Letter from the Director - December 2008

Dear Friends and Colleagues:

As we view this past year with hindsight, we have witnessed both new and continuing challenges that we all face as a society, and that demand increased efforts to support research to better understand ecological complexity in the context of providing essential information needed for making sound policy decisions. In addition, many challenges exist for training the next generation of scientists who are faced with understanding and mitigating the myriad threats to Earth’s air, land, and water and the ecosystems they support. CECB faculty associates and their students continue to meet many of these challenges by addressing environmental issues at both local and global scales, including introducing students in BU’s Tropical Ecology Program to the effects of deforestation and the extraction of oil reserves on biodiversity, assessing the ecological impacts of newly emerging diseases, and evaluating economic drivers that increasingly threaten marine biodiversity, ecosystem health, and sustainability. Socioeconomic issues on a global scale pose threats to the Earth’s fragile environments and ecosystems, affecting the availability of fresh water, food, fiber, and energy resources for an ever-increasing human population. Ecologists and environmental scientists are being faced with many complex environmental issues, at a time when funding from government and non-government sources have precipitously declined.

To help address the complex issues wrought by changing economic and ecological factors, we have highlighted a few recent research activities of CECB faculty associates and their students in this issue of CECB Update, and we encourage you to invest in these and other research activities of CECB faculty associates and their students. Novel cross-disciplinary approaches are being used to address many of today’s challenges, including how best to mitigate global demands for both fossil and renewable energy sources, determining the cause of unprecedented declines in terrestrial and airborne faunas, and addressing new and continuing threats to fresh water and marine environments using ecosystem-based management strategies. To adequately address threats to land, aquatic and airborne faunas, increased financial support is needed to provide the critical baseline data for making sound policy decisions. In addition, we highlight three basic research initiatives in this issue, including studies on the genetics of African parasitic birds that provide insight into how new species evolve and ultimately contribute to biodiversity, research on the importance of understanding phenotypic plasticity in neotropical frogs to better understand the complex interactions between embryonic development, other life-history traits, and population dynamics, and a focus on the emerging discipline of aeroecology, with an emphasis on daily and seasonal movements and migration of airborne fauna.

No less important, we congratulate the promotion of two CECB associates—John Finnerty and Karen Warkentin—to the rank of associate professor of Biology, the appointment of Robinson (Wally) Fulweiler as assistant professor in the Department of Earth Science, recipients of new grants and awards made to CECB faculty associates, and finally the awarding of 11 new Ph.D.s to students of CECB faculty associates.

With best wishes for a happy and productive New Year.

Sincerely yours,

Thomas H. Kunz, CECB Director
Environmental Concerns in Eastern Ecuador in the Region of the Tiputini Biodiversity Station
-Kelly Swing, Founding Director, TBS

The region around the Tiputini Biodiversity Station (TBS) is the most species-rich in the world, and as such deserves and requires the greatest level of protection possible. At present, the greatest threats to the Yasuní National Park and Biosphere Reserve include human population growth and expansion of the agricultural front, oil exploration and extraction, illegal timber harvest, acculturation of indigenous peoples and simple lack of funding for management of this protected area. Historically, access to Yasuní has been restricted and therefore much of the region remains essentially intact. This means that there is still a tremendous opportunity to protect this precious natural treasure. The burden for maintaining this UN-declared World Natural Heritage Site is one of the greatest responsibilities that fall to humankind. Unfortunately, pressures on this area are increasing and it might be considered unreasonable for the economically strapped country of Ecuador to not exploit a few billion barrels of crude oil that lie beneath Yasuní. Nonetheless, environmentalists around the globe are pleading that Yasuní be spared. Certainly a minimal demand from conservationists would be to not allow any more roads to be built in the region. Because oil can be exploited without road access, this possibility is feasible and may be acceptable. If no new roads are built into the region, indirect impacts could be decreased to almost nothing, and knowing that technology can minimize direct impacts of the oil industry, some cautious optimism is reasonable. Lots of effort and money will undoubtedly be required to provide a positive outcome for this story.

