CIEE Monteverde, Costa Rica

Course name:	Tropical Biology
Course number:	BIOL 3001 MVSU
Programs offering course:	Tropical Ecology and Conservation
Language of instruction:	English
U.S. Semester Credits:	4 semester/6 quarter hours (20 lecture hours, 120 lab hours)
Contact Hours:	60 hours
Term:	Summer 2019

Course Description

This course explores the variety of tropical communities, how they 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 be taught about the paradox of high tropical productivity despite poor soils, and will investigate nutrient and energy cycles. Students will explore the complexity of 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, and proximate and ultimate causes for the loss of biodiversity. They will compare intact and human-transformed tropical communities, and understand the forces that erode species and ecological functions, including those vital to human wellbeing. Finally, students will apply these lessons to conservation issues in Costa Rica that they have witnessed firsthand, and will explore how to lessen human impacts. Taxonomy and natural history of the flora and fauna of Costa Rica will be taught primarily during field trip laboratories and outings to diverse ecosystems (and reinforced in lectures as examples, as appropriate). In lecture sessions, students will participate by reading scientific literature and conducting discussions of the articles with others in the class.

Learning Objectives

Upon completion of the course the students will:

- 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.
- Understand fundamental evolutionary concepts such as speciation, extinction, natural selection, and drift, and apply these concepts to understanding the global distribution of biological diversity.
- Understand 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 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 100 species.
- Understand basic taxonomy and systematics.

- Learn and employ correctly basic quantitative, experimental, or observational ecological field methods, such as population censuses, making diversity and richness estimates, capture and release methods, etc.
- Learn and employ correctly basic descriptive statistics and graphing.
- Understand 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.
- Explore the fate of tropical biodiversity, and forge a stronger and more effective resolve to save it.

Course Requirements

In addition to traditional lectures, students read and present current literature. There is extensive time in the field learning the biodiversity of all major life zones in Costa Rica. Field trips, outings, and exercises highlight major taxa and explore their basic biology and taxonomy, or the fundamentals of a major ecosystem.

Textbook

Kricher, J. (2011). *Tropical Ecology*. Princeton University Press.

CIEE Tropical Ecology and Conservation. 2013. *Tropical Diversity Laboratory Diversity Day Handouts*. San José: printed by the authors

Masters, A. R., *et al.* 2012. *CIEE Handbook of Plant Taxonomy*. Costa Rica. San José: printed by the authors. Print.

Methods of Instruction

Students will attend lectures given by instructors, and make readings presentations, in which they read, present, and discuss current literature. Lectures and readings will focus primarily on theory and methodology. Students will attend laboratory sessions in which they carry out field experiments, collect and analyze data, and present the results in written and oral reports. In laboratory sessions, students will also participate in “Diversity days”, which immerse them in the natural history and taxonomy of important taxa or the fundamentals of major ecosystems.

Assessment and Final Grade

1. Midterm exam	30%
2. Final exam	30%
3. Laboratory problem set 5%	35%: field reports 20%, lab practical 10%,
4. Discussion participation:	5%

Weekly Schedule

Week 1 (field trip 1: classes and activities on location)

Lectures

Lecture 1 Important species and ecology of mangroves, lowland rainforests, coastal ecosystems; island-mainland contrasts; introduction to biological classification; common plant families and their identification.

Lecture 2: Theory of Island Biogeography. What the theory aspires to understand and predict; empirical patterns of species richness on islands; theoretical relationship between habitat size, extinction rate, isolation from mainland, and species richness; concept of an equilibrium S; landbridge versus volcanic islands; IBT as applied to nature reserves.
Lecture 3. History of Costa Rican conservation. National parks and protected areas; system of national conservation areas; components of conservation areas and their integration and coordiation; key legislation; innovative economic policy for conservation

Activities
Hikes: Ecology of Highland Oak Forest and Paramo, Coastal Mangrove Forest and Lowland Pacific Wet Forest, Islands

Readings
CIEE Tropical Ecology and Conservation. 2013. *Tropical Diversity Laboratory Diversity Day Handouts*.
Corlett 2015. The Anthropocene concept in ecology and conservation.
Courchamp *et al*. 2015. Fundamental ecology is fundamental.
Masters *et al.* 2012. *CIEE Handbook of Plant Taxonomy*.

