Center *for* Tropical Research

NEWSLETTER

March 2021 | UCLA Institute of the Environment and Sustainability | **www.ioes.ucla.edu/ctr**

Contents

Letter from the Director

It's been a dynamic year full of successes and challenges. While this newsletter focuses mostly on our recent successes, our challenges were – not surprisingly – dominated by COVID-19. Yet sometimes challenges create opportunities. With travel restrictions curtailing international travel for research since March 2020, we've engineered new ways of operating remotely. One has been a greater reliance on our collaborators and partners in Africa. Our pangolin project is one example. Before COVID-19 hit, CTR was planning extensive field research to collect samples for our conservation genomic project funded by the U.S. State Department and the National Geographic Society. Unable to travel there directly, our team began working more closely with colleagues already based in sub-Saharan Africa with great success.

Another challenge was how to continue our close collaborations with the many rural and indigenous communities we work with. At the beginning of the pandemic we brought hand-washing materials to assist communities and strictly limited further travel to remote areas, working instead with locals via cell phones and messaging. Despite these challenges, the Ebony Project reached its goal of planting 15,000 trees and the School for Indigenous and Local Knowledge was able to carry out its research and training efforts. Finally, we took advantage of the pause in international researcher visits to our field stations in Cameroon to make much needed repairs and do remodeling with funding from our recent NSF grant.

We are so very grateful to everyone who worked so hard to keep our research and conservation efforts on an upward trajectory.

Stay healthy and safe.

Tom Smith

FSML UPDATE AND FIELD KIT DEPLOYMENT

by Virginia Zaunbrecher

Conducting research in the rainforests of the Congo Basin, one of the world's most understudied ecosystems, just got a little easier.

The Bouamir and Somalomo Research Stations—run through a partnership between Cameroon's Ministry of Forestry (MINFOF) and the Congo Basin Institute (CBI)—are getting scientific instrumentation and amenities upgrades.

Located in the middle of the 525,000 ha Dja Faunal Reserve in southern Cameroon, Bouamir is home to more than 100 mammal species, 400 bird species and 2,000 plant species. Species include threatened African forest elephant (*Loxodonta cyclotis*), western lowland gorilla (*Gorilla gorilla*), chimpanzee (*Pan troglodytes*) and mandrill (*Mandrillus sphinx*), as well as many vulnerable species, including three pangolin species, black colobus (*Colobus satanas*), Bates's Weaver (*Ploceus batesi*), and the largest known breeding colony of the Grey-necked rockfowl (*Picathartes oreas*).

Since the mature tropical forest site opened to researchers and teaching groups in 2016 it has hosted over 1,600 person days. With screened platform tents for research, dining, and cooking, and open covered platforms for sleeping, the site is able to host anything from long-term sample collection trips to classes of up to 20 students. The Somalomo Research Station, which is located in a village on the edge of the Dja Reserve, is a staging ground for teams traveling to Bouamir, and hosts its own research on agriculture, anthropology, and anthropogenic effects on ecology. Sitting at the edge of human settlement and the protected area, it offers an important comparative site to Bouamir's mature tropical rainforest.

Located in the middle of mature tropical rainforest, Bouamir Research Station offers unique access to critical habitat in the Congo Basin. Photo credit: Shah Selbe, Conservify

A new grant from NSF's Department of Biological Infrastructure will enhance the scientific capacity of the two Research Stations. The ongoing improvements include:

1 **Installation of state of the art scientific equipment:** CBI, MINFOF and Conservify, a conservation technology NGO, are working to create a network of FieldKit sensors throughout the research site that can share data in real time using a low frequency radio wave (LoRa) network. Devices like camera traps, acoustic monitors, and environmental sensors can be linked to the LoRa network and monitored from camp. The FieldKit system is open-source, and Conservify plans to build out a series of tools to visualize, communicate, and share the data. Weather data from the station is now available here and here.

2 **Upgraded facilities:** New plumbing and other site upgrades will make the sites more comfortable for visitors and better accommodate support staff. New gravity fed showers at Bouamir and a new bathroom at Somalomo will provide some basic pleasures at the end of a long day of field work.

3 **More sustainable field stations:** New solar systems at both locations will increase electricity available for research equipment, eliminating the need for gas generators. The systems will also power lighting and outlets.

FieldKit's Jacob Lewallen installs a LoRa gateway high in a tree on the Bouamir inselberg in Cameroon's Dja Faunal Reserve
Photo credit: Peter Houlihan

CBI has also developed a support system for logistics, permit applications, research collaborations, research assistants, and ecoguards. Bouamir is a one day, 30 kilometer hike from Somalomo Research Station. CBI can coordinate porters to carry gear, cooks and cleaners, ecoguards to accompany teams, and Baka Research Assistants. The Baka are the local indigenous people of the area, traditionally hunter gatherers who have inhabited the area for millennia and have a deep knowledge of flora, fauna, and trophic interactions. Prior classes and researchers have found collaboration with the Baka to be unique and highly valuable, with one team researching giant pangolin crediting the collaboration with Baka Research Assistants as being critical to their success of capturing the first known camera trap video of the species in the wild to this collaboration. In addition to enhancing the research and teaching experience at Bouamir, employing Baka guides preserves and values their traditional ecological knowledge, and provides employment with fair compensation.

Caption: Field assistants from nearby communities provide local insights that deepen educational experiences and increase research productivity. Photo credit: Chris Sorenson

CBI has a strong commitment to building local scientific capacity, and works with all visitors to ensure that local students or researchers are included in visitors' research teams. CBI can assist visitors in finding relevant and qualified local collaborators or student researchers. CBI currently has funding available to pay some of the field costs for African researchers. The opportunity is open to all African researchers wishing to use the sites, although those from organizations affiliated with CBI have priority. Those interested in learning more about the site see stipends or about CBI partnership should contact me (zaunbrecher@ucla.edu).

CBI and MINFOF hope to have most of the planned upgrades to Somalomo and Bouamir completed by the time international travel becomes easier. Researchers and educators interested in using the sites can find more information here, or contact Dr. Kevin Njabo (kynjabo@ucla.edu). ■

Ambassador Visits Field Stations

The U.S. Ambassador to Cameroon visits with the local communities. *Photo credit: Vincent Deblauwe*

In December 2019, the U.S. Ambassador to Cameroon Peter Barlerin and other Embassy personnel visited CBI's Somalomo and Bouamir Field Stations, which involved the Ambassador and his wife making two 30 kilometer treks through the rainforest. The delegation met local communities, observed CBI programs, and learned about CBI's research.

