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MUVE: A Long-Term Science Museum-Based Environmental Volunteer Conservation Program

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ABSTRACT

Science museums and similar institutions provide informal science and environmental education, both on museum grounds and out in the community. Since 2007, the Phillip and Patricia Frost Museum of Science in Miami, Florida, USA, has run Museum Volunteers for the Environment (MUVE) program, a conservation volunteer program that is also an effective method of place-based education for the local community. Here, we document the evolution of MUVE over the past 15 years, from a small eco-art installation to a multi-faceted conservation program that brings the museum into nature, and share the program's recent achievements. We outline program activities, participation, funding sources, key challenges, and lessons learned. Our goal in doing so is to provide a case study to other museums interested in developing similar programs.

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Introduction: the history and core principles of MUVE

Science museums and similar institutions (e.g. botanical gardens, zoos, nature centers) are important providers of informal environmental and science education.¹ This educational work can be institution-based, such as through exhibitions, field trips, or guided experiences. It can also occur outside the institution through experiential learning within local landscapes, known as place-based education.² Place-based education links people to their community, giving them a sense of belonging in and personal attachment to their society and ecological setting.³

Museum Volunteers for the Environment (MUVE) is a volunteer-based habitat restoration program run by the Phillip and Patricia Frost Museum of Science (hereafter Frost Science, or the museum) in Miami, Florida, USA. Frost Science is a leading science museum dedicated to sharing the power of science, sparking wonder and investigation, and fueling innovation for the future. Environmental conservation is a core part of Frost Science's mission, and MUVE's initiatives collectively focus on enhancing the health and resilience of coastal landscapes. While MUVE is fundamentally a volunteer program, it is also a form of place-based environmental education by the museum, bringing the museum's conservation work into the community (Figure 1). The program is well-known around Miami; since MUVE's inception in 2007, more than 12,000 volunteers have participated in MUVE events.

MUVE formed out of an eco-art exhibit called *The Reclamation Project* by Miami artist Xavier Cortada. The installation involved the collection of red mangrove (*Rhizophora mangle*) propagules by volunteers; the propagules were then exhibited in a grid



Figure 1. MUVE activities in the community: (A) Public volunteers come together to celebrate a job well done after a Volunteer Workday at Virginia Key North Point in 2018–2019; (B) Miami Dade County’s Department of Environmental Resource Management assists MUVE with biological monitoring efforts in mangrove habitat managed under the department’s Environmentally Endangered Lands program at East Greynolds Park; (C) MUVE volunteers plant sea oats in the dune at a volunteer workday at Virginia Key North Point in 2014; (D) Local high school students learn how to properly plant a sea oat at a private fieldtrip on Virginia Key North Point in 2022; (E) MUVE hosts a private event for a local corporate group doing a citizen science cleanup on Virginia Key in 2021; (F) Upward Bound Math and Science volunteers remove invasive species from intertidal mangrove habitat on Virginia Key in 2022.

of biodegradable plastic cups on walls and windows of schools, stores and museums around Miami. Eight months later, they were planted on coastal public lands.⁴ The exhibit at Frost Science featured about 1110 propagules. Now, more than 15 years

later and after several iterations, MUVE has grown into one of Frost Science's flagship conservation education and outreach projects. Currently, MUVE works closely with the City of Miami and Miami-Dade County to enhance and maintain coastal ecosystems, primarily comprised of mangrove, beach dune, and coastal hammock sites. This network of ecosystems is habitat for native terrestrial and marine wildlife.⁵ It also protects the region from storms and sea level rise.

MUVE and the coastal sites it restores are also important vehicles for experiential environmental education, community learning, and ultimately positive change. Directly connecting people to nature, as MUVE does through its volunteer activities, helps advance conservation by increasing pro-environmental behavior.⁶ It makes environmental volunteerism an enjoyable and memorable activity, and the habitats restored by volunteers become permanent natural legacies for them to visit and enjoy. MUVE volunteers also directly care for the environment through planting of native species and removal of invasive/nuisance plants, which may foster a sense of environmental ownership and thus increase their stewardship of public natural resources.⁷ Finally, the landscapes MUVE helps restore are important for human well-being and climate change mitigation. This is particularly important in South Florida, where impacts of climate change are already apparent.⁸

