

Student research collaboration as conservation education: A case study from the primate field school at Maderas Rainforest Conservancy

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Abstract

Maderas Rainforest Conservancy (MRC) is a conservation-focused non-profit organization that is devoted to protecting the tropical forests they manage in Costa Rica and Nicaragua and to providing conservation education for international university students through biological field schools. The MRC Primate Behavior and Ecology course is their most frequent course offering and is aimed at developing students to be independent field researchers. This course involves classroom lectures, training in primate identification and field methods, and the execution of independent research projects that students design, collect data for, and write up as scientific papers. Student development as conservationists is facilitated through the research experience provided by this field course as well as through co- and extracurricular research opportunities available to students at the sites that MRC manages: La Suerte Biological Research Station in Costa Rica, and Ometepe Biological Research Station in Nicaragua. In tandem with their participation in the MRC primate field course, we (Laura M. Bolt and Amy L. Schreier) consistently offer students research opportunities in our ongoing project examining the impact of forest fragmentation on primate behavioral ecology. MRC student course evaluations indicate that this co- and extracurricular research participation substantially contributes to student academic development and conservation awareness. Student research collaboration, therefore, greatly benefits students as well as furthers MRC's conservation goals as a non-profit organization. In future MRC primate field school sessions, we will continue to offer research collaboration opportunities to students and will also endeavor to improve conservation education at MRC by involving more local community members in MRC's academic programs.

KEYWORDS

biological field school, conservation education, Costa Rica, Nicaragua, research collaboration

1 | INTRODUCTION

More than half of living primate species are currently at risk of extinction due to human-caused habitat alteration (Estrada et al., 2017). Given this catastrophic threat, much research in primatology focuses on conservation, with the goal of better understanding how and why various primate populations are declining and how they can best be protected (Bezanson & McNamara, 2019). In partnership with ongoing research, it is equally important to educate the next generation of primate scientists to internalize values promoting conservation, and to encourage them to undertake research that contributes to ongoing conservation initiatives. Primate field schools, where students study wild primates in natural habitats, are, therefore, excellent training grounds for raising student awareness of primate conservation needs and for implementing conservation-focused research programs. Research has shown that undergraduate students who complete a biological field course earn higher grades afterward compared to students who do not participate in the field study (Easton & Gilburn, 2012), attesting to the high learning potential of such experiences. Many field schools are run in human-altered landscapes, including fragmented forests (Garber et al., 2010; MacKinnon, 2011), and this allows students to see firsthand how habitat degradation affects primates while simultaneously allowing for conservation-focused research opportunities.

The conservation-focused activities and research training that primatological field schools offer include a variety of components. Most primate field courses are 2–4 weeks long and involve initial field training followed by the completion of an independent research project in the latter part of the course (<http://danta.info/index.php>; <https://www.wildsunrescue.org/primatology-field-course>; <https://www.sadabe.org>). Students who complete more substantial projects during 4-week field courses are generally encouraged to present their research at conferences and have the opportunity to collaborate in scientific publications (<http://danta.info/index.php>; <https://www.wildsunrescue.org/primatology-field-course>; <https://www.sadabe.org>). For example, in Madagascar, the non-profit organization Sadabe offers a 4-week primate field course that focuses on student completion of independent projects, and some former students have presented their work at academic conferences and become co-authors on journal articles (<https://www.sadabe.org>). Similarly, the non-profit organization Field Projects International offers international short-term field courses as well as 5-week long primatological research assistant internships in Peru, with the opportunity for highly motivated students to collaborate on published research (<https://fieldprojects.org/>).

Primate field schools complement this study training with conservation education components. In Costa Rica, the non-profit organization DANTA runs a 21-day-long primate field course, during which students participate in a 4-day applied conservation project as an integral course component (<http://danta.info/index.php>). Similarly, the Costa Rican non-profit Wild Sun Rescue runs a month-long primate field course that incorporates numerous visits

to nearby conservation organizations and research stations to learn from experts about the complexity of conservation in Costa Rica (<https://www.wildsunrescue.org/primatology-field-course>). In this commentary, we present a case study examining how student research opportunities work in concert with conservation education in the primate field courses operated by Maderas Rainforest Conservancy (MRC).

