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## Ecology, Policy, and Puerto Rico: El Yunque National Forest

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In April of 2017, a group of 23 exceptional young scientists came together in El Yunque National Forest, Puerto Rico, for a leadership workshop hosted by the ESA's Strategies for Ecology, Education, Diversity, and Sustainability (SEEDS) Program. SEEDS, established in 1996, offers hands-on and engaging experiences in ecology with a focus on expanding opportunities for undergraduate minorities. In a 2013 outcomes survey, current SEEDS students are a diverse group, wherein about 44% identify as Hispanic/Latino, 13% as African American, and 15% as white, 3% as Bi/Multiracial, 15% as Native American/Alaskan Native, and 3% as Native Hawaiian/Pacific Islander (Fig. 1). This trip's cohort was no exception and included students from diverse backgrounds with research interests including soil microbial communities, indigenous usage of natural resources, and environmental management, to name a few. Over the course of a few short days together, this diversity of experiences and trajectories created an atmosphere of mutual support, collaboration, and optimism that we will carry with us into our careers.

We began our trip at El Yunque, the only tropical rainforest in the U.S. National Forest System. They are currently working on a new land management plan, a process more than four years in the making. The plan, though not project-specific, embodies a comprehensive, holistic approach that incorporates ecology, the community, and economics. With their new region-specific perspective, the team is opening up new doors for collaboration. Though a small forest compared to other sites in the system, the 29,000 acres are a huge chunk of land for the small island of Puerto Rico. Eight endangered species live in the forest, and the management focus is on habitats, which include a range of forest types across the elevation gradient. These unique habitats attract 1.1 million visitors every year, posing a challenge to park managers to ensure that these guests stay on the designated trails and do not trample on the soil or create unplanned trails. Climate change and the pressure put on the soil and watersheds due to the high concentration of visitors are just a few of the planning problems that the forest faces.

In addition to these visitors, many people live in the forest and have shops on site. Most of these businesses revolve around selling goods and services to the visitors of El Yunque. The vitality of the forest is paramount to the livelihood of these small business owners, so they are a vital component of the new management plan, which features a business incubator called El Yunque Emprende. They are also establishing Community Interface Resource Management (CIRMA) to create space for citizens to share their ideas through stakeholder meetings and town hall events. The journey to create a holistic plan was not easy, but this new management plan hopes to create a symbiotic relationship between the people and

### The racial/ethnic demographics of SEEDS. Alumni and Current Students identify as:

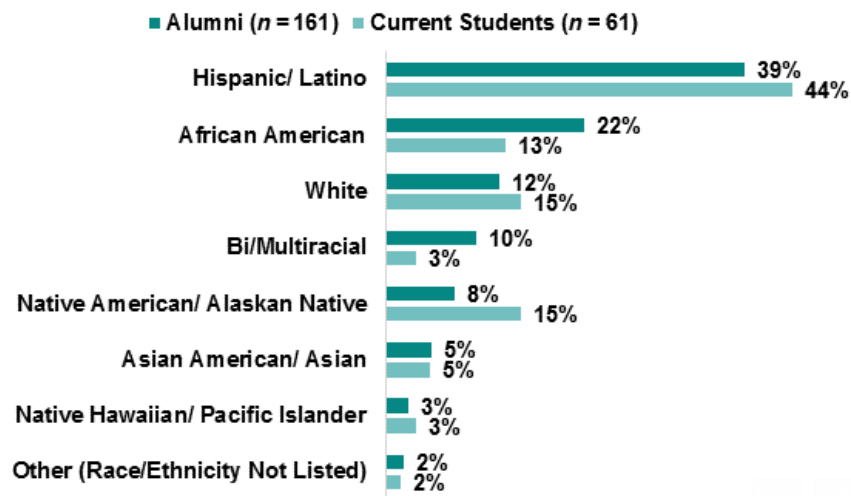


Fig. 1. The racial/ethnic demographics of SEEDS, from a 2013 SEEDS outcomes survey.

the forest. This management plan is unique due to the constant interaction with the community, adding a human element to complement the science-based management decisions. As scientists, we were all very interested to learn about these developments in how research was being applied to meet conservation goals for this unique ecosystem.

Several of the students who attended the leadership meeting also participated in the SEEDS Partnership for Undergraduate Research (SPUR) Fellowship and had interesting research of their own to present. Fellows on the trip included Kathryn Bloodworth, Chelsea Hazlett, Nikita Kowal, Michelle Poletti, Rebekah Sánchez, and Maggie Yarnold. These included projects in agroecology, invasion ecology, and even urban ecology. The SPUR Fellowship presentations exposed past, present, and future fellows to available programs. This demonstrated how the experience affects the students both as researchers and on a personal level, and the main takeaways from each project. For SPUR alumni, it offered a way to reflect on their previous research and think about what they can do in their future endeavors to expand on their newfound knowledge. For current SPUR fellows, it gave them some insight on what to expect during their research and what they may be expected to do during future leadership meetings. Future fellows were inspired to really delve into research they love and reminded them that ecology is a diverse science that can open doors to endless opportunities, some of which include cultural perspectives.

Additionally, Celina Gray, one of the students gave a presentation on cultural contexts and perspectives from her point of view as a Native American student, accompanied by a faculty member, Janene Lichtenburg, from Salish Kootenai College, her tribal college. This presentation brought the first nation story to life for us, immersing us in a new culture to learn how they are spiritually, economically, and socially connected with the environment and what this connection means to them in terms of education, outreach, and research.

