AMAZONIAN ABCs

Fundamentals of rainforest ecology & field biology

July 30 – August 12, 2020

ACADEMIC SYLLABUS

Lead instructor: Dr. Varun Swamy (varunswamy [at] gmail [dot] com); **Co-instructor:** Dr. Geoff Gallice

Location: This course will be conducted at two biological research stations in Madre de Dios, in the southeastern Peruvian Amazon: 1) Finca Las Piedras, located at the edge of the agricultural frontier and bordered by extensive concessions for Brazil nut (*Bertholletia excelsa*) harvest, and 2) the Malinowski Biological Station, located within Peru's Tambopata National Reserve, on the Tambopata River at the mouth of the Malinowski River.

Course credit: This is the equivalent to a 5-quarter or 3-semester credit undergraduate-level course. Credit is not offered through the Alliance for a Sustainable Amazon. Please inquire with your academic advisor at your university about the possibility of receiving credit for this field course or contact us at info@sustainableamazon.org with any questions.

Readings: A Readings Packet that includes various selections from the primary literature will be an integral part of our learning in the field. The Packet will be provided to students in advance of the program; students should print it in its entirety, have it bound, and bring it with them to Peru. Field guides and other reference materials will also be available at the field sites, as well as a small, shared library with selections spanning various topics in tropical biology.

Required text: Students should purchase the following text and read it completely before arriving in Peru:

Forsyth, A. & K. Miyata. 1984. *Tropical nature*. Touchstone, New York.

Contents of this Syllabus

1. Course Overview – Introduction & Objectives
2. Lecture & Discussion Topics
3. Course Work
4. Assessment
5. Grading Scheme
6. General Reminders
7. Daily Schedule & Course Contents
8. Reading List

1. COURSE OVERVIEW

Introduction

The Amazon basin brings to mind many superlatives in describing its geography and biology – it is the largest tropical forest ecosystem on Earth, harboring the greatest proportion of its terrestrial and freshwater

biodiversity. The Amazon rainforest can also be thought of as an incredibly complex machine, comprised of millions of individual components working together, as represented by its biotic and abiotic elements. Ecological interactions – between fungi, microbes, plants, insects, birds, mammals, soil, air, water, sunlight – form the basis of the Amazon rainforest's identity and stability, and acting over an evolutionary time scale have given rise to its amazing diversity. The existence and maintenance of this diversity has fascinated ecologists and inspired multiple generations of scientific careers, dating back to Alfred Russel Wallace's vivid impressions from his expeditions in the late 19th century. In the present day, ecological research in the Amazon rainforest continues to be a compelling endeavor, aided by 21st century technology and tools that have generated new insights and fields of enquiry. At the same time, the Amazon rainforest faces a multitude of existential threats from rampant anthropogenic disturbances – logging, agriculture, hunting, mining, road-building, urban expansion, and climate change. Given the dire consequences of the loss and degradation of the Amazon rainforest for planet's biodiversity and climate, there is an urgent need for increasing efforts towards the conservation, restoration and sustainable resource use of the Amazon rainforest. The success of these efforts relies on understanding the fundamentals of the ecosystem and its functioning, i.e., the ABCs of Amazon rainforest ecology.

Objectives

This course is intended to provide an introduction and broad overview of Amazon forest ecology and conservation, with a geographic focus on the Madre de Dios basin in southeastern Peru. The overarching theme is the incredible biodiversity of the Amazon rainforest, the key factors and processes underlying its creation and maintenance, and the impact of anthropogenic disturbance – past, current and future – on these critically important forest ecosystems. Classroom-style lectures will complement extensive field-based activities and interpretation, and individual and group projects. The basics of insect and tropical plant taxonomy, as well as field biology skills spanning a diversity of other topics and taxa, will be imparted through hands-on instruction and practice. The 2-week course will be divided between two long-term research sites and field stations in the Madre de Dios region that provide access to a variety of representative habitats.

By the end of this course, participants will have acquired a solid ecological grounding that will substantially enhance their interpretation and appreciation of Amazon rainforest ecosystems and their splendid complexity. This knowledge will serve as a launch pad for careers dedicated to research, conservation and advocacy of our planet's most valuable and irreplaceable ecosystem.

