Universität Bremen

Universität Bremen

Master of Ecology Course Catalogue

Master of Ecology board of examiners
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THE MASTER OF ECOLOGY PROGRAMME

The Master of Ecology at the University of Bremen is a programme for European and Non-European students with a background in biology, ecology or a related subject. All courses are offered in English. The Master of Ecology is multidisciplinary and contains many innovative elements such as a mentoring programme, integrated skills courses, supporting online material, scientific projects, and individual research training.

CURRICULUM

The programme consists of 4 semesters (two years) including M.Sc.-thesis. Specialisation is offered with individual choice of courses, i.e. in Molecular, Behavioural, Population, Vegetation, and Soil Ecology, as well as Conservation Biology and Risk Assessment. Especially during the 3rd term, students have the possibility to study at one of our partner universities abroad.

THIS MASTER WILL PREPARE YOU FOR RESEARCH AND MORE

The Master of Ecology will provide you with a broad ecological background and will train you to become a critically thinking scientist. Not only will you get extensive research experience qualifying you for PhD studies and an academic career. The acquired scientific, technical and communication skills also open a wide array of additional opportunities. During the programme, you will become familiar with many techniques and approaches including field experiments, analysis of animal behaviour, sustainability research, advanced statistics, and modern genetic methods.

Time scheme of the Master of Ecology at the University of Bremen

Week 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Concurrent courses or semester break
1. Semester (Winter semester)														
Concepts of Ecology (Module 401, 3 CP)*	Experimental Design and Data Analysis (Module 402, 12 CP)*					Exam week	Earth Sciences (Module 403, 6 CP)*			Molecular Ecology (Module 404, 9 CP) + 1st week of semester break				Current Topics in Ecology 1 & Mentoring (Module 405, 3 CP)*
2. Semester (Summer semester)														
Population Ecology (Module 411, 9 CP)*				Behavioural Ecology (Module 413, 6 CP)			Vegetation Ecology and Conservation Biology (Module 415, 6 CP)			Ecological Excursion and Field Course (Module 417, 6 CP)		Soil and Ecosystem Ecology (Module 416, 6 CP) + 1st week of semester break		Marine Macroalgae and associated animals (Module 409, 6 CP, semester break)
				Research Project (Module 412, 12 CP)* (The project may be started in any of the blocks or after the teaching term)										
3. Semester (Winter semester)														
Ecophysiology (Module 503, 6 CP)			Microbiology of Terrestrial Ecosystems (Module 507, 6 CP)			Exam week	Grant Proposal and Defense (Module 502, 6 CP)			Spatial Data Analysis and GIS (Module 504, 6 CP)			Exam week	Introduction to Behavioural Ecology (Module 406, 3 CP) Biodiversity (Module 407, 3 CP) Environmental Risks and Ecotoxicology (Module 408, 3 CP) Current Topics in Ecology 2 & Mentoring (Module 505, 3 CP) Introduction to Ecological Modelling (Module 506, 3 CP; semester break) Coral Reef Ecology of the Red Sea (Module 508, 6 CP; semester break)
Sustainability Research (Module 501, 6 CP)														
4. Semester (Summer semester): Master Thesis and Defense (Module 510, 30 CP)*														

*- compulsory courses (401-405, 411, 412, 510)

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Name of Module (number)	**Concepts of Ecology** (401)
Person responsible for the module	Prof. Dr. Martin Diekmann
Lecturer/s	Prof. Dr. Martin Diekmann, Dr. Annette Kolb
Course titles / teaching form	Concepts of Ecology (Diekmann, Kolb) Lecture Seminar
Compulsory / Elective	Compulsory
Workload / Credit points	3CP Presence at the course: Lecture 8 h, Seminar 12 h, Review of lectures 24 h, Preparation of seminars 16 h, Individual studying:30 h
Learning outcome	A general overview of universal, modern concepts of ecology and their historical developments; knowledge of important hypotheses and methods to test these in different fields of ecology
Contents	Exemplary work on current concepts and questions in different subdisciplines of ecology: autecology (life forms, responses of species along resource gradients, distribution), population ecology (population growth and intraspecific competition, interspecific competition, plant-animal interactions), community ecology (biodiversity, energy flow and nutrient cycles), global change ecology (invasions, habitat fragmentation, climate change, nitrogen enrichment of ecosystems)
Assessment	Preparatory performance - Seminar presentation
Literature	Begon, Harper, Townsend: Ecology. Individuals, Populations and Communities, Blackwell

Name of Module (number)	**Experimental Design and Data Analysis** (402)
Person responsible for the module	Prof. Dr. Thomas Hoffmeister
Lecturer/s	Prof. Dr. Thomas Hoffmeister, Prof. Dr. Martin Diekmann
Course titles / teaching form	Experimental Design (Hoffmeister) — Lecture, Seminar Advanced Statistics (Hoffmeister, Diekmann) — Lecture, Seminar, Laboratories
Compulsory / Elective	Compulsory
Workload / Credit points	12 CP Presence at the course: Lecture 42 h, Seminar 7 h, Laboratories 81 h Individual studying: 230 h
Learning outcome	Knowledge of the basic approaches and possible pit-falls in experimental design; the ability to critically verify the adequateness of a chosen design as well as the capability to develop an adequate experimental design for an ecological research question. Knowledge of current univariate and multivariate statistical models and the competence to apply these to the research question at hand using R. Aptitude to interpret and present results from statistical models
Contents	The consequences of bad experimental design; formulation of hypotheses, manipulative experiments and correlative studies; replication, pseudoreplication and randomisation; controls, factorial and block designs, crossover and split-pot designs; bias of the measurement; General and generalised linear models with one or more continuous or factorial variables; GLMs with repeated measurements, generalised linear mixed models, nested models, model selection using backward optimization, MAM, Akaike and other criteria; Ordination (principal component analysis, correspondence analysis, canonical correspondence analysis), cluster analysis, Monte Carlo testing
Assessment	Preparatory performance — - Research proposal in text and presentation Examination — - Written or oral examination
Literature	Ruxton, Colegrave: Experimental design for the life sciences, OUP Knell: Introductory R: A Beginner's Guide to Data Visualisation and Analysis Using R Grafen, Hails: Modern Statistics for the Life Sciences, OUP Quinn, Keough: Experimental Design and Data Analysis for Biologists, Cambridge Zuur, Ieno, Walker, Saveliev. Smith: Mixed Effects Models and Extensions in Ecology with R Lepš, J. & Šmilauer, P. 2003. Multivariate analysis of ecological data using CANOCO. Cambridge University Press, Cambridge.