We were equally excited to get to work and volunteer with a citizen science project, an excellent modern example of scientists fusing vital data collection and effective communication with the public in a learning environment. These projects give people hands-on experiences, as well as an understanding

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of why scientists do what they do. We got to learn about one of Puerto Rico's most invasive species, *Iguana iguana*. Better known as the Green Iguana, this project hosted by the conservation organization Para la Naturaleza, we learned much about the biology of the iguana while physically contributing to the efforts of decreasing its population.

Green iguanas are highly destructive in Puerto Rico, causing damage not only to agricultural lands, but also to infrastructure by digging nesting burrows that compromise building foundations. For scientists, the booming population of the iguanas is garnering attention due to the ecological problems they cause. In order to minimize the effects of the iguana on the environment, field crew members work to remove them by finding and removing eggs from nest sites. This is no easy feat, as female iguanas can dig up to a meter deep to build their nests, and digging can prove to be very intensive work under the scorching tropical sun. In spite of the back breaking work, we were excited to do our part to prevent the spread of iguanas. The scientist in each of us was also excited to help the team collect data, like soil temperature in the nest, nest depth, number of eggs, and egg dimension. The team will use and analyze these data to develop a better method of eliminating the green iguanas, and better educate the public on the rapid spread of this invasive species.

Part of the eradication efforts include no-permit-required hunting and a year-round harvesting season, ideal from an ecological point of view. However, since Para la Naturaleza is a conservation organization, our host explained, supporters are looking at the issue from a social perspective. They question the ethics of digging up and removing iguana nests, exemplifying how ecological challenges cannot be disentangled from the human environment. Just as participating in this project helped us understand the issue, the goal of the project is to convince the public to contribute to, rather than fighting against, efforts to decrease the iguanas' ecological impacts.

In addition to scientists having to come up with innovative ways to protect ecological communities, it is increasingly clear that our role extends far beyond the scope of our research. In the United States, integrating science in policy, communication, and leadership has always been a challenge. In 1945, the dominant thinking of the progression from science to application was described by V. Bush's linear model (1945), and largely kept the sphere of research distinct from that of action. During World War II, it became obvious to government officials that science was something that could not be ignored—but it did not have to be integrated entirely. While public funding was developed through organizations like the National Science Foundation and Rachel Carson's seminal work, *Silent Spring*, was published, the implication remained that science must be kept distant from politics. This continued until public responses in the 1960s and 1970s resulted in the passage of the Clean Air and Clean Water Acts, Endangered Species Act, and the National Environmental Policy Act. Even with "limited scientific evidence," by today's standards, these pieces of legislation set the stage for greater integration of science-based policy into United States governance.

Today, we rely heavily on "expert authority," but many decision makers do not know who the experts are or how to find them. Public access to a growing amount of scientific information is increasing every day. The change of pace is fast, and the media can often send mixed messages, using science that is convenient to substantiate their positions. Scientists can feel held back by an ethical dilemma in this turmoil, walking a thin line between advocacy and objectivity. Therefore, it has become unavoidable, and essential, for science and politics to collide. It is important to ensure that the general population understands what kind of scientific work is being done, and how to interpret the results. This is especially pertinent in the context of climate change, as catastrophic events become more frequent and its effects are becoming more perceptible.

Therefore, one of the most vital parts of a scientist's role is communication. Science is a pathway to new discoveries and information, but it is useless if it cannot be communicated to the general public. During our leadership meeting, we participated in a scientific communication workshop where we learned how to read, summarize, and communicate entire scientific journal articles in a brief 30-second timeframe in a way that the public would understand. The most important parts to include, we learned, were answers to the six fundamental questions we all learn in elementary school: who, what, when, where, why, and how. By answering all of these questions, we could condense 15-page papers into a short paragraph. We also learned how to rephrase scientific jargon so that anyone would understand the context. In order for science to impact the world, we need to relate the issue to different cultures and present a take-home message or task. Different groups have different views on science, and ensuring that all populations understand their connection to the issue is important. Many of us came out of the workshop enlightened and refreshed on communication. Being able to clearly communicate scientific information is a struggle most of us face, but after the workshop, we are confident that we can communicate a journal article to a wide variety of demographics quickly and effectively.

With this new model of politics, public engagement, and science, we can overcome complexity with understanding and bridge the gap between science and policy to solve problems in a timely manner. This is where we must really take cultural differences into account. Different peoples' perception of what ecology is, how it differs from environmentalism, and the ethical role of scientists as citizens must all be considered. This will allow us to transfer ecological knowledge through social relationships, providing a vast array of opportunities on a local scale rather than concentrating the wealth of knowledge at only the national scale. Overall, we all need to work on not only our IQ, but also our emotional intelligence. An understanding of where everyone comes from can make for very effective science, and it is the inclusion of these different perspectives that makes us stronger. After all, that is what SEEDS is all about—diverse people for a diverse science.

In conclusion, SEEDS is an organization with an undergraduate focus on ecology, which helps inspire young scientists who are unsure of what being an ecologist means through research and travel opportunities. On the final day of the trip, as we were sharing final thoughts, it became clear that science cannot reach its full potential until it is applied to policy all over the world. Finally, for this Leadership meeting we would like to acknowledge and thank the co-coordinators of the trip: Teresa Mourad and Fred Abbott as well as the many faculties that nominated the university students as well as encouraged students to complete a fellowship. Finally, a huge congratulations go out to the Undergraduate Fellowship Presenters for a completion of their research.

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