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PERSPECTIVES

Saiga saga

Aligning people's socio-economic interests with wildlife conservation in the Central Asian Steppe.

Living with Giants

Women of Natural Resources

A Tale of Two River

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PERSPECTIVES

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Cover: Wild saiga of the Kazakh steppe (Credit: Darwin Initiative)

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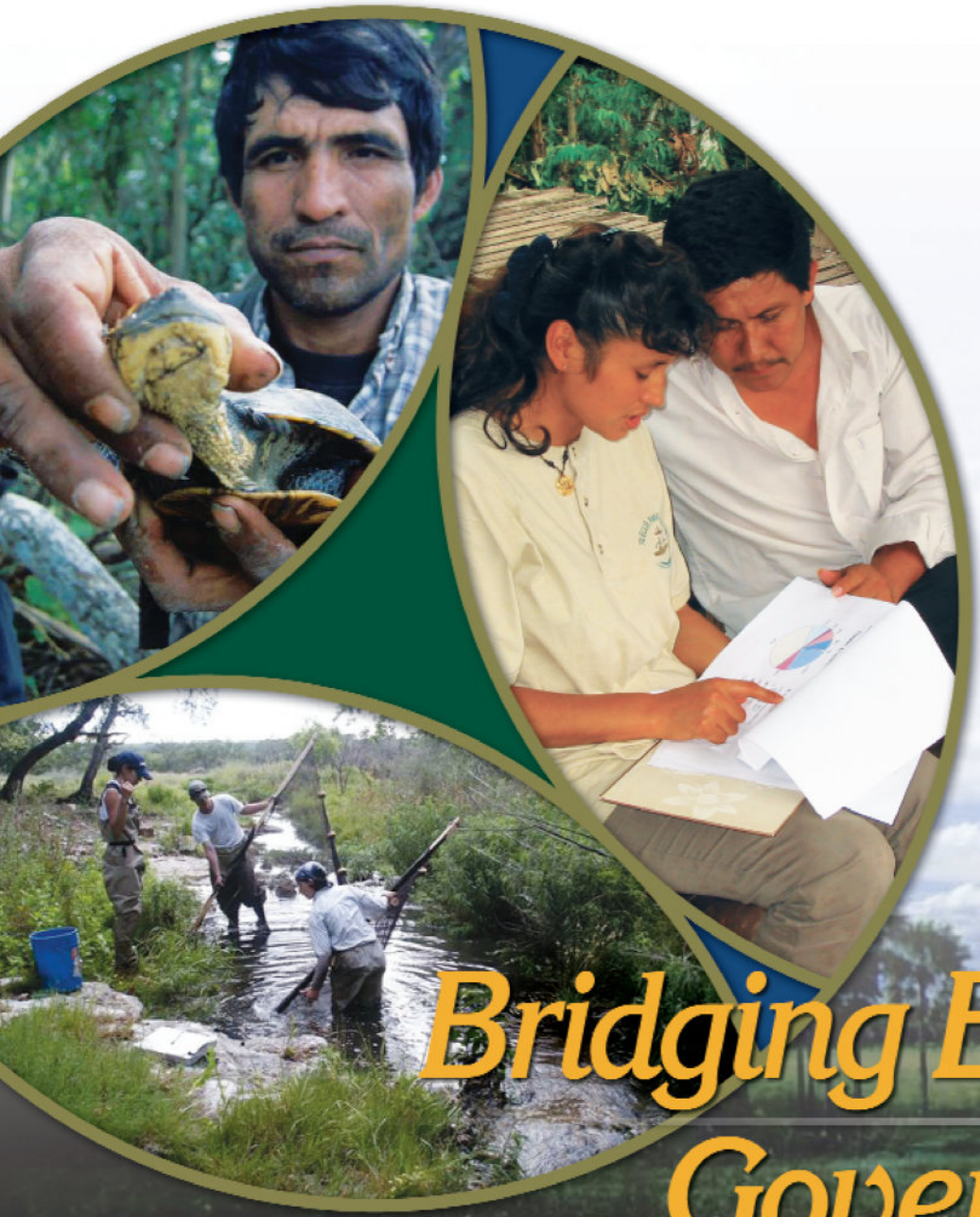
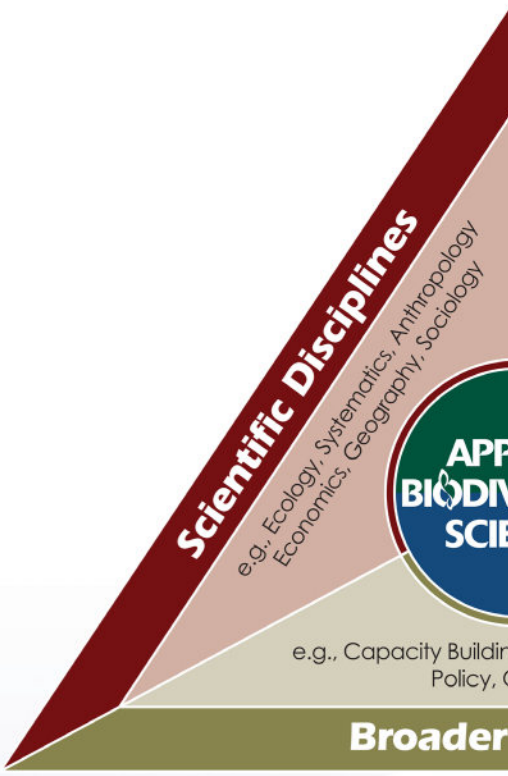
APPLIED BIODIVERSITY SCIENCE

The vision of the Applied Biodiversity Science (ABS) Program is to integrate biodiversity research and on-the-ground conservation practices.





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Research teams of students and faculty collaborate with international partners in one of four regions of Latin America. They develop complementary dissertations related to:

- Ecological Functions and Biodiversity
- Communities and Governance

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"Wild elephants are as helpless as before", says U Khin Maung Gyi, my friend and colleague. "I believe we could do better for elephants and villagers if there is more transparency and discussion."

CLEMSON UNIVERSITY

Christie Sampson
Clemson University
Smithsonian Conservation Biology Institute

We are in the Bago Yoma mountain range in south-central Myanmar, eating dinner in a former timber camp as the generator--powered lights hum in the background. ere are still a few captive elephants staying in the camp overnight. Every so often a low rumble or soft trumpet can be heard flowing between the collection of 50 or so thatch homes. But most of the 20-30 captive elephants are released by their handlers, called mahouts, into the surrounding forests and hills. There they will forage until dawn. As the sun rises, the mahouts will follow their individual elephant's tracks and bring them back to camp to work for the day.

Thousands of people in Myanmar live in landscapes they share with elephants. Farming is the dominant occupation in these rural areas, where little other infrastructure exists. Many homes in rural Myanmar do not have running water or electricity. If a house or village does not have a water pump, women and children are often required to carry water from a nearby stream for the day's meal preparations (left).

A child walks through the dust of a passing truck as the sun fades. The severe dry season that begins every February and extends until the rains start in May coats everything in the village in a fine red grit and limits the water available to support both humans and wildlife. Sharing this resource can force humans and elephants into closer contact, increasing the potential for conflict.

People in rural areas often smoke locally made cigarettes as a deterrent to mosquitoes which carry life-threatening diseases such as malaria, dengue fever, and chikungunya. This threatens the lives of people, especially the children and elderly, in areas where medical access is poor and communities already experience challenges from poverty and low employment opportunities. Above, village headman's son uses incense to imitate his father and local councilman as we discussed the human-elephant conflict (HEC) challenges facing their village.

Farming is the primary occupation for people in the Bago Yoma. Thirty-eight percent of rice farmers in our study site reported that they lost half or more of their crop in 2013. Farmers who participated in our seasonal electric fence program in 2016 and 2017 reported no loss of crops, which has helped draw more people into our mitigation programs.

Sugarcane plantations owners have scaled back their operations over the past few years due to frequent crop-raiding from elephants, reducing the number of jobs available for local community members.

Elephants and humans have a rich shared history in Asia. Elephants feature prominently in local religions. They guarded ancient palaces. They served in armies, even assisting American troops for non-combat purposes during World War II. In Myanmar, elephants have long been beasts of burden, essential to the success of the country's timber industry. But as human populations expanded and developed the landscape from wildlands into agriculture and permanent settlements, incidences of human-elephant conflict began to rise. The elephant, an animal so entwined in the culture and tradition of Myanmar's people, is also the source of significant loss and devastation for many people living in rural areas across the country.

Every morning, mahouts retrieve their elephants from the forest and take them to the stream to bathe them. This allows the mahout to inspect the elephants for any injuries incurred the night before and reinforces the relationship between mahout and elephant (opposite page).

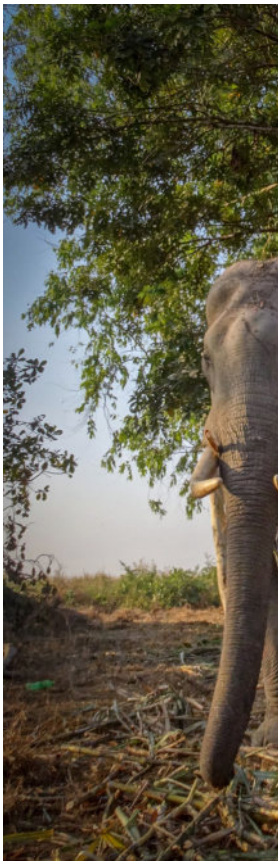
A farmer shows injuries from elephant encounted in rice paddy, a crushed hip and immobile leg; with injuries he can't maintain his fields to support his wife and child.

Communities in the southern Bago Yoma experience high levels of crop-raiding (primarily rice and sugarcane), and property damage from their elephant neighbors. For the past two decades, between 3 and 6 people have died annually in this area due to HEC. U Khin Maung Gyi and I are part of a collaborative project working to implement effective strategies to reduce HEC and find ways for both species to co-exist on the landscape. We have also recently begun a study to quantify some of the indirect ways HEC affects communities, such as opportunity loss (i.e., it's too dangerous to travel to attend school or collect wood), and health impacts (i.e., higher stress levels, inability to sleep). Project collaborators include: the Smithsonian Conservation Biology Institute, Clemson University, World Wildlife Fund-Myanmar, Compass Films, Friends of Wildlife, Growth for Prosperity, and the Myanmar government.

A boy surveys the damage caused by a herd of elephants that destroyed a home and the family's small grove of banana trees. Fortunately, the family had been staying with relatives when the event occurred.

Elephant presence near a village can make the journey from a child's home to their school dangerous, especially if the local schoolhouse is in the next village. This can prevent children from attending school especially during periods of high HEC, such as when the crops are ripening and can draw elephants nearer the villages.

The largest captive elephants in a camp are called koonkies, or warrior elephants. Koonkies are used by the Myanmar government to help farmers push wild elephants out of an area and protect crops. If the farm or plantation is located far from the camp, koonkies and their mahouts travel by truck.



We are currently at the Myaing Hay Wun elephant camp, where we are working with nearby villages to collect dung samples and construct seasonal electric fences that will protect their crops from elephants until they can be harvested. But as we finish dinner and settle in for the evening cup of tea, U Khin Maung Gyi and I discuss a different problem for the elephant population.

