CIEE Global Institute – Monteverde

Course name: Conservation Biology
Course number: (GI) BIOL 2003 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: 3
Contact hours: 45
Term: Fall 2019

Course Description

This course critically explores principal drivers behind the erosion of natural capital and resilience of ecosystems in light of them. Students will take a solutions-based approach for how best to deal with habitat transformation, biodiversity loss, climate change, overexploitation of natural resources and contamination. Solutions will incorporate a biological understanding of local and global impacts, drawing from the physical and life sciences, and extend it to actual and potential political, economic, and socio-cultural instruments appropriate and effective to address threats and changes to global biodiversity and ecosystem health.

Learning Objectives

By completing this course students will be able to:

- Define and quantify biological diversity and estimates of biodiversity loss
- Calculate the degree and rate of land transformation and its impact on biodiversity loss and ecosystem health
- Identify main drivers of biodiversity loss, land transformation, disruption of biogeochemical cycles, including climate change, as well as sources of contamination in the environment, invasive species and overexploitation
- Explore major issues in conservation biology, including deforestation, defaunation, disease, hunting, local people, and the loss of ecosystem integrity and function
- Apply principles of physical and life sciences to address general conservation problems
- Assess the responsibility of humans in loss of natural capital
- Discuss how conservation science guides social decisions to best care for our

natural resources

- Demonstrate an understanding of conservation science locally, regionally and globally
- Articulate the role of culture in designing effective conservation strategies

Course Prerequisites

None

Methods of Instruction

Students will attend lectures and related activities. Lectures will emphasize theory and current empirical patterns. Lecture Activities will place important concepts into hands on learning opportunities. These will result in worksheets that will be graded.

Assessment and Grading

1.	Weekly Quizzes	15 %
2.	Lecture Activities	15 %
3.	Midterm Exam	20 %
4.	Final Exam	30 %
5.	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.

Lecture Activities

During each lecture session, students will have a series of tasks and demonstrations related to the lecture material. They will work in groups to complete the tasks, handing in answers to a series of questions before leaving the class.

Midterm and 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 but these exams will be open book, open notes with a focus on interpretation of statistical analyses.

Participation

Participation is valued as meaningful contribution to tangible learning, utilizing resources and materials as part of the course. Meaningful contribution requires students to be prepared in advance of each class session and to have regular attendance. Students must clearly demonstrate they have engaged with the materials as directed, for example, through classroom discussions, online discussion boards, peer-to-peer feedback (after presentations), interaction with guest speakers, and attentiveness on co-curricular and outside-of-classroom activities. Participation is NOT the same as attending.

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, punctuation is critical to professional engagement in your studies. Students will be marked absent when 15-minutes or longer. Attendance policies also apply to any required co- curricular class excursion or event, as well as 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. 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 practical class, or up to 2 content classes	Participation graded as per class requirements
10 – 20%	2 practical classes, or 3-4 content classes	Participation graded as per class requirements; **written warning**
More than 20%	3 practical classes, or 5 content 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 Introduction to Conservation Biology

Class 1.1 Introductory Concepts and Patterns of Biodiversity

Students will explore the goals, values and principles of conservation biology. Students define biodiversity at different scales, from genes to ecosystems. They then focus on species diversity. They explore how many species there are on earth, realizing there is considerable uncertainty. Students will also explore what taxonomic groups and areas of the world have more species. Keystone species will be defined and their special significance to conservation will be discussed. Students will collect data from a nearby park or reserve to learn the challenges faced when species richness has to be estimated in megadiverse areas. The concept of biodiversity hotspots will be critically discussed as conservation concerns. Students will use species accumulation curves to estimate species diversity at different scales. This will result in a worksheet that would be graded.

Readings: Chapters 1 and 2, and Kareiva, P. and Marvier, M., 2012. What is conservation science?. *BioScience*, *62*(11), pp.962-969 and Godet, L. and Devictor, V., 2018. What Conservation Does. *Trends in Ecology & Evolution*, *33*(10), pp.720-730.