2. LECTURE & DISCUSSION TOPICS

The underlying basis of Amazon forests: Rainforest soils and nutrient cycling

- Edaphic distinction between floodplain vs. tierra firme forests in the lowland Amazon, and its geologic basis.
- The "paradox of tropical luxuriance" i.e. how do these hyperdiverse and hyper-productive ecosystems persist on very low-nutrient soils (particularly in tierra firme forest) and what are their key adaptations?
- Exploring the feasibility, opportunities and limitations of doing agriculture of different scales and intensities on rainforest soils.
- Impact of alluvial gold mining on tropical soils, and exploring mitigation/reforestation strategies.

Building an Amazon forest: Primary riparian succession and the development of diversity

- The role of rivers in continually creating new habitat and destroying/recycling mature forest.
- The development of tree diversity is a long process that takes place over multiple centuries, involving multiple distinct stages and turnover of species that represent different life history and biological traits/guilds.
- Successional processes and dynamics in non-floodplain habitats i.e. tierra firme, swamps, bamboo-dominated forests, etc.

- Why conventional commercial logging i.e. clear-cutting is ecologically unsustainable in Amazon forests, and what are the alternatives?

Hyperdiversity of Amazon forests: creation, maintenance, processes and patterns

- How has it developed, factors responsible at different spatiotemporal scales (continental > hectare, evolutionary > ecological), major mechanisms and theories.
- Tree diversity and the role of plant-animal interactions: the Janzen-Connell hypothesis.
- The impact of bushmeat hunting and defaunation on diversity, structure and carbon stocks of tropical forests.

Rainforest rhythms: Phenological cycles, keystone resources & climate change

- What is phenology, and how do tropical forest plants coordinate their phenophases i.e. leafing, flowering and fruiting, in relation to abiotic (climatic) and biotic factors?
- How does the consumer (animal) community depend on/respond to plant phenological cycles?
- Keystone plant resources: theoretical basis and practical determination
- The potential impact of climate change on Amazon rainforest phenology, and its trickle-down impacts on diversity and ecosystem function.

Neotropical insect diversity, biology & natural history

- An overview of biodiversity of Amazonian insects, including major orders and important families
- An introduction to key methods for collecting and surveying insects
- Basic insect identification skills

Breaking down the green wall: a primer in neotropical plant systematics and taxonomy

- A survey of the neotropical flora and the prominent orders, families and genera that comprise it
- Botanical terminology and the fundamentals of taxonomic identification
- The Gentry method of field botany and its application to western Amazonian flora

Conservation & sustainable use of Amazon forests: issues, challenges, opportunities

- A history perspective: megafaunal extinctions, pre-Colombian landscapes, the rubber boom
- Recent and contemporary drivers of deforestation: logging, agriculture, road-building, urban expansion
- The “golden curse” of Madre de Dios: alluvial gold mining and its impacts
- Conservation and sustainable use strategies: protected areas, community reserves, ecotourism

3. COURSE WORK

Field Journal (200 points)

The field journal is an integral part of the course, reflecting the importance of consistent, detailed note-taking in field biology—all scientists who conduct field research keep a journal in which they record everything they find, observe, and collect. Observations at all levels of organization, from the individual organism to the ecosystem, including behavior, natural history and life history traits, distribution, abundance, habitat, landscape, human dimensions, and how all of these things might be interrelated go into the field journal. The journal is a permanent record of observations and, no matter what the purpose of the field trip, the journal contains all the evidence on which subsequent work will be based. It is also a place where your observational skills are repeatedly and continuously tested and sharpened. We will introduce journal-writing style and expectations during the first few days of the course. Please note that FPI will provide students with a high-quality, waterproof field journal for use during the field course; journals will be graded but returned to students before completion of the course.

