gland, Switzerland. Martinić I. (2010) Upravljanje zaštićenim područjima prirode - planiranje, razvoj i održivost. Šumarski fakultet, Sveučilište u Zagrebu, Zagreb. Worboys G.L., Lockwood M., Kothari A., Feary S., Pulsford I. (2015) Protected Area Governance and Management. ANU Press, Canberra.		
Optional reading	Chape S., Blyth S., Fish L., Fox P., Spalding M. (2003) 2003 United Nations List of Protected Areas. IUCN, Gland, Switzerland and Cambridge, UK and UNEP-WCMC, Cambridge, UK. UNEP-WCMC (2018) 2018 United Nations List of Protected Areas. Supplement on protected area management effectiveness. UNEP-WCMC, Cambridge, UK. Recent professional and scientific publications and legal documents related to the course topics.		
Conditions for obtaining teacher's signature	Active participation in lectures and fulfilment of all assignments within the course.		
Exam passing procedure	During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. After the lectures and seminars, students take the written exam, and proceed to the oral exam. The final grade is determined according to the number of points achieved at written and oral exam and the number of points gained during lectures and seminars.		
Main language of instruction; other languages	Croatian language, English language		
Method of monitoring the quality and efficiency of teaching	Making reviews during lectures; Carrying out of a student survey to obtain remarks and comments referring to organisation and realisation of teaching after the course; Monitoring of students' success at exams.		

Course title	**Nature and Environment Protection in Education**
Code	ZPIO-I18
Study programme	Graduate University Study Programme in Nature and Environmental Protection
Semester	IV semester
Workload/ECTS credits	3
Course status	Elective
Course teacher	Assist. Prof. Dr. Irena Labak
Associate teachers	
Course entry requirements (Preceding courses)	
Course objective	To develop students' skills for active engagement in schools and community, with the aim to raise awareness of the need to protect nature and environment, to design appropriate and innovative solutions, and to contribute to protection by establishing partnership relations with schools, and to contribute to education of pupils to become responsible members of a society based on sustainability.
Learning outcomes	1. Ability to determine pupils' attitudes and their awareness of the need to preserve nature, to maintain natural balance and biological diversity in their surroundings, as well as in Croatia and worldwide. 2. Ability to identify ways by which pupils determine threats to nature, and potential dangers associated with everyday life activities for the immediate environment in which they live, as well as for nature on Earth. 3. Development of natural science literacy by applying scientific methodologies in problem-solving and in decision-making processes regarding nature protection. 4. Ability to design a workshop as a form of learning/teaching with the aim to implement nature protection actions. 5. Ability to discuss the importance of cooperation between schools and local community, and to make a proposal for their partnership focused on nature and environmental protection with an emphasis on sustainable development.

Link between learning outcomes, teaching and students' activities

Learning outcome	Share of ECTS	Form of teaching	Activities of learning and teaching	Assessment		
				Methods of monitoring and evaluation	Grading Points	
					min	max
1-5	1	Lecture	Critical conversation and discussion about teaching methodology (outcome 1-2); Flipped classroom: analysis of relevant curricula (outcome 3-4); collaborative learning and debate by analysing different types of information sources (outcome 5)	Records related to active participation in discussions and in analysis, and in collaborative learning	15	20

	1-5	1	Seminar	Planning of inquiry-based learning, workshop	Analysis of proposal for inquiry-based learning and analysis of activities at the workshop	20	35
	1-5	0.75	Written exam	Preparation of a workshop	Simulation of a workshop	20	35
	1-5	0.25	Oral exam	Preparation for oral exam	Oral exam	5	10
	Total	**3**				**60**	**100**
	Final grade: **60-70 points: grade 2 (sufficient)** **71-80 points: grade 3 (good)** **81-90 points: grade 4 (very good)** **91-100 points: grade 5 (excellent)**						

Consultation hours	By appointment		
Teaching	**Lectures**	**Seminars**	**Practices**
Hours - total	15	15	0
Course content / teaching units	• Research methods in education (survey, interview) • National curriculum, subject curricula, curricula of interdisciplinary topics • Educational areas, natural sciences, forms of opinion, types of literacy with emphasis on natural science literacy, domains in prescribed curricula • Inquiry-based learning (definition of problems, setting up of hypotheses, planning and implementation of research, analysis of obtained results and drawing of conclusions), rules for workshop organisation, debate • Nature Protection Act, Environmental Protection Act, Natura 2000, protection categories (national parks, strict reserves, nature parks, etc.) • Sustainable development: concept and components of sustainable development, education for sustainability, pedagogical principles of education for sustainable development, student and teacher competencies for sustainable development		
Recommended reading	Cohen L., Manion L., Morrison K. (2007) Metode istraživanja u obrazovanju. Naklada Slap. Gabel D.L. (1994) Handbook of Research on Science Teaching and Learning, New York: Macmillan. Graef B. (1994) Environmental Inquiry for Students and Teachers. Grassroots.		
Optional reading	Agencija za odgoj i obrazovanje (2011) Obrazovanje za održivi razvoj. Priručnik za osnovne i srednje škole. Zagreb. Gardner M., Greeno J.G., Reif F., Schoenfield A.H., DiSessa A., Stage E. (eds.) (1990) Toward a Scientific Practice of Science Education. Hillsdale, NJ: Erlbaum. Hogan K. (1994) Eco-Inquiry. Iowa: Kendall/Hunt Publishing Company.		
Conditions for obtaining teacher's signature	Students are obliged to participate in lectures actively and to fulfil all assignments within the course.		
Exam passing procedure	During the course, the teacher monitors and evaluates the activities of students by awarding points according to determined criteria. The teacher thus provides continuous feedback, which students use to assess their learning progress with the aim to improve their learning process and professional development. At the end of the course, students shall simulate the independently prepared workshop, upon which they proceed with the oral exam. During the oral exam, the teacher asks questions that are related to learning		

	outcomes. The final grade is determined according to the number of points that students collected during the course, for the workshop simulation and at the oral exam.
Main language of instruction; other languages	Croatian language
Method of monitoring the quality and efficiency of teaching	During the course, the teacher performs evaluation for learning by continuous monitoring of the learning process and student achievement, thus determining and adapting his/her teaching. After the course, the teacher conducts a survey among students to evaluate their subjective impression about the teaching quality, all with the aim to improve future teaching.