

## **Biology Foreign Studies Program (Bio 55,56,57): Winter terms**

### **Course description**

**Instructors:** Matt Ayres, Jess Trout-Haney, Celia Chen

**Graduate TAs:** Two

**Meeting times:** Various sites in Costa Rica (ca 6 Jan - 18 Feb).  
Little Cayman Research Center (ca 19 Feb - 12 March).  
See detailed schedules..

**Course website:** <https://biology.dartmouth.edu/foreign-study-program>

#### Ecological Research in the Tropics I and II (Bio 55 and 56)

The Biology Foreign Studies Program (Biology 55, 56, 57) exposes students, through intensive, full-immersion study, to Earth's most diverse biological communities. Biology 56 is a continuation of Biology 55; these courses comprise the first two-thirds of the FSP, and focus on land (tropical forests) and tropical freshwater ecosystems in Central America (Panama and Costa Rica). Biology 57 focuses on coral reef ecosystems in the Caribbean. Students are challenged to know, understand and appreciate the diversity of form and function in organisms, and the interactions that generate the often-spectacular patterns they see in the field. Habitats in Central America include lowland rain forest (Barro Colorado Island and Corcovado), cloud forest (Monteverde), dry forest (Palo Verde and Santa Rosa), pre-montane wet forest (Las Cruces), montane forest (Cuerici), alpine paramo, streams, and wetlands. The schedule is full, including fieldwork, laboratories, lectures and discussions, with emphasis on original research, mostly in small groups of 2-3. Faculty and advanced graduate TAs share field accommodations with students and are in continuous contact as mentors throughout the program. Students master field and analytical methods (including hypothesis testing, statistical and software skills) for observational and experimental research. We pursue a great variety of research topics, including plant-pollinator and plant-herbivore interactions, processes driving coral reef structure (and coral reef decline), determinants of species distributions, animal behavior, and conservation ecology. Students practice contemporary scientific inquiry: making observations, asking testable questions, generating hypotheses, developing experimental protocols, collecting data, making statistical inferences - including multi-model comparisons, writing scientific papers, and presenting seminars. Research papers are published in an annual book. Accommodations are at field stations in Costa Rica, and at a marine laboratory in the Caribbean.

#### Ecological Research on Coral Reefs (Bio 57)

Field and laboratory investigations of marine organisms and coral reef communities. A continuation of Bio 55 and 56 above. Lecture and research topics include studies of algae, aquatic plants, invertebrates, and fish, with emphasis on populations, species interactions, community structure and energetics, and reef conservation and management. The course is based at the Little Cayman Research Center, Little Cayman Island. Scuba diving is optional.

Prerequisite: Bio 16 plus one course for which Bio 16 is a prerequisite; acceptance into program.

**Grading policy:** Grades are based on the quality of research projects (including seminar presentations and resulting manuscripts); development of skills in natural history; development of skills in research design, statistical analyses, and strong inference; and development of skills as collaborators within research work groups.

Students with disabilities are encouraged to discuss them with the staff so that appropriate accommodations can be made.

# COSTA RICA SCHEDULE

Bio FSP 2023. Detailed schedule for first six weeks of program.

