CONSERVATION BIOLOGY, doctoral study programme, third Bologna cycle

Compulsory and elective course descriptions

COMPULSORY COURSES

Course name: **RESEARCH METHODOLOGY**
Number of ECTS credits: **10**

Content:
The course provides basic knowledge and tools for students to understand, plan and conduct research in the field of biological sciences, and to present their findings in the form of written and oral communications. The course is a prologue to the cycle of the research processes including conceptualization, information searching, evaluation, analysis, report-writing and presentation technique. It addresses underpinnings of research design, among them the issues of validity, reliability, scientific rigour and ethics.

Main topics:
- science: definition and characteristics; classification of scientific disciplines,
- the process of knowledge creation and production of scientific knowledge,
- information types in science: primary, secondary and tertiary information; evaluation of information,
- information/literature search and review; bibliographic on-line search engines,
- planning research: problem formulation and hypothesis creation, research design, scientific rigour,
- sampling and data collection, data analysis and interpretation; possibilities and limitations of quantitative and qualitative research,
- types of scientific communication,
- principles and rules of scientific writing and self-editing,
- communicating science: oral presentations, poster presentations,
- ethics in science.

The course can be taught in Slovene or English, thus enabling students to improve their knowledge of English, the language in which we provide most scientific information.

Course name: **SEMINAR**
Number of ECTS credits: **10**

Content:

Within the course, the student must study in detail the previous literary and scientifically based data from the field he has chosen together with the mentor. The emphasis will be on specific research that covers various aspects of conservation biology and is conceptually and substantively related to it.
Before starting the practical work on the doctoral dissertation, students must prepare as much as possible and get acquainted with the basic information and results of scientific research in the selected field of conservation biology. This will make it easier for the student and the mentor to decide to research a specific problem in the chosen field.

Course name: **INDIVIDUAL RESEARCH WORK 1**
Number of ECTS credits: **20**

Content:

- opredelitev teme doktorske disertacije
- izbira raziskovalnega problema
- priprava raziskovalne hipoteze
- pregled relevantne temeljne literature
- preverjanje stanja raziskav na raziskovanem področju
- definiranje vrzeli v literature
- razvoj raziskovalnega načrta
- opredelitev znanstvene metodologije

Course name: **PREPARATION OF A DOCTORAL DISPOSITION**
Number of ECTS credits: **10**

Content:
The student prepares a disposition in accordance with the Rules on the Preparation and Defence of Doctoral Dissertations at the University of Primorska.

According to the regulations, the disposition of the dissertation must contain the following:

1) Title page with the name of the university and member institution, the name of the study programme, the first and last name of the candidate, the title of the proposed dissertation topic, which should be brief and concise and reflect the scientific problem, the first and last name of the proposed supervisor and possible co-supervisor, and the place and year;
2) Indication of the scientific field to which the expected original contributions of the dissertation relate;
3) Definition of the theoretical basis of the research;
4) Definition of the problems, objectives, and hypotheses or research questions of the dissertation;
5) Contribution to science and expected results;
6) Planned research methods and sample;
7) The structure or outline of the proposed content of the dissertation;
8) List of basic literature and sources;
9) Ethical approvals for the research, if required.

In addition to the above, the candidate prepares a CV, focusing on his/her scientific research and professional work, and a bibliography. Other approvals and other formalities are addressed in the above regulations.

Course name: **INDIVIDUAL RESEARCH WORK 2**
Number of ECTS credits: **30**

Content:
As part of the course, the students will engage in planning and conducting research that will be the topic of their dissertation. Their work will include:

- collection of research data in the field, in the cabinet or in the laboratory and preliminary preparation of the results,
- based on the preliminary results, students will work with the tutor to evaluate the progress and, if necessary, modify the course of the research work,
- in parallel with the research work, the students will collect and acquire knowledge from published sources and prepare a literature review,

presentation and discussion of the preliminary results to colleagues and other representatives of the academic and research community.

Course name: **INDIVIDUAL RESEARCH WORK 3**
Number of ECTS credits: **60**

Content:
The course includes the completion of the results obtained and their final analysis for the preparation of doctoral theses and scientific publications
- completion of the research results,
- preparation of the final results,
- presentation and discussion of the final results to colleagues and other representatives of the academic and research community,
- preparation of a review scientific article or meta-analysis,

Course name: **INDIVIDUAL RESEARCH WORK 4**
Number of ECTS credits: **30**

Content:
The course will include the preparation of a PhD dissertation and preparation of scientific publications:
- finalization of the research for the PhD dissertation,
- publication of a scientific article (s).

