

Faculty: Colin Orians, Professor, School of Arts & Sciences

Project Locations: Medford, MA and Santa Maria de Dota, Costa Rica

Dates: mid-May – early August, 2019

Project Title: Managing for Coffee Farm Resilience: A Socio-ecological Approach

Project Details: Drastic fluctuations in the quantity and quality of perennial crop yields, also known as alternate-bearing, are an important socio-ecological problem. Such oscillations are common among fruit and nut crops, including apple, pistachio and citrus, but the mechanisms differ across species and remain poorly understood in a globally important commodity crop: coffee. Coffee (*Coffea arabica*) is predominantly cultivated on small-scale family farms in rural regions of developing countries with limited adaptive capacity (Barrucand et al., 2017; Quiroga et al., 2015). In pilot interviews conducted with 33 coffee farmers, all participants confirmed alternate-bearing as an obstacle to livelihood stability but reports varied regarding its underlying causes and the potential for effective management (Garcia et al., in press). The overarching aim of this project is to fill a critical knowledge gap by revealing the mechanisms of coffee's alternate-bearing and their relation to the broader context of farm management decision-making and farm landscape. In doing so, we hope to identify the social and natural factors that promote yield stability- a critical component of the system's socio-ecological resilience. Objective 1: Identify the mechanism underlying fluctuations in fruit quantity and quality and isolate the effects of two key management practices (fertilizer and shade trees) on resource allocation tradeoffs. To address this aim, we have established a three-year manipulative experiment grounded in an ecological theory of resource allocation tradeoffs. The theoretical model offers a mechanistic understanding of the phenomenon and our study will provide a detailed understanding of how fertilization and shading affect long-term fluctuations. Objective 2: Determine the effects of landscape, management, and their interaction on growth-reproduction tradeoffs and alternate-bearing. Develop a conceptual model of the relationships and feedbacks between the social and environmental factors affecting stability. For our second objective, we expand our scope to understand how alternate-bearing relates to a broader suite of farm management practices on farms distributed along a 500m altitudinal gradient. We pair farmer surveys, interviews, and ecological farm assessments to characterize the role of farmer perception, knowledge, and priorities in farm management, and ultimately, alternate-bearing. This coffee project, started in March of 2017, is forming the basis for the PhD thesis of Orians' graduate student Gabriela Garcia. Through hands-on participation in all research activities described above, the global research assistant will gain unique exposure to environmental field work methods from both natural and social sciences. Upon return to Tufts, the student will perform a supervised analysis of the plant tissue samples they collect in Costa Rica. In addition to the satisfaction of seeing their results, the student will gain valuable skills in laboratory techniques, statistical analysis, and data visualization. We believe this experience in international environmental research will provide the global research assistant with important lessons that will continue to serve them throughout their academic journey.

Tasks and Responsibilities of Research Assistant: This summer's research will build upon the three-year experiments established in the summer of 2018 by biology PhD candidate Gabriela Garcia and last year's Global Research Assistant. The specific tasks involved in each research objective are described below. Objective 1: The student will assist in detailed data collection to characterize coffee plant reproductive tradeoffs and maintain the experimental manipulations of shade cover and fertilization on the three study farms. The student will also help collect and process plant tissue samples from the experimental farms which s/he will then analyze for resource concentration in the Orians laboratory upon return. Objective2: On a wider set of farms that scale a 500m altitudinal gradient, the student will learn a wide set of ecological field methods to collect data on a suite

of farm characteristics (including shade canopy cover, ground cover, planting density, and measures of plant health) and their relation to growth-reproduction tradeoffs in coffee plants. The student will also assist in administering quantitative surveys with the farmer participants to capture data on management practices that cannot be readily observed (such as fertilization and pest management regimes). Finally, the student will help conduct qualitative, semi-structured interviews with farmer participants to capture how farmer perception, knowledge, and priorities might affect their management choice and ultimately the degree of plant tradeoffs observed on their farm. Upon return to Tufts, the student will analyze the tissue samples collected in Costa Rica under the guidance of Gabriela. The student will gain hands-on experience with laboratory techniques, statistical analysis, and data visualization. Upon returning to Tufts in the fall, there would be the possibility of continued research as a Bio93 project in the Orians lab.

Qualifications:

All interested students are encouraged to apply. Students with a background in biology, an interest in agriculture and knowledge of Spanish would be preferred. Preference will be given to students with prior research experience, and evidence of independence and comfort working in the field.

Description of Field Site:

The field site is in a small, rural town nestled in the coffee-covered mountains of Costa Rica. The farms are at a high elevation (1500-2000 masl) very close to a tropical cloud forest. WiFi access will likely be limited to the local cafes and restaurants, though cell service is good if students choose to purchase an international plan or a local SIM-card (requires an unblocked phone).

Housing in Costa Rica:

We will stay in a hotel in San Jose before departing to Santa Maria, where we will rent a house. Students should feel comfortable preparing most of their own meals at the field house.