UCLA Institute of the Environment
Center for Tropical Research

Conservation Through Science

The Seed

Newsletter of the Center for Tropical Research

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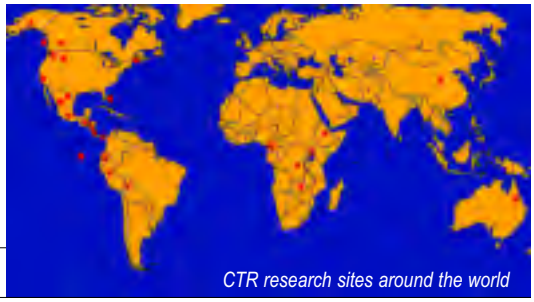


CTR research sites around the world

LETTER FROM THE DIRECTOR

Coral reef, Raja Ampat Islands
Photo: Virginia Bria

Dear Readers,

Understanding the ecological and evolutionary processes that maintain marine ecosystems is critical for their conservation. The resilience of coral reef ecosystems depends on complex interactions among functional groups of fishes. In many parts of the world, overfishing and the loss of mangroves, which provide important habitats for young fish, result in trophic cascades that pose serious threats to marine ecosystems.

I recently visited the Raja Ampat Islands in West Papua, Indonesia, to explore new research opportunities for the Center for Tropical Research (CTR). The region is believed to harbor the greatest diversity of coral species in the world and is home to more than 1,000 fish species. In this newsletter we highlight UCLA faculty and students whose research is focused on marine ecology, evolution, and the preservation of coastal ecosystems.

Our feature article this month is by Dr. Ravinder Sehgal, a CTR Senior Research Fellow. He reports on the work by our research team in Cameroon, West Africa, this past June and July as part of our National Science Foundation-funded study on the effects of deforestation on blood-borne pathogens in African rainforest birds.

CTR continues to focus on research, training, and education in Ecuador, as described in articles in this newsletter by CTR's Latin America Director, Dr. Jordan Karubian, and NASA/Jet Propulsion Laboratory scientist, Dr. Sassan Saatchi. The Field Notes section reports on student research projects in the Bahamas, Cameroon, and Canada.

We would like to welcome three new professors to our CTR Steering Committee: Tom Gillespie (Geography), Peter Narins (Physiological Sciences and Ecology and Evolutionary Biology), and Allen Roberts (World Arts and Culture).

We hope you will share this issue of The Seed with your friends and colleagues.

Sincere Regards,

Thomas B. Smith, Ph.D.

IN THIS ISSUE:

CTR **news & updates**

CTR Moves to La Kretz Hall, Suite 300

CTR and the Institute of the Environment moved our offices to the newly-built La Kretz Hall in June 2005. Nearly 400 people attended the La Kretz Hall inaugural lecture by UCLA professor and author Jared Diamond. Our new contact information is on the back of the newsletter.

LA Audubon Supports Ecuador Student Training

The Los Angeles Audubon Society contributed funds to CTR to help support a three-month conservation genetics laboratory internship for Ecuadorian university student Gabriela Nicholls. Her laboratory research at UCLA focused on analyzing the genetic differences in the orange-bellied euphonia, a bird species found along an altitudinal and geographic gradient in western and eastern Ecuador.

Above Right: Gabriela Nicholls
Left: Orange-bellied euphonia (Euphonia xanthogaster)

Contribution for CTR Graduate Student Researcher

CTR would like to thank Margery Nicolson for her generous contribution to provide support for a CTR graduate student researcher for one year. Her contribution will be used to support Ecuadorian biologist Jaime Chaves who is studying the evolution of speckled hummingbirds in South America.

CTR Members Give Presentations and Win Awards

CTR graduate students and postdoctoral researchers John McCormack, Borja Milá, and Elena Berg presented talks at the 2005 American Ornithologists' Union (AOU) meeting in Santa Barbara in August 2005. Allison Alvarado, Katy Semple Delaney, and Tom Dietsch gave poster presentations. Alvarado received an AOU Research Award and McCormack received an AOU Council Award for best student presentation. John McCormack was also the recipient of a 2005 UC MEXUS Dissertation Research Grant for $11,490 to study "The Sky Islands of Northern Mexico as generators of diversity in a bird species."

