Principles of Natural Resource Management
SFS 3742

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, this is a field program, and the field can change.

Course Overview

The tropics are globally known for their abundant natural resources. For instance, more than half of the world's biodiversity is found in tropical forests, which are considered biodiversity hotspots among terrestrial ecosystems (Mittermeier et al., 2011; Pillay et al., 2022). However, in this biogeographic region increased land use intensification (e.g. industrial agriculture, urban expansion) has resulted in environmental degradation, forest fragmentation and habitat loss, threatening the long-term functioning of ecosystems and the services they provide (Tabarelli, 2004; Alroy, 2017, de Oliveira et al., 2018). It is critical to implement management strategies that allow for the proper use of natural resources, while also ensuring the equity among the actors involved and maintaining ecosystem functionality.

Traditionally, environmental management has assumed that natural resources are static systems, so human intervention must be regulated to maintain their stability. Given the global scale of environmental problems (e.g. climate change) this approach may be unrealistic. As an alternative natural resource managers have proposed new theories based on the concept of resilience (Benson & Garmestani, 2011). Resilience can be defined as the system's ability to absorb internal and/or external change and recover while maintaining long-term functionality (Holling 1973; Benson & Garmestani, 2011). Thus, management of natural resources can focus on identifying key aspects of ecosystems that contribute to their resilience, while also acknowledging the possibility for change and providing a framework for developing adaptive capacity in social and ecological systems (Gunderson et al., 2010). While this approach provides new ways of thinking about social and ecological systems, it also implies modifications to the legal framework and management strategies that are already implemented, which can be challenging, especially in tropical countries such as Costa Rica.

Costa Rica, while having only 0.03 % of the world's land area (51 100 km²), is home to about 5% of the world's biodiversity (Avalos, 2019). The country is well-known for its conservation efforts, with over a quarter of its land area under some form of protection. Historically, protected areas have been managed under the paradigm of biodiversity protection, with strict controls over the socioeconomic activities that can take place within them. Consequently, these activities have concentrated outside protected areas, where urban expansion and economic incentives for cattle production and agriculture has resulted in drastic deforestation processes (Stan and Sánchez-Azofeifa, 2019). Currently, unplanned urban development, expansion monoculture plantations (e.g. pineapple, bananas, oil palm), and poor management of tourism, exert great pressure on natural resources, increasing forest fragmentation and habitat loss, degrading soils and polluting the environment.

Furthermore, deteriorated infrastructure in combination with weak regulations and enforcement is creating severe pollution and water scarcity in many parts of the country. In Costa Rica 93.4% of the population (about 4.7 million people) has access to potable water, although population growth, lack of financing and vulnerability of water sources, jeopardize this valuable resource (Mora & Portuguez, 2020). This is especially concerning in rural areas where environmental regulations are poorly enforced, and access to drinking water by local communities is more challenging. Due to this, community-based water management has been promoted as a solution for expanding water access in rural communities (Dobbin & Sarathy, 2015). Community water associations provide water service to about 25% of Costa Rican population and manage forest fragments that protect water sources, while conserving multiple species.

The relationship between water source protection and conservation of biodiversity has not been explored in Costa Rica, although forest fragments associated with water protection may serve as refuge for a diverse array of organisms, connecting forested areas and contributing to gene flow (Bogoni et al., 2020).

Understanding these processes is critical for identifying key aspects of ecosystems that contribute to their resilience, ensuring their long-term functioning, which are specially threatened outside protected areas, where the landscape is dominated by forest patches embedded in agricultural and urban matrices (Morera et al., 2018; Stan and Sánchez-Azofeifa, 2019). It is essential to expand natural resource management to areas that are not legally protected and where wildlife-human interactions are more likely to occur. Proper management of these resources can help preserve species in a changing landscape while also strengthening the adaptive capacity in social and ecological systems.

This inter-disciplinary course focuses on principles and applications of natural resources management, exploring alternative ways to ensure equity among the stakeholders involved in the use of these resources, while sustaining social and ecological resilience. The course will introduce the challenges faced by managers of natural resources at the global level, with emphasis on Costa Rica, within the context of a fragmented landscape, agriculture, and urban expansion. Based on specific case studies, illustrated during classes and field trips, the course will show concepts and tools used for addressing complex environmental issues such as mammal conservation, solid waste management and water management problems.