An alternative to the Panama Canal, an overland and river transportation route from the Ecuadorian coast to central Amazonia, is another threat to the region. This so-called Manta-Manaus project would develop major highway access near the northern border of Yasuní and thereby, impose possibly even greater risks to the area than typical scenarios of the past. As another way to link commerce between the Atlantic and Pacific Oceans, this represents an important business venture, so incentives are especially attractive to countries such as Ecuador and Brazil.

In September 2008, Ecuador approved a new Constitution, and several articles applicable to nature and the environment are promising with regards to the previously mentioned threats:

• Article 71. Nature has the right to be respected in its entirety. Every person, community, people or ethnicity can demand that public authority comply with the rights of nature to exist, to be maintained, to regenerate, to carry out natural cycles and evolutionary processes.

• Article 395. The State will guarantee a sustainable model of development, environmentally balanced and respectful of cultural diversity, one that conserves biodiversity and the natural regenerative capacity of ecosystems, and ensures the satisfaction of these needs for present and future generations.

• Article 396. The State will adopt policies and opportune measures that avoid negative environmental impacts whenever there is probability of damage. In case of doubt concerning environmental impacts, the State will adopt efficacious protective measures even when scientific evidence of damage does not exist. Each and every actor involved in the production, distribution or commercialization and use of goods or services will assume responsibility to prevent any and all environmental impacts, to mitigate and repair all damage caused, and to maintain a permanent system of environmental monitoring.

• Article 400. The conservation of biodiversity and all its components are declared to be of public interest.

• Article 405. The national system of protected areas will guarantee the conservation of biodiversity and maintenance of ecological functions. The State will assign the economic resources necessary for the financial sustainability of this system.

• Article 407. Extraction of non-renewable resources as well as forestry resources from protected areas is prohibited.

Some of these new constitutional articles sound too good to be true, so conservationists will have to be patient to see how this document is applied in practice.
Natural Elements
In March 2008, CECB Director Tom Kunz visited Ecuador with a group of eighteen travelers. The group included two BU visual arts graduate students who won a newly established Fellowship to travel to Ecuador and create art inspired by the rainforest. The group of ecotourists spent time in the city of Quito, traveled to the Tiputini Biodiversity Station, and toured the Galápagos Islands. The visual arts students - Lika Yurkovetsky and Lindsey Warren - held an exhibit entitled “Natural Elements: Images from Ecuador” in June 2008, where they displayed some of their artwork created in Ecuador (see above). The CECB hopes to continue the tradition of inviting students from other disciplines to join us in Ecuador. Another ecotourism trip is planned for February/March 2010.

White Nose Syndrome in Bats: Why are bats dying across the northeast?

CECB Director Thomas Kunz and several lab members and colleagues have been busy trying to get to the bottom of that very question. In the winter of 2006/2007, researchers began to find dead or dying bats at hibernacula in upstate New York. Many of these bats had a mysterious white fungus growing on their nose and faces - hence “White Nose Syndrome” or WNS. The following winter (2007/2008), a disturbing increase in bat fatalities was accompanied by an equally disturbing geographical shift. Sick and dead bats were suddenly being found at sites in Massachusetts, Vermont, and New Hampshire, in addition to upstate New York. Six of the nine bat species found in the northeast US were affected by WNS, and bat mortality rates reached an astounding 90% at some sites. Researchers acted quickly to begin to determine the cause of the bats' illness. In June 2008, over 90 scientists and natural resource managers held an emergency conference on WNS in Albany, NY, where they discussed several proposed hypotheses.

Researchers at the conference agreed that among the highest priorities was to address why hibernating bats with WNS have little or no body-fat by mid-winter during hibernation. Affected bats may be entering hibernation with too little fat reserves to make it through the winter, or the bats may be prematurely depleting fat reserves during hibernation. One thing is clear: bats affected by White Nose Syndrome are starving.