CTR graduate student and Fulbright scholar Adam Freedman spoke at an Earth Day panel debate in April sponsored by the Embassy of the United States in Cameroon. The meeting was attended by some 40 environmental professionals, journalists, educators, NGO representatives, and students and was featured on the Embassy web site.

Five New Postdoctoral Researchers Join CTR Team in 2005

ELENA BERG, previously at the University of California, Davis, is using molecular markers to investigate the population genetic structure and connectivity of Neotropical migrant songbird species whose populations are declining in California.

CAMILLE BONNEAUD, from France, is conducting research on the role of avian blood parasites as part of CTR's NSF-funded study on the effects of deforestation on the prevalence of blood-borne pathogens in African rainforest birds.

WOLFGANG BUERMANN, from Germany, is working on the NSF grant team to relate patterns of blood-borne pathogens to changes in habitat using remote sensing.

TOM DIETSCH, previously at the Smithsonian Migratory Bird Center, is starting a new project on avian ecology and conservation in cacao agriculture in Cameroon, West Africa.

CASSIA PRATES, from Brazil, is part of the team using remote sensing data to evaluate the potential of both climate and environmental variables to model and predict bird species distribution habitat in South America, a part of CTR's study funded by NASA.

February 2007 - UCLA International Symposium on Evolutionary Processes

CTR Director Thomas Smith, Professor Louis Bernatchez, from Université Laval in Quebec, Canada, and the UCLA Institute of the Environment are organizing an international symposium entitled "Microevolutionary Change in Human-altered Environments" to be held February 8-11, 2007 on the University of California, Los Angeles (UCLA) campus. The symposium will bring together many of the leaders in the subdiscipline of evolution that focuses on how human activities are altering evolutionary processes. Forty-four scientists are scheduled to speak on three large topical areas: 1) Captive Breeding and Exploitation, 2) Habitat Degradation and Climate Changes, and 3) Invasive Species and Pathogens. More information will be posted on the CTR web site in the next few months.

Deforestation and Its Effect on Diseases in Rainforest Birds in Cameroon

Ravinder Sehgal, Ph.D., *Adjunct Professor of Biology, San Francisco State University*

The morning greets us with the loud hornlike calls of colorful coucals and turacos. We get out of our tents at sunrise, put on our rubber boots, and begin the day's work. We first open all the mist nets, and then return to camp for a quick breakfast of oatmeal, biscuits, and coffee. Some nets are in the muddy swamp and others in the relatively dry forest. In all, there are 35 nets, covering nearly half a kilometer, stretched in lines cut by our Baka guides. After 20 minutes, the first birds have flown into the nets. We bring them into the screened processing tent and examine each bird. These small birds, in the middle of the jungles of Cameroon, West Africa, are our research subjects. They harbor diseases, such as avian malaria, which are very similar to their human counterparts, making the study of birds an excellent model system.

Setting up camp in Cameroon

Quickly, Tom Smith, CTR Director and our field leader, weighs a bird, attaches a band to its leg, identifies the species, measures the wing, tail, tarsus, culmen, and lower bill length, and then takes a few drops of blood from under the bird's wing. Meanwhile, I scramble to write all the numbers down and simultaneously label tubes and envelopes for each specimen. Tom passes a drop of blood to Gediminas Valkiunas, our expert parasitologist from Lithuania, who methodically makes three blood smears for microscopic study. It is all synchronized, and each bird takes just a few minutes before it is released. By the end of the trip, we joke that we would win the gold medal in a bird-processing competition. We just barely finish one batch of birds when our Cameroon colleagues, Dennis Anye and Tony Chasar, and UCLA postdoctoral researcher Tom Dietsch arrive with more birds that they have collected from the nets.

