

COURSE SYLLABUS
Biodiversity, land and water
MASUS Master 2022-2023



Lecturer: Dr Martin Godefroid

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Office hours: by appointment

Class time and location: Tuesday 16:00-21:00 @Puerta de Toledo Campus

Course overview

This course aims to introduce students to the main concepts, issues and perspectives related to biodiversity in terrestrial and aquatic ecosystems. First, the course will seek to comprehensively define the main concepts related to biodiversity, the crucial importance and value of biodiversity to human societies, the factors that determine biological diversity and the existing tools to measure it. Second, the course will describe the main threats to biodiversity and how human activities have had a long-lasting negative impact on biodiversity in terrestrial and aquatic ecosystems. Finally, this course will address the main existing biological conservation strategies and the current complexity of biodiversity conservation at different spatial and temporal scales.

Competence and skills

The student should be able to on completion of the course:

- Describe the concept of biodiversity
- Describe the value of biodiversity and ecosystems for society
- Describe the main spatio-temporal global patterns of biodiversity
- Describe the drivers shaping the spatio-temporal patterns of biodiversity
- Describe the major threats to biodiversity (climate change, pollution, invasive species, overexploitation, habitat change)
- Describe past, current and estimated future extinction rates.
- Describe the tools to quantify biodiversity and the related uncertainty
- Describe the main concepts of conservation biology
- Critically evaluate the existing strategies for protecting biological systems and restore biodiversity
- Describe the complexity of designing biological conservation plans

Exam

The exam will consist of two parts

- (1) An individual written exam about main topics addressed in class
- (2) A working group presentation (20 minutes). Each group will focus on a biome/ecosystem and describe the following topics:
 - Overview of the main characteristics of the biome/ecosystem (functioning, main vegetation, levels of biodiversity, distribution, climate, disturbance regimes, resource limitations, etc.)
 - Value of this ecosystem; ecosystem services
 - Present and predicted future state of the ecosystem
 - Main threats to the ecosystem (describing exhaustively an example for each threat)
 - Identification of a threatened species (IUCN red list) with a description of the threats for this species
 - Potential conservation strategies

Evaluation

Students will be evaluated in function of:

- oral presentation of case studies (50 %)
- the written exam (50 %)

Course #1: The concept of biodiversity

Date: November 8, 2022

Duration: 3 hours

Location: Puerta de Toledo Campus

Teacher: Martin Godefroid

Course content

1 Introduction to the course

Description of the main objectives, course logistics and general expectations of commitment; formation of working groups and presentation of study cases for the practical sessions.

2 Lecture

- The different definitions of biodiversity (species diversity, genetic diversity, ecosystem diversity)
- The value of biodiversity for human society (concepts of cultural, supporting, regulating, provisioning ecosystem services)
- Approaches to measure and quantify biodiversity
- Global spatial patterns of biodiversity on earth
- Drivers shaping global biodiversity
- Accuracy of estimations of the magnitude of earth biodiversity

Recommended readings

- Taylor et al. Campbell Biology: Concepts & Connections, 10th Edition – Chapters 34, 37 & 38
- Cain, M. L., Bowman, W. D., & Hacker, S. D. (2008). Ecology. Sinauer Associates, Incorporated. Chapter 17
- Sodhi, N. S., & Ehrlich, P. R. (Eds.). (2010). Conservation biology for all. Oxford University Press. Chapters 2-3

Course #2: Biodiversity loss

Date: November 15, 2022

Duration: 4.5 hours

Location: Puerta de Toledo Campus

Teacher: Martin Godefroid

Course content

1 Lecture

- Quantification of the current loss of biodiversity and its impact on ecosystems services
- Predictions of future biodiversity loss
- Extinction rates
- The 6th mass extinction
- Drivers of biodiversity loss (e.g. global change, overexploitation, pollution, habitat loss)

2 Practical part

Preparation of working groups presentations

Recommended readings

- Taylor et al. Campbell Biology: Concepts & Connections, 10th Edition – Chapter 38
- Cain, M. L., Bowman, W. D., & Hacker, S. D. (2008). Ecology. Sinauer Associates, Incorporated. Chapter 22
- Sodhi, N. S., & Ehrlich, P. R. (Eds.). (2010). Conservation biology for all. Oxford University Press. Chapters 4-5-6-8-10

Course #3: Invasive species

Date: November 22, 2022

Duration: 1.5 hours

Location: Puerta de Toledo Campus

Teacher: Martin Godefroid

Course content

1 Lecture

- Description of biological invasions
- The main drivers of biological invasions
- Impact of biological invasions on society and biodiversity
- Strategies to control invasive species

