



S F S THE SCHOOL
FOR FIELD STUDIES

Mountain Ecology

SFS 3060

Syllabus
4 credits

The School for Field Studies (SFS)
Center for Climate and Sustainable Futures (CCSF)
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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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 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 hotspots 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 challenge's 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 (%)
Participation (including ungraded FEXes)	10
Quiz: Plant Identification	15
FEX 2: Vegetation Profiling Along Elevational Gradient	15
FEX 3: Surveying Large Mammals Using Camera Traps	15
FEX 4: Measuring aquatic macroinvertebrates	15
Final Exam	30
TOTAL	100

Participation (10%)

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.

Quiz: Plant Identification (15%)

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 plant identification 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 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.

Field Exercises (FEX) (15% for each graded FEX)

NOTE: Not all FEXs are graded, but there will be questions in the final exam related to each FEX.

FEX 1: Quantifying Ecological Data (Not graded)

This exercise will introduce students how to collect ecological data, analysis, and make inferences about the ecological phenomena.

FEX 2: Plant Identification and Vegetation Profiling Along Elevational Gradient (graded)

This exercise will enable students to identify the main plant species and major life zones of Bhutan. During our field trips, we will make regular stops at different elevation gradients. The students will be given field lectures on identification of different plant species 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 make a map of vegetation profile at different elevation. A detailed handout will be provided for this FEX.

FEX 3: Surveying Large Mammals Using Camera Traps (graded)

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 trophic 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 trophic and food web dynamics in the forest of Paro valley and interpret findings in a report.

FEX 4: Measuring Fresh Water Macro Invertebrates (Graded)

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 Campus, looking at how flow rates influence invertebrate communities. We will also survey some key terrestrial invertebrates using appropriate methodologies. Students will learn to use standardized survey techniques and keys to identify aquatic invertebrate species. Students will write up their findings in a short report.

FEX 5: Avian Mist-netting and Field Census Techniques (Not graded)

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 two 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. Between net checks, we will observe and identify bird species on campus, as well as learn how to conduct standardized observational transect and point count surveys.

FEX 6: Floristic Composition in the Sub-Tropics (Not graded)

This activity will take place during our visit to Phuntsholing, a town located in the sub-tropical region of Bhutan at an elevation of just 230 meters above sea level. The floristic composition in the sub-tropical region is highly diverse and fascinating, markedly different from the temperate and cool broadleaf forests of Bhutan. During this visit, students will learn to identify the common flora of the sub-tropical ecological zones of Bhutan. At each stop, students will:

- **Record Observations:** Note plant species, elevation, aspect, adaptations, and the utility of those plants.
- **Study Plant Adaptations:** Observe and analyze specific adaptations in plants that allow them to thrive in the sub-tropical climate.
- **Explore Plant-Environment Relationships:** Study how flora interacts with soil type, water availability, and sunlight in this region.

FEX 7: Counting Black-Necked Cranes at Phobjikha/Bioblitz (Not graded)

During this activity, we will explore the black-necked crane habitat, count cranes, and observe basic behaviors such as preening, sequential vigilance, and estimating walking distances during feeding. This session will take place early in the morning before breakfast, from 5:30 AM to 7:30 AM (2 hours). After breakfast, we will visit the Black-Necked Crane (BNC) Center.

Final Exam (30%)

One final comprehensive final exam will be administered, 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

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.

"I approach coursework, fieldwork, and research with integrity and commit to full participation. I do my own work with honesty and give credit where it's due. I use tools and technology responsibly and only as permitted. I speak up when something conflicts with our shared values. I respect the communities we learn from and commit to ethical, non-extractive research that keeps knowledge connected to the places and people who share it with us."

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.

