THE SCHOOL FOR FIELD STUDIES

# Tropical Forest Ecology and Resource Management
# SFS 3740

**Syllabus**
**4 credits**

The School for Field Studies (SFS)
Center for Tropical Island Biodiversity and Conservation Studies (CTIBCS)
Isla Colón, Bocas del Toro, Panama

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

## Course Overview

The Tropical Forest Ecology and Resource Management course in the Tropical Island Biodiversity Studies (TIBS) program introduces students to concepts and tools to study and manage tropical forest ecosystems. The course covers basic principles about the factors driving biodiversity patterns, with a focus on tropical systems, explores symbiotic relationships among species within the rain forest and provides insights into the importance of neotropical forests worldwide. Thus, as part of this course we will conduct activities focused on learning about how to assess changes in biodiversity, learn about ecological processes such as forest dynamics and soil productivity, and ecosystem services.

In addition, this component of the academic program will link some of the principles of tropical forest ecology and resource management to the Tropical Coastal Ecology (TCE) course. Within the context of resource management, we will learn about the relationship between biodiversity and ecosystem function (and services), the impact of habitat modification on these services, the role of terrestrial protected areas in maintaining ecosystem services and the impact of pollution. Throughout the course, lecture materials, extensive field activities and laboratories will address local issues in resource use, resource exploitation and resource management, which are important to the environmental and social well-being of the Bocas del Toro region. The experiences associated with this course will allow the students to better understand and conduct ecological and resource management research to inform policy-makers.

During the semester, discussions and activities will be framed in the following two major subjects, each of which will address specific local examples: 1) Principles of tropical forest ecology and 2) Principles of resource management.

## Learning Objectives

Following this course, students should:

1. Master the basic ecological principles for understanding natural resources within the tropics and their management.
2. Know how to observe and identify patterns and interactions in tropical ecosystems.
3. Understand how resources within the Bocas del Toro region and the country of Panama have historically been utilized and determine which actions should be taken in order to balance biodiversity conservation and natural resource use for human development.
4. Gain experience to develop high quality research to inform conservation efforts and strategies for natural resource management.

## Assessment

| Assessment Item | Value (%) |
|---|---|
| Participation | 10 |
| In-class assignments | 10 |
| Laboratory exercises | 10 |
| Frog report | 20 |
| Leaf-Cutter Ants and Regression | 20 |
| Web page entry | 10 |
| Final Exam | 20 |
| **TOTAL** | **100** |

### Participation (10%)

Active participation during classes, discussions and hikes is expected. Every student should be prepared for each academic session; these include not only lectures but also field trips and field exercises. It is strongly encouraged to read the materials for each session with enough detail to be able to ask relevant questions, and to participate in analytical discussions about the topics of interest.

### In-class assignments (10%)

An undefined number of in-class assignments related to the topic of the class will be asked to evaluate the understanding of the students. These in-class assignments will be conducted only in some lectures and will be prepared during class. Sometimes these assignments will be conducted without previous notification.

### Laboratory Exercises (10%)

Laboratory exercises aim to collect data and interpret results about an ecological question or phenomena. These activities are intended to complement the observations made during field activities or to test some of the ecological questions discussed in class. This activity also aims to stimulate discussion about key ecological processes. Instructions and guidelines for laboratory reports will be given in advance.

### Frog Report (20%)

The research report will be based on a particular topic relevant to the archipelago. Poison-dart frogs are well known to show a dramatic variation in their body coloration across the different islands. A group project focused on the "Population and behavioral Ecology of *Oophaga pumilio*" will be conducted throughout two field trips. After collecting data on the frogs' morphometric, coloration, and behavior at Isla Solarte and Isla Colón, students will hand in a written report answering a research question regarding these particular populations of *O. pumilio*. Students will be provided with lectures and guidelines for their written report, which should consist of a comprehensive, well-written, and well-organized document in the format of a scientific short communication, including the following sections: title, authors, introduction, materials and methods, results, discussion, conclusions, and references. During this Field Exercise students will gain experience conducting field observations, data collection and scientific research and writing.

### Leaf-Cutter Ants and Linear Regression (20%)

This lesson provides students with an open-inquiry research experience. Students will learn about one of the most iconic organisms and ecological interactions of the rain forest while learning about study design and statistics. In this lesson, students (in groups) will develop a hypothesis, design a study, collect field data (i.e., videos of leaf-cutter ants foraging), conduct image analyses to generate quantitative data, conduct linear regression analyses, and communicate results in the form of a scientific presentation. This lesson aims to provide an effective approach to teach a fundamental analytical skill, such as linear regression.

