COURSE GUIDE

Systems Ecology (2001135)

Approval date: 27/06/2022

Grado (Bachelor's Degree)	Grado en Biología	Branch	Sciences
Module	Ecología	Subject	Ecología

Year of study	3º	Semester	2º	ECTS Credits	6	Course type	Compulsory course

PREREQUISITES AND RECOMMENDATIONS

- It is recommended to have taken the courses: Physical environment, Biostatistics, and Population and Community Ecology
- Statistics knowledge is recommended

BRIEF DESCRIPTION OF COURSE CONTENT (According to the programme's verification report)

- System theory
- Abiotic factors. Biogeochemical cycles: C, H, O and nutrients.
- Matter cycle and energy flow.
- Landscape ecology. The biomes.
- Succession. Complexity and stability in ecosystems.
- Man-biosphere relations.

SKILLS

GENERAL SKILLS

- CG01 - Organisational and planning skills
- CG02 - Teamwork
- CG04 - Capacity for analysis and synthesis
- CG05 - Knowledge of a foreign language
- CG06 - Critical reasoning
- CG08 - Self-directed learning for continuous professional development
- CG09 - Oral and written communication in the mother tongue
- CG12 - Sensitivity to social and environmental issues

- CG13 - Skills in interpersonal relations
- CG17 - Information management skills
- CG18 - Interdisciplinary teamwork
- CG19 - Ethical commitment
- CG22 - Recognition of diversity and multiculturalism

SUBJECT-SPECIFIC SKILLS

- CE01 - Recognise different levels of organisation in the living system.
- CE05 - Identify organisms
- CE07 - Catalogue, evaluate and manage natural resources
- CE09 - Identifying and using bioindicators
- CE18 - Obtain, handle, conserve and observe specimens
- CE25 - Design models of biological processes
- CE27 - Diagnose and solve environmental problems
- CE28 - Sample, characterise and manage populations and communities
- CE29 - Manage, conserve and restore populations and ecosystems
- CE30 - Develop and apply biocontrol techniques
- CE32 - Assess environmental impact
- CE33 - Obtain information, design experiments and interpret results
- CE35 - Direct, write and execute projects in Biology
- CE43 - Knowing the types and levels of organisation
- CE68 - Understand functional adaptations to the environment
- CE69 - Understand biological cycles
- CE70 - Knowing the physical environment: hydrological, atmospheric and terrestrial
- CE71 - Knowing the structure and dynamics of populations
- CE72 - Understanding Interactions between species
- CE73 - Understanding the structure and dynamics of communities
- CE74 - Knowing the energy flows and biogeochemical cycles in ecosystems

LEARNING OUTCOMES

The student will know/understand:

- The principles and use of the scientific method, understanding its capabilities and limitations.
- The methods and techniques commonly used in the discipline.
- The structure and functioning of ecosystems and the Biosphere.
- The idea of globality and interconnectedness among the components of ecological systems.
- Realistic perception of human action on the environment and the need for environmental protection and conservation

The student will be able:

- To develop a critical spirit, sustained equally by a thirst for knowledge and curiosity on the one hand, and skepticism in the face of answers on the other. This will allow him/her to evaluate the hypotheses, generate alternative explanations, and suggest procedures to test them.
- To develop an inquiring mind that allows him/her to evaluate and take sides for different explanations, theories and hypotheses for a given ecological phenomenon.

