UNIVERSITÄT BAYREUTH

Study Guide to the Specialisation

Biodiversity and Ecosystem Functions

(MSc Global Change Ecology)

April 2026

Scientific and societal challenge

The diversity of life and the functioning of ecosystems are fundamental to the stability and adaptability of the earth system. They arise from processes operating across multiple levels of organization, ranging from demographic dynamics within populations to large-scale biogeographical patterns. These systems are shaped by interactions and feedbacks between organisms and their environment, as well as by disturbance regimes, extreme events, and long-term changes in climate and land use. Developing a deeper understanding of these complex interactions is key to strengthening functional resilience and to addressing global challenges such as biodiversity loss, the degradation of natural resources, and the resulting impacts on ecosystem services in a scientifically robust way.

At the same time, it has never been a more exciting time to work in ecology. Internationally coordinated research initiatives and standardised data collection in field ecology, covering species occurrence and distribution, now enable both global analyses for testing fundamental ecological theories and highly resolved local assessments to address conservation challenges. Technological advances are also transforming ecological research. Novel monitoring approaches, sensor technologies, remote sensing, and digital observation systems now make it possible to study ecological processes at unprecedented spatial and temporal resolution. Analysing and modelling these data opens up new opportunities to quantify system dynamics and to build a stronger scientific foundation for nature-based solutions.

Learning objectives

In this specialisation, you will engage with the theoretical foundations that explain how biodiversity emerges, is maintained, and shapes ecosystem functioning. You will learn to process and analyse complex ecological datasets, including floristic field data, digital monitoring data, and remote sensing products, and to interpret them using models and theory-driven approaches.

You will apply both data-driven and mechanistic methods to test ecological hypotheses and to derive generalizable insights into biodiversity and ecosystem functioning. In addition, you will explore how societal valuation processes in politics, economics, and society transform ecosystem functions into ecosystem services.

Throughout the specialisation, you will develop a solid understanding of the ecological processes that structure and stabilise biodiversity on earth. You will gain insight into how species and communities contribute to ecosystem functioning and why they are critical for key processes such as productivity, nutrient cycling, and climate regulation. You will also examine the impacts of global environmental change and learn to systematically assess their consequences for biodiversity, ecosystem functioning, and ecosystem services.

Teaching is strongly practice- and research-oriented. You will work with real-world datasets, contribute to ongoing research projects, and carry out your own supervised research studies. This will equip you with skills that are essential both for an academic career and for data-intensive roles in conservation, environmental planning, monitoring, and nature-based resource management.

Required knowledge

- To benefit fully from this specialisation, you should have a solid foundation in core areas of ecology and Earth system science. This includes knowledge of species and communities, population and process dynamics, and an understanding of how biotic and abiotic factors shape ecosystems. Familiarity with patterns and mechanisms of species distributions, as well as structural and functional properties of ecosystems, is essential.
- In addition, basic skills in statistics and data analysis are required. You should be comfortable with fundamental statistical methods, have some experience working with datasets, and understand how scientific questions can be translated into quantitative models and analytical approaches. These skills provide the foundation for the more advanced and methodologically focused training in this specialisation.

Skills and Competences

- In this specialisation, you will learn to independently address research questions related to biodiversity and ecosystem functioning, from developing appropriate study designs to analysing and interpreting data.
- You will gain proficiency in applying empirical and quantitative methods to investigate ecological processes and understand their dynamics.
- You will also develop the ability to critically evaluate the complex relationships between biodiversity, ecosystem functioning, and environmental change, and to translate these insights into management and conservation strategies. A key component is learning how to communicate your findings clearly and effectively to scientific audiences, decision-makers, and society at large.

Content of specialisation

You can shape your individual focus through three core modules (5 ECTS each), which cover key theoretical and conceptual aspects of ecological systems. These are complemented by a broad range of quantitatively oriented methods courses and several research-focused “Science Schools,” allowing you to further deepen your profile.

Each module is led by an active research group that integrates its scientific expertise directly into teaching. This close link between research and teaching fosters strong engagement from instructors and ensures intensive academic support.

The modules are designed to be both practical and research-oriented. You will work with current research datasets, participate in ongoing projects, and conduct your own supervised research studies. Teaching formats emphasise interaction and active participation, including research-based learning, project- and problem-based approaches, and interactive small-group work.

Area Module	ECTS	final grade	Teaching by...
T&C Theories & Concepts			
B Biodiversity and Ecosystem Functions (Ecological Change)			
Biogeography and Global Ecology	5	yes	Biogeography and Sport Ecology, UBT
Disturbance Ecology and Resilience	5	yes	Disturbance Ecology, UBT
Ecosystem Services	5	yes	Ecological Services, UBT
Rhizosphere Biogeochemistry	5	yes	Agroecology UBT
Population Ecology in Forest Ecosystems	5	yes	Ecosystem Analysis and Simulation, UBT
Dynamic Vegetation Ecology	5	yes	Plant Ecology, UBT
Biodiversity in the Tropics	5	yes	Functional and Tropical Plant Ecology, UBT

Related method courses

The methodological training directly benefits from the strong research activity of the participating research groups. As a result, you can choose from a wide range of methodological courses, allowing you to tailor your training to your individual interests and focus areas.

