



## **CIEE Monteverde, Costa Rica**

<b>Course name:</b>	Tropical Community Ecology
<b>Course number:</b>	ECOL 3001 MVCR
<b>Programs offering course:</b>	Costa Rica: Monteverde - Tropical Ecology and Conservation
<b>Language of instruction:</b>	English
<b>U.S. Semester Credits:</b>	4 semester/6 quarter hours
<b>Contact Hours:</b>	60 hours
<b>Term:</b>	Fall 2019

### **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 Blumenthal (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.

Blumenthal, 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). The 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. Schiatti. (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.
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- 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.
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- 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
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- 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.
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- 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.