CIEE Monteverde, Costa Rica

Course name:	Tropical Conservation Biology and Policy
Course number:	BIOL 3001 / CONS 3001 MTVE
Programs offering course:	Monteverde Sustainability and the Environment
Language of instruction:	English
U.S. Semester Credits:	4
Contact Hours:	60
Term:	Spring 2020

Course Description

This course critically explores principal drivers behind the erosion of biological capital and ecological resilience of tropical ecosystems, and what can be done to slow or reverse them. Armed with the scientific foundation for biodiversity conservation plus firsthand knowledge of Costa Rica's natural capital and wealth of ecosystem services, students empirically examine processes threatening the environment. Focus is on habitat loss, climate change, and overexploitation. Students investigate high-profile governmental programs and key legislation, and critique their efficacy in biodiversity protection. With an enhanced understanding of the principles of tropical conservation and how they are actually implemented, students generate imaginative solutions for how conservation practices can evolve more quickly and effectively toward the protection of biodiversity and ecosystem services for the future.

Costa Rica is the little country with the big reputation for biological diversity and environmental protection, and offers a perfect venue for students seeking to experience, understand, and protect global biodiversity. The country emerged as a world leader in the 1970's with bold initiatives to create a national park system and protect its impressive natural capital. Today, nearly 25% of the land is under legal protection, about half of that in public lands and the other under private conservation. The result is that about 5% of global terrestrial biodiversity may be harbored in a nation only the size of West Virginia. To incentivize private conservation and regulate natural resource use, the government has innovative programs such as direct payments for land conservation and highly progressive environmental legislation. Nevertheless, Costa Rica is not immune to global forces, such as large-scale climate change or the international demand for food and fiber at the expense of forest cover. Likewise, common pool resources, such as fisheries, are not always adaptively governed nor are laws regularly enforced. The complexity challenges even the country considered to be a leader in the vanguard of conservation. In this course, students use a scientific framework to understand the ecological impacts of deforestation, climate change, and overexploitation on ecological communities, deconstruct the impacts of environmental policy on biodiversity conservation, and propose a way forward.

Learning Objectives

Upon completion of this course, students will

1. Have command over the concepts and terminology of ecological resilience, biodiversity, species richness, diversity, abundance, community composition, functional groups, genetic diversity, and adaptive capacity.

2. Be able to explain (or predict) ecosystem consequences following disruptions to trophic interactions caused by overharvesting, habitat loss, climate change, and loss of resiliency.
3. Become adept at interpreting IUCN Redlist threat categories and using them in conservation priority-setting
4. Give informed assessments of the levelized environmental impacts of renewable energies in both technical dimensions and policy realms for Costa Rica.
5. Become adept at using data from Global Forest Watch databases to assess forest coverage and the effectiveness of different land management categories
6. Provide critiques of the effectiveness of Costa Rican policies and programs for biodiversity conservation, including key environmental legislation, government incentives programs, and policy, such as the Payment for Ecological Services Program.
7. Critique reserve and landscape conservation planning strategies in terms of their ability to meet “climate-smart” tenets.
8. Be capable of articulating the land-sparing versus land-sharing debate, including the pro’s and con’s of each position from an environmental perspective.
9. Have enhanced oral and written skills in science communication for policy makers and the public.
10. Become an enlightened and engaged stakeholder in matters related to tropical biodiversity conservation, at home and abroad
11. Provide critiques of the effectiveness of Costa Rican policies and programs for biodiversity conservation, including key environmental legislation, government incentives programs, and policy, such as the Payment for Ecological Services Program.
12. Understand the basic governance of REDD and REDD+ programs, how they operate and are implemented, and why they remain controversial in some sectors of the Costa Rican population.

Course Prerequisites: None.

Methods of Instruction

This course is taught through the use of lectures, readings, and activities, including field visits and travels to significant ecosystems or biodiversity, regions of renewable energy, or communities where important environmental policies pertain. Resources or activities involved will include interviews with researchers and conservation professionals, online databases, ecological fieldwork, and visits to reserves/protected areas and conservation projects. CIEE-led lectures and guided discussions supply foundational information, concepts, and terminology, and help students make necessary connections. Guest interviews with researchers, professionals, and conservation practicioners will offer unusual opportunities to learn about “on-the-ground” application of conservation principles. Science communication assignments (“Summaries for Policy makers”; oral and written) give students opportunities to develop communication skills. Excursions to world-renowned reserves and protected areas give exposure to areas of high conservation value.