13-Jan-23

Date	Day	Location	Morning	Afternoon	Evening
4-Jan	Wed	Miami to San Jose	Travel	Travel	Arrive at hotel in evening
5-Jan		In San Jose	Orientation (logistics and safety). OTS (pickup gear).	Museum. San Jose exploration	Group dinner
6-Jan		To Palo Verde	Travel	Orientation (logistics and safety).	Night walk
7-Jan		At Palo Verde	Orientation (Guided hike #1). Vert lab begins.	Lec: Field notebooks; observation exercise. (FKT)	ORP-1 project development
8-Jan	Sun	At Palo Verde	Lec: Species interactions (FKT); field lab	ORP-1 proposals, research	Lec: Goals of course, Research tactics (FKT). <b>Student Paper 1 (WC).</b>
9-Jan		At Palo Verde	Guided hike #2	ORP-1 research	Intro to comparative projects (AF,MP)
10-Jan		At Palo Verde	ORP-1 research	Lec: Data frames & metadata, stats. Visual hypotheses. (FKT); CP: soils (AF)	CP: bioacoustics (MP)
11-Jan		At Palo Verde	ORP-1 research & analysis	Lec: Data Analysis II & Writing (FKT); ORP-1 research	<b>Student Paper 2 (HW)</b>
12-Jan		At Palo Verde	Vertebrate practicum	Lec: CR & Cons Biol I; ORP-1 analysis & writing	Lec: Theories & Hypotheses. Arthropods Lab (MP)
13-Jan		At Palo Verde	Rio Tempisque Riverboat	ORP-1 writing; Botany (AF)	ORP-1 symposium, ORP-1 v1 due
14-Jan		To La Selva	Travel	Orientation (logistics and safety).	Night walk
15-Jan	Sun	At La Selva	Orientation (guided hike)	Lec: Biodiversity (FKT) ORP-2 project development	ORP-2 proposals
16-Jan		At La Selva	ORP-2 research	Arthropods (MP), ORP-2 research	Lec: Forest Ecology (FKT). <b>Student Paper 3 (DG).</b>
17-Jan		At La Selva	ORP-2 research	CP: soils (AF)	Lec: Ecosystems I (AF). <b>Student Paper 4 (JZ).</b>
18-Jan		At La Selva	ORP-2 research	Botany (AF), ORP-2	Lec: Evolution (FKT)
19-Jan		At La Selva	ORP-2 research	ORP-2 research	CP: bioacoustics (MP), ORP-2 analysis
20-Jan		At La Selva	ORP-2 analysis and writing	ORP-2 writing, v1 due	ORP-2 symposium
21-Jan		To Cuerici	Travel	Travel. Hike through Paramo to Cuerici.	Orientation (logistics and safety). Lec: High altitude adaptations (MA)
22-Jan	Sun	At Cuerici	Orientation (guided hike)	ORP-3 project development	ORP-3 proposals
23-Jan		At Cuerici	ORP-3 research	CP: soils (AF). <b>Student paper 5 (WT).</b>	Lec: Coevolution (MP).
24-Jan		At Cuerici	ORP-3 research	Botany (AF), ORP-3 research	Night walk, CP: bioacoustics (MP)
25-Jan		At Cuerici	ORP-3 research	Lec: Pollination (MA); ORP-1&2 wrap up as needed	<b>Student Paper 6 (LR).</b>
26-Jan		At Cuerici	ORP-3 analysis	Arthropods (MP), ORP-3 analysis & writing	<b>Student Paper 7 (TC).</b>
27-Jan		At Cuerici	ORP-3 writing	ORP-3 Symposium	ORP-3 v1 due
28-Jan		To Campanario	Travel	Boat travel through mangroves and down Pacific coast of Osa to Campanario.	Orientation (logistics and safety).
29-Jan	Sun	At Campanario	Orientation (hike)	Self-guided exploration	ORP-4 project development
30-Jan		At Campanario	ORP-4 research	ORP-4 research. Lec: Avian ecology (MP).	Night walk
31-Jan		At Campanario	ORP-4 research	ORP-4 research. Lec: Social insects (MP).	ORP-4 research. CP: bioacoustics (MP).
1-Feb		At Campanario	ORP-4 research	ORP-4 research. Lec: Soil ecology (AF). CP: soils (AF).	ORP-4 research. Bats.
2-Feb		At Campanario	ORP-4 research	ORP-4 research. ORP-3 v2 due.	ORP-4 research. Bats.
3-Feb		At Campanario	ORP-4 research	ORP-4 analysis	ORP-4 analysis. Bats.
4-Feb		At Campanario	ORP-4 interpretations and context	ORP-4 Symposium	Practicum: Milling of <i>Saccharum officinarum</i>
5-Feb	Sun	To Las Cruces	Travel	Orientation (logistics and safety).	Lec: Ecology of seasonality (MA)
6-Feb		At Las Cruces	Orientation (guided hike)	Self-guided exploration. ORP-4 v1 due.	CP: bioacoustics (MP)
7-Feb		At Las Cruces	ORP-5 project development	ORP-5 proposals. ORP-3 revisions. CP: soils (AF).	Lec: Plant-herbivore interactions (MA)
8-Feb		At Las Cruces	ORP-5 research. Botany.	ORP-4 revisions. <b>Student paper 8 (JR). Student paper 9 (KS).</b>	ORP_5 research. Manuscript revisions.
9-Feb		At Las Cruces	ORP-5 research. Botany.	Manuscript revisions. <b>Student paper 10 (ML). Student paper 11 (TM).</b>	ORP-3 final due.
10-Feb		At Las Cruces	ORP-5 research. Botany.	Manuscript revisions. <b>Student paper 12 (IM). Student paper 13 (KJ).</b>	ORP-4 final due.
11-Feb		At Las Cruces	ORP-5 research. Botany.	ORP-5 analysis, interpretations, and context. <b>Student paper 14 (KM). Student paper 15 (LV).</b>	ORP-5 v1 due
12-Feb	Sun	At Las Cruces	ORP-5 symposium. ORP-5 revisions.	ORP-5 revisions. Botany.	ORP-5 final due. Lec: Cons Bio 2 (MA).
13-Feb		At Las Cruces	Botany	Botany practicum	Discussion: What is the purpose of science?
14-Feb		To San Jose	Travel	Travel	Group dinner
15-Feb		To Miami	Travel	Travel	Overnight in Miami
16-Feb		To Grand Cayman, then Little Cayman	Travel	Travel	Orientation (logistics and safety).
9-Mar	Thu	To Miami	Travel	Travel	