Name of Module (number)	**Earth Sciences** (403)	
Person responsible for the module	Dr. Thilo Eickhorst	
Lecturer/s	Dr. Thilo Eickhorst	
Course titles / teaching form	Basic Earth Sciences (Eickhorst) Basic Soil Analysis (Eickhorst)	Lecture + Seminar + Excursion Laboratories
Compulsory / Elective	Compulsory	
Workload / Credit points	6 CP Presence at the course: Lecture 48 h, Seminar 8 h, Laboratories 22 h, Excursion 18 h Individual studying: 84 h	
Learning outcome	Students should be able to - describe the formation and evolution of the earth and its structure from its core to the atmosphere. - outline the interactions of the geosphere, hydrosphere, atmosphere, and biosphere and explain the related processes of geomorphology, climatology, and soil formation.. - discuss the role of these processes in the context of dynamics and anthropogenic influences over periods of years, decades and centuries. - illustrate the pedosphere as a central element of ecosystems and as a complex system including its chemical, physical, and biological properties and its role of ecological functioning related to nutrient cycling, soil aeration and soil moisture. - apply basic lab techniques to describe soils as site factors and interpreting their potentials. - interpret thematic maps with respect to spatial data of above ground features. - document and discuss lab data in a short report.	
Contents	This module will introduce the basics of processes related to geological development of the Earth, formation of rocks and the aboveground with focus on terrestrial ecosystems. The following contents will be addressed: - Geological processes, magmatic and volcanic rock, sediments, metamorphic rock, plate tectonics, geological eras, ice ages - Geomorphology, landscape formation, glacial series - Climatology, ocean and atmospheric circulation, hydrological balance - Field- and ecological climatology - Moor, marshland, wetlands, moraine, loess - Soil formation, pedogenesis, soil types, soil evaluation - Soil classification and description - Nutrient cycling, organic matter, fertilization Methods for the evaluation of natural site conditions will be presented including the use of thematic maps. Basic soil parameters will be analysed in the lab. Climatological measurements and soil description will be done in the field.	
Assessment	Preparatory performance Examination	- no - Written examination (70 %) - Lab report (30 %)
Literature	Brady, Weil: Elements of the Nature and Properties of Soils, Pearson Kump, L R, Kasting, J F & Crane, G The Earth System Press, Siever: Understanding Earth, Freeman Rowell, Soil Science: Methods & Applications, Prentice-Hall Strahler: Introducing Physical Geography, Wiley	

Name of Module (number)	**Molecular Ecology** (404)	
Person responsible for the module	Dr. Marlis Reich	
Module unit 1 Course title	Principles and Tools of Molecular Ecology (404)	
Lecturer/s	Dr. Marlis Reich	
Compulsory / Elective	Compulsory	
Workload / Credit points	3 CP Presence at the course: Lecture 28 h Individual studying: 62 h	
Learning outcome	• Illustration of basic molecular biological rules • Classification of molecular markers • Evaluation and illustration of molecular tools in the context of ecological research • Interpretation of results from molecular ecological research	
Contents	• Basics of molecular biology: -Structure of genomes -Organization of genes -Transcription, translation, replication -Mutation pattern • Tools of molecular ecology • Molecular markers • Phylogenetic reconstructions	
Assessment	Examination	Written examination
Literature	Beebee, Rowe; Molecular Ecology; Oxford University Press Clark, David P. (2006) Molecular Biology. Spektrum Akademischer Verlag, Heidelberg Nei, Kumar; Molecular Evolution and Phylogenetics; Oxford University Press	
Module unit 2 Course title	Molecular Community Analysis (404a)	
Lecturer/s	Dr. Marlis Reich	
Compulsory / Elective	Compulsory	
Workload / Credit points	6 CP Presence at the course: Lectures 25h, Seminar 25 h, Laboratories 60 h Individual studying: 70 h	
Attendance	mandatory premise for participation at each laboratory unit is the knowledge about the respective safety regulations and operational procedure that is checked in brief oral tests Regelmäßiges Abfragen der Sicherheitsvorkehrungen und Arbeitsablaufes für die einzelnen Labortage als Teilnahmevoraussetzung	
Learning outcome	• Performance of biodiversity analysis using molecular biological tools • Evaluation of strength and pitfalls of different analysis tools • Performance and organization of molecular biological experiments in the laboratory • Documentation, evaluation and interpretation of lab experiments in a scientific written form • Outline, presentation and judgment of work in scientific papers dealing with community analysis/metagenomics	

Contents	• Principles of work in molecular biological laboratories • Genomic DNA isolation and purification • Principles of polymerase chain reaction (PCR) • Techniques for the identification of species/community analysis: -Cloning/Sanger-sequencing -Phylogenetic reconstruction -Restriction Fragment Length Polymorphism (RFLP)	
Assessment	Preparatory performance	• Seminar presentation • Protocol
Literature	Nicholl; Genetic Engineering; Cambridge University Press	