Assessment and Final Grade

Class Participation	10%
Science Communication 1	15%
Science Communication 2	15%
Biodiversity Worksheet	5%

Global Forest Watch Worksheet	5%
Midterm Exam	25%
Final Exam	25%

Course Requirements

Class Participation (10%)

Attendance is noted for each lecture, discussion session, and field activity. As the semester proceeds, students earn points for thoughtful commentary, questions, and participation in discussions and for attendance.

Science Communication (30%)

Students write two articles written for a lay audience that describe published conservation research. Students will submit two drafts (submission 1 = 10%; submission 2 = 5%).

Biodiversity Worksheet (5%)

Students work in small groups to tally camera trap data and calculates species richness and abundance for mammals in 3 habitats and answer a series of questions regarding the results and their interpretations.

Global Forest Watch Worksheet (5%)

Students will work in small groups to learn to use the GFW data portal to estimate deforestation rates. The groups will work to answer a series of questions regarding the results and their interpretations.

Midterm Exam (25%)

Students take an 80-point exam consisting of multiple choice and short answer questions. Materials covered: Lectures 1-7, readings, and outings. Short answer questions are related to "Scenarios". See examples A and B, below.

Scenario A: The golden toad was endemic to (was only known from) Monteverde cloud forests. The small population disappeared following climatic anomalies in the 1980s, when outbreaks of chytrid fungi were recorded for other amphibians in Central America.

1. Is this extinction better described as a "local" or "global" extinction? Explain.
2. Hypothesize (guess) how this could be an example of *synergistic effects* leading to extinction.
3. Explain why it is relevant to the case that the population was small.
4. What is one principal reason for why conservationists should be concerned about a single population extinction, if other populations persist elsewhere?

Scenario B: You work with MarViva, which has been instrumental in helping the fishers of Palito advance toward their goal of more sustainable fishing practices. Imagine that MarViva is now turning its attention to clamming, and has hired a group of former poachers to raise clams in the mangroves. In the process of raising clams, the poachers-turned-clammers notice that the population is suddenly growing rapidly, they want to harvest large numbers of clams. Some clammers even want to harvest very small clams. Your job, as the biologist, is to explain the principles of sustainable harvesting to them.

1. Explain the phrase "maximum sustainable yield".

2. Explain to the clammers why they need to wait until the population growth rate starts to slow down and the population size stabilizes.
3. Explain why they should only harvest large clams.
4. Explain what a “moratorium” is.
5. Offer an idea for an incentive that favors collecting clams that are large and only collected once the population has reached carrying capacity.

Final Exam (25%)
Students take an 80-point exam consisting of multiple choice and short answer questions related to the Lectures 9 and beyond, readings, and outings. Short answer questions are related to “Scenarios”. See examples A and B above.

Weekly Schedule

Week 1 **Orientation; no TCBP classes**

Week 2 **Field Trip 1; classes on Isla Chira and in Monteverde**

2.1 Lecture 1: Tropical Conservation in the Anthropocene. Biodiversity, ecosystem resilience, and global change. Species richness, diversity, functional diversity; relationship between diversity and resilience. Threats to biodiversity in the Anthropocene.

2.2 Lecture 2: Harvesting of common pool resources: Threats and safeguards for fisheries. Minimum viable populations and minimum dynamic areas; metapopulation dynamics; small populations and extinction proneness (genetic diversity, demographic and environmental stochasticity); sustainable versus not sustainable harvests, defined; MSY (maximum sustainable yield) and limitations; examples of overharvesting; Marine Protected Areas (MPAs) in Costa Rica as a way forward.

Reading
Bates *et al.* (2013)
Halpern (2003)
Poti *et al.* (2012). Pp. 1-11

2.3 Excursion: Palito Marine Protected Area fishing and tour

2.4 Lecture 3: Conservation of Freshwater Resources in the Tropics. Characteristics of tropical streams, wetlands, lakes, and ponds, and estuaries, including abiotic conditions, ecological communities, and adaptations; contrast of temperate and tropical lakes; contrast of tropical lakes and artificial reservoirs; threats to freshwater ecosystems. Policy and practice for aquatic ecosystem protection in Costa Rica.

