Tropical Ecology and Ecosystem Resilience
SFS 3771

Syllabus

The School for Field Studies (SFS)
Center for Ecological Resilience Studies
Atenas, Costa Rica

This syllabus may develop or change over time based on local conditions, learning opportunities, and faculty expertise. Course content may vary from semester to semester.

www.fieldstudies.org

COURSE CONTENT SUBJECT TO CHANGE

Please note that this is a copy of a recent syllabus. A final syllabus will be provided to students on the first day of academic programming.

SFS programs are different from other travel or study abroad programs. Each iteration of a program is unique and often cannot be implemented exactly as planned for a variety of reasons. There are factors which, although monitored closely, are beyond our control. For example:

- Changes in access to or expiration or change in terms of permits to the highly regulated and sensitive environments in which we work;
- Changes in social/political conditions or tenuous weather situations/natural disasters may require changes to sites or plans, often with little notice;
- Some aspects of programs depend on the current faculty team as well as the goodwill and generosity of individuals, communities, and institutions which lend support.

Please be advised that these or other variables may require changes before or during the program. Part of the SFS experience is adapting to changing conditions and overcoming the obstacles that may present. In other words, the elephants are not always where we want them to be, so be flexible!

Course Overview

The clearing of the world's forests has created habitat fragmentation and caused a considerable number of species extinctions. Increasingly fragmented populations succumb to the demographic and genetic consequences associated with small population sizes. It is estimated that between 3,000 and 30,000 species are going extinct every year based on rates of forest habitat loss and estimates of global biodiversity. This is particularly true for tropical regions where biodiversity is highest. The drivers of forest loss are complex and operate across a variety of geographic and socio-political scales. In addition, the ongoing global climate change is altering the phenology of many species and inducing shifts in species geographic range. These ecological alterations act synergistically with other anthropogenic factors (e.g., hunting, urban development, pollution, etc.) thus accelerating the rate of species extinction. Therefore, it is critical for tropical communities to be resilient to those changes, and adapt to the Anthropocene; we also need to analyze those examples of success or understand what factors facilitate the healing of natural systems.

Developing countries have different development models that directly or indirectly affect the environment, biodiversity, and ecosystem services. Costa Rica took a major shift from an agriculture-based economy to a service-based, environmentally friendly economy. For instance, the ecotourism industry is supported by a network of protected areas that form the national system of conservation areas. However, the downside of ecotourism development brings an increase in infrastructure, such roads and resorts that cause environmental alteration. In addition, emerging diseases, invasive species, biodiversity loss and climate change are modifying the communities of organisms in tropical areas as Costa Rica. Our next goal is not just understanding the level of those affectations, but to monitor how tropical ecosystems can be resilient to those rapid changes. Many of these negative impacts can be avoided or mitigated, or resilience-regeneration processes can be facilitated, if the necessary knowledge of the interacting ecological processes and human activities is acquired.

Modern science, including conservation biology and applied ecology, is a multidisciplinary effort with a significant social impact. The construction of a sustainable future, and resilient ecosystems, will depend on a multidisciplinary approach to understand and solve conservation problems. This understanding ought to be based on solid ecological information, especially in tropical ecosystems where the diversity of life forms and biological interactions are complex, and where social and economic challenges are daunting. Thus, in order to have an understanding of the current ecological problems and to look for potential solutions to those problems, we will study the main following themes: a) tropical forest dynamics, b) the origin of tropical diversity, c) mechanism of species extinction, d) assessment and use of biodiversity, e) ecosystem dynamics and human-initiated disturbances (ecological consequences of infrastructures and forest fragmentation), f) climate change and tropical forest dynamics, g) the ecology of emerging diseases and invasive species, e) panarchy applied to ecosystem resilience and circular economy. We will do this through lectures, group discussions, field trips, and field research. In this integrated multidisciplinary program, the students will examine the negative impacts of development on the ecosystems in various parts of Costa Rica and Panama and evaluate cases of effective conservation and management practices.

Learning Objectives

The Tropical Ecology course seeks to provide students with:

1) An introduction of the natural history of the major ecosystems in Costa Rica and Western Panama.
2) An introduction to the ecological complexity of tropical forests and evolutionary processes of species co-existence.
3) An understanding of the causes of the origin of tropical species diversity.
4) An understanding of present-day ecological factors affecting the distribution of tropical organisms (climatic and topographic heterogeneity).
5) An understanding of the richness of life forms and biological interactions (herbivory, seed dispersal, pollination, coevolution).
6) An understanding of how species and ecosystems are resilient to human.
7) An understanding of how a tropical forest functions, such as nutrient cycling, regeneration and response to disturbances, and the physiological characteristics of tropical organisms.
8) Definitions and quantifications of the biodiversity concept.
9) An understanding of current threats to tropical biodiversity. This includes habitat fragmentation, ecological impacts derived from agricultural and urban sprawling.
10) An understanding of how climate change affects species distribution, community changes, phenology, and the likelihood of species extinction.
11) The ability to integrate the above topics to generate alternatives to minimize negative impacts on tropical ecosystems or induce natural resilient processes.
12) The necessary creativity to develop ecological alternatives of land use practices and conservation mechanisms. This includes sustainable agriculture that enhances habitat connectivity, climate change mitigation (e.g., carbon offset mechanisms), environmentally friendly certification programs (e.g., RFA), panarchy, and strategic alliances with stakeholders.

Assessment

Assessment Item	Value (%)
Quizzes	10
Field Lab	15
Field Exercise	30
Oral Presentation	15
Comprehensive Essay or Blog	15
Participation	15
TOTAL	**100**

Quizzes (10%)

Two short quizzes will be used to evaluate the field lectures or classes. 5% each quiz.

Field Lab: Manu (15%)

This field activity will be carried out in Manu Center, during the first field trip. The students will learn about bird and herpetofauna survey in ecology, as well as animal manipulation, and identification skills.

Field Exercise: Experimental Design in Ecology (30%)

Science is based on intuition, logic, and reason. The scientific method begins with an *observation*; we seek *patterns* and then formulate *hypotheses* that could explain those patterns. We can also use experiments to test hypotheses. Finally, we conclude on the results thus contributing to a broader theory. Our objective is to practice the scientific method to answer a question in ecology.

Students will develop their own project to respond to a question in ecology based on their own scientific curiosity. Students need to discuss the project with the professor to receive feedback about the theory, logistics and equipment involved during the field data collection. This FEX could be developed in Atenas or/and during our field trips (previously coordinated with staff in charge). With this FEX students will gain experience for the Directed Research component at the end of the semester. The FEXs require a blueprint (10%) with the question, hypothesis, and theoretical framework (including literature review). Finally, a report (20%= with the format of a scientific paper should be presented. The format will follow a selected journal related to the research topic. Students will be assessed based on their ability to develop a hypothesis, data collection effort, data analysis and the written blueprint and report.

Oral Presentation (15%)

After the FEX, the students must present their research to the classmates and professor. The goal is to communicate their results to other people, work on the slides, improve presentation skills and make questions to other researchers (a simulation of a congress or symposium).

Comprehensive Essay or Blog (15%)

A written essay (max. 5-8 pages, or 5000 words), blog or similar that involves most topics and experiences (FLABs, FEXs, field trips, Study cases, etc.) from the course. A story telling format is suggested, with pictures and infographics, to communicate science and research to broader audiences.

Participation (15%)

Everybody should be prepared for each academic session. This implies reading the materials for each session with enough detail to be able to ask relevant questions, and to participate in analytical discussions about the key issues. Active participation during classes, discussions, assignments, and hikes is expected.

Grading Scheme

A	95.00 - 100.00%	B+	86.00 - 89.99%	C+	76.00 - 79.99%	D	60.00 - 69.99%
A-	90.00 - 94.99%	B	83.00 - 85.99%	C	73.00 - 75.99%	F	0.00 - 59.99%
		B-	80.00 - 82.99%	C-	70.00 - 72.99%		

General Reminders

Honor Code/Plagiarism – SFS places high expectations on their students and we hold students accountable for their behaviors. SFS students are held to the honor code below. SFS has a zero-tolerance policy towards student cheating, plagiarism, data falsification, and any other form of dishonest academic and/or research practice or behavior. Using the ideas or material of others without giving due credit is cheating and will not be tolerated. Any SFS student found to have engaged in or facilitated academic and/or research dishonesty will receive no credit (0%) for that activity.

"SFS does not tolerate cheating or plagiarism in any form. While participating in an SFS program, students are expected to refrain from cheating, plagiarism and any other behavior which would result in a student receiving credit for work which they did not accomplish on their own. Students are expected to report any instance of cheating or plagiarism by others."

Deadlines – Deadlines for assignments are established to promote equity among students, to allow faculty enough time to review and return comments and grades before other assignments are due, and to avoid clashes with other activities and courses. Therefore, deadlines are firm, and extensions will only be considered under extreme circumstances. When appropriate, the files should be placed in the assigned folder within the students drive on the server. Late assignments will incur a 10% penalty for each day that they are late. Papers submitted after 3 days of the dateline will not be accepted. Please plan to avoid such situations. Assignments will be handed back to students within one-week grading period.