Name of Module (number)	**Current Topics in Ecology 1 and Mentoring** (405)
Person responsible for the module	Prof. Dr. Juliane Filser
Lecturer/s	Prof. Dr. Thomas Hoffmeister, Prof. Dr. Martin Diekmann, Prof. Dr. Juliane Filser, Prof. Dr. Uwe Nehls, Dr. Marlis Reich, Dr. Andra Thiel
Course titles / teaching form	Ecological Seminar (Filser, Diekmann, Hoffmeister, Nehls, Reich, Thiel) Seminar Comprehensive Writing (Filser, Diekmann, Hoffmeister, Nehls) Seminar Mentoring (Filser, Diekmann, Hoffmeister, Nehls, Reich, Thiel) Seminar
Compulsory / Elective	Compulsory
Workload / Credit points	3 CP Presence at the course: Seminars 28 h Individual studying: 38 h Essay 24 h
Learning outcome	*Ecological seminar*: Students gain knowledge of current research questions in ecology; they develop the ability to critically assess research approaches and to discuss them in English; *Comprehensive Writing*: they achieve the competence to analyse research presented in original research papers, to extract the essence and to present the essential aspects in consisley written text, *Mentoring*: students develop a personal study profile and gain competence in planning course portfolios and research work fitting into their career goals
Contents	*Ecological seminar*: current research results, presented by invited speakers in the seminar *Comprehensive Writing*: recent publications of research results in international, peer-reviewed professional journals *Mentoring*: target-aimed counselling towards a study profile regarding professional qualifications
Assessment	Preparatory performance - Discussion contributions in seminars Examination - Essay
Literature	Recent research literature in professional ecological journals

Name of Module (number)	**Introduction to Behavioural Ecology** (406)
Person responsible for the module	Prof. Dr. Thomas Hoffmeister
Lecturer/s	Prof. Dr. Thomas Hoffmeister
Course titles / teaching form	Introduction to Behavioural Ecology (Hoffmeister) Seminar
Compulsory / elective	Elective
Workload / Credit points	3 CP Presence at the course: Seminar 28 h, Preparation of seminar: 40 h, Preparation of oral presentation 22 h
Learning outcome	Students learn to explain concepts of behavioural ecology; they understand behaviour as trait under natural selection and are able put this into context; they gain the competence to derive hypotheses from these concepts and develop research approaches; they understand the evolutionary foundations of different mating systems, the selective forces operating on group living and group size, and on cooperative behaviour, they achieve the ability to explain and present the concepts as oral presentation and to defend scientific arguments in group discussions
Contents	1. Natural selection, ecology and behaviour, 2. Testing hypotheses in behavioural ecology, 3. Economic decisions, 4. Predator prey evolutionary arms races, 5.Competition, 6. Group living, 7. Sexual selection, competition and sexual conflict, 8. Parental Care, 9. Mating systems, 10. Sex allocation, 11. Social behaviour, 12. Cooperation, 13. Altruism and conflict in social insects, 14. Communication and signals
Assessment	Preparatory performance Active participation in discussions Examination Seminar presentation
Literature	Davies, NB, Krebs, JR, West, SA, An Introduction to Behavioural Ecology, 4th ed., Wiley-Blackwell

Name of Module (number)	**Biodiversity** (407)
Person responsible for the module	Prof. Dr. Martin Diekmann
Lecturer/s	Prof. Dr. Martin Diekmann, Prof. Dr. Juliane Filser
Course titles / teaching form	Biodiversity (Diekmann, Filser) Lecture Seminar
Compulsory / elective	Elective
Workload / Credit points	3 CP Presence at the course: Lecture 14 h, Seminar 14 h, Preparation of seminar: 24 h, Review of lectures 14 h, Preparation for oral exam 24 h
Learning outcome	The lecture presents basic concepts of biodiversity which are exemplified in the seminar based on current scientific literature. The focus will not only be on the study of biodiversity patterns, but also on the archiving and documentation of information. An objective is also to reflect on the importance of biodiversity for ecosystem functions and services in a societal context.
Contents	1. Basic definitions of the concept of biodiversity, 2. Changes in biodiversity through time and the history of biodiversity research, 3. Spatial and temporal patterns of biodiversity and their ecological reasons, 4. Biodiversity and ecosystem functions, 5. Biodiversity in the face of global change, 6. Methods of biodiversity research, 7.Biodiversity and society.
Assessment	Preparatory performance no Examination: portfolio Seminar presentation (30%), oral examination (70%)
Literature	Gaston, K.J. & Spicer, J,I. 2004. Biodiversity. An introduction. 2. ed. Blackwell. Baur, B. 2010. Biodiversität. Haupt / UTB.

Name of Module (number)	**Environmental Risks and Ecotoxicology** (408)
Person responsible for the module	Prof. Juliane Filser
Lecturer/s	Prof. Juliane Filser, Dr. Stefan Stolte
Course titles / teaching form	Environmental Risks and Ecotoxicology Lecture Seminar
Compulsory / elective	Elective
Workload / Credit points	3 CP Presence at the course: Lecture 14 h, Seminar 14 h, Preparation of seminar: 30 h, Individual studying 32 h
Learning outcome	Overview on most relevant environmental hazards, knowledge how to assess mode of action and potential risks (a priori) under varying environmental conditions, overview on analytical methods in chemistry and understanding of their importance in risk assessment, basic understanding of risk assessment and regulation, critical view on associated potentials and limitations.
Contents	Hazardous substances, emission, environmental behaviour, bioavailability, acute and chronic exposition, biomagnification, principles of ecotoxicological test systems (from molecules to model ecosystems), modes of action and test endpoints, toxicodynamics, biomarkers, thinking in terms of structure-activity relations (T-SAR), persistency, bioaccumulation, biodegradation, data availability and uncertainty, environmental monitoring, chemicals regulation, legal aspects.
Assessment	Preparatory performance - Seminar presentation - Discussion contributions in seminars Examination Written or oral examination
Literature	Walker, C.H., Hopkins, S.P., Sibly,R.M., Peakall, D.B. (2001): Principles of Ecotoxicology. Taylor & Francis Newman, M.C. (2010): Fundamentals of Ecotoxicology. CRC Press Van Leeuwen, C.J., Vermeire, T.G. (2007): Risk Assessment of Chemicals: An Introduction. Springer, Dordrecht Alloway, B.J., Ayres, D.C. (1997): Chemical principles of environmental pollution. Chapman & Hall, London Spiro, T.G., Stigliani, W.M. (1996): Chemistry of the Environment. Prentice-Hall, London In German: Breckling,B., Müller,F. (2000): Der ökologische Risikobegriff. Peter Lang, Frankfurt/Main Fent, K. (2007): Ökotoxikologie. Thieme, Stuttgart – New York Jastorff, B., Störmann, R., Wölcke, U. (2003): Struktur-Wirkungsdenken in der Chemie. Universitätsverlag Aschenberg & Isensee, Bremen – Oldenburg Internet Sources: http://www.eea.europa.eu/publications/environmental_issue_report_2001_22 **(EEA Report „Late Lessons from Early Warnings“, 2000)** http://www.reach-info.de/ **(EU chemical legislation)** http://www.oecd.org/department/0,3355,en_2649_34377_1_1_1_1_1,00.html **(Guidelines for the testing of chemicals)** http://cfpub.epa.gov/ecotox/ **(Ecotoxicology database)** http://toxipedia.org/display/toxipedia/Toxipedia