Course name: **INDIVIDUAL RESEARCH WORK – PREPARATION AND DEFENSE OF DOCTORAL DISSERTATION**
Number of ECTS credits: **30**

Content:
The course will include the preparation of a PhD dissertation in line with the standards of scientific writing in natural sciences and defense.

ELECTIVE COURSES

Course name: **CONSERVATION PARASITOLOGY**
Number of ECTS credits: **10**

Content:
Main topics:
- introduction to conservation parasitology,
- the effect of parasites on the food web,
- the effect of parasites on biodiversity,
- host-parasite coevolution,
- endangered parasite species,
- protection of parasitic biodiversity,
- medically and veterinary important parasites,
- principles of disease, epizootiology, epidemiology and microbiology,
- basics on microbiology (bacteria, viruses, viroids, prions and fungi),

- overview and bionomy of medically important insect vectors and arachnids (sand flies, mosquitoes, ticks and others),
- global parasite eradication programs,
- field and laboratory work: visit to the field study area and a captive holding center (game farm),
- methods of determining the parasites (field and laboratory techniques),
- methods for sampling the pathogens and their vectors,
- interactions between host species and pathogens,
- introduced species as disease factors,
- examination of various parasites and vectors in the laboratory.

In addition to lectures and tutorials, students will have the opportunity to be engaged in current research projects in epizootiology and parasitology. Topics new to students will be followed by practical examples so that students will be able to understand them independently

Course name: **CONSERVATION ECOLOGY**
Number of ECTS credits: **10**

Content:
Main topics:
Patterns, causes, and consequences of biodiversity:
- patterns of biological diversity,
- biodiversity and ecosystem functioning.

Species interactions
- population growth and density dependence,
- the fundamentals of predator-prey interactions,
- selective predators and responsive prey,
- the fundamentals of competitive interactions,
- species coexistence and niche theory,
- intra/interspecific competition,
- mutualism and facilitation,
- parasitism.

Food webs, ecological networks and community assembly:
- species interactions in ecological networks,
- food chains and food webs.
- community assembly and species traits

Spatial Ecology: metapopulations and metacommunities
- patchy environments, metapopulations and fugitive species,
- metacommunities,
- ecological niche and its implication in predicting habitat suitability and potential distribution.

Ecology and evolution
- Species in variable environments

Evolutionary community ecology

Course name: **SYSTEMATICS AND EVOLUTION OF SELECTED TAXONOMIC GROUPS**
Number of ECTS credits: **10**

Content:
Selected taxonomic groups
The content of the course will follow a student's individual programme that fits into his/her topic of doctoral thesis and will focus on a chosen taxonomic group (plant, animal or other taxonomic group).

Different aspects will be covered:
- overview of a broader taxonomic group,
- evolution of the selected group,
- morphological and physiological peculiarities and characteristics of a group,
- reproduction,
- ecology.

Overview of different approaches to systematics (morphology, anatomy, ecology, ontogeny, cytogenetics, biochemistry).

Evolutionary perspective:
Special focus will be held on evolutionary history and newest knowledge on phylogeny and phylogeography of a chosen group/species. Different approaches of molecular taxonomy that try to solve the taxonomy and systematics of a given group will be stressed.

Students will have the chance to choose an appropriate lecturer who covers a taxonomic group he/she will be focused on during the doctoral study. Specific topics will be determined according to the students' needs.

Course name: **MOLECULAR MARKER IN GENOMIC ERA**
Number of ECTS credits: **10**

Content:
The course will be focused on acquiring basic knowledge in the genomics and epigenomics, which is necessary for understanding how wildlife species genomes adapted to the change in enviroment.

Main topics:
- molecular markers in management and conservation,
- barcoding and species identification,
- genomic rescue,
- inbreeding and loss of genetic variation in small populations,
- conservation units thorough genomic data,
- estimating gene flow with molecular markers,
- parentage analyses with SNPs,
- estimating effective population size,
- detecting of genetic bottlenecks,
- analysis of gene expression in population conservation,
- epigenomics,
- paleogenomics,
- enviromental DNA and other metagenomics approaches,
- genomics and society,
- approaches of conservation genomics – project work with specific software tools.

