SEMINAR PROPOSAL

Title: *Functional plant ecology: keys to the conservation and restoration of global ecosystems in a changing world*

INSTRUCTORS:

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Semester: Spring 2026. Classes begin: second week of March (Monday, March 9, 2026)

Class Schedule: Every Monday 10:30 AM – 12:00 PM

Format: Online via Zoom

1. Background

Unsustainable human intervention in ecosystems, driven mainly by the demand for food, raw materials, and especially energy, has sparked an unprecedented environmental crisis. This crisis manifests as significant biodiversity loss, climate change and the disruption of ecosystem functions, which in turn leads to the loss of essential services that ecosystems provide to society (e.g. air, water, food, energy, medicines, genetic resources). Addressing this issue effectively demands a multidisciplinary approach. Ecology is a cornerstone science in this effort, as it helps us understand the complex interactions driving the crisis and allows us to develop strategies for mitigation, conservation and restoration. Specifically, the field of functional plant ecology is crucial, as it examines how plants adapt to their surroundings and influence ecosystem functions; not only describes which species are present, but also what they do and how they do it. By focusing on functional traits (measurable morphological, physiological, or phenological characteristics), this discipline provides the physiological mechanisms necessary to understand and predict responses to global change. However, scientific understanding of ecological processes alone is insufficient; crafting truly viable and sustainable solutions requires acknowledging the crisis's deep connections to global economic and power relations and actively pursuing environmental justice.

2. Course Description

This 10-week seminar will examine the major impacts of global change on ecosystem processes, making complex science accessible by starting with the basics of how plants adapt, and then scaling up to show how entire ecosystems function. Building on this foundation, the course will analyze critical issues such as climate warming and habitat fragmentation, using a variety of illustrative examples. Special attention will be dedicated to Andean tropical mountain ecosystems, such as montane cloud forests and tropical alpine vegetation (Páramos). The critical focus on these regions is because they are Earth's highest biodiversity hotspots in terms of endemic species. Ultimately, the course bridges scientific knowledge with practical action. It will explain how this foundational understanding is not only useful but necessary for proposing and evaluating effective strategies for mitigation, conservation, and ecosystem restoration. Participants will gain the insight needed to critically assess modern environmental tools, such as carbon offset credits, understanding both their potential benefits and their limitations.

2.1. Learning objectives:

1. Overview of ecology as a science and its importance for understanding the environmental crisis.

2. The main abiotic drivers (e.g., climate, geology-geomorphology and soil) of the global distribution of vegetation (i.e., biomes).

3. Processes at the organism level: carbon balance and gas exchange, water relations, mineral nutrition. Plant adaptations to major abiotic factors (e.g., light, temperature, water and nutrient availability).

4. Ecosystem-level processes: Biogeochemical processes in terrestrial ecosystems (fluxes of water, carbon, and nutrients). Scaling up to global biogeochemical cycles. Ecosystem services.

5. Climate change: evidence, causes, effects, scientific consensus.

6. Deforestation and habitat fragmentation: effects on biodiversity and ecosystem functioning.

7. Biodiversity (concepts, scales, types), Conservation Biology as the applied ecology of endangered species and ecosystems, conservation practices.

8. Restoration ecology as a science for understanding and aiding the recovery of degraded ecosystems.

9. Andean ecosystems in Venezuela, South America, as a case study: Functional diversity as a key aspect for their conservation and restoration.

10. Final considerations: International agreements as a roadmap for implementing measures that will help us address global change.

3. Teaching Methods and Schedule

The course will be given in weekly sessions that include lectures, discussions, and interactive activities.

Week 1: *Overview of ecology as a science and its importance for understanding the environmental crisis.*

Brief descriptions: Addressing the current environmental and biodiversity crisis requires a multidisciplinary approach, in which ecology, as the scientific discipline responsible for studying the interactions of living organisms with their environment, plays a crucial role. In this context, we will explore how the disruption of these complex relationships affects the functioning of ecosystems and the services they provide. To understand this complexity, ecology studies processes at different levels of organization (i.e., organisms, populations, communities, ecosystems, landscapes), which often require us to move between these levels to gain insights into the functioning of cycles and biological systems, from local and regional scales to even a planetary scale (e.g., biogeochemical cycles, biomes). We will explore the functional plant ecology approach as a key discipline for understanding the relationship between ecosystem functioning and the consequences of global changes, as well as for developing strategies for mitigation, conservation, and ecosystem restoration.

