

BL/ES 329 MANAGEMENT AND SUSTAINABILITY OF MEDITERRANEAN ECOSYSTEMS

IES Abroad Granada Summer: Sustainable Development & Equitable Living Across Borders: Spain & Morocco

DESCRIPTION: This course will provide an introduction to the study of Mediterranean-type ecosystems and sustainable development in the context of the Western Mediterranean region. The course covers the main topics on basic ecology (abiotic factors, interactions, disturbance, succession, diversity, communities, ecosystems, etc.) while providing a comprehensive picture of the main current ecological challenges for sustainability (invasions, global warming, loss of biodiversity, habitat restoration, human impact in the ecosystem, etc.). Three course-related trips and the final week in Morocco will complete the course, with field work directly related to the topics offered in the classroom, including collection of data and a basic *in situ* analysis to draw conclusions and generate functional responses to ecological challenges.

CREDITS: 3

CONTACT HOURS: 45

LANGUAGE OF INSTRUCTION: English

INSTRUCTORS: Dr. Jorge Castro and Fernando Morales-Rueda

PREREQUISITES: At least one semester of college-level biology, or consent of instructor.

METHOD OF PRESENTATION: Lectures, case studies, group discussions, workshops, and course-related trips. For each unit, the instructor will provide a general outline of the subject, and later the topic will be approached and discussed with specific texts that the students must read (required readings indicated for each unit, see below). List of readings may be slightly modified at each term to incorporate new scholarship on the subject.

REQUIRED WORK AND FORM OF ASSESSMENT:

- Participation -10%
- Course-related trip reports:
 - Written Report 1 -15%
 - Written Report 2 -15%
 - Oral Presentation -10%
- Final exam -15%
- Collaborative team project -35%

Participation

Students are expected to participate actively during class sessions and to come prepared to class having completed the required readings. A rubric for participation will be posted on Moodle and discussed in the first sessions.

Course-Related Trip Reports

A summary of the topics covered during two of the trips, placing them in the context of ecological and sustainability theory (that is, topics covered in the lectures). The report should not be a description of what we have seen in the field, nor a journal of the field trip. It must contain the ecological processes and sustainability characteristics analyzed during the journey. In addition, students should be able to develop potential responses to ecological challenges for sustainable development, complemented with the personal discussion and perspective of the student. Extensive note taking during the field trips is recommended.

The two reports will have a written format, with a length of ca. 1500 words ($\pm 15\%$). Font: Times 12 or similar, double spaced. First line: Full name of the student. Second line: Field trip number and denomination. Third line onward: Content of the report. The report must be uploaded to the Moodle platform, and the student will receive comments with track changes or in printed version. The strict deadline will be indicated in the calendar outline and in the Moodle platform.

Oral Presentation

A third trip report must be a recorded oral presentation, with an *Elevator Pitch* format used to present to professors and peers, and to open reactions in a Moodle forum. Each speaker will present a sustainability challenge analyzed during the field trip together with a proposal for sustainable development integrated in the main body of ecological theory.

Final exam

In the final exam, students will have to demonstrate their acquired knowledge of the syllabus content and the course-related trips by answering several open-ended questions. Students will be evaluated on the integration of concepts addressed in the content as well as the capacity for critical analysis and reflection. The duration of the exam will be one hour.

Collaborative team project

Teams of 3-4 students will identify a key sustainability challenge within the framework of the course and design a viable, complex answer to meet the challenge. At the end of the course, each team will deliver a multi-media presentation on their final project. Additionally, each student must submit a personal report reflecting on her or his role in the project, in the context of the class. Rubrics for the different possible formats of this project will be provided, although students will have space for creativity and originality.

LEARNING OUTCOMES:

By the end of the course students will be able to:

- Identify and describe ecosystem components, functional roles, and integration
- Explain the dynamics of ecosystem processes such as succession and nutrient cycling
- Understand management practices balanced between environmental, economic, and social values
- Compare and contrast ecosystem management practices in Spain and Morocco
- Recognize and explain the complexity and interrelatedness of sustainability challenges
- Potentially present their ideas to stakeholders and sustainability experts in a range of fields
- Differentiate between realistic and unrealistic goals for sustainability solutions

ATTENDANCE POLICY:

Attendance to all lectures is mandatory. Only one lecture may be missed without penalty. Attendance to all field trips is strictly mandatory.

