THE SCHOOL FOR FIELD STUDIES

Mountain Ecology

SFS 3060

Syllabus

The School for Field Studies (SFS)
Centre for Himalayan Environment and Development Studies
Ugyen Wangchuck Institute for Conservation and Environment Research (UWICER)
The Bhutan Ecological Society, Thimphu Bhutan
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.

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 be 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. The 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; Bhutan and the Eastern Himalayan region are globally recognized as one of the hotpots for the 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 of 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 and
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 (includes ungraded FEXES)	10
Plant Identification and individual report	15
Measuring plant community along elevation gradient	15
Measuring aquatic marco-invertebrates	15
Midterm exam	10
Forest succession after fire	15
Final examination	20

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 Bhutanese 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 institutions, 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 write.

When using citable material from your field notebook in written assignments, use the following format to acknowledge the source: (Sonam Phuntsho, Field notes, 12 October 2014). Whenever possible, use the name of the person providing the information; if not possible, cite descriptively, for example: "A *Cordyceps* collector of Soe-Yaktsa."

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.

FEX I: Plant Identification: This exercise will enable students to identify the main plant species and major life zones of Bhutan. The students will be given field lectures on identification of different plant species around the 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, habitat where it grows, its uses and how it is propagated. A detailed handout will be provided for this FEX.

FEX II: Measuring Plant Communities along Elevational Gradient: 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 a predictable way.
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. The students will identify the plant species and measure woody trees for their DBH, height and other attributes of the trees within the plot. Additionally the group will collect and record ecologically important morphological characteristics of a species. Using these data the students will estimate 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. Each group should produce comprehensive written report covering different aspects of the exercise.

FEX III: Measuring Fresh Water Macro Invertebrates: 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 to standardized survey techniques and keys to identify aquatic invertebrate species. Students will write up their findings in a short report.

FEX IV: Measuring Terrestrial Macro Invertebrates: Terrestrial macro invertebrates are critical in decomposition, nutrient cycling, physical processes, and disturbance regimes. Soil invertebrates modulate the environment such as soil temperature, moisture, nutrients, plant species composition, soil compaction, mixing, trace gas production, aggregate formation and stability, soil crusting, aeration, runoff, carbon storage, organic matter stabilization, macropores, water transport, and microbial community structure to varying degrees. There are also sources of food within the complex food chain. Insects are also important ecosystem regulators via the action of many species as powerful herbivores. Therefore understanding their ecological roles becomes critical for their conservation. We will learn a few basic methods to quantify terrestrial macro invertebrates. A detailed guideline will be provided to conduct this survey.

FEX V: 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 three mornings in capturing the birds in mist net and learn how to handle the captured birds, as well as how to determine age, sex, and score molt on certain species. This is part of a long-term study of UWICER. Between net checks, we will observe and identify bird species on SFS campus, as well as learn how to conduct standardized observational transect and point count surveys.

FEX VI: Surveying Large Mammals Using Camera Traps: Camera traps are the most efficient method of surveying shy, low density animals such as large mammals and some large ground-walking birds. We will do a lab exercise using camera trap data from previous semesters and analyze this data to understand tropic web interactions. Students will set and retrieve camera traps in different habitats across Paro valley. Upon retrieval of the traps, students will identify photos (captures), calculate diversity and abundance estimates in different habitats, and study tropic and food web dynamic in the forest of Paro valley and interpret findings in a report.

FEX VII: Counting Black -Necked Cranes at Phobjikha Valley/Bioblitz: The black-necked crane (*Grus nigricollis*) is a crane species in Asia that breeds on the Tibetan Plateau and remote parts of India and Bhutan. In Bhutan, Phobjikha valley is one of the main winter roosting sites for this bird species. In small groups of three, we will count cranes and discuss the importance and fate of this bird species in the valley. In the event that the cranes have not landed in the valley, we will conduct **Bioblitz.** A detailed handout will be provided for each of these exercises.

