CIEE Monteverde, Costa Rica

Course name:	Tropical Community Ecology
Course number:	ECOL 3001 MVCR
Programs offering course:	Costa Rica: Monteverde - Tropical Ecology and Conservation
Language of instruction:	English
U.S. Semester Credits:	4 semester/6 quarter hours
Contact Hours:	60 hours
Term:	Spring 2020

Course Description

This course explores the variety of tropical communities, how they are organized, how they function and how they are compromised by human activity. Students will build a tropical community from the ground up, both theoretically and through direct experience and experimentation in the field. They will learn to define the Tropics based upon global climate patterns, to know why tropical forests are productive despite poor soils, how plants adapt to live according to their growth form, how energy flows through Tropical communities and what this tell us about their organization and stability, the many ways species interact and how this impacts ecosystem function. Students contrast intact and human-transformed Tropical communities and assess how they are different structurally and understand how this can lead to loss of function. Ecosystem functions that are vital to human wellbeing are explored. Finally, students will extrapolate these issues to conservation and how to lessen human impact on Tropical communities.

Learning Objectives

Upon completion of the course students will:

- Understand fundamental ecological concepts, particularly those related to Tropical Ecosystems and how the Tropics are different from Temperate and Boreal forests.
- Appreciate the full range of variation in Tropical communities, where this variation comes from and how it impacts structure, function and conservation of these communities.
- Critique models of Tropical Conservation and how likely these are lessen human impact.
- Merge Language, Culture and Ecology to construct a more holistic conservation ethic.
- Tackle the biological complexity of Tropical communities, more fully appreciate their importance and forge a stronger and more effective resolve to save them.

Course Prerequisites

One year of Introductory Biology and one elective in whole organismic biology or conservation.

Methods of Instruction

Students will attend lectures and related activities. Lectures will emphasize theory and current empirical patterns. Students will read and analyze current literature. In addition, students will travel and spend extensive time in the field in different ecosystems to understand the impact of climate on their composition, structure and function. Faculty-led, short experiments in groups will emphasize patterns of diversity and species interactions.

Assessment and Final Grade

1.	Midterm exam	25%
2.	Final exam	40%
3.	Written field report	15%
4.	Oral field reports	15%
5.	Participation	5%

Course Requirements

Midterm Exam

The midterm exam will include True/False, Multiple Choice, Short and Long Answer formats for material covered in lecture or in readings. These will cover objective, factual information.

Final Exam

The final exam will include True/False, Multiple Choice, Short and Long Answer formats for material covered in lecture or in readings. These will cover objective, factual information.

Written Field Report

One short experiment will result in a field report, which is written as manuscript in the style of a short note in a scientific journal. This will be no more than three pages in length and will include cited literature, data analysis, presentation and interpretation.

Oral Field Reports

Short field experiments on topic of species interaction, behavioral ecology, etc. Will require an oral presentation with specific grading rubrics. The student will be graded on how well they present and explain the project: justification, study question, methods, results and conclusions.

Participation

Students are expected to attend all lectures and activities, hand in all assignments, as well as ask questions and participate in discussions. Only students who are active participants will receive full credit. Perfect attendance and handing in all assignments will

result in 3 of 5 points. To earn beyond 3 points, students must engage fully in all lectures, activities, and discussions.

Weekly Schedule

Week 1

Topic: Orientation; Field Trip 1 (Survey of Seasonal Tropical Ecosystems). Why Study Tropical Ecology and Conservation? Tropical ecology and the conservation agenda.

Activities:
Outings in Paramo, Mangroves, Lowland Wet Forest.
Field Experiments: Diversity and Species Interactions. Statistical analyses.

Discussion:
Current State of Tropical Forests

Readings:
Malhi *et al.* (2014)
Janzen and Martin (1981)

Assessments:
Oral report on field experiment due

Week 2

Topic: Field Trip 1, continued. Why Study Tropical Ecology and Conservation? Tropical ecology and the conservation agenda.

Activities:
Outings in Lowland Moist Forest, Lowland Dry Forest
Field Experiments: Diversity and Species Interactions. Statistical analyses.

