Tropical Ecology of the Amazon
SFS 3831

Syllabus
4 credits

The School for Field Studies (SFS)
Center for Amazon Studies (CAS)
Tarapoto, Peru

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.

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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 they may present. In other words, this is a field program, and the field can change.

Course Overview

Tropical regions are highly biodiverse. Among them tropical forests are the most species-rich biome, and particularly the tropical forests in South America are more species rich than the tropical forests in Africa and Asia. The tropical rainforest in the Amazon biome covers most of the Amazon basin of South America and represents over half of the planet's remaining rainforest.

Like the biodiversity of the Amazon rainforest, where 1 out of 10 known species can be found, the interactions of their organisms are also outstanding. Ecology studies these interactions, the interactions of organisms with other organisms and with their environment.

In this course, we will look at the natural history and processes that created and sustained the Amazon's biodiversity at multiple scales: species, community, ecosystem, and landscape.

The goal of this course is to understand the processes that contribute to diversity in the Western Amazon, gain insight into similar processes in tropical areas around the world, and explore how different interacting organisms form a functioning ecosystem. We will explore fundamental principles of ecology by studying diverse ecosystems and the habitats and species found there, including a variety of lowland tropical and high-elevation forests at the headwaters of the Amazon River in the Andes Mountains.

Our exploration is grounded by three themes:

1. What is biodiversity? evolutionary origins, scales, and measurement.
2. Why are the tropics so diverse? ecosystem dynamics, succession.
3. How are tropical ecosystems formed? Interactions, types, and classifications.

Using field methodology and guided by the scientific method, we will focus on learning tools that allow students to measure, describe, and explain biodiversity and its dynamics. This course is intricately linked to the *Conservation Science* course, where the focus will be more on threats to, monitoring of, and strategies for the conservation of biodiversity. It also will provide background information on the natural arena in which human use and extraction of Amazonian natural resources by global, national, and local actors takes place (discussed in *Political Ecology of Developing Landscapes*).

This class is focused on field-based and hands-on learning, so come prepared to get your feet wet and hands dirty!

Learning Objectives

Students will draw on observations and evidence to assess threats, evaluate the efficacy of conservation In this course students should develop conceptual understandings and practical skills that afford them an appreciation of the diversity and complexity of the natural systems of the Amazon region. Specific learning objectives are the following:

1. Gain an understanding of ecological complexity of tropical ecosystems, evolutionary processes, and landscape patterns that underlie species diversity and co-existence.
2. Differentiate the types of forests within the Amazon biome.
3. Understand the richness of life forms and their interactions.
4. Describe the structure and composition of the major ecosystems in the Northwestern Amazon region.
5. Employ field research methods and analytical tools used in the study of ecology and biogeography.

Assessment

The evaluation breakdown for the course is as follows. Full rubrics for each assessment are at the end of this syllabus.

Assessment Item	Value (%)
Participation	5
Quiz 1	7.5
Quiz 2	7.5
Communication and Collaboration in Science	10
Field Exercise 1	15
Field Exercise 2	15
Field Exercise 3	15
Final Exam	25
TOTAL	**100**

Participation (5%)

Active participation in all class activities is expected in this course, including promptness and preparedness for field activities. Students are encouraged to engage in class discussion (active listening, constructive contribution by raising or answering questions). Engagement in discussion, contribution to group work during FEXs, timeliness and preparedness for activities throughout the semester are expected for full participation marks. The contribution, listening and attitude during classes will be considered for this item.

Quiz (15%, 7.5% each)

Two short quizzes will be administered throughout the semester to assess periodic comprehension of the course's material. Answers are expected to be concise.

Communication and Collaboration in Science (10%)

Effective communication of findings and ideas and collaboration among individual scientists are important for the advancement of science. Research and review articles are a valuable tool for communication among scientists and learning to read them effectively is an important skill for understanding and eventually writing scientific papers. In addition to collaboration on research projects, scientific peers also frequently collaborate on writing by serving as peer-reviewers of manuscripts in progress or submitted to journals.

Students will practice how to read and convey information in research/review articles and provide constructive criticism effectively and efficiently, by reading and reviewing a classmate's FEX report and provide feedback in the form of a "Letter to the Editor." Detailed instructions will be given after the submission of each assignment.