Name of Module (number)	**Marine Macroalgae and Associated Animals** (409)
Person responsible for the module	Prof. Dr. Thomas Hoffmeister
Lecturer/s	Dr. Inka Bartsch, Dr. Lars Gutow,
Course titles / teaching form	Marine macroalgae and associated animals Seminar Excursion/field course (choice between different project offers)
Compulsory / Elective	Elective
Workload / Credit points	6 CP Presence at the course: Seminar: 14 h, Excursion/field practical: 93 h, individual study: 73 h
Learning outcome	Students obtain insights into the general ecology of rocky reefs and the taxonomy of temperate shore biodiversity. They develop the competence in studying rocky shore communities taxonomically and quantitatively and to develop experimental designs for ecological studies in these habitats.
Contents	Annual 12 days spring excursion to the island of Helgoland (North Sea) with emphasis on the taxonomic identification of major benthic macroalgae and associated animals (first 5 days). Subsequently (second week), group work on specific projects that aim to investigate interactions between seaweeds and invertebrates, to quantify rocky shore biodiversity and abundance of selected intertidal and subtidal benthic habitats, and to investigate reproductive traits in seaweeds. The biology and ecology of major groups of seaweeds and invertebrates will be presented during the first week of the course in oral presentations that students prepare prior to the course. Results and discussion of projects are presented in groups in form of oral presentations by the end of week 2.
Assessment	Oral presentation of selected themes which have been chosen prior to the beginning of the course - Seminar Oral presentation after termination of experimental unit - Excursion/field course Drawings of algae and animals
Literature	Scientific papers (for oral presentations), field guides available at Helgoland (for excursions and taxonomic identification of species)

Name of Module (number)	**Population Ecology** (411)
Person responsible for the module	Prof. Dr. Thomas Hoffmeister
Lecturer/s	Prof. Dr. Thomas Hoffmeister, Prof. Martin Diekmann, Dr. Annette Kolb
Course titles / teaching form	Population Ecology (Hoffmeister, Diekmann, Kolb) Lecture Laboratories
Compulsory / Elective	Compulsory
Workload / Credit points	9 CP Presence at the course: Lecture 30 h, Seminar 16 h, Laboratories 66 h Individual studying: 158 h
Learning outcome	Knowledge of and the ability to explain important concepts of population ecology, the aptitude to test these concepts experimentally, competence in gathering, analysing and presenting data
Contents	Factors of demography: life cycles and life tables; survivorship curves; distribution and dispersal; methods in the estimation of population size; genetic variation and population genetics, inbreeding, outbreeding and asexual reproduction; evolutionary and ecological genetics; population growth, intraspecific competition, density dependence, self-thinning and population dynamics; interspecific competition, species interactions and models of interspecific competition; niche differentiation and partitioning, temporal and spatial aggregation and coexistence; stage specific interspecific competition, apparent competition; predator-prey systems, food choice, functional responses, population cycles and models; regional dynamics; metapopulations; invasive species, nature conservation and population viability analysis; demographic models
Assessment	Preparatory performance - Data analysis and summary of laboratories Examination - Written examination
Literature	Begon, Harper, Townsend: Ecology, Blackwell Silvertown, Charlesworth: Introduction to Plant Population Ecology, Blackwell Townsend, Harper, Begon: Essentials of Ecology, Blackwell Krebs: Ecological Methodology, 2nd ed., Addison Wesley Longman

Name of Module (number)	**Research Project** (412)
Person responsible for the module	Prof. Dr. Thomas Hoffmeister
Lecturer/s	Prof. Dr. Thomas Hoffmeister, Prof. Dr. Martin Diekmann, Prof. Dr. Juliane Filser, Prof. Dr. Uwe Nehls, Dr. Marlis Reich, Dr. Andra Thiel
Course titles / teaching form	Research Project (Diekmann, Filser, Hoffmeister, Nehls, Reich, Thiel) Seminar Laboratories
Compulsory / Elective	Compulsory
Workload / Credit points	12 CP Presence at the course: directed laboratory or field work 56 h Individual studying and laboratory work: 304 h
Learning outcome	Mostly independent execution of a small scientific project in group work. This way, students will experience the entire procedure of a scientific work from the stage of planning and testing of methods, to the practical execution. Ideally, a student projects ends with the submission of a manuscript to a peer-reviewed journal.
Contents	Project topics of variable content in connection with the research topics of the participating workgroups; The theoretical work involves a literature review, interpretation and statistical analysis of the experimental data and finally the process of scientific writing. The seminar involves the acquirement of topics via discussions and lectures; planning and arrangement of projects; the analysis and discussion of data; the structuring and formatting of the project report. The laboratories involve the execution of scientific field and laboratory work and project-specific data analysis; arrangements with other projects, if necessary.
Assessment	Preparatory performance - no Examination - Project report
Literature	Mostly research literature in professional journals, depending on the subject