With funds from the National Science Foundation (NSF), this team of six scientists traveled through Cameroon for five weeks in June and July of 2005. The project, entitled "Effects of deforestation on the prevalence of blood-borne pathogens in African rainforest birds," also involves several scientists who continued the research in California while we were in Cameroon: UCLA postdoctoral researchers Camille Bonneaud and Wolfgang Buermann, and NASA/Jet Propulsion Laboratory scientist Sassan Saatchi. During the past 15 years, scientists at CTR have collected more than 6,000 individual blood samples from over 200 rainforest bird species in a variety of habitats across Cameroon, the Ivory Coast, and Uganda. Significantly, the samples were collected from sites both before and after habitat degradation, permitting a unique examination of the direct effects of human-induced habitat alterations. Using blood smear analyses and molecular biology, these samples are being assayed for the pathogens that cause malaria, trypanosomiasis, filiariasis, and tuberculosis.

White-bellied kingfisher (Alcedo leucogaster)

An exciting component of the project is the implementation of remote sensing satellite data. This technology allows us to measure soil moisture, density of forest cover, and how the forests have changed during the past 15 years. We are able to determine how prevalence rates have changed in certain populations of birds and we can determine if certain strains of these diseases are invading areas where they previously were not found. Over generations, birds develop natural immunity to certain strains, but they may be susceptible to new strains that appear due to pressures humans are putting on the forests.

Over the five weeks of fieldwork, we visited four sites. Two of them are near villages and have experienced extensive deforestation. The other two are deep in the pristine rainforest. Tom Smith had been to all of these sites before and at one of the interior forest sites he found the orange flagging on a tree from a previous expedition nearly 15 years ago.

Chestnut-flanked sparrow hawk (Accipiter castinilius)

On our return to Zoebefame village after two weeks in the rainforest, we requested that the villagers bring us all of their chickens to examine. Our goal was to determine whether the chickens harbored similar strains of parasites to those we found in the rainforest, and to determine how prevalence rates and disease strains vary in villages near intact forests versus those near deforested areas. There were many more mosquitoes and biting insects in the deforested areas.

This research project is significant because it will develop models to predict how deforestation will influence future disease outbreaks as well as facilitate development of reforestation strategies. Our research team caught and took samples from nearly 700 birds, which made the trip enormously successful. This project is also helping to train students and environmental researchers at U.S. institutions and in Lithuania and Africa.

We returned to our respective universities with many photos and a greater appreciation of the balance of nature and the tremendous speed with which tropical rainforests are being destroyed. We carry out our research with a sense of urgency; our intention is to impact the establishment of effective conservation policies so that in 15 years we will be able to again find that tree in Cameroon, now labeled with a second piece of orange flagging.

CTR **marine research**

Human Impact on Coastal Ecosystems

Richard Ambrose, Ph.D., *Professor of Environmental Health Sciences and Director, Environmental Science and Engineering Program, UCLA*

My research focuses on the ecological impacts of human activities in coastal habitats and the restoration of degraded habitats. Throughout the world, people choose to live near the coast, so coastal environments have experienced disproportionate environmental impacts. I have been studying the effectiveness of restoring wetlands, especially salt marshes and riparian habitats, throughout California.

Anemone fish collector

Photos: Craig Shuman

Boats with aquarium fish collectors in the Philippines

My students and I are also evaluating a key fisheries management tool—no-take marine reserves in which fishing is prohibited—as a means for restoring coastal fish populations. One of my students conducted a study of marine protected areas on the Great Barrier Reef and another examined the effects of collecting for the ornamental fish trade on coral reefs in the Philippines. Besides assessing the effects of collections on anemones and anemone fishes, we have evaluated different management approaches, and especially eco-certification, as a means of minimizing the negative effects of overfishing without adversely affecting the income of artisanal fishers.

We are also conducting long-term monitoring of rocky intertidal habitats and studies in coastal watersheds to evaluate the link between land use and aquatic community health. All of these projects provide information that serves as the foundation for the management and protection of these important coastal ecological communities.

Swimming Biomechanics and Hydrodynamics in Some Reef Fishes

Malcolm S. Gordon, Ph.D., *Professor of Ecology and Evolutionary Biology and Institute of the Environment, UCLA*

Boxfishes, cowfishes, trunkfishes, and pufferfishes are mostly tropical reef-dwelling marine fishes that swim unusually smoothly (with little lost energy in movements extraneous to locomotion). They are also surprisingly fast and agile. My research associates and I study swimming biomechanics and hydrodynamics in these fishes both in the lab and in the field in Australia, Hawaii, and the Caribbean.