MRC is a conservation non-profit organization that operates biological field stations in fragmented forests in Costa Rica (La Suerte Biological Research Station, LSBRS) and Nicaragua (Ometepe Biological Research Station, OBRS) (Molina, 2015). LSBRS is a tropical lowland rainforest site situated in a fragmented forest with roads and cattle pastures bordering the forest, while OBRS consists of a mosaic of tropical dry forest fragments bordered by agricultural fields on a volcanic island in Lake Nicaragua (Bezanson et al., 2008, 2013; Brandt & Singleton, 2018; Huettman, 2015; Molina, 2015). Three primate species inhabit LSBRS: mantled howler (*Alouatta palliata*), white-faced capuchin (*Cebus imitator*), and Central American spider monkeys (*Ateles geoffroyi*); mantled howler and white-faced capuchin monkeys also populate the area surrounding OBRS (Garber et al., 2010). MRC can serve as an example of how the teaching objectives of a primate field school can simultaneously further the goals of both a non-profit organization dedicated to protecting tropical forests and a faculty-led, conservation-focused research program. Through both hands-on instruction and co- and extra-curricular research participation opportunities, MRC promotes conservation education in undergraduate and graduate students.

2 | BACKGROUND ON MRC

The Nicaraguan Molina family purchased land and founded LSBRS in northeastern Costa Rica and OBRS on Ometepe Island, Nicaragua, in 1987 and 1996, respectively (Molina, 2015). Each site was originally a cattle ranch and operated as a farm by the family, with biological field courses first offered in 1994 at LSBRS and 1999 at OBRS (Garber et al., 2010; MacKinnon, 2011). The family patriarch, Rene Molina (1933–2013), his wife Lillian Molina, and his son Alvaro Molina partnered with primatologist Dr. Paul Garber to offer the first primate field course at LSBRS in 1994 (Molina, 2015). Although many different types of field courses have been offered through the years, the primate field course was the first and has been the most consistently offered (Bolt, Brandt, et al., 2021; Garber et al., 2010). Courses are aimed at English-speaking international university students, and while students from around the world do attend field courses at LSBRS and OBRS, the majority of students are American (Bolt, Brandt, et al., 2021; Garber et al., 2010). In 2008, LSBRS and OBRS were incorporated into MRC, a non-profit organization registered in Costa Rica, Nicaragua, and the USA, and led by Rene and Lillian's daughter Renee Molina. Both the LSBRS and OBRS sites are still privately owned by the Molina family, and Renee manages LSBRS and OBRS and serves as MRC director to the present day.

MRC is committed to 1) protecting the forests they manage at LSBRS and OBRS, 2) partnering with local communities to better preserve natural ecosystems and improve the quality of life of local people, and 3) promoting conservation education by consistently offering biological field courses to undergraduate and graduate-level university students (Bolt, Brandt, et al., 2021; Halloran, 2013). MRC, therefore, takes a One Health approach to conserve its site and maintain its academic programs (Bolt, Brandt, et al., 2021).

MRC offers its own biological field courses at both LSBRS and OBRS sites and additionally hosts field courses that are run through individual high schools and universities worldwide, with more than 50 different institutions and more than 1000 associated students visiting MRC sites since 2010 (Molina (personal communication, 2021); Huetteman, 2015). In these instances, MRC acts as a facilitation agency for these universities and allows them to rent LSBRS and OBRS as host sites (Molina, 2015).

MRC also has a strong involvement with the surrounding communities in Costa Rica and Nicaragua, as exemplified by their One Health and outreach programs (Bolt, Brandt, et al., 2021; Garber et al., 2010; Molina, 2015). To serve the surrounding communities, MRC has offered veterinary outreach programs since 2009 at OBRS and 2016 at LSBRS and began offering human medical outreach programs at OBRS in 2017 and LSBRS in 2018 (Bolt, Brandt, et al., 2021). MRC provides veterinary care for domestic animals as a way of better protecting rainforest animals and offers medical care to better serve the health needs of children living near OBRS and LSBRS (Molina (personal communication, 2021); Molina, 2015). Both veterinary and medical programs provide free care to residents of the communities surrounding LSBRS and OBRS and are overseen by local veterinarians and doctors, with 50–100 local families typically served annually (Bolt, Brandt, et al., 2021). MRC also employs local part-time instructors to offer English as a second language (ESL) teaching and environmental education to elementary school students from the communities surrounding OBRS and LSBRS and has done so since 2009 in Nicaragua and 2014 in Costa Rica (Bolt, Brandt, et al., 2021; Molina, 2015). Attesting to the effectiveness of these programs, the number of students completing elementary school and entering high school in the area near OBRS has increased dramatically since MRC began offering ESL and environmental education to students, jumping from 20% to 80% between 2009 and 2017 (Bolt, Brandt, et al., 2021). MRC also bolsters the local economies by providing full-time employment to 3 year-round and four seasonal staff members at LSBRS, and to 1 year-round and six seasonal staff members at OBRS (Bolt, Brandt, et al., 2021). Finally, MRC funds Proyecto Jade, a women's empowerment initiative that provides craft training and supplies, then purchases finished jewelry made by women living in the local community surrounding OBRS (Molina, 2015). The jewelry is then sold internationally by MRC, with profits directed back to further support the Proyecto Jade initiative (Molina, 2015). Through this project, the women involved have paid for school supplies for their children and generally improved the financial health of their families (Bolt, Brandt, et al., 2021). All of MRC's community projects work together to promote the well-being

of local people, wild and domestic animals, and of the forests at LSBRS and OBRS.

