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Five Seasons in Ecotopia: Rainforest Immersion and Conservation Action in Costa Rica

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A vibrant blue and yellow macaw is captured in flight, its wings spread wide. The bird's body is primarily blue, with a bright yellow patch on its chest and a red patch on its neck. The background is a soft, out-of-focus green, suggesting a lush rainforest. The overall composition is dynamic and colorful.

FIVE SEASONS IN
ECOTOPIA

Rainforest Immersion and Conservation Action
in Costa Rica

Edited by
Troy D. Abel

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TROY D. ABEL

I am an Associate Professor of Environmental Policy in the Department of Environmental Studies and the graduate program in Geography.

My teaching and research interests focus on the dynamic tensions of environmental science and democratic politics in a variety of arenas including community-based environmental protection, environmental justice, and international conservation projects. I hold an appointment with the faculty of Environmental Studies at Western Washington University's Huxley College of the Environment where I annually teach environmental policy, environmental regulation, environmental impact assessment, and environmental policy analysis. Service-learning is one of my central teaching philosophies and the core of my Rainforest Immersion and Conservation Action (R.I.C.A.) study abroad program in Costa Rica.

*Front cover credit.
Abel Brothers Photography 2010 with cover design
by Kendra Hobbs. The photo captures a Scarlet
Macaw approaching a stand of almond trees along
a Pacific beach.*

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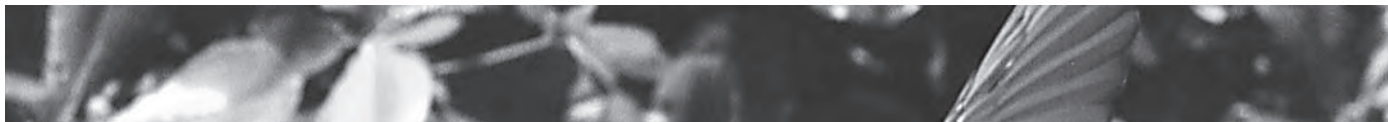
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ABSTRACT

Biodiversity conservation begins inside of Costa Rica's protected areas but will be finished, for the good or the bad, outside of them.



This book is an effort to share our perspectives from five years of experience studying and teaching in Costa Rica through the intersections of geography, ecology, and political science. These reflect the dominant pedigrees of more than one-hundred students who annually spent five weeks in Huxley College of the Environment's RICA program in Costa Rica. The RICA program was designed to foster global ecological citizenship through practices of democratic ecology that activate learner awareness and efficacy among undergraduate participants, Costa Rican students from local schools, and community members. In the 2011 field season, faculty and twenty-one students conducted observational studies of tree diversity, soil composition, avian bioacoustics, collaborative conservation

management, and environmental education. Comparative observations were made at biological stations in Carara and Corcovado National Park in collaboration with Park staff. We hypothesized that significant contrasts will occur between the secondary forests of Carara and primary forests of Corcovado and their neighboring communities. Our results inform Costa Rican conservation and management strategies as well as contribute to the growing field of participatory ecological monitoring. Biodiversity conservation begins inside of Costa Rica's protected areas but must be complemented by research, education and outreach in the communities outside of National Parks.





RESUMEN

La conservación de la diversidad biológica se inicia dentro de las áreas protegidas de Costa Rica y de otras naciones y, sino que es necesario complementar con la investigación, educación y divulgación en las comunidades fuera de los parques nacionales.



Los profesores de la Universidad Western de Washington (WU) del colegio Huxley del medio ambiente va a poner en práctica un curso de campo de cinco semanas en Costa Rica para explorar el monitoreo participativo ecológico y la pedagogía de la educación ambiental. El programa de inmersión en la selva y acciones de conservación (R.I.C.A) del colegio Huxley, se forma para fomentar la ciudadanía ecológica global por las prácticas de ecología democrática que activan la conciencia y la eficacia entre los estudiantes participantes, los estudiantes de escuelas locales en Costa Rica y los miembros de la comunidad. Profesores y estudiantes va a hacer estudios de observación de la diversidad de árboles, la composición del suelo, bioacústica aviar, gestión de la conservación de colaboración, y la educación ambiental. Observaciones

comparativas se llevará a cabo en estaciones biológicas en Carara y el Parque Nacional Corcovado, con la colaboración de personal del Parque. Nuestra hipótesis es que va a ser diferencias significativas que se producen entre la selva secundaria de Carara y los bosques primarios de Corcovado y entre sus comunidades de vecinos. Nuestros resultados se informará a la conservación de Costa Rica y las estrategias de gestión, también se contribuirá con el tema del monitoreo ecológica participativa. La conservación de la diversidad biológica se inicia dentro de las áreas protegidas de Costa Rica y de otras naciones y, sino que es necesario complementar con la investigación, educación y divulgación en las comunidades fuera de los Parques Nacionales.





ECOTOPIA'S PRISM

Written by Troy D. Abel

"Costa Rica. Rich coast." A name that derives from the great expectations of conquistadors and colonizers who thought this land would be teeming with gold. Columbus set eyes on a Caribbean coastline in 1502 that stretched for 132 miles (212 km). In letters a year after his travels, Columbus had this recollection. "I arrived in the land of Cariay, where I stopped to mend and provision the ships, and to give some rest to the crew members who were



Photo credit Abel Brothers 2010

quite ill . . . There I heard tales of the gold mines that I was searching for in the province of Ciamba" (July of 1503, quoted in Molina and Palmer 2007, 23). To the west of where Columbus first anchored, nearly 20,000 square miles of land undulates through 23 different ecozones (Holdridge, 1967). Framed on the other three sides by

a 192 mile northern border with Nicaragua, a 397 mile border with Panama, and 800 miles of Pacific coast on the western side, many later recognized that Costa Rica's riches were more green than gold.

Countless observers have documented Costa Rica's natural exceptionalism. An unknown observer in Richard Villafranca (1895) called it the gem of American republics. "A naturalist's paradise" proclaimed Alexander Skutch. One coffee table book labeled Costa Rica *The Last Country the Gods Made* (Colesberry et al. 1993). It was one of *The Living Edens* featured in a Public Broadcasting Service (PBS) television series. An environmental historian labeled it The Green Republic (Evans, 1999). Others would proclaim that Costa Rica was the Switzerland of Central America. In a more infamous reference, conservative radio voice Rush Limbaugh exclaimed that he would go to Costa Rica if the 2010 health care reform legislation passed. Ironically, he would have found a nation with universal health care, a longer life expectancy than the U.S., and a larger share of land protected from development.

