CIEE Global Institute - Monteverde

Course name:	Principles of Tropical Biology (Lab course)
Course number:	(GI) BIOL 2403 MOCR
Programs offering course:	Monteverde Open Campus Block: STEM and Society
Open Campus track:	STEM and Society
Language of instruction:	English
U.S. semester credits:	4
Contact hours:	45 lecture and 45 laboratory/field
Term:	Fall 2019

Course Description

This course will provide an introduction to the understanding of tropical ecology and conservation. Students will explore how tropical communities function, the ecological and evolutionary forces that generate and maintain their biological diversity, and why the integrity of these forests is compromised by human activities. Students will learn about global and local climate patterns, and biological response to global warming at Monteverde. They will investigate the paradox of high tropical productivity despite poor soils, including nutrient and energy cycles. Students will explore species interactions in tropical communities and learn how these features impact ecosystem structure and function. They will learn about global patterns of biodiversity and theories for the patterns. Students will contrast historical and contemporary rates of species extinction, as well as the proximate and ultimate causes for the loss of biodiversity. They will understand the forces that erode species and ecological functions, including those vital to human wellbeing.

Learning Objectives

By completing this course students will be able to:

- Understand fundamental ecological concepts, such as nutrient and energy flow in ecosystems, particularly those related to tropical ecosystems and how the tropics are different from extra-tropical ecosystems.
- Articulate fundamental evolutionary concepts such as speciation, extinction, natural selection, and drift, and apply these concepts to understanding the global distribution of biological diversity.
- Survey fundamental concepts of species interactions, such as competition and mutualism, comprehend how species interactions differ between tropical and extra-tropical communities, and appreciate how species diversity impacts structure, function, and conservation of these communities.

- Appreciate the full range of biological variation harbored in tropical communities, and apply current evolutionary and ecological theories for how this diversity was created and is maintained.
- Identify and know the taxonomy and natural history of over 50 key species.
- Use basic taxonomy and systematics.
- Make diversity and richness estimates.
- Employ basic descriptive statistics and graphing.
- Differentiate the proximate and ultimate factors that erode biodiversity, particularly in the tropics, recognize how human activity is related to these, and know which species are most prone to extinction.
- Develop public speaking abilities for communicating the results of scientific studies.
- Merge language, culture, and ecology to construct a more holistic conservation ethic.
- Articulate with data the fate of tropical biodiversity and forge a stronger and more effective resolve to save it.

Course Prerequisites

None

Methods of Instruction

Students will attend lectures and related lab and field activities. Lectures will emphasize theory and current empirical patterns. They will read and analyze current literature. In addition, students will spend considerable time in the field to learn the natural history of local species, and how to identify them. Faculty-led, short experiments in groups will be used to teach how biodiversity studies are conducted, including how data are collected and analyzed statistically. Laboratory activities will be used to better illustrate key concepts.

Assessment and Grading

Participation	20 %
Weekly Quizzes	10 %
Laboratory/Field	30 %
Final Exam	20 %
Participation	20 %
Total	100 %

Course Requirements

Weekly Quizzes

Each week, students will take a quiz on the previous week's course material, including lectures, labs, activities and readings. Quizzes will have True/False, Multiple Choice, calculations, filling in blanks and short answer questions. Quizzes will cover only new material, but similar questions to those on the quizzes will be seen again on the comprehensive final exam.

Laboratory/Field

Each lecture topic will have associated laboratory or field activities that stress or emphasize key concepts. Lecture Activities will place important concepts into hands on learning opportunities. These will result in worksheets that will be graded. Students are asked to collect data in the field to answer basic ecological questions. Results of these research projects will be presented orally. Species reports will be evaluated in the form of a practical exam.

Lab Assessment (total of 30% for final evaluation)

Lab Reports	10 %
Practical Exam	10 %
Independent Research Manuscript	10 %

Final Exam

In the middle and at the end of the course, students will take an exam covering all previous material. As with quizzes, the midterm and final exam will have a variety of question formats, including True/False, Multiple Choice, calculations, filling in blanks and short answer questions.

Attendance and Class participation (20%)

Attendance is noted for each lecture and activity. Participation is noted in discussions, activity, and presentations.

Attendance Policy

Regular class attendance is required throughout the program, and all unexcused absences will result in a lower participation grade for any affected CIEE course. Due to the intensive schedules for Open Campus and Short Term programs, unexcused absences that constitute more than 10% of the total course will result in a written warning.