In Costa Rica, approximately 2.2 km² of the LSBRS forest (which totals 3.3 km²) has been formally protected by the Costa Rican government since 2004, through a contract with Ministerio de Ambiente y Energía (MINAE/ASIRAE) and Fondo Nacional de Financiamiento Forestal (FONAFIFO). This contract protects all forest components within the protected area from human interference (e.g., fallen branches cannot be cut or moved) while providing MRC with carbon tax credits and a stipend for maintaining the forest (Bolt, Brandt, et al., 2021; Molina, 2015). The rest of the LSBRS forest (1.1 km²) lacks formal governmental protection, allowing MRC to maintain forest trails and clear areas for student classrooms and housing (Bolt, Brandt, et al., 2021; Molina, 2015). In 600 m² of this unprotected area, MRC planted teak (*Tectona grandis*) and gmelina (*Gmelina arborea*) trees for sustainable harvest from 2015 to 2017, and these were logged in 2018 and 2021 to sustain MRC's ongoing operations (Bolt, Brandt, et al., 2021; Molina, 2015). In Nicaragua, the forests in OBRS lack formal legal protection because comparable governmental incentive programs for forest owners do not currently exist (Molina, 2015). MRC protects the forests at OBRS by employing a full-time forest ranger to oversee their properties and to prevent any logging or poaching from occurring within (Molina, 2015).

While MRC generates some income through sustainable wood harvesting at LSBRS and through government partnerships with MINAE/ASIRAE and FONAFIFO in Costa Rica, these comprise a small proportion of MRC's overall operating budget (<15% of MRC's operating budget; Molina (personal communication, 2021)). Instead, MRC depends primarily on student tuition, researcher fees, and donations for financial support (>85% of MRC's operating budget; Molina (personal communication, 2021); Bolt, Brandt, et al., 2021; Molina, 2015). The ongoing biological field courses at LSBRS and OBRS are, therefore, of paramount financial importance to MRC's ongoing operations as a multifaceted non-profit organization (Bolt, Brandt, et al., 2021).

3 | MRC PRIMATE BEHAVIOR AND ECOLOGY FIELD COURSE

The first primate field course at LSBRS was offered in 1994, with Paul Garber designing and teaching a 3.5-week-long biological field course for university students, aimed at training aspiring primatologists to undertake field research. The original Primate Behavior and Ecology course were offered through DuMond Conservancy (now Monkey Jungle) in Miami, with undergraduate and graduate students from across the USA and Canada mailing in their applications to be considered for admission (P. Garber (personal communication, 2020)). The primate field course was extremely effective in training students; it maintained a 5:1 student-to-faculty ratio and provided an intensive learning opportunity for students to study the behavior of wild primates (Garber et al., 2010). Classes were taught 7 days per week, with students participating in daily lectures and field exercises to

view and study primates, taking exams to assess their learning, and conducting high-quality independent projects to gain field research experience (Garber et al., 2010).

MRC biological field courses are typically taught in English by foreign instructors who are native English speakers, which impacts student enrollment and means that native English-speaking students are more likely to enroll and participate. For example, the Primate Behavior and Ecology course has consisted primarily of students from the USA and Canada (85.5% and 5.9% of students) since 2010, with <3% of students being Costa Rican or Nicaraguan nationals (Bolt, Brandt, et al., 2021). Although MRC typically waives fees or finds other sources of support to allow habitat country primatologists to enroll in the field course (Garber et al., 2010), there has been lower participation by nationals in MRC programs since 2010, as a greater number of Spanish-language primate field schools became available through universities in Costa Rica and Nicaragua (Molina (personal communication, 2019)).

The Primate Behavior and Ecology course have been consistently taught several times annually since 1994 (e.g., it was taught 3–4 times per year from 2014 to 2020) and continues to be the most frequent course offering at MRC today (Bolt, Brandt, et al., 2021), with the 3.5-week course offered in 2–3 different sessions annually between May and August and a shorter 2-week version offered in late December–January (<https://maderasrfc.org>). While the field course developed by Paul Garber is still the general course model used by primatology instructors at MRC in the present day (MacKinnon, 2011), individual instructors use their own lectures and data collection exercises and have altered some course components over the years.