Shaw's cowfish (Aracana aurita)

We are gradually coming to understand the various structural features and biomechanical mechanisms that contribute to their swimming capacities and performance. Major components include: the shapes of their bodies, the placement of fins on their bodies, the ways in which fin movements are coordinated to produce multiple swimming gaits, and the ways in which they control patterns of water flows over their body surfaces and around their fins. We are finding that they are extremely sophisticated multi-propulsor autonomous underwater vehicles—much more sophisticated than any existing human-made underwater vehicles. There also appear to be at least several fairly general mechanisms that they use, despite their great morphological diversity.

Ornate cowfish (Aracana ornata)
Photos: Dean V. Lauritsen

One of our most significant findings is that sharp-edged keels on the bony carapaces of boxfishes act as vortex generators while the fishes swim. These vortices are important contributors to unusually great dynamic stability in boxfish swimming.

Model of a Coral Reef Fish Population

Richard Vance, Ph.D, *Associate Professor of Ecology and Evolutionary Biology, UCLA*

My research program spans several topics in marine and theoretical ecology. I am currently constructing a large, individual-based population model of bridled gobies *(Coryphopterus glaucofraenum)*, small fish that live on coral reefs in the Bahama Islands. The model's purpose is to explore the large-scale consequences of the density-dependent ecological processes that my field collaborators have studied experimentally in small study sites. Specifically, the model will examine how demographic processes influence the dynamics of the goby metapopulation that occupies the collection of all reefs in the Bahama Island archipelago.

Aerial view of Lee Stocking Island, Bahamas
Photo: Caribbean Marine Research Center

The model tracks thousands of individual gobies on one subject reef connected via larval dispersal to similar goby populations on all other reefs. It represents explicitly all properties of individual gobies that influence demographic events like survival, somatic growth, and spawning. Systematically varying parameter values will reveal how each demographic property, like the strength of density dependence in somatic growth, for example, can influence fluctuations through space and time in the number of gobies that occur throughout the archipelago.

Among its other uses, this model can help inspire the design of marine protected areas to provide maximum economically feasible protection to breeding stocks of commercially important fish species.

Bridled gobies can be individually marked and observed through time

The Evolutionary Origin of California's Marine Biodiversity

David Jacobs, Ph.D., *Associate Professor of Ecology and Evolutionary Biology, UCLA*

California coastal marine diversity is arguably the highest of any temperate marine system. Why should this be? California might accumulate diversity through immigration of species that evolved elsewhere. However, kelp, crabs, fish, and fish-eating birds in the temperate Atlantic and on the west coast of South America have their evolutionary origin in the north Pacific, not the other way around. Thus the northeast Pacific is a significant evolutionary source, not a sink, for marine species.

Synthesis of molecular and paleontological data reveals that marine evolution in the northeast Pacific is not constant. Many groups diversified dramatically in the Late Miocene, a time when global cooling of the deep ocean facilitated nutrient upwelling and oceanic productivity in the region. Exceptional California coastal diversity is a relict of this period of higher marine productivity, speciation, and diversity present from twelve to five million years ago. California marine diversity reflects oceanographic conditions that are no longer operative on the coast today. For more information: Jacobs, D.K., et al. 2004. Genes, diversity, and geologic process on the Pacific Coast. Ann. Rev. Earth Planet Sci. 32: 601-652.

Top: Collecting marine samples
Bottom: Marine samples for molecular work

Demographic Studies of Damselfish and Gobies in the Bahamas

Jameal F. Samhouri, *Graduate Student, Department of Ecology and Evolutionary Biology, UCLA*

For the last five years, I have spent the summer months working on my Ph.D. dissertation at the Caribbean Marine Research Center in the central Bahamas. My research is focused on the demography of coral reef fishes. Essentially, I serve as the Census Bureau for two species of coral reef fish: the bicolor damselfish and the goldspot goby.

My goal is to determine how different ecological factors, such as the availability of food and shelter, drive changes in the size of reef fish populations. In particular, I have examined how the traits of individual fish affect a population's overall growth trajectory. I have shown that: 1) female damselfish produce the most offspring when food is abundant and crowding by other damselfish is minimal, and 2) when there is a shortage of refuges from predators, natural selection favors the survival of relatively small juvenile gobies rather than relatively large juvenile gobies.