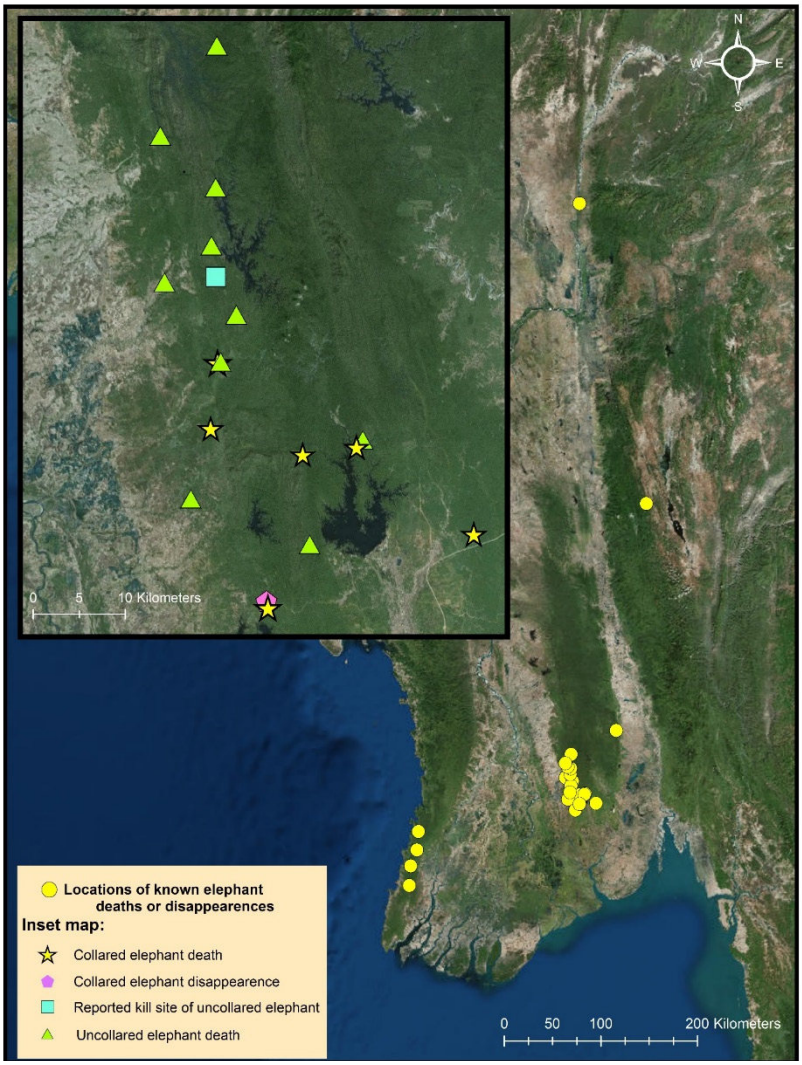
"It appears to be more motherless elephant infants in our country", he says. Our elephant movement project, designed to track how the elephants were moving through the landscape, had instead revealed the devastating extent of poaching occur-

Captive elephants are also used by the research team to track and capture wild elephants to attach satellite GPS collars (below). The captive elephants can help ensure the safety of both people and the wild elephant during the collaring process.

ring in the Bago Yoma and in several of our other field sites across the country. We lost 7 of 15 collared elephants in the Bago Yoma to poachers, one only six days after the collar was attached. Once we realized the breadth of the problem, we began searching for other carcasses, documenting the loss of 19 total elephants within our ~35 km^2 study site in the Bago Yoma in a two-and-a-half year period. Searches in other field sites raised that number to 70 elephants for the same time frame, including a mass grave that housed the remains of an entire herd of 20 elephants.

"The number of wild elephants is so decreasing that there will be no elephant left", he worries. Despite our findings, I'm not sure I agree. It is true that experiencing high levels of HEC can make people more willing to accept or engage in poaching. And the sale of the body parts from a single elephant on the black market can be more than 25 times greater than the annual salary for a farmer in the Bago Yoma (approx. $1000/yr).

The skinned carcass of an elephant is not an uncommon sight (found April 2017; credit: Dr. Zaw Min Oo). Locations of elephant deaths and disappearances in Myanmar (map, right) shows elephants lost at the Bago



Yoma field site, including collared and uncollared elephants (source: World Imagery: Esri, DigitalGlobe, Earthstar Geographics, males CNES/Airbus DS, GeoEye, USDA FSA, USGS, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community [accessed November 2017]).

For Asian elephants, only males have tusks, which means poachers can only kill males if they want ivory. But if they poach for skin, they can kill any elephant regardless of age or gender. Due to the elephants' reproductive ecology, females are much more important in maintaining population stability than males. Targeting females for poaching will have a devastating effect on the survivorship rates of this endangered species.

Interview surveys in the area have shown that the local communities value elephants and want to protect them for future generations. Many of the community members remark on elephants' importance as 'part of nature' and that they are 'precious' to Myanmar. Most people are also willing to engage in mitigation activities such as electric fencing, though ensuring proper maintenance of the fence and equipment has proven difficult in some areas. Educational outreach programs in the area are also well received, but the effectiveness of the programs is still being assessed.

No single HEC mitigation or anti-poaching strategy can address the issue and achieve the balance we need between elephant conservation and protecting people and their livelihoods. Identifying different methods and compiling a toolbox of potential approaches is key. But what's more important is listening to the community and engaging them in elephant management and the creation of conservation policies. The will to conserve elephant populations is there. We as researchers need to provide the science and resources that communities can use to overcome some of the obstacles sharing a landscape with elephants presents, and support them as they find their own ways to live with the last remaining giants.

Further details on the poaching crisis: Sampson C, McEvoy J, Oo ZM, Chit AM, Chan AN, et al. (2018) New elephant crisis in Asia—Early warning signs from Myanmar. PLOS ONE 13(3): e0194113. https://doi.org/10.1371/journal.pone.0194113

GRADUATE PERSPECTIVE

A Tale of Two Rivers

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Integrative Biology Department

Robert Paine said that the most successful graduate students are the ones having the most fun. Having good friends who are fellow graduate students and maintaining those connections as folks enter the workforce helps make a successful career probable. While graduate students are encouraged to interact with established professionals, forming lasting connections with peers is also critical for creating an emotional support team and developing a network of young collaborators.

Graduate School **Initiating Connections**

"Which way?" Jess yelled to Erin, who was paddling out front.

"No idea! Last time I was here was 10 years ago!" Erin grinned over her shoulder at Jess's expression of excitement and anxiety.

Erin loved paddling into the unknown, confident that she was prepared. Having paddled dozens of whitewater rivers around the world, Erin expected a fun trip with Jess on the intermediate whitewater of the Chattooga River in North Georgia. But still, Erin didn't know any of the routes through the upcoming rapids. She and Jess would have to trust themselves, rely on previous experience, and figure it out as they went. Paddling is a lot like graduate school in that way, which is fitting because that's where Jess and Erin met.

Jess and Erin connected a couple of years before their Chattooga River paddling trip at the University of Georgia, where Erin got her Masters and Jess is working on her PhD. Erin wanted to run her first 5k before moving across the country to start her Ph.D. at Oregon State University. Erin sent a graduate student-wide email asking if anyone wanted to run with her, and Jess responded.

During the race, Jess started talking about her Ph.D. research studying dam impacts in Puerto Rico. Erin hadn't realized that Jess was doing her PhD research on dams, which was what Erin was moving to Oregon to study! Recognizing an opportunity to strengthen both their support and professional networks, Erin and Jess committed to growing their friendship and research collaborations while on opposite sides of the country

Building a Network **You Can Trust**

After a stretch of slow-moving water, the Chattooga River started to roar. Erin and Jess were being pulled towards a deafening waterfall. Erin paddled up to the edge, surveying the river for a path free of rocks. Jess followed close behind, trusting Erin's expertise more than her own.

As Erin's kayak began to go over the waterfall, she turned and yelled, "Don't go this way!" before disappearing. Jess fought back a panic attack, waiting for Erin to pop up below the rapid. A few seconds later, relief flooded Jess when she saw a grinning Erin appear downriver. Erin pointed out a less rocky route, and Jess successfully flew off the 6-ft drop to the river below.

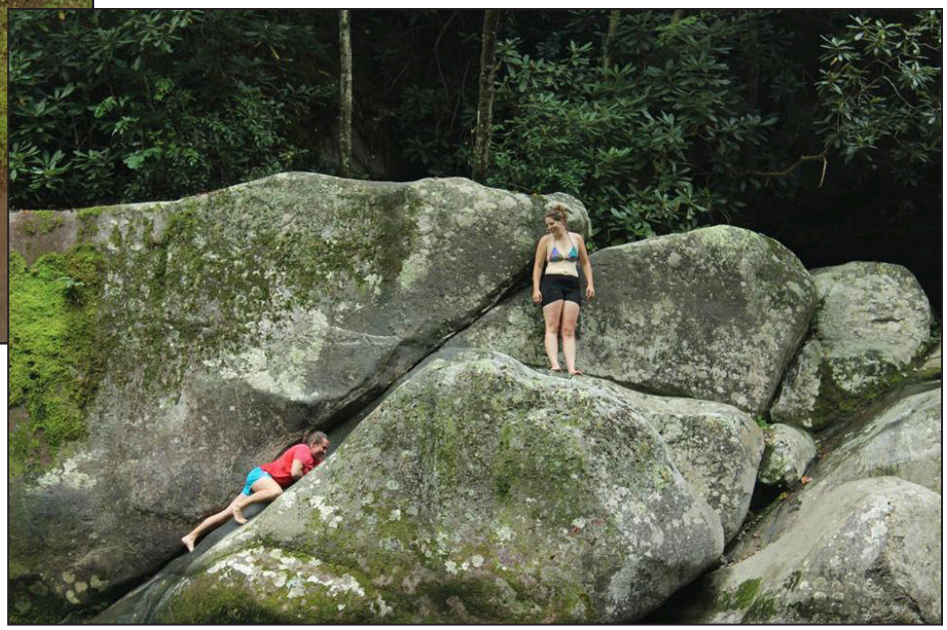
"Perfect!" Erin yelled, grinning as Jess gave an adrenaline fueled-cackle. Jess glanced at the jumbled pile of rocks Erin had paddled through and shuddered, glad she had an experienced kayaking partner she trusted.

But keeping up with all your inspirational graduate friends, in addition to new research in your field, can be challenging.

To strengthen their connection after Erin moved, Jess and

Left: Jess (left) and Erin (right) at the Chattooga River. They'll have to rely on their previous experience and each other to navigate down the river, much like navigating graduate school. Below: Jess and Erin at the 2017 Ecological Society of America meeting in Portland, Oregon. Professional meetings are where young researchers make new connections and strengthen existing collaborations.

Below: Jess (left) and Erin (right) at the end of their Twilight 5k run in Athens, GA. It was pouring down rain for most of the run, but they did it! Erin waits while Jess climbs up the rock face. Successful graduate students network with each other and make sure to have lots of fun.



Erin started a cross-continental book club, focused on something they were both researching and passionate about: dams.

The first book they selected was Silenced Rivers: The Ecology and Politics of Large Dams by Patrick McCully [2]. Since their projects both deal with the ecological impacts of dams, Erin and Jess were aware of the consequences for stream animals when a river system is dammed. But they didn't realize how global these issues are, or how severe the social consequences can be.

McCully details dozens of instances in which entire human communities were forcibly removed with inadequate or no compensation so that a dam could be constructed. Millions of people have died because of improper dam management, which includes everything from poor placement to failed dams. Shockingly, these issues are ongoing today. This past summer, an unfinished dam collapsed in Laos, killing over 30 people and displacing thousands.

Discussing the book and their projects, Erin and Jess began to see how their ecological research fit into the larger conservation conversation surrounding dam construction, management, and removal. Additionally, over these weekly phone chats, Jess and Erin covered more than just dams. They talked through dissertation ideas, advisor relationships, and learned from each other's experiences.

Communicating thoughts about McCully's book and each other's dissertations while also self-reflecting, Jess and Erin practiced valuable communication skills that have helped them grow their professional network at conferences and home universities, critical for success in graduate school and conservation careers.

Get to the **Dam Research**

Erin's dissertation research examines the effects of large dams on aquatic invertebrates in the Colorado River Basin. The Colorado River Basin stretches over seven states, and its dams supply drinking water to 30 million people, irrigate 4 million acres of cropland, and generate >10 billion kilowatt-hours annually (enough to power a million homes) [3]. While clearly important for humans, the dams on the Colorado River do have unintended consequences for animals. Erin's research characterizes how the aquatic invertebrate communities immediately downstream of large dams on the Colorado River are dominated by just a few species. Additionally downstream of one dam, Erin will model how insect population sizes respond to certain river flows (like a flood), and she will compare the relatedness of insect populations living in small side streams of the Colorado River. This research will detail dam flows that benefit insects, which are the base of the aquatic food web and critical to many of the world-class fisheries in the Western USA.