The trip was extremely successful, and highlights the continuing support CBI has from the U.S. Embassy in Cameroon.

Cows, chickens, and pigs share common areas on a mixed animal farm in northern Cameroon. *Photo credit: Kevin Njabo*

ZOONOTIC INFECTIOUS DISEASES – WHAT ARE THEY?

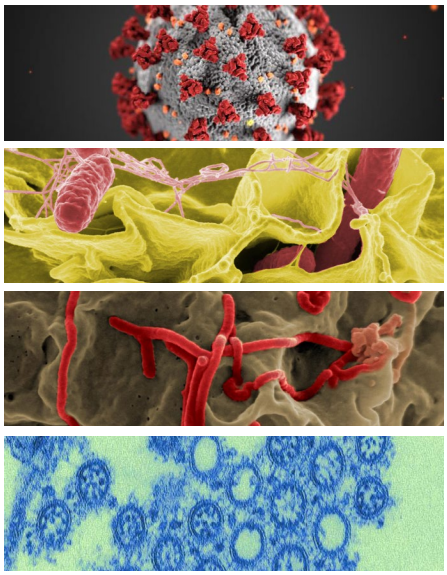
by Kevin Njabo

Since its inception, CTR has had a focus on zoonotic diseases - infectious diseases of animals that can cause disease when transmitted to humans. Animals and humans have been living together for millennia, with humans becoming increasingly dependent on livestock and poultry for food. In many countries, and particularly in communities affected by poverty, backyard animal rearing is an important activity as it contributes to the livelihoods of families. But sometimes, these animals create risks for diseases for people who depend on them.

Identifying whether novel human viruses disproportionately originate from certain animal groups could inform risk-based allocations of research and surveillance effort. Whether such special reservoirs exist remains controversial, but human encroachment into biodiverse areas increases the risk of spillover of novel infectious diseases by enabling new contacts between humans and wildlife. Regular activities such as hunting, farming and the global movement of people to cities have led to massive declines in biodiversity and increased the risk of dangerous viruses spilling over from animals to humans (GFW 2019). Scientists have been able to trace which animals are most likely to share pathogens with humans, and are now convinced that the underlying cause of the present COVID-19 pandemic is likely to be increased human contact with wildlife. Human-wildlife contact with a bat or an intermediate host species in China likely triggered the coronavirus spillover event, with the spillover likely occurring at a wildlife market, ultimately leading to the pandemic. Bats alone have been linked to diseases like SARS, Nipah, Marburg and Ebola. CTR researchers are currently developing an ensemble modeling approach to examine the environmental drivers behind coronavirus prevalence in bats under current and future climate conditions. The expected results from the CTR research could help predict future spillover events across sub-Saharan Africa, enabling more focused monitoring in regions at high risk for future epidemics.

Avian influenza is one of the most widely distributed avian viral diseases, which causes great economic losses to the poultry industry and an incipient threat to humans. In a study carried out in Egypt, CTR researchers found that despite the various control measures such as culling and vaccination efforts, outbreaks of the highly pathogenic avian influenza, HPAIV- H5N1 continue every year. While the virus' primary target is birds, it is capable of infecting mammals, including humans, causing serious illness and rates of mortality that may reach alarming proportions.

The 2009 swine flu pandemic, the second of two pandemics involving H1N1 influenza virus was hypothesized to have originated from Mexico, but southern China still remains a major hotspot for the generation of novel influenza viruses. Spatial models from CTR researchers are compatible with this longstanding observation insofar as they predict that the southern coastal province of Guangdong is a potential hotspot for the evolution of novel influenza viruses by reassortment.



Pictured from top to bottom:
* Coronavirus disease 2019 (COVID-19) responsible for the 2020 worldwide pandemic. *Photo credit: CDC/ Alissa Eckert, MSMI; Dan Higgins, MAMS*
* Salmonella Typhimurium (red), an enteric pathogen linked to animal contact. *Photo credit: NIAID*
* Ebola virus. *Photo credit: NIAID*
* Novel influenza H1N1 virus, responsible for the 2009 pandemic. *Photo credit: CDC / Cynthia Goldsmith*

The 2009 swine flu pandemic resulted from a previous triple reassortment of bird, swine, and human flu viruses further combined with a Eurasian pig flu virus. CTR researchers provided evidence of the circulation of the pandemic (H1N1) 2009 influenza in central Africa and these results point towards the need for all countries to implement livestock surveillance to detect the virus and molecular assays to identify possible changes in viral structure that increase pathogenicity or antiviral resistance.

The Ebola virus disease outbreak remains a global challenge and has recently been reported from several West African countries with a staggeringly high mortality rate of 65.74% (WHO 2020). Scientists think people are initially infected with Ebola virus through contact with an infected animal, such as a fruit bat or nonhuman primate. The virus spreads through direct contact (such as through broken skin or mucous membranes in the eyes, nose, or mouth) with blood or body fluids, objects, infected fruit bats or nonhuman primates and semen (CDC 2019). There is however no evidence that Ebola can be spread through sex or other contact with vaginal fluids, but the virus can remain in areas of the body that are immunologically privileged sites after acute infection. An Ebola outbreak in non-human primates (chimpanzee and gorilla) as well as in the human population was reported from West Africa between 1994 and 2002. The incidence of animal-human conflict and the close proximity to wild animals are thought to be the primary factors behind the disease progression; however, human-to-human contact is another crucial factor for further disease dissemination.

CTR researchers have developed ecological niche models, using Maxent, in collaboration with national experts in Cameroon, and have amassed a dataset of nearly 400 individual locations and case counts to predict how Ebola spread among regions. The models developed by CTR perform remarkably well, suggesting they can maximize efficiency in control efforts while outbreaks are occurring, rather than after they have already had devastating effects.

Infected fruit bats can spread disease-causing viruses. *Photo credit: Hans Veth*

Vets from GOVS Egypt sampling backyard farm animals during the Center for Tropical Research field research in Egypt. *Photo credit: Kevin Njabo*

Monkeypox (MPXV) is another zoonotic viral disease with a high prevalence in Africa. The dependence of the local population on bushmeat is one of the major driving factors behind the spread of monkeypox in West Africa. Apart from this, exposure to the body fluids of infected individuals is another mode of human-to-human transmission of the disease. CTR researchers have used occurrence of MPXV to develop models useful for identifying areas where environmental conditions may become more suitable for human MPXV, targeting candidate reservoir species, including multiple members of the rope squirrel family for future screening efforts; and prioritizing regions for future MPXV surveillance efforts. The work by CTR researchers have also determined several environmental factors associated with higher risk of exposure to MPXV, such as proximity to dense forests, and habitats suitable for the rope squirrel reservoirs.