White adipose tissue (WAT) is the primary source of energy that sustains bats throughout the winter, when they have little or no access to insects. Over-winter survival requires a sufficient quantity and quality of WAT deposited during the pre-hibernation period. Kunz's graduate student Jon Reichard is currently conducting a study that aims to quantify colony composition, body condition, and body composition of pre-hibernating and hibernating bats. The study focuses on the little brown myotis (Myotis lucifugus), because it is the most abundant species in northeastern US hibernacula, and members of the genus Myotis have been most affected by WNS. Bats from affected and unaffected sites will be assessed during pre-hibernation and hibernation, and analyzed for body and wing condition, and body composition (water content, lean mass, body fat content).

It is hoped that these data will help explain why fat reserves of affected hibernating bats are depleted by mid-winter. Reduction in the quantity and quality of insects during pre-hibernation in autumn may explain the depleted WAT reserves in mid-winter. Moreover, depleted WAT at this time may contribute to increased mortality and a decrease in leptin production (necessary for ovulation and successful reproduction by females).

Complimentary studies on the immune system of affected bats, arousal rates, frequency of arousals, depth of torpor, and changes in leptin concentration will be conducted to help explain why hibernating bats are dying prematurely in the northeastern US. With so many bats already affected by WNS, it is imperative that researchers act quickly to find the cause of the mysterious new illness – and hopefully, the cure.
Join us in the
TIPUTINI SUPPORT GROUP

Current Goals:
• Raise awareness about the Tiputini Biodiversity Station by developing a new support group
• Raise funds to support alternative energy at TBS - including stationary energy-generating bicycles and solar panels - lessening the station’s dependence on the encroaching oil industry
• Raise funds for new books for the library, and other materials for the new laboratory facility at the station

Contributors of $100 or more may elect to receive a 2009 calendar featuring photos from Tiputini. Payment can be made via check to “Boston University - Tiputini Support Group” and sent to CECB, 5 Cummington St., Boston University, Boston, MA 02215. For more information, see http://www.bu.edu/cecb/tsg/default.html.

Questions? Please contact cecb@bu.edu. We hope to hear from you soon!

Tropical rainforests not only are havens for the great diversity of life, but they are also crucial to the current and future health of humans and other life forms around the planet. Rainforests influence regional and global weather systems, carbon dioxide sequestration, albedo effects, and harbor potential medicinal benefits. The Tiputini station – adjacent to the Yasuní National Park – plays a key role in northwest Amazonian conservation efforts.

With this in mind, we ask you to join the Tiputini Support Group (TSG). Affiliated with CECB and the International Symbiosis Society, the Group’s main focus is to create a source of targeted funding support for necessary conservation research and education assistance at Tiputini.

Plasticity in Panama: Warkentin Lab News

In Spring 2008, CECB Faculty Associate Karen Warkentin, along with her former post-doc James Vonesh and several lab members, began field work on a new project in Panama aimed at assessing the importance of phenotypic plasticity for population processes. Many prey have plastic defenses that they use only when at risk of predation, otherwise saving the costs of defense. In some contexts, these plastic responses and their costs can have surprisingly large consequences both for individuals later in life and for population dynamics. In other contexts the lethal effects of predation matter much more. Warkentin’s and Vonesh’s current project focuses on predator-induced plasticity in hatching and metamorphosis, two ecologically pivotal events that exemplify the life-stage transitions common among animals. The focal species, red-eyed treefrogs, hatch early to escape egg predators, metamorphose early in response to tadpole predators, and delay metamorphosis in response to predators of froglets. The project uses mathematical models and field experiments integrated across these three life stages to assess how environmental context shapes the relative importance of plastic responses to risk and direct predation for both population dynamics and individual fitness. This will advance our understanding of population ecology, life history, and development, and strengthen links among these fields.