Jess' research is focused on the effects of small dams in Puerto Rico, specifically El Yunque National Forest. You probably wouldn't think of a national forest having dams, but these small dams (less than

5-ft tall) provide drinking water to thousands of people on the island. Unfortunately, this drinking water comes at a large ecological price. These dams can completely block water moving from the river down to the ocean. Without this water, animals that complete their life cycle by moving from the river to the ocean can't make this journey. Eventually these migratory animals won't be found in rivers where water doesn't flow to the

ocean. This is a big problem for freshwater shrimp, the most abundant animal in Puerto Rican streams. Shrimp are very hardworking, filtering river water and scraping algae off rocks in the river bed. If these animals are lost, the river becomes overrun by green algae. Since the main ways people rely on the forest is for drinking water and swimming, losing animals like shrimp harms humans as well.

Humans are now aware of the ecological consequences of dams, even small dams. Weighing dam costs and benefits, the question arises: are the trade-offs balanced? In addition to ecological and social costs, dam maintenance comes at a significant economic cost. Sediment builds up behind dams and needs to be dredged regularly for intakes to function. The actual structure of dams needs to be inspected and reinforced to prevent failure. All this combined with ecological and social impacts has people questioning world-wide if dams are worth the continued investment. While Erin and Jess both agree dams provide valuable services, they also believe there are dams that should be reevaluated. If these dams aren't worth continued investment due to ecological, social, and economic costs, then it may be time to consider removal.

Left: Juvenile freshwater shrimp, climbing along the river shore, returning from the ocean. Shrimp do not migrate upwards if there is no water in the channel, and populations will eventually die out (credit: Luquillo Long Term Ecological Research Project). Top: Erin participated as a scientist on two raft trips down the Colorado River with Grand Canyon Youth and the US Geological Survey. She taught high school students the importance of sampling aquatic insects. Above: Erin poses in her inflatable kayak on the Chattooga River. Erin led Jess down a 10 mile stretch of Class II and III intermediate whitewater. Right: Jess and Erin celebrate a colleague's wedding in September 2018. Who knows what's next for them after they finish their PhDs.

Create a Career **From PhD**

Jess and Erin plan to pursue leadership positions in conservation to directly affect how freshwater is conserved and managed in the United States. Though they recognize that career plans change, they see importance in developing their plans for the future. Writing a career plan helped them determine which connections and skills they should focus on developing in graduate school to be most effective and competitive in their chosen careers, whether it's in academia, agency, non-profit, etc.

If it seems like Erin and Jess have it all figured out, it's only because they've been thinking about these issues for a while. Over the last several years, they've learned the importance of a support network, but also the necessity of relying on yourself. Although PIs and advisors can encourage graduate students to explore various career paths, students must often seek advice independently. Academics may only know academia, so it has been helpful for Erin and Jess to talk with conservation researchers working for agencies and non-profits. Erin and Jess have learned to maneuver within their contact networks, pushing for introductions to researchers working on projects they aspire to be a part of.

Additionally, they've pushed for and attended department-sponsored events in which graduate students talk with professionals involved in conservation. Oregon State University's Integrative Biology Department has brought in individuals from Microsoft, ESRI, the Environmental Protection Agency, and the Bureau of Land Management. Meanwhile, the University of Georgia's Odum School of Ecology has invited researchers from the Nature Conservancy, US Fish and Wildlife, Army Corps of Engineers, and SESYNC to discuss their work. Erin and Jess continue to take advantage of opportunities like these to develop their career plans, both on campus and at professional meetings. Of course, they also make time to create lasting friendships with colleagues and maintain them. Although they still get anxious about chapter deadlines, grading papers, and comments from reviewer #3, having friends to lean on/ paddle with and a plan in hand keeps them energized and focused.

"I think this is Bull Sluice! Let's pull over and check it out," Erin shouted as she calmly started paddling away from the roar of another waterfall. Jess shot Erin a look of pure terror and made a bee-line for the shore. Erin and Jess had decided earlier that they would portage around Bull Sluice, a Class IV rapid with a two-tiered 15ft waterfall. But unfortunately, they had pulled over on the side of the river that was across from the portage path. They were just 20-ft upstream of the waterfall and would now have to paddle across the swift current.

"Once you hit the current, paddle hard," Erin said. Jess watched as Erin ferried herself easily across the river, telling herself that she could also do this. Erin parked her boat and waved Jess over. Digging in hard with each stroke, Jess quickly reached the other side.

"I knew you had that," Erin said with a smile. On solid ground, the two women sat and watched the water thunder through Bull Sluice, appreciating the power of the untamed river. The take out was just around the bend, but neither Erin nor Jess was quite ready for the trip to end.

They recognized that although challenging, this adventure had been one of their best. Going outside their comfort zone, trusting themselves and each other, had been rewarding and served to strengthen their friendship, much like their experiences in graduate school. Exploring this free flowing river in the southeastern US, a rarity, had reminded them of the broader purpose of their research and why they had originally picked their PhD projects.

Before climbing back into their kayaks to float to the car, Erin and Jess took one last look at Bull Sluice and shared a smile, proud of what they had achieved. They will have to continue to rely on each other so that they can reflect on their graduate careers with the same fondness.

GRADUATE PERSPECTIVE

LESSONS FROM EMBRACING THE UNKNOWN

PROPOSING & CONDUCTING PRE-DISSERTATION RESEARCH

Writing a research proposal is writing about the unknown. This is especially true for predissertation projects, which provide doctoral students with place-based insights to facilitate the development of feasible research questions for a successful dissertation. Predissertation work helps students in interdisciplinary conservation programs foster understanding of local conservation issues and establish cross-discipline collaborations. However, planning and funding are required to do predissertation work, which means that proposals need to be written and research questions posed. The challenge of proposing predissertation research, in part, is coming up with initial research questions to develop viable, future research questions.

As a first-year graduate student, I experienced doubts that come with proposing research yet-to-be-conducted. My preliminary research would be in Brazil, an area of the world I knew little about; in Portuguese, a language I had never studied; and on water management, a topic I was just beginning to learn about. Throughout the proposal-writing process, and even during my time in the field, I doubted my research interests, questioned what I was doing, and considered going in a completely different direction. An inherent trust in trying something new helped me to better define my research interests, as I continue to carve out my path toward a dissertation project.

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Departement of Anthropology
Integrative Conservation Program (ICON)

UNIVERSITY OF GEORGIA

From Unknown **To Opportunity**

In fall 2017, I started my PhD studies in Anthropology and Integrative Conservation (ICON) at the University of Georgia (UGA) without a clear idea of what or where I wanted to study. ICON is an interdisciplinary program among the departments of anthropology, geography, forestry, and ecology. The program encourages students to explore complex conservation challenges from multiple perspectives. When I applied to UGA, I had originally proposed to do research in Spain, where I had lived since graduating from the University of Michigan. However, I later decided that for my dissertation, I wanted to expand my understanding of diverse cultures and how people relate to their environment beyond my second home in Spain. So, I spent my first year of graduate school trying not to worry about lacking a research focus and at the same time, managing the implicit pressure of coming up with a topic.

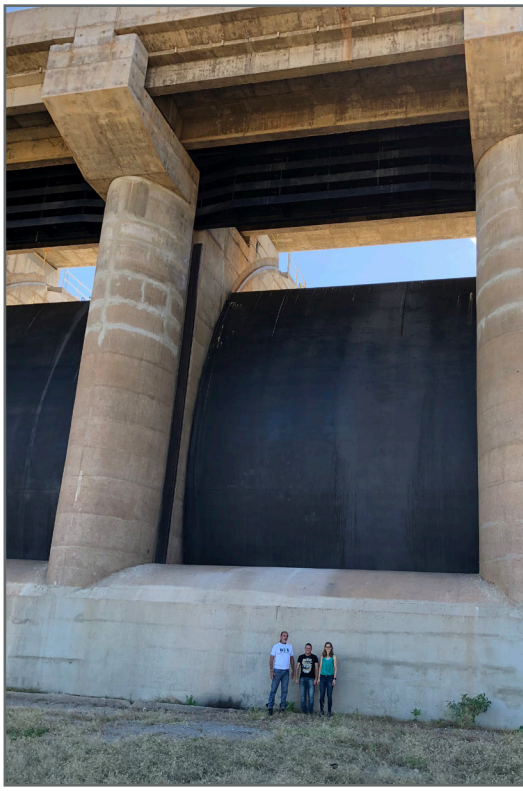
But ultimately, a doctoral student must decide on a research topic. So, how could I come up with that idea? In my case, the answer ended up entailing choosing something and going with it—reading the literature and seeing where it could take me.

During my first semester, my advisor offered me the opportunity to collaborate on an interdisciplinary project that was investigating water management in Brazil. I developed a comprehensive literature review on adaptive management to identify the characteristics of water management systems we would analyze. The project provided me with a potential place to conduct my dissertation research, as well as an initial direction to formulate my own research ideas.

As I worked on the water-management project, I began to see how one of the topics I identified, the role of different types of knowledge in decision-making, reflected my general research interests. I read how scientific knowledge is generally prioritized over local knowledge in decision-making, which influences how decisions are made and whose voices are heard in this process. In a decisive conversation with my advisor, in which I proposed to explore the types of scientific information used in Brazilian water-management decisions, Brazil went from a potential place to do research to a definite one; the question went from what would I study and where to how.

My advisor and I agreed that going Brazil over the summer would give me important place-based, understanding of the country I had, up until that point, only read about. Because I did not speak Portuguese, a logical course of action was to spend the summer learning Portuguese, and I therefore applied for UGA's summer Foreign Language Areas Study (FLAS) fellowship to do an intensive Portuguese language course in southeast Brazil.

At the same time, my advisor suggested that I try to get funding to visit Ceará, in northeast Brazil, where my future research would be based. So, I applied for three predissertation research grants. Before I submitted these proposals, however, I found out that I was not awarded the FLAS scholarship, which fundamentally changed my summer plans. On one hand, I would not be doing the language studies I had counted on. On the other hand, I could spend more



"My preliminary summer research would be in Brazil, an area of the world I knew little about; in Portuguese, a language I had never studied; and on water management, a topic I was just beginning to learn about."

"The unknown is typically unspoken and implicit."

time engaged in actual research. As I expanded my proposals, though, it bothered me that the language I was using seemed to convey more confidence than I really felt about the "risk assessments" and "water allocation scenarios" I was proposing to study.

When I brought up my doubts to my advisor, he told me that if I already understood everything, I would not be proposing research to study these topics. Conversations with others in the ICON program helped me understand that while my professors and fellow PhD students agreed that writing research proposals is writing about the unknown, within the proposals themselves, the unknown is typically unspoken and implicit. At the same time, the process of writing and rewriting my summer research proposals helped me identify more specifically how my research could fill a gap in knowledge and also what I would need to learn in order to answer my overarching question of how scientific knowledge was developed, shared, and used in water-management decisions in Ceará, Brazil. My research plan emerged through the proposal-writing process; by the time I submitted my proposal I was able to visualize my future research.

In the end, I was fortunate to receive the funding necessary to carry out my proposed research. I was heading to Brazil! However, the realization that I would actually be going to Fortaleza to do the research I had proposed made me question the confidence I had gained while crafting my research questions and methods. I felt fear of going to an unknown, potentially dangerous, place with no local contacts.

Two UGA-based encounters—and the relationships that subsequently developed—helped transform my fears into excitement to immerse myself in Brazilian culture and water management. First, in April, I met Amanda, a PhD student originally from Fortaleza who had come UGA to work with my advisor for a

week. About six weeks later, Amanda and I would meet again, but this time in Brazil. Although Amanda was living in São Paulo, she happened to be visiting her family during my first month in Fortaleza. Over the course of that month, Amanda treated me like part of her family and helped me acclimate to life in her city. Before leaving UGA for the summer, though, I also met Dr. Eduardo Martins, the president of the Cearense Foundation for Meteorology and Water Resources (FUNCEME), who was visiting UGA to discuss collaborative projects with my advisor. I had the opportunity to meet with Dr. Martins to explain the focus of my research, which he found interesting. When I brought up my concerns about working in Fortaleza, Dr. Martins offered support, a workspace at FUNCEME, and help establishing connections in other state agencies, which would be necessary to carry out the research I proposed.

Three weeks later, and feeling a mix of excitement and fear, I arrived in Fortaleza. The support from FUNCEME was fundamental as I adjusted to the tropical humidity of northeast Brazil. Yet, the first two weeks of my stay still proved challenging. For example, I quickly learned that running at midday was only a thing a naive foreigner would do. At the same time, I feared that my limited Portuguese would a barrier to any research I proposed, research for which I realized I did not know where to start.