In this paper, we describe the growth and evolution of MUVE from a small mangrove planting effort inspired by an eco-art exhibit in 2007 to a multifaceted volunteer program that, as of the end of 2022, has helped restore 25.5 acres of coastal habitat through the work of over 12,000 volunteers. By sharing this information, we aim to inspire other museums and science institutions to think outside of the walls of a museum and establish ecosystem restoration and environmental education volunteer programs like MUVE. Not only has MUVE been an effective method of bringing healthy ecosystems to the forefront of individuals' minds, but it has also helped establish Frost Science as a conservation leader in our wider community. Along the way, it brings hands-on educational experiences to South Florida residents, whether they are ticketed guests or not.

MUVE's organization and scope

Program organization

Since MUVE's establishment in 2007, the program has been led by a Frost Science staff member in the museum's Biological Programs Division (formerly co-author and Frost Science Director of Marine Conservation F. Bretos, currently first author and Frost Science Curator of Ecology and Environmental Restoration S. Jones), with assistance from one or two additional Frost Science staff. MUVE staff are responsible for coordinating with local stakeholders and partner organizations to plan restoration work and beach cleanups, organizing volunteers, executing all public workday and outreach events, and communicating conservation science to Frost Science guests. As MUVE is supported largely by grant funding and donations, the program's director is also responsible for writing grant proposals and reporting outcomes to funders. MUVE also regularly supports interns from local universities who complete conservation projects with the team and assist with workdays and other events as needed.

This small group of Frost Science staff are assisted by a group of approximately 10–15 lead volunteers who help facilitate MUVE events and assist Frost Science staff with

managing ever-changing groups of public volunteers, MUVE's key constituency. Public volunteers are recruited for MUVE events through the Frost Science online events calendar and newsletters. They generally range in age from 5 to 65 years old, with a majority being high school students or family units. Public volunteers sign up for events on a one-off basis; they make no ongoing commitment to MUVE. Despite this, approximately 10% of MUVE volunteers have participated in two or more events within the past six years.

Environmental and educational activities

Frost Science is located on Biscayne Bay in downtown Miami, Florida and has been in this location since 2017. MUVE's work is also concentrated in this general vicinity (Figure 2). The first MUVE event, which involved planting the mangrove seedlings from the 2007 eco-art installation, was held on Virginia Key, an uninhabited, yet highly developed barrier island off the coast of Miami. The program then expanded to state and county parks such as Oleta River State Park, East Greynolds Park, and R. Hardy Matheson Preserve. Currently, MUVE events are concentrated at Virginia Key (managed by the City of Miami), Crandon Park (Miami-Dade County), and Haulover Park (Miami-Dade County). These locations are selected in coordination with the city and county, since these entities are the primary landowners and managers. Specific partner agencies within Miami-Dade County include the Parks, Recreation and Open Spaces Department, the Natural Areas Management Division, the Miami EcoAdventures, the Department of Environmental Resource Management, as well as the City of Miami's Natural Areas Division.

Public MUVE events are structured around one or more of the program's four main activities: (1) native vegetation planting; (2) invasive and nuisance vegetation removal; (3) marine debris pickup on local beaches; and (4) citizen science data collection. Specific activities for each event are selected based on the time of year and to fulfill commitments to funders. In Florida, the months of May to September are the wet season, so MUVE focuses almost exclusively on native vegetation planting during this time. The rest of the year—the dry season—is better suited to invasive and nuisance vegetation removal and beach clean-ups. MUVE also participates in the International Coastal Cleanup each year,¹⁰ and is a team organizer for south Florida in the annual City Nature Challenge, a global four-day bioblitz-style competition aimed at introducing citizen scientists in urban areas to the nature around them.¹¹

MUVE's goal of providing environmental education to the broader Miami-Dade community is woven through public volunteer experience. Each volunteer event begins with a brief presentation about MUVE's history and the past and current restoration efforts at the day's worksite. Frost Science staff and lead volunteers discuss the importance and interconnectedness of native coastal ecosystems and the critical ecosystem services they provide, then provide guidance specific to the day's activity (e.g. demonstrate how to properly plant sea oats, explain how to identify invasive species for removal). They also engage with volunteers throughout the event to ensure they learn about the plant species and restoration techniques they are working with. When a workday includes citizen science data collection, Frost Science staff and lead volunteers walk public volunteers through the collection process and share the broader impacts of the specific initiative in which they are participating.