In addition to Warkentin’s post-doc Michael McCoy and graduate student Myra Hughey, this field season the Warkentin/Vonesh labs hosted nine interns at the Smithsonian Tropical Research Institute to assist with the large-scale project. Undergraduate students from BU, other US universities, and Venezuela, Guatemala and Panama all participated in field research. In other lab news, Warkentin and grad student Justin Touchon’s research on amphibious eggs was published in Proceedings of the National Academy of Sciences in May 2008 (see cover image, left). Warkentin’s paper with former student Jessica Rogge, “External gills and adaptive embryo behaviour facilitate synchronous development and hatching plasticity under respiratory constraint,” was featured on the November 2008 cover of Journal of Experimental Biology (see above, right).
Every so often in the history of science and technology, empirical discoveries, theory, and technological developments converge, making it possible to establish a new discipline. Some past examples include astrobiology, biomechanics, molecular biology, sociobiology, and more recently, bioinformatics, macroecology, and nanotechnology-disciplines that are now well established in the lexicon of modern science and technology. Aeroecology is a new discipline that embraces and integrates the domains of atmospheric science, animal behavior, ecology, evolution, earth science, geography, computer science, computational biology, and engineering. The unifying concept that underlies aeroecology as an emerging discipline is its focus on the planetary boundary layer, or aerosphere, and the myriad of organisms that, in large part, depend upon this environment for their existence.

The aerosphere represents one of three major components of the biosphere. From ecological and evolutionary perspectives it is one of the least understood substrata of the troposphere with respect to how organisms interact with and are influenced by this highly variable, fluid environment. While no organism spends its entire life in the aerosphere, propagules such as seeds and spores and numerous animal species spend a significant proportion of their lives in this dynamic environment. The biotic interactions and physical properties in the aerosphere provide important selective pressures that influence the size and shape of organisms, but also their behavioral, sensory, metabolic, and respiratory functions. In contrast to organisms that spend their entire lives on land or in water, organisms that use the aerosphere are almost immediately affected by changing boundary layer conditions (e.g. winds, air density, oxygen concentrations, precipitation, air temperature), sunlight, polarized light, moonlight, and geomagnetic and gravitational forces.

Moreover, organisms that use the aerosphere are influenced by an increasing number of anthropogenic factors such as skyscrapers, air pollution, aircraft, radio and television towers, lighted towns and cities, and more recently from the proliferation of communication towers and wind turbines that now dot the Earth’s landscape. Human alteration of landscapes by forest fragmentation, intensive agriculture, and urbanization and assorted industrial activities are all rapidly and irreversibly transforming the quantity and quality of available habitats that airborne organisms rely upon for navigational cues, sources of food, water, nesting and roosting habitats: conditions that in turn influence the structure and function of terrestrial and aquatic ecosystems and the assemblages of organisms therein. Climate change and its expected increase in global temperatures, altered circulation of air masses, and its effects on local, regional, and weather patterns have had and continue to exert profound influences on the dispersal, foraging and migratory behavior of insects, birds and bats. Ultimately, understanding ecosystem services provided by arthropods, birds, and bats that use the aerosphere will be important for maintaining biodiversity, human health, and ecosystem health of planet Earth.

Kunz and former post-doctoral researcher Nickolay Hristov (currently a post-doc at Brown University), organized a symposium entitled “Aeroecology: Probing and Modeling the Aerosphere: the Next Frontier,” convened at the Annual Meeting of the Society for Integrative and Comparative Biology, January 5-8, 2008, in San Antonio, TX. Eleven papers were presented in this symposium, each of which were recently published in the July 2008 issue of the journal Integrative and Comparative Biology. In addition to Kunz’s lead paper, which introduces the concept of aeroecology, two other papers from his lab make important contributions to this emerging discipline.