Field Exercises (45%, 15% each)

See the end of the syllabus for grading considerations for FEX reports.

FEX I: Understory Plant Diversity - Measuring and Quantifying Plant Biodiversity (15%)
We will use the quadrats method to systematically survey and collect understory plants along trails of the CAS forest and try to identify them to the lowest taxonomic unit.

Context: The quadrats method can be used for plant sampling in most plant communities and is vastly used in the tropics. In the studied area the plants are counted, and species (or morphospecies) listed to later estimate the richness and abundance of the vegetation cover.
Objectives: For the students to learn the main method of plant sampling used in the tropics, and to process the data obtained to later decipher and discuss it.

FEX II: Data collection of forest structure - Measuring and Quantifying Biodiversity- Forest Trees & Forest Structure (15%)
We will survey forest structure in a white-sand forest. We will use several plots or transects to collect standard forest structure metrics: tree height, DBH (Diameter at Breast Height), among others. We will use standard statistical analyses (t-tests, ANOVA (analysis of variance) and Chi-Square Tests) to compare the plots or transects.
Context: The forest and its components are also studied three-dimensionally, considering the horizontal and vertical distribution of the plants and their own features. This information is used to maintain a sustainable flow of forest products and services and can even be used in the global carbon cycle, as it is vital to estimate carbon gains.
Objectives: For the students to learn to measure the forest structure and compare the structures of two different areas.

FEX III: Vertical structures: canopy comparison (15%)
Students will make observations of canopy closure, light, and general vegetation structure. We will come together as a class to discuss any patterns observed, hypotheses regarding any natural patterns and how we might test them. Observations will be made in a rainforest of Sucusari and in a cloud montane at Wayquecha. From the observations we will formulate hypothesis and then brainstorm how we might use carefully planned observational surveys or manipulative experiments to test them.
Context: Canopy research is a new scientific field because access to the tree canopies and appropriate means of housing have developed in recent decades. In recent years it has been discovered that a considerable great diversity of animals and plants live in the upper levels of the large trees.
Objectives: For the students to learn the importance of canopy studies and develop hypothesis and means to test them.

Final Exam (25%)
The final exam is closed book. You will be given time to study for the exam; a class period will be designated as review. You will be examined on what you have been exposed to in class (lectures, discussions, etc.) and in the field, and what you have been asked to read. The exam will ask you to draw on multiple concepts and experiences and synthesize information in response to ecological scenarios.

Grade corrections in any of the above items should be requested in writing 24 hours after assignments are returned. No corrections will be considered afterwards.

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 written and oral assignments are instated to promote equity among students and to allow faculty ample time to review and return assignments before others are due. As such, deadlines are firm; extensions will only be considered under extreme circumstances. Late assignments will incur a penalty of 10% of your grade for each day you are late. After two days past the deadline, assignments will no longer be accepted. Assignments will be handed back to students after a one-week grading period. Grade corrections for any assessment item should be requested in writing at least 24 hours after assignments are returned. No corrections will be considered afterwards.

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 Exercise, **LAB -** Lab Exercise, **D** – Discussion

***Readings in bold are required**

No	*Title and outline*	*Type*	*Time (hrs)*	*Readings*
TE 01	**Introduction to Tropical Ecology** This lecture will introduce tropical ecology as an interdisciplinary field and set course expectations.	L	2.0	
TE 02	**Climate & Soils of the Tropics** What does "tropical" mean? Explore how terrestrial topography and the interactions between air, water, and landmasses generates tropical ecosystems. Explore characteristics and distributions of soils in the tropics and how they create variability in the landscape.	L; FL	2.0	Quesada et al. (2011) Myster (2017)