AI Usage for Assignments – SFS acknowledges the growing role of artificial intelligence (AI) tools in education and professional settings. While AI can be a valuable resource for learning and productivity, its use must align with the learning goals and integrity of each assignment. For this reason, students are encouraged to discuss the acceptable uses of AI for each assignment with the instructor. If you wish to use AI for any part of an assignment, consult with the instructor beforehand to ensure that its use adheres to the academic expectations of the course. Let's work together to navigate this evolving landscape responsibly!

Course Content

Type- L: Lecture, **FL:** Field Lecture, **GL:** Guest Lecture, **FEX:** Field Exercise, **D:** Discussion

***Required readings are in bold**

No	Topics Covered	Hours	Type	Required Readings
1	Course Overview Course Objectives, Syllabus, Field Exercises, Deadlines, Questions and Expectations for semester.	1.0	L; D	
Mountain Physical Environments				
2	General Introduction to Ecology	1.0	L; D	Smith and Smith (2006) (Chapter I).
3	Biogeography of Himalayas 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 with particular focus on Himalayas.	1.0	L; D	Mini (1974). Smethurst (2010). <i>Optional:</i> <i>Foggin (2016).</i> <i>Sayre, et al. (2018).</i> <i>Pandit, et al. (2014).</i>
4	Himalayan Geology and Soils We will learn about basics of Himalayan geology and soils. We will discuss various implications of geology and soil management.	1.0	L; D	Crowther, et al. (2019). <i>Optional:</i> <i>Harrison (1992).</i>
5	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 ecological manifestations of climate change on mountain systems.	1.0	L; D	Spicer (2017). Barry (2008) (Ch. 1 and 5). <i>Optional:</i> <i>Srinivasan (2013).</i>
6	FEX I: Quantifying Ecology Here students will be taught how to deal with ecological data. Handout and analysis guidelines will be provided.	3.0	L; FEX	Smith and Smith (2006) (Chapter 1, Page 9-11).
Mountain Lifeforms and Biodiversity				
7	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.	1.0	L; D	Wangda and Ohsawa (2011). Ohsawa (1987). <i>Optional:</i> <i>Singh (1987) (p. 89-95).</i> <i>Wangda and Ohsawa (2006).</i> <i>Lugo (1999).</i> <i>Banerjee (2016).</i>

No	Topics Covered	Hours	Type	Required Readings
8	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 is the adapting mechanism of plants and animals in the mountainous environment?	1.0	L; D	Halbritter, et al. (2018). Fjeldsa, et al. (2013). <i>Optional:</i> <i>Badgley (2008).</i> <i>Manish and Pandit (2018).</i>
9	Visit to National Takin Preserve During the visit to National Takin Preserve, students will learn about the ecology of Bhutan's national animal takin, its history, mythology associated with Takin and Lam Drukpa Kuenley, and conservation threats of takins.	3.0	FL	Sangay, et al. (2016). Badgley (2008).
10	Field Survey Method (Wildlife Survey Methods) We will learn different survey methods to study animal communities and learn how to handle basic equipment for measurement of various environmental variables. We will also learn to develop data recording methods.	1.0	L; D	Oli and Mills (2013).
11	FEX I: 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.	4.0	FEX	Kelly, et al. (2013).
12	Conservation Genetics Here students will learn genetics as an important tool for both monitoring wildlife and understanding ecological processes. We will also introduce how noninvasive genetic sampling has opened the horizon for the application of genetics to many wildlife species that previously could not be effectively studied.	1.0	GL; D	Janecka, et al. (2013). Dendup, et al. (2023).
13	Fundamentals of Plant Identification Skills We will understand the basic morphological characteristics of leaves, fruits, flower, and other parts of the plant species to use in plant species classification system.	1.0	L; D	Wondafrash (2008).
14	FEX II: Plant Identification and Plant Communities Along Elevational Gradient We will explore and identify major life forms, identify plant species and their floral characteristics at different points along the elevational gradient. Each student will make and submit a vegetation profile map along elevational gradient from Paro Wochu to Chelela top.	4.0	FEX	Web based (3, 4, 6 and 7).