Reading
Anderson *et al.* (2007)
Pringle (2001)

Week 3 **Classes in Monteverde**

3.1 Activity. Biodiversity Assessment. Use camera trap data to estimate community richness, composition, functional diversity metrics for three habitats.

Assignment in class: Biodiversity Worksheet

Readings and online resources
IUCN (2014). http://www.iucnredlist.org.

Assignment
Science Communication 1

Week 4 **Field Trip 2; classes in Monteverde and on location**

4.1 Lecture 4: Environmental Impacts of Hydropower. Flooding, habitat loss, habitat substitution; GHG emissions; fragmentation of rivers and aquatic populations; case of ArCoSa and Diquís Projects in Costa Rica.

4.2 Excursion: Arenal hydropower plant

4.3 Lecture 5: Environmental Impacts of Wind Power. Alteration of habitats; visual, noise, and aesthetic impacts; impacts on birds and bats; materials and transport; mining for neodymium; Case of Celsia Wind Farms in CR

Excursion: Celsia wind farm

Readings
American Wind Wildlife Institute (2016)

4.3 Lecture 6: Environmental Impacts of Geothermal Power. Infrastructure and land footprints; water footprints; greenhouse gasses and their management; brine components and management; impacts on wildlife; geothermal expansion in Costa Rica and impacts on national parks

Excursion: Miravalles Geothermal Plant

4.4 Lecture 7: Environmental Impacts of Solar Power. Photovoltaic contrasted with passive solar; infrastructure and land footprints; water footprints; impacts on wildlife and other land uses; hazardous compounds in batteries; recyclability and end-of-life considerations

4.5 Excursion: Miravalles solar power plant

Week 5 **Midterm week**

5.1 Midterm Exam. Students take an 80-point exam consisting of multiple choice and short answer questions. Materials covered: Lectures 1-7, readings, and outings. Short answer questions are related to “Scenarios”. See examples.

Week 6 Classes in Moneverde

6.1 Lecture 8: Tropical deforestation and degradation. Definitions; impacts on populations and communities; impacts on local climate and other abiotic parameters; estimating deforestation rates; historical and contemporary rates of deforestation for different forest types, in Costa Rica and beyond. Drivers (past and present) of destruction in the tropics.

Readings
Gibson *et al.* (2011)
González-Maya *et al.* (2015)

6.2 Lecture 9: Solutions, Part 1: Protected areas.Types of IUCN protected areas; UNESCO protected areas; RAMSAR wetlands; Indigenous Territories; Protected Area Design; zoning in protected areas (core, buffer, transition); priority-setting; conservation goals; management in public v. private areas in CR.

6.3 In-class activity. Deforestation Assessment. Use Global Forest Watch computational platform to estimate deforestation.
In class assignment: Global Forest Watch worksheet.

Assignment
Science Communication 2

Week 7-9 No classes

Week 10 Forest fragmentation and solutions

10.1 Lecture 10: Fragmentation. Definitions; characteristics of the resulting habitat matrix; impacts on biotic communities (introduction of exotics, pathways for predators, parasites, loss of core area); impacts on abiotic parameters (temperature, light, wind)

Readings
Rudel *et al.* (2009)

10.2 Lecture 11: Solutions, Part 2: Corridors and buffer zones. Corridors for migratory paths and habitats; examples of Central American and Costa Rican corridors (MesoAmerican Biological Corridor and the Bellbird Biological Corridor). Micro-corridors and wildlife passages. Definition, role and importance of buffer zones.

10.3 Lecture 12: Solutions, Part 3: Policy solutions. Ecological Services Payments in Costa Rica.

Readings
Morse et al. (2009)

Week 12 **Field trip 3; classes on location**

12.1 Lecture 13: Environmental impacts of monocultures (bananas). Impacts such as habitat loss, water and air contamination, and toxicity of agrochemicals on non-target species will be covered. Emphasis will be on local and regional scales of impact.

12.2 Excursion: Visit Costa Rican farm under PSA.

12.3 Lecture 14: Policy solutions: Global initiatives: REDD and REDD+. The UN-supported global initiative to reduce emissions through deforestation and habitat degradation will be explained. How REDD and REDD+ differ; how they are implemented in developing countries; controversies over REDD and REDD+ that concern indigenous people in Central America.