Readings:
Seddon et al. (2014)
Corlett (2012)

Assessments:
Written field report assigned (not due)

Week 3

Topic: Defining and Distinguishing between Ecological Communities

Lecture: How to define ecological communities and distinguish between tropical communities. Hierarchy of biological organization, community assembly rules, stochastic vs. deterministic effects, empirical patterns, Tropical forests vs. temperate forests.

Activities:
Field experiments: Diversity and Species Interactions. Statistical analyses.

Readings:
Gillespie (2004)
Fayle et al. (2015)

Assessment:
Written field report due

Week 4

Topic: Global Climate and Ecology

Lecture: Global Climate: Impact in Defining the Tropics and Tropical Community Types. The impact of Earth's relationship with the sun on global rainfall and seasonality, windward/leeward effects, Costa Rican and Monteverde weather, el Niño and global warming effects, Holdridge Life Zone Classification System.

Activities:
Weather activity
Field Experiments: Diversity and Species Interactions. Statistical analyses.

Readings:
Corlett (2014)
Brodie et al (2012)
Olson et al. (2001)

Assessment:
Oral field report due.

Week 5

Topic: The Paradox of Tropical Luxuriance.

Lecture: The paradox of tropical luxuriance. The causes and consequences of Tropical soil composition and fertility, plant responses and sustained high productivity, mycorrhizae, likelihood of sustainable agriculture in the tropics.

Activities:
Soil analyses

Readings:
Townsend (2008)
Mann (2002)
Nadeau and Sullivan (2015)

Week 6

Topic: Movement of Matter and Energy through Tropical Communities.

Lecture: How energy moves, how much is captured, trophic relationships, food webs, that matter is finite and is recycled, major biogeochemical cycles, how cycles are disrupted by humans.

Readings:
Laurance, *et al.* (1997)
Bello *et al.* (2015)
Poorter *et al.* (2016)

Weeks 7

Topics: Plant Growth Forms.

Lecture: Plant growth forms: their ecology and physiology. Identifying and defining growth form: understory, subcanopy, canopy, lianas, vines, epiphytes, hemi-epiphytes, epiphylls. Abiotic differences experienced by different growth forms, morphological and physiological adaptations

Activities:
Plant growth form presentations

Readings:
Rundel and Gibson (1996)
Valladares *et al.* (2002)
Collins *et al.* (2015)

Assessment:
Midterm exam

Week 8

Topic: Field Trip 2. Community assemblages and ecological relationships in Atlantic Slope Forests and Caribbean Marine ecosystems

Activities:
Hikes in Atlantic Slope Forest

Week 9

Topic: Field Trip 2 (continued). Community assemblages and ecological relationships in Atlantic Slope Forests and Caribbean Marine ecosystems

Activities:
Hikes along Caribbean coastal ecosystems
Swim in coral reefs in Bocas del Toro

Week 10

Topic: Gap Dynamics and Natural Succession in Tropical Forests.

Lecture: How a gap forms, gap size distribution and frequency, succession in gaps, who wins a gap, the random walk to extinction.

Readings:
Brokaw and Busing (2000)
Chazdon (2008)
Hunter *et al.* (2015).

Week 11

Topic: Introduction to Species Interactions.

Lecture: Species interactions in the tropics and beyond: Mutualism, Commensalism, Parasitism, Predation, Neutralism, Ammensalism, Competition

Readings:
Janzen (1983)
Schoener *et al.* (2005)
Bregman *et al.* (2015)

Lecture: Herbivory and Plant Defenses in Tropical Forest. Defining and quantifying herbivory, how the tropics differ from temperate forests in amount and type of herbivory, physical and chemical plant defenses and their impact on herbivores, mimicry and coevolution.

Readings:
Hunt (2003)
Fine *et al.* (2004)
Salazar and Marquis (2012)
Leal *et al.* (2014)

Week 12

Topic: Pollination and Seed Dispersal.

Lecture: Pollination and Seed Dispersal: Payoffs of both partners, optimal outcrossing distances, morphological, physiological and behavioral changes, density-dependent mortality, impact on gene pool and distribution, disruption by humans and associated problems.