Week 2 Extinction

Class 2.1 Factors of extinction

Proximate and ultimate causes of extinction will be explored this week. Students will learn that habitat loss is the most important factor leading to extinction. Students will also recognize that a habitat can be effectively lost without being actually being destroyed. In groups, students will explore and present the main factors leading to extinction through habitat loss, starting with fragmentation, edge effects, and habitat shredding. Other factors will be explored and presented by students in groups: effect of over exploitation of resources, introduction of exotic species and emergent diseases. The main traits that make some taxa more susceptible to these factors will be discussed as well.

Reading: Chapters 9 and 10 and Newbold, T., Hudson, L.N., Arnell, A.P., Contu, S., De Palma, A., Ferrier, S., Hill, S.L., Hoskins, A.J., Lysenko, I., Phillips, H.R. and Burton, V.J., 2016. Has land use pushed terrestrial biodiversity beyond the planetary boundary? A global assessment. *Science*, *353*(6296), pp.288-291.

Class 2.2 Climate change and Biological Change

Students will explore the main findings used by climate scientist around the world to suggest that humans most likely caused the changes in climate we have experienced in the past decades. Special attention will be given to how the IPCC predicts future changes in climate using mathematical models, and the accuracy of those models. The documented case of amphibian declines and extinctions following changes in climate will be discussed. Students will learn how to predict changes in species abundance and distribution using mathematical models based on climate envelopes. This will result in a worksheet that would be graded.

Readings: Chapter 3 and IPCC Fifth Assessment Report: summary for policymakers. Pounds et al. 2006. Nature, 439: 161–167 **and** Belote, R.T., Dietz, M.S., McKinley, P.S., Carlson, A.A., Carroll, C., Jenkins, C.N., Urban, D.L., Fullman, T.J., Leppi, J.C. and Aplet, G.H., 2017. Mapping conservation strategies under a changing climate. *BioScience*, *67*(6), pp.494-497.

Week 3 Analytical tools to predict extinctions

Class 3.1 Island Biogeography Theory

Students will be exposed to mathematical tools that are used to predict changes in the number of species based on area and distance from large protected areas. The discussion will focus on the classic Island Biogeography Theory and how it has been applied to predict changes in the number of species in reserves.

Readings: Chapter 7 and 8, Mendenhall, C.D., Karp, D.S., Meyer, C.F., Hadly, E.A. and Daily, G.C., 2014. Predicting biodiversity change and averting collapse in agricultural landscapes. *Nature*, *509*(7499), p.213.

Class 3.2 Species-Area Curves

Students will learn how Species-Area Curves are created, how to use them to predict changes in species numbers, and the uncertainty around those estimates. The students in groups will discuss the Half-Earth Project by E.O. Wilson, which is based on this type of curve.

Readings: http://www.half-earthproject.org and Mace, G.M., Barrett, M., Burgess, N.D., Cornell, S.E., Freeman, R., Grooten, M. and Purvis, A., 2018. Aiming higher to bend the curve of biodiversity loss. *Nature Sustainability*, *1*(9), p.448.

Class 3.3 Fitting Species-Area Curves to Field Data

Students will collect data in the field or from online sources and analyze them using species-area curves. The activity will focus on how to collect the data and assess the quality of the data before even fitting a curve. The students will fit curves to the data and assess the quality of the predictions made. This will result in a worksheet that would be graded.

Readings: Gerstner, K., 2017. The global distribution of plant species richness in a human-dominated world. *Frontiers of Biogeography*, *9*(1).

- Midterm Exam

Week 4 Conservation of small populations

Class 4.1 The problem of small populations

How big do populations need to be to prevent extinction? Students will tackle this question using theory and analytical tools developed for this specific purpose. Population Viability Analysis will be discussed as a tool used to determine The Minimum Viable Population necessary for endangered species to persist. Students in groups will estimate the Minimum Viable Population for a tropical species. This will result in a worksheet that would be graded.

Readings: Chapters 11 and 13 and Mathews, F., 2016. From biodiversity-based conservation to an ethic of bio-proportionality. *Biological Conservation*, *200*, pp.140-148.