Evaluations
Discussion Topic 1: Tropical Conservation with Costa Rica as model

Week 2 (field trip 1 continued: classes and activities on location)

Lectures
Lecture 4. Important species and ecology of transitional and seasonally dry tropical forests.
Lecture 5. Introduction to plant growth forms
Lecture 6: Introduction to Mammal Diversity
Lecture 7 Introduction to Herp Diversity

Activities
Hikes: Ecology of Moist Forest and Seasonal Dry Forest; herp night hike
Group Field Experiments
Mammal Camera Traps

Readings
CIEE Tropical Ecology and Conservation. 2013. *Tropical Diversity Laboratory Diversity Day Handouts*.
Janzen & Martin. 1982. Neotropical anachronisms: the fruits the gomphotheres ate.
Masters *et al.* 2012. *CIEE Handbook of Plant Taxonomy*. Costa Rica.
Seddon et al. 2014. Reversing defaunation: Restoring species in a changing world.

Evaluations
Laboratory: Field Report 1
Discussion Topic 2: Building a National Park System, Guanacaste Conservation Area Regeneration

Week 3

Lectures
Lecture 8. Important species and ecology of cloud forests.
Lecture 9. Global climate, climate and communities, and climate change in the Tropics.
The impact of Earth's relationship with the sun on global rainfall and seasonality,

windward/leeward effects, Holdridge Life Zones; Costa Rica and Monteverde weather, el Niño and global warming. Close-up on climate and climate change in Monteverde
Lecture 10: Tropical soils; seasonality in the tropics. Causes and consequences of tropical soil composition and fertility, agents of decomposition and recycling, the role of mycorrhizae.

Activities
- Hike in the Monteverde Cloud Forest
- Plant Diversity Workshop

Readings
- Pounds, Fogden, & Campbell. 1999. Biological response to climate change on a tropical mountain.
- Brodie *et al.* 2012. Climate Change and Tropical Biodiversity: A New Focus.
- Townsend *et al.* 2008. The biogeochemical heterogeneity of tropical forests.
- Nadeau & Sullivan. 2015. Relationships between Plant Biodiversity and Soil Fertility in a Mature Tropical Forest.

Evaluations
- Laboratory: Lab Practical

Week 4

Lectures

Lecture 11: Species Interactions and Food Webs in the Tropics. Interactions: mutualism, commensalism, predation/parasitism neutralism and ammensalism. Herbivory, pollination and seed dispersal in the Tropics. Population persistence and species coexistence under competition. The significance of food webs for tropical diversity and the challenges for conservation.

Activities
- Group Field Experiment
- Insect Diversity Workshop
- Plant Growth Forms Workshop
- Bird Diversity Workshop

Readings
- Salazar & Marquis. 2012. Herbivore pressure increases toward the equator.
- Leal *et al.* 2014. The multiple impacts of leaf-cutting ants and their novel ecological role in human-modified neotropical forests.
- Rundel & Gibson.1996. Adaptive strategies of growth form and physiological ecology in neotropical lowland rain forest plant
- Scheffer. 2104. Why trees and shrubs but rarely trubs?

Evaluations
- Laboratory: Field report 2
- Midterm Exam

Week 5

Lectures

Lecture 12: Distribution of biodiversity. Concept of biodiversity; levels of biological organization; the concept of species and its relationship to biodiversity; the latitudinal gradient in species richness; definitions and patterns of endemism; hotspots of biological diversity.Criteria and methodology for hotspot designation; spatial distribution and congruence of hotspots; conservation priority-setting

Activities (field trip 2; lectures and activities on location)
- Hike to Atlantic slope
- Fungal Diversity Workshop
- Bird Walks and Mist-netting
- Night Hike

Readings
- Caley *et al.* 2014. Global species richness estimates have not converged.
- Stork & Habel. 2014. Can biodiversity hotspots protect more than tropical forest plants and vertebrates?
- Scheffers *et al.* 2012. What we know and don't know about Earth's missing biodiversity.