The first half of the Primate Behavior and Ecology course focuses on providing students with sufficient background on primate behavioral ecology to undertake primate field research and involves daily lectures and supervised field exercises. Lectures take place every afternoon for the first half of the course and provide students with the theoretical training to undertake field exercises and design research projects. During morning field exercises each day, students typically spend 2–4 h in the forest learning field techniques, including how to: 1) find and census monkeys, 2) identify monkey species, sex/age class, and individual characteristics when possible, 3) identify other common plant and animal species and general tropical forest habitat characteristics at the site, 4) perform a vegetation survey and measure tree circumference, 5) construct an ethogram, and 6) collect data on the behavioral ecology of wild nonhuman primates using standardized behavioral sampling methods (e.g., continuous focal animal sampling, instantaneous scan sampling, all-occurrences sampling, one-zero sampling, estimating the distance to the nearest neighbor, identifying food items consumed, and identifying species-specific vocalizations and social behaviors) (Figure 1; Altmann, 1974; MacKinnon, 2011; <https://maderasrfc.org>).

During the second half of the Primate Behavior and Ecology course, each student designs and develops their own independent research project on some aspect of primate behavioral ecology with



FIGURE 1 Maderas Rainforest Conservancy instructor Dr. Laura Bolt (far right) and Primate Behavior and Ecology students observe mantled howler monkeys (*Alouatta palliata*) at La Suerte Biological Research Station in January 2022.

support from the course instructor, with students learning about the scientific method in the process (Garber et al., 2010). Students form a hypothesis and prediction(s), choose appropriate data collection methods, collect behavioral data on primates, compile results, and write project results in the form of a scientific journal article (Garber et al., 2010; MacKinnon, 2011). While individual instructors may vary the amount of data required for independent projects, most require between 20 and 40 h of primate behavioral data (<https://maderasrfc.org>). Except in circumstances of prolonged extreme weather, students have more than enough time to collect sufficient data. After completing their research projects, students also gain experience in communicating the results of their findings to their peers and other students and researchers at the field site, by giving a conference-style oral presentation on the last day of the course, called the “MRC Primate Behavior & Ecology Symposium” (Garber et al., 2010). This MRC Symposium allows students to practice their scientific presentation skills and gain experience in answering questions about their work.

MRC additionally offers an Advanced Primate Behavior and Ecology course for students who have already completed the first MRC primate field course and wish to undertake a more involved research project with hands-on instructor guidance (<https://maderasrfc.org>). Students who complete the advanced course are typically advanced undergraduate students with well-developed research ideas or graduate students undertaking thesis data collection.

Students who complete the MRC Primate field course self-report as becoming more focused on their coursework and taking more initiative in achieving their future learning goals (Bolt, Brandt, et al., 2021). After completing an MRC field course, close to half of MRC students since 2010 have gone on to complete a master's or doctoral degree in a related subject (19.9% and 14.8% of former students), or to complete medical or veterinary school (9.6% of

former students, Bolt, Brandt, et al., 2021). These findings are consistent with the gains in academic attainment typical of students who complete biological field schools (Easton & Gilburn, 2012), and attest to the educational effectiveness of MRC's programs.

4 | RESEARCH AS PART OF THE MRC PRIMATE BEHAVIOR AND ECOLOGY FIELD COURSE

One of the main objectives of the MRC Primate Behavior and Ecology course is to train students as independent researchers and to prepare them for potential graduate work in anthropology, biology, or a related discipline (Garber et al., 2010; MacKinnon, 2011). Students gain experience as researchers both through field course components and co- and extracurricular research opportunities. Students often submit their final MRC papers to their home institutions for course credit as an honors thesis or capstone project, with some of the strongest papers later published in regional or student institutional journals (e.g. Cancelliere, 2012; Russak, 2005). Students applying to graduate school also typically use their final MRC papers as part of their application packages since this substantial piece of work showcases their writing and research abilities. Additionally, students are encouraged to present the findings from their MRC research projects as first or sole authors on a poster or oral presentation at an institutional, regional, national, or international conference (Table 1).