Name of Module (number)	**Behavioural Ecology** (413)
Person responsible for the module	Dr. Andra Thiel
Lecturer/s	Prof. Dr. Thomas Hoffmeister, Dr. Andra Thiel
Course titles / teaching form	Behavioural Ecology (Hoffmeister, Thiel) Seminar Laboratories
Compulsory / Elective	Elective
Workload / Credit points	6 CP Presence at the course: Seminar 28 h, Laboratories 36 h Individual studying: 116 h
Learning outcome	Profound knowledge of selected, important concepts of behavioural ecology; the ability to derive hypotheses for manipulative experiments regarding these concepts, as well as to plan, conduct, and analyse these experiments. With seminar presentations and poster presentations, the competence will be gained to clearly present complex theoretical concepts, in a way upcoming scientists often need to present their research at conferences or invited seminars.
Contents	Resource utilisation and optimal behaviour; resource competition and the ideal free distribution; ecology of information use, variability and status dependence of behavioural decisions; frequency-dependent processes and the social environment; cooperation and conflict, sexual selection and mate choice
Assessment	Preparatory performance - no Examination - Oral presentation (50%) and poster presentation (50%)
Literature	Davies, Krebs, West: An Introduction to Behavioural Ecology, Wiley Krebs, Davies: Behavioural Ecology – An Evolutionary Approach, eds. 1-4, Blackwell; Danchin, Giraldeau, Cézilly: Behavioural Ecology, OUP; Research literature in professional journals

Name of Module (number)	**Ecological Excursion and Field Course** (414) (414b)
Person responsible for the module	Prof. Dr. Martin Diekmann
Lecturer/s	Lecturers of the Master of Ecology programme
Course titles / teaching form	Excursions and field courses (choice between different offers) With corresponding seminars Seminar Field course and / or Excursion
Compulsory / Elective	Elective
Workload / Credit points	6 CP (414) 3 CP (414b) Presence at the course: (414) Seminar 14 h, Excursion and/or field course 120 h Individual studying: 46 h ; (414b) Seminar 14 h, Excursion and/or field course 55 h Individual studying: 21 h ;
Learning outcome	Students obtain insight into plant and animal communities within different habitats and the abiotic and anthropogenic factors driving habitat features and community structure; students will be able to us a broad spectrum of methods in field ecology and gain the competence to conduct research studies under field conditions.
Contents	One or two week excursions and field courses with an emphasis on botany and zoology, to variable destinations on offer. Regular destinations: For example dunes and salt meadows on Schiermonnikoog, high mountain range habitats of the eastern Alps, cultural landscape and tundra of the Krkonoše Mountains, marshes of the Baltic states as well as boreal and temperate regions of southern Scandinavia. Field courses around Bremen and in Denmark are also offered. Field courses and longer excursions are connected with specific preparation seminars, which are either integrated or held during the teaching term.
Assessment	Preparatory performance Examination - no - Excursion or field course report, not graded
Literature	Field guides

Name of Module (number)	**Vegetation Ecology and Conservation Biology** (415)
Person responsible for the module	Prof. Dr. Martin Diekmann
Lecturer/s	Prof. Dr. Martin Diekmann, PD Dr. Maike Isermann, PD Dr. Broder Breckling
Course titles / teaching form	Vegetation Ecology and Conservation Biology (Diekmann, Isermann, Breckling) — Lecture Seminar Laboratories Excursions
Compulsory / Elective	Elective
Workload / Credit points	6 CP Presence at the course: Lecture 14 h, Seminar 12 h, Laboratories 30 h, Excursions 40 h, Preparation of presentation, poster and report 84 h
Learning outcome	The students will develop a basic understanding of the theoretical concept of a plant community and of real plant communities and their interactions with environmental factors. Key concepts include the importance of plant traits for the relationship between vegetation and environment and the importance of human impact for the differentiation of vegetation types. The students will also learn about the close link between vegetation types and biotope types and the importance of these types for mapping purposes. Based on the understanding of vegetation-environment relationships, the students will get in touch with the concepts of biodiversity and ecosystem services, and will develop an understanding of the main problems of species conservation and environmental protection. Examples of good and bad practise will show the importance of nature management and various approaches of conservation biology on the species level. Opportunities are provided to learn about recent research projects in environmental protection and conservation at the University of Bremen.
Contents	*Vegetation Ecology:* What is a plant community? (continuum debate) Interactions between vegetation and abiotic / biotic factors Indicator values Plant traits, growth and life forms, plant strategies Ecological niches Ecograms of plant communities Human impact on vegetation and management Important vegetation types in Central Europe Applied and conservation aspects of vegetation ecology Vegetation sampling and analysis of vegetation data Examples and use of ecological databases Plant identification *Conservation Biology:* Strategies for the preservation of biodiversity Species conservation Protection of ecological processes Invasive species Regional effects of global environmental change Impact assessment of land and resource use Funding opportunities in applied research
Assessment	Examination portfolio — Poster presentation (25%), Oral presentation (25%), report of group work (50%)
Literature	Ellenberg & Leuschner (2010) Vegetation Mitteleuropas mit den Alpen. 6. Aufl. Ulmer Kowarik (2010) Biologische Invasionen - Neophyten und Neozoen in Mitteleuropa. 2. Aufl. Ulmer Primack (2010) Essentials of Conservation Biology. Sinauer Van der Maarel & Franklin (Eds.) (2012): Vegetation Ecology. 2nd ed. Blackwell Streeter & Hart-Davies (2009) Collins flower guide. HarperCollins, London Stace (2011) New flora of the British Isles. Cambridge Univ. Press