Recommended readings

- Hulme, P. E., Bacher, S., Kenis, M., Klotz, S., Kühn, I., Minchin, D., ... & Vilà, M. (2008). Grasping at the routes of biological invasions: a framework for integrating pathways into policy. *Journal of Applied Ecology*, 45(2), 403-414.
- Website: <http://www.iucngisd.org/gisd/> (it describes most invasive species addressed during the lecture)
- Diagne, C., Leroy, B., Vaissière, AC. *et al.* High and rising economic costs of biological invasions worldwide. *Nature* **592**, 571–576 (2021).
<https://doi.org/10.1038/s41586-021-03405-6>
- Hulme, P. E. (2006). Beyond control: wider implications for the management of biological invasions. *Journal of Applied Ecology*, 43(5), 835-847.
- Sodhi, N. S., & Ehrlich, P. R. (Eds.). (2010). Conservation biology for all. Oxford University Press. Chapter 7

Course #4: Forest ecosystems in a context of global change

Date: November 29, 2022

Duration: 4.5 hours

Location: Puerta de Toledo Campus

Teacher: Dr Jean-François Bastin

Course content

1. Lecture

Part 1: Forest and climate

- What is a forest?
- What is the state of global forest ecosystems?
- Forest, from the ground and from space
- Forest and Climate (focus on the carbon cycle, water availability, albedo and temperature)

➤ **Part 2: Forest and humans**

- History
- The human threat (direct: deforestation, degradation, defaunation; indirect: climate)
- Forest protection and restoration as a solution for climate change? (afforestation, reforestation, restoration, rewilding)

Part 3: Tools

- Current methods and tools from the field and remote sensing

2. Practical part

Working groups of 5-6 students will present a comparison of the state of forest and deforestation for a given country comparing tools, methods and definition from a code shared in the part 3 of the lecture. Requirements for the exercise will be provided 1 week before the class.

Course #5: Biological conservation - part1

Date: December 13, 2022

Duration: 3 hours

Location: Puerta de Toledo Campus

Teacher: Martin Godefroid

Course content

1 Lecture

- Basic concepts of conservation biology
- The need of monitoring tools for biodiversity conservation
- Strategies of prioritization (biodiversity hotspots, key biodiversity areas, endangered species, keystone species, etc.),
- Complexity of designing conservation strategies

2 Practical part

Preparation of the working group presentation

Recommended readings

- Taylor et al. Campbell Biology: Concepts & Connections, 10th Edition – Chapter 38
- Cain, M. L., Bowman, W. D., & Hacker, S. D. (2008). Ecology. Sinauer Associates, Incorporated. Chapter 22-23
- Sodhi, N. S., & Ehrlich, P. R. (Eds.). (2010). Conservation biology for all. Oxford University Press. Chapters 12-13

Course #6: Practical session

Date: December 15, 2022

Duration: 1.5 hours

Location: Puerta de Toledo Campus

Teacher: Martin Godefroid

Course content

1 Practical part

Preparation of the working group presentation

Course #7: Biological conservation part #2

Date: December 20, 2022

Duration: 3 hours

Location: Puerta de Toledo Campus – Online

Teacher: Martin Godefroid

Course content

Lecture

- Existing strategies of conservation
- In-situ conservation strategies
- Protected areas, ex-situ strategies
- Concepts of introduction, reintroduction, reinforcement, de-extinction
- Complexity of designing conservation strategies
- Protected areas; challenges when implementing protected areas (funding, connectivity, adequate staff, protected areas management, size and representativeness of protected area, efficiency of protected areas, climate change, etc.)

The last hour of the class will be dedicated to discuss potential students' questions about the course and the exam.

Recommended readings

- IUCN website: http://www.iucn.org/about/work/programmes/gpap_home/
- Convention on biodiversity website: <https://www.cbd.int/sp/>
- Haddad, Nick M., et al. "Potential negative ecological effects of corridors." *Conservation Biology* 28.5 (2014): 1178-1187.
- Ratajczak, Zak, et al. "Reintroducing bison results in long-running and resilient increases in grassland diversity." *Proceedings of the National Academy of Sciences* 119.36 (2022): e2210433119.
- Maxwell, S. L., et al (2020). Area-based conservation in the twenty-first century. *Nature*, 586(7828), 217-227.
- Gill DA, et al. (2017) Capacity shortfalls hinder the performance of marine protected areas globally. *Nature*. Doi:10.1038/nature21708
- Shapiro, Beth. "Pathways to de-extinction: how close can we get to resurrection of an extinct species?." *Functional Ecology* 31.5 (2017): 996-1002.