No-take areas are currently being favored as a conservation and management strategy for marine resources. One of the most important issues in designing and implementing no-take areas is deciding which habitats to protect. My work suggests that prioritizing habitats with abundant food and shelter will increase the conservation benefits of this management strategy.

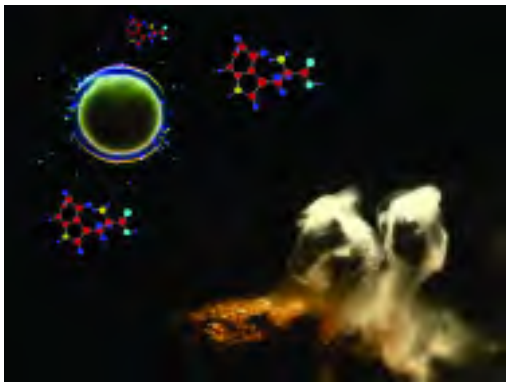
Photo: K. Nickols

Top: Jameal Samhouri at the goby settlement cage
Bottom: Bicolor damselfish (Stegastes partitus)

Chemical Communication and the Language of Sperm and Egg

Richard K. Zimmer, Ph.D., *Professor of Ecology and Evolutionary Biology, Neurosciences Program, and Brain Research Institute, UCLA*

Chemically mediated behavior is a key component of sperm-egg dynamics in habitats ranging from the turbulent ocean to a mammalian reproductive tract. Our recent discovery of the sperm attractants, bourgeonal in *Homo sapiens* and L-tryptophan in abalone (*Haliotis rufescens*), bridged the gap between molecular biology and fertilization ecology. In humans, a bourgeonal-sensitive, olfactory receptor protein (hOR17-4) is expressed exclusively on sperm membrane. Thus, sperm have a "nose." The receptor acts through a G-protein-coupled cAMP transduction pathway in regulating calcium uptake and sperm chemotactic responses. In abalone (a large marine mollusk), sperm detect shallow concentration gradients that develop when tryptophan is released naturally by an egg. The male gametes integrate chemosensory information over 200 milliseconds and negotiate attractant gradients in laminar-shear flows by using helical klinotaxis to redirect swimming motions (rotational and translational velocities).



(Reprinted as a courtesy of the Society of Biologists, Limited)

The top image in the picture shows molecules of L-tryptophan (an abalone sperm attractant), and sperm of the red abalone navigating towards a conspecific egg in response to a natural gradient of this chemoattractant. In contrast, the bottom image shows a male releasing sperm. Like many marine animals, male and female abalone synchronously spawn their gametes into the surrounding seawater, where fertilization depends upon contact between sperm and egg.

Because human and abalone sperm navigate similarly, chemical communication apparently involves species-specific dialects of a common language at the molecular, cellular, and behavioral levels.

CTR **field notes**

CANADA – Hermit Thrush

Allison Alvarado, *Graduate Student, Department of Ecology and Evolutionary Biology, UCLA*

Although the forests of the Pacific Northwest and the tropics seem worlds apart in terms of distance and diversity, they have much in common. They are home to the same migratory birds during different seasons, providing shelter in their lush green foliage and an abundance of food. I spent this summer in the vast forests of British Columbia studying the hermit thrush (*Catharus guttatus*), a short-distance migratory songbird. My field assistants and I sampled birds along northern and southern transects, from the Pacific Coast to the Canadian Rockies. We drove through mountainous regions on remote logging roads in search of breeding populations and used mist nets and song playback techniques to capture birds. After taking morphological measurements and a genetic sample from each bird, we tagged it with a numbered leg band and then released it back into the wild.

I am using the data collected in the field to uncover the mechanisms responsible for creating and maintaining a migratory divide in the hermit thrush. Migratory divides are regions where adjacent breeding populations exhibit different migratory directions. Data from last year's fieldwork provide support for the hypothesis that different migratory behaviors are the result of eastern and western populations diverging in separate glacial refugia and then expanding their geographic ranges to where they now meet in the Pacific Northwest. Data from this year's fieldwork will pinpoint the exact location of the contact zone and assess the extent of mixing between eastern and western forms.

