

Mountain Ecology

SFS 3060

Syllabus

Center for Himalayan Environment and Development Studies
The School for Field Studies (SFS)
UWICER and Bhutan Ecological Society
Himalayan Environment and Society in Transition
Paro, Bhutan

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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Sp19



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, the elephants are not always where we want them to be, so be flexible!

Course Overview

The kingdom of Bhutan lies in the eastern Himalayan typically characterized by extensive and numerous mountains and valleys, world's highest peaks and a diversity of vegetation and wildlife. Mountain environments dominate Bhutan and shape both the culture and ecology of the land. Within this compact and mountainous country, are an extraordinary diversity of ecosystems and habitats, and Bhutan and the Eastern Himalayan region are globally recognized hotspots for biodiversity.

In this course, we focus on mountains. What are the processes that form mountains and shape their ecological communities? We will begin by studying the physical environment of mountains — the geology and climate. Upon gaining an understanding of the physical environment, we will investigate the effect of elevation gradients on vegetation, and highlight special features of mountain animals and the interaction between habitat and animal communities. How do mountains influence the distribution of biodiversity and how do scientists study ecology in mountainous environments? Finally, what are the threats to mountain regions in a rapidly changing world and what conservation tools are scientists and conservation biologists implementing to protect sensitive mountain environments and species?

Learning Objectives

The objective of this course is to provide students the background and tools necessary to understand and study the mountain environments of Bhutan and to learn its fauna and flora. Through classroom lectures, discussions, seminars, field lectures, and field exercises, we will examine what makes the Eastern Himalayan region unique. Classroom and field lectures will provide core concepts and tools for inquiry, whereas field exercises will reinforce these concepts and allow students to practice scientific inquiry skills and data collection. In this course students will develop a conceptual and practical understanding of the ecological complexity the Eastern Himalaya region. Specific learning objectives are the following:

1. Understand the geological history and biogeography of mountain regions in general and the Eastern Himalayan region specifically, while distinguishing characteristics of mountain environments that explain species distributions and speciation
2. Learn the natural history, biology and ecology of organisms in Bhutan
3. Employ field research methods and analytical tools, including qualitative and quantitative methods scientists and managers use to study and conserve biodiversity
4. Gain an understanding of the challenges mountain communities face and the unique and progressive conservation efforts being made in Bhutan
5. Practice the scientific method, gain experience conducting collaborative research in a multidisciplinary learning environment and advance science communication skills.

Assessment

Our goal is to conduct ongoing assessment of student learning throughout the course, and provide timely and constructive feedback. Some assignments encourage students to work together, to share ideas and knowledge. This allows students to take advantage of the range of backgrounds within the group. Assessment will be conducted on an individual basis, unless otherwise stated. The final course grade will be based on the following:

Assessment Item	Value (%)
Active participation	10
Field Methods I: Plant Identification Quiz and Group Presentation	12

Field Methods II: Survey Methods of Biodiversity and Life Zone Productivity	12
Field Methods III: River and Terrestrial Invertebrate Community Sampling	12
Midterm Exam	10
Field Methods V: in Sampling Small Mammals	12
Field methods VIII: Forest Succession after Fire	12
Final examination	20
Total	100

Assessment Descriptions

Active participation: During this program we will travel through many eco-regions and rural communities. We expect that you will be an active observer, constantly observing the landscape, livelihoods, and culture and participating in discussions regarding these observations. Active participation includes constructive engagement with the full range of course activities, respectful awareness of our cultural context, and responsible behavior as a group member who is involved in others' learning. There will be opportunities throughout the semester for constructive feedback.

Because 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 program is mandatory because your actions can significantly affect the experience you and your classmates have while at SFS. Therefore, it is important that you are prompt for all activities, be prepared by reading your assignments, bring the necessary equipment for the field, and simply get involved and stay engaged.