No	***Title and outline***	***Type***	***Time (hrs)***	***Readings***
TE 03	**What is biodiversity?** This lecture will review the different definitions of biological diversity ranging from genetic to landscape scales. We will introduce classic methods and indices used to quantify and analyze data.	L	2.0	Morton & Hill (2015)
TE 04	**The tropics...why they are so biodiverse?** We will introduce the high biodiversity of tropical regions and the Western Amazon in a global context (e.g., latitudinal diversity gradient). A guided walk and trail orientation in the forest around the center will introduce students to some of this diversity and start honing their observation skills.	L; FL	2.0	**Gentry (1988)** Hillebrand (2004) Kricher (2011) Rahbek (1995)
TE 05	**Tropical plant families I** We will learn about the plant diversity in the tropics, particularly the diversity of angiosperms in the Peruvian jungle.	L; FL	2.0	**León et al. (2006)** Leon & Young (1996) Ulloa Ulloa et al. (2004) - Spanish
TE 06	**Tropical animal diversity I – daytime** How do we measure animal biodiversity? We will use various field methods to survey faunistic diversity.	LAB	2.0	
TE 07	**Tropical animal diversity II – night-time** How do we measure animal biodiversity? We will use various field methods to survey faunistic diversity.	LAB	2.0	
TE 08	**Amazon Geology & Flooded Forest Ecology** How has geological history and variable river system influenced the high biodiversity of the Western Amazon? What is left of what was once a Mega-Wetland? How does flooding seasonality shape the ecology of flooded forest communities? What might future climate scenarios mean for the future of flooded forests?	L	2.0	**Bodmer et al. (2017)** Bodmer et al. (2014)
TE 09	**Fauna Survey Techniques** We will learn techniques to survey various animal groups, from shorebirds to dolphins.	LAB	2.0	
TE 10	**FEX I: Understory Plant Diversity** How do we measure plant biodiversity? Use methods and indices used to quantify biodiversity to practice.	FEX	2.0	
TE 11	**Tropical plant families II** We will appreciate plant biodiversity in the Center with a guided walk. We will identify plant species in our reach using knowledge acquired in our previous class and with the help of a guest co-instructor. We will use this information to identify the samples collected in our FEX I.	LAB	4.0	

No	***Title and outline***	***Type***	***Time (hrs)***	***Readings***
TE 12	**Identification keys** We will understand the importance of identification keys and how to prepare and use them for species identification.	L; FL	2.0	
TE 13	**Functional biodiversity** We will see how genotypic and phenotypic variation presents within each species, as well as learn how spatial and temporal variability are also part of biodiversity. How do these differences influence how an ecosystem operates or functions? How are they measured?	L; LAB	2.0	Asnet et al. (2017)
TE 14	**Ecological interactions I** We will briefly discuss various types of ecological interactions, highlighting their importance in the current state of biodiversity and ecosystems.	FL	1.0	Cuta-Pineda et al. (2021)
TE 15	**Plant secondary metabolism** We will briefly discuss plant secondary metabolisms as results of certain ecological interactions, and how they are used by the plants themselves and later by us, humans. We will also appreciate and take part of a Shaman Ceremony and visit Botanical Garden.	FL	1.0	Agrawal & Konno (2009)
TE 16	**Canopy Walkway - Into the Treetops** How does the forest environment change vertically and how to organisms use this structure? We will use a canopy walkway to explore the vertical structure of a mature rainforest and observe how light and temperature varies with height, and how organisms such as epiphytes and birds change along this gradient.	LAB	2.0	**Madigosky & Vatnick (2000)** Nadkarni & Solano (2002)
TE 17	**Ecological interactions II** Why are ecological interactions so important? We will deeply understand their role in biodiversity and their importance at various levels: for the species, for their ecosystems, and for us, humans. We will further discuss their services.	L	2.0	Ohgue et al. (2018) Imada (2020)
TE 18	**FEX II: Data collection of forest structure** Data collection of forest structure in the forests around the Center.	FEX	2.0	Phillips et al. (2021)
TE 19	**Pollination: observation and characterization of ecological interactions** Pollination is a remarkably interesting mutualistic interaction and can be found in most ecosystems around the globe. We will look for flower-visiting interactions and register their characteristics.	LAB	2.0	Dellinger (2020)
TE 20	**Climate Change Effects on Amazonian Forests** The responses of trees and microbial communities could have important consequences for biogeochemical cycles.	FL; D	2.0	Feldpausch et al. (2016)