Class 4.2 Conservation genetics

The concept of genetic drift and effective population size will be used to explain how genetic diversity can be lost in small populations. The effects of inbreeding depression will be discussed using real data. Solutions based on increasing genetic diversity in populations will be considered. Students will recalculate Minimum Viable Populations taking into account genetic data. This will result in a worksheet that would be graded.

Readings: Chapter 12 and Wolf, J.B.W., 2015. Genomics and the challenging translation into conservation practice. *Trends in Ecology & Evolution*, *30*(2).

Class 4.3 Removals and reintroductions

Different practical methods used to prevent the extinction of endangered species will be discussed. Students will recognize that these methods are usually considered as a last resort because they involve removing a species from its natural setting. This is done to keep them alive, especially for captive breeding with the goal of reintroducing species into areas from where they were locally extirpated. Solutions to the problem of conservation of small populations will be discussed.

Reading: Chapter 14 and Corlett, R.T., 2016. Restoration, reintroduction, and rewilding in a changing world. *Trends in ecology & evolution*, *31*(6), pp.453-462.

Week 5 Reserves and Management

Class 5.1 Reserves

Creating reserves to prevent populations from becoming too small is a proactive solution to biodiversity loss. Emphasis will be given to how to create reserve networks to maximize protection of biodiversity at different levels, not only species richness, using the concepts of metapopulation dynamics and the island biogeography theory. The success of these methods will be compared using the case of the Costa Rican network of protected areas as a model for other developing countries and how it differs from US, European and Asian protected areas. Conservation outside protected reserves will also be discussed after students recognize that the agricultural landscape surrounding protected reserves often offers suitable habitat to a variety of species and therefore impacts conservation inside reserves as well. Students will research and discuss why some countries have more protected areas than others.

Readings: Chapters 15 and 16 and D'agata, S., Mouillot, D., Wantiez, L., Friedlander, A.M., Kulbicki, M. and Vigliola, L., 2016. Marine reserves lag behind wilderness in the conservation of key functional roles. *Nature communications*, *7*, p.12000.

Class 5.2 Management and Restoration

Students will recognize that even the most pristine habitat has already been impacted by human activity somehow, for instance through climate change, and therefore some level of managing is likely necessary to maximize the conservation of biodiversity in those areas. Students will also learn that management can also involve the restoration of an area to emulate specific ecosystems. Specific management and restoration projects conducted in temperate and tropical areas will be analyzed.

Readings: Chapter 17 and 19 and Wiens, J.A. and Hobbs, R.J., 2015. Integrating conservation and restoration in a changing world. *BioScience*, *65*(3), pp.302-312.

Class 5.3 Management of Local Reserves

Students will visit a local reserve with the goal of learning the practices employed by the organizations/managers that run of those areas to maximize the conservation of local biodiversity. A group discussion would follow to assess the effectiveness of the conservation practices employed, the challenges faced by local biodiversity, and potential solutions to address these challenges.

Reading: Allen, A.M. and Singh, N.J., 2016. Linking movement ecology with wildlife management and conservation. *Frontiers in Ecology and Evolution*, *3*, p.155.

Week 6 Economics and Legislation

Class 6.1 Economics of conservation

The potential monetary value that biodiversity provides to humans will be explored. The cost of protecting biodiversity will be discussed. Students in groups will critically discuss the (partial) solution implemented by the Costa Rican government through payments for environmental services.

Readings: Chapters 4 y 5 and Scharks, T. and Masuda, Y.J., 2016. Don't discount economic valuation for conservation. *Conservation Letters*, *9*(1), pp.3-4.

Class 6.2 Legislation and Agreements

Legal approaches to biodiversity protection will be discussed, including the US Endangered Species Act. The most important international agreements on biodiversity protection, including climate change, will be also discussed, including REDD+,CITES, the Paris Agreement and the Convention on Biological Diversity. In groups, students will explore and present the different conventions and agreements.

Reading: Chapters 20 and 21 and Maron, M., Gordon, A., Mackey, B.G., Possingham, H.P. and Watson, J.E., 2015. Conservation: stop misuse of biodiversity offsets. *Nature News*, *523*(7561), p.401.

Class 6.3 The future of biodiversity conservation

Students will analyze the results of the conservation efforts conducted in recent decades in major biomes. The role of research in conservation biology on the future of conservation will be discussed. The final discussion will be focused on where to go with the knowledge gained during the course.