Suggested readings:

1. Krebs, Charles J. 2008. The ECOLOGICAL World View. CSIRO PUBLISHING, Australia. ISBN 978 1 84593 376 0. **Reading pages 1-7**.

2. Yvonne M. Buckley, Amy Austin, Richard Bardgett, Jane A. Catford, Andy Hector. Amy Iler, Pierre Mariotte. 2024. The plant ecology of nature-based solutions for people, biodiversity and climate. Journal of Ecology 112:2424–2431. DOI: 10.1111/1365-2745.14441. **Reading pages 2424-2429.**

3. IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondízio E.S., H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany. 56 pages. **Reading pages 9-19**.

Week 2: ***The main abiotic drivers of the global distribution of vegetation.***

Brief descriptions: The distribution of biota, particularly of large plant formations (i.e., biomes) on our planet, is determined by a defined set of environmental conditions which, although dynamic and changing, have shaped the adaptive characteristics of organisms. In other words, to use G.E. Hutchinson's terminology, this is the "ecological stage" where the "evolutionary drama" unfolds. In this class, we will briefly review the environmental processes that determine climatic conditions (i.e., radiation, temperature, water regime) and substrate characteristics (geology-geomorphology, soils), which in turn define the set of environments for the distribution of organisms in the biosphere.

Suggested readings:

1. Alan Strahler. 2011. Introducing Physical Geography. John Wiley & Sons, ISBN 13 978-0470-13486-3. **Reading pages 4-11.**

2. Tara Jo Holmberg. 2026. General Ecology. CT State Community College Northwestern. LibreTexts. https://libretexts.org/

Reading Chapters. Chapter 2. The Physical Environment: 2.2 Earth's Energy Balance (pages 1-7); 2.3 Soils (pages 1-9); 2.6 Atmospheric and Ocean Circulation (pages 1-10). Chapter 5. Terrestrial and aquatic communities: 5.1.2 Terrestrial Biomes (pages 1-8).

Week 3: ***Processes at the organism level: Plant adaptations to major abiotic factors*****.**

Brief descriptions: In this class, we will review the main processes that define plants as the primary engine that transforms solar energy and makes it available to the different trophic levels of the biosphere. We will study how this energy transformation occurs through photosynthesis, which produces the food and oxygen that living beings breathe. We will analyze the basic processes of water and nutrient absorption, as well as the mechanisms of adaptation to different conditions of light, water availability, and nutrient levels. We begin with the premise that, in order to adequately understand the consequences of alterations in environmental conditions resulting from climate change, it is necessary to understand how the affected biological machinery works.

Suggested readings:

1. Hans Lambers, Rafael S. Oliveira. 2019. Plant Physiological Ecology, 3rd edition, Springer Nature Switzerland AG. ISBN 978-3-030-29638-4. https://doi.org/10.1007/978-3-030-29639-1. **Reading pages 1-6.**

2. Matthew R. Fisher. 2017. Environmental Biology, Open Oregon Educational Resources, Creative Commons Attribution 4.0 International License. **Reading pages 53-55; 261.**

3. Ray F. Evert, Susan E. Eichhorn. 2013. Raven Biology of Plants, 8th edition, W. H. Freeman and Company Publishers, New York. ISBN-13: 978-1-4292-1961-7. **Reading pages 708-722.**

Week 4: *Ecosystem-level processes - Biogeochemical cycles*.

Brief descriptions: Extending the process of carbon assimilation by plants to an area with specific environmental conditions, that is, an ecosystem, constitutes the process of primary production, which is linked to water circulation and nutrient recycling, and involves an intricate network of interactions among producers, consumers, and decomposers. Similarly, extrapolating these processes to the planetary level gives rise to the major biogeochemical cycles of carbon, water, and nutrients, which enable the evolution and sustenance of life on Earth. This approach moves beyond the details of particular species and concentrates on the physics of ecosystems as energy machines and nutrient processors. Understanding these cycles as a whole allows us to comprehend the consequences of climate change and land use, as well as to envision potential solutions.