ORP = Original Research Project.

CP = Comparative Project

## PAPERS FOR STUDENT PRESENTATIONS

Bio FSP 2023: Papers for student presentations in Costa Rica (in order of occurrence).

#	Site*	Presenter	Student Paper
1	PV	Wyatt Cummings	<b>Janzen and Martin. 1981.</b> Neotropical anachronisms: the fruits the gomphotheres ate. <i>Science</i> 215:19-27. [See also: Sanchez et al. 2003. Feeding ecology, dispersal, and extinction of South American Pleistocene gomphotheres (Gomphotheriidae, Proboscidea). <i>Paleobiology</i> 30: 146-161.]
2	PV	Haley Warzecha	<b>Fedigan and Jack. 2001.</b> Neotropical primates in a regenerating Costa Rican dry forest: A comparison of howler and capuchin population patterns. <i>International Journal of Primatology</i> 22:689-713.
3	LS	David Goodman	<b>Brady 2003.</b> Evolution of the army ant syndrome: The origin and long-term evolutionary stasis of a complex of behavioral and reproductive adaptations. <i>PNAS</i> 100: 6575-6579. (See also: Rettenmeyer et al. 2011. The largest animal association centered on one species: the army ant <i>Eciton burchellii</i> and its more than 300 associates. <i>Insectes Sociaux</i> 58:281-292. Chadab and Rettenmeyer. 1975. Mass recruitment by army ants. <i>Science</i> 188:1124-1125. Schneirla, T. C. 1934. Raiding and other outstanding phenomena in the behavior of army ants. <i>PNAS</i> 20:316-321.)
4	LS	Jake Zikan	<b>Vanderbilt 2015.</b> Variation in the performance of cross-contextual displays suggests selection on dual-male phenotypes in a lekking bird. <i>Anim Behav</i> 107:213-219. (See also: McDonald and Potts. 1994. Cooperative display and relatedness among males in a lek-mating bird. <i>Science</i> 266:1030-1032.)
5	Cuer	Whitney Thomas	<b>McCain 2009.</b> Vertebrate range sizes indicate that mountains may be 'higher' in the tropics. <i>Ecology Letters</i> 12:550-560. (*See also: Janzen, D. H. 1967. Why mountain passes are higher in the tropics. <i>American Naturalist</i> 101:230-243. Sheldon et al. 2018. Fifty Years of Mountain Passes: A Perspective on Dan Janzen's Classic Article. <i>American Naturalist</i> 191:553-565.)
6	Cuer	Log Reano	<b>Galetti et al. 2013.</b> Functional extinction of birds drives rapid evolutionary changes in seed size. <i>Science</i> 340:1086-1090. (See also: Palacio and Ordano. 2018. The Strength and drivers of bird-mediated selection on fruit crop size: a meta-analysis. <i>Frontiers in Ecology and Evolution</i> 6)
7	Cuer	Theo Castellani	<b>Endara et al. 2017.</b> Coevolutionary arms race versus host defense chase in a tropical herbivore-plant system. <i>PNAS</i> 114:E7499-E7505. (See also: Ehrlich, P. R., and P. H. Raven. 1964. Butterflies and plants: a study in coevolution. <i>Evolution</i> 18:586-608.)
8	Cuer	Jack Roney	<b>Herre 1993.</b> Population-structure and the evolution of virulence in nematode parasites of fig wasps. <i>Science</i> 259:1442-1445.
9	Osa	Kate Singer	<b>Little et al. 2006.</b> Defending against parasites: fungus-growing ants combine specialized behaviours and microbial symbionts to protect their fungus gardens. <i>Biology Letters</i> 2:12-16. (See also: Schultz and Brady. 2008. Major evolutionary transitions in ant agriculture. <i>PNAS</i> 105:5435-5440. Currie et al. 1999. Fungus-growing ants use antibiotic-producing bacteria to control garden parasites. <i>Nature</i> 398:701-704.)
10	Osa	Megan Liu	<b>Akre and Ryan. 2011.</b> Female tungara frogs elicit more complex mating signals from males. <i>Behavioral Ecology</i> 22: 846-853.
11	Osa	Tori Moss	<b>Nowakowski et al. 2016.</b> Infection risk decreases with increasing mismatch in host and pathogen environmental tolerances. <i>Ecology Letters</i> 19:1051-1061. (See also Pound et al. 2006. Widespread amphibian extinctions from epidemic disease driven by global warming. <i>Nature</i> 439:161-167.)
12	LC	Isaiah Menning	<b>Ramirez et al. 2011.</b> Asynchronous diversification in a specialized plant-pollinator mutualism. <i>Science</i> 333:1742-1746.
13	LC	Kiera Jackson	<b>Temeles and Kress 2000.</b> Evidence for ecological causation of sexual dimorphism in a hummingbird. <i>Science</i> 289: 441-443. (See also: Linhart 1973. Ecological and behavioral determinants of pollen dispersal in hummingbird-pollinated <i>Heliconia</i> . <i>American Naturalist</i> 107: 511-523.)
14	LC	Kris Moreno	<b>Marra and Holmes. 2001.</b> Consequences of dominance-mediated habitat segregation in American Redstarts during the nonbreeding season. <i>Auk</i> 118: 92-104. (See also Marra et al. 1998. Linking winter and summer events in a migratory bird by using stable-carbon isotopes. <i>Science</i> 282: 1884-1886.)
15	LC	Lalli Vergara	<b>Poorter et al. 2021.</b> Multidimensional tropical forest recovery. <i>Science</i> 374: 1370-+.