No	Topics Covered	Hours	Type	Required Readings
15	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.	1.0	GL; D	Zhang, et al. (2017). Norbu (2017). <i>Optional:</i> <i>Hu, et al. (2018).</i> <i>Hawkes, et al. (2011).</i>
16	FEX III: Avian Mist-netting and Field Census Techniques We will learn a few fundamentals on avian research through mist netting and field survey of birds along an elevational gradient.	4.0	FEX	Pandit, et al. (2016). Acharya and Vijayan (2017). <i>Optional:</i> <i>Amrhein (2012).</i>
17	FEX IV: Floristic Composition in the Sub-Tropics This activity will take place during our visit to Phuntsholing, a town located in the sub-tropical region of Bhutan at an elevation of just 230 meters above sea level. The floristic composition in the sub-tropical region is highly diverse and fascinating, markedly different from the temperate and cool broadleaf forests of Bhutan. During this visit, students will learn to identify the common flora of sub-tropical ecological zones of Bhutan.	4.0	FEX	Wangda and Ohsawa (2011). Ohsawa (1987).
18	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.	1.0	GL; D	Von Oheimb (2013). Verhoeven (2006). <i>Optional:</i> <i>Sherub, et al. (2013).</i>
19	FEX V: 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) and presence of different macro-invertebrates.	4.0	FEX	Mackey (1984).
20	FEX VI: Counting Black-Necked Cranes at Phobjikha / Bioblitz Here we will explore black-necked crane habitat, count cranes and observe basic behavior such as preening, sequential vigilance and estimate walking distance during feeding. After breakfast, we will visit BNC Center and watch documentary on BNC and threats of BNC conservation in Bhutan.	4.0	FL; FEX	Namgay and Wangchuk (2016). <i>Optional:</i> <i>ICIMOD and RSPN (2014).</i> <i>Lind (2010).</i> <i>Zhongqiu (2014).</i>

No	Topics Covered	Hours	Type	Required Readings
21	Large Mammals Ecology of Bhutan Discussion of Large Carnivore Conservation and keystone species conservation such as tiger and its implications for conservation of forest ecosystems.	1.0	L	Tempa, et al. (2019). Carter and Lindell (2016). <i>Optional:</i> <i>Lindsey, et al. (2017).</i>
22	Population Ecology of the Mountain Wildlife We will learn about dynamics of population structure which relates to density, foraging, habitat requirement especially of wild animals.	1.0	L; D	Tamma (2016). Amrhein (2012).
23	Ecology of Small Himalayan Mammals Here we will learn the basic and fundamental of small mammal species of Bhutan.	1.0	L; D	Hoffmann (2010). Flowerdew (1976).
24	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 parasites and their hosts.	1.0	L; D	Zamora-Vilchis, et al. (2012). Telwala, et al. (2009). <i>Optional:</i> <i>Hobbs (2006).</i>
25	Plant Identification Quiz	1.0		
Mountain Disturbance Ecology				
26	Mountain Forest and Disturbance Ecology We will identify major disturbance regimes in the mountain forests and how these disturbances cause change in species diversity and how species respond to these disturbances.	1.0	L; D	Manral (2017). <i>Optional:</i> <i>Dortch (2009).</i> <i>Bajracharya (2014).</i>
27	Capstone: How Will Mountain Ecosystems Respond to Climate Change Here we will discuss about how mountain species both plants and animals will be affected by climate change and how they will adapt to these emerging threats.	1.0	L; D	
28	Final Exam Review	1.0		
	Total	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