Learning Objectives

1. An introduction to basic principles of natural resources management in the tropics using a resilience-based approach.
2. An awareness of the priorities of sustainable use of natural resources in Costa Rica.
3. An understanding of the importance of balancing biodiversity conservation and natural resource use for social and ecological resilience.

Assessment

Assessment Item	Value (%)
Field Lab 1	20
Field Lab 2	15
Discussion session	10
Field Exercise	30
Final Assignment	15
Participation	10
TOTAL	**100**

Field Lab 1: Edge effect on forest structure and bat diversity in a forest fragment (20%)

Tropical forests are facing an accelerated loss through deforestation, resulting in fragmented forest landscapes. Fragmentation increases edge effect, leading to changes in species composition and affecting ecological dynamics. Bats, for instance, play crucial roles in forest functioning, serving as seed dispersers, pollinators, and controlling insect and small vertebrate populations, among others. Understanding the impact of edge effect on forest structure and bat diversity is essential to inform effective conservation strategies in fragmented landscapes. In this field lab students will learn how to quantify forest structure and how to estimate biodiversity of bats in a tropical forest fragment. Students will prepare a short report to present their main findings. Detailed instructions will be given in advance.

Field Lab 2: Mapping exercise (15%)
Mapping represents an essential tool for understanding ecological interactions at the landscape level, as it facilitates land-use and conservation planning. In this exercise students will use aerial images and QGIS software to generate a map and provide a comprehensive description of the land use.

Discussion Session (10%)
In groups, students will present a study case of community-based natural resource management in Costa Rica and discuss about strategies to increase community participation. Detailed instructions will be given in advance.

Field Exercise: Medium-large arboreal mammal richness in two water source protected areas (30%)
Agriculture and urban expansion are one of the main drivers of deforestation and forest fragmentation in Costa Rica. Outside protected areas, some forest fragments persist since they are crucial for water protection. Understanding mammal habitat use is a key element to defining spatial conservation priorities. In this field exercise students will use camera traps to survey medium and large arboreal mammals, and GIS software to represent two areas used as water sources. In groups, students will write a report in the form of a scientific paper (2500-3000 words).

Final Assignment (15%)
In groups, students will prepare, present and facilitate an interactive activity that highlights the importance of mammal conservation in Atenas. Activities will aim to raise awareness about endangered local species, habitat protection and how people can contribute to mammal conservation efforts in Atenas. Detailed instructions will be given in advance.

Participation (10%)
Everybody should be prepared for each academic session. This implies reading assigned materials with enough detail to be able to ask relevant questions; and to participate in analytical discussions about key issues. Participation will be evaluated during classes and discussions, considering the quality and quantity of your contributions.

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 Experience, **D**: Discussion, **O**: Orientation, **FLAB:** Field Lab, **LAB**: Lab/workshop, **P:** Presentation

No	*Title and outline*	*Type*	*Time (hrs)*	*Required Readings*
1	**Course Introduction** – Course overview and syllabus review	L	0.5	
2	**History of Conservation in Costa Rica** – Socio-economic drivers of deforestation in CR – History of Conservation in CR	L	1.5	
3	**Introduction to the mammals of Costa Rica** – Orders of mammals of Costa Rica – Ecological importance of mammals in the tropics – Challenges for mammal conservation in Costa Rica	D	1.5	Ramírez et al. (2023).
4	**Introduction to Field Exercise (FEX)** – "Proyecto Más que agua" – Camera trapping for animal monitoring and management of water source protected areas	L	1.0	Cambronero et al. (2023).