PLANNED LEARNING ACTIVITIES

THEORY SYLLABUS

- **Unit 1. Systems theory.** General Theory of Systems. Definitions. Characteristics: structure and function. The ecosystem as a system. Relationships among the elements of a system. Simple vs. complex relationships. Tools: stable isotopes, satellites. Compartment models. Renewal rate and residence time. Ecosystem services. Biomes and biogeographic regions.
- **Unit 2. The physical environment: atmosphere, hydrosphere.** The atmosphere. Earth's energy balance.
  Planetary temperature. Atmospheric circulation on a global scale. Climate. Ocean circulation. Global water cycle. Water balance in an ecosystem.
- **Unit 3. Primary production.** Gross and net primary production. Methods of measuring primary production: local and global scales. Relationship between production and biomass. Factors limiting primary production in terrestrial and aquatic ecosystems. Explanatory hypotheses. Latitudinal patterns in primary production.
- **Unit 4. Secondary production.** Concept of secondary production and approaches. Functional feeding forms: phagotrophs and saprotrophs. Methods for measuring Secondary production. Metabolic costs. Limiting factors.
- **Unit 5. Dead organic matter and decomposition.** The deposit of dead organic matter or detritus. Forms of dead organic matter in terrestrial and aquatic ecosystems. Measurements of decomposition rates. Decomposition: immobilization vs. mineralization. Factors controlling decomposition. Accumulation of detritus in different ecosystems.
- **Unit 6. Flow of matter and energy: trophic networks.** Energy transfer efficiencies: consumption, assimilation and production efficiencies. Biomass and energy pyramids. Trophic and food webs: grazing chains and detritus chains. Energy flow in the food web: differences between ecosystems. Regulation of trophic levels (bottom-up vs. top-down).
- **Unit 7. Ecological succession and stability.** Explanatory models of succession. Description of regularities. Succession, regression and exploitation. Succession, diversity and stability. Models of succession.
- **Unit 8. Biogeochemical cycles (C, O).** Redox potential. Coupling between biogeochemical cycles. Transformation of C and O in the atmospheric, aquatic and terrestrial compartments. Time scales. Sources and sinks. Global carbon cycle balances. Anthropic alterations.
- **Unit 9. Biogeochemical cycles (N, P, S).** Global cycle of nitrogen, phosphorus and sulfur. Main metabolic transformations. Sources and sinks. Particularities of the cycles in terrestrial and aquatic compartments. Climate regulation. Anthropic alterations.
- **Unit 10. Human-biosphere relationships.** Human demography. Ecological footprint. Biocapacity. Ecological deficit and surplus. Anthropocene. Ecological thresholds and planetary boundaries.

PRACTICAL SYLLABUS

Laboratory practice

- **Practice 1. NOAA databases: atmospheric monitoring of greenhouse gases and their relation to climate change.** This practice requires the use of several web tools to analyze the concentrations of greenhouse gases (CO_2, CH_4, CFCs, N_2O) in different parts of the

planet, as measured by NOAA. By analyzing short- and long-term trends of gases the student learns how the atmosphere and climate is changing and determines the causes responsible for the ongoing climate change.

Field Practicum (2-day camp)

- **Practice 1. Acid neutralizing capacity in aquatic ecosystems.** Determination of inorganic carbon. Proportion of different forms of inorganic carbon. Relationship with pH. Evaluation of the capacity to neutralize acids in different aquatic ecosystems.
- **Practice 2. Measurements of primary production and respiration in lakes.** Measurement of the oxygen concentration (Winkler Method). Light and dark bottle method. Net primary production and respiration. Monitoring of daily changes in oxygen concentration. Daily estimates.
- **Practice 3. Analysis of the macroinvertebrate food web in a river system.** Characterization of the macrobenthic community: identification of organisms at family level. Quantification of macroinvertebrate diversity in two sections of the same stream (upstream and downstream of the reservoir). Estimation of ecological attributes from functional feeding groups.
- **Practice 4. Determination of CO2 exchange in the ecosystem as a function of environmental parameters**. Quantification of CO2 emission from soils by manipulating the type of plant community, substrate type, and soil moisture. Effect of temperature on daily CO2 emission.
- **Practice 5. Organisms as ecosystem engineers: evaluation on the role of seed dispersers in pine-forest reforestation.** The interaction of woody plants with seed dispersers as engineers for vegetation regeneration. Estimation of the economic budgets of ecosystem services.

The use of gown, goggles, gloves and closed footwear is mandatory in practices with chemical reagents.

RECOMMENDED READING

ESSENTIAL READING

- Krebs, C. (2001-2009) Ecology: The experimental analysis of distribution and abundance, Addison Wesley Longman.
- Smith, R. L. & T.M. Smith (2009) Elements of Ecology. Pearson, 9th Edn.
- Chapin III, P.; Matson, P.A.; Mooney, H.A. (2002) Principles of Terrestrial Ecosystem Ecology. Springer
- Schlesinger, W. H. (2002-2013) Biogeochemistry: An Analysis of Global Change. Academic Press. Nueva York.
- Molles, M. (2006) Ecología. Conceptos y aplicaciones. McGraw-Hill, Interamericana.
- Rodríguez, J. (2001-2010) Ecología. Edn. Pirámide, Madrid.
- Piñol, J. & Martínez-Vilalta, J (2006) Ecología con números. Lynx Edn.