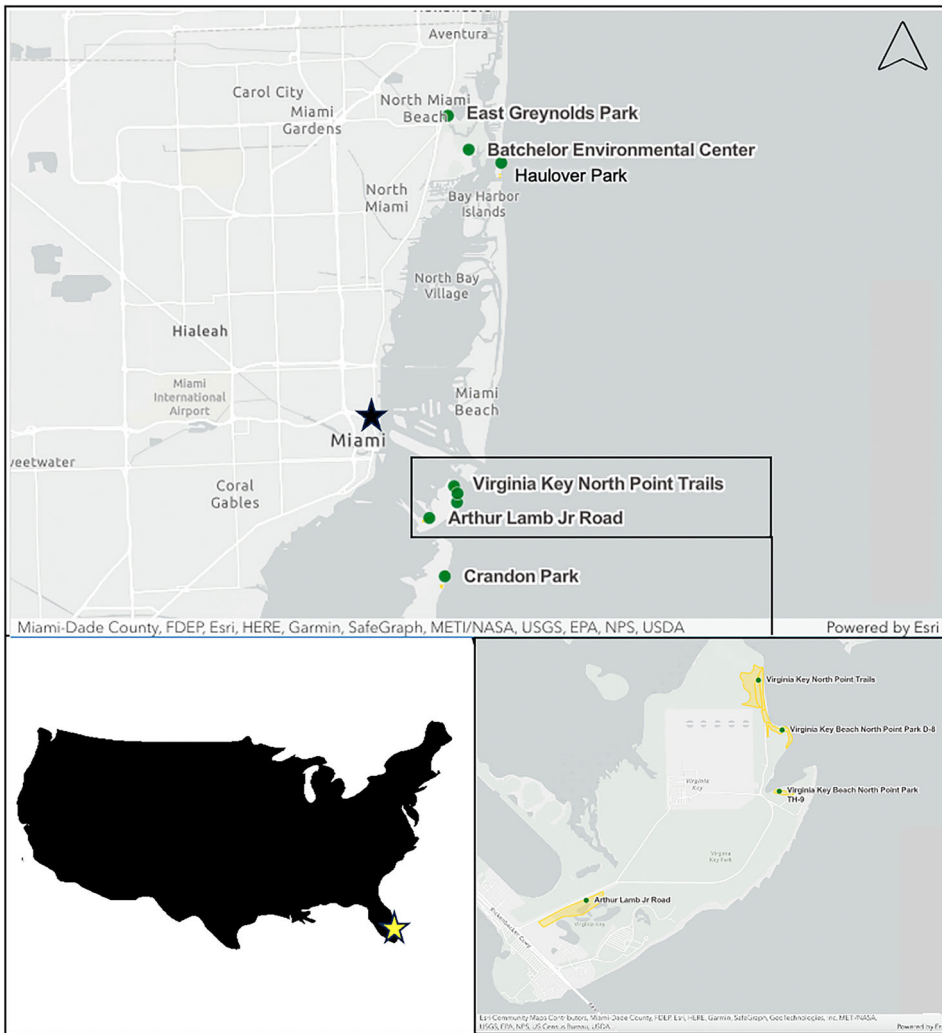


Figure 2. Map of historic and present MUVE sites (top), with inset showing the location of Miami, FL in the USA (bottom left). The Virginia Key area of Miami is expanded to better display worksites on the key (bottom right). The location of the Phillip and Patricia Frost Museum of Science is denoted by the black star on the top right panel. Credits: Miami-Dade County, FDEP, Esri, HERE, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA (top); Esri Community Maps Contributors, Miami-Dade County, FDEP, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA (bottom right).⁹

Funding sources

MUVE’s work is funded or supported in-kind by local and national governmental agencies, environmental non-profits, public elementary and high schools, and universities. The program also raises private and federal funding. Current MUVE funders include Wells Fargo, FedEx, Brightmark, and the National Fish and Wildlife Foundation. Recently, it has received a grant from Surfing’s Evolution & Preservation Foundation,

funded through the sale of the foundation's Florida license plate design. Since 2018 MUVE has also offered private and/or corporate workday events with a requested donation amount. This diversity of funding sources is a strength of the program. In-kind donations are also important to MUVE's work; partners at the city and county provide local knowledge and expertise surrounding land use planning and park needs and commonly are the permit holders for all restoration activities. They also support on-site during events with additional volunteer-guidance, debris disposal, storage space for program supplies, access to water and public restrooms, and complimentary parking vouchers for all volunteers.

