THE SCHOOL FOR FIELD STUDIES

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 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. Comprehend and apply the concept of biodiversity and its various levels (genetic, functional, species and ecosystem diversity) to promote a better interaction between people and the natural world.
2. Strengthen student's critical thinking in order they can provide informed opinions while debating topics related with ecology and environment.
3. Develop scientific curiosity, observational and questioning skills, field research abilities, and analytical approaches for studying different organisms and ecosystems.
4. Improve student's science communication abilities to make difficult science subjects more understandable and interesting for broader audiences.
5. Discover the tight ties that bind all the different tropical ecosystems (from the Andes to the Amazon), how these ecosystems are linked to economy and society, and how these connections are being threatened in the anthropocene.

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	10
Quizzes	10
Science Communication	15
Field Exercise 1	15
Field Exercise 2	25
Final Exam	25
TOTAL	**100**

Participation (10%)

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 (10%)

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

Science Communication (15%)

Context: The loss of biodiversity, pollution, and climate change are referred to as the "triple planetary crisis," and the public's ignorance and misperception of the environmental services and threats are its strongest allies. There is a lot of oversimplified information about nature in the world today. Under this scenery, the findings of scientists must be supported. Science needs to be translated for a non scientific public in order to influence people's choices and actions, and promote a better understanding and respectful coexistence with our natural surroundings. Effective communication of findings and ideas are important for the advancement and application of science. Research and review articles are a valuable tool for communication among scientists, but we need to look for different strategies for increasing people bioliteracy.

Students will practice a) reading and conveying information in research/review articles, b) providing constructive criticism effectively and efficiently, and c) looking for an alternative to transmit the most important findings to a nonscientific public.

Methodology: students will read a scientific paper, present it orally to a scientific audience, and design an infographic to convey the main ideas of the research to a broader audience. Detailed instructions will be given after the submission of each assignment.

Field Exercises (45%)

FEX I: Species distribution patterns (15%)

Context: Ecology looks for patterns on nature. The better we understand those patterns, the better we manage and conserve the nature. Species distribution patterns are influenced by the environment, the

species traits and the interactions between the species and the environment. We will visit Cordillera Escalera to study the distribution pattern of some important understory plants along the trails.
Students will learn a) to use a GPS for creating tracks and waypoints, b) to implement the plot method for plant sampling, and c) to process the data obtained to describe, analyze and discuss the species distribution pattern.
Methodology: students will create and georeference plots in a systematic way along the trails in Cordillera Escalera. They will take environmental variables related to each plot, create a database with the information collected, and analyze it later. The outcome of this FEX will be a group scientific paper written by the students.

FEX II: Plant-animal interaction (25%)
Context: After ecological disturbances, some of the first changes are not in the species community structure, but in the behavior and interactions of those species. We will create a baseline that describes those interactions to have information for monitoring and detecting perturbation signals in the ecosystem faster than using species richness. We will survey plant-hummingbird interactions in the cloud forest of Wayquecha. Cloud forest is one of the most threatened ecosystem, that is why we will start monitoring it using the pollination network between hummingbirds and the plants they visit.
Students will learn a) to identify different species of hummingbirds, b) to collect and classify pollen samples, and c) to create, describe and discuss interaction networks.
Methodology: students are going to observe hummingbirds visit the flowers in the Wayquecha Gardens, count the number of visits by hummingbird species, compile data, and use interaction networks for analysis afterwards.The outcome of this FEX will be an individual scientific paper written by the students.

Final Exam (25%)
The final exam is open book. Students will have one day to answer several short and long-answer questions related to different ecological topics. 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	**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.	FL	2.0	Morton & Hill (2015)

No	***Title and outline***	***Type***	***Time (hrs)***	***Readings***
TE 03	**Forest concept, perception and conservation** We will analyze and compare the concept of forest given by: a) the government, b) Lamas and Chirikyacu communities, and c) the ecology. We will also study how the forest perception influence the forest management.	FL	2.0	**Chazdon et al. (2016)**
TE 04	**Great American Biotic Interchange** We must take into account the historical environmental conditions in order to comprehend the spread of species across the American continent, and particularly in South America. We will discuss how biogeography and paleontological data from the past can shed light on how ecosystems function in the present.	L	2.0	Woodburne (2010)
TE 05	**Angiosperm origin, evolution and diversity** We will learn about the plant diversity in the tropics, particularly the diversity of angiosperms in the Peruvian jungle.	L	2.0	Boyce et al. (2010)
TE 06	**Tropical plant families and sampling techniques** We will learn about the main characteristics used to identify and appreciate the most common family plants in the surrounding area.	L, LAB	2.0	
TE 07	**Landscape ecology: analyzing biodiversity from a broader lens** We will learn the main concepts related to landscape ecology (fragment, matrix, corridor, edge effect, etc), while we visit ”Bosque Las Nuwas”.	FL	1.0	**Laurance et al. (2018)**
TE 08	**Ecology of wetlands** We will visit Santa Elena Reserve where we will analyze the concept of wetlands; we will observe the organisms around the wetlands and discuss their importance and threats.	FL	1.0	Kingsford et al. (2016)
TE 09	**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., species distribution patterns and speciation processes). A guided walk and trail orientation in the forest around Lamas will introduce students to some of this diversity and start honing their observation skills.	L; D	3.0	Gentry (1988) Hillebrand (2004) Kricher (2011) Rahbek (1995)
TE 10	**Scientific method and hypothesis testing** We will introduce the process of doing science trough the scientific method lens. Students will practice the process of observation, questioning and hypothesis formulation during the class.	LAB	2.0	
TE 11	**FEX I Data collection** See Field exercise section above	LAB	3.0	