One New York Times journalist would celebrate Costa Rica's ban on oil drilling (Friedman, 2009), while another its seven decades without an army (Kristof, 2010). *"Maybe Costa Rican contentment has something to do with the chance to explore dazzling beaches on both sides of the country, when one isn't admiring the sloths in the jungle . . . Costa Rica has done an unusually good job preserving nature, and it's surely easier to be happy while basking in sunshine and greenery than while shivering up north and suffering 'nature deficit disorder'."* The nation's former



Ecotopia's Prism cont'd

Minister of Natural Resources, Alvaro Urmana (quoted in Honey 2008, 169), called his home “a biological superpower.” The accolades could be continued, but surprisingly few have associated Costa Rica with one of the most provocative environmental images: Ecotopia.

Wandering around my college bookstore in 1986, I saw Ecotopia for the first time. I was a wide-eyed freshman buying my first college books. None of them were about Costa Rica. I grabbed calculus, geology, and ecology; books representing the accumulated knowledge of scientific disciplines. But for English 101, the required book was titled *Ecotopia Emerging*. This wasn't going to be your typical freshman text. Ernest Callenbach's second novel was published in 1981 and served as a prequel for his 1975 book, *Ecotopia*. Inside each, I would find the fictional stories of a new nation forming when parts of northern California, Oregon, and Washington seceded from the United States to form a more environmentally friendly nation.

I now call this region home in Bellingham, Washington. The northwest of the northwest. I can see Canada to the north, the Puget Sound to the west, and in the rights spots around town, the snowcapped Mount Baker to the east, The Olympic mountains are seen to the south, as is the majestic and often ghostly peak of Mount Rainer. This and the other parts of the North America's temperate rainforest zone are also imagined as the Cascadia bioregion. Or, as Joel Garreau (1981) would provocatively

argue, a geography whose features draw more attachment from its residents than their state or nation. He too would call the Pacific Northwest 'Ecotopia'. But Callenbach's imaginative and provocative nation never materialized in the northwest. The idea of Ecotopia, however, remains an inspirational image for many people and their places.

Callenbach's books, according to one journalist (Timberg, 2008), “. . . speaks to our ecological present: in the flush of a financial crisis, the Pacific Northwest secedes from the United States, and its citizens establish a sustainable economy, a cross between Scandinavian socialism and northern Californian back-to-the-landism, with the custom—years before the environmental writer began his campaign—to eat local.”

The following stories are not about the American Northwest. Nor will they be utopian. In several aspects, Costa Rica comes closer to Ecotopia than most regions. However, it falls short for other reasons. Our research explores these promises and pitfalls and we hope they inform and even inspire your own thinking about sustainability.





The Greenest Republic

Since 2003, I've taken more than 150 students of environmental studies to explore the landscapes, culture and economy of Costa Rica. Costa Rica's tourism bureau proudly proclaims "no artificial ingredients" to draw visitors from around the world. Situated at the confluence of two oceans and bridging two continents in the tropical latitudes, this small nation hosts some of the greatest concentration of biodiversity anywhere. Costa Rica is about the size of West Virginia, or 0.03% of the world's surface, yet it holds an estimated 5 percent of the world's biodiversity. Species from North and South America mixed on this continental land bridge for over millennia leading to new combinations of flora and fauna.

In the south central spine of the nation's Talamanca mountains, the highest peak of Chirripo reaches over 12,000 feet capped by Costa Rica's rarest life zone—an alpine paramo. To the east, an alluvial plain spreads into the Caribbean and north to the Nicaraguan border. On the Pacific side, the geography varies more with clusters of mountains criss-crossing the landscape to create numerous valleys. A second and distinct volcanic range rises up again north of the central valley. This undulating terrain and climate creates the variations of elevation, temperatures, and rainfall that form differentiated cauldrons where the alchemy of speciation led to new life forms. Over 87,000 have been identified and scientists expect they might discover a half million species across Costa Rica (Zamora and Obando, 2001). You can't really understand biodiversity in climax until you are immersed in a tropical rainforest.

This book is not just about tropical ecology however. We have offered a broader study of the environment annually for five seasons. Our expeditions monitor rare Scarlet Macaws, study deforestation from satellite images and explore botany, but they also take action to conserve



Howler Monkey. Photo credit Troy D. Abel

the rainforests by building trails and volunteering in the communities outside Costa Rica's conservation areas. We learn about globalization and how economic forces can help and harm this nation in studying the tension between profits and people. The essays that follow are not about a fictional nor a utopian experience however.

Like my course and students, however, the stories in here wrestle with these complicated webs of economy, ecology, and equity that will make or break Costa Rica's achievement of sustainability. Such strategies now join a whole range of environmental policies that contrast with the centralized, command-and-control style of environmental policy developed during the seventies and eighties. The history of top-down natural resource management is rapidly eroding as "fortress and fence" approaches gave way to sustainability initiatives in the nineties and two-thousands.

Costa Rica faces many challenges. Writing in the journal *Conservation Biology*, (Boza et al. 1995) would assert that: "Costa Rica Is a Laboratory, Not Ecotopia." In an assessment of the nation's conservation areas, Powell, Barborak, and Rodriguez (2000) found 11 ecozones of Costa Rica's 23 underrepresented in protected areas. They warned that a significant amount of the country's biodiversity was therefore at risk because it lay outside of conservation zones. Others also discovered that while little deforestation occurred within Costa Rica's parks, it was widespread just outside protected areas in a 10 km buffer (Sanchez-Azofeifa et al., 2003).



Costa Rica might be better understood as a terrestrial green archipelago; a chain of natural islands increasingly isolated from one another by the encroachment of agriculture, roads, and settlements. Moreover, this isolation undermines the functional conditions of the ecosystems that support the

wildlife which draws so many visitors to this tiny nation. We hope to bring you insight and inspiration from our experiences and research from this place I find closer to Ecotopia than any other place I've known.



Rio Tarcoles. Photo credit Troy D. Abel



FACES

How Tourism is Changing the Face of Costa Rica
Written by Ceila Jackson

Embedded between Nicaragua and Panama in Central America, Costa Rica has lured nature lovers for decades. Today, Costa Rica is known as much for its Cancun-style resorts as its exotic fauna. A growth spurt has resorts, eco-lodges and national parks jumbled like a misguided patchwork quilt, and the next generation of travelers may never know the eco-friendly Costa Rica.

Over the last decade, Costa Rica's tourism industry grew three times the world rate—7.1 percent compared to other popular destinations, such as Hawaii's 4.6 percent or Europe's 3 percent.

According to Kelly Hanika, a travel agent based in Snohomish County, Wash., Central America is an up-and-coming region. She said her clients go to Costa Rica for the surf. "Most people go to the Central Pacific region," Hanika said. "It's an alternative to Hawaii, where the same kinds of beaches are less expensive."