Neglected zoonotic diseases (zNTDs)

Neglected zoonotic diseases (zNTDs) are also a subset of diseases that prevail in tropical and subtropical conditions in 149 countries – affecting more than one billion people and costing developing economies billions of dollars every year. The term “neglected” highlights that the diseases affect mainly poor and marginalized populations in low-resource

settings. Due to their low priority in the health systems in many countries, zoonotic neglected tropical diseases are major causes of poor health among rural populations where they impose a large burden on human health, with dramatic consequences. There is now recognition that several zoonotic diseases within the NTDs merit attention and these include rabies, echinococcosis, taeniasis/cysticercosis and foodborne trematodiases. Populations living in poverty without adequate sanitation and in close contact with infectious vectors, domestic animals, and livestock are those worst affected.

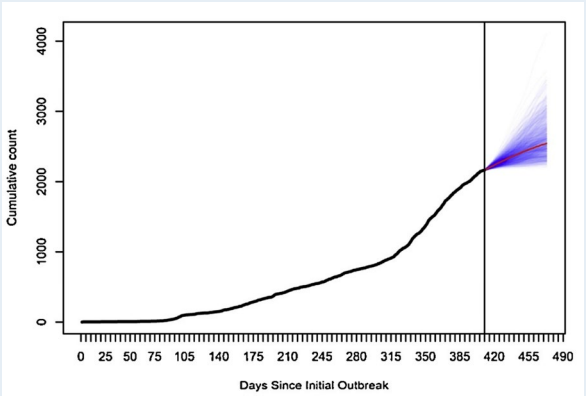
The above examples show that spillover of viruses from animals are a direct result of human actions involving wildlife and their habitat, and these actions simultaneously threaten species survival while increasing the risk of spillover. Attention needs to be paid to how humans interact with wildlife and the activities that bring humans and wildlife together. Specifically, there must be a collaboration and a practical application of the multipronged 'One Health' strategy to decrease the risk of zoonotic disease transmission. The Center for Tropical Research is building one health approaches with the goal to enhance human, animal, and environmental health, and bring about the much-needed synergy between medical and veterinary practices, improve the health of animals and improve food security, as well as improve preparedness through strengthening public health infrastructure and outreach in regions where it works.

Mixed backyard farm conditions in Western Cameroon. *Photo credit: Kevin Njabo*

Predictive Disease Modeling

There has never been a time, perhaps in human history, quite like the year we are all currently facing. The COVID-19 pandemic has forced us to rethink both our public health efforts and understanding of how such wildlife diseases enter into, and spread among, human populations. We hope, as part of these efforts, that we can look back at recent infectious disease outbreaks to help guide our plans for current mitigation and future planning.

Researchers at CTR have teamed up with mathematicians to develop models to predict cases of diseases, in space and time, before they happen. These models are derived from ones originally used to predict earthquakes, and rely only on knowing where and when previous occurrence of events happened. CTR Researcher Dr. Ryan Harrigan and UCLA Chair of Statistics Dr. Rick Schoenberg led work conducted on outbreaks of Ebola virus disease in West and Central Africa from the years 2014-2019. Their work has found that such models (called "point process" models) were able to do a remarkable job predicting the number of cases that public health agencies could expect to see weeks, or even months, into the future. Their findings suggest that such models may be able to assist with surveillance, mitigation, and prevention of infectious diseases in the future, not only in this region of the world, but on a global scale.



An example of the number of cases predicted to be seen (blue lines) during the 2018-2019 Ebola outbreak in the Democratic Republic of Congo, based on previous cases (black line). The median expected cases are represented by the red line. Adapted from Kelly et al. 2019.

NSF FELLOWSHIP RESEARCH IN CAMEROON

by Nick Russo

As a second-year PhD student in CTR and the department of Ecology and Evolutionary Biology, I study the movement ecology of black-casqued and white-thighed hornbills in Cameroon. I recently received the National Science Foundation Graduate Research Fellowship (GRF), which will support me for the next three years as I travel to the Dja Faunal Reserve of southeast Cameroon to work with these comical, yet majestic birds.

From left to right: Black-casqued hornbill. *Photo credit: Benjamin Wang*; Nick Russo radio-tracking birds on Rocher Bouamir, Cameroon. *Photo credit: Hongie Mandela*; Aerial view of Bouamir, Dja Reserve. *Photo credit: Tom Smith*

Hornbills are large, fruit eating birds of the African and Asian tropics that play a critical role in seed dispersal. Black-casqued and white-thighed hornbills inhabit the rainforests of Central Africa and together, they disperse the seeds of more than 50 species of rainforest trees. Both species travel up to 180 miles from their breeding location in search of fruits during Cameroon's major dry season (November to March). During these long-distance movements, seeds may travel in the hornbill gut for more than four miles from the parent tree before they are deposited. This natural process ensures that seeds arrive at regenerating forests in an increasingly fragmented Central African landscape.

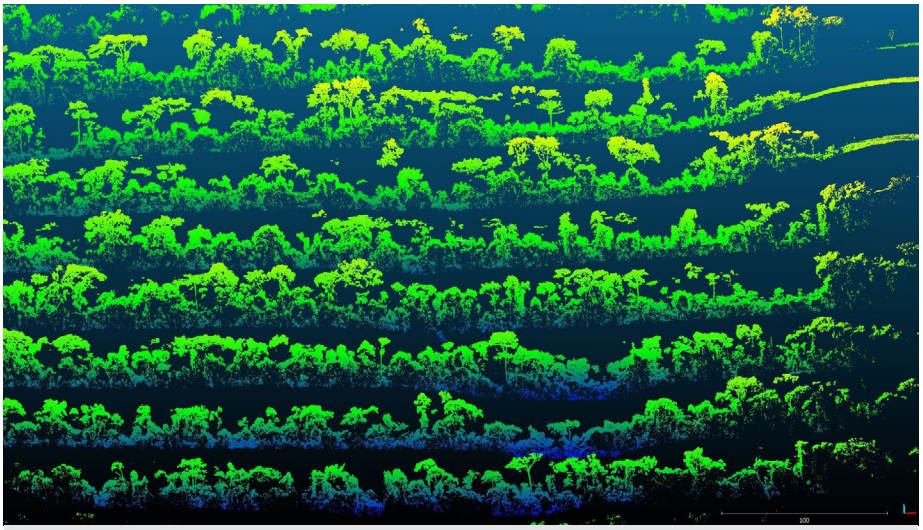
My fieldwork is based in the Dja Faunal Reserve, a UNESCO World Heritage Site and the largest protected area in Cameroon. I will be fastening GPS transmitters to hornbills as an ultra-lightweight "backpack" that transmits GPS locations to a receiver on the International Space Station. The birds will be part of a global wildlife monitoring network called ICARUS (International Cooperation for Animal Research Using Space). The solar-powered ICARUS transmitters will collect locations every 1-2 hours for up to several years. The result is that we can track the birds remotely and download their GPS locations in near real-time, in all seasons, and year after year.