Name of Module (number)	**Soil and Ecosystem Ecology** (416)
Person responsible for the module	Prof. Dr. Juliane Filser
Lecturer/s	Prof. Dr. Juliane Filser, Dr. Thilo Eickhorst
Course titles / teaching form	Soil and Ecosystem Ecology (Filser, Eickhorst, Warrelmann) — Lecture, Seminar, Laboratories
Compulsory / elective	Elective
Workload / Credit points	6 CP Presence at the course: Lecture 16 h, Seminar 10 h, Laboratories 42 h, Excursion 12 h Individual studying: 100 h
Learning outcome	Students will be able to - name soil conditions, their associated communities and their interactions with environmental factors, mostly in terms of physico-chemical properties, climate and vegetation. - illustrate life forms and strategies of species as key factors for the establishment of communities. - discuss the historical development of ecosystems and the influence of management as important causes for community composition and ecosystem services. - perform basic and advanced soil ecological methods. - evaluate related methods for studies at different scales and the advantage of combining different viewpoints, descriptive and experimental approaches. - analyze the interactions between abiotic soil parameters, vegetation, soil fauna and microorganisms. outline analyzed data in oral presentations; discuss and interpret results in scientific reports
Contents	The lecture deals with the most important groups of organisms living in soil in context of the chemical and physical framework conditions. It focuses on the biology, functions, and services of all groups of organisms in the soil compartment, and gives insight in the multitude of interactions between different soil organisms and their biotic and abiotic environment. In the field course, students will gain first-hand experience in practical ecological field studies. Various kinds of habitats and a multitude of methods will be used for a comparative survey with different methods in soil ecology (pedology, microorganisms, micro-, meso- and macrofauna; , identification and process measurements). The students will additionally design and conduct experiments in the lab. For this, methods will be introduced for basic soil characterisation as well as for the study of soil mesofauna, microbial activities, and microbial ecology. In the seminar, the students will select appropriate methods and design their studies in group work, perform statistical analyses and work out a portfolio consisting of an oral presentation and a written report.
Assessment	Examination portfolio — Oral presentation (30%) and written report (70%)
Literature	Bardgett (2005): The Biology of Soil: A Community and Ecosystem Approach. Oxford University Press Coleman, Crossley & Hendrix (2004): Fundamentals of Soil Ecology. Elsevier Academic Press Ellenberg (2009): Vegetation Ecology of Central Europe. Cambridge University Press Paul (2007): Soil microbiology, ecology, and biochemistry. Academic Press Southwood & Henderson (2000): Ecological Methods. Wiley-VCH Sylvia, Fuhrmann, Hartel & Zuberer (2004): Principles and Applications of Soil Microbiology. Pearson – Prentice Hall Recent research literature in professional journals

Name of Module (number)	**Sustainability Research** (501)
Person responsible for the module	Prof. Dr. Hartmut Koehler
Lecturer/s	Prof. Dr. Hartmut Koehler Guest speakers, including lecturers from our partner University of Ngaoundéré, Cameroon
Course titles / teaching form	Introduction to Sustainability Research — Lecture Case studies — Seminar
Compulsory / Elective	Elective
Workload / Credit points	6 CP; Presence at the course: Lecture 28 h, Seminar 28 h Individual studying: 124 h
Learning outcome	In the course you learn • to put ecological knowledge in an inter- and transdisciplinary context to analyze sustainability; • to use sustainability criteria and indicators and how to present complex results graphically, e.g. in a spider-diagram; • to analyze complex situations independently with the necessary information competency; • to develop solutions for sustainability problems; • to lead a discussion and to communicate your ideas and solutions to a specified target-group (e.g., stakeholders, policy makers, NGO's, scientists, ...) The course contributes to the student's professional qualification in scientific ecological consulting in the context of administration, e.g., of NGO's or the environmental UN-conventions and in international project management.
Contents	Inter- and transdisciplinary approaches. The concept of sustainability: history, present day use and application. Sustainable development; sustainability indicators; gender and sustainability. Biodiversity and ecosystem services. Ecological disturbance and damage. Ecological values and economics. The ecological background of the environmental conventions of the UN; the practice of implementation of UNCBD and UNCCD; Millennium Ecosystem Assessment and Global Development Goals. Holistic management: the ecosystem approach of the UNCBD; participation and acceptance, especially in rural areas; cases studies with focus on desertification and regionally Cameroon and China. The soil ecosystem: Soil degradation and desertification; approaches to combat soil degradation and desertification. Projects of the University of Bremen to combat soil degradation and desertification, including those with the partner universities of Ngaoundéré (Cameroon), Ismailia (Egypt) and Inner Mongolia (China).
Assessment	Course participation and preparation of topics (continuous assessment) — - Yes Examination (poster presentation [ppt] and defense, handout) — - Poster presentation
Literature	Millennium Ecosystem Assessment: http://www.maweb.org. Agenda 21 The UN environmental conventions: Desert/soils: http://www.unccd.int, climate http://unfccc.int, biodiversity http://www.biodiv.org, Ecosystem Approach of CBD http://www.biodiv.org. The conventions are more than a documents but a process, which started in 1992 (UNCED, Rio Conference). More will be assigned at Stud IP and at http://www.uft.uni-bremen.de/oekologie/hartmutkoehler.htm

Name of Module (number)	**Grant Proposal and Defence** (502)
Person responsible for the module	Prof. Dr. Martin Diekmann
Lecturer/s	Prof. Dr. Martin Diekmann, Dr. Marlis Reich
Course titles / teaching form	Grant Proposal and Defence (Lecturers of the MSc Ecology) Lecture Seminar
Compulsory / Elective	Elective
Workload / Credit points	6 CP Presence at the course: Lecture 14 h, Seminar 14 h Individual studying: 152 h
Learning outcome	Understanding of the planning, application for funding, financing and procedure of modern project-oriented research propositions. Identification of interesting research questions and currents as a foundation for promising proposition. Introduction to project management as well as to the economical and financial aspects of scientific research.
Contents	The various national and international institutions for research promotion are introduced in the lectures and seminars. The students will work on the structure and contents of a typical grant proposal. Building on that, they will create a proposition for their own research project, structure and phrase it, to finally defend it in a simulated consultant conference.
Assessment	Preparatory performance - no Examination part 1 - grant proposal Examination part 2 - Oral presentation and defence of the grant proposal
Literature	Subject specific