Feeling overwhelmed by these initial challenges, I returned to my research plan and remembered that facing the unknown was part of the process. Eventually, things started falling into place. My Spanish helped me to cultivate a sufficient level of Portuguese to understand the meetings I attended and to actively participate in conversations. Additionally, Dr. Martins helped me schedule interviews and facilitated my visits to field sites outsides of Fortaleza, while a researcher at FUNCEME became my go-to for everyday doubts. At the same time, outside of research life, I joined a running group and soon felt part of a close-knit community in an initially isolating city.

On the plane ride back to United States, I was already looking forward to my next time in Fortaleza. During my two months in Brazil, I not only investigated the research questions I had proposed but also established contacts at state agencies, within the river-basin committees, and at different universities. These contacts facilitated my research over the summer and will be fundamental as I pursue further research in the region. Every conversation, encounter, and experience I had during my fieldwork has contributed to my overall perception of the culture of Ceará. I more intimately understand how water-related conflicts and inequalities permeate daily life in the region. An inherent trust in trying something new guided me as I wrote my proposals and ventured off to Ceará. It also helped me to develop a deep appreciation for the Brazilian landscape where I will continue to work and learn over the course of my graduate studies.

The process of proposing and carrying out predissertation research makes the unknown a little more familiar. At the same time, predissertation research enhances interdisciplinary doctoral research by providing students with the opportunity to foster local collaborations and to gain a deeper understanding of local conservation issues. Because of my experience this summer, and as my dissertation proposal evolves, I am more equipped to propose to study new unknowns, which is what research is all about.

"Every conversation, encounter, and experience I had during my fieldwork has contributed to my overall perception of the culture of Ceará"

A PRAGMATIC APPROACH TO STREAM RESTORATION

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The Anthropocene, our present age, faces the task of remediating environmental degradation that follows from rapid industrial growth and a shift towards consumer-based economies. Ecological restoration is a discipline and practice that attempts to mitigate environmental damages with a hope that restorative measures can repair ecosystems subject to ongoing and/or prior degradation. Our current Western neoliberal sociopolitical economic structures have popularized the use of ecosystems services (ES), in general, and Natural Channel Design (NCD), specifically as a means of stream restoration, as the methods employed to mitigate these damages. One reason being that ES and NCD have correctly identified that science, society, economics, and politics are inseparably linked. However, the problem is not knowing how to link science and social goods, rather it is that we do not agree on what is a social good; this "epistemic problem has a moral complexity" for which we lack the understanding of whether our choices, in the end, are good or bad [1]. In other words, we lack the appropriate knowledge to accurately assess the consequences of our current restorative actions and their future impacts.

Natural Channel Design is an ecological restoration and stream mitigation method that stems from the scientific and ethical tenets and approach of (ES). NCD is widely employed by government agencies and private industries as the primary method for restoring rivers, especially in the Eastern United States. Ecosystem services are a market-based approach that seek to monetize the value of ecosystems as they relate to anthropocentric concerns. Proponents of ES argue that the monetizing of ecosystem goods and services is a means to secure more efficient trade-offs between societal demands and scarce resources [2]. Therefore, arguments for ES seek to balance societal demands for cheap fuel, goods, and development with the notion that societies also need clean air, water and ecosystem stability. But are economic markets the best evaluators of ecosystem values?

In response, I offer American Pragmatism as an alternative approach to ES and NCD, specifically the pragmatism of Charles Peirce. I argue that economics is a deficient means to assess ecosystem value and offer a pragmatic approach as an alternative approach for valuing ecosystems, particularly fluvial systems.

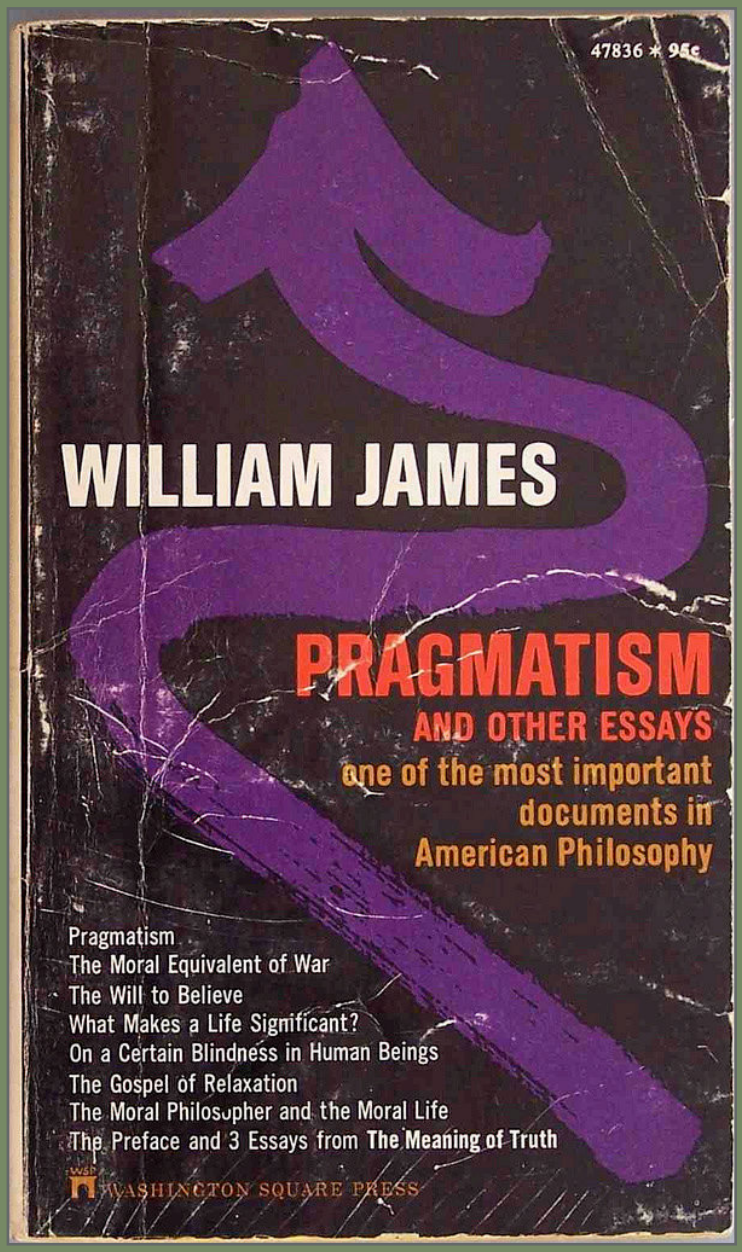
Pragmatism, which began as an American philosophical movement by Peirce and others, attempts to answer the moral complexity posed by the epistemic question of 'goods' by asserting that 'goods' are fulfillment of 'ends'; 'ends' being the outward expression of function/purpose. Pragmatism, being foremost a theory of truth, as Peirce contends, is a method for arriving at the true meaning of "any concept, doctrine, proposition, word or other sign" [3]. Therefore, a pragmatic approach to stream restoration is predicated on ascertaining the truth of what it means to say something is a stream. Peirce further defines pragmatism as – "the principle that every theoretical judgement expressible in a sentence in the indicative mood is a confu-

sed form of thought whose only meaning, if it has any, lies in its tendency to enforce a corresponding practical maxim expressible as a conditional sentence having its apodosis in the imperative mood". In addition, Peirce claims that pragmatism is an "inseparable connection between rational cognition and rational purpose" [3]. All to say, if I desire y (and I believe y to be true), then I should do x to achieve y. If what I mean by a stream y is that it has x traits, then any restoration project should seek to restore traits x so that stream y emerges out of the relationships of those traits interactions.

The word 'stream', 'river', or a blue-line on a map are signs which stand in a semiotic relationship with their object and our perception of what it means to be a stream. To claim that an object is a stream is to make ontological claims about its necessary and accidental properties. Peirce's early definition of the pragmatic maxim bears this out – "Consider what effects, that might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object" [3]. Therefore, to explicate what it means to be a stream is to systematize the necessary and accidental properties of a fluvial system. Necessary properties (universals) are moving water, bed load and suspended load, and supporting flora and fauna, etc. Accidental properties (local) are secondary properties such as bed material, headwater vs. valley bottom stream, flora and fauna species, etc. A stream is not a top-down process; simply building a channel and providing in stream structure (as NCD proposes to do) cannot encompass all the processes and interactions that define a stream. Rather, a 'stream' is a bottom-up process which emerges from the necessary and accidental properties of its members. Therefore, a pragmatic approach to restoration is predicated on the normative functions of a system.

In contrast, supporters claim ES provides a context for raising environmental awareness, consideration of environmental accounting, designing incentives and aid in quantifying economic compensation, during the litigation process, in light of environmental damage [4]. Yet ES focuses on the benefits that humans derive from an ecosystem [5] and, by design, fails to

"Economics is a deficient means to assess ecosystem value and offer a pragmatic approach as an alternative methodology for valuing ecosystems."



"Pragmatism, being foremost a theory of truth, as Peirce contends, is a method for arriving at the true meaning of 'any concept, doctrine, proposition, word or other sign.' Therefore, a pragmatic approach to stream restoration is predicated on ascertaining the truth of what it means to say something is a stream."

consider whether an ecosystem is beneficial in and of itself (intrinsic value) [6]. Even trait-based ES, which recognizes the complexity of ecosystems, opts for the generalization and simplification of ecosystem selected traits which are beneficial to humans [6]. Consequently, the ability to simplify and generalize makes ES adaptable and appealing to our current economic model — neoliberal capitalism.

The claim that the monetization of ecosystems can better account for how ES ought to be utilized appears untenable under our current economic system. Neoliberalism, generally speaking, is the prioritizing of individual needs over the collective, towards a universal expansion of competitive markets into all areas of life, including economics, politics, and society. Neoliberalism promotes the commercialization and privatization of science in order to support a marketplace for ideas and has shifted the focus of many environmental regulatory bodies. The neoliberal philosophy of competitive markets has caused regulators not only to ease environmental regulations perceived as hindrances on market growth but to adapt market-based solutions to environmental problems (e.g. cap and trade, and mitigation banking) [7].

Ecosystem services and NCD benefit in popularity because of their ability to translate value in the context of capitalist markets. Lave [8] attributes the widespread acceptance of NCD by regulators to its ability to adhere to the "central tenet of neoliberalism," namely the epistemological "claim that the market is the best information processor, [and] the only entity capable of accurately comprehending the world." Stream restoration, designed to aid in meeting state and federal water quality standards, is a billion-dollar-a-year industry [9] seeking to restore streams and their floodplains, which provide beneficial ES deemed necessary for human well-being [10].

What NCD provides is a metric that allows regulators and practitioners to assess restoration practices. As Lave points out, NCD is the only step-by-step guide which makes checking practices, such as channel reconfiguration, possible [8]. The widespread use of NCD despite the substantial number of academics in the geosciences who argue this method is inadequate to address the complex dynamics and open nature of riverine systems is evidence of NCD's ability to ingratiate itself to neoliberal markets [8,11,12].

Natural Channel Design assist the infiltra-

tion of neoliberal markets into environmental management via its use in stream mitigation banking. Stream mitigation banking attempts to offset stream degradation from new development by banking credit through the restoration of previously degraded streams at another location. Lave claims that NCD is the central metric for determining the condition of restored and degraded streams and without NCD stream mitigation banking might not be possible. Lave also contends that NCD success with, and the increase of neoliberal ideas into science management, has led even opponents of NCD into more market-focused research. While the neoliberal agenda continues to advance, many question the validity of ES methods, such as NCD, to address environmental woes using market-based approaches [8].

The use of cost-benefit-analysis as a means to assess the environment assumes that market-based approaches adequately capture ecosystem value [13]. Conversely, ES does not place a value on ecosystem constituents with no known anthropocentric benefits; instead, it suggests that economic value is the desired end rather than protecting ecosystems [13]. Harizaj states that "monetary evaluations represent always finite numbers. However large they could be, these numbers remain always smaller than the infinite value the world ecosystems have for humanity" [14]. In other words, there is no monetary value that can capture the importance of clean air, water, food, etc. for human flourishing.