CONTENT:

Session	Content	Required readings and assignments
Unit 1: Setting the scene: the physical and climatic scenario		
Session 1	Setting the scene: the physical and climatic scenario of the Mediterranean Region. The connection with Africa: implications for biota	Blondel J, Aronson J, Bodiou J-Y and Boeuf G (2010). Setting the scene. Pp. 1-22 in: <i>The Mediterranean region. Biological diversity in space and time</i> (2nd ed.). Oxford University Press. Chapter 1.
Session 2	Determinants of climate in the Mediterranean region. Vicissitudes during the Pleistocene: glaciations and implications for biota.	
Unit 2: Major ecosystem types in the Mediterranean region		
Session 3	Major ecosystem types in the Mediterranean region. Determinants of vegetation distribution. Vegetation belts in Mediterranean ecosystems.	Olea L and San Miguel-Ayaz A (2006). The Spanish dehesa. A traditional Mediterranean silvopastoral system linking production and nature conservation. <i>21st General Meeting of the European Grassland Federation.</i>
Session 4	Major climax communities. Oak forests. Pine forests. Arid and semiarid ecosystems. Mediterranean high mountain. Wetlands. Human-created landscapes: dehesas and agroecosystems.	
Trip 1	Wetlands and oak forests from Southwestern Spain; Atlantic coast and Strait of Gibraltar area.	- Finlayson C (2007). Janda. Pp. 144-165 in: <i>Al-Andalus. How nature has shaped history.</i> Santana Books. Chapter 9. - Fritz J, Kramer R, Hoffmann W, Trobe D and Unsöld M (2017). Back into the wild: establishing a migratory Northern bald ibis <i>Gerontocuseremitapopulation</i> in Europe. <i>International Zoo Yearbook</i> 51: 107-123.
Unit 3: Functioning of Mediterranean ecosystems		
Session 5	Functioning of Mediterranean ecosystems. Life-history traits in Mediterranean-type ecosystems	Blondel J, Aronson J, Bodiou J-Y and Boeuf G (2010). Setting the scene. Pp. 165-185 in: <i>The Mediterranean region. Biological diversity in space and time</i> (2nd ed.). Oxford University Press. Chapter 8.

Session 6	Adaptations of plants and animals to cope with Mediterranean conditions. Alteration of the ecological functioning by human activities.	
Unit 4: Humans as sculptures of the Mediterranean-region ecosystems		
Session 7	Humans as sculptures of the Mediterranean-region ecosystems. Influence of human activity on Mediterranean ecosystems: from the Pleistocene to the Anthropocene	Rick T, Ontiveros MÁC, Jerardino A, Mariotti A, Méndez C and Williams AN (2020). Human-environmental interactions in Mediterranean climate regions from the Pleistocene to the Anthropocene. <i>Anthropocene</i> 31: 100253 <i>An ecological history</i>. Yale University Press. Chapter 15.
Session 8	Basics of Sustainable Development in the Western Mediterranean Region, with a particular focus on Southern Spain and Northern Morocco. Sustainable Development Goals (SDGs) and the UN 2030 Agenda.	Due Date for Written Report 1
Unit 5: Disturbance and succession in Mediterranean-type ecosystems		
Session 9	Disturbance and succession in Mediterranean-type ecosystems	Allen HD (2016). Land use. Pp. 169-208 in: <i>Mediterranean ecogeography</i>. Routledge. Chapter 8.
Session 10	Major anthropogenic drivers of disturbance in the Mediterranean context	
Trip 2	Badland area of Guadix basin, Sierra de Baza Natural Park, and Cabo de Gata Natural Park.	Grove AT and Rackham O (2001). Badlands. Pp. 271- 287 in <i>The nature of Mediterranean Europe</i>.
Unit 6: Biodiversity of the Mediterranean region. Biodiversity and its measurements		
Session 11	Biodiversity of the Mediterranean region. Global and regional patterns of diversity.	Convention on Biological Diversity (2016). Biodiversity and the 2030 agenda for sustainable development. <i>Policy Brief</i>.
Session 12	The biodiversity crisis in the Anthropocene: the sixth mass-extinction? Drivers of the biodiversity crisis.	