\* Sites in order: Palo Verde, La Selva, Cuerici, Campanario, Las Cruces

## LITTLE CAYMAN SCHEDULE

Date		Morning	Afternoon	Evening
16 Feb Thurs	Group Arrives at 3:05 pm from Grand Cayman		Pick up students Unpack, get settled, and start orientations  Introduction to CCMI (Alex Chequer)	<b>Lecture:</b> Introduction to Caribbean geology and Cayman History (CC)  <b>Discussion:</b> schedule (tentative) and expectations for LC segment.
17 Feb Fri	Orientation and General natural history	Dive Gear assigning (Greg Locher) Snorkel and diving safety talks Snorkeling in back reef	<b>SCUBA and Snorkeling Shore dive/snorkel at Cumber's (1:30)</b> <b>Lecture:</b> Coral reefs in the Caymans and past projects (CC)	<b>Lecture:</b> Invertebrates and Introduction to Queen Conch (CC)  Creature Feature
18 Feb Sat	Queen Conch project	<b>Queen Conch Project</b> Data collection design Snorkeling in South Hole	<b>Lecture:</b> Corals (Katie Ebanks, 2-4pm) Snorkeling in back reef	Creature Feature
19 Feb Sun	Queen Conch project	<b>Queen Conch Project</b> Data analysis and findings	<b>Queen Conch Project</b> Algae sampling and identification	<b>Film:</b> Secret sex life of fish Creature Feature
20 Feb Mon	Queen Conch project Prince Edward visiting	<b>Queen Conch Project</b>	<b>Queen Conch Project</b> Visit other project sites (Salt Rock, Greg's house) Lionfish cull	<b>Queen Conch Project Presentation</b> Creature Feature
21 Feb Tues	Project 1 begins	Project 1 Brainstorm and idea discussion	Project 1 Proposal Development Earl Wessex visit	"The Deep Sea" Dr. Joanna Kohler Beach Resort (5:30-6:30) <b>Critique:</b> Seagrass Ecology (Lali Vergara) <b>Film:</b> Sponges: Oldest Creatures
22 Feb Wed	Project 1	Project 1 data collection	Project 1 data collection	<b>Critique:</b> Invertebrates (Megan Liu) <b>Critique:</b> Herbivory (Logan Reano)
23 Feb Thu	Project 1	<b>Project 1 Proposal due</b> Project 1 data collection	Project 1 data collection	<b>Critique:</b> Coral Calcification (Kris Moreno) <b>Critique:</b> Sponges (Isaiah Menning)