*Required readings are in bold

1. Acharya and Vijayan (2017).
2. **Amrhein, V., Scaar, B., Baumann, M., Minéry, N., Binnert, J.-P., & Korner-Nievergelt, F. (2012).** Estimating adult sex ratios from bird mist netting data. *Methods in Ecology and Evolution*, 3(4), 713–720. doi:10.1111/j.2041-210x.2012.00207.x.
3. Badgley (2008).
4. Bajracharya (2014).
5. Banerjee, A., & Bandopadhyay, R. (2016). Biodiversity hotspot of Bhutan and its sustainability. *Current Science*, 110(4), 521-527. doi:10.18520/cs/v110/i4/521-527.
6. **Barry, R.G. (2008).** *Mountain Weather and Climate*, Cambridge.
7. **Carter, N.H. and J.D.C. Lindell. (2016).** Co-adaptation is key to coexisting with large carnivores. *Trends in Ecology and Evolution* 31: 575-578.
8. **Crowther, T.W., van den Hoogen, Wan, J., Mayes, M.A., Keiser, A.D., Mo, L., Averill, Maynard, C., D.S. (2019).** The global soil community and its influence on biogeochemistry. *Science* 365, eaav0550.
9. Dendup, et al. (2023). Dhendup, T., Sharma, S., Painter, S., Whiteley, A.R. and Mills, L.S. (2023). Evidence of tiger population structure and dispersal in the montane conservation landscape of Bhutan. *Global Ecology and Conservation*, 43, p.e02459.
10. Dortch, J. M., Owen, L. A., Haneberg, W. C., Caffee, M. W., Dietsch, C., & Kamp, U. (2009). Nature and timing of large landslides in the Himalaya and Transhimalaya of northern India. *Quaternary Science Reviews*, 28(11-12), 1037–1054. doi:10.1016/j.quascirev.2008.05.002.
11. **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*.
12. **Flowerdew, J. R. (1976).** Chapter 4: Ecological methods. *Mammal Review*, 6(4), 123–159. doi:10.1111/j.1365-2907.1976.tb00208.x.
13. Foggin, J. M. (2016). Conservation Issues: Mountain Ecosystems. Reference Module in Earth Systems and Environmental Sciences. doi:10.1016/b978-0-12-409548-9.09199-5.
14. **Halbritter, A. H., Fior, S., Keller, I., Billeter, R., Edwards, P. J., Holderegger, R., ... Alexander, J. M. (2018).** Trait differentiation and adaptation of plants along elevation gradients. *Journal of Evolutionary Biology*, 31(6), 784–800. doi:10.1111/jeb.13262.
15. **Harrison, T.M., Copeland, P. Kidd, W.S.F. and Yin, A. (1992).** Raising Tibet. *Science*, 255(5052), 1663–1670. doi:10.1126/science.255.5052.1663.
16. Hawkes, et al. (2011).
17. Hobbs, R. J., Arico, S., Aronson, J., Baron, J. S., Bridgewater, P., Cramer, V. A., . . . Zobel, M. (2006). Novel ecosystems: Theoretical and management aspects of the new ecological world order. *Global Ecology and Biogeography*, 15(1), 1-7. doi:10.1111/j.1466-822X.2006.00212.x.
18. Hoffmann (2010).
19. **Hu, Y., Ding, Z., Jiang, Z., et al. (2018).** Birds in the Himalayas: What drives beta diversity patterns along an elevational gradient? *Ecology and Evolution*, (8):11704–11716.
20. **ICIMOD and RSPN (2014).** An integrated assessment of the effects of natural and human disturbances on a wetland ecosystem: A retrospective from Phobjikha Conservation Area, Bhutan. Kathmandu: ICIMOD.