Field notebook: You will develop a comprehensive program field notebook that documents and captures your on-the-ground learning experiences and serves as your primary record of content and reflections during the course. This notebook should accompany you at all times: in the classroom, guest lectures, and the field. All class notes, field notes, data from field exercises, reflective comments and questions on course material, notes from discussions, and short written assignments should be contained in this notebook, which will serve as your main study tool. You may want to develop sections for observations during travel, translations or words in local languages, notes to remember for your directed research, cultural notes, and reflective writing on how this experience is reshaping your understanding of people and the environment. Keep this separate from personal journaling you may do. Additional course handouts should be kept in the folder provided.

When using citable material from your field notebook in written assignments, use the following format to acknowledge the source: (Sonam Phuntsho, Field notes, Pillcopata, 12 October 2014). Whenever possible, use the name of the person providing the information; if not possible, cite descriptively, for example: "Firewood gatherer in Manu forest."

Floral and faunal identification: A fundamental skill in ecology is the ability to identify organisms. In Mountain Ecology, we will focus on forest and common understory plant community identification, mammal, bird, terrestrial and river macro-invertebrate identification, because these are the most recognizable and best known taxonomic groups in the area. Field and laboratory practicums will be used for identification purposes.

Field Exercises (FEX): Field exercises are designed for students to learn and practice a series of different field techniques to collect data on biodiversity. You will learn how to use these techniques,

collect data, and perform statistical tests and interpretation of the results. Handouts will accompany each FEX, which will ask students to interpret their findings and reflect on study design and improvement.

Exploration of Organisms and their Micro-Environments (ungraded): This exercise will be first one for this course, wherein the students are expected to get familiarize data gathering and recording methodology and processes in different micro-environments (streams, agricultural fields, forests etc) and we will also introduce some instrument use to measure biophysical attributes.

Field Methods I: Plant Identification Quiz: This exercise will enable students to know the main plant species major life zones in of Bhutan. The students will be given field lectures on identification of different plant species around Centre's campus, along the elevational gradient covering temperate to sub-tropical region. There will be plant identification quiz in the class using sample specimens. Individual student will pick a favorite plant species and a write short description illustrating its phylogeny, eco-region, its uses and management practices. A detail handout will be provided for this FEX.

Field Methods II: Survey Methods of Floral Biodiversity and Life Zone Productivity: Elevation transects provide important natural experiments for ecologists to understand plant and animal responses to environmental gradients. We will observe plant and animal distributions and document changes in species occurrence and richness along a gradient spanning the mountain top and valleys and consider how climate change may affect these communities in unpredictable ways. We will document biodiversity along elevational gradient by dividing the class into groups of four/ five: each group will conduct detail survey of life forms in series of plots and woody trees, you will collect DBH, height and other attributes of the trees within the plot. Additionally the group will collect and record ecologically important morphological characteristics of those trees and then use the collected data to produce an estimate of total biomass, calculate biodiversity index and other ecologically important bio-indicators and plasticity. Additionally student will be taught to collect tree cores for growth pattern/trend analysis. The surveys will cover altitudinal gradient from valley bottom to mountain top. A detailed handout will be provided to conduct the field exercise and the group should produce comprehensive written report covering different aspects of the exercise.

Field methods III: River and Terrestrial Invertebrate Community Sampling : Aquatic invertebrate communities are determined by resources available in streams, rivers, and lakes– and are often influenced heavily by pollution. We will survey sites near the SFS Campus and Paro town, looking at how flow rates influence invertebrate communities. We will also survey some key terrestrial invertebrates such as dragonflies and ants using appropriate methodologies. Students will learn standardized surveys and aquatic invertebrate identification. Students will interpret their data in a short written report.

Field methods IV: Forest and Avian Community Changes along an Elevation Gradient (ungraded): We admire birds not only for their beauty, songs, and their miraculous ability to fly but they are also ecologically component of the ecosystems; pollinations, seed dispersal agent, maintain ecological balance through prey-predators relationships. In this course, we will travel to different parts of Bhutan, from the high temperate-Himalayan valleys to the sub-tropical valleys. Along the way we'll stop en route to observe and collect natural history data on plants and birds, while practicing field censusing techniques between different elevational transition zones and habitats.