Readings – The assigned readings will be available in a printed anthology and digital PDF files. Please take good care of this anthology and do not lose it. The goal of this compilation of articles is to eliminate the need for printing more copies using laser printers (reducing our impact on paper and other center resources). It is important to read the assigned readings prior to class or discussions. We will often use these as starting points or examples for class discussion or as background information for field trips. Reference and resource materials are useful starting points for your directed research. Additional references can be provided upon request.

Content Statement – Every student comes to SFS with unique life experiences, which contribute to the way various information is processed. Some of the content in this course may be intellectually or emotionally challenging but has been intentionally selected to achieve certain learning goals and/or showcase the complexity of many modern issues. If you anticipate a challenge engaging with a certain topic or find that you are struggling with certain discussions, we encourage you to talk about it with faculty, friends, family, the HWM, or access available mental health resources.

Participation – Since we offer a program that is likely more intensive than you might be used to at your home institution, missing even one lecture can have a proportionally greater effect on your final grade simply because there is little room to make up for lost time. Participation in all components of the course is mandatory, it is important that you are prompt for all activities, bring the necessary equipment for field exercises and class activities, and simply get involved.

Course Content

Type: L: Lecture, **FL:** Field Lecture, **FEX:** Field Experiment, **D**: Discussion, **O**: Orientation

*Required readings are in **bold**

No	Title and outline	Type	Time (hrs)	Readings
1	**Course Introduction** a) Objectives of the Tropical Ecology course in relation to the general goals of the SFS program. b) Review of the main themes in tropical ecology, theory and the application of ecological concepts in conservation and sustainability.	O	1.0	
2	**Rainforest ecology (Manu Center)** Introduction to the general ecology of tropical rainforests and natural history of several representative species.	O	4.0	
3	**Field trip Lecture** Biodiversity in agroecosystems	FL	2.0	
4	**Field Lab** Bird and herpetofauna: natural history, morphology, adaptations, species ID, and mist-netting techniques.	FLAB	3.0	
5	**Natural History of Costa Rica** a) Geologic formation of Central American land bridge b) Biogeographic consequences of the land bridge formation for terrestrial and marine biota. c) Climate and topography of Costa Rica. d) Life Zones, habitats, and species richness. e) Humans and the environment.	L	3.0	Costa Rican Natural History (1983). Avalos, G. (2018).
6	**Diversity of tropical rainforests** a) The Latitudinal Diversity Gradient (LDG) b) Habitat heterogeneity and species richness c) Alpha and Beta diversity	L	2.0	**Brown, J.H. (2014).**
7	**Field Exercise (FEX) Prep** Observational skills and hypothesis testing. Data collection in FEX in SFS Ceres campus	FEX	4.0	
8	**Tropical Ecology Biodiversity Assessment** a) Species-area relationship b) Species richness and evenness c) Species accumulation curves d) Methods and metrics to quantify biological diversity	FEX	1.5	
9	**Tropical Cloud Forest Ecology** a) Physical environment of premontane forests b) Forest structure, dynamics, and species diversity c) Animal-plant interaction	FL	1.0	**Lawton, et al. (2016).** **Nadkarni and Wheelwright (2000).**

No	Title and outline	Type	Time (hrs)	Readings
10	**Field trip: Natural history of tropical cloud forest species (Monteverde Reserve)** a) Introduction to the general ecology of tropical cloud forests and natural history of various representative species of this ecosystem.	FL	4.0	
11	**Mechanisms of species diversity** a) Mechanism of speciation b) The competitive exclusion principle c) The Negative Density Dependence effect d) Mechanism of species coexistence	L	1.5	**Coley and Kursar. (2014).**
12	**Natural history of highlands of Costa Rica (Cerro de la Muerte)** Exploring the montane oak forest and paramo ecosystems	FL	5.0	**Kappelle (2016).** Kappelle and Horn (2016).
13	**Neotropical Forest Dynamics** a) Forest gap dynamics and species diversity b) Spatio-temporal variation and niche regeneration c) Intermediate Disturbance Hypothesis	L	1.5	
14	**Field Exercise (FEX) Project design + Data Collection**	FEX	2.0	
15	**Landscape Ecology** a) Ecological consequences of habitat fragmentation. b) Conservation of the conservation of biodiversity in a human-dominated landscape c) Hike into the Alto del Roble (Heredia) to explore the landscape ecology topic	L	2.0	**Lewis, Edwards, and Galbraith (2015).**
16	**Climate Change and Tropical Forests** a) Tropical forest changes and Climate Change (CC) b) Implications of CC on tropical biodiversity c) Predicting future negative impacts through understanding and monitoring biodiversity d) Monteverde and Alto del Roble: A case study on climate change and global amphibian decline	L	1.5	**Acosta-Chaves, et al. (2019).**
17	**FEX Data collection**	FEX	2.0	
18	**The Ecology of Osa Peninsula Rainforest** a) Natural history and status of biodiversity in Osa Peninsula and Golfo Dulce b) Ecotourism and conservation c) Wildlife -human conflict	L	2.0	**Gilbert, et al. (2016).**
19	**Topic discussion I** Biodiversity loss cascade effect (Osa Field Trip)	D	1.0	**Zipkin and DiRenzo (2022).**