Name of Module (number)	**Ecophysiology** (503)
Person responsible for the module	Prof. Dr. Uwe Nehls
Lecturer/s	Prof. Dr. Uwe Nehls
Course titles / teaching form	Ecophysiology (Nehls) Lecture Seminar Laboratories
Compulsory / Elective	Elective
Workload / Credit points	6 CP Presence at the course: Lecture 28 h, Laboratories 56 h Individual studying: 96 h
Learning outcome	Insight into ecophysiological adaptation of plants to environmental impacts • Basics of molecular plant physiology • Selected aspects of plant adaptation strategies (cold, drought, salt, nutrient limitation) • Practical application of ecophysiological techniques
Contents	Discussion of basic plant strategies of adaptation to stable and changing environments. Selected examples of plant mechanisms defending abiotic (e.g. temperature, flooding/drought, salt, nutrient limitation) and biotic stresses. Methods used in the practical course: Gene expression analysis. Measurement of photosynthetic capacity and actual photosynthesis. Enzymatic and chromatographic determination of metabolite content. Inspection for fungal endophytes (selective staining and microcopy). Measurement of long distance transport in plants.
Assessment	Preparatory performance Seminars and protocols Examination Presentation (50); exam (50)
Literature	Larcher W. 2003. Physiological Plant Ecology. 4th edn. Springer Berlin Heidelberg

Name of Module (number)	**Spatial Data Analysis and GIS** (504)
Person responsible for the module	Prof. Dr. Thomas Hoffmeister
Lecturer/s	Prof. Dr. Winfried Schröder, Dr. G. Schmidt, Dr. R. Pesch
Course titles / teaching form	Spatial Data analysis and GIS (Prof. Dr. Winfried Schröder mit Dr. G. Schmidt, Dr. R. Pesch) — Lecture + Seminar + Laboratories
Compulsory / Elective	Elective
Workload / Credit points	6 CP Presence at the course: Lecture 30 h, Seminar 30 h, Laboratories 30 h Individual studying: 90 h
Learning outcome	The module introduces the overall context of environmental monitoring - including its ecological and epistemological basis. Complex environmental data of different area coverage, derived from aquatic as well as terrestrial ecosystems, are analysed. Exercises in data quality control are held; alternatives to geostatistical mapping are presented. We will use Web-GIS to integrate and analyse environmental data.
Contents	Basics of environmental monitoring Data quality control Geostatistical analysis and modelling Predictive mapping WebGIS
Assessment	Preparatory performance - Seminar presentation or protocol Examination - Written or oral examination
Literature	Di Zio S., Fontanella L. and Ippoliti L., 2004. Optimal spatial sampling schemes for environmental surveys. Environ. Ecol. Statistics. 11, 397-414 Parr TW, Ferretti M., Simpson IC, Forsius M, Kovács-Láng E, 2002. Towards a long-term integrated monitoring programme in Europe: Network design in theory and practice. Environ. Monit. Assess. 78, 253-290 Wackernagel, H., 2003. Multivariate geostatistics. An introduction with applications. 3rd ed., Springer, Berlin Webster R, Oliver, MA, 2001. Geostatistics for Environmental Scientists. John Wiley & Sons, Ltd., Chichester

Name of Module (number)	**Current Topics in Ecology 2 and Mentoring** (505)
Person responsible for the module	Prof. Dr. Thomas Hoffmeister
Lecturer/s	Prof. Dr. Thomas Hoffmeister, Prof. Dr. Martin Diekmann, Prof. Dr. Juliane Filser, Prof. Dr. Uwe Nehls, Dr. Marlis Reich, Dr. Andra Thiel
Course titles / teaching form	Ecological Seminar (Diekmann, Filser, Hoffmeister, Nehls, Reich, Thiel) Seminar Literature Review (Diekmann, Filser, Hoffmeister, Nehls) Seminar Mentoring (Diekmann, Filser, Hoffmeister, Nehls) Seminar
Compulsory / Elective	Elective
Workload / Credit points	3 CP Presence at the course: Seminar 28 h Individual studying: 62 h
Learning outcome	Gaining an overview of current research in ecology; the ability to critically scrutinize research approaches and to lead a scientific discussion; the competence to obtain an overview about a research topic, the ability to perceive and explain weaknesses and strength in published or presented research Development of a study profile in the mentoring programme
Contents	*Ecological colloquium*: current research results, which are presented in the seminar by invited speakers; *Literature review*: extensive search for literature regarding an ecological research topic, evaluating and criticizing research approaches and analyses, the writing of a manuscript review. *Mentoring*: target-aimed counselling towards a study profile regarding professional qualifications
Assessment	Preparatory performance - - Discussion contributions in seminars Examination - Review manuscript
Literature	Subject specific research articles from international journals

Name of Module (number)	**Introduction to Ecological Modelling** (506)
Person responsible for the module	Prof. Dr. Thomas Hoffmeister
Lecturer/s	PD Dr. Hauke Reuter, PD Dr. Broder Breckling
Course titles / teaching form	Introduction to Ecological Modelling Lecture + Laboratories
Compulsory / Elective	Elective
Workload / Credit points	3 CP Presence at the course: Lecture 24 h, Laboratories 16 h Individual studying: 50 h
Learning outcome	Understanding the role of models in ecological knowledge acquisition. Achieving an overview about different approaches how to model complex ecological dynamics. Knowledge to apply different ecological models to specific problem settings, including estimation of time and effort for the model development process
Contents	- Model representation of self-organisation processes and emergent properties, analysis of causal networks - Iteration as a basic principle in model construction - Non spatial approaches to ecological modelling: Population dynamics with differential equations - Spatial explicit approaches to ecological modelling: Individual-based models and Actor-based models to represent processes involving spatio-temporal dynamics - Literature examples - Model application and adaptation, model validaton problems and outlook
Assessment	Preparatory performance - no Examination - Written exam
Literature	Jopp, Breckling, Reuter 2011 Modelling Complex Ecological Interactions, Springer, Chapters 1-13,23