Week 6

Lectures
- Lecture 13: Theories for the latitudinal gradient in species richness, Part 1. Evolutionary processes in the tropics: Theory of evolution, natural selection; models of selection (stabilizing, directional, and divergent); genetic drift; models of speciation (allopatric and parapatric); speciation and extinction in the tropics
- Lecture 14: Theories for the latitudinal gradient in species richness, Part 2. Ecological processes that affect species coexistence in the tropics: species interactions, concept of niche, productivity and resource availability, dispersal, metacommunities

Readings
- Brown. 2014. Why are there so many species in the Tropics?
- Romdal *et al.* 2013. Life on a tropical planet: niche conservatism and the global diversity gradient.
- Gillman *et al.* 2015. Latitude, productivity and species richness.

Evaluations
- None

Week 7

Lectures
- Lecture 15: Tropical forests under pressure. Major anthropogenic influences on tropical forests (land-use change, poaching, invasive species, global warming).
- Lecture 16: The loss of biodiversity. Historical and contemporary rates of biodiversity; proximate and ultimate causes; extinction-prone taxa; the case of tropical amphibian extinctions; changing climate, disease outbreak, negative synergisms

Activities
- Workshop on Species Diversity and Richness Calculations

Readings
- Pounds, J. A., *et al*., 2006. Widespread amphibian extinctions from epidemic disease driven by global warming.
- Galetti *et al*. 2013. Functional extinction of birds drives rapid evolutionary changes in seed size.
- Laurance *et al*. 2014. Agricultural expansion and its impact on tropical nature.

Evaluations
- Laboratory: Problem set

Week 8

Lectures

Lecture 17: Future of Tropical Biodiversity. 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

Readings

Ehrlich and Pringle. 2008. Where does biodiversity go from here? A grim business-as-usual forecast and a hopeful portfolio of partial solutions.

Orr. 2004. Hope in hard times.

Week 9 (Departure week)

Evaluation

Final Exam

Course Materials

Readings

Brodie, J. *et al.* (2012). Climate Change and Tropical Biodiversity: A New Focus. *Trends in Ecology and Evolution, 27,* 145-150.

Brown, J.H. (2014). Why are there so many species in the Tropics? *Journal of Biogeography, 41*, 8-22.

Corlett, R. T. (2015). The Anthropocene concept in ecology and conservation. *Trends in Ecology & Evolution, 30(1),* 36-41.

Courchamp F. *et al*. (2015). Fundamental ecology is fundamental. *Trends in Ecology & Evolution, 30(1),* 9-16.

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.

Janzen, D.H. & Martin, P. S. (1982). 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. & Sullivan, T.P. (2015). Relationships between Plant Biodiversity and Soil Fertility in a Mature Tropical Forest. *International Journal of Forest Research,* 1-13.

Orr, D. W. (2004). Hope in hard times. *Conservation Biology, 18,* 295-298.

Pounds, J. A. P., Fogden, M.P., & Campbell, J. H. (1999). Biological response to climate change on a tropical mountain. *Nature, 398,* 611-614.

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., & Gibson, A. C. (1996). Adaptive strategies of growth form and physiological ecology in neotropical lowland rain forest plants. *Neotropical Biodiversity and Conservation, 1,* 33.
Salazar, D. & Marquis, R. J. (2012). Herbivore pressure increases toward the equator. *PNAS, 109,* 2616-12620.
Scheffer, M. *et al.* (2014). Why trees and shrubs but rarely trubs? *Trends in Ecology and Evolution, 29,* 433-434.
Seddon, P.J. *et al.* (2014). Reversing defaunation: Restoring species in a changing world. *Science, 345,* 406-412.
Townsend, A. R., Asner, G. P. & Cleveland, C. C. 2008. The biogeochemical heterogeneity of tropical forests. *Trends in Ecology and Evolution, 23*, 424-431.