Requirements:

Daily Entries (12 total)
The daily entry contains the who, what, where, why, and when of the day's activities. This should begin with the basics: site name/location, date, temperature and weather conditions (cloudy, sunny, windy, raining, cold, hot, and for what portion of the day/night, etc.), soil conditions (e.g., moist or dry, clay, sand, etc.), who you were with, etc. Then record your observations—keep in mind that you can never record too many details, no matter how trivial some might seem at the time. Every observation in the field journal will become valuable information later as you attempt to recall and synthesize your experiences. Things to note might be dominant trees or other plants in flower/fruit at the field site, any pollination or feeding activities observed, groups of conspicuous animals or behaviors, dominant vegetation types, patterns of human land use, condition of the local habitat (e.g., pristine, degraded/disturbed, etc.). Anything you think might be important goes in the journal, and remember, nothing is too trivial to be recorded; when in doubt, *write it down*. This is also a place to record and describe some of the many new species of plants and animals that you will observe in the field. Each new species that captures your attention should be recorded in the field journal, including details covering where and at what time the sighting occurred, the organism's scientific and common names, its size, form, appearance, behavior, microhabitat, interactions with other species, and anything else you found interesting about it, etc. An important part of a species description is a drawing of the organism, including important details about its habitat if relevant; the drawing will add information that cannot be easily expressed in words and will complement the written description. A major part of the job of a field naturalist is species identification, and although sometimes difficult, this is an important and rewarding aspect of field biology.

Group Activities (see Section 4 for point values)
Throughout the field course we will conduct a number of group activities that will help students sharpen their skills in tropical field biology and ecology. Each assignment will require students to submit a final report of varying detail. Activities and associated assignments are described in detail in the Group Activities document, which will be distributed to students in electronic format before the start of the course.

Camera trapping for rainforest vertebrates
Camera traps are a relatively new tool available to biologists working in the tropics and offer several advantages to surveying cryptic and otherwise difficult-to-study Amazonian wildlife. In this activity students will deploy camera traps along the trail network and at strategic locations in the rainforest to survey medium to large vertebrates at our field site. We will discuss the requirements for using camera traps to evaluate species' abundance and some of their practical applications in the study region.

Estimation of aboveground biomass
Tropical forests store massive amounts of carbon and thus are extremely important for global climate change. In this activity students will study and practice techniques for estimating the carbon storage of different rainforest habitats at a variety of field sites, and apply what we learn locally to evaluating the potential of rainforests in southeastern Peru in mitigating climate change.

Amazonian insect diversity
Insects are the most abundant and diverse organisms on Earth and reach their peak diversity in the western Amazon. They are also of key ecological importance as pollinators, drivers of the evolution of plant secondary compounds, and as integral parts of complex tropical food webs and interaction networks. After a series of lectures covering the diversity of insects in the western Amazon students will be tasked with collecting and identifying a number of insects to order and family.

Reading Discussions (200 points)
Group reading discussions are ongoing throughout the course and include discussions of each of the readings presented in the Reading List, incorporating selections from tropical ecology, biology, and conservation. Reading topics will mirror field activity themes, so that readings complement hands-on activities and learning in a logical fashion. We will cover the basics of reading and critically evaluating primary literature at the beginning of the course. Discussions will be led by the course instructor at the beginning of the course,

but students will be expected to progressively lead discussions (with the instructor acting as moderator) as the course progresses. The reading discussion grade will be based on whether students participate in the discussions, as well as whether it is obvious that they have read and understand the article to a reasonable degree. We recommend that students read each paper carefully before arriving in Peru, and then re-read each one before the discussion—this method has been shown to increase understanding and retention of new, often challenging ideas.

Practical (100 pts)
This will be a chance to evaluate students' learning of plant identification. Students may be asked to identify plants to family using morphological characters studied during field activities and justify their identifications based on those characters.

Final exam (200 pts)
This is a written exam during the final days of the course. The exam format is a series of short essay questions designed to test students' synthesis of the course material, including field experiences, course lectures, reading material, and discussions. This will require an understanding of the course material, rather than only straightforward memorization. For example, rather than being asked to identify individual plants or animals, students may be asked to synthesize what they have learned about field research methods in entomology or plant ecology, as well as the flora, fauna, habitats, and conservation issues of the study region, by designing a study to investigate the biology of a focal group of plants or animals. The final exam will take roughly 1-3 hours to complete.