No	***Title and outline***	***Type***	***Time (hrs)***	***Readings***
	Long-term monitoring and observations of responses to extreme climate events (drought/flood) can offer a window into potential responses.			Bhomia et al. (2019)
TE 21	**Tropical Forest Types, Structure and Succession** We will discuss forest classification and the four major forest types of the lowland Amazon we will see during the course and the influence of rivers on some of these forests. We will also characterize the forest succession levels and their features, to later classify the various forests near the Center, and identify the causes of disturbance.	L; FL; LAB	2.0	**Myster (2016)**
TE 22	**Tropical Alpine & Montane Ecosystems** We will examine how vegetation communities respond to mountain climate and vegetation. Students will be introduced to the highland tropics and variety of ecosystems found in the Eastern Andes-Amazon interface as we cross across a west-east moisture gradient from (high elevation wetlands, Puna grassland, tussock grassland, and elfin/cloud forest). We will discuss adaptations tropical alpine plants have to deal with the unique climatic challenges of living high in the tropics.	FL; D	1.0	**Sklenár et al. (2016)**
TE 23	**FEX III: Vertical structures: canopy comparison** Data collection at canopy walkway of cloud montane rainforest and contrast with data of TE16.	FEX	2.0	
TE 24	***Polylepis* forests of the high Andeans** We will visit forests in high elevations dominated by *Polylepis*. These forests are of high conservation concern. We will discuss their distribution and ecology importance.	FL; D	1.0	
TE 25	**Fishes of the amazon** We will examine how geologic history has shaped fish diversity in the Amazon basin. We will also learn about how the floodplain forests are the setting of an incredible interactions between fish and trees.	L; LAB	2.0	**Freitas et al. (2014)** Lucas (2008) Lundberg et al. (2010) Albert et al. (2011)
TE 27	**Course Wrap-up**	L	2.0	
	Total contact hours		**50**	

Reading List

***Readings in bold are required**

1. Adeney, J.M, Christensen, N.L., Vincentini, A., and M. Cohn-Haft (2016). White-sand Ecosystems in Amazonia. Biotropica 48: 7-23.
2. Agrawal, A. and K. Konno (2009). Latex: A Model for Understanding Mechanisms, Ecology, and Evolution of Plant Defense Against Herbivory. Annual Review of Ecology, Evolution, and Systematics 40: 311-331.
3. Albert, J. S., Carvalho, T. P., Petry, P., Holder, M. A., Maxime, E. L., et al. (2011). Aquatic Biodiversity in the Amazon: Habitat Specialization and Geographic Isolation Promote Species Richness. Animals: An Open Access Journal from MDPI 1: 205–241.
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6. **Bodmer R., Fang, T., Antunez, M., Puertas, P., Chota, K., et al. (2017).** Impact of recent climate fluctuations on biodiversity and people in flooded forests of the Peruvian Amazon in: The Lima Declaration on Biodiversity and Climate Change: Contributions from Science to Policy for Sustainable Development. CBD Technical Series No. 89. (eds. Rodriguez, L. and I. Anderson). Secretariat of the Convention on Biological Diversity, Montreal. pp. 81-90.
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11. Fine, P.V.A, Mesones, I., and P.D. Coley (2004). Herbivores promote habitat specialization by trees in Amazonian Forests. Science 305:663-665.
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13. **Gentry, A. (1988).** Tree species richness of upper Amazonian forests. Proceedings of the National Academy of Sciences 85: 156-159.
14. Hillebrand, H. (2004). On the generality of the latitudinal diversity gradient. The American Naturalist, 163(2), 192-211.
15. Imada, Y. (2020). A novel leaf-rolling chironomid, Eukiefferiella endobryonia sp. nov.(Diptera, Chironomidae, Orthocladiinae), highlights the diversity of underwater chironomid tube structures. ZooKeys, 906, 73.
16. IUCN Standards and Petitions Committee. (2022). Guidelines for Using the IUCN Red List Categories and Criteria. Version 15.1. Prepared by the Standards and Petitions Committee. Downloadable from https://www.iucnredlist.org/documents/RedListGuidelines.pdf

17. Kato, M. (2017). Introduction in Obligate Pollination Mutualism (eds. Kato, M., Kawakita, A.). Ecological Research Monographs. Springer, Tokyo. pp.
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34. Ulloa, C. U., Zarucchi, J. L., and León, B. (2004). Diez años de adiciones a la flora del Perú: 1993-2003.