Reading: Tilman, D., Clark, M., Williams, D.R., Kimmel, K., Polasky, S. and Packer, C., 2017. Future threats to biodiversity and pathways to their prevention. *Nature*, *546*(7656), p.73.

- Final Exam

Course Materials

Course Textbook

Primack, Richard B. 2014. Essentials of Conservation Biology. Sixth Edition. Oxford University Press.

Readings

Allen, A.M. and Singh, N.J., 2016. Linking movement ecology with wildlife management and conservation. *Frontiers in Ecology and Evolution*, *3*, p.155

Belote, R.T., Dietz, M.S., McKinley, P.S., Carlson, A.A., Carroll, C., Jenkins, C.N., Urban, D.L., Fullman, T.J., Leppi, J.C. and Aplet, G.H., 2017. Mapping conservation strategies under a changing climate. *BioScience*, *67*(6), pp.494-497

Coops, N.C., Kearney, S.P., Bolton, D.K. and Radeloff, V.C., 2018. Remotely-sensed productivity clusters capture global biodiversity patterns. *Scientific reports*, *8*

Corlett, R.T., 2016. Restoration, reintroduction, and rewilding in a changing world. *Trends in ecology & evolution*, *31*(6), pp.453-462

D'agata, S., Mouillot, D., Wantiez, L., Friedlander, A.M., Kulbicki, M. and Vigliola, L., 2016. Marine reserves lag behind wilderness in the conservation of key functional roles. *Nature communications*, *7*, p.12000

Gerstner, K., 2017. The global distribution of plant species richness in a human-dominated world. *Frontiers of Biogeography*, *9*(1)

Godet, L. and Devictor, V., 2018. What Conservation Does. *Trends in Ecology & Evolution*, *33*(10), pp.720-730

Kareiva, P. and Marvier, M., 2012. What is conservation science? *BioScience*, *62*(11), pp.962-969.

Mace, G.M., Barrett, M., Burgess, N.D., Cornell, S.E., Freeman, R., Grooten, M. and Purvis, A., 2018. Aiming higher to bend the curve of biodiversity loss. *Nature Sustainability*, *1*(9), p.448.

Maron, M., Gordon, A., Mackey, B.G., Possingham, H.P. and Watson, J.E., 2015. Conservation: stop misuse of biodiversity offsets. *Nature News*, *523*(7561), p.401

Mathews, F., 2016. From biodiversity-based conservation to an ethic of bio-proportionality. *Biological Conservation*, *200*, pp.140-148

Mendenhall, C.D., Karp, D.S., Meyer, C.F., Hadly, E.A. and Daily, G.C., 2014. Predicting biodiversity change and averting collapse in agricultural landscapes. Nature 509: 213–217.

Newbold, T., Hudson, L.N., Arnell, A.P., Contu, S., De Palma, A., Ferrier, S., Hill, S.L., Hoskins, A.J., Lysenko, I., Phillips, H.R. and Burton, V.J., 2016. Has land use pushed terrestrial biodiversity beyond the planetary boundary? A global assessment. *Science*, *353*(6296), pp.288-291.Pounds, J.A., Fogden, M.P. and Campbell, J.H., 1999. Biological response to climate change on a tropical mountain. Nature 398: 611–615

Pounds, J.A., Bustamante, M.R., Coloma, L.A., Consuegra, J.A., Fogden, M.P., Foster, P.N., La Marca, E., Masters, K.L., Merino-Viteri, A., Puschendorf, R. and Ron, S.R., 2006. Widespread amphibian extinctions from epidemic disease driven by global warming. . Nature 439: 161–167

Scharks, T. and Masuda, Y.J., 2016. Don't discount economic valuation for conservation. *Conservation Letters*, *9*(1), pp.3-4

Wiens, J.A. and Hobbs, R.J., 2015. Integrating conservation and restoration in a changing world. *BioScience*, *65*(3), pp.302-312

Wolf, J.B.W., 2015. Genomics and the challenging translation into conservation practice. *Trends in Ecology & Evolution*, *30*(2).