Course name: **CONSERVATION AND MANAGEMENT OF LARGE MAMMALS**
Number of ECTS credits: **10**

Content:

The course will be focused on acquiring basic knowledge in the field of ecology of wildlife, which is necessary for understanding the need, goals and principles of the management of wildlife populations as an important renewable natural resource.

Main topics:

- **populations of wildlife and their characteristics** (population size/density, spatial distribution of individuals, sex and age structure, natality and mortality, immigrations and emigrations, population dynamic, environmental resistance, compensatory mortality),
- **methods for determination (assessment) of population size** (census, sampling methods, control methods with indicators in adaptive management, modern technologies for distant censusing/registering of individuals),
- **carrying capacity** (ecological, economical and socio-political carrying capacity),
- **inter- and intra-specific interactions** (parasitism, predation, competition, induced competition with alien species; sexual relationship, cannibalism, social behaviour, territoriality),
- **basis of ecology/biology of the keystone large mammalian species: wild ungulates, carnivores** (reproductive potential, spatial behaviour, feeding ecology, variability of body mass, demographic structure and age assessment),
- **conflicts between humans and wildlife in cultural landscape** (traffic collisions; damages in agriculture and forestry; mitigation measures for reducing conflict situations),
- **wildlife in urban environment** (trends, conflicts, public attitudes, management alternatives),
- **(invasive) alien game species** (alien species in Slovenia and in region, causes for and consequences of the spreading, countermeasures for reducing the problematic),
- **principles and methods of population management** (causes for and importance of systematic management, management goals, basic legislation, principles of game management in Slovenia and abroad, planning of the harvest),
- **Sustainable and conservation management of wildlife populations and their habitat** (principles, indicators, similarities and differences between sustainable and conservation management, habitat management / conservation as a component of management / conservation of wildlife populations, impacts of non-sustainable use of natural resources (e.g. over-hunting) on the condition of wildlife populations),
- **database and large national collections on wildlife in Slovenia and their importance** (hunting-information system, national collection of mandibles),
- **actual case studies on management of selected wildlife species in Slovenia and in Europe** (wild boar, red deer, European roe deer, brown bear, grey wolf, golden jackal, coypu etc.).

Course name: **CONSERVATION BIOLOGY OF LARGE MARINE VERTEBRATES**
Number of ECTS credits: **10**

Content:
Main topics:
Conservation Ecology of Large Marine Vertebrates

- Large marine vertebrates: evolutionary strategies and life histories of elasmobranchs, large pelagic fin fishes, sea turtles and marine mammals;
- Convergent evolution and adaptations to marine environment, physiological ecology and energetics;

- Taxonomy, diversity and biogeography of large marine vertebrates;
- Behavioral ecology, communication and population structure;
- Spatial ecology, navigation and movements;
- Reproductive biology and ontogeny of large marine vertebrates;
- Ecological roles of large marine vertebrates in shaping marine ecosystems structure and dynamics.

Threats, Status and Conservation
- Status of and threats to large marine vertebrates;
- Impact of fisheries and bycatch on large marine vertebrates;
- Impact of habitat loss and habitat degradation;
- Climate changes and impacts on large marine vertebrate populations;
- Impacts of extraction industries, including oil, gas and renewables, and tourism;
- Population health and diseases, impact of biomagnifying contaminants;
- Application of population dynamics and modeling to large marine vertebrates management;
- Ecosystem based approach to conservation of large marine vertebrates and multispecies conservation strategies;
- Marine protected areas and transboundary conservation of large marine vertebrates;
- Legislative approaches to conservation of large marine vertebrates and international convention;
- Human dimension of large marine vertebrates conservation and impact of science on conservation policy;
- Captivity and conservation of large marine vertebrates.

Research Methods for Large Marine Vertebrates
- Experimental design and field surveys;
- Population abundance estimate methods;
- Population trend analysis and modeling;
- Sampling methods and analysis in feeding ecology studies;
- Sampling methods and analysis in reproductive biology studies;
- Age and growth research methods for large marine vertebrates;
- Sampling methods and analysis in eco-toxicological and genetic studies;
- Remote tracking methods for studying movements and migrations;
- Spatial modeling and identification of critical habitats;
- Research methods in fishery interactions studies and bycatch mitigation tools;
- Methods for dynamic management of large marine vertebrate populations;
- Application of citizen science in study and conservation of large marine vertebrates.