Suggested readings:

1. Matthew R. Fisher. 2017. Environmental Biology, Open Oregon Educational Resources, Creative Commons Attribution 4.0 International License. **Reading pages 71-79.**

2. Ernst-Detlef Schulze, Erwin Beck, Nina Buchmann, Stephan Clemens, Klaus Müller-Hohenstein, Michael Scherer-Lorenzen. 2019. Plant Ecology, 2nd edition, Springer-Verlag GmbH Berlin, Germany. ISBN 978-3-662-56231-4. https://doi.org/10.1007/978-3-662-56233-8. **Reading pages 529-533; 545-560.**

Week 5: ***Climate change: evidence, causes, effects, scientific consensus.***

Brief descriptions: The Earth is a dynamic and ever-changing planet. However, the changes introduced by humankind since the Industrial Revolution have triggered a very rapid rate of climate warming and transformation of natural ecosystems, which are producing significant consequences for biodiversity, the functioning of ecosystems, and biogeochemical cycles. These changes are disrupting the delicate balance that maintains life on the planet. In this class, we will review some evidence regarding the causes and effects of climate change, especially on natural ecosystems, and we will explore some possible measures for mitigating and/or adapting to its effects.

Suggested readings:

1. IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 184 pp., doi: 10.59327/IPCC/AR6-9789291691647. **Reading pages 3-11.**

2. Ernst-Detlef Schulze, Erwin Beck, Nina Buchmann, Stephan Clemens, Klaus Müller-Hohenstein, Michael Scherer-Lorenzen. 2019. Plant Ecology, 2nd edition, Springer-Verlag GmbH Berlin, Germany. ISBN 978-3-662-56231-4. https://doi.org/10.1007/978-3-662-56233-8. **Reading pages 865-868; 876-887.**

Week 6: ***Deforestation and habitat fragmentation: effects on biodiversity and ecosystem functioning.***

Brief descriptions: This class aims to demystify the idea that "global change" is simply about rising temperatures. We will focus on the physical alteration of the Earth's surface. The goal is for the audience to understand that when we transform a forest into a pasture or a city, we don't just "remove trees," but we also alter the flows of energy and matter (e.g. water, carbon, nutrients) and disrupt nature's interconnected systems (fragmentation). From a functional ecology perspective, the objective is to show that fragmentation creates artificial "edges" that change the microclimate, and species composition, favoring generalist species and disadvantaging specialist species, thus reducing the ecosystem's resilience.

Suggested readings:

1. Ernst-Detlef Schulze, Erwin Beck, Nina Buchmann, Stephan Clemens, Klaus Müller-Hohenstein, Michael Scherer-Lorenzen. 2019. Plant Ecology, 2nd edition, Springer-Verlag GmbH Berlin, Germany. ISBN 978-3-662-56231-4. https://doi.org/10.1007/978-3-662-56233-8. **Reading pages 868-876; 887-891.**

2. Nick M. Haddad et al. 2015. Habitat fragmentation and its lasting impact on Earth's ecosystems. Science Advances 1, e1500052. DOI:10.1126/sciadv.1500052. **Reading pages 1-9.**

3. FAO. 2022. The State of the World's Forests. Food and Agriculture Organization of the United Nations, Rome. ISSN 1020-5705 (print); ISSN 2521-7542 (online). **Reading pages 1-3.**

Week 7: ***Biodiversity (concepts, scales, types), Conservation Biology as the applied ecology of endangered species and ecosystems, conservation practices.***

Brief descriptions: Biodiversity is much more than just the number of species on Earth. It is the foundation of how ecosystems function and how they sustain human life, regulating the climate, producing food, purifying water, and maintaining soil fertility. In the context of rapid climate change and land-use transformation, understanding biodiversity is essential to understanding what is at risk, why it is important, and how we can take action. In this class, we will review how the term biodiversity encompasses several levels, from the diversity of species in a given area to the diversity within species (genetic variability), and the diversity of ecosystems and their functioning. We will distinguish between taxonomic and functional biodiversity and understand the role of Conservation Biology as a scientific discipline dedicated to planning strategies for the preservation of biological diversity in a changing world.

Suggested readings:

1. Ernst-Detlef Schulze, Erwin Beck, Nina Buchmann, Stephan Clemens, Klaus Müller-Hohenstein, Michael Scherer-Lorenzen. 2019. Plant Ecology, 2nd edition, Springer-Verlag GmbH Berlin, Germany. ISBN 978-3-662-56231-4. https://doi.org/10.1007/978-3-662-56233-8. **Reading pages 744-748; 754-761.**

2. Navjot S Sodhi, Paul R Ehrlich. 2010. Conservation Biology for All. Oxford University Press, New York. ISBN 978–0–19–955423–2 (Hbk.). **Reading pages 7-16; 199-208.**

Week 8: ***Restoration ecology as a science for understanding and aiding the recovery of degraded ecosystems.***

Brief descriptions: Human activities have transformed ecosystems at unprecedented rates. Climate change, land-use change, biodiversity loss, and altered nutrient cycles are now tightly interconnected challenges. Restoration Ecology emerges as a scientific and practical field that seeks not only to repair degraded ecosystems, but also to recover the ecological processes that sustain life on Earth. In this class, we will explore Restoration Ecology as a bridge between ecological theory and real-world action. We will focus on how plant functional ecology helps us understand ecosystem recovery, resilience, and adaptation under global change.