4. ASSESSMENT

Individual and group assignments will be assessed according to the following point schedule:

Assessment item		Points possible	Course total points possible
Field journal	Daily entries	200	1000
Group activities	Camera trapping	50	
	Aboveground biomass	100	
	Insect diversity	150	
Reading discussions	Participation	200	
Practical	Plant identification	100	
Final Exam		200	

5. GRADING SCHEME

To convert final grade percentages to letter grades for each course that will appear on your transcript, we will use the following grading scheme:

Letter grade	Percentage	Letter grade	Percentage
A	92.5 ≤ % < 100	C+	77.5 ≤ % < 80.0
A-	90.0 ≤ %< 92.5	C	72.5 ≤ % < 77.5
B+	87.5 ≤ %< 90.0	C-	70.0 ≤ % < 72.5
B	82.5 ≤ %< 87.5	D+	67.5 ≤ % < 70.0
B-	80.0 ≤ %< 82.5	D	62.5 ≤ % < 67.5
		D-	60.0 ≤ % < 62.5
		F	%< 60.0

6. GENERAL REMINDERS

Academic Integrity

Academic integrity is as important during this field course as it is at your home institution. Plagiarism, using the ideas or materials of others without giving due credit, cheating, or submitting another student's work as your own will not be tolerated. Any instance of these, or any instance of aiding another to cheat, either actively or passively, will result in a zero for the assignment. Cases of academic dishonesty may be reported to your home institution in the case of students taking this course for credit.

Deadlines

Assignment deadlines are established to promote equity among students and to allow for ample assessment time from faculty before other assignments are due or other activities are to occur. Therefore, deadlines are firm and late work will receive at a minimum a 10% loss of grade points for each day they are late. If you believe that extenuating circumstances have prevented you from completing your work on time, make sure to discuss this with the relevant instructor as soon as possible and certainly before the work is due.

Participation and Attendance

Participation and attendance are crucial throughout this field course. Because of the demanding schedule and limited time, all components of the program are mandatory (unless indicated) and missing even one lecture can have a disproportionate effect on your final grade. Hence, it is important to be prompt and prepared (i.e., with required equipment) for all activities.

Special Accommodations

Students with special needs should meet with the lead faculty member as soon as possible to discuss any special accommodations that may be necessary.

7. SCHEDULE AND COURSE CONTENTS

Typical Daily Schedule

7am	Breakfast
8am-12pm	Morning field activities

12-1pm Lecture or reading discussion
1pm Lunch
2-5pm Afternoon field activities
5:30-6:30pm Lecture or reading discussion
6:30pm Dinner
7:30pm Nocturnal activities & planning for next day

ITINERARY & COURSE CONTENTS

Date	Overnight	Activities	Readings	Assignments Due
30 July	Finca Las Piedras	Arrive in Puerto Maldonado Travel by road to Finca Las Piedras (FLP) Introduction to the field site & research activities at FLP Safety & health briefing Course overview	Tobler et al. 2008	
31 July	Finca Las Piedras	**Morning** Introductory rainforest hike Lecture – Tropical plant diversity: patterns and processes **Afternoon** Set up camera traps Lecture – Tropical plant diversity part 2 **After dinner** Night hike (optional)	Levi et al. 2019	
1 Aug	Finca Las Piedras	**Morning** Activity – Field botany and plant biology Reading discussion – **Afternoon** Activity – Field botany and plant biology practice Lecture – Insect diversity pt.1 **After dinner**	Higgins et al. 2011 Swamy 2017	
2 Aug	Finca Las Piedras	**Morning** Lecture – Insect diversity pt.2 Activity – Butterfly diversity & biology **Afternoon** Lecture – Soils, nutrient cycling, forest succession Reading discussion –	Terborgh & Petren 1991	