12.4 Excursion: Visit indigenous territories in Costa Rica where REDD and REDD+ are debated.

Week 14 **A look into the future**

14.1 Lecture 15: Climate change. Essential background. IPCC: what it is, how it operates, who are contributors; consensus on anthropogenic climate change; patterns and evidence of anthropogenic forcing on climate; greenhouse gases and radiative forcing components; trends in global change; understanding climate projections. Climate change in MV; adaptation and mitigation.

Readings
Townsend & Masters (2015)

14.2 Lecture 16: The future of biodiversity. Review of the challenges that Costa Rica confronts in terms of protecting biological diversity and ecosystem services in the face of habitat loss, climate change, and overexploitation. Assessment of current legislation, government-sponsored incentives programs, and grassroots conservation initiatives to promote private conservation and the adaptive management of common pool resources. Promising economic incentives, environmental education initiatives, and the importance of individual choice. Recommendations to global citizens for how to protect global biodiversity into the future.

Week 15 **Final Exam**

Final Exam: Students take an 80-point exam consisting of multiple choice and short answer questions related to the Lectures 8 and beyond, readings, and outings. Short answer questions are related to “Scenarios”. See examples.

Course Materials

Readings

American Wind Wildlife Institute (AWWI). (2016). Wind turbine interactions with wildlife and their habitats: a summary of research results and priority questions. Viewed 28 August (https://awwi.org/resources/summary-of-wind-wildlife-interactions-2/)

Anderson, E., Pringle, C. & Rojas, M. (2007). Transforming tropical rivers: an environmental perspective on hydropower development in Costa Rica. *Aquatic Conserv: Mar. Freshw. Ecosyst., 16*, 679–693

Bates, A. E., Barrett, N. S., Stuart-Smith, R. D., Holbrook, N. J. Thompson, P. A. and Edgar, G. J. (2013). Resilience and signatures of tropicalization in protected reef fish communities. *Nature Climate Change*. DOI: 10.1038/NCLIMATE2062

Gibson, L., Lee, T.M., Pin Koh, L., Brook, B.W., Gardner, T.A., Barlow, J., Peres, C.A., Bradshaw, C., Laurance, W.F., Lovejoy, T.E., & Sodhi, N. (2011). Primary forests are irreplaceable for sustaining tropical biodiversity. *Nature, 478,* 378-383. doi:10.1038/nature10425

González-Maya J.F., Víquez-R L.R., Belant J.L., Ceballos G. (2015). Effectiveness of protected Areas for representing species and populations of terrestrial mammals in Costa Rica. *PLoS ONE* 10(5): e0124480. doi:10.1371/journal.pone.0124480

Halpern, B.S. (2003). The impact of marine reseves: do reserves work and does size matter? *Ecological Applications, 13,* 117-137.

Morse, W.C., Schedlbauer, J.L., Sesnie, S.E., Finegan, B., Harvey, C.A., Hollenhorst, S.J., Kavanagh, K.L., Stoian, D., & Wulfhorst, J.D. (2009). Consequences of environmental service payments for forest retention and recruitment in a Costa Rican biological corridor. *Ecology and Society,14,* 23.

Poti, K., Babue, A., Cabral, K., & Hartmann, J. (2012). Evaluating the socioeconomic impacts of sustainable fishing practices: a study of the fisherman of Palito and Montero. Pp. 1-11. (In the CIEE Library, bound copy)

Pringle, C. (2001). Hydrological connectivity and the management of biological reserves: A global perspective. *Ecological Applications, 11,* 981-998.

Townsend, P.A. and Masters, K. L. (2015). Lattice-work corridors for climate change: a conceptual framework for biodiversity conservation and social-ecological resilience in a tropical elevational gradient. *Ecology and Society, 20*, doi.org/10.5751/ES-07324-200201

Rudel, T. K., Defries, R., Asner, G. P., Laurance, W. F. (2009). Changing drivers of deforestation and new opportunities for conservation. *Conservation biology, 23,* 1396-1405.

Online Materials and Resources

Global Forest Watch. http://www.globalforestwatch.org/. Accessed 10 August 2017.

International Union for the Conservation of Nature and Natural Resources. (2014). *Red List*. http://www.iucnredlist.org. Accessed 10 August 2017.