Top: Hermit thrush (Catharus guttatus)
Bottom: Sampling site in the Canadian Rockies

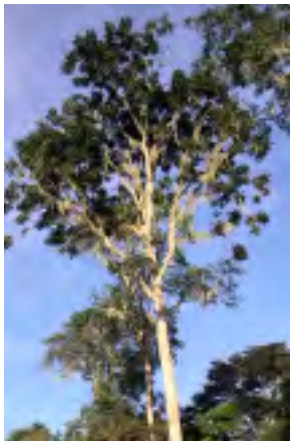
CAMEROON – Seed Dispersal and Bushmeat Hunting

Benjamin Wang, *Graduate Student, Department of Ecology and Evolutionary Biology, UCLA*

From October to December, 2004, I spent my fifth field season in the rainforests of Cameroon, where I have been studying the impacts of hunting on seed dispersal dynamics. Upon arrival, we discovered that poachers had been using our research camp in the Dja Biosphere Reserve. We also faced another major challenge: this was a low rainfall year, and many of the trees that I planned to use for my study did not set fruit. Without adequate sample size, I had to quickly redesign my project.

Cameroon field team: Francois Manene, Misha Leong, Armand Abah, Paul Mesa, and Benjamin Wang

Despite these obstacles, we had a productive trip. Thanks to my dedicated field team, including Misha Leong, a UCLA senior, a Cameroonian field assistant, and a dozen Baka and Badjoue guides, we surveyed five 16-ha plots, mapping and sampling all ozambeli trees (*Antrocaryon klaineanum,* Family: Anacardiaceae), and collecting 121 dispersed ozambeli seed piles (totaling over 1,100 seeds). We logged over 150 hours watching fruiting ozambeli trees, investigating which animals consumed the fruits and dispersed the seeds, and quantifying the undispersed fruits and seeds. We also collected 400 seeds from 18 mother trees to germinate in the UCLA greenhouse for a pollen flow study. Since ozambeli seeds are dispersed almost exclusively by mammals, the samples will allow us to assess how the hunting of seed-dispersing mammals is affecting the gene flow of these rainforest trees.



Ozambeli tree (Antrocaryon klaineanum)

BAHAMAS – Lizards

Erin Marnocha, *Graduate Student, Department of Ecology and Evolutionary Biology, UCLA*

My research focuses on understanding the mechanisms that generate intraspecific morphological variation in brown anoles (*Anolis sagrei*). I conduct my fieldwork on the islands of the Bahamas, where brown anoles thrive in both their natural forest scrub habitat as well as habitat that has been greatly disturbed by human activities. Results from an initial study have revealed several striking morphological differences between anoles occupying natural and disturbed habitat types, including a remarkable shift in body size.

The objective of my current work is to understand the processes driving the observed phenotypic divergence. One hypothesis is that the phenotypic divergence results from differences in selection pressures between habitat types that in turn create differences in survivorship patterns. In order to test this hypothesis, I have initiated an extensive mark-recapture study aimed at estimating the form and strength of natural selection acting on anoles in both habitat types. An additional hypothesis is that phenotypic plasticity is responsible for the observed morphological variation. To address the role of plasticity, I am conducting a series of laboratory manipulations to identify key environmental factors influencing growth patterns and morphology in this species.

Brown anoles waiting in a bucket to be measured

Downloading data from lizard models

ECUADOR

Jordan Karubian, Ph.D., *Center for Tropical Research Associate Director and Latin America Director, UCLA*

Due to its outstanding importance for conservation, Ecuador remains the primary focus of CTR's efforts in South America. Recently, Dr. Michael McColm, a long-time leader of conservation work in Ecuador, joined the CTR team.

In northwestern Ecuador, we are leading a multidisciplinary effort to understand and save the Chocó rainforest, one of the world's centers of diversity and endemism. Our scientific research is uncovering important baseline information on general rainforest dynamics such as seed dispersal, phenology, forest regeneration, and diversity in relation to habitat type. We are also conducting groundbreaking work on endangered species such as the long-wattled umbrellabird and the banded ground-cuckoo.