		After dinner		
3 Aug	Malinowski	**Morning** Travel overland and by boat to the Malinowski Biological Station (MBS) Welcome by rangers, introduction to Tambopata National Reserve Overview of activities at MBS **Afternoon** Introductory rainforest hike - terra firme forest Lecture – Rainforest rhythms: Phenological cycles, keystone resources & climate change **After dinner** Night hike (optional)	Mendoza et al. 2017	
4 Aug	Malinowski	**Morning** Visit to floodplain forest visit across Tambopata River **Afternoon** Lecture – Geophagy in Amazon rainforests Reading discussion – **After dinner**	Diaz-Martin et al. 2013	
5 Aug	Malinowski	**Morning** Chuncho clay lick visit Reading discussion – **Afternoon** Activity – AGB pt.1: Terra firme **After dinner**	Brightsmith et al. 2018	
6 Aug	Malinowski	**Morning** Activity – Insect diversity **Afternoon** Activity – AGB pt.2 - Floodplain **After dinner**		Insect diversity activity report due
7 Aug	Malinowski	**Morning** Mammal clay lick visit Field botany practicum **Afternoon** Reading discussion – Free time	Peter et al. 1989	Field botany practicum

		After dinner		
8 Aug	Finca Las Piedras	**Morning** Travel by boat then overland from MBS to Finca Las Piedras **Afternoon** Activity – AGB pt.3 Terra firme: Finca Las Piedras **After dinner**		
9 Aug	Finca Las Piedras	**Morning** Brazil nut concession visit **Afternoon** Reading discussion – **After dinner**	Brodie et al. 2012	
10 Aug	Finca Las Piedras	**Morning** Review & final exam **Afternoon** Activity – Collect & review camera traps Free time **After dinner**		Final exam Field journals due for grading AGB activity report due Camera trapping activity report due
11 Aug	Puerto Maldonado	**Morning** Travel from Finca Las Piedras to Lago Sandoval (oxbow lake) **Afternoon** Return to Puerto Maldonado Group dinner		
12 Aug		Course concludes Flights home		

8. Reading List

Material will be discussed according to the following schedule (dates listed are discussion dates; students should be prepared to discuss material on the date assigned). Discussion of readings will occur in the morning or evening, depending on the day's activities.

July 30 Tobler, M.W., Carrillo-Percastegui, S.E., Leite Pitman, R., and G. Powell. 2008. An evaluation of camera traps for inventorying large- and medium-sized terrestrial rainforest mammals. Animal Conservation 11: 169- 178.

July 31 Levi, T., Barfield, M., Barrantes, S., Sullivan, C., Holt, R.D., & Terborgh, J. 2019. Tropical forests can maintain hyperdiversity because of enemies. Proceedings of the National Academy of Sciences 116: 581-586.

Aug. 1 Higgins, M.A., Ruokolainen, K., Tuomisto, H., Llerena, N., Cardenas, G., Phillips, O.L., Vásquez, R. & Räsänen, M. 2011. Geological control of floristic composition in Amazonian forests. Journal of Biogeography 38: 2136-2149.

Swamy, V. 2017. Forest composition and spatial patterns across a western Amazonian river basin: The influence of plant–animal interactions. In: *Forest structure, function and dynamics in western Amazonia* (ed. R.W. Myster), pp. 159-180. John Wiley & Sons, Ltd, Chichester, UK.

Aug. 2 Terborgh, J. & K. Petren. 1991. Development of habitat structure through succession in an Amazonian floodplain forest. In: Habitat structure: The physical arrangement of objects in space (eds. Bell, S.S., McCoy, E.D., & H.R. Mushinsky), pp. 28-46. Chapman-Hall, London, UK.

Aug. 3 Mendoza, I., Peres, C.A., & L.P.C. Morellato. 2017. Continental-scale patterns and climatic drivers of fruiting phenology: A quantitative Neotropical review. Global and Planetary Change 148: 227-241.

Aug. 4 Diaz-Martin, Z., Swamy, V., Terborgh, J., Alvarez-Loayza, P. & F. Cornejo. 2014. Identifying keystone plant resources in an Amazonian forest using a long-term fruit-fall record. Journal of Tropical Ecology 30: 291-301.

Aug. 5 Brightsmith, D.J., Hobson, E.A., & G. Martinez. 2018. Food availability and breeding season as predictors of geophagy in Amazonian parrots. Ibis 160: 112-129.

Aug. 7 Peters, C.M., Gentry, A.H., & R.O. Mendelsohn. 1989. Valuation of an Amazonian rainforest. Nature 339: 655-656.

Aug. 9 Brodie, J., Post, E., & W.F. Laurance. 2012. Climate change and tropical biodiversity: A new focus. Trends in Ecology & Evolution 27: 145-150.