Volunteer engagement

Since 2018, MUVE has been closely tracking volunteer engagement and contributions (Table 1). Even though MUVE continued to host small, outdoor workday events during 2020 and 2021, the total number of volunteers each were not accurate reflections of the program's capacity due to the COVID-19 pandemic. However, the statistics from 2018, 2019, and 2022 were representative of MUVE's annual engagement levels. Across these three years, the program averaged 1050 volunteer participants per year. These participants contributed an average of 2342 volunteer hours per year. The number of volunteer workdays has fluctuated as MUVE has experimented with different models, such as holding a few relatively large public workdays (as in 2018) and the 2022 model of having more frequent smaller workdays, with private and/or staff-only workdays interspersed with public events for approximately 50 volunteers. While there is no specific data on who volunteers with MUVE, they generally fall into four categories: people affiliated with Frost Science in some way (e.g. museum members); student groups of all ages, including individual students who come—often accompanied by their families—to complete volunteer service hours; corporate groups; and people interested in the environment who find the program through other local environmental groups.

Environmental and scientific impact

Over the past 15 years, MUVE has led the enhancement and maintenance of 25.5 acres of mangrove, coastal hammock, and beach dune ecosystems. Since 2018, MUVE volunteers and Frost Science staff have planted 30,869 native plants across all project sites. MUVE

Table 1. MUVE participation statistics for 2018–2022. The number of workdays includes staff-only workdays. Reach is the combined total of volunteers at workdays and people engaged in outreach events. During 2020–2021, MUVE activities were impacted by the COVID-19 pandemic.

	2018	2019	2020	2021	2022
Number of workdays	26	34	31	83	60
Outreach events	28	17	4	2	15
Volunteers	1138	1109	139	613	904
Volunteer hours	2822	2228	231	1199	1977
Reach	4073	2651	392	511	7809
Plants planted	13,648	6233	480	280	10,228

Note: Table showing MUVE participation statistics for the time period of 2018–2022. The table has six columns and seven rows, with columns representing years and rows representing different measures of participation: Number of workdays, outreach events, volunteers, volunteer hours, reach, and plants planted.

volunteers have also contributed to environmental data collection through the citizen science applications CleanSwell (a marine debris tracking application) and iNaturalist. Since 2020, MUVE participants have collected and logged 14,274 total items in CleanSwell during beach clean-ups. Notably, MUVE's contribution has increased eightfold over the 2020–2022 time period, from 1012 items collected in 2020 to 8610 items in 2022.

Similar successes have been realized in the annual City Nature Challenge, a four-day global bioblitz led by the California Academy of Sciences and the Natural History Museum of Los Angeles County.¹² In 2022, the South Florida team came in 23rd of 445 cities/regions globally for both number of unique species and the number of observers. Current MUVE Coordinator and co-author L. Reilly represents MUVE on the South Florida City Nature Challenge organizing team, a small group of people who use their networks to recruit challenge participants, find groups to host citizen science trainings and events, and coordinate South Florida's social media presence. This group has grown over the years to include organizers from four South Florida counties and includes individuals from government agencies, schools and universities, local NGOs and non-profits, and other community leaders. With increasingly diverse representation, the scope of volunteer participation more than doubled from 2022 to 2023, to 3070 species logged by 1055 observers through a staggering 22,718 observations. The City Nature Challenge is an excellent opportunity for other museums to join and mobilize their communities around to raise awareness of local biodiversity.

Challenges and lessons learned over 15 years of MUVE

Since its inception in 2007, Frost Science's MUVE program has grown substantially and evolved from a single mangrove planting exhibit inspired by an eco-art project to a thriving volunteer-oriented program that collaborates with local environmental organizations to enhance Miami's coastal ecosystems. MUVE is a prime example of how science museums and similar institutions can work beyond their building's walls to engage their communities in educational volunteer opportunities and learn about nature. Since 2007, MUVE volunteers have collectively dedicated thousands of hours to environmental restoration, planting tens of thousands of native plants and removing both invasive vegetation and trash from Miami's coastal ecosystems. These achievements were not necessarily simple or straightforward to accomplish, and in the following paragraphs, we identify challenges and lessons learned.