Unit 7: Global change and Mediterranean-type ecosystem		
Session 13	Global change and Mediterranean-type ecosystems	Cramer W, Guiot J, Marini K, Secretariat M and Bleu P (2020). Climate and environmental change in the Mediterranean Basin: current situation and risks for the future. <i>First Mediterranean Assessment Report</i>.
Session 14	Mitigation and adaptation responses in the Western Mediterranean region for socio-ecological resilience. Sustainability under a global change scenario.	Due Date for Written Report 2
Trip 3	Alpujarra, Sierra Nevada	Martín JM, Rouco J, Abellán J, Ramos B, Sánchez A, Martos S and González A (2022). Singular Cultural Landscapes of the Sierra Nevada. Pp. 31-46 in: <i>The Landscape of the Sierra Nevada</i>. Springer. Chapter 3.
Unit 8: Towards a real sustainable development		
Session 15	Towards a real sustainable development. The social dimension of Sustainable Development in Southern Spain and Northern Morocco	Wyborn C, Davila F, Pereira L, Lim M, Alvarez I, Henderson G, Luers A, Martinez MJ, Maze K, Montana J, Ryan M, Sandbrook C, Shaw R and Woods E (2020). Imagining transformative biodiversity futures. <i>Nature Sustainability</i> 3: 670-672.
Session 16	- VISIT: Rif Mountains. Organic agriculture - VISIT: GIZ Morocco. Deutsche Gesellschaft für Internationale Zusammenarbeit. German Agency for International Cooperation.	Perry, Megan: Moroccan agriculture: Facing the challenges of a divided system: Sustainable Food Trust https://sustainablefoodtrust.org/news-views/moroccan-agriculture-a-divided-system/ Oral presentation recording due (third course-related trip)
Session 17	Project presentations & Conclusions	
Session 18	Final Exam	

COURSE-RELATED TRIPS

- Field trip 1. Wetlands and oak forests from Southwestern Spain; Atlantic coast and Strait of Gibraltar area. Localities visited: Los Alcornocales Natural Park (Cádiz province), Laguna de Fuente de Piedra (wetland), Laguna de

La Janda (wetland), Atlantic coast (area between Barbate and Strait of Gibraltar). Although Mediterranean-type ecosystems are all characterized by a hot, dry summer, rainfall may vary within a wide range, with sites close to semi-desertic conditions and others where autumn to spring rainfall reaches high values. This is the case of the SW of the Iberian Peninsula, where we can find the rainiest places in Spain, reaching values close to tropical forests in some spots. Oak forests here reach the highest complexity. In the area there are also abundant wetlands where birdlife flourishes. Besides, the proximity to the Strait of Gibraltar, which is a main passage for migratory birds flying to and from Sub-Saharan Africa, makes this region a very important one for birdlife. During the trip we will work on topics related to determinants of oak forest distribution, relevance of wetlands in the context of Mediterranean-type ecosystems, fauna associated to wetlands (including comments on local animal species extinction and reintroduction programs), or habitat management for fauna conservation. We will also address topics in plant ecology such as pollination and pollination systems, and other mutualistic plant-animal interactions. Special attention will be paid to the role of humans as modifiers of the Mediterranean-type ecosystems since ages, with a (very) possible visit to a cave with pre-historic rock paintings. Discussions will be held on the ecological conflicts generated by the exploitation of natural resources, especially the use of water for agriculture and its impact on the Laguna de La Janda area. We will create a general picture of territorial sustainability by analysing the influence of human systems on the environment, with a special focus on dehesa systems as a case of sustainable ecosystem management, as well as the impacts generated by renewable energy systems.