Readings:
Mawdsley, *et al.* (2008)
Wang and Smith (2002)
Betts *et al.* (2015)
Bruna (1999)
Hamilton (1999).

Topic: Seasonality. Patterns related to seasonality in flowering and fruiting, underlying reasons and consequences to mutualistic partners.

Readings:
Sakai (2001)

Week 13 Topic: Disturbance, Biodiversity and Community Stability.

Lecture: How high biodiversity in Tropical communities impacts its stability, including resistance to invasion, resistance, resilience, robustness, redundancy, Portfolio Effects, increase in function with biodiversity, loss of biodiversity and its impact on stability.

Readings:
Zavaleta *et al.* (2009)
Lewis (2009)
Basic and Blummenthal (2005).

Week 14 Topic: The Future of Tropical Forests and How to Save Them.

Lecture: The Future of Tropical Forests and How to Save Them. Personal behavior vs. government policy, regeneration and restoration, the importance of reserves, the place humans have in an intact ecosystem, the future, where to go with the knowledge gained on the program, how to make difference.

Readings**:**
Wright (2005)
Laurence (2005)
Tabarelli *et al.* (2012)
du Toit *et al.* (2004)
Wilson (2000)
Orr (2004)

Assessment:
Final exam

Readings

Bello, C. M., M.A. Pizo, L.F.S. Magnago, M.F. Rocha, R.A.F. Lima, C.A. Peres, O. Ovaskainen, P. Jordano. (2015). Defaunation affects carbon storage in tropical forests. Sci. Adv. 1: 1-10.

Blummenthal, D. (2005). Interrelated Causes of Plant Invasion. Science 310: 243-244.

Betts, M. G., Hadley, A. S., & Kress, W. J. (2015). Pollinator recognition by a keystone tropical plant.
PNAS, 112: 3433.

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 *in press*.
Brodie, J., E. Post and W.F. Laurance. (2012). Climate Change and Tropical Biodiversity: A New Focus. Trends in Ecology and Evolution 27: 145-150.
Brokaw, N. and R.T. Busing. (2000). Niche versus Chance and Tree Diversity in Forest Gaps.TREE 15: 183-188.
Bruna, E.M. (1999). Seed Germination in Rainforest Fragments. Nature 402: 139.
Chazdon, R. L. (2008). Chance and Determinism in Tropical Forest Succession, in Walter P. Carson and Stefan A. Schnitzer (eds). Tropical Forest Community Ecology. Wiley-Blackwell.
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. (2012). The Shifted Baseline: Prehistoric Defaunation in the Tropics and its Consequences for Biodiversity Conservation**.** Biological Conservation 163: 13-21.
Corlett. R.T. (2014). 4The Impacts of Climate Change in the Tropics. State of the Tropics 2014 Report: 155-160.
du Toit, J.T. B.H. Walker and B.M. Campbell. (2004). Conserving Tropical Nature: Current Challenges for Ecologists. TREE 19: 12-17.
Fayle, T.M., P. Eggleton, A. Manica, K.M. Yusah and W.A. Foster. (2015). Experimentally testing and assessing the predictive power of species assembly rules for tropical canopy ants. Ecology Letters 18: 254-262.
Fine, P.V.A., I. Mesones and P.D. Coley. (2004). Herbivores Promote Habitat Specialization by Trees in Amazonian Forests. Science 305: 663-665.
Gillespie, R. (2004). Community Assembly through Adaptive Radiation in Hawaiian Spiders. Science 303: 356-359.
Hamilton, M.B. (1999). Tropical Tree Gene Flow and Seed Dispersal. Nature 401: 129-130.
Hunt, J.H. (2003). Cryptic Herbivores of the Rainforest Canopy. Science 300: 916-917.
Hunter, M. O., Keller, M., Morton, D., Cook, B., Lefsky, M., Ducey, M., S. Saleska, R. Cosme de Oliveira Jr and J. Schietti. (2015). Structural Dynamics of Tropical Moist Forest Gaps. PloS one, 10(7), e0132144
Janzen, D. H. and P.S. Martin. (1981). Neotropical Anachronisms: The Fruits the Gomphotheres ate. Science 215: 19-27.
Janzen, D.H. (1983). Food Webs: Who Eats What, Why, How and with What Effects in a Tropical Forest? In: Golley, F. B. (ed.) Tropical Rainforest Ecosystems. Elsevier Scientific: New York.
Laurence, W. F. (2005). When Bigger is Better: the Need for Amazonian Mega-Reserves. TREE 20: 645-648.