Key challenges

Like many small conservation programs, funding has been a consistent challenge over the past 15 years. A main reason program funding is a persistent concern is that at its core the program does not fundamentally change from year to year, which makes it difficult to meet ever-changing trends in donor funding priorities. MUVE has responded creatively to this challenge. The program has shifted to seeking mission-driven, rather than project-driven, grants and has leveraged opportunities to incorporate MUVE activities into museum exhibitions, which is appealing to funders interested in more traditional educational outreach. It has also diversified its funding sources to include paid programming (e.g. MUVE workdays for corporate staff team-building days). Recently, MUVE has

also forged new cross-departmental collaborations within Frost Science, namely partnering with the museum's Upward Bound Math and Science program, a STEM education program for under-resourced high school students that prepares them to pursue STEM careers in college and beyond. This creative partnership has opened new doors for grant opportunities that MUVE on its own is not well-positioned for, and that mutually benefit both programs, advancing Frost Science's mission to connect people of all ages and backgrounds to science and the world around them.

Working with local stakeholders has been another consistent challenge, though a rewarding one. MUVE's stakeholders and partners are the City of Miami and Miami-Dade County governments, local schools, area non-profits doing similar conservation work, and scientists who use citizen science data. Whether working with one or multiple stakeholders, identifying programming synergies that meet different parties' needs requires flexibility. For example, one of MUVE's long-standing volunteer sites contains mountain biking trails that are maintained by the local mountain bike club. The cyclists prioritize a variety of terrain with shady rest areas and they were initially extremely wary of the restoration work at the site, creating conflict during the restoration planning process. However, the cyclists were invited to join ongoing project planning conversations, which led to a compromise that established bike pathways throughout the restoration sites. The pathways were planted with native trees, which provide shade and are more resistant to tropical storms than the invasive vegetation. Now, MUVE plans to expand its partnership with the club.

Lessons learned

Despite the challenges inherent in working with a range of stakeholders, one of the biggest lessons MUVE has learned over the past 15 years is the power of partnerships. By working in coordination with the City of Miami and Miami Dade-County government, MUVE was able to align itself with existing city planning goals and fill gaps in environmental management plans. This ensures the program's time and financial resources go toward work that will help the community instead of unproductive projects (for example, restoring an area slated for development). The same is true of collaborating with local non-profit organizations; there is also great value in partnering with established local non-profit conservation organizations to work together toward shared goals instead of initiating conservation efforts from scratch and "re-inventing the wheel." This approach has paid off. In 2022, MUVE was recognized as the Florida Recreation and Parks Association's Voluntary Service Group of the Year. In January 2023, the program was recognized by the City of Miami Mayor for its "commitment, dedication, and volunteer efforts" on Virginia Key. The City of Miami Natural Areas team, a key MUVE partner, was recognized alongside the program.

Perhaps the most salient lesson learned from MUVE's 15-year history is how to balance consistency with flexibility. MUVE started as a mangrove planting program, although mangroves have since faded from the program's current repertoire due to a reduction in the availability of suitable public mangrove areas in need of restoration under current legal frameworks. The community conservation need has shifted toward coastal beach dunes, critical green infrastructure that protects nearby urbanized coastal areas. Beaches maintain community health and well-being and support the

tourism-based economy, and Miami-Dade County's 2020 Strategic Plan prioritized the protection and enhancement of these critical natural assets.¹³ This change in ecosystem priorities, from mangroves to dunes, is now reflected in MUVE's programming. However, the program's fundamental identity as a public conservation volunteer program dedicated to enhancing Miami's coastal habitats for biodiversity and human well-being has not changed. MUVE's clear mission and core identity allows it to add and remove activities to meet community priorities and access a variety of funding sources while staying true to its mission. Strong organizational identity has been proposed to be an essential element for a non-profit's long-term success;¹⁴ MUVE is an excellent example of this.