Name of Module (number)	**Microbiology of terrestrial ecosystems** (507)	
Person responsible for the module	Dr. Thilo Eickhorst	
Lecturer/s	Dr. Thilo Eickhorst	
Module unit 1 Course titles / teaching form	Microbial ecology of terrestrial systems (Eickhorst)	Lecture + Seminar
Compulsory / elective	Elective	
Workload / Credit points	3 CP Presence at the course: Lecture 20 h, Seminar 8 h Individual studying: 62 h	
Learning outcome	Students should be able to - name microbiological aspects in different environments with focus on terrestrial systems and explain the role of microbial ecology as part of ecological research. - explain relevant functions microorganisms are involved in e.g. nutrient cycling and transformation. - differentiate and characterize microorganisms and related microbiological processes. - illustrate living conditions in terrestrial microbial habitats including promoting and inhibiting influences on microbial life. - compare different microbiomes in terrestrial ecosystems and related ecological consequences on large scale processes. - interpret the role of microorganisms in terrestrial systems in greenhouse gas emission. - summarize given aspects in an oral presentation.	
Contents	The course deals with microbial systems in terrestrial environments which are mainly soils. The role and function of microorganisms in soils will be addressed with respect to their different geochemical conditions and land uses. A focus will be on soil of arable land basically used for crop production. The role of the microbial habitat in soil ecosystems will be discussed intensively. Differently induced microbial dynamics in space and time will be presented. Recent research questions and appropriate methodological approaches will be discussed and exemplarily presented referring to recent research.	
Assessment	Preparatory performance Examination	- no - Portfolio (seminar presentation 70% and handouts 30%)
Literature	Elsas, J.D.: Modern Soil Microbiology, CRC Press Paul, E.A.: Soil microbiology, ecology, and biochemistry, Academic Press Schmidt, T.M. & Schaechter, M.: Topics in ecological and environmental microbiology, Academic Press Sylvia, D.M.: Principles and applications of soil microbiology, Pearson Prentice Hall Recent research literature in professional journals	
Module unit 2 Course titles / teaching form	Analysis of microbial habitats in soil ecosystems (Eickhorst)	Laboratories + Seminar
Compulsory / elective	Elective	
Workload / Credit points	3 CP Presence at the course: Laboratories 28 h, Seminar 7 h Individual studying: 55 h	

Learning outcome	Students should be able to - apply methods of classic microbiology and molecular ecology for the study of microorganisms and their habitats in soil. - investigate the potential and limitations of these techniques as well as their potential in combination with methods being useful for the characterization of habitats on the microscale. - evaluate the influence of different soils, soil management practices, and biogeochemical conditions on microbial habitats and consequences for microbiological processes. - summarize results in a scientific lab report.	
Contents	The role and function of microorganisms in nutrient cycling in terrestrial ecosystems will be discussed. Influences of land use and soil management on microbial populations and their activity will be demonstrated based on recent research questions. Techniques for the characterization of biogeochemical conditions in microbial habitats and induced dynamics will be presented. Hands-on lab training will be based on lab simulations or refer to recent research of the lecturer‘s lab. Traditional microbiological methods and molecular techniques for the study of microorganisms in their environment will be applied.	
Assessment	Preparatory performance Examination	- no - Lab report
Literature	Alef, K.: Methods in applied soil microbiology and biochemistry, Academic Press Hurst, C.J. & Crawford, R.L.: Manual of environmental microbiology, ASM Press Weaver et al. (Eds.): Methods of Soil Analysis: Part 2 - Microbiological and Biochemical Properties, Soil Science Society of America Recently published methods in professional journals	

Name of Module (number)	**Coral Reef Ecology of the Red Sea** (508)
Person responsible for the module	Prof. Dr. Thomas Hoffmeister
Lecturer/s	Prof. Dr. Christian Wild
Course titles / teaching form	Actual Topics of Coral Reef Ecology — Literature seminar Coral Reef Ecology of the Red Sea — Excursion/field course (choice between different project offers)
Compulsory / Elective	Elective
Workload / Credit points	6 CP Presence at the course: Seminar: 14 h, Excursion/field practical: 140 h, individual study: 26 h
Learning outcome	Students obtain insight into coral reef ecology and fundamental techniques/instruments. They develop the competence to study benthic and pelagic reef communities in a taxonomic and quantitative way.
Contents	Annual two week spring excursion to the Egyptian Red Sea (Sinai coast) with an emphasis on the taxonomic identification of major benthic and pelagic coral reef organisms (first week). Subsequently (second week), group work in specific projects (selective) that aim to quantify reef associated biodiversity and abundance of important functional groups (e.g. herbivores, bioeroders, primary producers, top predators). Additionally, side projects from the disciplines of biogeochemistry and behaviour ecology are offered.
Assessment	Oral presentation - Seminar Species list (first week) - Excursion/field course Mini-paper (second week)
Literature	Scientific papers (for literature seminar and excursion), field guides (for excursion)

Name of Module (number)	**M.Sc. Thesis** (510)
Person responsible for the module	Prof. Dr. Thomas Hoffmeister
Lecturer/s	Lecturers of the MSc Ecology
Course titles / teaching form	Lab seminar — Seminar Subject specific research for the thesis in the different groups of the ecology; — Thesis Thesis defence
Compulsory / Elective	Compulsory
Workload / Credit points	30 CP Presence at the course: Seminar 14 h Individual studying, field and /or lab work, thesis preparation: 886 h
Learning outcome	Implementing the scientific competence and knowledge in the field of ecological concepts and research in independent research. Competence in planning, designing, and conducting a scientific research project. Proficiency to analyse the results and report on the research project in a written thesis.
Contents	Definition of an independent research theme, planning and discussion of the contents and the time frame of the research work in lab meetings; introduction to research subject related methods; realization of the research project; analysis and discussion of the data; structuring and writing of the thesis with the guidance of university lecturer.
Assessment	Preparatory performance - no Examination - Thesis, Defence
Literature	Subject specific research articles from international journals