Laurence, W.F., S.G. Laurance, L.V. Ferreira, J. M. Rankin-de Marona, C. Gascon and T.E. Lovejoy. (1997). Biomass Collapse in Amazonian Forest Fragments. Science 278: 1117-1118.
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.
Lewis, O.T. (2009). Biodiversity Change and Ecosystem Function in Tropical Forest. Basic and Applied Ecology 10: 97-102.
Malhi, Y. (2012). The Productivity, Metabolism and Carbon Cycle of Tropical Forest Vegetation. Journal of Ecology 100: 65-75.
Malhi, Y. T.A. Gardner, G.R. Goldsmith, M.R. Silman and P. Zelazowski. (2014). Tropical Forests in the Anthropocene. Ann. Rev. Environ. Resour. 2014. 39:125–59.
Mann, C. C. (2002). The Real Dirt on Rainforest Fertility. Science 297: 920-923.
Mawdsley, N.A., S.G. Compton and R.J. Whittaker. (2008). Population Persistence, Pollination, Mutualism, and Figs in Fragmented Tropical Landscapes. Conservation Biology 12: 1416-1420.
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.
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.
Orr, D.W. (2004). Hope in Hard Times. Conservation Biology 18: 295-297.
Poorter, L. et al. (2016). Biomass Resilience of Neotropical Secondary Forest. Nature 530: 211-214.
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.
Sakai, S. (2001). Phenological Diversity in Tropical Forest. Population Ecology 43: 77-86.
Salazar, D. and R.J. Marquis. (2012). Herbivory pressure increases toward the equator. PNAS 109: 12616-12620.
Schoener, T. W., J.B. Losos and D.A. Spiller. (2005). Island Biogeography of Populations: An Introduced Species Transforms Survival Patterns. Science 310: 1807-1809.
Seddon, P.J., C.J. Griffiths, P.S. Soorae, and D.P. Armstrong. (2014). Reversing defaunation: Restoring species in a changing world. Science 345: 406-412.
Stökstad, E. (2006). Plants May be Hidden Methane Source. Science 311: 159.
Tabarelli, M., C.A. Peres and F.P.L. Melo. (2012). The 'Few Winners and Many Losers' Paradigm Revisited: Emerging Prospects for Tropical Forest Biodiversity. Biological Conservation 155: 136-140.
Townsend, A.R., G.P. Asner and C.C. Cleveland. (2008). The Biogeochemical Heterogeneity of Tropical Forest. TREE 23: 424-431.

Townsend, P.A. and K.L. Masters. (2015). Lattice-work corridors for climate change: a conceptual framework for biodiversity conservation and social-ecological resilience in a tropical elevational gradient. Ecology & Society 20: 1-11

Valladares, F. J.B. Skillman and R. W. Pearcy. (2002). Convergence in Light Capture Efficiencies among Tropical Forest Plants with Contrasting Crown Architectures: A Case of Morphological Compensation. American Journal of Botany 89: 1275-1284.

Wang, B.C. and T.B. Smith. (2002). Closing the Seed Dispersal Loop. TREE 17: 379-385.

Wilson, E.O. (2000). On the Future of Conservation Biology. Conservation Biology 14: 1-3.

Wright, J. (2005). Tropical Forests in a Changing Environment**.** TREE 20: 553-560.

Zavaleta, E., J. Pasari, J. Moore, D. Hernández, K.B. Suttle and C.C. Wilmers. (2009). Ecosystem Responses to Community Disassembly. Annals of the NY Academy of Sciences 1162: 311-333.