Because hornbills move out of mature rainforests and into younger forests and agricultural plantations during the major dry season, they pose a conservation challenge. Which habitat features do hornbills require in order to function as seed-dispersers? Most of the fruits they eat are in the high canopy, so I am looking for similarities in canopy structure between locations hornbills use to search for fruits.

Measuring habitat structure throughout a hornbill's home range would be costly and labor-intensive to complete on the ground, so I am turning to remote sensing observations from drone and satellite to characterize the habitat features hornbills select when they move from one location to the next. One of the approaches I will use is called Light Detection and Ranging (LiDAR), which entails using a laser mounted on aircraft or spacecraft to actively scan rainforests and measure the 3D structure of vegetation from ground to canopy.

A drone-based LiDAR scan is already underway for Bouamir Research Station,

The transmitters specially designed for Icarus weigh only five grams. They measure the position and various body data of the animal and transmit the measured data by radio. *Photo credit: MPI f. Animal Behavior / J.Stierle*



First LiDAR imaging of 3D vegetation structure for Bouamir Research Station, showing a forest height gradient from blue (low) to yellow (high). Data was acquired via unmanned aerial vehicle. *Photo credit: Nicolas Barbier, IRD*

a 2500-hectare site near the center of the Dja Faunal Reserve. I will measure vegetation structure outside of Bouamir Research Station using newly available spaceborne LiDAR data from the Global Ecosystem Dynamics Investigation (GEDI), a sensor on the International Space Station. Colleagues from the Institute of Research for Development (IRD) in France, and the NASA Jet Propulsion Laboratory are developing continuous maps of canopy structure attributes for the full Dja Reserve by using the drone LiDAR data for a machine learning algorithm that fills in gaps in the spaceborne LiDAR coverage.

By measuring attributes of habitat structure at each hornbill GPS location, I aim to figure out how habitat use by hornbills varies throughout the year, and how their movement behavior in turn influences where they disperse seeds of tropical trees. Past studies by CTR researchers showed that white-thighed hornbills appear to cross roads and villages freely, while black-casqued hornbills avoid them. The difference in movement behavior between the two species is likely crucial for the persistence of hornbill-dispersed trees in an ever-changing Congo Basin landscape. I have been revisiting movement tracks from a CTR paper that tracked five white-thighed and three black-casqued hornbills for three years and I am excited to continue the study with ICARUS transmitters, which collect locations at a higher resolution (3-5 m). I have also partnered with Romeo Kamta of the Congo Basin Institute (CBI) and the CBI Student Association to increase access to environmental education in villages of the Dja Reserve periphery. We are developing elementary-level science curricula and raising funds for school materials—notebooks, pencils, and other items that are difficult to distribute to this rural part of Africa. One of our goals is to teach major concepts of animal ecology to students of two partner schools, which we will illustrate in part by displaying maps of movement data to follow the journeys of the tagged hornbills.

I received lots of advice and input from the CTR, several members of the UCLA Ecology and Evolutionary Biology Department, the UCLA Writing Center, and students and professors from UConn, where I began my journey in ecology. I thank everyone who reviewed my project proposal and personal statement. I look forward to sharing results!

GCRF Cameroon Country Meeting

The Cameroon country meeting of the UK Research and Innovation Global Challenges Research Fund (UKRI GCRF) Trade, Development and the Environment Hub held its first meeting from January 22-29, 2020 at the CBI camps in Yaoundé Cameroon.

The purpose of the meeting was to present the workplan for 2020, introduce Basecamp, and prepare a soft launch for the project for April 2020. UKRI GCRF is working with over 50 partner organizations from 15 different countries (including Brazil, Cameroon, Congo, DRC, Gabon, Tanzania, Indonesia, China and the UK).

The project aims to make sustainable trade a positive force in the world by focusing on the impact of the trade of specific goods (cocoa, palm oil) and seeking solutions to these impacts.

The meeting was co-chaired by the project coordinator, CBI Africa Director Dr. Kevin Njabo and the International Institute of Tropical Agriculture's country Representative Dr. Cargele Masso. The soft launch of the project has been postponed due to COVID-19.

GCRF
Global Challenges Research Fund

PANGOLIN WORKSHOPS

by Cristian Gruppi

Pangolins, the only mammals covered by scales, are considered the most illegally trafficked wild mammal in the world. All species of pangolins, four in Africa and four in Asia, are threatened with extinction. In the last 16 years, over 1.1 million pangolins have been poached for the illegal trade for use in traditional medicine, as leather, and as food in Africa and Asia.

In October 2019, as part of the CBI's initiative to fight illegal trafficking of wildlife and in the framework of "Mapping Pangolin Trafficking from Africa to Asia" project supported by INL, CTR and CBI organized two training workshops held on the CBI campus in Yaoundé, Cameroon. The aim of these workshops was to increase the awareness on the current African pangolin condition, disseminate knowledge on a DNA analysis tool called "Genoscape" helpful for studying illegal pangolin trafficking, and train students and early career scientists on the molecular techniques employed in the "Genoscape" pipeline.

The Genoscape approach, recently-developed by CTR, is based on sequencing and analysis of Single Nucleotide Polymorphisms (SNPs), and it creates a map of genetic variation across a geographic distribution for a species, created using DNA from the individual samples. Genoscapes are particularly suited to mapping and identifying the unknown origins of illegally trafficked wild animals, so allowing scientists and wildlife protection agencies to understand exactly where vulnerable populations are, making conservation and protection efforts more efficient

Dr. Gruppi leads Pangolin Conservation Genetics Workshop. ***Photo credit: Matthew LeBreton***

Pangolin. ***Photo credit: Richard Rosomoff***

.