Students who transfer from one CIEE class to another during the add/drop period will not be considered absent from the first session(s) of their new class, provided they were marked present for the first session(s) of their original class. Otherwise, the absence(s) from the original class carry over to the new class and count against the grade in that class.

For CIEE classes, excessively tardy (over 15 minutes late) students must be marked absent. Attendance policies also apply to any required co-curricular class excursion or event, as well as to Internship, Service Learning, or required field placement. Students who miss class for personal travel, including unforeseen delays that arise as a result of personal travel, will be marked as absent and unexcused. No make-up or re-sit opportunity will be provided.

Attendance policies also apply to any required class excursion, with the exception that some class excursions cannot accommodate any tardiness, and students risk being marked as absent if they fail to be present at the appointed time.

Unexcused absences will lead to the following penalties:

Percentage of Total Course Hours Missed	*Equivalent Number of Open Campus Semester classes*	*Minimum Penalty*

Up to 10%	1 content classes, or up to 2 language classes	Participation graded as per class requirements
10 – 20%	2 content classes, or 3-4 language classes	Participation graded as per class requirements; **written warning**
More than 20%	3 content classes, or 5 language classes	Automatic **course failure**, and possible expulsion

Weekly Schedule

NOTE: this schedule is subject to change at the discretion of the instructor to take advantage of current experiential learning opportunities.

Week 1

Class 1.1 What and where are the Tropics?

Students will see that tropical habitat includes far more than lowland tropical rain forest. What determines tropical habitat type will be explored globally, regionally and locally.

Readings: Chapter 1

Week 2

Class 2.1 Classifying Tropical Ecosystem Diversity

Due to the wide variety of tropical ecosystem types, biologists, conservationists and others need a system to describe them, beyond general biomes. Students will be exposed to various methods to classify and name communities. The Holdridge Life Zone system will be explored, as it is still the standard for naming tropical ecosystem types in Costa Rica and many other Neotropical countries.

Readings: Chapter 11, Olson et al. 2001

Lab/Field 2.1 Holdridge Life Zone Calculations

Students will use weather data from the internet to map ecosystems in Costa Rica. Students will use weather data to calculate biotemperature and understand how it differs from temperature. Likewise, students will use biotemperature to calculate Potential Evapotranspiration (PET). Finally, students will calculate PET ratio and use the Holdridge Life Zone graph to name and map major sites of biological study in Costa Rica.

Class 2.2 Biogeography of the Tropics

As with temperature and precipitation, altitude and latitude also impact tropical ecosystems. Students will also study the causes and consequences of Tropical soil composition and fertility, plant responses, nutrient recycling and replenishment, plant adaptations for sustained high productivity and the importance of mycorrhizae as foundation species.

Reading: Chapter 10, Chapter 12, Nadeau and Sullivan 2015

Quiz

Lab/Field 2.2 Exploring an elevational gradient

Students will go on a local excursion from 700 – 1700 meters with their instructor to see and learn how ecosystems change with altitude first hand. They will also start finding key tropical species. Species reports will be given on key taxa at the family, genus and species level.

Quiz

Week 3 Major taxonomic groups

Class 2.3 Classifying Tropical Biodiversity

Students will then learn about the notion of biodiversity used in the field of Ecology, from individuals to landscapes. They will also learn about how species are currently classified. The domains and kingdoms in the tree of life will be explored.

Reading: Naeem et al. 2016, Caley et al. 2014.

Quiz

Lab/Field 3.1 Species Reports

Student will go on a local excursion from 700 – 1700 meters with their instructor to find key species. Species reports will be given by students and instructor on key taxa at the family, genus and species level.

Class 3.2 Plants and Fungi

Students will explore the basic biology and taxonomy of this group. Students will learn the biology of the most important taxa, both at the regional and global level. Human-caused threats to these taxa will be discussed.

Readings: Chapter 11 (Introduction) in Janzen 1983.

Lab/Field 3.2 Species Reports

Student will go on a local excursion from 700 – 1700 meters with their instructor to find key species. Species reports will be given on key taxa at the family, genus and species level.

Class 3.3 Vertebrates

Students will explore the basic biology and taxonomy of this group. Students will learn the biology of the most important taxa, both at the regional and global level. Human-caused threats to these taxa will be discussed.

Reading: Chapter 8-10 (Introduction only) in Janzen 1983.

- Practical Exam

Week 4

Class 4.1 Tropical Forest Structure and Plant Growth Forms

Students will identify and definine growth form: understory, subcanopy, canopy, lianas, vines, epiphytes, hemi-epiphytes, epiphylls. Abiotic differences experienced by different growth forms, morphological and physiological adaptations.