For a country whose name literally means "rich coast," expensive beach resorts have become an invasive species in the landscape of Costa Rica's tourism industry. The success of traditional ecotourism has attracted international investors looking for new, untapped markets.

Isthmus Realty, a real estate firm in Costa Rica that sells hotel, resort and vacation home properties to foreign investors, handles millions of dollars in property transactions every year, and is anticipating a 20 percent growth rate over the next few years.

"We complain about the Californians here [in Bellingham], but they've already been to Costa Rica and built their oversized retirement homes," said Troy Abel, assistant professor of environmental studies at Western Washington University, who has been traveling to Costa Rica annually since 2000.

Investors with extra capital chose the country because Mexico is too expensive and Nicaragua and Panama are too dangerous, Abel said. But in a country known for having the only drinkable tap water in Central America, unrestrained development has turned many beaches into open sewers, according to scientists at the Costa Rica Institute of Drainage and Aqueducts (AyA).

Jaco, a surf-town in the Central Pacific region, has tested for fecal coliform levels eight times the regulatory limit,



Paving Pura Vida ... In the picture above, a cattle ranch borders second growth rainforest near Monteverde Private Reserve, a cloud forest in the central highlands of Costa Rica. Once Costa Rica's main export, the beef trade is now less profitable than preserving land and rainforest. The title typography was created by Amy Diehl.



according to AyA. Of the 30 WWU students and faculty who traveled to Costa Rica in the summer of 2008 as part of Huxley College's Rainforest Immersion Conservation Action (RICA) program, more than six were diagnosed with giardia, a serious intestinal infection caused by water-born parasites.

All along Costa Rica's stretches of white sandy beach, resorts and sky-scraping condos are sprouting like mushrooms after a hard rain. One, the Punta Leona Beach Resort on Costa Rica's Pacific coast, is a popular getaway for urbanites from San Jose, the country's capital. It is

also part of a development company responsible for many of the condo and vacation homes in the Central Pacific region. Its slogan, splashed across billboards, reads "Costa Rica – the way it should be."

WWU graduate Chris Andersen, who spent five and a half weeks in Costa Rica and stayed at eco-lodges, beach resorts and ranger stations with RICA program peers, found resorts like Punta Leona and luxury hotels like the San Jose Marriot disconnected from traditional Costa Rican living.



The glasswing butterfly (Greta Oto) perches on a flower in the Monteverde Private Reserve cloud forest. Its Spanish name, "espejitos," means "little mirrors" because much of the tissue on its wings is translucent. As a caterpillar, the species feeds on toxic plants and retains much of this toxicity into its adult butterfly life to deter predators. Butterflies are often a good indicator of the health of an ecosystem.



The white-faced coati, also known as a coatimundi, is a carnivorous mammal in the raccoon family that resides in North, South and Central America. About the size of a large housecat, these scavengers travel in troops and can be found traversing the jungles of Costa Rica night or day. Here, one pops up on a beach in the Central Pacific region of Costa Rica to forage through the backpacks and lunches of WWU's RICA group.



“You can stay in Costa Rica, but never be in Costa Rica.” Andersen said.

Abel, who created the WWU RICA program in 2006, said he wanted his students to experience every side of the tourism industry.

“There are underappreciated contradictions in a place like Costa Rica,” Abel said. “I wanted students to experience that contradiction by sitting in opulence at a resort in Costa Rica where the only traditional item on the menu was rice and beans.”

Another implication of heavy development is habitat fragmentation, said Michael Medler, an associate professor of environmental studies at WWU who has traveled to Costa Rica multiple times with the RICA program.

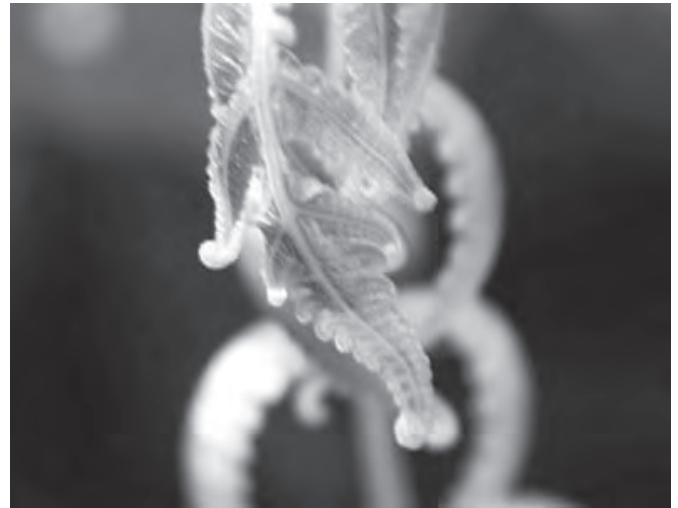
After decades of deforestation from agriculture and logging, the development boom is further turning Costa Rica’s national park system into a series of separated islands. This may mean extinction for charismatic megafauna like the jaguar, because of the hefty space required to sustain such large creatures.

“We’re constantly learning that we’re protecting too small an area. We save 10,000 acres when we need a million,” Medler said. “Migration patterns and species interactions show we need more area. It’s hard for tourists to see the difference, but it’s going to take huge areas to preserve the jaguar.”

But while the Punta Leonas of Costa Rica flourish, its national parks are hampered by bureaucratic politics and lack of funding. National parks operate under tight government budget restrictions, so the parks only see a small percentage of the money they make.

“There are folks in the central government in San Jose whose power is connected to pots of money,” Abel said. “There are these ‘black boxes’ in San Jose, where all the money goes and disappears.”

Carara National Park, on the Pacific coast, has a fully remodeled visitor center that is empty because a concessions law that allowed parks to operate vendors (like gift and coffee shops) was derailed by politicians in the 1990s.



A fern leaf on a trail in the Monteverde cloud forest. This private reserve sits at an elevation of 4,662 feet and sustains more than 2,000 species of plants, including over 200 species of ferns. Because the forest exists at such a high altitude, it receives less rainfall than a rainforest, but has substantially higher humidity levels--producing a misty, cloudy cover that supports a plethora of flora and fauna.



The Lonely Planet travel guide, used by thousands of students and low-budget travelers every year, dismisses Carara as a waste of time because it doesn't offer the same trail guide teams and lodging amenities that privately-operated reserves have.

Louis Giovanni Soto, the park's Chief Ranger, depends on foreign education programs, including WWU's RICA, to help maintain the park. Years of college students visiting from the United States have contributed to trail maintenance and infrastructure development, and many of the concrete bridges on the park's trails are imprinted with student's names and personal messages.