### Webpage entry (10%)

The purpose of this writing assignment is to practice conducting a critical assessment of questions and issues relevant to the Bocas del Toro region. Students will be required to write a web page entry of up to 300 words promoting destinations for ecotourism or sustainable agro forests. The text will aim to attract visitors to these projects by highlighting the approaches they used to manage natural resources and to preserve biodiversity. This exercise will be based on several field trips that we do to different kind of

projects around the archipelago. For example, a cacao (chocolate/multicrop) farm in Finca "La Magnita" in Changuinola, or a visit to the San San Pon Sac National Park. Students will be required to ask questions during these fieldtrips so they can collect information for this assignment.

**Final Exam (20%)**
The final exams will be given based on material covered in lectures, readings, and field experiences. There will be an exam review session before the exam.

## 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.

**Readings** – Optional readings provide students with background information about the topics discussed in class. All readings are available in PDF format. The purpose of using PDFs is to avoid printing in order to reduce the impact on the environment and on the center's resources. ***Readings might be updated or changed during the course of the semester***. Please, review the course outline on a regular basis.

## Course Content

**Type: D**: Discussion, **E**: Exam, **FL:** Field Lecture, **GL:** Guest Lecture, **Lab**: Laboratory, **L**: Lecture, **O**: Orientation, **W**: workshop

*Readings in **Bold** are required.

| *Code* | *Lecture Title and Description* | *Type* | *Time (hrs.)* | *Readings* |
|---|---|---|---|---|
| **MODULE 1 – Principles of Tropical Ecology** | | | | |
| 01 | **Course Intro**<br>Course overview: learning objectives, course structure and assignments. | O | 0.5 | |
| 02 | **Introduction to a Tropical Forest**<br>first glance at the inhabitants of a Neotropical evergreen moist forest and their attributes. | L/FL | 2.0 | **Kircher (2017b)**<br>Kircher (2017a) |
| 03 | **Rainforest climate and implications for plant diversity**<br>Lecture about the environmental conditions that facilitate plan diversity in the tropics, and main characteristics of its plants. | L | 1.0 | **Kricher (2017c)** |
| 04 | **Tropical Forest Structure and Dynamic**<br>Vertical structure of the forest, forest gaps and changes in abiotic conditions | L | 1.0 | Kricher (2011)<br>Kircher (2017d) |
| 05 | **Long Forest hike: A 3 hour walk through the Isla Colón reserve to assess Animal Diversity**<br>Exercise to integrate what we have learned so far about the ecology of the rain forest, and students will make videos for the leaf-cutter ants' activity. | FL | 3.0 | **Schwartz (2008)**<br>**Zuk (2016)**<br>Kricher (2017e) |
| 06 | **Fascinating Tales of the Rainforest**<br>Presentations (freestyle) by students of iconic symbiotic interactions and behaviors of some of rainforest organisms. | W | 3.0 | **Kricher (2017f)** |
| 07 | **Night hike in the Tropical Forest**<br>To observe rare nocturnal animal species and take photos for field guide. | FL | 1.5 | |
| 08 | **Tropical Soil and Nutrient Cycling**<br>Soil characteristics, nutrient cycling in wet tropical systems, the paradox of tropical luxuriance | L | 1.0 | **Kricher (2017g)**<br>Turner et al. (2018) |
| 09 | **Tropical Soil composition Laboratory**<br>Collect soil samples in the rain forest and other habitats around the SFS Center and within a | Lab | 2.0 | |