Suggested readings:

1. Margaret A Palmer, Joy B Zedler, Donald A. Falk. 2016. Foundations of Restoration Ecology, 2nd edition, Island Press Washington, DC 20036. **Reading pages 3-6.**

2. Richard J Hobbs, Viki A Cramer. 2008. Restoration Ecology: Interventionist Approaches for Restoring and Maintaining Ecosystem Function in the Face of Rapid Environmental Change. Annual Review of Environment and Resources 33:39–61. doi:10.1146/annurev.environ.33.020107.113631. **Reading pages 39-54.**

3. Nelson, C.R., Hallett, J.G., Romero Montoya, A.E., Andrade, A., Besacier, C., Boerger, V., Bouazza, K., Chazdon, R., Cohen-Shacham, E., Danano, D., Diederichsen, A., et al. 2024. Standards of practice to guide ecosystem restoration – A contribution to the United Nations Decade on Ecosystem Restoration 2021-2030. Rome, FAO, Washington, DC, SER & Gland, Switzerland, IUCN CEM. https://doi.org/10.4060/cc9106en. **Reading pages 1-8.**

4. Robin L. Chazdon. 2008. Beyond Deforestation: Restoring Forests and Ecosystem Services on Degraded Lands. Science 320, 1458. DOI: 10.1126/science.1155365. **Reading pages 1458-1460.**

Week 9: ***Andean ecosystems in Venezuela, South America, as a case study.***

Brief descriptions: The tropical Andes mountain range is characterized by a complex geography and varied climatic conditions, which gives the countries of the subregion enormous ecosystem heterogeneity and high biological diversity. In this class, we will review different aspects of the functional ecology of plants from two of the main plant formations characteristic of the northern Andes of South America, specifically in Venezuela: The Andean cloud forest and the high-mountain alpine vegetation, that is, the páramos. In this regard, we will refer to aspects related to the conservation and restoration of these unique ecosystems.

Suggested readings:

1. Fermin Rada, Aura Azócar & Carlos García-Núñez (2019): Plant functional diversity in tropical Andean páramos, Plant Ecology & Diversity, DOI:10.1080/17550874.2019.1674396. **Reading pages 1-2; 9-12.**

2. Carlos García-Núñez, Fermin Rada and Michele Ataroff. 2025. Cloud forests in the Venezuelan Andes: A review of functional characteristics at ecosystem and plant scale. Conservation of Andean Forests. Nicola Clerici (Ed.). Springer Nature, Switzerland AG. https://doi.org/10.1007/978-3-031-80805-0_2. **Reading pages 31-34; 44-47.**

3. Carlos García-Núñez, Fermin Rada, Ana Quevedo-Rojas, Mauricio Jerez-Rico, Luis D. Llambí, Carlos E. Pacheco, Luis. E. Gámez, Emilio Vilanova. 2025. A multi-scale ecological approach for the conservation and restoration of Venezuelan Andean cloud forests. Conservation of Andean Forests. Nicola Clerici (Ed.). Springer Nature, Switzerland AG. https://doi.org/10.1007/978-3-031-80805-0_6. **Reading pages 127-131; 145-150.**

Week 10: *Final considerations: International agreements as a roadmap for implementing measures that will help us to address global change.*

Brief descriptions: Over the last decades, science has shown with increasing clarity that climate change and land-use change are profoundly altering ecosystems worldwide. In response, the international community has developed a series of global agreements aimed at mitigating climate change, conserving biodiversity, and promoting sustainable land use. In this class, we will explore the main international environmental agreements promoted by the United Nations and other institutions, evaluate their strengths and weaknesses, and reflect on what functional plant ecology tells us about where we are today—and where we may be heading if effective action is not taken.

Suggested readings:

1) United Nations Environment Programme (2025). Global Environment Outlook 7: A future we choose – Why investing in Earth now can lead to a trillion-dollar benefit for all. Nairobi. https://wedocs.unep.org/handle/20.500.11822/49014. **Reading pages 9-20.**

2) Sandra Díaz et al. 2019. Pervasive human-driven decline of life on Earth points to the need for transformative change. Science366,eaax3100. DOI:10.1126/science.aax3100. **Reading pages 1-8.**