Capitalism is not egalitarian when it comes to the ecosystem; capitalism is premised on the amassing of wealth and profit. Magdoff and Foster contend that multinational and transnational corporation's loyalty is to their bottom lines and, therefore, continue to exploit resources and people wherever they find them; much of this is done with help from political leaders who see it as their duty to further corporate interests, through market growth, as the best means to serve public interest. Furthermore, they maintain that the greenwashing of corporations and public consumption of 'green' technology allows corporate exploitation of resources and people [15].

ES supporters believe that "on balance it is safe to say that the exploitation of ecosystems has greatly benefited humankind and increased human well-being, but if humankind continues this way the costs of overexploitation are likely to exceed the benefits at some point" [16]. First, there is an unstated assumption that our current level of existence is in some sense optimal (Western culture), that other cultures and civilizations past and present are in some sense inferior. Second is the idea that we have not already reached the point when our benefits no longer exceed the costs. As Madoff and Foster point out, individual greed drives capitalism through consumption, and human needs are met as a by-product [15]. Ecosystems are not consumers and therefore their needs are not met as a by--product of consumption.

Therefore, ES methods, such as NCD, in their attempt to direct sociopolitical outcomes, using market strategies are, in some way, facilitating environmental degradation – if not through neoliberal policies than due to their inability to fully assess the moral complexity of decisions related to ecosystem dynamics. For example, Lave states that NCD uses non-deformable structure (i.e. boulders, wood structures) as a means for creating channel equilibrium (stationary channels) and fails to address steam biology or ecology in the restoration practice. Conversely, a pragmatic method would incorporate meandering channels as well as biological and ecological conditions as necessary properties. NCD frequently claims that when stream bank erosion is threatening to collapse a barn into the river, there is no time to study it, rather, immediate action is required [8]. Pragmatism is sympathetic to NCD's dilemma; however, stream bank erosion is a natural symptomatic response to upstream processes, and pragmatism would argue that maybe the barn needs moving, not the bank needs hardening. Pragmatism also differs from ES on principles. Where ES would seek to restore a stream in order to provide anthropocentric benefits, pragmatism strives to restore a stream to its own ends, and in doing so considers anthropocentric benefits as possible traits alongside other accidental properties constituted into what it means to be a stream.

Instituting the pragmatic method as a means

for stream restoration will inevitably require a paradigm shift in restoration ecology. Pragmatism, unlike ES and NCD, does not fit within the tenants of neoliberal market-based environmental management. Pragmatism intends to promote restorative practices that recover what it means to be a stream. This method is closely aligned with the academic geosciences which promote function over form. Pragmatic stream restoration may provide more flexibility in the restoration practice as it recognizes that, in some cases, what is needed is not instream channel reconfiguration; rather, out-of-channel solutions (for buildings, run-off control, etc.) might be the better place to focus restoration methods and expenses.

REFERENCES

1. Briggle AR. Opening the Black Box: The Social Outcomes of Scientific Research. Social Epistemology. 2014 Apr 3;28(2):153–66.
2. van Beukering PJH, Brouwer R, Koetse MJ. Economic values of ecosystem services. In: Bouma JA, van Beukering PJH, editors. Ecosystem Services: From Concept to Practice. Cambridge: Cambridge University Press; 2015. p. 89–107.
3. Peirce CS. Collected papers of Charles Sanders Peirce / edited by Charles Hartshorne and Paul Weiss. Vol.5, Pragmatism and pragmaticism. Cambridge, [Mass.]: Harvard University Press; 1934.
4. Dendoncker N, Keune H, Jacobs S, Gómez-Baggethun. Inclusive ecosystem services valuation. In: Jacobs S, Dendoncker N, Keune H, editors. Ecosystem Services: Global Issues, Local Practices [Internet]. Saint Louis, UNITED STATES: Elsevier; 2013 [cited 2018 Sep 11]. Available from: http://ebookcentral.proquest.com/lib/bham/detail.action?docID=1495656
5. Millennium Ecosystem Assessment. Ecosystems and human well-being. The Assessment Series. Washington, D.C. 2005.
6. van Beukering PJH, Brouwer R, Koetse MJ. Economic values of ecosystem services, p. 89-107.
7. Springer, S., Birch, K., MacLeavy, J., 2016. Handbook of Neoliberalism. Routledge, London, United Kingdom.
8. Lave R. Fields and Streams: Stream Restoration, Neoliberalism, and the Future of Environmental Science [Internet]. Athens, UNITED STATES: University of Georgia Press; 2012 [cited 2018 Jun 30]. Available from: http://ebookcentral.proquest.com/lib/bham/detail.action?docID=1222471
9. Bernhardt ES, Palmer MA, Allan JD, Alexander G, Barnas K, Brooks S, et al. Synthesizing U.S. River Restoration Efforts. 2005:26.
10. Palmer MA, Filoso S, Fanelli RM. From ecosystems to ecosystem services: Stream restoration as ecological engineering. Ecological Engineering. 2014 Apr; 65:62–70.
11. Miller JR, Kochel RC. Use and performance of in-stream structures for river restoration: a case study from North Carolina. Environ Earth Sci. 2013 Mar 1;68(6):1563–74.
12. Simon A, Doyle M, Kondolf M, Shields FD, Rhoads B, McPhillips M. Critical Evaluation of How the Rosgen Classification and Associated "Natural Channel Design" Methods Fail to Integrate and Quantify Fluvial Processes and Channel Response1. JAWRA Journal of the American Water Resources Association. 2007 Oct 1;43(5):1117–31.
13. Spangenberg JH, Settele J. Precisely incorrect? Monetising the value of ecosystem services. Ecological Complexity. 2010 Sep;7(3):327–37.
14. Harizaj PR. Pricing Nature: Failing to Measure the Immeasurable. Albanian Journal of Agricultural Sciences; Tirana. 2015;14(3):206-213H.
15. Magdoff F, Foster JB. What every environmentalist needs to know about capitalism. In: Newell P, Roberts JT, editors. The Globalization and Environment Reader [Internet]. Hoboken, UNITED KINGDOM: John Wiley & Sons, Incorporated; 2016 [cited 2018 Sep 12]. Available from: http://ebookcentral.proquest.com/lib/bham/detail.action?docID=4499566
16. Bouma JA, van Beukering PJH. Ecosystem services: from concept to practice. In: Bouma JA, van Beukering PJH, editors. Ecosystem Services: From Concept to Practice. Cambridge: Cambridge University Press; 2015. p. 3–22.

Marsh Creek Restoration at Creekside Park, City of Oakley, before (left) and after (right) resotration (credit: Restoration Design Group).

WOMEN OF NATURAL RESOURCES

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University of Arkansas at Monticello

The origin story of Women in Natural Resources at the University of Arkansas at Monticello is, we think, not unique. Nonetheless, it is ours. Female undergraduates, graduate students, and professionals in the conservation and natural resource fields have and continue to have the same experiences that initiated our genesis and journey.

Our story begins in the fall of 2016. Female enrollment had reached an all-time high in the School of Forestry and Natural Resources. Although it was an uptick, upon arrival on campus it was hard not to see how few female SFNR students there still were. Compounding that were the exceptionally few female SFNR faculty (two at that time and none as we write this article). Everywhere we looked our peers, our instructors, were male.

There is nothing inherently wrong with gender-skewed departments or disciplines. Our program is built on a tradition of forestry and training forestry professionals, which is historically male-dominated. So it is no surprise that that legacy has a tendency to skew the gender makeup of students and faculty. And in the past few years, the program has attempted to increase enrollment of minority groups. The male-dominated setting and legacy did not, by itself, inspire the creation of WNR but it does set the stage for our origin. A number of incidents inspired us, they were not singular but commonplace.

The occurrence we describe below is illustrative of what many female students in natural resources programs can encounter and experience in a male-dominated landscape. Our characterization of the event is obviously subjective. Our intent is not to claim that we were wronged or to provide others with objective proof that we were wronged; we simply aim to describe the types of incidents and experiences that galvanized us and provided the catalyst to create WNR.

It was a warm sunny day in early summer. And by warm, we mean hot and humid; we are in southeast Arkansas, y'all. A group of students are collecting samples around a giant, heavy soil sampling auger in a lonely mixed stand in the university's campus forest. Per our instructor, the goal of this exercise is to gain experience with how this machinery is setup and operates and to successfully collect viable samples for analysis. Simple enough, a classroom activity to learn how and why it works and then use it for a practical application.

A group of male students are given instructions on how to operate the equipment and given the opportunity to do so (with supervision). Then a few female students are ready to be given instructions and operate the machinery. The instructor shows us what do, providing instruction and a walkthrough. However, we are not given the same opportunity to operate and understand the equipment. Instead the physical task of operating the auger, and practical experience of obtaining a soil sample was taken from us, withheld, by the instructor. He wanted to help us, and he did, but it also resulted in a missed opportunity for us. Instead of having the opportunity to learn and do an exercise that is part to the course curriculum, and something a practitioner in the career fields we aspire to should have knowledge and experience doing, we were left wanting. To add to the injury, this event also included a one young woman being told by the instructor that preparing the soil samples is "just like cutting cookies."

This incident may seem small and insignificant, even trivial, but it was not an isolated incident. It is a symptom of a culture that impacts us and other women in STEM fields. For us, upon reflection by the group who experienced it, it boiled down to nothing less than feeling we were denied the same education, experience, and practical learning opportunities as male students under the same instructor and course, intentionally or not.

Women in **Science**

Science is male dominated. Natural resources and conservation fields, much like STEM fields, face issues of sexism, bias, harassment, disregard, aversion, and recognition. Eileen Pollack, author of "Why Why Are There Still So Few Women in Science?" and "The Only Woman in the Room", recounts the frustration she felt when, upon graduating among the top of her class at Yale, she received little encouragement to continue on in the sciences. Returning to Yale decades later, her work outlines the persistent and systemic cultural, social, psychological, and institutional facets of gender bias and the tremendous, often unspoken, barriers these pose to women in the sciences.

In the natural resources field, calls for gender equality began as early as the 1920's, particularly in the US Forest Service, whose history often typifies the barriers and challenges women face. For example, in 1973, discrimination lawsuit was filed after a hiring manager stated he would rather wait for a male applicant than hire a qualified female. Nearly a century later, in 2008, Forest Service Chief Tony Tooke resigned in the midst of sexual miscount allegations. In 2016, Krista Langois showed that the legacy of harassment continues but that steps in the right direction are being taken.

In the sciences, overall, women face a similar reality. On the heels of the #MeToo and #TimesUp movements, a NASEM study found that sexual assault in the sciences (59% reported) is second only to sexual assault in the military (68%). The aftermath of which is student tardiness, absenteeism, and declining grades. The end result being a vastly different educational experience compared to that of men. Coupled with day-to-day sexism and harassment, women face an uphill battle just to find equal footing with their male counterparts.

Gender biases are not unique to the United States. Female scientists in Africa often abandon science after starting families because child care facilities are unavailable in work settings. Women scientists only account for 19% of researchers in south and east Asia. However, some Asian countries are taking huge steps to ensure gender equality among science professions, even going so far as to set on hiring qualified female applicants. For the first time in Nepal's history, women work and earn their own wages. Job listings often detail that qualified women applicants will receive preference, as many agencies make strides to bridge the gender gap. In many cases, skilled women are chosen over men to conduct field research, as well. This does not mean that Nepali women do not work as hard or harder, they simply do not encounter the same biases and barriers to employment.

Parikrama Sapkota, a graduate student at our university and member of WNR, recounts that as a Nepali woman with a degree in biotechnology she never felt she would not be chosen for a position in her field simply because she is female; the experience of gender bias in the workplace was foreign to her. Since moving to the US, she has not experienced sexism from graduate students or professors but from student workers in the lab who fail to listen to her when she assignd them tasks or when they simply ask her major professor if those tasks need to actually be done.