5 | STUDENT INVOLVEMENT IN LONG-TERM RESEARCH PROJECTS AT LSBRS

In addition to sites for biological field courses, LSBRS and OBRS are also established research sites that have hosted a number of long-term projects, including graduate theses (e.g., Álvarez, 2019; Mallott, 2016; Raguet-Shofield, 2010; Russell, 2018b; Sheehan, 2018). One of the key objectives of MRC's mission as a non-profit organization is to facilitate academic research, with the goal of contributing to biological conservation efforts (Halloran, 2013). With pure research needed to inform conservation initiatives (McIntosh et al., 2018), long-term research projects at LSBRS and OBRS are key to MRC's mission. Research done at MRC sites is regularly cited in the Spanish-language scientific literature and has been incorporated in Costa Rican governmental reports related to species and landscape conservation (e.g., Castro-Avendano et al., 2021; Román et al., 2021), demonstrating the research impact of MRC's work. Several MRC Primate Behavior and Ecology course instructors have conducted research projects at LSBRS and OBRS and have included student contributions in published research (e.g., Bezanson et al., 2013; Occhibove et al., 2015; Pruetz & Leason, 2002); however, this article will primarily focus on the authors' research collaborations with MRC students. Amy L. Schreier began teaching MRC courses in 2009, while Laura M. Bolt began in 2014. With both of us teaching MRC courses at least once annually at LSBRS, leading to consistent, long-term access to this site, we started

TABLE 1 Examples of the first or sole-authored poster and oral conference presentations, master's theses, and co-authored journal articles by students based on their MRC Primate Behavior and Ecology and Advanced Primate Behavior and Ecology course projects

Citation	Type of presentation
Bolt et al. (2019)	Journal article
Bolt, Russell et al. (2020)	Journal article
Bolt et al. (2021a)	Journal article
Carter (2020)	National conference
Cash (2020)	National conference
Doelling and Bolt (2019a)	International conference
Doelling and Bolt (2019b)	Regional conference
Doelling and Bolt (2019c)	National conference
Hicks (2019)	National conference
Jacobson (2016)	Regional conference
Jacobson et al. (2019)	National conference
Lam et al. (2020)	National conference
MacAusland (2018)	National conference
Mencia (2020)	National conference
Merrigan-Johnson (2018)	National conference
Owens (2018)	Regional conference
Prasher (2016)	National conference
Pryor and Schreier (2015)	National conference
Reints and Schreier (2015)	National conference
Rosso et al. (2019)	National conference
Russell (2017)	National conference
Russell (2018a)	National conference
Russell (2018b)	Master's thesis
Schlaht and Schreier (2017)	National conference
Schreier et al. (2021)	Journal article
Sheehan (2018)	Master's thesis
Simmons and Bolt (2021)	National conference
Steinhardt (2017)	National conference
Thurau and Bolt (2016)	Regional conference
Thurau and Bolt (2017)	Regional conference
Wilkins (2015)	National conference
Zhu (2018)	National conference

Abbreviation: MRC, Maderas Rainforest Conservancy.

an ongoing conservation-focused research project in 2015 that investigates the impact of forest fragmentation and edge effects on the behavioral ecology of the three monkey species at La Suerte. Due to the nature of LSBRS as a disturbed forest surrounded by human-



FIGURE 2 Environmental Science MSc student Dorian Russell (front) and Maderas Rainforest Conservancy instructor Dr. Laura Bolt (third from left) led Primate Behavior and Ecology students in completing a vegetation survey at La Suerte Biological Research Station in the summer of 2017. Vegetation survey results were later published in Russell's (2018b) thesis and in a refereed journal article (Bolt, Russell, et al., 2020), with the students who assisted in the vegetation survey thanked in the paper's acknowledgments.

altered habitat, it is an ideal site at which to undertake a project centered on how primates and their rainforest habitats are affected by anthropogenic deforestation. Ongoing primate and landscape-focused research are also generally needed to inform conservation action plans (McIntosh et al., 2018) and to increase awareness of the devastation caused by human habitat alteration in tropical regions, like the areas surrounding LSBRS and OBRs.

From the beginning, MRC students have been key partners in our research program, participating in all aspects of data collection including establishing forest transects, assisting with vegetation surveys, completing primate behavioral data collection, and recording tree measurements (Figure 2). When no longer physically present at LSBRS, students have assisted with GIS and statistical analysis, literature reviews, and generating site maps and figures. Field course students who complete independent projects that have comparable objectives and data collection methods to our ongoing project at LSBRS may complete interobserver reliability training (Schreier et al., 2021) and have their course project data incorporated into our long-term research; many of these students earn coauthorship on conference presentations and refereed journal articles through their contributions (Table 2). These research partnerships benefit students and also help MRC to achieve its goals as a conservation-focused non-profit organization.