FEX 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 providing practical application of forest fire is fundamental to forest management especially in dry region of the country. Students will learn the ecological processes of forest succession after a forest fire. The students will conduct a field survey in groups of four and produce a written report for a scientific journal. Detailed guidelines will be provided to conduct this exercise.

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	59.99 to 0.00
		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 week. 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 are compulsory reading materials for students to read and others are optional.**

No	Title	Type	Course Duration (hrs.)	Readings
1	**Course Overview** Course Objectives, Syllabus, Field Exercises, Deadlines, 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	**Smethurst, 2010 Price et al. Chapter 2** Foggin,2016 Sayre et al, 2018
3	**Mountain Geology and Soils** We will learn about basics of Himalayan geology and soils. We will discuss various implications of geology and soil management	L and D	1:15	**Crowther et al, 2019** **Harrison, 1992**
4	**Mountain Climate** How do mountains affect climate? How are mountains shaped by climate? What are the geological processes in mountainous ecosystems? We will examine how elevation affects atmospheric processes, and discuss an ecological manifestation of climate change on mountain systems**.**	L and	1:15	**Spicer, 2017** **Barry, 2008 (Ch.1 and 5)** Srinivasan, 2013
Mountain Life forms and Biodiversity				
5	**Adaptations of Organisms in the Mountains** What are the basic requirements for plants and animals for their growth and development? How do they adapt to different environment? What are the adapting mechanism of plants and animals in the mountainous environment?	L and D	1:15	**Halbritter et al,2018** **Fjeldsa et al, 2013** Badgley, 2008 Manish and Pandit, 2018
6	**Field Survey Method I** We will learn different survey methods to study animal communities and also learn how to handle basic equipment for measurement of various environmental variables. We will also learn to develop data recording methods.	L and D	1:15	**Lohmus et al, 2018**
7	**Field Survey Method II** We will learn about different sampling methods for ecological studies of plant communities including dendrochronology and also learn how to handle different equipment used for surveys.	L and D	1:15	**Arenas-Castro et al, 2015** GLAV 2 Users Manual
8	**Terrestrial Life Zone Ecology of Bhutan Himalaya** We will learn and discuss different life forms (biomes), their special characteristics and implications for biodiversity conservation including cloud forests.	L and D	1:15	**Singh, 1987 (p89-95)** **Wangda and Ohsawa ,2011** Wangda and Ohsawa, 2006