No	***Title and outline***	***Type***	***Time (hrs)***	***Readings***
TE 12	**FEX I Data analysis session** See Field exercise section above	LAB	2.0	
TE 13	**Tropical animal diversity and long-term monitoring projects** How do we measure animal biodiversity? We will introduce some of the field methods to survey faunistic diversity used in the Rio Amazonas Field Station Boat.	FL	1.0	
TE 14	**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	1.0	**Bodmer et al. (2017)** Bodmer et al. (2014)
TE 15	**Fauna survey techniques** We will collect data on different group of animals for the monitoring projects implemented by Río Amazonas Field Station Boat.	LAB	5.0	
TE 16	**Tropical Alpine & Montane Ecosystems** We will introduce the main vegetation communities and how they respond to mountain climate and vegetation. We will discuss adaptations tropical alpine plants have to deal with the unique climatic challenges of living high in the tropics.	FL; D	2.0	Sklenár et al. (2016)
TE 17	**Bioindicators, key and flagships species and conservation** Conservation is a long term process that requires evaluation, indicator species are useful tools for monitoring and evaluate how efficiently the ecosystems have been managed. However, what are the characteristics of good bioindicators, key and flagships species? We will try to answer this question.	L; D	2.0	**Siddig et al. (2016)**
TE 18	**Interaction behind diversity hot spots** 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 19	**FEX II Preparation** Co-evolutionary adaptations and ecological implications Ecosystem services	LAB	1.0	
TE 20	**Andean bear as key species and bioindicator of forest connectivity**	FL	1.0	
TE 21	**Canopy Walkway - Into the Treetops** How does the forest environment change vertically and how to organisms use this structure? We will use a	FL	2.0	Madigosky&Vatnick (2000)

No	Title and outline	Type	Time (hrs)	Readings
	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.			Nadkarni& Solano (2002)
TE 22	**FEX II: Plant-animal interactions** See Field experiment section above	LAB	3.0	
TE 23	**Andean ecosystem** Students will observe 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).	FL	1.0	
TE 24	**Andean-Amazon connectivity** We will visit El Manu National Park in the highest part of its area to observe how the Andes Mountain range is connected with the Amazon forest.	FL	1.0	
TE 25	***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	2.0	
TE 26	**Climate change impacts on water and biodiversity** Global warming, uncommon rain patterns, increasing number of sunny days…All of them are affecting biodiversity, but also the ecosystem services we obtained from the forest. We will discuss those climate change effects and propose ideas to improve ecosystem health.	FL; D	2.0	Zhao et al. (2024)
TE 27	**Anthropocene and biodiversity loss** This last geological era is characterized for the 6th largest biodiversity extinction event, driven by human being. We are going to discuss the hypothesis behind this association and determine if human being is the real responsible of this biodiversity loss.	L	2.0	**Lewis & Maslin (2015)** Johnson et al. (2017)
TE 28	**Urban ecology: looking for green cities and better human-nature coexistence** Most of the investigation and conservation efforts have been focus on protected areas, but conservation needs to start from the cities. We will see some examples about how to connect cities with nature.	L	2.0	**McPhearson et al. (2016)**
TE 29	**Course Wrap-up**	L	1.0	
	Total		**55**	
	UMN Instructional Hours*		**66**	

**UMN defines* an instructional hour as a 50-minute block. SFS syllabi are written in full 60-minute hours for programming purposes. Therefore 50 full hours = 60 UMN instructional hours (for four credit courses) and 25 full hours = 30 UMN instructional hours (for two credit courses).*