6 | STUDENT ASSESSMENTS OF MRC CONSERVATION EDUCATION

MRC Primate Behavior and Ecology students rate their training in both conservation and research highly. Course evaluations from 2009 to 2020 ($n = 138$ students) show that students believed attending the

TABLE 2 Refereed publications and conference presentations that include data contributed by MRC Primate Behavior and Ecology students

Citation	Type of presentation
Azzara et al. (2018)	National conference
Bolt, Schreier, Voss, and Barrickman (2018)	National conference
Bolt, Schreier, Voss, Sheehan et al. (2018)	Journal article
Bolt et al. (2019)	Journal article
Bolt, Cavanaugh et al. (2020)	National conference
Bolt, Russell et al. (2020)	Journal article
Bolt, Schreier et al. (2020)	Journal article
Bolt, Brandt et al. (2021)	Journal article
Bolt, Cavanaugh et al. (2021)	Journal article
Bolt et al. (2021a)	Journal article
Bolt et al. (2021b)	National conference
Bolt et al. (2022)	Journal article
Britton et al. (2022)	International conference
Coggeshall et al. (2019a)	National conference
Coggeshall et al. (2019b)	Regional conference
Jacobson et al. (2019)	National conference
Owens et al. (2020)	National conference
Rosso et al. (2019)	National conference
Schreier et al. (2014)	National conference
Schreier, Barrickman et al. (2016)	International conference
Schreier, Franco et al. (2016)	National conference
Schreier et al. (2018)	International conference
Schreier and Bolt (2020)	National conference
Schreier et al. (2021)	Journal article
Schreier and Bolt (2022)	International conference
Schreier et al. (2022)	Journal article
Sheehan, Schreier et al. (2018)	National conference

Note: Students are thanked in the acknowledgments or are credited as co-authors.

Abbreviation: MRC, Maderas Rainforest Conservancy.

field course greatly enhanced their interest in conservation as well as their overall academic development (Figure 3). Quantitative metrics indicate that student awareness of conservation issues and student interest in biological research increased through both field courses and research participation (Figure 3). Qualitative course evaluations also include many comments about conservation awareness, indicating that living in the rainforest had a huge impact. One student remarked that "it was not until I lived in the rain forest for 3.5 weeks at La Suerte that I truly appreciated its beauty and realized the importance of conserving its rich biodiversity." The Primate Behavior

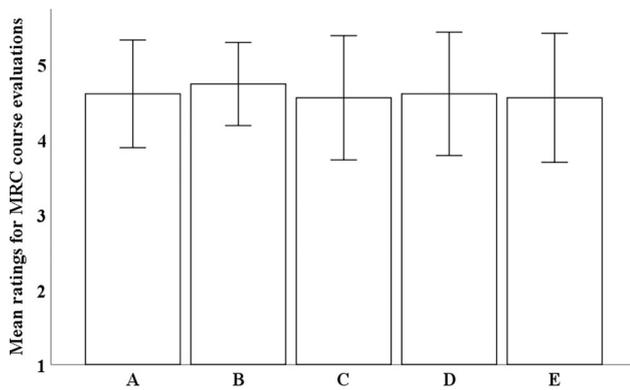


FIGURE 3 Mean ratings for Maderas Rainforest Conservancy (MRC) Primate Behavior and Ecology course evaluations in response to statements A–E. Students ranked statements about the course on a scale from 1 to 5, with 1 being strongly disagreed and 5 strongly agreed. Bars indicate mean values and whiskers show one SD ($n = 138$ students). Columns show responses to the statements: A) My understanding of conservation issues increased as a result of completing this field course, B) my academic and professional goals were advanced as a result of completing this field course, C) my interest in biological research was advanced as a result of completing this field course, D) my involvement in the field school at La Suerte/Ometepe motivated me to do further fieldwork and research, and E) my involvement in research at La Suerte/Ometepe motivated me to do further fieldwork and research.

and Ecology course itself also increased conservation consciousness. One student felt that “this program completely influenced my understanding of conservation. It gave me a first-hand experience of the issues facing tropical environments, nonhuman primates, and the world as a whole. It opened my eyes to how decisions we make halfway across the world can impact this area most people wouldn’t even think about in their daily life. It gave me a life-long love and passion for animals and conservation and finding ways to have a positive impact on our world and all the species that call it home.” Another student felt that their conservation values had been fundamentally altered by participating in the primate field course, remarking that, “the primate field school/research provided me with all of my initial understanding about the need for conservation and the effects on nonhuman primates and on tropical environments. It really was an incredibly valuable course that has left lasting impacts on me and on my core values.”