Field methods V: Study of Small Mammals: Small mammals have significant influences on vegetation and soils, exert predatory pressure on other animals, and provide food for predators. Future management efforts should include consideration of these diverse influences

Traps are the most efficient method of surveying such animals such as rodents. We will strategic sampling methods and set of traps to capture small mammals at least in two systems (agricultural fields and a pine forest). Using the data from such traps, we will identify the species and estimate species diversity, estimate biomass and establish their significance in two ecosystems. Students will assist in set up and checking of traps and the findings will be interpreted in a written report.

Field methods VII: Bioblitz! in High Altitude Environments (ungraded): Use of data gathered by non-professional ‘citizen’ scientists is growing tremendously in ecology. One popular event to gather biodiversity data in a set area is to organize a Bioblitz: a time- constrained exercise to document as many species as possible in a set area and time. Common locations for these events include urban parks or areas slated for development in order to raise awareness of the biodiversity living in close proximity.

Field methods VIII: Avian Mist-netting and Field Census Techniques (ungraded): Birds have become the model vertebrate group in ecology because of their ubiquity, diversity, and ease of observation. Yet, catching them, which is often needed for population studies, can be tough. We will spend at least one morning capturing and marking birds by banding [ringing] them, as well as learning how to age, sex, and score molt on certain species – part of a long-term study at UWICER. Between net checks, we will observe and identify bird species on UWICER campus, as well as learn how to conduct standardized observational transect and point count surveys.

Field methods VIII: Forest succession after Fire: Disturbance plays a vital role in ecosystem dynamics. Fire is one of the most important disturbances in Bhutan. Understanding its impact and make practical application of forest fire is fundamental to forest management especially in dry region of the country. Here the students will learn basic about forest fire and conduct a field survey and understand how forest successional takes place after fire. The students will work in group; conduct survey and produce write a written report.

Exams: One mid-term exam will be administered, followed by a comprehensive exam at the end of the course. You will be examined on what you have been exposed to in class (lectures, discussions, etc.), the field, and readings. The exams will challenge students to draw on multiple concepts and experiences, and to synthesize information.

Grading Scheme

The following grading scheme will be employed to award the final grade to the students.

A	95.00+	B+	86.00 – 89.99%	C+	76.00 – 79.99%	D	60.00-69.00%
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

Readings: Students are expected to have read all the required readings prior to each class. Information from required readings will be part of the course assessments. It is encouraged that ‘optional readings’ be reviewed by students.

Plagiarism: Using the ideas and material of others without giving due credit is cheating and will not be tolerated. A grade of zero will be assigned if anyone is caught cheating or aiding another person to cheat actively or passively (e.g., allowing someone to look at your exam). All assignments unless

specifically stated should be individual pieces of work. Plagiarism cases may be reported to the student's home institution and may be grounds for further academic disciplinary action.

Deadlines: Deadlines for written and oral assignments are instated for several reasons: They are a part of working life to which students need to become accustomed and promote equity among students, and deadlines allow faculty time to review and return assignments before others are due. Assignments will be handed back to students after a one-week grading period. Late assignments will incur a 10% penalty for each day that they are late. No assignment will be accepted after third day from the agreed date.

Participation: Since we offer a program that is likely more intensive than student might be used to at home institution, missing even one lecture can have a proportionally greater effect on final grade as there is little room to make up for lost time. Participation in all components of the program is mandatory because student actions can significantly affect the experience a student and his/her classmates have while at SFS. Therefore, it is important that students are prompt for all activities, bring the necessary equipment for the field, and simply get involved.

Course Content

L lecture and discussion, **GL** guest lecture, **GFG** guest field guide, **FL** field lecture, **FEX** field exercise, **D** discussion, **DR** directed research.

*Readings in **Bold** fonts are compulsory reading materials for students to read and not bolded readings are meant for preparing lectures and students are also encouraged to read them.