During the workshops, I described the Genoscape approach and its potential for pangolin conservation and led discussions among participants on how science can be translated into effective policy.

CBI Pangolin Conservation Policy Workshop

The first workshop was a 2-day workshop (14-15 Oct 2019) targeted towards policymakers and environmental NGOs. 38 participants from 4 countries (Cameroon, Congo Republic, Gabon and the Democratic Republic of Congo) attended. Participants included policy makers from Government Forestry Services, Research Institutes, Universities, and NGO leaders.

The policymakers went through a review of laws on pangolin trade and use, and of historical and current pangolin trade. Traditional tools for pangolin trade management were exposed, and finally, a general overview of the Genoscape method and some practical examples on how Genoscape can be used as a tool for conservation purposes and on how to leverage this genomic approach to understand the pangolin illegal trade dynamics were described.

Policymakers welcomed this new technology as they had no idea of its existence nor how to use it in the field of conservation biology and the organizers obtained interesting feedback from them on how to implement a policy and technical analysis system that could be utilized for pangolin protection and law enforcement, highlighting that lobbying, advocacy, and efficient communication and sensitization could be used to overcome the possible challenges.

CBI Pangolin Conservation Genetics Workshop

The second workshop, a 3-day workshop (16-18 Oct 2019) was attended by 29 early career researchers and graduate students from 4 countries of the Congo Basin (Cameroon, Congo Republic, Gabon and Democratic Republic of Congo).

I led this hands-on workshop presenting a Genoscape overview and introducing many different laboratory techniques, such as PCR, library prep and genotyping, required for developing the genetic markers panel used in the Genoscape approach. The participants also did laboratory work on DNA extraction, DNA PCR, and DNA quality control.

Drs. Ruksan Bose and Vincent Deblauwe also trained participants in Geographical Information Systems (GIS) mapping using QGIS as part of capacity building for early career professionals from the Congo Basin region.

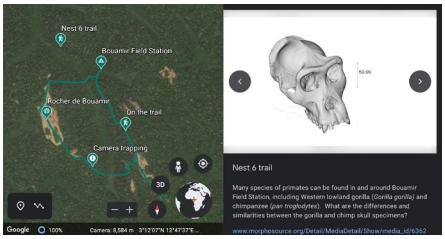
Traveling to Cameroon has been an unexpected gift for me. Through these workshops, I had the opportunity to be a part of CBI's mission and I want to thank Thomas Smith, Virginia Zaunbrecher, and Kevin Njabo for this great professional and personal experience. I met amazing researchers that I can now call friends, such as Ruksan Bose, Vincent Deblauwe, and Matthew LeBreton. I was able to visit the city of Yaoundé, see a small portion of Cameroon and its stunning nature, but above all experience and eat Eru during the lunch breaks under the gazebo in the middle of the green CBI campus.

Gazebo located on the CBI campus. ***Photo credit: Virginia Zaunbrecher***

Meeting the Challenges of COVID-19

As the COVID-19 pandemic has forced CBI to halt nearly all in-person programmatic activities, we have pivoted to identify innovative ways to leverage CBI's unique assets in this new operating environment, and sought opportunities to employ CBI's strengths to advance our understanding of coronaviruses. Actions include:

Joining the fight against coronavirus. The SARS-CoV-2 coronavirus, like many other viruses that affect humans, likely moved from wild animals into people. The Congo Basin is a hotspot for such zoonotic disease transmission to humans. CBI has leveraged its scientific expertise and regional research collaborations to develop a rapid research project to assess the environmentally-based risk of bat coronavirus infection and spillover into humans, under current and future climate conditions.



Accelerating our efforts on distance learning. CBI is working to provide UCLA with unique remote learning content from our research stations so students who do not have the opportunity to travel to Cameroon can benefit from CBI's work. This effort has taken on more urgency as all classes have become remote. CBI will work to develop learning assets that allow UCLA students to explore the ecology, economics, and people of the Congo Basin remotely.

Developing plans to support more local researchers. As opportunities for training decrease because of social distancing, CBI is expanding the support it will provide to local scientists who are interested in working at our field sites. This means that once domestic travel in Cameroon is unrestricted, more Cameroonian researchers will be able use our facilities, which will increase user fees during a time when international researchers cannot visit.

THE SILK PROJECT

by Ruksan Bose

While walking in the rainforest, one cannot see very far ahead due to the thick undergrowth. Hearing, rather than seeing, becomes the most important sense. The indigenous Baka people find their way by "listening to the forest," following tracks unseen to us. They have an intimate knowledge of the sounds, smells and sights of the flora and fauna, and how they interact and change through the seasons. Baka understanding of one of the most complex ecosystems in the world has been passed down from generation to generation. In the face of rapid environmental and socio-economic changes, the continuation of their rich traditions is uncertain. But CBI and the Baka are working on changing this by using their knowledge as an innovative educational and conservation tool.

The forests the Baka have roamed in for millennia are a core element of the Congo Basin forest ecosystem, the world's second largest remaining contiguous block of rainforest covering almost 200 million hectares (2 million square km) in Central Africa. Today, with a deforestation rate of 0.14% per year and a forest elephant population that has declined by 62% in the last ten years, these forests are facing severe environmental threats.

We cannot conserve what we do not understand, and there is a critical need to tap the wealth of indigenous ecological knowledge to better understand the Congo Basin's rainforests. However, the Baka are increasingly marginalized and alienated from the forest.

CBI's School for Indigenous & Local Knowledge (SILK) is developing a way to preserve and pass on the Baka traditional ecological knowledge (TEK) using CBI's Bouamir camp and study area in the Dja Biosphere Reserve as its main classroom. For the past 30 years, Thomas Smith has been leveraging the profound knowledge of the Baka in his research in and around the Dja. In the past, elder Baka worked side-by-side in the forest with younger Baka as they assisted with field research. SILK expands and formalizes this approach, combining it with a modern curriculum in ecology and conservation biology.

Ruksan Bose, education director of the Congo Basin Institute, assists a Baka elder in teaching Baka children. Here, the animal being discussed is the aardvark or *Orycteropus afer*, *Kpinya* in the Baka language. *Photo credit: Vincent Deblauwe*

Baka youth examining a *libenji* (pile of insect carcasses created by ants), that the Baka use as an indicator of honey nearby if there are many bees in the pile.
Photo credit Ruksan Bose

Baka knowledge is not restricted to the biology of subsistence activities and encompasses detailed observations of population ecology and species interactions arising from long-term association with local flora and fauna. TEK is increasingly being sought by academics, agency scientists, and policymakers as a potential source of ideas for emerging models of ecosystem management, conservation biology, and ecological restoration. This makes the possibility of losing TEK—a concern the Baka themselves have voiced repeatedly—a pressing risk we seek to address.