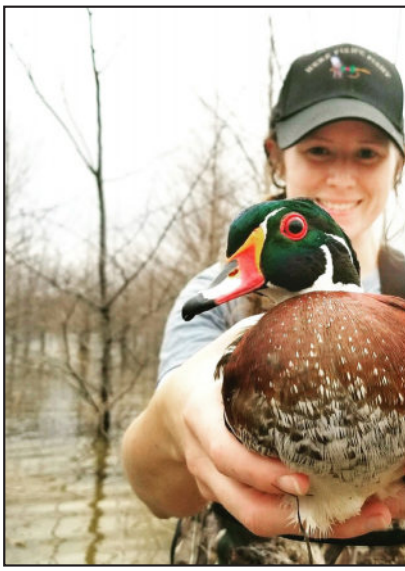
In the face of gender bias, femininity is often veiled or masked. Many women dress in plain, dark clothing with simple hairstyles to be taken seriously and not seen as a distraction. A recent study on authorship, in which sex was determined by name, found an alarmingly low number of females author scholarly articles even in fields where sexes are equally represented. It is not an uncommon practice for female authors of peer reviewed articles to choose gender neutral pen names. For example, both authors of this article have names that when shortened become gender neutral. Professionally, one shortens her name (Gabe) and the other used her first and middle initials (S. A.), all in an effort to be taken more seriously by reviewers and readers alike, lest we "publish or perish".

There are blogs and presentations geared toward women in science that tell them how to to dress, but more notably, how to act. One such presentation took place at a Women in STEM conference at Pulaski Tech in North Little Rock, Arkansas. The goal of this conference was to encourage women to enter STEM fields and to obtain advanced degrees, however during this presentation the speaker addressed topics like not wearing wedding bands to job interviews and not voicing strong opinions. She stated that women should not behave this way because they are often seen as aggressive, and other less flattering terms. She claimed that this behavior is fine for men because it makes them appear strong and goal-oriented, perfectly detailing the double standard, and negating the intended message of the conference.

The barriers and challenges women in science and academia — STEM, natural resources, conservation, or otherwise — face has been bolstered by contemporary events like the events the March For Science, #WomenInScience, #WomenInStem, and, notably, the #MeToo and #TimesUp movements. That is, women are not alone, and never have been; though we have all probably felt alone at one time or another. Organizations like the Association for Women in Science, 500 Women Scientists, and Women in Conservation Leadership provide support to women across the US and world. In the natural resources, and in Arkansas and the southeast, organizations like Arkansas Women in Agriculture, Women Owning Woodlands, Becoming an Outdoors Woman, and Artemis provide support, opportunity, and inspiration.

"As a woman, it is hard to fit seamlessly into the roles which we have, until recently, occupied sparingly. There are cracks and crevices, the mold is not quite fitted to form. We have to stretch to accommodate it."

Credit: Ron Key



Below: Jess (left) and Erin (right) at the end of their Twilight 5k run in Athens, GA. It was pouring down rain for most of the run, but they did it! Erin waits while Jess climbs up the rock face. Successful graduate students network with each other and make sure to have lots of fun.

It is human nature to take comfort in people who are like you and to be part of a "tribe", a group of like-minded individuals with similar backgrounds, goals, and aspirations. After the incident with our instructor and soil sampling, throughout the 2016 school year we found comfort and understanding among the female students of our program and the faces that became so familiar to us.

Out of this, Women of Natural Resources was born. It is a student organization dedicated to supporting women in fields like forestry, wildlife, agriculture, and other natural resources management disciplines. These fields, like our program, are traditionally male-dominated. At the University of Arkansas at Monticello, our mission is to ensure that women, and interested others, leave here with the same education, tools, and opportunity to succeed as men.

As a woman, it is hard to fit seamlessly into the roles which we have, until recently, occupied sparingly. There are cracks and crevices, the mold is not quite fitted to form. We have to stretch to accommodate it. As a woman from the southeast, studying in that same region, we often encounter cultural norms where men are invariably expected to be polite to women and women are invariably raised to expect such etiquette.

From this, the expectations for individuals entering natural resources fields and positions — fieldwork basics like driving a four-wheeler, side-by-side, or truck and trailer, wildlife techniques like live-trapping, handling, and field dressing, forestry basics like handling an axe, cant hook, or chainsaw, or other tasks placed in the domain of "man's work" — women are inadvertently deprived of these skills and experiences. Physical or demanding tasks are seen a "man's work" and has often led to, through personal experience, the man taking the task for himself. This creates a gap, some women think they they are notfully functioning member of the teak, a hinderance even. When the tasks are so skewed, she may even be so because she is not carrying her weight, so to speak. The crux of these issues is that these sorts of behaviors are considered polite, and in a cultural sense are not wrong. However, when these actions are taken from you it leaves your experience incomplete and a facet of your education that has been overlooked, neglected. If you are a woman in a natural resource or STEM field, you likely have a story similar to those we described.

The results of discounting these slights is not hypothetical but tangible. For those that never realized what they lost or were unintentionally denied, they come out of a higher education program lacking practical skills and experience that many men already have. For example, one of the big realizations WNR had was that, as a group, almost none of the women in our program knew how to properly load and ATV on a trailer. It is an area of expertise that many men have before they come to school at all, a skill that is taken for granted that everyone in our field has.

To improve our education and practical skills, WNR decided to take the initiative. Last year, our start-up year, a graduate student member hosted the first annual women's duck banding night. She, along with several male colleagues, taught WNR members proper duck banding procedures and techniques. It was a smashing success, which provided a great learning atmosphere and camaraderie. This year, our second year, we hope to tackle a few more areas. A small mammal trapping project is scheduled for the winter, as well as an ATV certification course and training session with those pesky trailers. By actively engaging and encouraging our female students with projects and training designed to fill in the gaps we are taking our education in our own hands and attempting to remedy the gender gap. In doing so, we hope to provide the workforce with women who are well-trained and ready to tackle anything thrown at them.

Our goal in creating WNR is not to facilitate more segregation of the sexes, indeed, it is the exact opposite. We hope that one day specialized groups targeting women and minorities in male-dominated fields will no longer be needed.

Join us

A Steppe Towards a Secure Future

Aligning people's socio-economic interests with wildlife conservation to conserve the critically endangered Saiga antelope in the Central Asian Steppe

Munib Sajad Khanyari
University of Oxford; University of Bristol
International Center for Conservation Sciences

On a seemingly never-ending expanse, green fades to gold as the fiery suns fades into the evening light. Sunsets on the Kazakh steppe are magical! The vast lands of Central Asia are now one of the few remaining homes of the strange yet fascinating Saiga Antelope (*Saiga tatarica*). The rather ungainly species once roamed widely over the steppes and semi-arid deserts from South-Eastern Europe to Mongolia and into China [1]. In fact, saigas roamed this planet well before the Woolly Mammoth (Mammuthus primigenius). Today, however, they are found only in five populations across four countries (Russia, Kazakhstan, Uzbekistan and Mongolia)[2].

Saiga are the true nomads of the steppe, travelling hundreds of kilometres in large aggregations on a seasonal basis to track resources in this rather harsh environment [3]. The sheer magnitude of this coordinated, tandem migration across the steppe is one of nature's greatest spectacles. To quote Pishchevich from 1884, "in the lands of the Cossacks (modern day Southern Russia and South-Eastern Ukraine), there were so many saigas that in places their herds covered the whole steppe."

Traditionally, saigas were hunted for meat by steppe communities and the male's horns were, and remain, highly priced for their medicinal value in Chinese Traditional Medicine (CTM) [4]. Throughout the Soviet Era of the 20th century, saiga numbers remained stable and were managed and harvested with an effective quota system accompanied by meticulous data collection. Through these years, the Soviet steppe was grazed by livestock in high densities under the government's collectivization scheme. Like saigas, they too would largely migrate between wintering ground (southern regions) and summer grounds (the central and northern regions of the country) [5]. Imagine this, if you can; literally, millions of saigas grazing the steppe alongside millions of livestock.

Like a flash flood that sweeps away all in its path, there came a rather sudden switch from collectivization to privatisation. With the fall of the Soviet Union in the early 1990s, livestock herders almost overnight lost the institutional support that helped them to maintain their large herds. Within four years, over 50 million livestock (mainly sheep, goat, cows and horses) were either slaughtered for meat or sold to keep the local's income and livelihood afloat (5).

Imagine yourself making a living in one of the most isolated and unforgiving environments in your country. Now imagine that almost immediately you no longer having access to the essential supplies, like medicine and medical care, you have relied on for years. On the rather lonesome steppe, people and families are several hundred kilometres away from any truly inhabited areas and the supply truck from Moscow, full of much needed supplies, does not arrive as it has consistently for years... and never again will... what do you do?

The Soviet Collapse had disastrous effects on saiga populations. Poaching for horns increased drastically, villages were abandoned, and hunting for meat increased to unsustainable levels [6]. Within a decade of the Collapse, saiga population across their historical range crashed to near extinction. Accordingly, the species was listed as vulnerable on the 1996 IUCN Red List and critically endangered in 2002 [6].

But there was another problem. Poaching targeted males and their valuable horns disproportionately more than females, who are hunted solely for meat. This resulted in a massively declining sex ratio. In a harem breeding species like saigas, we expect males to comprise about 25% of the population. Amid their population decline, males dropped to just 2% of the population in many places. And in 2001, researchers observed 1 male for every 109 females! This culminates in drastically low pregnancy rates and populations that struggle to sustain themselves on the steppe [7].

With populations in freefall, the newly formed Saiga Conservation Alliance (SCA), led by Dr. E. J. Milner-Gulland, began organizing on-ground collaborations across all remaining saiga ranges and countries under the shared goal of securing the saiga's future through action-driven research. Largely due to these collaborative efforts through the 21st

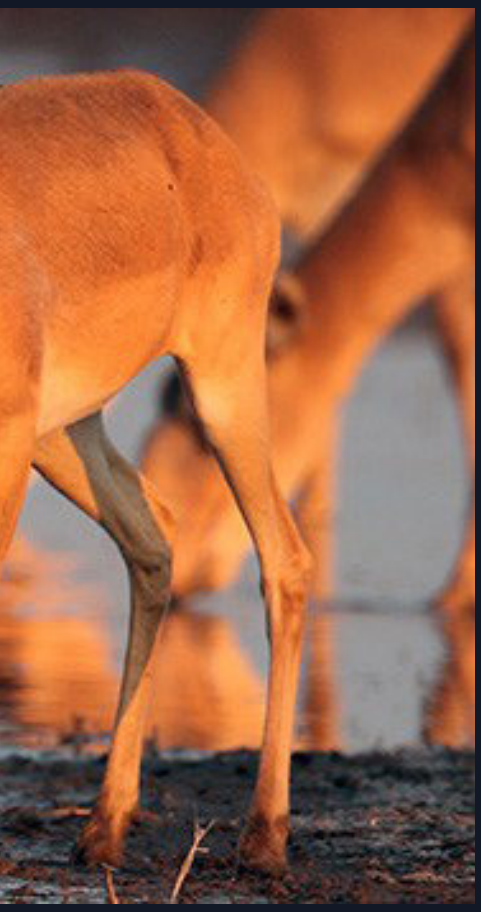
century, saiga are on the verge of a new dawn.

In 2015, monitoring revealed that current populations in Kazakhstan were on the increase for the first time in over a decade. There were more than 300,000 individuals in existence; a considerable increase from the predicted 50,000 in 2003. The Saiga Conservation Alliance's in-country Kazakhstan collaborators, the Association for Conservation of Biodiversity of Kazakhstan (ACBK), began monitoring saiga populations and movements in 2010. By 2014, observations suggested that herds were aggregating and selecting calving sites without incident. And in 2015, aerial surveys conducted by ACBK, in collaboration with the Institute of Zoology of the Kazakhstan Academy of Sciences, observed three main major herds in Kazakhstan: Ural, Ustiurt and Betpak-Dala (see map).