No	Title and outline	Type	Time (hrs)	Readings
20	**The globalization of species extinction** a) Revision of major extinction events: are we facing another mass extinction? b) Major causes of extinction (habitat loss and fragmentation, defaunation, climate change, overhunting). c) Species co-extinction and ecological cascade effects. d) Climate change and extinction risks.	L	1.0	Zumbado-Ulate, et al. (2021).
21	**Topic discussion II** Ecosystem change, invasiveness, and ecosystem resilience	D	1.0	**Chaffin, B. C. 2016.** Barrantes-Madrigal, et al. (2022).
22	**Panarchy** Theory of panarchy and its application in ecology and ecosystem resilience.	L	2.0	**Angeler, et al. (2016).**
23	**FEX Symposium I** Oral presentations	L	1.5	
24	**FEX Symposium II** Oral presentation	L	1.5	
25	**CEB Review and Discussion**	D	2.0	
	Total hours		**52**	

Reading List

*Required readings are in **bold**

1. Costa Rican Natural History. (1983). Ed. Daniel H. Janzen, Univ. of Chicago Press.
2. **Avalos, G. (2018).** Still searching the rich coast: Biodiversity of Costa Rica, numbers, processes, patterns, and challenges. In Global Biodiversity (pp. 101-135). Apple Academic Press.
3. **Brown, J.H. (2014).** Why are there so many species in the tropics? J. Biogeogr 41, 8-22.
4. **Lawton, R. O., Lawton, M. F., Lawton, R. M., & Daniels, J. D. (2016).** The montane cloud forests of the volcanic cordilleras. Costa Rican Ecosystems, 415-450.
5. Nadkarni, N and N.T. Wheelwright. (2000). Monteverde Ecology and conservation of a tropical cloud forest. Oxford University Press (SFS Library)
6. **Coley, P.D & T.A. Kursar. (2014).** On tropical forest and their pests. Science 343, 35-36.
7. **Kappelle, M. (2016).** The montane cloud forests of the Cordillera de Talamanca. Costa Rican Ecosystems, 541.
8. Kappelle, M., & Horn, S. P. (2016). The Paramo ecosystem of Costa Rica's highlands. Costa Rican Ecosystems, 744.

9. **Lewis, L.S., D.P. Edwards & D. Galbraith. (2015).** Increasing human dominance of tropical forests. Science, 349: 827-832.
10. **Acosta-Chaves, V. J., Madrigal-Elizondo, V., Chaves, G., Morera-Chacón, B., García-Rodríguez, A., & Bolaños, F. (2019).** Shifts in the diversity of an amphibian community from a premontane forest of San Ramón, Costa Rica. Revista de Biología Tropical, 67(2), 259-273.
11. **Gilbert, L. E., Christen, C. A., Altrichter, M., Longino, J. T., Sherman, P. M., Plowes, R., ... & Kappelle, M. (2016).** The southern pacific lowland evergreen moist forest of the Osa region. Costa Rican ecosystems, 360-411.
12. **Zipkin, E. F., & DiRenzo, G. V. (2022).** Biodiversity is decimated by the cascading effects of the amphibian-killing chytrid fungus. PLoS pathogens, 18(7), e1010624.
13. Zumbado-Ulate, H., Searle, C. L., Chaves, G., Acosta-Chaves, V., Shepack, A., Salazar, S., & García-Rodríguez, A. (2021). Assessing Suitable Habitats for Treefrog Species after Previous Declines in Costa Rica. Diversity, 13(11), 577.
14. **Chaffin, B. C. (2016).** Biological invasions, ecological resilience, and adaptive governance. Journal of Environmental Management, 1-9.
15. Barrantes-Madrigal, J., Parallada, M. S., Alvarado, G., & Acosta-Chaves, V. J. (2022). Occupancy and probability of detection of the introduced population of Eleutherodactylus coqui in Turrialba, Costa Rica. Acta Herpetologica, 17(2), 177-186.
16. **Angeler, D. G., Allen, C. R., Garmestani, A. S., Gunderson, L. H., & Linkov, I. (2016).** Panarchy use in environmental science for risk and resilience planning. Environment Systems and Decisions, 36(3), 225-228.