We aim to preserve TEK within the Baka community, and employ it as a novel and innovative educational and conservation tool with the next generation of biologists and natural resource managers in mind. In addition to providing employment for Baka as 'professors of the forest' and research assistants, integrating Baka knowledge into scientific education and research will improve the quality of research in this critical region. It will also make it easier to incorporate Baka knowledge into planning and policy and help protect the ecosystem the Baka rely upon.

Activities

The SILK project was launched at the end of 2018 with initial funding from the Arcus Foundation. It has since received an additional three years of funding from Arcus as well as a National Geographic Explorer grant. In the forest and in the village of Bifolone north of the Dja Reserve, we have been busy collecting and archiving Baka knowledge on animals, plants and their inter-relationships, forest foods and gathering techniques, and traditional plant remedies. In keeping with the Baka oral tradition and lack of literacy, especially among women, audio and video recordings are being created and will be accessible to all. While documenting Baka TEK, numerous mini-courses were run regularly, initially taking seed informally as children gathered around as Baka elders were interviewed. Trainings in photography, video, GPS use and research methods were conducted more formally in the village and in the forest to assist the community to document their own traditions and archive them for future generations. Another goal is to set up a Documentation Centre in Bifolone with low-cost and low-energy-use raspberry-pi computers powered by solar energy where the community can access both print and digital material.

Mindjo Gladice, age 12, learning how to take photos and videos to document their own traditional knowledge. *Photo credit Vincent Deblauwe*

Field courses and collaborative research projects

Based on Baka TEK we have documented, and complementary content from ecology and conservation biology, we developed curriculum for courses in collaboration with the Baka, and trialled the curricula through a field course co-taught by seven Baka "professors of the forest" last summer. 15 Baka boys and girls ranging from 11 to 18 years of age hiked 30km into the heart of the Dja reserve to participate in the course.

While formal field courses are important pedagogical tools, transmission of TEK to youth greatly benefits from regular intergenerational interaction in the forest. For example, adult Baka can identify and name hundreds of tree species at sight, and this knowledge is best transferred to youth through regular exposure and practice. After the first year of the project we increasingly involved promising students in monthly, multi-year phenology and frugivore abundance monitoring projects. As part of these collaborative research projects with the Baka where we learn from the elders, their youth learn to identify different species and learn about crucial plant-animal interactions upon which seed dispersal depends. They see first-hand the impact of over-hunting on tree regeneration and acquire skills that would increase their ability to find employment based on their own TEK. This complements the village and field courses with regular camping missions in the forest where younger Baka work alongside elder Baka and CBI scientists.

Bambo Mempong Samuel, a Baka professor of the forest, explaining the trails in the Bouamir Research station in the Dja. *Photo credit Ruksan Bose*

Ownership and pride

Our focus on the participatory process of knowledge preservation and transmission is key to ensuring the Baka themselves feel ownership and interest in recording and dissemination. CBI's training and education programmes connect researchers and classes at our research station with Baka guides, providing a natural channel of dissemination of Baka TEK. This approach compensates the Baka for their knowledge, gives them autonomy over what and how they share, and demonstrates to younger members of the community that there is value and opportunity in TEK.

An unanticipated result of the project was that the Baka set aside 2 x 2km of their village forest as a conservation zone which they are inventorying, labelling and monitoring. It is now

also an extended classroom for youth to record elders sharing TEK and has served to include women, children and elders who cannot join us in the Dja.

By helping to instill a sense of pride in their traditions, giving the Baka a sense of purpose, and carefully compensating the community, the SILK project appears to have decreased alcohol abuse, a significant challenge in Baka communities. We compensate the village as a whole for their time with in-kind items of their choice like rice and tools, and have a policy of not hiring individuals who are regularly inebriated. But there was a knowledgeable Baka man who struggled with alcohol use, and whom we took the risk of involving in our work in the Dja. As a result, he and his wife are now mostly sober, and he is proud of being active and useful, sends money to his children in school, and takes better care of his appearance.

Regular employment by the project has also facilitated the creation of a village emergency fund for health and education. They are also in the process of setting up a museum to showcase Baka knowledge and an educational forest trail to attract visitors and resources.

Keenly aware of the erosion of the Baka knowledge, the initiative has resonated deeply with this indigenous community, creating momentum to expand and enhance our work. Based on this pilot project, the Baka of Bifolone have requested we expand to other Baka villages where they have kin. Our plans for the future are to expand our model to other villages and create a network of 'professors of the forest.' This will enable exchanges between Baka villages to widen the pool of elders who can equip youth with skills and TEK through traditional modes of transmission.

Baka professors and students. *Photo credit: Ernest Simpoh*

CBI's reforestation programs help conserve the Congo Basin's spectacular rainforest. *Photo credit: Chris Sorenson*

The Ebony Project is:

- active in six Cameroonian communites with plans to add two more villages in 2021
- using GPS coordinates to record plot locations for each planted tree
- also planting hIgh-demand fruit trees which provide value to farmers while the ebony trees mature

EBONY PROJECT MILESTONE ACHIEVED

This year the Ebony Project planted its 15,000th ebony tree, reaching its initial goal despite challenges due to COVID-19

The Ebony Project began in 2016 and is funded by Bob Taylor of Taylor Guitars. It is a partnership where business, communities, and researchers work together to protect a valuable timber species, reforest degraded land, and improve rural livelihoods. Ebony tree saplings are produced in community-built and managed local nurseries before being transplated.

Community members plant ebony saplings in Cameroon. *Photo credit: Chris Sorenson*

TOM SMITH RECEIVES AOS RESEARCH AWARD

The American Ornithology Society (AOS) honors Tom Smith as a recipient of a 2020 Elliott Coues Award.

The Elliott Coues Award recognizes outstanding and innovative contributions to ornithological research. This year the American Ornithology Society (AOS) has selected Dr. Smith to receive the award, citing his "contributions to our understanding of the speciation and distributions of tropical birds, with a focus on how diversity is generated and maintaind in tropical rainforests."