21. Janečka, et al. (2013). Janečka, J.E., Alves, P., Karmacharya, D., Samser, N., and Cheng, E. (2013). Wildlife Genetics in Mountainous Rugged Asian Landscapes: Methods, Applications, and Examples.
22. Kelly, et al. (2013). Kelly, M., Tempa, T., Nidup, T., and Wangdi, Y. (2013). The use of remote cameras in wildlife research in rugged mountainous Asian landscapes. In: Mills, S. and Tempa, T. (eds.) Wildlife Research Techniques in Rugged Mountainous Asian Landscapes. UWICE: RGoB. Lamai Gompa, Bumthang.
23. Lind (2010).
24. Lindsey et. al (2017). Relative efforts of countries to conserve the world's megafauna. *Global Ecology and Conservation* 10:243-252.
25. Lugo, A. E., Brown, S. L., Dodson, R., Smith, T. S., & Shugart, H. H. (1999). The Holdridge life zones of the conterminous United States in relation to ecosystem mapping. *Journal of Biogeography*, 26(5),
26. Mackey, A. P., Cooling, D. A., & Berrie, A. D. (1984). An Evaluation of Sampling Strategies for Qualitative Surveys of Macro- Invertebrates in Rivers, Using Pond Nets. *The Journal of Applied Ecology*, 21(2), 515. doi:10.2307/2403426.1025–1038. doi:10.1046/j.1365-2699.1999.00329.x.
27. Manish, K. and Pandit, M.K. (2018), Geophysical upheavals and evolutionary diversification of plant species in the Himalaya. *PeerJ* 6:e5919; DOI 10.7717/peerj.5919.
28. **Manral, Upma; Badola, Ruchi; Hussain, Syed Ainul (2017).** *Forest Composition and Structure Under Various Disturbance Regimes in the Alaknanda River Basin, Western Himalaya. Mountain Research and Development*, 37(3), 310–322. doi:10.1659/MRD-JOURNAL-D-16-00109.1
29. Mini (1974).
30. **Namgay, R., & Wangchuk, S. (2016).** Habitat preferences and conservation threats to black-necked cranes wintering in Bhutan. *Springer Plus*, 5(1), 1-6. Doi: 10.1186/s40064-016-1923-0.
31. **Norbu, N., Wikelski, M., and D. Wilcove. (2017).** Partial altitudinal migration of the near threatened Satyr Tragopan *Tragopan satyr* in the Bhtuan Himalayas: implications for conservation in mountainous environments. *Oryx* 51: 166-173.
32. Ohsawa (1987). Ohsawa, M. (Ed.). (1987). Life zone ecology of the Bhutan Himalaya. Laboratory of Ecology, Chiba University, Chiba, Japan.
33. Oli and Mills (2013). Oli, K.M. and Mills, L.S. (2013). Monitoring Wildlife Populations. In: Mills, S. and Tempa, T. (eds.) Wildlife Research Techniques in Rugged Mountainous Asian Landscapes. UWICE: RGoB. Lamai Gompa, Bumthang.
34. **Pandit et al. (2016).** Elevational pattern of bird species richness and its causes along a central Himalaya gradient, China. *PeerJ* 4:e2636; DOI 10.7717/peerj.263.
35. Pandit, M.K., K. Manish, and L.P. Koh. (2014). Dancing on the roof of the world: ecological transformation of the Himalayan landscape. *BioScience* 64: 980-992.
36. **Sangay, T., Rajaratnam, R. & Vernes, K. (2016).** Current distribution and conservation status of Bhutan Takin *Budorcas whitei* Lydekker, 1907 (*Artiodactyla: Bovidae*). *Journal of Threatened Taxa* 8(14): 9630–9637; <http://dx.doi.org/10.11609/jott.2925.8.14.9630-9637>.
37. Sayre, R., Frye, C., Karagulle, D., Krauer, J., Breyer, S., Aniello, P., Wright, D.J., Payne, D., Adler, C., Warner, H., Van Sistine, D.P., Cress, J. (2018). A New High-Resolution Map of World Mountains and an Online Tool for Visualizing and Comparing Characterizations of Global Mountain Distributions. *Mountain Research and Development*, 38(3):240-250 (2018). <https://doi.org/10.1659/MRD-JOURNAL-D-17-00107.1>.
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39. Singh, J.S. and Singh, S.P. (1987). Forest Vegetation of the Himalaya. *The Botanical Review*, (53)1,80-192.

40. **Smethurst, D. (2010).** Mountain Geography. *The Geographical Review* 90 (I): 35-56.
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