Soto, who has watched over Carara for more than 30 years, said the tourism boom is also changing Costa Rica's culture, and places like Jaco are now nearly unrecognizable to him. He said the area has changed so much it doesn't even feel like home.

"We'll have nothing left of our own culture," Soto said. Ever since it began in the 1980s and 1990s, ecotourism in Costa Rica has been a glass half-full, half-empty debate. It's a compromise between environmental protection and the needs of a developing country's economy. There are still true eco-lodges in Costa Rica, but they are few and far between.

Danta Corcovado Lodge is located on an 86-acre private nature reserve on the Osa Peninsula, five miles from Corcovado National Park and close to the Guaymi Indian Reserve.

Merlyn Oviedo, the lodge's owner, said he is part of a group of entrepreneurs who believe in giving back to the communities they live in. The WWU RICA program students, who stayed for week, were able to meet and play soccer with the locals. Part of the money paid for their stay was used to paint six houses in the village of

Guadalupe, and by the end of the trip, dozens of bright, eclectic murals decorated the villager's homes, with everything from hummingbirds and sunsets to pandas and Dalmatians.

Of an average all-inclusive packaged tour, 80 percent goes to hotels, airlines and other international companies, but more than 90 percent of the revenue from an eco-lodge goes back to the local community, according to the International Ecotourism Society.



Known as "hot lips" for the voluptuous shape of its pink petals, Psychotria poeppigiana is related to coffee and attracts hummingbirds and butterflies with its sweet nectar. It grows deep in the rainforest, shown here in the undergrowth at Monteverde Private Reserve in Costa Rica.



To help travelers make more environmentally- and socially-conscious choices, the Costa Rica Tourism Board is developing a Certificate of Sustainable Tourism. It rates hotels and resorts on a scale of one to five, indicating their level of sustainability, much like a hotel star rating system. Moreover, Costa Rican President and Nobel Peace Prize winner Oscar Arias Sanchez announced plans last year to make Costa Rica carbon neutral by 2021, according to a Center on Ecotourism and Sustainable Development press release.

Focusing on carbon neutrality may be an attempt to apply a veneer of eco-friendliness on a country struggling to keep its “green” reputation, Abel said.

“Costa Rica is touted as an environmentally-friendly place,” he said, “but there’s no political will to support the parks.”

But for a country trying to get to first-world status with limited means, the tourism industry is putting it light years ahead of other Central American countries, Medler said.

“Those folks [Costa Ricans] are damn excited about their environment,” he said. “The upper middle class folks were as enthusiastic as the tourists. They’re more excited about seeing the coatimundi at Punta Leona than American tourists at Yellowstone National Park seeing the buffalos.”

This story first appeared in the Fall 2008 issue of Planet. It is the quarterly student magazine of Western Washington University’s Huxley College of the Environment. Founded by students in 1979, the publication is the capstone course for students enrolled in Huxley College’s undergraduate environmental journalism major.



Deadwood hollowed trees make ideal nests for the scarlet macaw. In Carara National Park, this pair is shown shearing away bark from the entrance of their nest, a technique thought to prevent the grip of predators that climb up in pursuit of precious eggs. While the scarlet macaw population is finally in recovery after decades of illegal poaching, habitat destruction, often from resort construction, is whittling away the parrot’s nesting and feeding grounds.



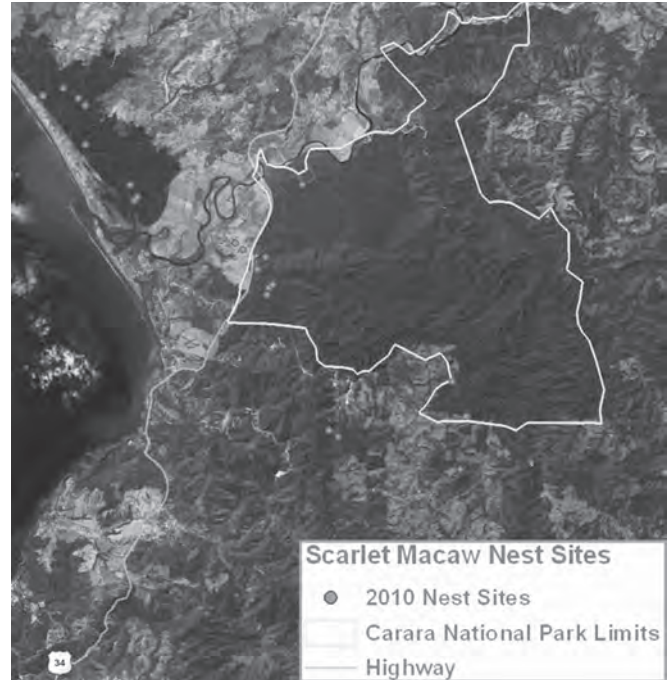
LARGE AND SMALL

Conserving Single Large and Several Small

Written by Troy D. Abel

Huxley College of the Environment's field course on rainforest conservation traces some of its roots to a seminal 1967 publication. MacArthur and Wilson's *The Theory of Island Biogeography* presented two fundamental principles. Larger islands support more species than smaller ones and remote islands support fewer species than less remote ones. Moreover, they also established how habitat can be insulated by not only distance between islands, but anything that divides a landscape such as mountains and climate. But the conservation implications of biogeography became dichotomized during the seventies and eighties into a debate between preserving a Single Large section of habitat, or Several Small and captured in the acronym SLOSS? Costa Rica's preserved natural areas presented WWU students with an excellent case study of this history of conservation biogeography and its future where protected area management embraces Single Large AND Several Small (SLASS). Moreover, Costa Rica offered a stimulating laboratory to explore the promise and pitfalls of SLASS for students from around the world and its implications for ecosystem conservation challenges everywhere (Boza, Jukofsky, and Willie, 1995).

Preston (1962a, 1962b) first raised the concern that many nature preserves and parks were just too small to support many species. Later, Diamond (1975) connected these ideas and developed a set of design principles for the management of an ecologically sound park system. These included: (1) larger protected areas will hold more



Carara Island. Map credit Kathryn Mork

species than smaller ones; (2) a protected area closer to others will support more species than an isolated one; (3) a round park will hold more species than a long narrow area; and (4) corridors between conservation areas might mitigate the island problem. Another dichotomy that dominates biodiversity protection strategies around the



world is between “fortress conservation” (Brockington, 2002) or “fence-and-fine” policies with “democratic” or “participatory conservation” (Kubo and Supriyanto, 2010).