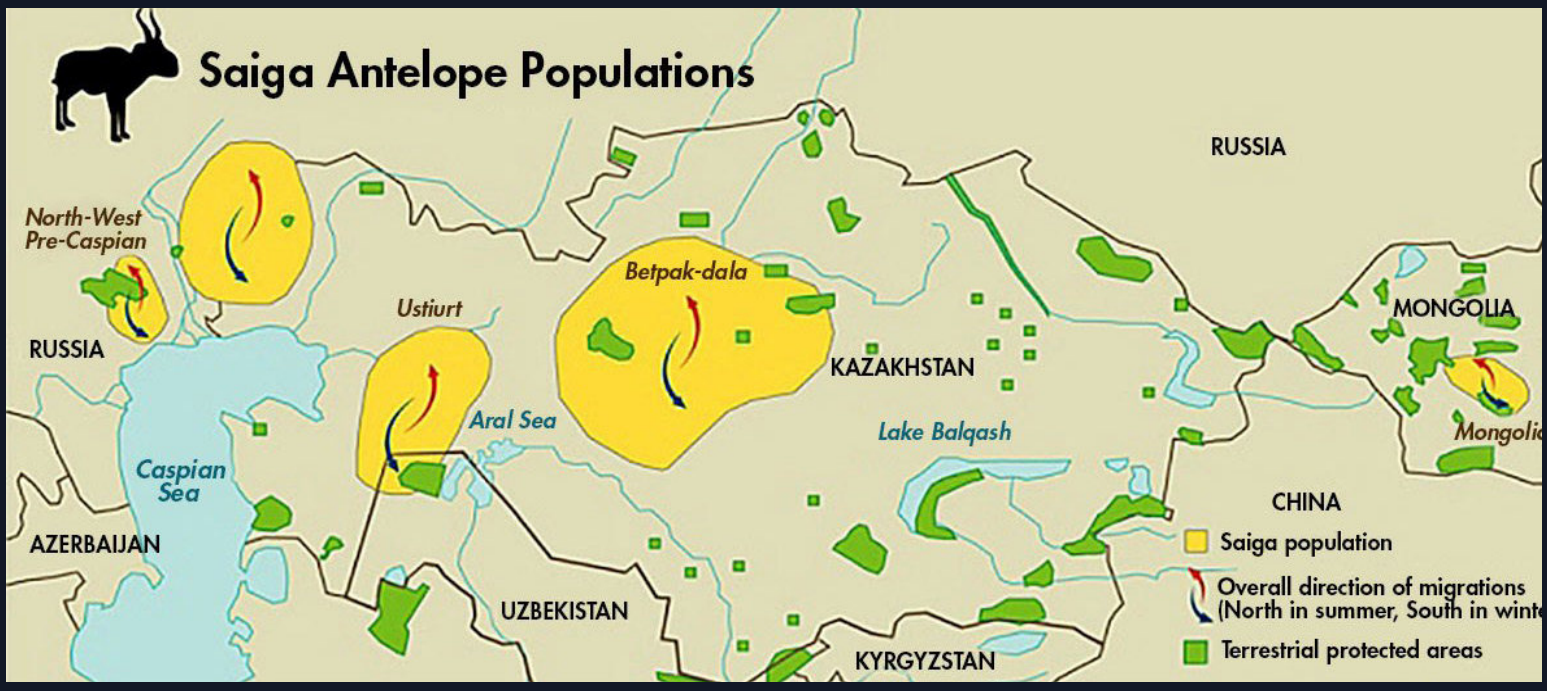
But the journey to a happy conservation story ending is never so straightforward. In Betpak-Dala, over a period of two weeks in 2015, the most unfortunate event unfolded; over 200,000 saigas were found dead across various calving aggregation sites. Males, females, young, all died as if a mass genocide was being orchestrated. This resulted in an 88% decrease in the Betpak-Dala population, which prior to the die-off constituted nearly 80% of the world's saiga population! Yes, conservation efforts by SCA and its collaborators were working, but it seemed like all their eggs were in one basket.

An interdisciplinary team of researchers and policy makers collaborated to investigate this mystery. They concluded the cause of death to be pasteurellosis, a bacterial infection, that caused haemorrhagic septicaemia. This was caused when the normally commensal bacteria, Pasteurella multocida, found in the oesophagus of saigas, found its way into the saigas' bloodstream. The viral outbreak was driven by unusually high temperature and humidity ten days prior to the onset of calving [8].

With that event, climate change became a clear and present factor in saiga conservation efforts, in addition to the challenges of growing and sustaining declining populations and breeding.



Top, left: Sunset group of saiga at watering hole (credit: Eugeny Polonsky, SCA). Top: Aggregating Saigas with face of farm in the background (credit: author) and a group of dead saiga female from one of the many aggregation in Betpak-Dala, 2015. (credit: Steffen Zuther, ACBK). Top: In today's world saigas are found solely in five population: (left to right) Pre-Caspian, Russia; Ural, Kazakhstan; Ustiurt, Kazakhstan-Uzbekistan; Betpak-Dala, Kazakhstan; Western Mongolian, Mongolian sub-species (credit: SCA). Next page: New born saigas employ the hiding tactic to avoid predators once they are born. Their body camouflages well with the dirt and dust of the steppe. Saiga new born are ready to walk within a day of being born (credit: SCA).



"By knowing more about a disease and its effect on wild and domestic species, the better we can design targeted disease management systems to address economic security, social well-being and conservation goals."

The Betpak-Dala mass mortality event (MME) was unfortunate in its timing and unusual with respect to its scale but MMEs caused by pasteurellosis and other diseases (foot and mouth, FMD) are not unpresented. But the Betpak--Dala MME highlights a critical point for conservation. With changes in seasonal climate increasing average temperatures, MMEs are likely to occur more readily in the future. Hence, conservation needs to invest in preventive measures to build saiga population to large enough sizes to survive with these events.

We need to establish collaborative and sustainable landscape--level conservation approach to facilitate coexistence between saigas, livestock, climate, and people so its migratory lifestyle may continue. This is especially key as post-Collapse livestock activities on Kazakh rangelands are increase with governmental support in the form of subsidies and policies [9]. This produces both a renewed threat of disease spill-over to saigas and opportunities to understand shared drivers of disease.

Though the Soviet Era reflects a rather peaceful co-existence, saiga did contract parasites and diseases from livestock, i.e. FMD. Some disease events required blanket vaccination for livestock herds to eradicate outbreaks in both domestic and wild ungulates [10]. For example, in winter 2016, nearly two-thirds of the Mongolian subspecies, Saiga tatarica mongolica died from the Petit Peste des Ruminants (PPR) virus. Saiga contracted PPR from livestock and the outbreak was exacerbated by reduced forage availability due to overstocked and overgrazed rangelands. Considering all of this, the Kazakh rangelands have seen few studies on parasites, diseases, and vectors, all of which can affect the critically endangered saiga. Disease surveillance and management needs to become proactive to conserve saiga.

My research aims to change that by building evidence and work with stakeholders to manage disease transmission between domestic and wild ungulates in the Kazakh rangelands. My research partners and I want to understand the effects of environmental and climatic change on the transmission of gastrointestinal nematodes – think of very small worms in the animals' stomachs – between migratory and domestic ungulates (between saiga and cows, sheep, goats, etc.). Knowing how diseases and parasites move between species, and how changes in climate and on the steppe landscape exacerbate this, we can more readily predict where disease transmission hotspots will occur (like shared watering holes) and begin identifying patterns and actions to control or mitigate disease and future MMEs. By knowing more about a disease and its effect on wild and domestic species, the better we can design targeted disease management systems to address economic security,

"The hope is our research and collaborations can be used to engage with herders and develop appropriate interventions to improve livestock health."

social well-being and conservation goals.

The hope is our research and collaborations can be used to engage with herders and develop appropriate interventions to improve livestock health. This serves the dual purpose of improving economic security to the largely resource-poor herders of the Kazakh steppe and wildlife conservation due to reduced spill-over to Saigas.

At this point, when I take a step back and ponder about the next steps and the potentially precarious future of a prehistoric creature, I am left ponderous. What a shame would it be to lose them in my own lifetime! As I overcome the fear of that thought, my mind wonders to the image of nearly 60,000 saiga females that I witnessed aggregating to calve in May 2018 on the steppes of Ural. I distinctly remember seeing the massifs of old farms dotting my horizon. People and their livestock were housed there going about their daily routine. Growing up we are nearly indoctrinated to believe that people and wildlife need to be two separate entities to thrive. But I remember thinking that this situation offers an opportunity to work alongside local people to understand them, and via this, work towards the conservation needs of the saigas whilst upholding local livelihoods and well-being.

REFERENCES

1. Cui S, Milner-Gulland EJ, Singh N, Chu H, Li C, Chen J, Jiang Z. Historical range, extirpation and prospects for reintroduction of saigas in China. Scientific Reports, 2017, 7: 44200
2. Singh N, Milner-Gulland EJ. Conserving a moving target: planning protection for a migratory species as its distribution changes. Journal of Applied Ecology, 2016, DOI: https://doi.org/10.1111/j.1365-2664.2010.01905.x
3. Bekenov AB, Grachev IA, Milner-Gulland EJ. The ecology and management of the Saiga antelope in Kazakhstan. Mammal Review, 1998, 28, 1-52.
4. Theng M, Glikman JA, Milner-Gulland EJ. Exploring saiga horn consumption in Singapore. Oryx. 2018, 52(4): 736-743.
5. Robinson S, Milner-Gulland EJ. Political change and factors limiting numbers of wild and domestic ungulates in Kazakhstan. Human Ecology, 2003, 31(1): 87-110.
6. Milner-Gulland EJ, Kholodova MV, Bekenov A, Bukreeva OM, Grachev IA, Amgalan L, Lushchekina AA. Dramatic declines in saiga antelope populations. Oryx, 2001, 35(4): 340-345.
7. Milner-Gulland EJ, Bukreeva OM, Coulson T, Lushchekina AA, Kholodova MV, Bekenov AB. Reproductive collapse in saiga antelope harems. Nature, 2003, 422, 135.
8. Kock R, Orynbayev M, Robinson S, Zuther S, Singh N, Beauvais W, Morgan E, et al. Saigas on the brink: Multidisciplinary analysis of the factors influencing mass mortality events. Science Advances, 4(1), DOI: 10.1126/sciadv.aao2314.
9. Kerven C, Robinson S, Behnke R, Kushenov K, Milner-Gulland EJ. A pastoral frontier: from chaos to capitalism and the recolonisation of the Kazakh rangelands. Journal of Arid Environments. 2016;127:106–119. doi: 10.1016/j.jaridenv.2015.11.003.
10. Morgan E, Lundervold M, Medley G, Shaikenov BS, Torgerson PR, Milner-Gulland EJ. 2006. Assessing risks of disease transmission between wildlife and livestock: The Saiga antelope as a case study. Biological Conservation, 131(2): 244-254.

INVESTIGATING IMPERMANENCE

Rachel E. Golden Kroner
George Mason University
Conservation International

I awoke in the darkness, gear packed. I joined my companions for the day, both avid birders, and prepared — but not to watch birds. Instead, we set out on a mission to visit a contested landscape in a remote corner of Peru. We drove for hours, passing rice and lime fields, watching the roads get more rugged and the dwellings more humble. We then hiked for two hours, wading down the Puyango-Tumbes River, which straddles the border with Ecuador. Early in the afternoon, we reached our destination: the spot where protections for the *Cerros de Amotape National Park* were cut back — reduced by more than 200-hectares — to authorize the construction of a dam for irrigation. In isolation, the small loss of protected land may seem insignificant, but this case is a microcosm. Protected lands and waters around the world face myriad legal, ecological, social, and political pressures. Their futures remain uncertain. Through site visits, as well as interviews with experts and archival research, I embarked on a journey to understand the history of Cerros de Amotape.

THE CASE OF PARQUE NACIONAL CERROS DE AMOTAPE, PERU

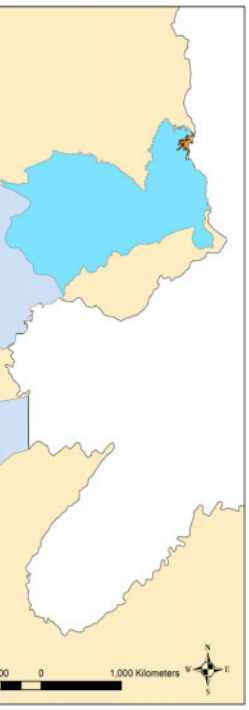
"Despite the intentions to establish them 'in perpetuity,' it's clear that that protected areas are subject to political bargaining, shifting and disappearing with the political and economic winds."

The story of the downsizing of Cerros de Amotape National Park starts decades ago, following a long history of conflict between Peru and Ecuador over territorial control. As part of post-war peace agreements, a Binational Accord between the countries was initiated in 1971, developed further in 1985, and approved in 1998. This accord prioritized the development of irrigation dam and reservoir projects in the Puyango-Tumbes region on the border of Ecuador and Peru. As context, lands slated for dam development were located, at the time, inside the Tumbes National Forest, which was established in 1975. Also in 1975, Cerros de Amotape National Park was established to protect rare and threatened dry forest ecosystems that are typically underrepresented in protected areas (1). It did not overlap with the Tumbes National Forest at the time. Later in 1994, the Tumbes National Forest was replaced with the Tumbes Reserved Zone, albeit with slightly different boundaries; the new reserve was implemented to help control and reduce logging (in Peru, Reserved Zones are a transitory category – sort of "pre-protected areas" – they are not yet fully protected but are usually intended to be officially designated as protected areas later).