Students felt that the setting of the Primate Behavior and Ecology course in fragmented tropical forest sites at LSBRS and OBRS was especially helpful for gaining an experiential understanding of conservation issues. One student said that “seeing these [conservation] issues with your own eyes, instead of on a slide in a PowerPoint is critical to bring awareness to these issues. Once you see the on the ground situation, you can see how dire and critical the conservation of these places and species are.” Another remarked, “it was a formative experience to see primates in the wild, but also to see how fragmented their habitat was. Without having been to Costa Rica, it’s difficult to understand

what deforestation really means and what it looks like. I have a distinct memory of coming to the edge of the La Suerte forest fragment and suddenly seeing a field with cows in it. The contrast was so stark!” Similarly, other students commented, “while standing in parts of the forest at La Suerte, you could hear music and helicopters and people talking. It put into perspective how little rainforest is left in the world, and how small fragmented areas are,” and that before visiting LSBRS, “[they] did not quite understand the breadth of impact commercial farming of bananas and pineapples had on the environment in Costa Rica. It was honestly devastating to see.” At Ometepe, students found MRC’s forest protection and regeneration efforts encouraging. One student commented, “the joy of seeing primates at Ometepe was inspiring. Furthermore, the fact that the Ometepe forest was a regenerating forest on a former coffee plantation [with] howlers, capuchins, other animals, and plants was the first time I got to see a successful conservation project like that.”

Our ongoing conservation-focused research initiatives at MRC also positively impacted student understandings of conservation. One student wrote, “the La Suerte field course [and ongoing research at the site] helped me to understand the impacts and urgency of research in fragmented-edge habitats, as well as the importance of [scientific] collaboration to meet conservation aims.” Another student wrote that, “participating [in research] at La Suerte gave me a direct physical experience of conservation issues affecting tropical environments, and made me both more aware of the issues, and animated to take action in regard to promoting conservation efforts.” Overall, the student evaluations demonstrate that the ongoing conservation-focused research at LSBRS helps to achieve two of MRC’s key goals as a non-profit organization: protecting the forest and promoting conservation education (Bolt, Brandt, et al., 2021; Halloran, 2013).

7 | MRC CONSERVATION EDUCATION: WAYS TO IMPROVE

While MRC is devoted to student conservation education as one of its prime directives (Bolt, Brandt, et al., 2021; Halloran, 2013), student evaluations suggest that there is room for improvement. Some students suggested that more direct teaching about conservation would be helpful, with a greater number of classroom lectures devoted to primate conservation. Students requested, “more general conservation material in the lectures,” and “more time dedicated to conservation issues during the lecture portion of the field course.” Other students suggested that having more context for understanding primate conservation would be helpful, requesting, “a bit more discussion on the larger ecosystem (i.e., organisms besides primates)” and, “a little bit more information about anthropogenic factors such as the illegal wildlife trade to help show how widespread conservation could be.” In response to these comments, we now more directly teach about primate conservation during classroom lectures. Students also suggested field trips, with one student remarking that “additional conservation-focused excursions or pit



FIGURE 4 Watching monkeys: Maderas Rainforest Conservancy (MRC) director Renee Molina (far right), local elementary school students, and MRC Primate Behavior and Ecology students engaged in conservation education outreach at La Suerte Biological Research Station in summer 2018.

stops between La Suerte and San Jose would be a value add [to the course].” While the course usually includes an overnight visit to Tortuguero National Park which includes exposure to sea turtles and the conservation efforts on their behalf (<https://maderasrfc.org>), further field trips will be incorporated when possible.

Students also indicated an interest in participating in more of MRC’s other conservation projects as means of enhancing their own conservation efforts. MRC regularly hosts conservation education field trips for local elementary school students near LSBRS and OBRS as part of their environmental education program (Bolt, Brandt, et al., 2021), and some Primate Behavior and Ecology students wanted to be more involved in this initiative, with one saying, “I would have loved to be able to observe the school trips that were hosted at La Suerte to teach local kids about the rainforest.” While MRC students are encouraged to participate in an elementary school trip that happens when they are present, this does not work out with the timing of every primate field school (Bolt, Brandt, et al., 2021; Molina, 2015; Figure 4). Finally, students were fascinated by MRC’s future participation in the biological corridor which will link Tortuguero National Park with Braulio Carillo National Park in Costa Rica, and the future incorporation of LSBRS into this larger protected region (Bolt, Brandt, et al., 2021; Programa Nacional de Corredores

Biológicos de Costa Rica, 2019). Students wanted the MRC Primate Behavior and Ecology course to include activities that allow students to “take a more active role in the initiative,” allowing them to “learn more about the green corridor being implemented.” As more information becomes available to MRC about the creation of the Corredor Biológico Suerte-Tortuguero, further student involvement will be possible (Programa Nacional de Corredores Biológicos de Costa Rica, 2019).