For environmental conservation, Garret Hardin’s seminal 1968 publication concluded that: “Freedom in a commons brings ruin to all” (Hardin, 1968, 1244). Moreover, his tragic analogy about farmers and their herds overgrazing a pasture has informed policy designs around the world and Hardin’s prescriptions are an even more powerful force in environmental management. One must regulate or privatize and the commons world was painted black and white (Wiens, 2007).

Our field course presumed that the SLOSS dichotomy is a false debate. It’s not single large and it’s not several small, but conservation requires the networking of both (Bennett, 2004). Our experiences have been more consistent with a rich literature suggesting that humans are not always trapped in the commons tragedy. Instead, a complicated web of resources, user, and institutional conditions can lead to successful Common Pool Resource (CPR) management. The 2009 Nobel Prize for the Economic Sciences was shared by the most influential scholar in this field.

Elinor Ostrom (1990, 1999, 2000, and 2009) has developed a scholarly strand that includes a focus on the ability of citizens to participate and influence resource management strategies. Ostrom and others would push the debate beyond just a dichotomous choice between markets or a hierarchical government. In particular, they began to illuminate a third path that was more plural, local, and potentially more civic. Two specific components of such a “civic environmentalism” include both the devolution of policy-making responsibility from the federal government to state and local jurisdictions and attempts to increase

the influence of citizens in environmental decisions (Abel and Stephan, 2000).

For example, a demand for more participation in environmental policy decision-making led to Costa Rica’s regionalization of conservation area management in the mid-nineties. In 1996, the national and centralized system was reorganized into regional offices in an effort to decentralize, deconcentrate, and democratize conservation management (Evans, 1999). The Sistema Nacional de Areas de Conservacion (SINAC), or National System of Conservation Areas, was established to move from a strategy of protection and preservation to one of sustainable development.

Thus, Costa Rica and its National Parks offer an excellent case study of the opportunities and challenges of democratic ecology and biodiversity conservation for WWU undergraduates and other students of the environment. More specifically, Carara National Park has been the center of a participatory Scarlet Macaw conservation program that combined research (Arce et al., 2010a; Meyers



Photo credit Troy D. Abel



Large and Small cont'd

and Vaughn 2004; Vauhan et al. 2003, 2005, and 2006), collaborative monitoring and conservation (Arce et al., 2010b; Vaughan et al., 2005), and environmental education (Mork et al., 2011 and Vaughan et al., 2003). Huxley College of the Environment's Rainforest Immersion and Conservation Action (RICA) program had three teaching objectives. First, we expected students to connect the global and local forces influencing ecosystem conservation in a developing country. Second, our fieldwork immersed students in an interdisciplinary experience that required them to navigate the democratic and scientific issues of protecting rainforests. Finally, the program emphasized service-learning to foster community-based ecological awareness and the civic responsibility needed to achieve global environmental sustainability. The first course, titled International Biodiversity Conservation, aimed to bridge traditional teaching schisms between environmental science and political science, or, between learning about nature and learning about civics. For instance, students learned about rainforest biodiversity and how its demand for technical expertise can impede the influence of Costa Rican communities in conservation decision-making.

In the second course on Environmental Peace, students learned how sustainability became an alternative to the preservation versus development dilemma faced by many developing countries. First articulated in the 1987 Brundtland report as "development that meets the needs of today without compromising the ability of future generations to meet their needs," this strategy became central to environmental thinking in the nineties. Conservation strategies aiming for a nexus of ecology, economy, and equity (E3) were the main subjects of several lectures during the students' field experience at two different national parks. The economics of this triple bottom line were also addressed primarily through discussing, observing, and journaling about the role of

ecotourism in Costa Rica's economy. Two days at the University of Peace campus in Costa Rica presented students with the sphere of equity issues. For instance, they contemplated how environmental conflicts can be driven by unequal and degraded natural resource conditions.

Students also engaged in the development of several participatory monitoring projects for their third Environmental Research Experience course. Conceived as "civic ecology," a growing body of work combines the development of scientific indicators of ecosystem integrity and volunteer participation in natural resources monitoring (Chopyak 2001; Fleming and Henkel 2004; Gasteyer and Flora et. al 2000; and Shultz and Saenz 1998). A key element of successful environmental monitoring is the development of cost-effective environmental indicators that provide scientifically defensible and reliable information about the status of resources.

Rainforest Immersion

On one August day in our RICA program, I was leading a small team of my students in a pre-dawn excursion to kick off the annual count of Scarlet Macaws (*Ara macao*), or Lapa Rojas. We woke before dawn in a quiet block of cabins and wound our way up the switch backed road between luxury resort homes and condominiums to one of the area's high hills. During the next three hours, we would watch the forest come alive from a vista above the mangroves, farm fields, and landscaped terraces. The town of Tarcoles was in front of us. The Nicoya gulf and Guanacaste Peninsula framed the horizon. A mix of forest fragments and housing developments stretched south. Behind us was Carara National Park, the ecological core of these biological and social communities. Like the tide coming in that morning, waves of life were emerging from the dark green hued canopy below us.



We were in the middle of a private, and foreign owned housing development with a westerly view of one of three flyways Carara's Scarlet Macaws used for their morning commute. After spending the night in the Guacalillio Mangrove Reserve, Macaws would spread across this region in search of food. But White Egrets flew first. They floated below us in small flocks traversing north and south. A pair of Black-bellied Whistling-Ducks fooled me as I squinted through my binoculars to sight the first Macaws. They were moving too fast I thought to myself. And they were quiet! The early darkness would not yet easily reveal the Lapa's reds, yellows, and blues.

The forest exhaled banks of wispy clouds that hovered in and over the trees. I inhaled the moist warm air of the morning. More light came. Then, the call of a Macaw pierced through the rhythmic wave sounds in the distance. It's mate squawked back. Their calls are as acoustically ugly as these birds are visually beautiful. The sound is hard to describe, but Barcott (2008) would put it this way. "The scarlet macaw sounds like one of nature's chain-smokers, their cry a throaty, blaring rrrra" (23). I struggled to focus on the still shadowy canopy with my binoculars and failed to find Macaws in flight. Dropping them for a few seconds to scan with my naked eyes, I realized how Costa Rica's rainforest provided a unique prism revealing our world in its many hues. In the morning light spreading across the jungle canvas, life began to explode before our eyes. It is only in this ecosystem that one fully understands biodiversity in climax.

Darwin ((quoted in Kircher 1999)) would observe that: "In tropical forests, when quietly walking along the shady pathways, and admiring each successive view . . . Epithet after epithet was found too weak to convey . . . the sensation of delights which the mind experiences . . . The land is one great wild, untidy, luxuriant hothouse, made by nature for herself" (21-22).