<b>Date</b>		<b>Morning</b>	<b>Afternoon</b>	<b>Evening</b>
24 Feb Fri	Project 1	Project 1 data collection	Project 1 data collection	<b>Critique:</b> Zooplankton (David Goodman) <b>Critique:</b> Fish Biology (Theo Castellani)  <i>Karaoke</i>
25 Feb Sat	Project 1	Project 1 data collection	Project 1 – data analysis, write methods <b>**Project 1 PRESENTATIONS**</b>	<b>Critique:</b> Fish Larval settlement (Kate Singer) <b>Critique:</b> Fish Ecology (Tori Moss)
26 Feb Sun	<b>Dia libre (OFF)</b>	<b>Sleep in and Brunch</b>	<b>Beach Cleanup and snorkeling at Point of Sand (cookout)</b>	<b>R&amp;R</b>
27 Feb Mon	Project 1 completion	<i>SCUBA and Snorkeling</i>	Write up Project 1	<b>Lecture:</b> Marine plastics
28 Feb Tues	Project 2 begins	Write up Project 1	Visit Owen Island Project 2 Brainstorm and exploration <b>Project 1 1<sup>st</sup> draft</b>	<b>Critique:</b> Fish Behavior (Whitney Thomas) <b>Lecture:</b> Underwater Sound (Mia Phillips)
1 Mar Wed	Project 2	<i>SCUBA and Snorkeling</i>	Finalize project 2 idea, design, and group members <b>Project 2 proposal DUE</b> Project 2 data collection	<b>Critique:</b> Damselfish and Lionfish (Haley Warzecha) <b>Critique:</b> Coral structure and fish (Jake Zikan)
2 Mar Thur	Project 2	<b>**Project 1 final draft Due**</b> Project 2 – data collection	Project 2–data collection	<b>Student Talk at Southern Cross (6pm)</b>
3 Mar Fri	Project 2	Project 2 – data collection	<b>Lecture:</b> Visit Iguanas with Tanja/ Project 2 – data collection	<i>Night SCUBA and Snorkeling</i>
4 Mar Sat	Project 2	<i>SCUBA and Snorkeling?</i>	Project 2 – data collection Project 2 –data analysis	<b>Lecture:</b> Mangroves (Amelia Fitch) <b>Critique:</b> Reef Conservation (Jack Roney)
5 Mar Sun	Finish Project 2	<b>**Project 2 PRESENTATION**</b>	Project 2 - writing Visit exhibits at Trust 4pm-5:30	<b>Critique:</b> Mangroves (Kiera Jackson) <b>Critique:</b> Seagrass Meadow (Wyatt Cummings) <i>R&amp;R: Karaoke 8pm</i>
6 Mar Mon	Finish Queen Conch write-up	<i>SCUBA and Snorkeling?</i>	<b>**Project 2 1<sup>st</sup> draft DUE**</b> Project 2 refine drafts	<b>Film:</b> Maug’s Caldera <b>Discussion:</b> Graduate School/Career
7 Mar Tue	Finish all project editing	<b>**Project 2 final draft DUE**</b> Self Evaluations	Revisions and copy editing of all LC projects Self Evaluations and Individual Meetings	Revisions & copy editing of all LC projects Individual meetings

8 Mar Wed	Clean up and pack	Clean up science equipment/field sites Individual meetings	Clean up & pack Individual meetings Faculty/TA evaluations/FSP survey	Dinner at Beach Resort
9 Mar Thur	Depart LC 7:50 and 10:20 am			

**Dartmouth Studies in Tropical Ecology**  
*Curso de Biología Tropical, Universidad de Dartmouth*

## **Palo Verde**

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- To Flee Or Not To Flee: Predator Avoidance Decisions In Two Costa Rica Tree Frogs (*Dendropsophus Microcephalus* And *Scinax Staufferi*)** Wyatt J. Cummings, David D.L. Goodman, Kate I. Singer, Citlalli Vergara, Haley R. Warzecha 9
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