**Recent Ph.D. Graduates of CECB Faculty Associates**

- Eric Crandall - Barber Lab
- Jennifer Culbertson - Valiela Lab
- Joshua Drew - Barber Lab
- Sophia Erith Fox - Valiela Lab
- Nahysa Martinez - Murray Lab
- Mariana Muñoz-Romo - Kunz Lab
- Justin Cory Pettijohn - Salvucci Lab
- Mindy Lou Richlen - Lobel Lab
- Vicki Rodgers - Finzi Lab
- Jim Sullivan - Finnerty Lab
- Gabrielle Tomasky Holmes - Valiela Lab

Thermal infrared image of flying Brazilian free-tailed bats (Tadarida brasiliensis). This image, recorded with an Indigo/FLIR Merlin Mid thermal camera, depicts variation in the surface temperature of these bats. Image by Nickolay I. Hristov and Thomas H. Kunz.
CECB Faculty Associate John Finnerty was awarded $200,000 from NSF to study the evolution and development of a parasitic sea anemone (Developmental Evolution of Facultative Parasitism: Mechanisms Underlying Body Plan Remodeling in the Sea Anemone Edwardsiella). Finnerty was also promoted to Associate Professor of Biology in 2008.

Finnerty lab member Adam Reitzel was awarded the Belamarich Award for Outstanding Doctoral Work in the Biology Department for 2007-2008 (Population Genetics and Life History Evolution in the Sea Anemone Family Edwardsiidae).

CECB Director Thomas Kunz was elected 2008 Honorary Member of the American Society of Mammalogists. The award is the Society’s highest honor. Kunz also received the Lifetime Achievement Award from the Karst Waters Institute in 2008.

CECB Faculty Associate Adrien Finzi was elected Chairperson of the Biogeosciences Section of the Ecological Society of America for 2008-2009.

CECB Faculty Associate Karen Warkentin received $409,000 in funding from NSF to assess the importance of phenotypic plasticity for population processes (Fear, death, and life history switch points: cumulative effects of predation and predator-induced plasticity across three life stages). Warkentin was also promoted to Associate Professor of Biology in 2008.

Understanding Our Oceans: Marine Management Evolves

Whether off the shores of Boston or in the warmer waters of Fiji, understanding the current state of our oceans is no small task. CECB Faculty Associate Les Kaufman has been busy as Principal Investigator of a massive world-wide program, Marine Management Area Science (MMAS), aimed at assessing...well, just about everything that can fall under the “marine” umbrella. Forty-five research projects involving more than 100 co-investigators are under way in collaboration with Conservation International (www.conservation.org/mmas), including a study examining connectivity among Hawaiian fish populations, and one that assesses the extinction-resistance of marine species in established marine management areas of the Galápagos and Fiji. Four research nodes in Fiji, Brazil, Belize, and the tropical eastern Pacific are up and running, and have already resulted in some major findings. For example, the Abrolhos reef system off the coast of Brazil is 100% larger than previously thought, and the one of the most important commercial fish species there was unknown to science! While assessing the ecological condition of sites is obviously a major goal, the socio-economic factors involved in the well-being of dependent coastal communities are also being examined and integrated with the natural science, both site-by-site and across the network. Understanding how different marine management areas affect socioeconomic and ecological conditions - and how these conditions in turn affect the area’s success - is key to furthering the field of marine ecosystem-based management. What types of management, and on what scale, are most effective in getting fish stocks up to sustainable levels? Is there any one answer, or do we need to examine each area (and culture) in a new light? While there are a few reef-monitoring programs already in place, they focus on a specific species or area, and are difficult to relate to other sites - the MMAS program is working to find a diagnostic system to compare the health of coral reefs and tropical continental shelf ecosystems around the world. All in all, the program is a major effort to get to the bottom of what works, and what doesn’t, in effective marine management.