In that morning's view, I soon sighted the first pair of Macaws with my naked eyes. After a closer look through my lenses, "one pair!" (una pareja!) I shouted to our recorder. A student quickly confirmed the couple departing the mangroves for points south. The sighting was relayed by walkie talkie to the count's coordinator. Macaws kept taking wing. Two, no, three more pairs. Several triplets appeared; the hallmark of parents socializing their January or February newborns. Since Macaws are presumed to mate for life, any tight formation larger than a pair is considered a family (Vaughn et al. 1991). We saw a rare quartet, more pairs, and then, a sad solo. My mind scrambled for words to describe what the eyes were drinking in. This is nothing like the biological monotony of my home in the northwest where, like the thousands of seagulls monopolizing the skies of Bellingham Bay, a few species dominate. Instead, from this natural (and unnatural) balcony near Carara, I saw Pelicans, Vultures, waves of Parakeets, Great Blue Herons, a massive Wood Stork, Solitary Fly-catchers, and many more. Carara and its surrounding landscapes are home to more than 360 bird species—nearly as many as the entire state of Washington.

In mid-morning, we heard a falling tree groan to its death by the river and five Lapas went flitting to new perches. Our team recorded 86 macaws that morning but numbers, words and pictures could never do these sights and sounds justice. Only after having all your senses engaged by its flora and fauna will you begin to grasp the complexity of rainforest life. But the story doesn't stop at the boundaries of this or any other of Costa Rica's renowned system of conservation areas. Natural resource conservation begins inside protected natural areas but will be finished, for the good or the bad, outside of them.



ALONG

A River of Crocodiles

Written by Derek Schruhl, Kathryn Mork, Ian Shives, and Tana Beus

Carara National Park encompasses 5,242 hectares of transitional forest at the intersection of the tropical wet ecosystems of Costa Rica's southern Pacific and the tropical dry habitats in the nation's northwest. Carara therefore hosts a great concentration of biodiversity, a microcosm of Costa Rica itself, and includes one of the country's last habitats for Scarlet Macaws (*Ara Macao*). Carara's name derives from an indigenous language that would translate as "river of crocodiles", and many guide books describe the park as a wildlife oasis. In reality, Carara is an ecological island.

The Rio Tarcoles forms Carara's northern border and hosts a large and rare concentration of American crocodiles. On Carara's eastern side, agriculture dominates the rural highlands with pasture fences marking the Park's edges. To the south, the real estate bubble's global footprint appears as luxury housing developments sprouted like an invasive species. But the most significant border may be on Carara's western edge.

Highway 34 cuts this terrestrial ecosystem off from the coastal plain to the west. A new road completed in 2010 brings even more traffic from the central valley to the Pacific coast resorts and beaches. While the Macaws fly effortlessly above such human developments, mammals, amphibians and snakes don't fare so well. The road takes, on average, about 16 animals a month. Here on the edge of a 12,000 acre rainforest preserve, the biodiversity conservation challenge is put into sharp focus.

Ecology conflicts or balances with the economy and social equities so one needs several lenses to better comprehend Costa Rica's sustainability progress in and out of its parks. Three different WWU student projects were inspired by Carara's Scarlet Macaw conservation challenges. First, undergraduate Derek Schruhl piloted the use of camera-traps for monitoring Scarlet Macaw nests at the invitation of Carara officials. Second, Ian Shives completed a remote-sensing analysis of deforestation in the Carara region and within 1 km of Macaw nests. Finally, graduate student Kathryn Mork explored the impact of a participatory mapping project on Costa Rican students from communities near Carara.

SCARLET MACAW CAMERA-TRAPS

The first of five Rainforest Immersion and Conservation Action (RICA) expeditions occurred in 2007 with 24 students and three faculty. Students were organized into smaller research groups that focused on mammals, bird recordings, tree plot diversity, biogeography, conservation management and policy, or environmental education curriculum. We also implemented several service work projects emphasizing the enhancement of park facilities by repairing trails in Carara and replacing two building roofs at Corcovado National Park and on the Cano Island biological reserve. But our most significant student project finding occurred with the mammal team who were the first in Carara's history to photograph a Margay (*Leopardus wiedii*) with an infrared camera-trap.



Photo credit Max, Kimberly, Mammal Team 2007

Attracted by a chicken sacrificed from a local farm, two videos captured the Margay circling the bait along with a possum. The camera-traps also recorded agoutis, pecaries, deer, pacas, and a Corcovado Tapir. Wildlife researchers are increasingly turning to modern technologies like video cameras to monitor bird and mammal populations (Dajun et. al 2006; Hudson and Bird 2006; King et. al 2001; McQuillen and Brewer 2000; Silver et. al 2004). Camera traps are a new tool helping conservation area managers monitor biological indicators of forest ecosystem conditions. Moreover, environmental monitoring is a cornerstone of adaptive management (Holling 1978, Walters 1986, Johnson 1999), providing vital evidence for success or failure of existing practices and a foundation for new conservation policy directions.

These 2007 results led to a request by public officials in Carara to help monitor Scarlet Macaw nesting sites. Scarlet Macaws are listed as a threatened species under the Convention on International Trade in Endangered Species (CITES). In Costa Rica, there are two remaining significant

populations in Corcovado and Carara National Parks in the Osa and Central Pacific Conservation Area respectively (Vaughn, et. al 2005). Several studies on the Scarlet Macaws of Costa Rica exist but the body of published work is not extensive (Meyers and Vaughn 2004; Vaughn et. al 1991; Vaughn et. al 2003 and 2005). Moreover, past nesting observational studies relied on human eye, mirror on pole, binocular and spotting scope strategies (Hudson et. al 2006, McQuillen et al 2000, Dajun et al 2006). Many of these are either opportunistic or conducted only when humans are present (Wall, 1995).

We received a \$4,000.00 Mentoring in Undergraduate Research (MUR) grant from Western Washington University's Foundation in 2008 to fund a student project complementing traditional approaches with new video monitoring techniques. Equipment. The Cuddeback NoFlash® (Non Typical, Inc. 860 Park Lane, Park Falls, WI 54552) is a digital camera with an infrared motion sensor and infrared camera abilities. During daylight hours the camera can take 3 megapixel color images and 1.3 megapixel black/



white images during darker periods of the day. When light is insufficient, the camera will use infrared light to enhance the exposure of the picture. Pictures can be recorded on specific time intervals and via motion detection using the motion sensor.

The sensitivity of the sensor can be adjusted between low, standard and high. The sensor is dependent upon ambient air temperatures providing higher detection distances in cooler temperatures. The camera's distance for infrared detection is approximately 20 feet with an ambient air temperature near 80 degrees Fahrenheit, or 26.6 Celsius. After a picture is taken there is a 'camera delay' that can be set between 1min and 60min.