Readings: Chapter 3, Rundel and Gibson 1996, Collins et al. 2015.

Lab/Field 4.1 Plant Growth Forms

Students will explore plant growth forms in groups, first using provided literature but adding online information, as well. Students will pull examples from the forest and present their growth form, how it relates to forest structure, its ecological challenges and several adaptations to face these challenges.

Class 4.2 Species Interactions and food webs in the tropics

Beginning with how individual populations respond to limiting resources and competition, students will examine the ecological changes of all interact types: Mutualism, Commensalism, Parasitism, Predation, Neutralism, Ammensalism, Competition. The significance of food webs for tropical diversity and the challenges for conservation will be discussed.

Readings: Chapter 7, Janzen 1983, Bregman et al. 2015.

Lab/Field 4.2 Food webs

Using actual data from bromeliad tank communities, students will construct food webs. Students will use these webs to determine attributes of food webs, including trophic species, connectance, interaction strength and omnivory. Students will remove species from the web as a viability analysis, looking for secondary extinctions and evidence of keystone species.

Class 4.3 Herbivory, pollination, seed dispersal

Students will explore the defintion of herbivory, how the tropics differ from temperate forests in amount and type of herbivory, physical and chemical plant defenses and their impact on herbivores. Students will analyze the importance of pollination ecology theoretically. They will examine the inherent coevolutionary conflict between pollinators and their flowers. They will see how this leads to pollination syndromes and odd cases of non-rewarding flowers, flowers that never open and plants that reproduce exclusively through vegetative means. Finally, students will probe theory suggesting seed dispersal is an important component of tropical plant reproductive success, food for many tropical forest animals and the movement of seeds can feedback to maintenance of tropical diversity.

Readings: Salazar and Marquis 2012, Leal et al. 2014, Wang and Smith 2002,

Hamilton 1999, Janzen and Martin 1981

Quiz

Week 5

Class 5.1 Distribution of biodiversity

Biodiversity is not distributed evenly in taxonomic or geographic terms. Students will see what taxonomic groups have more and less species even when the number of undescribed species is considered. Then students will learn that the tropics harbor more species, more endemic species. What area of the world is considered tropical will be defined.

Reading: Scheffers et al. 2012, Stork and Habel 2014

Lab/Field 5.1 Group Field Problem

Students in small groups will explore nearby habitats, collect and analyze data and present their findings orally to other groups. For this group field problem, emphasis will be placed on biodiversity patterns.

Class 5.2 Theories for latitudinal species gradient: Evolutionary

The two general mechanisms to explain why more species are created in the tropics than in the temperate zone will be explored: more time and area, and higher evolutionary rates. Key concepts to understand evolutionary rates will be explored: speciation, natural selection, sexual selection, genetic drift, fitness, adaptation, evolution, models of speciation.

Readings: Romdal et al. 2013,

Lab/Field 5.2 Independent Field Research

Students will begin a longer research opportunity focusing on any aspect of

Tropical Ecology. They will begin with brainstorming and will write a short proposal based on their ideas.

Class 5.3 Theories for latitudinal species gradient: Ecological

The latitudinal gradient in productivity will be presented as mechanism behind latitudinal gradient in species richness. Students will also learn the role of species interactions in maintaining biodiversity. The focus of the discussion will be on niche based-models and density-dependent factors that can maintain a higher diversity of species in the tropics.

Readings: Gillman et al. 2015

Quiz

Week 6

Class 6.1 Tropical forests under pressure

Students will explore the major anthropogenic influences on tropical forests. Land-use change, poaching, invasive species, and global warming will be discussed.

Readings: Pounds et al. 2006, Galetti et al. 2013

Lab/Field 6.1 Independent Field Research

Students will collect data for their independent field research.

Class 6.2 Loss of biodiversity

Beginning with the different definitions of extinction, and methods to calculate past and present extinction, student will address the issue of the sixth great mass extinction in the Anthropocene. Students will learn the traits that make tropical species more prone to extinction in the Anthropocene compared to temperate species.

Reading: Corlett 2015, Laurance et al. 2014

Lab/Field 6.2 Independent Field Research

Students will present the results of their research project orally.

Class 6.3 Future of Tropical Biodiversity

Students will discuss the relative importance of personal behavior vs. government policy to tropical conservation. Prospects for global biodiversity; relationship between population growth, resource consumption and environmental degradation; environmental ethics and activism; philosophy of denial, techno-fixes, stoic resignation, and tragic optimism will be discussed.