The course portfolio covers methods in field ecology, model-based analysis of dynamic systems, statistical and data-driven approaches for analysing complex datasets, as well as spatial analysis techniques such as GIS and remote sensing. In practice-oriented courses, you will be introduced to modern field data collection methods, including digitally supported and automated measurement and monitoring approaches.

All courses are designed to build your core quantitative skills and to support you in addressing ecological questions using data-driven approaches. You will learn how to independently select and apply appropriate methods, providing a strong foundation for your future research as well as for careers in both academic and applied fields.

M Methods			
Statistics, Data Sciences and Artificial Intelligence			
Ecoinformatics and Biogeographical Modelling	5		Biogeography and Sport Ecology, UBT
Environmental Models and Simulation			
Ecosystem Services Assessment of Landscapes	2		Ecological Services, UBT
Modeling Ecosystem Services	3		Teaching Assignments
Methods in Dynamic Vegetation Ecology	5		Plant Ecology, UBT
Field Surveys and Experiments			
Vegetation Science	3		Disturbance Ecology, UBT
Alpine Field Course in Vegetation Science	5		Disturbance Ecology, UBT
Experimental Ecology, Biodiversity and Ecosystem Functioning	5		Disturbance Ecology, UBT

Related science schools and excursions

As part of this specialisation, you can choose from a diverse range of engaging Science Schools and field camps, allowing you to set your own focus based on your interests. These formats combine intensive fieldwork with modern quantitative analysis and give you the opportunity to develop exactly the skills that best match your profile.

If you enjoy working in the field, two particularly exciting options are available. The Science School *Biodiversity Research* (Disturbance Ecology and Vegetation Dynamics, 10 ECTS), for example hosted in the Canary Islands, offers the chance to carry out your own field research in a volcanic island ecosystem under close supervision. The *Disturbance Ecology Field Camp* in the Alps (5 ECTS) provides hands-on training in vegetation ecology, disturbance research, and field data collection methods.

If you would like to further strengthen your analytical skills, you can choose Science Schools with a strong quantitative focus. The Science School on *Quantitative (Paleo-)Ecology* (Biogeography, 5 ECTS), offered in cooperation with Charles University in Prague, introduces modern statistical and computational approaches for analysing ecological and paleoecological data. In addition, the Science School *Trends in Quantitative Ecosystem Research* (Ecosystem Analysis and Simulation, 5 ECTS) gives you in-depth insight into current developments in ecosystem modelling and their application in the context of global environmental change.

I & S Internships & International Science Schools		
S International Science Schools / Field Camps		
Disturbance Ecology Field Camp	5	Disturbance Ecology, UBT
Science School / Expedition Biodiversity Research	10	Disturbance Ecology, UBT
Quantitative (Paleo-)Ecology	5	Biogeography and Sport Ecology, UBT
Science School for Ecosystem Analysis and Simulation	5	Ecosystem Analysis and Simulation, UBT

Participating chairs at UBT

- Biogeography and Sport Ecology (Prof. Manuel Steinbauer)
- Climatology (Prof. Cyrus Samimi)
- Disturbance Ecology (Prof. Anke Jentsch)
- Ecological Services (Prof. Thomas Köllner)
- Ecosystem Analysis and Simulation (Prof. Lisa Hülsmann)
- Functional and Tropical Plant Ecology (Prof. Bettina Engelbrecht)
- Plant Ecology (Prof. Steven Higgins)

Link to other specialisations

The ecological processes addressed in the *Biodiversity and Ecosystem Functions* specialisation strongly shape the climatological dynamics explored in *Global Climate Change and Ecosystems* specialisation. For example, vegetation plays a key role in influencing global climate change and microclimate. The loss of biodiversity and deterioration of ecosystem services are closely related to the specialisation *Global Policies, Economies, Civil Society and the Environment*, since there the societal response to global change problems is explored.

This specialisation is offered, with minor variations, in both the MSc Global Change Ecology and the MSc Geoecology programs.

Career opportunities

The quantitative, conceptual, and practice-oriented skills you gain in this specialisation open up a wide range of career opportunities in both scientific and applied ecological fields. Close involvement in ongoing research projects and experience working with complex ecological datasets provide an excellent foundation for pursuing an academic career, for example, through a PhD in ecology, biodiversity research, global ecosystem dynamics, or related Earth system sciences. Notably, a large proportion of professors in geoecology and related subjects across Europe began their academic training in Bayreuth.

At the same time, your strong competencies in data analysis, modelling, digital environmental monitoring, and the use of modern monitoring and remote sensing technologies qualify you for a variety of applied career paths. These include roles in nature conservation and environmental protection, biodiversity and ecosystem monitoring, public agencies and research institutions, environmental consulting and planning, nature-based resource management, as well as organisations working on climate adaptation, ecosystem restoration, and sustainable land use.

Contact persons and further information

Prof. Dr. Manuel Steinbauer

Prof. Dr. Anke Jentsch

GCE Webpage: https://www.bayceer.uni-bayreuth.de/gce
GCE Blog: https://globalchangeecology.com
Instagram: https://www.instagram.com/gcebayreuth