| | | | | |
|---|---|---|---|---|
| | comparative context assess the physiochemical characteristics of the samples. | | | |
| 10 | **Mangrove Ecology and Exploration Walk**<br>Walk through a mangrove island in the Bocas del Toro Archipelago to observe first-hand the characteristics of this particular type of forest and to collect data on mangrove bio-indicators. | FL | 1.5 | **Kricher (2017h)**<br>**Scott *et al*. (2024)** |
| 11 | **Introduction to Ecological Statistics and R/Jamovi**<br>Introduction to statistical analyses and software (R or Jamovi) that will be used for the Frog Report and Leaf-Cutter Ants/Regression assignment. This is also a time to answer and discuss any questions related to these assignments. | L; W | 1.5 | Statistical Analyses cheat sheet. |
| 12 | **Preparation for Field exercise (Frog report)**<br>A class to talk about biological context of the study, study design, fieldwork, hypothesis and predictions. | L | 1.5 | Willink *et al.* (2013)<br>Galeano & Harms (2016) |
| 13 | **Frog Research Exercise I**<br>Students will collect data in the field: focus on the red morph of the Strawberry Poison-dart frog. | FL | 2.5 | Pröl *et al.* (2013) |
| 14 | **Frog Research Exercise II** | FL | 3.0 | |
| 15 | **Epiphyte Life and Bromeliad Walk**<br>Field lecture about the morphological characteristics and ecology of epiphytes. | FL | 1.0 | Zotz (2016). Intro chapter.<br>Meunier et al. (2021) |
| 16 | **Protected Areas Design & Management**<br>Introduction to key concepts, types of Protected Areas, and a look at their effectiveness in the face of human population growth and climate change. | W; D | 2.0 | |
| 17 | **Leaf-Cutter Ants data analysis and preparation of presentations** | FL | 4.0 | Kingsford *et al.* (2021) |
| 18 | **Visit to a RAMSAR site: San San Pond Sac**<br>A field trip to a protected wetland to discuss the importance of such areas for biodiversity conservation (including manatees and migratory shorebirds). | FT | 4.0 | Kingsford *et al.* (2021) |
| 19 | **Leaf-Cutter Ants activity presentations** | D | 1.0 | |
| **MODULE 2 – Principles of Resource Management** | | | | |
| 20 | **Introduction to Natural Resource Management**<br>Key concepts in natural resource management, categories of resources, approaches to management and ultimate goals of natural resource management. | D | 0.5 | **Richardson *et al.* (2023)**<br>Rockström *et al.* (2009) |
| 21 | **Habitat Modification & Soil Resource Management**<br>Assess the disconnection between soil health, nutrient cycling and human activities, with a focus on agricultural practices. We will also discuss key concepts and major broad-scale trends in habitat modification and degradation. | L | 1.0 | **Fahrig (2003)**<br>Amit & Jacobson (2018)<br>Chavarria *et al.* (2021) |

| | | | | |
|---|---|---|---|---|
| 22 | **Island Biogeography and Conservation**<br>To explore the concept of Island Biogeography and its application for biodiversity conservation and management in Bocas del Toro. | W | 2.5 | |
| 23 | **Waste management and Ecological and Carbon Footprint: Estimating Personal Carbon Budget.**<br>Estimate our own personal carbon emissions and discuss potential lifestyle changes. | L | 0.5 | |
| 24 | **Waste Tour**<br>A visit to the town of Old Bank to learn about strategies led by local people to manage trash in remote locations. | FL | 2.0 | |
| 25 | **Forest Modification and Management**<br>We will discuss the implications of deforestation, and management strategies to preserve forest biodiversity and ecosystem services. | L | 1.0 | Kricher (2011): Forest Fragmentation and Biodiversity |
| 26 | **Birdwatching trip**<br>A trip to the Soropta Area (near mainland) to visit a project focusing on bird's habitat management to improve their diversity – birdwatching as an emerging economic alternative in the region. | FL | 4.0 | Pollock *et al.* 2022<br>Akresh *et al.* 2023 |
| 27 | **Land-use Management and Conservation**<br>Field trip to an agroforestry farm to assess the effect of land use change and its consequences in a tropical setting. | FL | 4.0 | |
| 28 | **Plastics and Pollution – Beach clean up**<br>Beach clean up in a local beach and characterization of types of trash. | FL; W | 2.0 | |
| 29 | **Final Exam Review** | 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


Akresh, M.E., D.I. King, S.L. McInvale, J.L. Larkin, A.W. D'Amato. 2023. Effects of forest management on the conservation of bird communities in eastern North America: A meta-analysis. Ecosphere. 14:e4315; https://doi.org/10.1002/ecs2.4315

Amit, R., S.K. Jacobson. Participatory development of incentives to coexist with jaguars and pumas. 2018. Conservation Biology. Vol. 32 (4), pp 938–948.

Chavarria, K.A., K. Saltonstall, J. Vinda, J. Batista, M. Lindmark, R.F. Stallard, J.S. Hall. 2021. Land use influences stream bacterial communities in lowland tropical watershed. Scientific Reports. 11:21752

**Fahrig, L. 2003. Effects of Habitat Fragmentation on Biodiversity. Annu. Rev. Ecol. Evol. Syst. Vol. 34, pp 487–515.**

Galeano, S.P., K.E. Harm. 2016. Coloration in the polymorphic frog Oophaga pumilio associates with levels of aggressiveness in intraspecific and interspecific behavioral interactions. Behav. Ecol. Sociobiol. Vol. 70, pages 83–97.