In the remote corner of Peru, park boundaries remained in flux: the Cerros de Amotape National Park was expanded in 2006, replacing the lands that were previously part of the Tumbes Reserved Zone. In other words, part of the newly expanded portion of the National Park included lands on the border of Peru and Ecuador that were on the table for an irrigation dam project. The park's expansion became a source of conflict, as lands previously promised for a dam and reservoir were now locked up. From 2009 to 2014, the governments of Peru and Ecuador conducted feasibility studies to

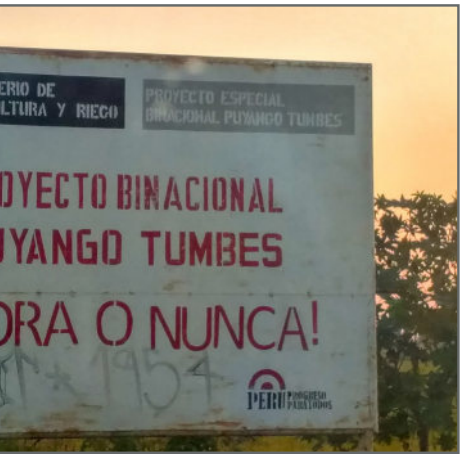
Left: Sign at guard house outside Cerros de Amotape National Park. Middle: sign supporting the dam project, "Binational Project Puyango-Tumbes – Now or never!". Right: sign supporting the dam project, "The future of Tumbes is the binational Puyango-Tumbes project".

consider alternatives for the dam project siting, until 2014, when both governments moved to stop feasibility studies and confirm development of the project. The presence of the National Park on the Peruvian side is likely to have held up implementation, but with pressure from the Ecuadorian government, the government of Peru passed a law reducing the Cerros de Amotape National Park in 2015. The park was "re-dimensioned" – reduced by 277.6344 hectares at the site where the dam would be built and forests flooded. As compensation, and perhaps due to backlash from researchers and environmental organizations, 483.87 hectares were added to offset the reduction. An unusual condition was added to the law: if the dam is not built by 2020, the downsized piece will be returned to the National Park. As of summer 2018 when I visited the site, dam construction had not started.



The ecological and social context of Cerros de Amotape National Park provide an important backdrop to understanding its fate. The park was established to safeguard its endangered dry forest ecosystem, which harbors high plant and bird diversity and endemism (2,3); the region is understudied, with two mammal species documented for the first time only three years ago (4). Despite the park's remoteness, threats persist, including habitat loss, fragmentation, cattle grazing, and hunting – all of which we observed on our journey (5). Lands deforested decades ago – even deep within the park – remain bare; tree growth in dry forests is extremely slow, as water scarcity limits natural regeneration and restoration (6). Conservation is a challenge, as the Tumbes region is one of the poorest in Peru, and the arid climate makes the need for water to support local irrigation palpable. Locally, the dam project is supported, perceived as

"As the global community comes together in the next year to discuss conservation targets under the Convention on Biological Diversity for 2020-2030, guardrails should be implemented to safeguard protected areas, ensuring that they can sustain nature and the people who depend on it."



CONSERVATION IMPERATIVE

"If protected places are not safeguarded, **we risk losing them, despite years of work to fight for their establishment**."

a welcome source of water. However – and this throws a wrench into the dam project plans – the waters in the region are contaminated by mercury pollution from mining upstream. Building a dam would not only inundate forests but would also fail to serve as an adequate source of water for crops or local use. This reality – compounded with the region's remote character, lack of passable roads, and inadequate funding for construction – have most likely prevented the dam project from moving forward. The dam would not only change the ecosystem and its hydrology, but would also lead to road improvements, expanding access to the region on the Peruvian side and enabling further deforestation.

What does this story mean for the future of protected areas in Peru and around the world? The downsizing of Cerros de Amotape is an example of protected area downgrading, downsizing, and degazettement (PADDD; (7)). Governments in more than 70 countries have enacted more than 3,000 cases of PADDD around the world (8,9). In Peru, this case represents the first time that a National Park – the protected area with the highest status – has been reduced (9,10) Because of this, conservationists have warned that the downsizing of Cerros de Amotape will set a precedent for other protected areas in the country; but notably, the law of 2015 states that the boundary adjustment would not constitute a prece-

dent. This case is unique because the reduction was compensated with an offset, which is a rare occurrence (9). However, the ecological character of the land downsized from Cerros de Amotape is quite different from the offset lands – dry forest vs. riparian moist forest. This raises questions about the nature of offsets to adequately compensate for lost protection. How much land is enough for an offset, and should it have the same ecological characteristics as where the protections were removed? How can we measure and verify this? With the lack of progress on dam construction, the downsize to Cerros de Amotape is likely to be reversed. However, this case reminds us of the impermanence of protected areas – and the importance of safeguarding them.

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Left: site removed from the Cerros de Amotape National Park to authorize construction of a dam. Right: the author at the site removed from the National Park. The boulder marks the spot within PNCA (Parque Nacional Cerros de Amotape).

REFERENCES

1. Miles L, Newton AC, DeFries RS, Ravilious C, May I, Blyth S, et al. A global overview of the conservation status of tropical dry forests. Journal of Biogeography. 2006 Mar 1;33(3):491–505.
2. Linares-Palomino R, Ponce Alvarez SI. Tree community patterns in seasonally dry tropical forests in the Cerros de Amotape Cordillera, Tumbes, Peru. Forest Ecology and Management. 2005 May 2;209(3):261–72.
3. Sanchez C, Saucier JR, Benham PM, Lane DF, Gibbons RE, Valqui T, et al. New and noteworthy Records from Northwestern Peru, Department of Tumbes. 2012 [cited 2018 Nov 16]; Available from: http://repository.si.edu//handle/10088/20895
4. Hurtado CM, Pacheco V. Nuevos registros de mamíferos en el Parque Nacional Cerros de Amotape, noroeste de Perú. Revista Peruana de Biología. 2015;22(1):77–86.
5. Piana RP, Marsden SJ. Impacts of cattle grazing on forest structure and raptor distribution within a neotropical protected area. Biodivers Conserv. 2014 Mar 1;23(3):559–72.
6. Vieira DLM, Scariot A. Principles of Natural Regeneration of Tropical Dry Forests for Restoration. Restoration Ecology. 2006 Mar 1;11–20.
7. Mascia MB, Pailler S. Protected area downgrading, downsizing, and degazettement (PADDD) and its conservation implications. Conservation Letters. 2011 Feb 1;4(1):9–20.
8. Mascia MB, Pailler S, Krithivasan R, Roshchanka V, Burns D, Mlotha MJ, et al. Protected area downgrading, downsizing, and degazettement (PADDD) in Africa, Asia, and Latin America and the Caribbean, 1900–2010. Biological Conservation. 2014 Jan;169:355–61.
9. Golden Kroner, RE, Qin, S, Cook, C, Krithivasan, R, Pack, S, Bonilla, OD, et al. The uncertain future of protected lands and waters. In review.
10. Forrest JL, Mascia MB, Pailler S, Abidin SZ, Araujo MD, Krithivasan R, et al. Tropical Deforestation and Carbon Emissions from Protected Area Downgrading, Downsizing, and Degazettement (PADDD). CONSERVATION LETTERS. 2015 May 1;8(3):153–61.
11. Tesfaw AT, Pfaff A, Golden Kroner RE, Qin S, Medeiros R, Mascia MB. Land-use and land-cover change shape the sustainability and impacts of protected areas. PNAS. 2018 Feb 8;201716462.

COLLABORATION ACROSS CONTEXTS

WHEN LANGUAGE AND PERSPECTIVE DIFFER

TEXAS A&M UNIVERSITY

Lauren Redmore & Erin Buchholtz
Texas A&M University
Applied Biodiversity Sciences Program

Collaborating across disciplines is no easy task. Miscommunications, mismatches, and misunderstandings are common, but rarely are missed opportunities. We found this to be the case when we undertook our own collaboration as students in the Applied Biodiversity Science (ABS) Program at Texas A&M University.

We were awarded an ABS Collaborative Multidisciplinary Research Award last year to expand our doctoral research and explore two species that could not be more similar and yet vastly different at the same time: people and elephants.

Erin is a landscape ecologist studying **elephant movement** in the Okavango Delta of Botswana and Lauren is an anthropologist studying **rural change and adaptation** to elephants in the same region. We are both Ph.D. Research Fellows with the Ecoexist Project, a Botswana-based non-governmental organization working in the Eastern Panhandle of the Okavango Delta that aims to foster **human-elephant coexistence**.

As the collaboration began, language and meaning were the unacknowledged elephants in the room. Even the term "coexistence," which has usage in common parlance, was an unanticipated barrier. In ecology, foundational works from Chesson and Warner posit that coexistence is the stable presence of two species in the same environment because of a balance between competitive interactions and other stabilizing mechanisms. To social scientists — particularly an anthropologist who studies of human-wildlife interactions — coexistence takes on a different meaning. From that perspective, it is the mutual acceptance of other's presence and can include attitudes and experiences of tolerance and acceptance. These definitional differences are reasonable enough considering that ecology has its roots in a positivist tradition while anthropology acknowledges, and even encourages, the placement of the self within the study system due to the sometimes subjective nature of interpreting others' culture.

How we define the concept serving as the nexus of our collaboration was important and a challenge that needed to be addressed. Perhaps less obvious was the challenge of working across vastly different spatial scales appropriate for studying human and elephant use of trees in this landscape. We compiled four years of movement data from 20 elephants in the Eastern Panhandle of the Okavango Delta and synthesized those with locations where people traveled to harvest firewood. Human movement data were the result of repeated firewood harvests Lauren participated in with 14 households over the course of four months while she lived in a remote village in the Eastern Panhandle.

For elephant movements, Erin needed a satellite to examine the broad range of elephant movement. But, in comparison, the collaboration needed a macro lens to understand how people move and the individual species of wood they collect. Lauren struggled to carry heavy bundles of firewood on her head through the deep Kalahari sand back to the village, while Erin struggled to decipher meaning out of the movements of two species that seemed to mutually avoid each other. Methods

from spatial ecology and for studying non-speaking animals lead Erin toward mechanistic "what" and "how" interpretations of elephant patterns. Meanwhile, through day-to-day ethnography, focal follows, and interviews, Lauren was able to parse out human motivations and preferences, delving deeper into the "why" behind their firewood collecting behavior.

This collaboration was a meaningful endeavor toward better understanding the complexity of interactions between people and elephants. Alone, ecological research will improve knowledge of elephant movement and preferences while ethnographic research explores what it means for the people who live with everyday threats of elephant encounters. Together, with a collaborative lens, we have found that it is impossible to explain the actions of one species without integrating the actions of the other. Our research has shown that multidisciplinary collaborations are critical to develop meaningful conservation research that allows for the emergence of systems-level complexity. The first academic product from our collaboration is a manuscript, currently under

Top, previous: Group photo (from left to right) of E. Buchholtz, field assistants Ipolokeng Katholo and Olorato Ratama, and L. Redmore around the village baobab tree. Middle: E. Buchholtz recording vegetation data in the field. Bottom: L. Redmore Lauren carrying a bundle of firewood. Left, opposite: Browsing elephant. Left: Two women harvest firewood in the Okavango Delta. Below: Elephant footprints along an elephant pathway where fieldwork was conducted.

review. We also look forward to sharing our results with the Government of Botswana, who can transform our work on human--elephant interactions around trees in to policy and on-the ground action.

Any collaboration is an ongoing, iterative learning experience. It would not have been possible without mutual respect between us and an openness to persevere through miscommunications and misunderstandings. We each brought our disciplinary backgrounds and theories to the table, but our collaboration persisted because of the shared passion for the work we do and the impact we believe it can have. We encourage others to intentionally build multidisciplinary collaborations in unexpected places for fruitful educational experiences.

PERSPECTIVES

Issue 8 December 2018