No	Title and outline	Type	Time (hrs)	Required Readings
5	**Introduction to Field Exercise (FEX)** – Tree climbing workshop – Camera trap models and settings	FL	4.0	Video: "Heroes of the high frontier" Lowman, (2020). Video: "Life in the Treetops"
6	**Methods and techniques to study mammals** – Introduction to field methods and techniques to study and monitor terrestrial mammals	L	1.0	
7	**Intro to FLAB 1** – Forest characterization – How to establish transects and measure trees	FL	2.0	
8	**Bats** – Ecological importance of bats – Observation of bat species captured at Manú	FLAB	3.0	
9	**Forest fragmentation and edge effect** – Landscape elements (patch, matrix) – Edge effect – Habitat fragmentation	FL	1.0	Fischer et al. (2021).
10	**FLAB 1** – Forest characterization – Establishing transects and measuring trees at Manú	FLAB	2.0	
11	**Field Exercise (Part 1)** – Setting canopy camera at Bosque Municipal – Establishing plot and measuring trees in a forest fragment	FEX	3.0	
12	**Field Exercise (Part 2)** – Setting canopy camera at Andrómeda – Establishing plot and measuring trees in a forest fragment	FEX	3.0	
13	**Biodiversity workshop** – What is biodiversity? – How to measure biodiversity? – Effective number of species	L	2.0	Jost (2006). Blog: Effective Number of Species
14	**FLAB analysis** – Comparing forest structure of two sites – Intro to Excel	FLAB	2.0	
15	**Community- based natural resource management** – Community-based water management in Costa Rica – Intro to ASADAs (Administrative Associations for Water Supply and Sewage Systems)	**D**	1.0	Bower (2013). Dobbin and Sarathy (2015).
16	**Briefing for ASADA visit** – History of local ASADA	L	0.5	

No	Title and outline	Type	Time (hrs)	Required Readings
17	**Visit to an ASADA** – Study case of an ASADA (Administrative Associations for Water Supply and Sewage Systems)	FL	3.0	
18	**Community- based NRM** – Challenges for CBNRM in Costa Rica – Discussion on strategies to increase community participation in NRM	D	1.5	Reading specific to each group. TBD
19	**Intro to FLAB 2** – Introduction to GIS – Operation of GPS receivers – How to generate field data: mapping points of interest, trails, etc.	FLAB	1.0	Video: "Why all world maps are wrong"
20	**FLAB 2** – Elaborate a map suitable from data generated in the field – Introduction to free, open-source GIS software	LAB	3.0	
21	**Santa Rosa National Park** – Orientation Santa Rosa	O	1.0	
22	**Santa Rosa National Park** – History of management, ecological restoration and biodevelopment of the ACG (Área de Conservación Guanacaste)	FL	1.0	Janzen and Hallwachs (2020).
23	**Field Exercise** – Collecting camera traps at Bosque Municipal and Andrómeda	FEX	2.0	
24	**FEX Data processing/tagging** – Using Digikam to tag videos from camera traps	FEX	4.0	
25	**FEX Data analysis and writing**	LAB	1.0	
26	**Final assignment** – Open house on mammal conservation in Atenas.	P	2.0	
27	**Integrated Discussion**	D	1.5	
	Total hours		**50**	
	UMN Instructional Hours*		**60**	

**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

1. **Alroy, J. (2017).** Effects of habitat disturbance on tropical forest biodiversity. Proceedings of the National Academy of Sciences, 114(23), 6056–6061. https://doi.org/10.1073/pnas.1611855114

2. **Avalos, G. (2019).** Still Searching the Rich Coast: Biodiversity of Costa Rica, Numbers, Processes, Patterns, and Challenges. In T. Pullaiah (Ed.), Global biodiversity. Volume 4: Selected countries in the Americas and Australia (pp. 101–138). Apple Academic Press.

3. **Benson, M. H., & Garmestani, A. S. (2011).** Can We Manage for Resilience? The Integration of Resilience Thinking into Natural Resource Management in the United States. Environmental Management, 48(3), 392–399. https://doi.org/10.1007/s00267-011-9693-5

4. **Bogoni, J. A., Peres, C. A., & Ferraz, K. M. P. M. B. (2020).** Extent, intensity and drivers of mammal defaunation: A continental-scale analysis across the Neotropics. Scientific Reports, 10(1), 14750. https://doi.org/10.1038/s41598-020-72010-w

5. **Bower, K. M. (2013).** Water supply and sanitation of Costa Rica. Environmental Earth Sciences, 71(1), 107–123. https://doi.org/10.1007/s12665-013-2416-x

6. **Cambronero, M., Sánchez-Calderón, R., & Lobo, R. (2023).** Medium and large-sized mammals in a premontane moist forest fragment, Atenas, Costa Rica. *Revista de Biología Tropical*, *71*(1), e53245. https://doi.org/10.15517/rev.biol.trop..v71i1.53245

7. **Cove, M. V., Spínola, R. M., Jackson, V. L., Sàenz, J. C., & Chassot, O. (2013).** Integrating Occupancy Modeling and Camera-Trap Data to Estimate Medium and Large Mammal Detection and Richness in a Central American Biological Corridor. *Tropical Conservation Science*, *6*(6), 781–795. https://doi.org/10.1177/194008291300600606