Course name: **CONSERVATION SCIENCE, SOCIETY AND DECISION MAKING**
Number of ECTS credits: **10**

Content:
Whilst biology plays the primary role in identifying species of importance and areas of high biological diversity, conservation management requires other skills. Understanding societal and individual values towards nature provides a basis for analysing the development of conservation strategies, policy and legislation.

Main topics:
1. **Methods in social science**

The means to understanding social processes lies in the observation and investigation of the motivations of conservation stakeholders. Observations can take many forms, and investigations require interactions with the relevant stakeholder groups.

2. **Decision making science**

Decisions are made every minute of every day. Where so these decisions come from? If we can understand the underlying reasons for decisions we can influence decision makers and ensure rational decisions are made for conservation.

3. **Developing conservation strategies**

Historically most decisions for the conservation of species or the development of protected areas on an ad hoc basis, with little consistency and logic. The development of decision support tools, such as Marxan allows the user to systematically and consistently identify sites that provide for conservation at the lowest social cost.

4. Bridging organisations

While there is often biological information available to conserve species and habitats we are still failing to hit conservation targets and species are disappearing at an alarming rate in the Anthropocene. Translating science into policy requires new skills and institutions to ensure science fulfils the needs of policy and policy reflects science.

5. Engagement tools

Brochures, leaflet and radio announcements have now been replaced by social media, QR codes, infographics and chat bots. Engaging with the new stakeholder groups requires new skills and knowledge of new technologies.

6. Legislation

Knowing the law will ensure that the work that you undertake is legal and applicable. Understanding the interactions between international, macro-regional, national and local law will provide the basis for developing policies that are legally and morally defendable.

7. Emergent conservation strategies

New methods are being promoted as remedies for species extinction and averting habitat loss. How applicable are these methods? What are the underlying frameworks and how can they be applied for maximum conservation gain?

Course name: **PROCESSES, CHANGES AND PROTECTION OF MARINE ECOSYSTEMS**
Number of ECTS credits: **10**

Content:

Main topics:

Patterns, processes and recent changes in marine ecosystems

- The global carbon cycle and the concept of Biological Carbon Pump (BCP)
- The role of microorganisms (phytoplankton) in the BCP in terms of their structural and functional biodiversity
- Influence of anthropogenic stressors on marine biodiversity and processes: selected examples at the level of organisms, habitats and communities
- Spatial heterogeneity and cryptic biodiversity
- Dynamic biogeography: bioinvasion and tropicalisation of the Mediterranean Sea biodiversity
- Climate change and its impact on marine biodiversity
- Life strategies in term of reproduction, feeding and survival
- Evolutionary dynamics and metapopulation structuring in the marine realm; structural and functional connectivity; genetic structuring of marine populations, metabarcoding and eDNA; demographic and evolutionary interdependence between populations and marine biological communities.

Marine Ecology Research Methods

- Methods in phytoplankton ecology and approaches to assessing to assessing community change
- Nondestructive techniques in sampling marine biodiversity
- Mapping and monitoring habitat types
- Data collection and quantitative sampling in benthic studies

- Methods in feeding ecology and marine food webs studies
- Modern techniques to restore marine biodiversity
- Concept and importance of Genomics Observatories and modern approaches (sampling strategy, NGS, metabarcoding, eDNA, Nagoya protocol and genetic resources, public repositories and research infrastructures) in scientific research and marine biodiversity protection

Course name: **ANTHROPOGENIC IMPACTS ON ECOSYSTEMS – SELECTED TOPICS**
Number of ECTS credits: **10**

Content:
- man, human society as a factor in changing the environment
- anthropogenic impacts on non-living factors of the environment
- carrying capacity of environmental components, self-cleaning capacity, over exploitation, pollution and degradation
- the impact of environmental changes on ecosystems and ecosystem services
- the impact of climate change on ecosystems and ecosystem services
- invasive species as one of the anthropogenic threats to ecosystems and minimizing their impact on the environment.
- susceptibility of communities to invasions
- management of invasive species – prevention of new invasions and management of already established species trough policy and education
- use and interpretation of predictive models for invasions and risk assessment
- analysis, use and visualisation of model fields with different computer tools

Course name: **BIOINFORMATICS TOOLS IN CONSERVATION BIOLOGY**
Number of ECTS credits: **10**

Content:
The course will be focused on acquiring basic knowledge in
bioinformatics, which is necessary for understanding the principles and tools in conservation genomics and epigenomics.