AOS highlights Dr. Smith's research on Black-billed Seedcrackers, his work on resource polymorphisms in vertebrates, plus innovations in the use of molecular genetics and remote sensing to study migratory connectivity and zoonotic diseases. AOS notes his leadership roles in advancing international conservation initiatives, including the development of the Center for Tropical Research, the Congo Basin Institute, and the Conservation Action Research Network. Dr. Smith's long-lasting contributions to the study of birds includes his mentorship of 27 postdocs and 34 graduate students who are working with birds around the globe.

Elliott Coues Medal.
Photo credit: AOS

Thanking Our Colleagues

We would like to thank the many colleagues who assisted CTR with obtaining biological samples for our pangolin trafficking monitoring project. The team in **Nigeria** was led by Dr. Excellence Akeredolu of the Department of Zoology of the University of Lagos with assistance by his Ph.D. student, Benson Andrew. Samples from **Gabon** were obtained with support by Dr. Stephan Ntie at the Department of Biology of the Masuku University of Science and Technology, in coordination with Dr Katharine Abernethy, Professor of Ecology at the University of Stirling, and Carla Louise Mousset Moumbolou of the Scientific Unit of Gabon's National Agency of National Parks led by Dr. Flore Koumba Pambo. Samples from the **Republic of the Congo** were sent by Markéta Swiacká, a Ph.D. student at the Czech University of Life Sciences Prague. **West African** samples were sent by Kim Labuschagne, Biobank Curator for the South African National Biodiversity Institute. Samples from **Cameroon** were collected by Valery Nobel Talla Kengne and Franklin Simo Talla, and shipped to CTR by CBI's Matthew LeBreton in Cameroon.

Building New Strategies: UCLA in Africa

In late January 2020, the Congo Basin Institute's Tom Smith, Virginia Zaunbrecher, and Matthew LeBreton were key participants at the UCLA Symposium on Sub-Saharan Africa led by Chancellor Gene Block in Johannesburg, South Africa. The Congo Basin Institute is working with other UCLA institutions to build new strategic efforts in Africa. The symposium included representatives from Cameroon, Mozambique, Malawi, the Democratic Republic of Congo, and South Africa who live and work in those areas and collaborate with global and regional partners to address complex issues such as health care and ecological preservation. For a spotlight on some of the UCLA partnerships under way in Africa, see the UCLA Newsroom piece, "UCLA and Africa: A history of partnership, a future of shared progress."

Led by UCLA Chancellor Block, CBI members and UCLA administrators met in Johannesburg to participate in a strategy workshop focused on UCLA in Africa.

CTR Researchers are involved in a wide variety of projects worldwide. Here are some highlights of their field work, news, and publications.

FIELD RESEARCH UPDATES

Researchers return from field work on an Inselberg near the Bouamir Field Station. *Photo credit: Alexa Sheldon*

Nick Russo obtained grants from the American Ornithological Society, Animal Behavior Society, Sigma Xi, and the UCLA Dept. of Ecology and Evolutionary Biology to pursue his research on the movements of seed-dispersing hornbills in southern Cameroon. While his field season is delayed, he will attach ICARUS tags to black-casqued and white-thighed hornbills in the Dja Faunal Reserve to investigate how vegetation structure and fruiting phenology influence their movements and resulting patterns of seed dispersal.

Vincent Deblauwe continues to work on the CBI's ebony project in Cameroon. This spring, Vincent, Cameroonian students and scientists have helped remote communities of the Dja Biosphere Reserve to plant 7000 ebony trees and 2000 native fruit trees. Vincent is conducting field research to understand the effect of forest disturbances on ebony regeneration. This year he set up forest inventories in the reserve, performed a parentage analysis and identified pollinators and seed disperses with camera traps.

Eric Nana is coordinating a study that strives to elucidate the distribution, abundance, and status of the Critically Endangered Preuss's Red Colobus monkey, one of the world's most endangered primates in the Ebo-Makombe-Ndokbou forest landscape in Cameroon. This project will start a locally-sensitive and long-term education and awareness program with local communities to highlight the uniqueness and irreplaceability of red colobus monkeys and their habitats.

Eric Nana is also leading a project on saving the rare and endangered Bates's weaver, Ploceus batesi in the Dja Faunal reserve. This project collects data on the presence/absence of Bates' weaver through a detailed field survey. This data will help direct conservation action on the ground.

Marina Rodriguez, a graduate student in the Ruegg lab at Colorado State University, is spending the summer traveling across 10 states to collect samples from 500 Yellow Warblers as well as collaborating with 15 MAPS banding stations for her doctoral research aimed at understanding how climate change affects survival and fitness of Yellow warblers across their range. Marina's work will use telomere shortening as a proxy for survival and fitness and will provide better information to conserve and protect populations from further declines.

Matt DeSaix, another graduate student in the Ruegg lab at Colorado State University, is heading out on his first field season to fill in critical gaps in sampling for the American Redstart, a long-distance Neotropical migrant with broad wintering and breeding ranges. Matt's research aims to address whether there is a link between adaptive divergence and migratory connectivity, and whether that connectivity influences genomic vulnerability. Matt's research will be widely applicable to other migratory bird species and will provide better understanding of the impacts of climate change on migratory birds across their annual cycle.

OTHER CTR NEWS

Ryan Harrigan is acting as Principal Investigator on a newly funded CTR project entitled "Building a framework to genetically characterize 'feather spots' and understand demographic impacts of solar energy sites on migratory bird populations." Funds for this award were provided by the U.S. Department of Energy's Solar Energy Technology Office (SETO) and will explore how solar facilities in the United Stated are impacting migratory and resident bird populations through use of next-generation genetic analyses and strong partnerships with federal, industry, and private stakeholders. This work will ultimately lead to reduction of soft costs to energy providers and will help make solar more affordable and accessible to more Americans. Stay tuned for updates on this project.

Whitney Tsai Nakashima joined the Center for Tropical Research as a Ph.D. student. She is an NSF Graduate Research Fellow and studies plumage coloration and how it evolves in relation to the avian visual system. She is also investigating the evolutionary history of Yellow Warblers and their response to climate change and has been awarded grants from the UC California Conservation Genomics Project and UCLA Latin American Institute. Her research will inform conservation decisions by predicting how climate change will affect species in the future and identifying which populations are most vulnerable to environmental shifts.

Nick Russo completed the 10-week NASA DEVELOP internship this spring at the Jet Propulsion Laboratory in Pasadena, CA. He was part of a team that developed a tool in Google Earth Engine that enables decision-makers in the U.S. Great Lakes region to monitor wetlands in near real-time using an algorithm that identifies wetland extent from remote sensing data. He and colleagues submitted a manuscript of this applied research for publication.