No	Title	Type	Time (hrs.)	Readings
1	Course Overview Cover Course Objectives, Syllabus, Field Exercises, Questions and Expectations for semester.	L and D	1:15	
Mountain Physical Environments (MPE)				
2	Introduction to Mountain Ecology We discuss why mountains are located where they are. How did they get there? We'll explore the physical origins of mountains, theories of mountain building, and how our changing ideas about mountains and their genesis have shaped our engagement with them.	L and D	1:15	Sayre et al, 2018 Price et al. 2013 Ch 1 Smethurst, 2010
3	Mountain Climate and Geology How do mountains affect climate? How are mountains shaped by climate? What are the geological processes in the mountainous ecosystem? We will examine how elevation affects atmospheric processes, and discuss an ecological manifestation of mountain climate.	L and D	1:15	Barry, 2008 (Ch.1 and 5) Price et al. Chapter 2 Lugo,1999 Manish and Pandit, 2018 Harrison, 1992
4	Adaptations of Organisms in the Mountains What are the basic requirements for plants and animals for their growth and development? How do they develop mechanism to adapt to different environment? What are the mechanisms of adaptation plants and animals in a mountainous environment?	L and D	1:15	Halbritter et al,2018 Srinivasan, 2013 Badgley, 2008

5	<p>Exploration and Discovering Organisms and their Micro-environments Here will explore different microsites and identify organisms their morphological traits. We will also learn how to handle basic equipment for measurement of various environmental variables. Here we will also learn to develop data recording methods.</p>	FL and FEX	2:30	Larcher, 2010 Körner,2011
6	<p>Terrestrial Life Zone Ecology of Bhutan Himalaya Here, we will learn and discuss different life forms (biomes) their special characteristics and implications for biodiversity conservation.</p>	L and D	1:15	Singh, 1987 (89-95) Ohsawa ,1987, Wangda, 2006 Banerjee,2016
7	<p>Fundamentals of Plant Identification Skills Understand the basic morphological characteristics of leaves, fruits, flower and other parts of the of plant species to use in plant species classification system.</p>	L and D	1:15	BinderPlantID
8	<p>Field Methods I: Plant Identification Here we will explore and identify major life forms, identify plant species and their floral characteristics on different along the elevational gradient.</p>	FEX	4:00	Web based (3, 4, 6 and 7)
9	<p>Alpine Life Zone We will discuss the alpine environment with reference to ecology of <i>Ophiocordyceps sinensis</i></p>	L and D	1:15	Cannon, 2009 Winkler, 2008 Müller,2016
10	<p>Quantifying Ecology We will learn the fundamental of Ecological Statistics including basic data manipulation</p>	Land D	2:30	
11	<p>Field Methods II: Survey Methods of Biodiversity and Life Zone Productivity Different types of sampling methods and basic calculations of forest statistics will be taught in this class. The output from this class will be applied in practice for descriptive statistics of forest structure and composition, estimates of forest volumes, biomass, forest stock increment, and other biodiversity indexes in life zone inventory field exercise.</p>	FEX	4:00	Asrat,2013 CIFOR,2016
12	<p>Mountain Aquatic Environments What organisms are found in different wetland habitats? What are their adaptation mechanisms? We will discuss wetland ecosystems including rivers and understand basic requirement for macroinvertebrate survival in those ecosystems.</p>	L and D	1:15	Sherub et al. 2013 Von Oheimb,2013 Verhoeven,2006
13	<p>Field Methods III: Sampling Techniques for Surveying Fresh Water Macroinvertebrates Here we will also learn to conduct baseline survey methods of aquatic environment (water velocity, water pH and total dissolved substance.</p>	FEX	4:00	Scientists at Work' Mary Powers Mackey,1984