Kingsford, R.T., G. Bino, C.M. Finlayson, D. Falster, J.A. Fitzsimons, D.E. Gawlik, N.J. Murray, P. Grillas, R.C. Gardner, T.J. Regan, D.J. Roux, R.F. Thomas. 2021. Ramsar Wetlands of International Importance–Improving Conservation Outcomes. Front. Environ. Sci. 9:643367.

Kricher, John C. 2017a. Welcome to the Torrid Zone. In: The New Neotropical Companion. Princeton University Press, Princeton, NJ. Pages 15–28.

**Kricher, John C. 2017b. Why Are There So Many Species. In: The New Neotropical Companion. Princeton University Press, Princeton, NJ. Pages 134–154.**

**Kricher, John C. 2017c. Why It is Hot, Humid, and Rainy in the Tropics. In: The New Neotropical Companion. Princeton University Press, Princeton, NJ. Pages 29–38.**

**Kricher, John C. 2011. Inside Tropical Rain Forests: Structure. Tropical Ecology. Princeton University Press, Princento, NJ. Page 79.**

Kricher, John C. 2017d. If a Tree Falls…Rain Forest Disturbance Dynamics. In: The New Neotropical Companion. Princeton University Press, Princeton, NJ. Pages 95–112.

Kricher, John C. 2017e. Finding Animals in Rain Forest. In: The New Neotropical Companion. Princeton University Press, Princeton, NJ. Pages 58–72.

**Kricher, John C. 2017f. Tropical Intimacy: Mutualism and Coevolution. In: The New Neotropical Companion. Princeton University Press, Princeton, NJ. Pages 154–180.**

**Kricher, John C. 2017g. Essential Dirt: Soils and Cycling. In: The New Neotropical Companion. Princeton University Press, Princeton, NJ. Pages 73–80.**

**Kricher, John C. 2017h. Cruising the Rivers to the Sea. In: The New Neotropical Companion. Princeton University Press, Princeton, NJ. Pages 205–234.**

Kricher, John C. 2011. Inside Tropical Rain Forests: Forest Fragmentation and Biodiversity. Tropical Ecology. Princeton University Press, Princento, NJ. Page 500.

MacArthur, R.H. & E.O. Wilson. 1967. The Theory of Island Biogeography. Prince University Press.

Meunier, F., M.D. Visser, A. Shiklomanov, M.C. Dietze, J.A. Guzmán et al. 2022. Liana optical traits increase tropical forest albedo and reduce ecosystem productivity. Glob. Change Biol. Vol. 28 pp 227–244.

Pollock, H.S., J.D.Toms, C.E. Tarwater, Th.J. Benson, J.R. Karr, J.D. Brawn. 2022. Long-term monitoring reveals widespread and severe declines of understory birds in a protected Neotropical forest. PNAS. e2108731119; https://doi.org/10.1073/pnas.2108731119

Pröl, H., B. Willink, S. Hauswaldt. 2013. Geographic variation in sexual signals and behavior in two species of poison frogs. Evolutionary Ecology Research. Vol. 15, pp 667–687.

**Richardson, K., W. Steffen, W. Lucht, J. Bendtsen, S.E. Cornell, J.F. Donges, M. Druke *et al.* 2023. Earth beyond six of nine planetary boundaries. Science Advances 9: eadh2458**

Rockström, J. W. Steffen, K. Noone, A. Persson, F.S. Chapin III, E.F. Lambin *et al.* 2009. A safe operating space for humanity. Nature. Vol. 461.

**Schwartz, Martin A. 2008. The importance of stupidity in scientific research. *Journal of Cell Science* 121, no. 11. Pages 1771–1771.**

**Scott, C.P., L. Mach, K.M. Lucas, A.E. Myers. 2024. Whose Cultural Ecosystem Service Values Matter? Exploring Power Inequities in Diverse Mangrove Communities. Human Ecology. https://doi.org/10.1007/s10745-023-00462-5**

Willink, B., E. Brenes-Mora, F. Bolaños, Pröl. 2013. Not Everything is Black and White: Color and Behavioral Variation Reveal A Continuun Between Cryptic and Aposematic Strategies in a Polymorphic Poison Frog. Evolution 67–10. Pages 2783–2794.

Zotz, G. 2016. Plants on Plants – The Biology of Vascular Epiphytes. Springer Nature. AG, Switzerland.

**Zuk, M. 2016. Temperate Assumptions: How Where We Work Influences How We Think. The Am. Nat. Vol. 188. Pages S1–S7.**