The camera also has the option to record videos both during the day and night with and without infrared. The length of the video taken can be set between 10 seconds and 60 seconds. With the video options activated the camera will still take an initial still image. The unit uses 4 alkaline D cell batteries. Pictures are recorded to a standard compact flash memory card up to 2GB in capacity. This card can be removed and the contents read via a computer or with the use of a USB cord the data can be



Photo credit Derek Schruhl

retrieved directly from the unit.

There are a few methods for attaching the camera to the desired substrate. It can be attached via a screw through the center of the unit. A strap, wire, cord, or bungee can be used to secure it. The unit itself is encased in plastic casing with a small plastic cover for the control area that is screw tightened. The system is weather resistant and operates proficiently in warm tropical conditions. The cost for this system was \$399 (batteries and compact flash extra).

Camera Monitoring Methods

We mounted camera units on two trees with nesting Macaws in Costa Rica's Carara National Park and monitored one nest remotely for seven consecutive months. Of which the camera actively operated for 4 months.

This pilot study included three separate field visits to Carara National Park. During the first field visit for 10 days between December 2007 and January 2008, we attempted to place a camera at two different nesting sites located along the trail system. During the second field visit at the end of February 2008 we verified the status of the camera and replaced picture storage. During our third and final field visit for 10 days in July 2008 we took down the camera, transferred video files, and conducted further visual observations of both nesting sites.

The camera was set to record a still image and video recording only when the infrared sensor was triggered. The camera delay was 1 minute and the video recording length was set to its maximum of 60 seconds. The sensor sensitivity was also set to maximum. Batteries were replaced only once during the February visit though the batteries had not been fully discharged. A 2GB compact flash memory card was used to ensure the maximum space available for pictures and videos.



Camera Placement

The aim of this pilot study was to test the feasibility and suitability of the Cuddeback system in the canopy monitoring scarlet macaw nest behavior. In locating sites for camera observation we found active nest sites within a couple hundred meters of the trail system. Two different tree types and locations were selected as camera sites to explore the potential applications of the cameras.

Two different methods for the placement of the cameras were explored based on the two different tree locations and conditions. The first tree was a snag tree isolated away from trails in the park. We used ropes to suspend the camera near the location of the nest. The camera was secured to a block of wood with three rope anchor points; one central hoisting rope and a lower dual stability rope. The second tree was a full canopy tree with the nest located near the center of the trunk. This site was adjacent to a length of the trail system on one side and a clearing on the other. The nest was freely visible from the ground with little understory nearby. We used a wooden A-frame

secured to the trunk of the tree close to the nest. At the end of the A-frame a block of wood was placed perpendicularly with the attached camera facing the desired direction. The block was fitted to the A frame so it could swivel to be better positioned once placed on the tree. It required four hours to hoist, place, and secure the camera system to the tree. Once this was finished the climbing ropes were exchanged with a place holding rope which was secured to the tree for future use.

Camera-Trap Results

Our first application of the cameras monitored the snag tree for 5 days. During that period (2) pictures of macaws were taken out of a total of (150) camera combined still image and video events. The camera was subsequently taken down due to its low capture rate of nesting macaws and high susceptibility to excessive motion by wind. During the second application of the cameras the nesting pair of Scarlet Macaws were periodically vocal and remained near the nest during the entire process of securing the



Photo credit Derek Schruhl



Photo credit .. Derek Schruhl, Tara Beus, and Michael Medler



camera. Once placement was finished, the Macaws gradually moved closer to the nest, inspecting the camera and wooden frame. Within an hour the Macaws had returned to the nest and appeared to be ignoring the camera.

The camera recorded 62 events in the first camera observation period from Jan3-Feb29 and 47 events in the second camera observation period from Feb29-Apr17 for

a total of 109 still images and one minute video events in three and a half months.

Due to the high sensitivity of the sensor and placement of the camera 43 events were of macaws or potential predators. The remaining events were tree branches in windy conditions, tourists, or other small animals around the nest.