Readings**:** Orr 2004, Ehrlich and Pringle 2008

- Final Exam

Course Materials

Course Textbook

Janzen, Daniel. H. 1983. *Costa Rican Natural History*. Chicago: The University of Chicago Press.

Kricher, J. 2011. Tropical Ecology. Princeton University Press

Readings

Bregman, T. P., A. C. Lees, N. Seddon, H. EA MacGregor, B. Darski, A. Aleixo, M. B. Bonsall, and J. A. Tobias. 2015. Species Interactions Regulate the Collapse of Biodiversity and Ecosystem Function in Tropical Forest Fragments. Ecology 96: 2692-2704.

Caley, J.C. et al. 2014. Global species richness estimates have not converged. Trends in Ecology and Evoution 29: 187-188.

Collins, C.G., J.S. Wright and N. Wurzburger. 2015. Root and Leaf Traits Reflect Distinct Resource Allocation Strategies in Tropical Trees and Lianas. Oecologia 2015:1-11.

Corlett, R. T. 2015. The Anthropocene concept in ecology and conservation. Trends in Ecology

& Evolution 30(1): 36-41.
Ehrlich and Pringle, R. M. 2008. Where does biodiversity go from here? A grim business-as-usual forecast and a hopeful portfolio of partial solutions. PNAS 105 (Supplement 1): 11579-11586.
Galetti, M. et al. 2013. Functional extinction of birds drives rapid evolutionary changes in seed size. Science 340: 1086-1090.
Gillman, L.N. et al. 2015. Latitude, productivity and species richness. Global Ecology and Biogeography 24: 107-117.
Hamilton, M.B. 1999. Tropical Tree Gene Flow and Seed Dispersal. Nature 401: 129-130.
Janzen, D. H. and P.S. Martin. 1981. Neotropical Anachronisms: The Fruits the Gomphotheres ate. Science 215: 19-27.
Laurance, W.F. et al. 2014. Agricultural expansion and its impact on tropical nature. Trends in Ecology and Evolution 29: 107-116.
Leal, I.R. et al. 2014. The multiple impacts of leaf-cutting ants and their novel ecological role in human-modified neotropical forests. Biotropica 46: 516-528.
Nadeau, M.B. and T.P. Sullivan. 2015. Relationships between Plant Biodiversity and Soil Fertility in a Mature Tropical Forest. International Journal of Forest Research 2015: 1-13.
Naeem, S., Chazdon, R., Duffy, J.E., Prager, C., and Worm, B. 2016. Biodiversity and human well-being: an essential link for sustainable development. Proc. R. Soc. B 2016 283 20162091.
Orr, D. W. 2004. Hope in hard times. Conservation Biology 18: 295-298.
Olson, D. M. E. Dinerstein, E. D. Wikramanayake, N. D. Burgess, G. V. N. Powell, E. C. Underwood, J. A. D'amico, I. Itoua, H. E. Strand, J. C. Morrison, C. J. Loucks, T. F. Allnutt, T. H. Ricketts, Y. Kura, J. F. Lamoreux, W. W. Wettengel, P. Hedao, and K.R. Kassem. 2001. Terrestrial Ecoregions of the World: A New Map of Life on Earth. Bioscience 51: 933-938.
Pounds, J. A., et al., 2006. Widespread amphibian extinctions from epidemic disease driven by global warming. Nature 439: 161-167
Romdal, T.S. et al. 2013. Life on a tropical planet: niche conservatism and the global diversity gradient. Global Ecology and Biogeography 22: 344-350.
Rundel, P.W. and A.C. Gibson. 1996. Adaptive Strategies of Growth forms and Physiological Ecology in Neotropical Lowland Rain Forest Plants. In: Gibson A.C. (ed.) Neotropical Biodiversity and Conservation. Occasional Papers of the Mildred E. Mathias Botanical Garden 1: 33-71.
Salazar, D. and R.J. Marquis. 2012. Herbivory pressure increases toward the equator. PNAS 109:12616-12620.
Scheffer, M. et al. 2104. Why trees and shrubs but rarely trubs? Trends in Ecology and Evolution 29: 433-434.
Stork, N.E. and J.C. Habel. 2014. Can biodiversity hotspots protect more than tropical forest plants and vertebrates? Journal of Biogeography 41: 421-428.
Wang, B.C. and T.B. Smith. 2002. Closing the Seed Dispersal Loop. TREE 17: 379-385.