				Lugo, 1999 Banerjee, 2016
9	**Fundamentals of Plant Identification Skills** We will understand the basic morphological characteristics of leaves, fruits, flower and other parts of the of plant species to use in plant species classification system.	L and D	1:15	**Wondafrash, 2008**
10	**FEX I: Plant Identification** We will explore and identify major life forms, identify plant species and their floral characteristics on different along the elevational gradient. It will be a continuous exercise.	FEX	4:00	**Web based (3, 4, 6 and 7)**
11	**Alpine Life Zone** We will discuss the alpine environment with reference to ecology of *Ophiocordyceps sinensis*	L and D	1:15	**Cannon,2009** **Winkler,2008** Müller,2016
12	**FEX II: Measuring Floral Biodiversity** Different types of sampling methods and basic calculations of biodiversity 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 biomass, forest stock increment, and other biodiversity indexes in life zone inventory field exercise.	FEX	4:00	**Tenzin and Dukpa,2017(p.16-22)** **Poorter,2009** CIFOR,2016
13	**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.	L and D	1:15	**Von Oheimb,2013** **Verhoeven,2006** Sherub et al., 2013
14	**FEX III: Measuring Fresh Water Macroinvertebrates** Here we will also learn to conduct baseline survey methods of aquatic environment (water velocity, water pH and total dissolved substance.	FEX	3:00	Mackey,1984 **NERR005**
15	**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** **Invertebrates**
16	**FEX IV: Measuring Terrestrial Macro 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 tolls.	FL and FEX	3:00	Kalkman and Gyeltshen, 2015 **Joshi et al, 2008**
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	**Large Mammals 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** Lindsey et al, 2017
19	Plant identification quiz		1:00	
20	Mid-term Review		1:00	
21	Mid Term Exam		1:00	
22	**Takin 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	3:00	**Sangay et al, 2016** **Badgley, 2008**
23	**Avian Ecology and Migration** Here we will learn about high elevation bird species, adaptations and migration of some key bird species of the Bhutan Himalayas.	L and D	1:15	**Zhang et al, 2017** Hawkes et al. 2011 **Norbu, 2013** **Hu et al,2018**
24	**FEX V: Avian Mist-netting and Field Census Techniques** We will learn a few basic fundamental on avian research through mist netting and also field survey of birds along an elevational gradient	FEX	3:00	**Pandit et al, 2016** Amrhein,2012 **Acharya and Vijayan, 2017**
25	**FEX VI: Counting Black-Necked Cranes at Phobjikha/Bioblitz** Here we will explore black-necked crane habitat, count cranes and observed basic behavior such as preening, sequential vigilance and estimate walking distance during feeding.	FL and FEX	3:00	**Namgay, 2016** **ICIMOD and RSPN, 2014** Lind, 2010 Zhongqiu, 2014
26	**Ecology of Small Himalayan Mammals** Here we will learn the basic and fundamental of small mammal species of Bhutan.	L and D	1:15	**Hoffmann, 2010** **Flowerdew, 1976**
27	**FEX VII: Surveying Large Mammals Using Camera Traps** Here we will learn methods to study large mammals using camera trapping in different micro-sites of Paro Valley.	FEX	4:00	**Wearn and Glover-Kapfer, 2019**
Mountain Interactive Ecology				
28	**Species Interactions in Mountainous Environment** We will examine the 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. We will also learn about Parasite and their host. Are montane communities more disease resistant than lowland communities, or have montane organisms escaped lowland disease vectors?	L and D	1:15	**Zamora-Vilchis et al, 2012;** **Telwala et al, 2009** Hobbs, 2006

29	**Mountain Forest and Disturbance Ecology** We will identify major disturbance regimes in mountainous terrain including human use of mountain forests in Bhutan and their implications on sustainable management of these mountainous ecosystems.	L and D	1:15	**Dortch, 2009** **Bajracharya, 2014** Beran et al, 2018 Jekins et al,2013
30	**Forest Ecosystem and Water** We will closely examine ecological processes in relation to forest and water and discuss the implication on mountain forests and management of water resources.	L and D	1:15	**Ellison et al, 2017** **Price et al, 2013**
31	**FEX VIII: Forest Succession Ecology after Fire** Here we will learn about forest succession after fire and discuss the pros and cons of forest fire and implications on mountain forets.	FEX	3:00	**Dobson, 1997**
32	**Mountain Biodiversity in Anthropocene** Here, students will choose certain topic of their interests and deliver a discussion. A detailed description will be provided.	L and D	1:15	**Ellis, 2011** **Xu, et al, 2009** Wilson, 2009 Dirzo, 2014
33	Final Exam Review		1:00	
34	Final Exam		2:00	
Total			61.5	

Reading List

Acharya, B. K., & Vijayan, L. (2015). Butterfly diversity along the elevation gradient of Eastern Himalaya, India. Ecological Research, 30(5), 909–919. doi:10.1007/s11284-015-1292-0.

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Fjeldsa, J., R.C.K. Bowie, and C. Rahbek. 2012. The role of mountain range in the diversification of birds. Annual Review of Ecology, Evolution and Systematics:

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1. http://www.mountainbiodiversity.org/datasets
2. http://www.birdlife.org
3. https://www.inaturalist.org/
4. https://biodiversity.bt/

Useful Apps for plant identification

6. PictureThis
7. https://www.ipni.org/