Kaufman is also involved with local research on nearby Stellwagen Bank. Stellwagen doubles as Massachusetts Bay’s major fishing area and a national marine sanctuary. If that sounds incongruous to you, many researchers and fishermen would agree – how does one area simultaneously support a fishing industry while it is aimed at preserving ecological health and wildlife? Kaufman recently helped draft a management plan for Stellwagen; he advocates for an ecosystem-based management style (EBM), rather than the species-specific management that is currently in place. By attempting to regulate the yield of particular fish species, we essentially assume that each species is independent of all others, while they are of course interlinked with each other and their supporting ecosystem. So far, the Commonwealth government strongly supports EBM through its new Massachusetts Oceans Act. Of course EBM is already familiar to terrestrial conservationists and land managers, as championed by Aldo Leopold. Federal marine policy lags far behind, though - and concrete answers for how best to put the theory into practice are still lacking. In the mean time, Kaufman continues to look for those answers by collaborating with colleagues here in Boston, researchers in Belize, and local fishermen in Fiji...that is, to name a few. His companions in these efforts include BU professors Phil Lobel, John Finnerty, Suchi Gopal, Tom Gilmore and Ulla Hansen; Biology graduate students Burton Shank, JF Bertrand, Briana Brown, and Nikki Traylor-Knowles, and a legion of undergraduates - sometimes the busiest of the lot! Students have a crack at the scientific underpinnings of EBM in Kaufman’s spring course, “Biological Design for Sustainable Development.”
Indigobirds exhibit a high degree of host-specificity, meaning that each indigobird species generally parasitizes one particular species of firefinch in the genus *Lagonosticta*. This specificity is evident in two remarkable forms of host mimicry. First, indigobird chicks mimic the begging behavior and mouth markings of the host chicks. These mouth markings are often elaborate patterns of spots and/or lines that are clearly visible in the gaping mouths of begging chicks, and are believed to be important in securing food from the parents. Second, indigobird chicks imprint on the songs of their host, which determines important aspects of their behavior later in life. Adult male indigobirds mimic the songs of their respective hosts during courtship, and adult females use these songs to choose both their mates and the nests they parasitize.

This process of behavioral imprinting allows males and females raised by the same host species to breed with each other, which results both in the “cohesion” of each indigobird species and the isolation of different indigobird species from each other. However, if females occasionally lay their eggs in the nest of a different host species then the story becomes more complicated. If the alternate host is truly novel (has never been parasitized by indigobirds), then the offspring produced learn a new song and have the potential to become the seed for a new reproductively isolated indigobird population. However, if the new host is already “occupied” by another indigobird species, the offspring will acquire the songs of this alternate host and therefore will likely hybridize with the other indigobird species. This fascinatingly complex system challenges our usual definitions of biological species, but provides a unique example in which to explore the ways in which different evolutionary processes interact to determine the level and structure of genetic variation in populations.

Sorenson and his graduate student Jeff DaCosta are currently studying the population structure and evolutionary history of four indigobird species distributed in southern and eastern Africa. This work brings them to Tanzania during the breeding season of indigobirds and their hosts (April-June), where they find territorial males, record their songs, capture them in mist nets, and collect samples for genetic analysis. These efforts have already enhanced our knowledge of the geographic distributions of different indigobird species — by carefully listening to songs, Jeff discovered Peter’s Twinspot Indigobirds, a species that had been overlooked by Tanzanian ornithologists for decades, in two different locations — and provide the raw material for sophisticated genetic analyses.

Back in the laboratory at Boston University, Sorenson and DaCosta will use cutting-edge techniques and fine-scale genetic analyses to help determine if indigobird species are in the process of diverging from a very recent common ancestor or if continuing hybridization between the species impedes the completion of the speciation process. This research is greatly improving our understanding of the evolution of indigobirds, which represent one of the most remarkable examples of sympatric (“living in the same place”) speciation in animals.

The CECB welcomes a new Faculty Associate: Robinson (Wally) Fulweiler. Fulweiler recently joined the BU Department of Earth Sciences as an Assistant Professor. She is an ecosystem ecologist and biogeochemist whose research aims to answer fundamental questions about energy flow and biogeochemical cycling of nutrients (nitrogen, phosphorus, and silica), carbon, and oxygen in a variety of environments. Wally comes to BU from the University of Rhode Island, where she conducted her Master’s and Ph.D. research.
Your donations help CECB continue the training of undergraduate and graduate students in the fields of ecology and conservation biology, and fund critical environmental and biological research.

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