Kelly Barr received a research grant from the California Conservation Genomics Project for research on Tricolored Blackbirds, a threatened species under the California Endangered Species Act. In collaboration with Drs. Beth Shapiro and Kim Ballare of UC-Santa Cruz, we are collecting whole genome data from recently obtained samples and from museum specimens collected a century ago to examine the impacts of severe population decline on the species.

Eric Nana was appointed Acting Chief of Station of the National Herbarium in Cameroon in June 2020. The National Herbarium in Cameroon is the government body that studies Cameroon's flora, its uses and works to conserve all threatened plant species and their habitats in country. Eric was elected to the position of President of Cameroon's Chapter of the Society for Conservation Biology (SCB), a community of conservation professionals in Cameroon devoted to scientific study of the maintenance, loss, and restoration of biological diversity. Eric was also awarded the Africa Oxford Initiative (AfOx) grant to undertake a collaborative trip to Oxford University in the UK where he will work with Tasso Leventis Professor and Director of the Interdisciplinary Centre for Conservation Science, Eleanor JaneMilner-Gulland. AfOx is a cross-university platform for academic and research collaborations between the University of Oxford and African researchers and institutions.

Ying Zhen joined Westlake University as a tenure-track assistant professor in Hangzhou, China. Ying's lab studies ecological and evolutionary genomics of various model and non-model organisms to understand the mechanisms that generate and maintain genetic diversity. She was awarded a grant from the National Science Foundation of China.

Cristian Gruppi joined Smith's team as a postdoc in 2018 and is interested in exploring and harnessing advantages of Next Generation Sequencing tools and genomics techniques for the conservation of wild animal populations. Cristian managed the Population Genetics and Tropical Ecology lab work for 1) the Pangolin project, which aims to analyze the population structure and geographically map the genetically diverse populations of White-bellied Pangolins in Central Western Africa to identify origins of confiscated and unknown samples and track illegal trafficking routes and identify hunting hot spots in Africa. 2) Genomic analyses on environmental DNA extracted from soil samples collected in Cameroon in order to evaluate its biodiversity through a new and non-invasive approach. Cristian has since transitioned to working on the Solar Facility Impact project funded by the U.S. Department of Energy which aims to evaluate the impact of solar installations on Neotropical migrant bird populations and on their migration flyways.

Dr. Kristen Ruegg received a National Science Foundation Faculty Early Career Development Program (CAREER) award of $1.18 million to continue research on connecting the process of natural selection in migratory bird populations across their full migratory cycle. Dr. Ruegg and her team will use advances in sequencing technology to test theories about the role of wintering grounds in adaptive evolution. This research, in turn, can help scientists and land managers understand how best to protect vulnerable populations of migrating birds.

Matthew DeSaix and **Marina Rodriguez**, doctoral students in the Ruegg lab, have both been awarded funding from the Colorado Field Ornithologists, and Marina was additionally awarded the Hesse Award from American Ornithological Society as well as a scholarship from the Biology department at Colorado State University, to continue their respective research.

Rachael Bay started a job as Assistant Professor in the Department of Evolution and Ecology at UC Davis in 2018. Her lab focuses on using genomic tools to understand and predict climate change impacts in taxa ranging from corals to seagrasses to birds. Rachael also gave the keynote address at the Audubon California Assembly in 2018. Her talk was entitled: "The Bird Genoscape Project: Genetic Tools for Understanding Avian Migration and Climate Change Impacts."

Dr. Jonas Ngouhouo-Poufoun has joined the Congo Basin Institute as its Visiting Scientist to the GCRF Trade, Development and the Environment (TRADE) Hub in Yaoundé Cameroon. Jonas will be performing fieldwork and research on measuring and modeling the ecological costs and benefits of trade in internationally traded agricultural commodities (Cocoa, Oil Palm), as well as coordinate with colleagues elsewhere in Central Africa the assessment of the trade in wild resources (wild meat, select wild flora such as Irvingia gabonensis).

PUBLICATION AND PRESS

Ryan Harrigan recently co-authored a paper with UCLA's Department of Mathematics Chair Frederic Schoenberg, on the application of mathematical models typically used to predict earthquakes, to instead predict the spread of infectious diseases. Their paper, entitled "A recursive point process model for infectious diseases" was published in the Annals of the Institute of Statistical Mathematics accessible here.

Christen Bossu presented her work using genomic tools to examine population structure and migratory connectivity in Common Yellowthroats to the 2019 North American Ornithological Conference in Anchorage, Alaska. She also presented on the Bird Genoscape Project as an innovative technological advance in bird conservation at the Society of Canadian Ornithologists in Quebec City, Canada.

Eric Nana and co-authors published a paper in the journal Ecology and Evolution on Patterns of host-parasite associations in tropical lice and their passerine hosts on Mount Cameroon. This paper supplements knowledge of host–parasite associations in lice using cospeciation analysis of feather lice (genus Myrsidea and the Brueelia complex) and their avian hosts in the tropical rainforests of Cameroon. Analysis revealed a limited number of cospeciation events in both parasite groups.

Matthew LeBreton has recently published on Adenovirus and Coronavirus diversity in rodents in Cameroon, the Democratic Republic of Congo and the Lao People's Democratic Republic, on liver flukes in sheep and cattle in slaughterhouses in Cameroon, on dengue virus circulation in people in Cameroon and on antimicrobial resistance from a one-health perspective.

Kristen Ruegg, **Ryan Harrigan**, and collaborators published "A genoscape-network model for conservation prioritization in a migratory bird" in the journal Conservation Biology. The publication describes the development of a novel modeling tool that utilizes genetic analyses, distribution modeling, and demographic data to assess risk factors to migratory species across their full annual cycle. This model was applied to a long distance, Neotropical migratory bird, Wilson's Warbler (Cardellina pusilla), and was used to show how conservation efforts might be managed depending on the ultimate goal of the efforts. Ultimately, genoscape-network models like these can facilitate conservation prioritization in migratory animals across the full annual cycle based on the priorities of the conservation needs.

Rachael Bay and co-authors published a study in Science on genomic signals of climate adaptation and vulnerability in Yellow Warblers. This study found that precipitation was a strong climatic driver of adaptation in the breeding range of Yellow Warblers. Furthermore, populations requiring the greatest degree of adaptation to future climate change had already experienced declines over the past half century. The study garnered press from a number of news outlets including PBS, NPR, and The Conversation.