- Field trip 2. Badland area of Guadix basin, Sierra de Baza Natural Park, and Cabo de Gata Natural Park. In the Guadix basin the field work will be related to plant-plant interaction and facilitation, with special emphasis in dry environments. Historical, natural resource management systems, such as water use and biodiversity in drylands, will be assessed, and the relationship of renewable energies with the ecosystem will be studied. At Sierra de Baza Natural Park we will study species interactions and cascade consequences at ecosystem level: connections between the mistletoe, thrushes, and the juniper. In addition, the impacts of the exploitation of mineral resources in the area will be analyzed. Cabo de Gata is a semi-desert area that limits with the Mediterranean Sea at the SW corner of the Iberian Peninsula (province of Almería). Bedrock, proximity to the sea, orography and aridity creates an ecosystem dominated by bushes and very often salt-resistant species (halophytes). A coastal marsh with a rich bird life will be also visited. Topics of paleoecology, adaptations to dry and salty conditions, and relevance of coastal marshes for animal populations (particularly birds) will be discussed. The region is also an important area of volcanic origin, whose relevance will be discussed. We will also address the analysis of the impacts of intensive agriculture (massive greenhouse production) on the ecosystem and the context of human migrations. Special attention will be given to the integration of resource extraction with biodiversity conservation, as well as the interrelations between ecological functionality and different human activities such as agriculture, mining, forestry, or tourism.
- Field trip 3. Alpujarra, Sierra Nevada. We will visit a socio-ecological system in the foothills of the Sierra Nevada National Park. Here, different land uses and cultural heritage are integrated with the protection of the natural features of a mountain ecosystem. We will analyze the natural characteristics of the Alpujarra, the evolution of occupation for this mountain range, and the anthropic factors that have modified the ecosystem (irrigation, pastures, crops, ethnography, reforestation, tourism...). The dynamics of the socio-ecological response to the implementation of the National Park protection measures will be analysed as a case of integrated territorial management for sustainable development. The ecosystem services will be evaluated in a context of global change. Finally, we will identify and discuss the effects of global change on the socio-ecosystem and the coping and adaptive responses that are being generated for social and ecological resilience.

REQUIRED READINGS:

- Allen HD (2016). Land use. Pp. 169-208 in: *Mediterranean ecogeography*. Routledge. **Chapter 8**.
- Blondel J, Aronson J, Bodiou J-Y and Boeuf G (2010). Setting the scene. Pp. 1-22 in: *The Mediterranean region. Biological diversity in space and time* (2nd ed.). Oxford University Press. **Chapter 1**.
- Blondel J, Aronson J, Bodiou J-Y and Boeuf G (2010). Setting the scene. Pp. 165-185 in: *The Mediterranean region. Biological diversity in space and time* (2nd ed.). Oxford University Press. **Chapter 8**.
- Convention on Biological Diversity (2016). Biodiversity and the 2030 agenda for sustainable development. *Policy Brief*.
- Cramer W, Guiot J, Marini K, Secretariat M and Bleu P (2020). Climate and environmental change in the Mediterranean Basin: current situation and risks for the future. *First Mediterranean Assessment Report*. Union for the Mediterranean, Plan Bleu, UNEP/MAP. **Summary for Policymakers**.
- Finlayson C (2007). Janda. Pp. 144-165 in: *Al-Andalus. How nature has shaped history*. Santana Books. **Chapter 9**.

- Fritz J, Kramer R, Hoffmann W, Trobe D and Unsöld M (2017). Back into the wild: establishing a migratory Northern bald ibis *Geronticus eremita* population in Europe. *International Zoo Yearbook* 51: 107-123.
- Grove AT and Rackham O (2001). Badlands. Pp. 271-287 in: *The nature of Mediterranean Europe. An ecological history*. Yale University Press. **Chapter 15**.
- Martín JM, Rouco J, Abellán J, Ramos B, Sánchez A, Martos S and González A (2022). Singular Cultural Landscapes of the Sierra Nevada. Pp. 31-46 in: *The Landscape of the Sierra Nevada*. Springer. **Chapter 3**.
- Olea L and San Miguel-Ayanz A (2006). The Spanish dehesa. A traditional Mediterranean silvopastoral system linking production and nature conservation. *21st General Meeting of the European Grassland Federation*.
- Perry, Megan: Moroccan agriculture: Facing the challenges of a divided system. Sustainable Food Trust <https://sustainablefoodtrust.org/news-views/moroccan-agriculture-a-divided-system/>
- Rick T, Ontiveros MÁC, Jerardino A, Mariotti A, Méndez C and Williams AN (2020). Human-environmental interactions in Mediterranean climate regions from the Pleistocene to the Anthropocene. *Anthropocene* 31: 100253
- Wyborn C, Davila F, Pereira L, Lim M, Alvarez I, Henderson G, Luers A, Martinez MJ, Maze K, Montana J, Ryan M, Sandbrook C, Shaw R and Woods E (2020). Imagining transformative biodiversity futures. *Nature Sustainability* 3: 670- 672.