Reading List

***Readings in bold are required**

1. 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.
2. Asner, G. P., Martin, R. E., Tupayachi, R., and Llactayo, W. (2017). Conservation assessment of the Peruvian Andes and Amazon based on mapped forest functional diversity. Biological Conservation, 210, 80-88.
3. Bhomia, R.K., van Lent, J., Rios, J.M.G. et al. (2019). Impacts of *Mauritia flexuosa* degradation on the carbon stocks of freshwater peatlands in the Pastaza-Marañon river basin of the Peruvian Amazon. Mitig Adapt Strateg Glob Change 24: 645.
4. **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.**
5. Bodmer, R., Fang. T., Puertas, P.E., Antunez, M., Chota, K. and W.E. Bodmer (2014). Abstract in: Cambio climático y fauna silvestre en la Amazonía Peruana. Pp. 25-26.
6. Boyce, C. K., Lee, J. E., Feild, T. S., Brodribb, T. J., & Zwieniecki, M. A. (2010). Angiosperms helped put the rain in the rainforests: the impact of plant physiological evolution on tropical biodiversity1. *Annals of the Missouri Botanical Garden*, *97*(4), 527-540.
7. **Chazdon, R. L., Brancalion, P. H., Laestadius, L., Bennett-Curry, A., Buckingham, K., Kumar, C., ... & Wilson, S. J. (2016). When is a forest a forest? Forest concepts and definitions in the era of forest and landscape restoration. *Ambio*, *45*(5), 538-550.**
8. Cuta-Pineda, J. A., Arias-Sosa, L. A., and Pelayo, R. C. (2021). The flowerpiercers interactions with a community of high Andean plants. Avian Research, 12(1), 1-14.
9. Dellinger, A. S. (2020). Pollination syndromes in the 21st century: where do we stand and where may we go?. New Phytologist, 228(4), 1193-1213.
10. Feldpausch TR, Phillips OL, Brienen RJW, Gloor E, Lloyd J, et al. (2016). Amazon Forest response to repeated droughts. Global Biogeochemical Cycles.
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.
12. Gentry, A. (1988). Tree species richness of upper Amazonian forests. Proceedings of the National Academy of Sciences 85: 156-159.
13. 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
14. Johnson, C. N., Balmford, A., Brook, B. W., Buettel, J. C., Galetti, M., Guangchun, L., & Wilmshurst, J. M. (2017). Biodiversity losses and conservation responses in the Anthropocene. *Science*, *356*(6335), 270-275.
15. Kingsford, R. T., Basset, A., & Jackson, L. (2016). Wetlands: conservation's poor cousins. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *26*(5), 892-916.
16. Kricher, J. C. (2011). What and where are the tropics? Tropical Ecology, pp. 7-25. Princeton UP, Princeton, NJ.

17. **Laurance, W. F., Camargo, J. L., Fearnside, P. M., Lovejoy, T. E., Williamson, G. B., Mesquita, R. C., ... & Laurance, S. G. (2018). An A mazonian rainforest and its fragments as a laboratory of global change. *Biological reviews*, *93*(1), 223-247.**
18. León, B., Pitman, N., and Roque, J. (2006).Introducción a las plantas endémicas del Perú. Revista peruana de biología, 13(2), 9-22.
19. **Lewis, S. L., & Maslin, M. A. (2015). Defining the anthropocene. *Nature*, *519*(7542), 171-180.**
20. Lundberg, J.G., Sabaj Perez, M.H., Dahdul, W.H. and O.A. Aguilera (2010). The Amazonian Neogene fish faunas in: Amazonia: Landscape and Species Evolution (eds. Hoorn C. and F. Wesselingh). Pp. 281-301.
21. Madigosky, S.R. and I. Vatnick (2000). Microclimatic characteristics of a primary tropical Amazonian rain forest, ACEER, Iquitos, Peru. Selbyana 21: 165-172.
22. **McPhearson, T., Pickett, S. T., Grimm, N. B., Niemelä, J., Alberti, M., Elmqvist, T., ... & Qureshi, S. (2016). Advancing urban ecology toward a science of cities. *BioScience*, *66*(3), 198-212.**
23. Morton, S. R., and Hill, R. (2014). What is biodiversity, and why is it important. Biodiversity, Science and Solutions for Australia, CSIRO Publishing, Collingwood, Melbourne, 1-12.
24. Nadkarni, N.M. and Solano, R. (2002). Potential effects of climate change on canopy community in a tropical cloud forest: an experimental approach. Oecologia 131:580-586.
25. Peruvian Ministry of Agriculture and Irrigation [MINAGRI]. (2014). Supreme Decree 004-2014-MINAGRI, Decreto Supremo que aprueba la actualización de la lista de clasificación y categorización de las especies amenazadas de fauna silvestre legalmente protegidas.
26. Phillips, O., Baker, T., Feldpausch, T., and Brienen, R. (2021). RAINFOR field manual for plot establishment and remeasurement. Moore Foundation, Leeds, UK.
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28. **Siddig, A. A., Ellison, A. M., Ochs, A., Villar-Leeman, C., & Lau, M. K. (2016). How do ecologists select and use indicator species to monitor ecological change? Insights from 14 years of publication in Ecological Indicators. *Ecological Indicators*, *60*, 223-230.**
29. Sklenár, P., Kucevora, A., Macková, J. and K. Romoleroux (2016). Temperature microclimates of plants in tropical alpine environment: How much does growth form matter? Arctic, Antarctic, and Alpine Research 48:61-78.
30. Ulloa, C. U., Zarucchi, J. L., and León, B. (2004). Diez años de adiciones a la flora del Perú: 1993-2003.
31. Woodburne, M. O. (2010). The Great American Biotic Interchange: dispersals, tectonics, climate, sea level and holding pens. *Journal of mammalian evolution*, *17*, 245-264.
32. Zhao, B., Russell, J. M., Blaus, A., Nascimento, M. D. N., Freeman, A., & Bush, M. B. (2024). Tropical Andean climate variations since the last deglaciation. *Proceedings of the National Academy of Sciences*, *121*(34), e2320143121.