Jorge Olivo, a resident of Dogola, assists with the capture of a long-wattled umbrellabird

In the social sphere, we are working with local Ecuadorians to promote conservation and sustainable practices. We provide training and employment as field biologists for local community members, conduct environmental education programs, and collaborate with Ecuadorian university professors and honor's thesis students on field training projects.

Outside of the Chocó, we are implementing a NASA-funded research project linking habitat and climate change to patterns of vertebrate diversity and developing projects in Brazil's Mata Atlantica rainforest.

A New Environmental Education Initiative in Ecuador

In 2005, CTR made dramatic and exciting advances in community outreach and education in Ecuador. In June 2005, we launched a full-scale education program in the Chocó region of northwestern Ecuador. Designed and implemented by myself and Mónica González, an Ecuadorian with an M.S. in environmental education, this project targets eleven local community schools and over 350 children. Our goal is to teach young people about local flora and fauna and to promote conservation awareness.

Ecuadorian university student Luis Carrasco provides hands-on education about Chocó birds

In her capacity as project director, Ms. González conducts weekend-long workshops each month for local teachers on environmental topics. After each workshop, she visits community schools and implements hands-on experiments designed to reinforce that month's theme.

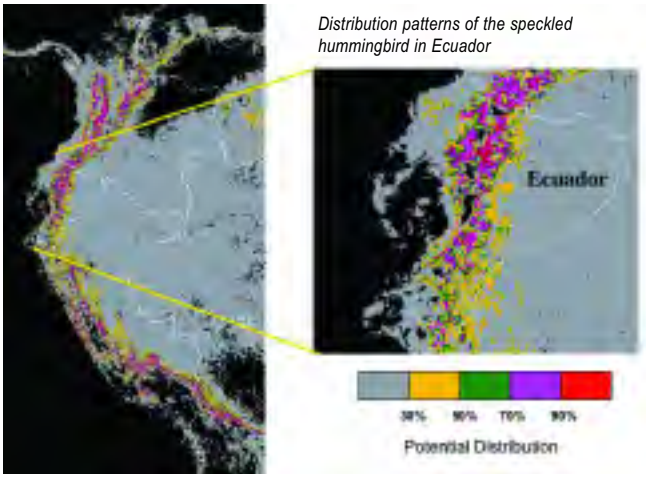
Outside of the classroom, CTR has organized community events that have already reached more than 700 people. Local community members and Ecuadorian university students working with CTR have given PowerPoint presentations in several communities and held mist-netting demonstrations to show how to catch, measure, and take samples from birds. This combination of training, capacitation, outreach, education, and scientific research is yielding meaningful conservation results in the Ecuadorian Chocó.

Local community member Domingo Cabrera entering field data

Ecuador and Cameroon – Patterns of Biodiversity and the Impact of Climate Change

Sassan Saatchi, Ph.D., *Senior Scientist, NASA/Jet Propulsion Laboratory, California Institute of Technology*

Cassia Prates and Wolfgang Buermann, two new postdoctoral researchers working under CTR's NASA and NSF grants, respectively, are developing new techniques for understanding the impact of global environmental changes on patterns of species distribution and diversity. By selecting species with a limited or broad environmental niche, using biogeographical models and climate and surface variables from NASA's earth observing satellites, they are generating patterns of species distribution and testing their stability under different human-induced or climate change scenarios. Here, we show the distribution patterns of the speckled hummingbird (*Adelomyia melanogenys*) as an example.



Distribution patterns of the speckled hummingbird in Ecuador

CTR's genetic data analysis from sites in Ecuador has shown a significant split between hummingbird populations from each side of the Andes that occurred about three million years ago during the last stages of the uplifting of the Andes. The result from the distribution model clearly highlights these patterns along the Andes. Climate variables, such as mean precipitation and temperature, topography, and vegetation characteristics (greenness, leaf area, and moisture), observed from remote sensing data, were the main factors in defining the distribution pattern of hummingbirds. These patterns, and further analysis of biological information, will allow us to determine what influences or limits the occurrence or abundance of this species and how physiological and ecological adaptation work across environmental variables.

CTR **People**

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