RECOMMENDED READINGS:

- Allen HD (2016). *Mediterranean ecogeography*. Routledge.
- Balbo AL, Martínez-Fernández J and Esteve-Selma MA (2017). *Mediterranean wetlands: archeology, ecology, and sustainability*. WIREs Water
- Blondel J, Aronson J, Bodiou J-Y and Boeuf G (2010). *The Mediterranean region. Biological diversity in space and time*, (2nd ed.). Oxford University Press.
- Castro J, (2021). Post-fire restoration of Mediterranean pine forests. Pp. 537-565 in: Ne'eman G and Osem Y (eds.), *Pines and their mixed forest ecosystems in the Mediterranean Basin*. Springer.
- Finlayson C (2007). *Al-Andalus. How nature has shaped history*. Santana Books.
- Grove AT and Rackham O (2001). *The nature of Mediterranean Europe. An ecological history*. Yale University Press.
- Hajian M, Kashani SJ (2021). Evolution of the concept of sustainability. From Brundtland Report to sustainable development goals. Pp. 1-24 in: *Sustainable Resource Management*. Elsevier.
- Joffre R, Rambal S and Damesin C (2007). Functional attributes in Mediterranean-type ecosystems. Pp. 285-312 in: - Pugnaire FI and Valladares F (eds.), *Functional plant ecology* (2nd ed.). Marcel Dekker.
- Médail F (2008). Mediterranean. Pp. 2296-2308 in: *Encyclopedia of Ecology*. Elsevier.
- Moreno G and Pulido F (2009). The functioning, management and persistence of Dehesas. Pp. 127-160 in: Riguero- Rodríguez A. et al. (eds.), *Agroforestry in Europe: current status and future prospect*.
- Plieninger T, Abunnasr Y, D'Ambrosio U, Guo T, Kizos T, Kmoch L, Topp E and Varela E (2022). *Biocultural conservation systems in the Mediterranean region: the role of values, rules, and knowledge*. Sustainability Science.
- Thompson JD (2005). *Plant evolution in the Mediterranean*. Oxford University Press.
- Waitz Y and Sheffer E (2021). Dynamics of mixed pine-oak forests. Pp. 345-362 in: Ne'eman G and Osem Y (eds.), *Pines and their mixed forest ecosystems in the Mediterranean Basin*. Springer.
- R and Oliva M (eds.) (2022). *The Landscape of the Sierra Nevada*. Springer.

INSTRUCTOR BIOS:

Dr. Jorge Castro is Professor of Ecology at the University of Granada. The main goals of his research lines are 1) To broaden knowledge of key ecological processes in Mediterranean ecosystems. 2) To develop conceptual tools and methodologies to improve the conservation and management of biodiversity and ecosystems. 3) To promote the transfer of research results to the management of protected areas, disseminating this information through training and advisory activities. Dr. Castro has a very extensive record of publications and presentations in the field. More information available at <https://scholar.google.com/citations?user=d5SEfi0AAAAJ&hl=es>

Fernando Morales is a Researcher and Instructor at the University of Granada Department of Ecology. He specializes in forest landscape restoration and governance and has conducted several trainings in the framework of the Sustainable Development Goals. In addition, he has actively participated in high-level climate discussions, such as the UNFCCC



Conference of the Parties (COPs). He has conducted entrepreneurship on nature-based solutions at Babson College (USA), Impact Hub (Italy) and Creative cities (Belgium) and has received a Top Innovator Award from the World Economic Forum. More information available at <https://www.linkedin.com/in/fernandomoralesderueda/>