The future for MUVE

At the end of 2022, MUVE instituted a post-workday online survey and began asking volunteers over the age of 18 for their feedback on the program. Through the beginning of June 2023, 13 people had responded to the survey. About half ($n = 6$) indicated they were repeat volunteers, with one respondent indicating they had attended six or more MUVE workdays. All said they were somewhat ($n = 4$) or very ($n = 9$) concerned about environmental issues. About 60% of respondents ($n = 8$) said they had changed their behavior toward the environment due to their MUVE experience. The most common behavioral change was talking to friends and family to raise awareness about the environment, followed by being mindful of native habitat (e.g. staying on trails, not trampling wild plants). For all, the program met or exceeded expectations. While this is a small snapshot of MUVE volunteers, it strongly suggests the program is driving small but sustainable environmental change among Miami residents. Continuing this survey over the coming years is a priority for the program, and this information combined with additional years of volunteer engagement data will allow the MUVE team to more carefully evaluate the program's local impacts.

Conclusion

Science institutions play important roles in educating the public about the world around them, and place-based education efforts are an effective, engaging way to do this. Frost Science's MUVE program is an example of one such effort rooted in environmental conservation and restoration. Here, we have described the evolution of the MUVE program from a small eco-art exhibition into a multi-faceted conservation program reaching thousands of people per year, with the goal of providing information so that other institutions may adapt the MUVE model to their own programming.

Notes

1. Winther et al., "Approaches to Environmental Education," 31–49.
2. Woodhouse and Knapp, "Place-Based Curriculum and Instruction."
3. Semken and Freeman, "Sense of Place in the Practice and Assessment," 1042–57.
4. Cortada, "About the Reclamation Project."

5. Roessler and Beardsley, “Biscayne Bay: Its Environment and Problems,” 186–204.
6. Frantz and Mayer, “The Importance of Connection to Nature,” 85–89.
7. Peck et al., “Caring for the Commons,” 33–49.
8. Sweet et al., “Global and Regional Sea Level Rise Scenarios.”
9. The Ocean Conservancy, “International Coastal Cleanup®.”
10. City Nature Challenge, “City Nature Challenge.”
11. Esri, “Light Gray Canvas” [basemap].
12. City Nature Challenge, “City Nature Challenge.”
13. Miami-Dade County, “Miami-Dade County Strategic Plan 2020.”
14. Young, “Organizational Identity in Nonprofit Organizations,” 139–57.

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About the authors

Shannon C. Jones is the Curator of Ecology and Environmental Restoration at the Phillip and Patricia Frost Museum of Science. A co-founder of the Miami-based Marine Order of Research and Action through Environmental Stewardship (MORAES), Shannon oversees sea turtle nesting activities on Virginia Key, Miami. She earned a Master of Professional Science degree in marine conservation from the University of Miami, and is an advanced Florida Master Naturalist Land Steward and member of Catalyst Miami’s Community Leadership on the Environment Advocacy and Resilience.

Lauren Reilly is the MUVE Coordinator at Frost Science. She has been a part of the MUVE Program since 2019. She began as a volunteer, completed an internship at Frost Science during her graduate studies, and now manages the program. In 2021, she earned her Master of Professional Science in Coastal Zone Management at University of Miami’s Rosenstiel School. Now, she engages with MUVE volunteers and builds program initiatives to highlight the importance of socio-ecological connections, encourage local stewardship, and advocate for South Florida’s public lands.

Fernando Bretos is a conversation scientist who focuses on the conservation of subtropical coastal and marine habitats, marine migratory species, and rare corals. As a program officer at the Ocean Foundation, he oversees blue carbon projects in the western Caribbean and Gulf of Mexico and directs an international marine protected area network called RedGolfo. He is the founder of Frost Science’s Museum Volunteers for the Environment, an Audubon and Kinship Conservation Fellow, and a National Geographic Society Explorer.

Cathryn A. Freund is the Director of Science Communication at Frost Science. She holds a master's degree in Conservation Biology from Columbia University and a Ph.D. in Biology from Wake Forest University. She has led research and conservation efforts in the rainforests of Indonesia and Peru, and since 2017 has been professionally communicating science through various online media. Currently, her research focuses on how depictions of wild animals on social media affect their conservation.

ORCID

Fernando Bretos  <http://orcid.org/0000-0002-7547-4820>

Cathryn A. Freund  <http://orcid.org/0000-0002-1570-5519>

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