COMPLEMENTARY READING

- Allaby, M. (2010). A dictionary of ecology (4th ed.). Oxford University Press, Oxford.
- Cain, M., Bowman, W., Hacker, S., Allen, J., Pizer, M. y Kohorn, L. (2008)

Ecology. Sunderland, Mass: Sinauer Associates
- Colinvaux, P. (1993) Ecology 2. Wiley & Sons, Inc.
- Collin, P. (2011). Dictionary of environment y ecology (5th Edn.). Bloomsbury, London.
- Calow, P. (1999) Blackwell's Concise Encyclopedia of Ecology. Blackwell Science Ltd.
- Jørgensen, S.E. (2009) Ecosystem Ecology. Academic Press-Elsevier.
- Mackenzie F.T. Our changing planet: An introduction to Earth System Science and Global Environmental Change. Prentice Hall.
- Ricklefs, R.E. (1998) Invitación a la Ecología. La Economía de la Naturaleza. 4ª Edn. Editorial Médica Panamericana. Madrid.
- Smith, R. L. y T. M. Smith (2009) Elements of Ecology (7th Edition). Pearson International Edn.
- Schultz, J. (2005). The Ecozones of the World: The Ecological Divisions of the Geosphere. Springer Berlin Heidelberg.
- Stiling, P.D. (1992) Introductory Ecology. Prentice Hall, Inc., New Jersey.
- Stiling P- D. (2012) Ecology. Global Insights & Investigations. Mc. Graw Hill.
- Townsend, C., Harper, J. L. and M. Begon (2002-2009) Essentials of Ecology. Blackwell Science. Oxford.
- Weathers, K.C., Strayer, D.L. y Likens, G.E. (2013) Fundamentals of Ecosystem Science. Elsevier/AP, Amsterdam.

TEACHING METHODS

- MD01 - Lección magistral/expositiva
- MD02 - Sesiones de discusión y debate
- MD03 - Resolución de problemas y estudio de casos prácticos
- MD04 - Prácticas de laboratorio y/o clínicas y/o talleres de habilidades
- MD05 - Prácticas de campo
- MD06 - Prácticas en sala de informática
- MD07 - Seminarios
- MD08 - Ejercicios de simulación
- MD09 - Análisis de fuentes y documentos
- MD10 - Realización de trabajos en grupo

ASSESSMENT METHODS (Instruments, criteria and percentages)

ORDINARY EXAMINATION DIET

The assessment of the students' level of acquisition of the general and specific competences will be carried out continuously throughout the academic period by means of the following procedures:

- **Theory. 65% of the final grade.** Examination of theoretical knowledge and resolution of problems that represent 55% of the final grade. It will be necessary to obtain a minimum grade of 5 points out of 10 to pass the exam and be able to pass the course. In addition, level tests throughout the course, which together represent 10% of the final grade.
- **Practices. 20% of the final grade.** With the results obtained during the practical activities, a scientific work in poster format will be carried out by groups and its quality and defense will be evaluated. To pass the subject, it will be necessary to obtain a minimum grade of 5 points out of 10 in this work.
- **Seminars (debates). 10% of the final grade.** The clarity and quality of the arguments

exposed in the debate sessions will be especially valued.
- **Attendance and participation. 5% of the final grade.**

EXTRAORDINARY EXAMINATION DIET

- The extraordinary assessment will be carried out by means of a global exam that will consist of a theoretical part and a practical part, with a contribution to the final grade of 80% of the theoretical part and 20% of the practical part. At least a 5 out of 10 will be required in each part (theoretical and practical) to pass this exam.
- Students may present in the extraordinary call only for the part not passed in the ordinary call (theory and/or practical exam) and keep the qualifications of the rest of the continuous assessment activities. This option will be applied only to the current course. Students who want to waive these qualifications for continuous assessment to opt for 100% of the final grade in the exam of the extraordinary call, they must communicate it in writing to their theory teacher sufficiently in advance of this final exam of the extraordinary call.

The calendar of ordinary and extraordinary exams for this academic year can be found at the website of the Degree in Biology:
http://grados.ugr.es/biologia/pages/infoacademica/convocatorias

SINGLE FINAL ASSESSMENT (evaluación única final)

- Students who are unable to follow the continuous assessment method due to work, health, disability, mobility programmes or any other duly justified reason that prevents them from following the continuous assessment system may apply for a single final assessment. To request the single assessment, the student, in the first two weeks of the course, or in the two weeks following his/her enrolment if this has taken place after the start of the course, will request it, through the electronic procedure, to the Director of the Department, alleging and accrediting the reasons for not being able to follow the continuous assessment system as indicated in Article 6, point 2 and Article 8 in the Regulations on Evaluation and Grading of Students of the University of Granada of 9 November 2016. http://secretariageneral.ugr.es/bougr/pages/bougr112/_doc/examenes/
- This single final assessment will be carried out by means of a global exam that will consist of a theoretical and a practical part, with a contribution to the final grade of 80% of the theoretical part and 20% of the practical part. At least 5 out of 10 will be required in each part (theoretical and practical) to pass this exam.