The most frequent conservation education suggestion from students requested greater incorporation of local community members in the MRC Primate Behavior and Ecology curriculum. This type of community involvement has educational benefits for students and has been successfully incorporated into other conservation education programs (Kling & Hopkins, 2015; Razanatsoa et al., 2021). MRC students overwhelmingly felt that their understanding of conservation issues would have been enhanced by “meeting with locals from the community,” having “a few community days woven into the program,” and being allowed to “[interact] with local landowners [to learn] about conservation issues in the region,” seeing “much benefit in including them in our conservation efforts and conversations.” Students wanted to learn “from locals about how the environment has changed around them” and to “have the opportunity to explore and talk to members of the community [in order to] work to develop community conservation plans [and] to think more holistically about human-wildlife conflicts.” Students also wanted to “[engage] more with local conservation agencies and also the mono-culture businesses [such as pineapple and banana farms] so that [they] could get a [more holistic] understanding of all the complexities of on-the-ground conservation [at LSBRS].”

We strongly agree with students that more local input is needed from community members to provide a more in-depth understanding of conservation issues and how local cultural values impact conservation practices at LSBRS and OBRS. Different perspectives from local scientists, land owners, farmers, business owners, and citizens at large should be incorporated into the MRC Primate Behavior and Ecology course to help students better understand the principles of integrating local communities into creating conservation solutions, and we are working towards incorporating these elements into future MRC courses. At MRC, local partnerships are better developed at OBRS due to the site’s prime location within the San Ramon, Ometepe community, and the hiring of locals as MRC employees (Bolt, Brandt, et al., 2021). At LSBRS, community relationships have formed much more slowly, due in part to LSBRS’ remote location and to the seasonal hiring of employees who are not permanent residents of the local community (Bolt, Brandt, et al., 2021). However, a local site administrator was hired in 2018 at LSBRS, greatly facilitating relationship building with the surrounding community (Bolt, Brandt, et al., 2021). MRC staff, instructors, and students are now beginning to more deeply engage with local landowners, and regular class visits to neighboring farms, palm oil plantations, and swamps have taken place since 2018. These initiatives and new components of MRC field courses will grow as relationships with other community members near LSBRS continue to develop.

Overall, the MRC Primate Behavior and Ecology course would benefit from the greater incorporation of local community members in class discussions and activities related to conservation, as well as further incorporation of local social and cultural perspectives on conservation. The conservation education impact of MRC programs would also be enhanced by greater recruitment of Costa Rican and Nicaraguan students, who will ultimately be the ones responsible for the long-term conservation of natural resources in their countries. While MRC typically waives fees to enable the participation of local students (Garber et al., 2010; Molina, 2015), MRC programs would be more effective at recruiting local students if they advertised their program more widely within Costa Rica and Nicaragua. One MRC researcher started a research collaboration with the University of Costa Rica in 2018 (Bolt, Brandt, et al., 2021), and we hope to expand this university partnership in the future to include more MRC faculty members. This would allow us to offer LSBRS courses that include guest lectures from Costa Rican professors on local conservation understandings and perspectives and provide some valuable balance to the conservation education provided by foreign instructors at MRC.

8 | CONCLUSION

The MRC Primate Behavior and Ecology course have been instrumental in enhancing the conservation awareness of field course students. The course itself is robust in educating students about primate conservation (Figure 3), while the ability to design and complete an independent project within a fragmented tropical forest invaluable contributes to student understanding of primate conservation issues. The opportunity for field course students at LSBRS to assist with and collaborate in our ongoing research program is also instrumental in shaping student attitudes and experiential understandings of tropical primate conservation (Figure 3). Laura M. Bolt's and Amy L. Schreier's experience as both instructors and researchers at MRC sites suggests that student involvement in faculty-led, long-term conservation-focused research is extremely beneficial for both student academic development and improved conservation education (Figure 3, Table 2). Future MRC field course sessions will continue to involve students in ongoing research while also increasing opportunities for students to engage with local community members and habitat country scientists to further enhance their conservation education.

While our case study focused on the integration of research with conservation education in the MRC Primate Behavior and Ecology course, other primate field schools offer comparable programs that include both conservation education and research training (<http://danta.info/index.php>; <https://www.wildsunrescue.org/primatology-field-course>; <https://www.sadabe.org>). Our experiences at MRC show that integrating research and conservation effectively trains students, and we hope that our findings can provide additional support for the conservation education and research training initiatives at other primate field schools.

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CONFLICTS OF INTEREST

Laura M. Bolt and Amy L. Schreier periodically teach field courses at Maderas Rainforest Conservancy sites and are co-directors of the La Suerte Forest Fragmentation and Primate Behavioral Ecology project at La Suerte Biological Research Station.

ETHICS STATEMENT

The research was conducted with the permission of the Molina family and met the legal requirements of Costa Rica. The research adheres to the American Society of Primatologists Principles for the Ethical Treatment of Nonhuman Primates and was approved by Regis University's Institutional Animal Care Committee (IACUC permit #17-006) and the authors' home institutions.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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