14	Fundamentals of Terrestrial Invertebrates Here we will learn about the role of terrestrial invertebrates and in functioning of the ecosystems in different microsites.	L and D	1:15	Acharya, 2015 Rosumek, 2009 Kalkman and Gyeltshen, 2015
16	Measuring Diversity of Terrestrial Invertebrates The minute organisms such as ants are often left out during standard biodiversity inventories due to logical constraints. These organisms constitute a diverse group, making up a large proportion of the biomass in the area, and perform important or diverse ecological functions in the ecosystem. Here we will practice inventory of ants and dragon flies using different methods and tools.	FL and FEX	2:45	
17	Population Ecology of High Mountains We will learn about dynamics of population structure which relates to density, foraging, habitat requirement especially of wild animals.	Land D	1:15	Tamma, 2016 Amrhein,2012
18	Carnivore Ecology of Bhutan Discussion of Large Carnivore Conservation and keystone species conservation such as tiger and its implications conservation of forest ecosystems.	GL- Dr. Tshering Tempa	1:15	Tempa et al, 2013 Carter & Lindell 2016; Wolf & Ripple 2017
19	Mid Term Exam		1:00	
20	Herbivore Ecology Here we will learn about the national animal (Takin) of Bhutan with lecture and field observations at Takin Reserve at Thimphu	L and D and FL	2:00	Wangchuk,2015 Badgley, 2008
21	Avian Ecology and Migration Here we will learn about high elevation bird species, adaptations and migration of some key bird species of Bhutan Himalaya.	L and D	1:15	Zhang et al. 2017 Hawkes et al. 2011 Norbu, 2013 Hu et al,2018
22	Field Methods IV: Mist Netting and Birds' Community Changes Along Elevational Gradients Here we will learn the fundamental on avian research through mist netting and also field survey of birds along an elevational gradient	FEX	4:00	Pan et al, 2016 Amrhein,2012 Acharya and Vijayan 2017
23	Field Methods V: Ecology of Black-Necked Cranes at Phobjikha Here we will explore the black-necked crane habitat, count the cranes and observed basic behavior such as preening, sequential vigilance, estimate walking distance during feeding etc.	FL and FEX	3:00	Lind,2010 Zhongqiu,2014 ICIMOD and RSPN, 2014
24	Ecology of Small Himalayan Mammals I Here we will learn the basic and fundamental of small mammals species of Bhutan	L and D	1:15	Hoffmann, 2010
25	Ecology of Small Himalayan Mammals II Here we will learn the methods to study small mammals (e.g. rodent on different micro-sites in the mountainous region)	FEX	3:00	Flowerdew, 1976 Hoffmann, 2010

26	Species Interactions in Mountainous Environment We will examine the diversity of species interactions, their influence on demographic processes, and their role as agents of natural selection. Interspecific competition, process of predation (prey and predator) and population regulation. Parasite and their host (Are montane communities more disease resistant than lowland communities, or have montane organisms escaped lowland disease vectors?)	SLD	1:15	Zamora-Vilchis et al. 2012; Rockwood 2006, Ch 9
27	Field Methods VII: Bioblitz Here we will explore the organism existing around UWICER campus as Bioblitz exercise. The students are expected to observe measure and calculate morphological traits of at least three organisms.	FEX	2:00	inaturalist
28	Mountain Forest and Disturbance Ecology We will identify the major disturbances in the mountainous terrain including human use of mountain forests in Bhutan and their implications on sustainable management of mountainous ecosystems.	L and D	1:15	Dortch,2009 Xu et al. 2009 Bajracharya. 2014 Hobbs, 2006 Ellis, 2011
29	Forest Ecosystem and Water We will closely examine the ecological processes relating to forest and water and discuss the implication on mountain forest and conservations.	L and D	1:15	O’Conner et al. 2015; Price et al. 2011
30	Field Methods VIII: Forest Succession Ecology after Fire Here we will learn about the forest succession after forest fire and discuss the pros and cons of forest fire and implications for conservations in relation to global climate change.	FEX	2:30	Dobson, 1997
31	Students Led Discussion: Mountain Biodiversity in Anthropocene Here students can pick up certain topic of their interests and deliver a discussion. I would suggest carbon foot print as one of the topic	GL	1:15	
32	Final Exam Review	TBA	1:00	
33	Final Exam	TBA	2:00	
		TOTAL	60	

Reading List

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Useful links

1. <http://www.mountainbiodiversity.org/datasets>
2. <http://www.birdlife.org>
3. <https://www.inaturalist.org/>
4. <https://biodiversity.bt/>
5. [birdinternational](http://birdinternational.org)

Apps

6. PictureThis

7. <https://www.ipni.org/>