8. **de Oliveira Roque, F., Menezes, J. F. S., Northfield, T., Ochoa-Quintero, J. M., Campbell, M. J., & Laurance, W. F. (2018).** Warning signals of biodiversity collapse across gradients of tropical forest loss. Scientific Reports, 8(1), 1622. https://doi.org/10.1038/s41598-018-19985-9

9. **Dobbin, K. B., & Sarathy, B. (2015).** Solving Rural Water Exclusion: Challenges and Limits to Co-Management in Costa Rica. Society & Natural Resources, 28(4), 388–404. https://doi.org/10.1080/08941920.2014.948245

10. **Fischer, R., Taubert, F., Müller, M. S., Groeneveld, J., Lehmann, S., Wiegand, T., & Huth, A. (2021).** Accelerated forest fragmentation leads to critical increase in tropical forest edge area. *Science Advances*, *7*(37), eabg7012. https://doi.org/10.1126/sciadv.abg7012

11. **Gunderson, L. H., Allen, C. R., & Holling, C. S. (Eds.). (2010).** Foundations of ecological resilience. Island Press.

12. **Janzen, D. H., & Hallwachs, W. (2020).** Área de Conservación Guanacaste, northwestern Costa Rica: Converting a tropical national park to conservation *via* biodevelopment. *Biotropica*, *52*(6), 1017-1029. https://doi.org/10.1111/btp.12755

13. **Lowman, M. (2020).** Life in the treetops—An overview of forest canopy science and its future directions. *PLANTS, PEOPLE, PLANET*, *3*(1), 16–21. https://doi.org/10.1002/ppp3.10125

14. **Mittermeier, R. A., Turner, W. R., Larsen, F. W., Brooks, T. M., & Gascon, C. (2011).** Global Biodiversity Conservation: The Critical Role of Hotspots. In F. E. Zachos & J. C. Habel (Eds.), Biodiversity Hotspots (pp. 3–22). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-20992-5_1

15. **Mora, D., & Portuguez, C. (2021).** Agua para consumo humano y saneamiento en Costa Rica para el 2020: Brechas en tiempos de pandemia. Unidad Técnica de los Servicios de Abastecimiento de Agua Potable y Saneamiento (UTSAPS) - AyA.

16. **Morera, C., Sandoval, L. F., & Alfaro, L. D. (2021).** Ecological corridors in Costa Rica: An evaluation applying landscape structure, fragmentation-connectivity process, and climate adaptation. Conservation Science and Practice, 3(8). https://doi.org/10.1111/csp2.475

17. **Perfecto, I., & Vandermeer, J. (2008).** Biodiversity Conservation in Tropical Agroecosystems. Annals of the New York Academy of Sciences, 1134(1), 173–200. https://doi.org/10.1196/annals.1439.011

18. **Perfecto, I., & Vandermeer, J. (2010).** The agroecological matrix as alternative to the land-sparing/agriculture intensification model. *Proceedings of the National Academy of Sciences*, *107*(13), 5786–5791. https://doi.org/10.1073/pnas.0905455107

19. **Pillay, R., Venter, M., Aragon-Osejo, J., González-del-Pliego, P., Hansen, A. J., Watson, J. E., & Venter, O. (2022).** Tropical forests are home to over half of the world's vertebrate species. Frontiers in Ecology and the Environment, 20(1), 10–15. https://doi.org/10.1002/fee.2420

20. **Ramírez-Fernández, J. D., Sánchez, R., May-Collado, L. J., González-Maya, J. F., & Rodríguez-Herrera, B. (2023).** Revised checklist and conservation status of the mammals of Costa Rica. Therya, 14(2), 233–244. https://doi.org/10.12933/therya-23-2142

21. **Stan, K., & Sanchez-Azofeifa, A. (2019).** Deforestation and secondary growth in CR along the path of development. Regional Environmental Change, 19(2), 587–597. https://doi.org/10.1007/s10113-018-1432-5

22. **Tabarelli, M., Cardoso da Silva, J. M., & Gascon, C. (2004).** Forest fragmentation, synergisms and the impoverishment of neotropical forests. Biodiversity and Conservation, 13(7), 1419–1425. https://doi.org/10.1023/B:BIOC.0000019398.36045.1b