Main topics:
- databases in bioinformatics, nucleic acid sequences, protein sequences, bibliographic information,
- tools for analysis of NGS data,
- genomic projects of model organisms (domestic relatives of wildlife), comparative genomics, identifying genes and regulatory regions of genomes, SNP analysis,
- bioinformatics tools in phylogenomics, arheogenomic, metagenomics,
- bioinformatics tools in transcriptomics,
- bioinformatics tools in proteomics,
- bioinformatics in metabarcoding (single-amplicon sequencing) – insight into ecology of specific taxa, populations and communities,
- applications: Bioinformatics in environmental genomics,
- applications: Bioinformatics in conservation and landscape epigenomics,
- ontologies and knowledge databases in bioinformatics,

bioinformatics approaches in conservation genomics –project work with specific software tools during the lectures and within seminar.

Course name: **STATISTICAL TOOLS IN CONSERVATION BIOLOGY**
Number of ECTS credits: **10**

Content:
Main topics:
In lectures and tutorials students will be theoretically and practically acquainted with basic tool for statistical analysis – R programme and the following regression and multivariate statistical techniques and ordinate techniques:

- multiple regression,
- time series analysis,
- basics of spatial statistics,
- principal components analysis (PCA),
- correspondent,
- canonical correspondences analysis,
- discriminative analysis,
- hierarchical classification,
- classification of the estimated number of clusters in advance.

Course name: **SPATIAL TOOLS IN CONSERVATION BIOLOGY**
Number of ECTS credits: **10**

Content:

Main topics:

Data collection

- introduction to different typologies of spatial data: data on species occurrence, environmental data, primary data (e.g. field observation data, remote sensing data), secondary (literature data, archive collections, web collections, etc.),
- data collections and data elaboration tools (GBIF, Worldclim, IUCN, ARSO etc.).

Data exploration

- displaying spatial data based on knowledge of coordinate systems and geographic projections,
- data exploration using GIS tools.

Data manipulation

- analysis of spatial data using GIS tools (e.g. definitions of ranges – measurement of the extent of occurrence and area of occupancy, accumulations of occurrences – grid analysis and density estimation, data extraction, analysis of protected areas),
- geostatistical analysis using GIS tools (e.g. spatial interpolations, spatial clustering, spatial patterns of variability, correlations, distances, zonal statistics),
- ecological niche modelling using correlative presence/absence and presence only models,
- ecological niche identification and evaluation using Monte Carlo statistics.

Results presentation and visualization

- presentation and interpretation of research results,
- evaluation of model results,
- graphical and tabular presentation of research results,
- thematic cartography.

Course name: **QUANTITATIVE METHODS IN SYSTEMATICS AND ECOLOGY**
Number of ECTS credits: **10**

Content:
Present interdisciplinary course covers methodology engaged in description of new species as well as in various fields of ecological studies of this study program.

Main topics:

- description of new species: methodology,

- morphometry:
  -classical morphometry,
  -geometric morphometry,

- water quality assessment:
  -hidromorphological parameters: methodology, analysis,
  -physical and chemical parameters: methodology, analysis,
  -biological methods and analyses (biochemical analysis, ecological analysis: diversity indices, saprobic index, biotic indices),

- methods in plant sociology

-methods in plant sociology, phytosociologial data, revision and classification of vegetation, syntaxonomy, and multivariate analysis.

- diet analysis and feeding ecology:
  -stomach contents, excrements contents, pellets content,
  -stable isotopes analyses (food chains, migrations),
  -tissue content of heavy metals and persistent organic pollutants and bioaccumulation through food webs,

- animal behaviour – data collection and analysis.

Students will have the chance to choose an appropriate lecturer who covers a methodology he/she will be focused on during the doctoral study. Specific topics will be determined according to the students' needs.