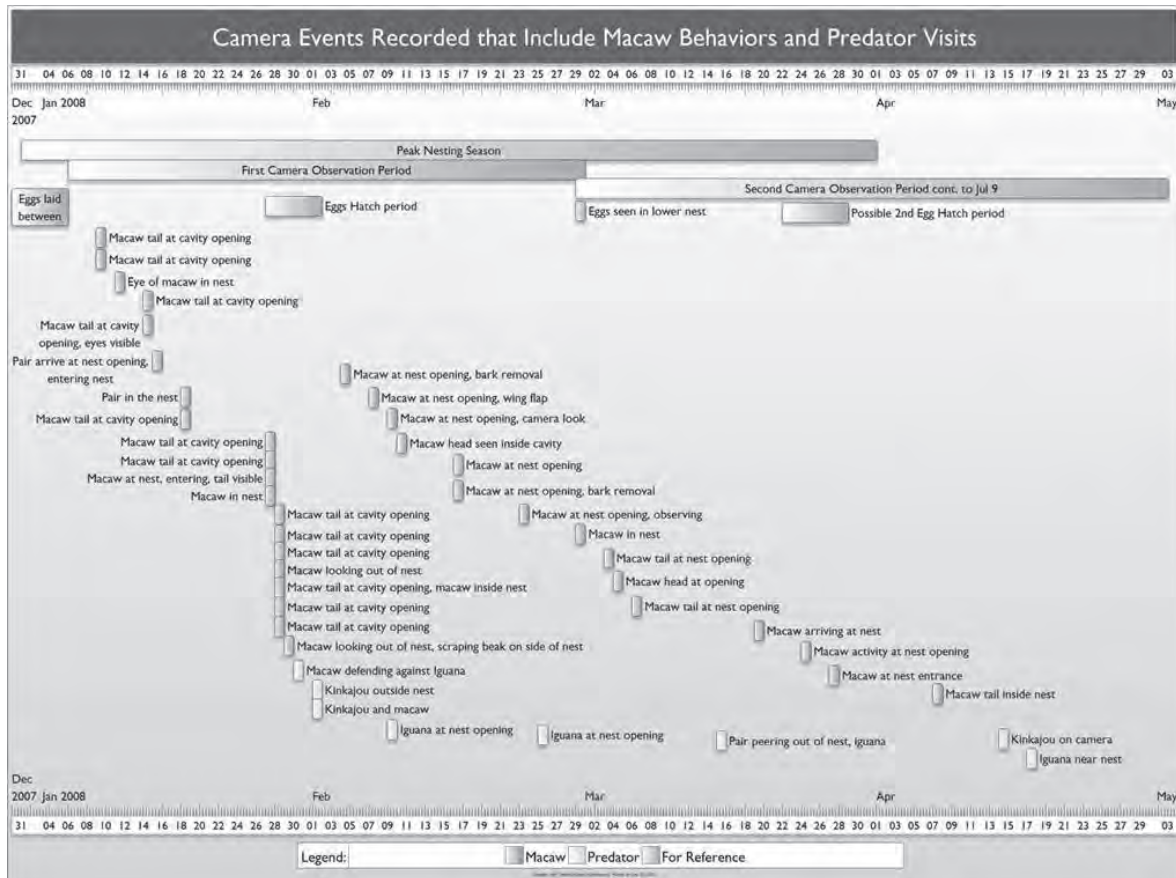


Table credit Derek Schruhl



Photo Credit Tana Beus, Michael Medler, and Derek Schruhl



The potential predators captured on camera were iguanas and kinkajous. Iguanas are a well known predator of Macaws (Vaughn et al. 2009). There were recorded in five events generally at the nest opening or moving along side of it. One specific event shows a macaw inside the nest as an iguana is clearing at the edge of the nest opening.

Kinkajous, considered to be frugivores (Kays 1999), were captured in four events. In one event they were seen climbing out of the nest cavity. In another, both a Macaw and kinkajou are seen in the same frame.

The camera also captured Scarlet Macaws arriving and leaving the nest, perched at the nest opening observing, and bark removal behavior (6 events). During bark removal behavior a Scarlet Macaw would scrape old and peeling bark from around the nest cavity opening creating an area of the trunk that was smooth. This was possibly an effort to reduce the traction afforded to potential predators near the nest.

Scarlet Macaws generally nest between late December and into (mid-May) when hatchlings fledge the nest (Vaughn et al. 1991). Over the course of this time period they will begin to transition to their non-nesting season behavior, roosting at night in the nearby mangroves and occasionally visiting their nest during the day. The trend in the frequency of recorded events showing Scarlet Macaws showed this transitional behavior over the time period as the frequency of events with Scarlet Macaws was progressively lower throughout the season.

The second application did malfunction after three and a half months for unknown reasons. A potential difficulty is accessing the camera for maintenance.

Conservation Implications

Overall, this study has shown the successful use of low cost camera traps in monitoring Scarlet Macaw nests in a harsh tropical environment. In addition to visually observed behaviors being recorded on camera, new behaviors including defensive behavior and bark removal from around the nest, these camera traps have illuminated the role of natural predation in the nesting success of Scarlet Macaws. This new knowledge relating to Scarlet Macaw nesting behaviors and predation events can inform new conservation strategies to aid the recovery and stability of Scarlet Macaws in the Carara National Park region.

Another important outcome of this research is the archival footage that enhances our scientific understanding as well as providing information to educate park visitors and local communities about the impacts of natural predation and human poaching on the Scarlet Macaw lifecycle. The methods utilized in this study simultaneously contribute to conservation science, improve policy, and provide a foundation for education through participatory ecological monitoring.

This research was presented at the November 2010



Congress of the Mesoamerican Society of Conservation and Biology and disseminated in the 14th volume of the journal *Mesoamericana* with the following citation. The Spanish abstract appears below.

Adrián Arce-Arias, Derek Schruhl, Tana Beus, Troy D. Abel, and Michael Medler (2010), "La tecnología a favor de la conservación: uso de camera trampa en nidos naturales de Lapa Roja (*Ara macao*) como técnica para la conservación, manejo y protección de la especie." *Mesoamericana* 14(2): 193.

Resumen

En este estudio se ubicaron Cuddeback Digital Scouting camaras (modelo NF-4300) trampa para observar el comportamiento de parejas de lapas roja (*Ara macao*) en sus nidos naturales. Este estudio se realizó en el Parque Nacional Carara en el Pacífico Central de Costa Rica (2008), donde se encuentra la segunda población de lapas más importante de Costa Rica. Las camaras trampas son cada vez más importantes en los estudios ecológicos pues permite el monitoreo constante de sus acciones de anidación y proporciona datos importantes en cuanto a observación de depredadores, comportamiento y hábitos de la especie entre otras. Las lapas rojas son un indicador ecológico importante así como especie bandera en la conservación ambiental.

DEFORESTATION NEAR CARARA

A second student project examining deforestation trends around Carara was also initiated in 2008 by Ian Schives. Utilizing remote-sensed images and Geographic Information System (GIS) software analysis, our team analyzed the forest cover change between 1997 and 2001. The Carara area is broken into very small areas of forest cover by interspersed human development.

Scarlet macaw nest locations for this study were collected

during nesting seasons in 2006 and in 2010. In 2006 the locations of 22 macaw nests were recorded and 43 nests identified in 2010. In both these cases the data was collected by students or researchers as part of a larger study. To collect the data the researchers were guided to known nest sites or followed macaws and their calls. Once found the coordinates were taken with the GPS. These data were then combined with satellite imagery to investigate land cover changes around Scarlet Macaw nests and the surrounding region.

A Little Rocket Science

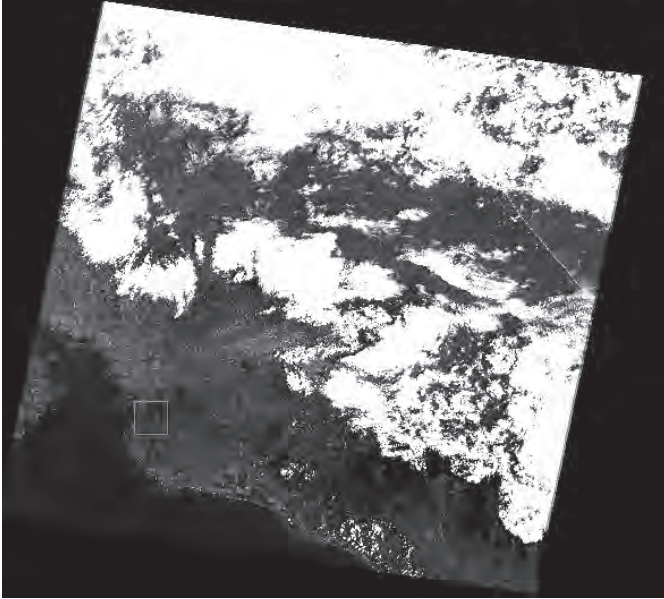
Huxley's Professor David Wallin likes to tell his remote sensing students that it is one of the few times they will ever do rocket science. Joking aside, satellite imagery is an effective tool for detecting change in land cover over large areas when detailed aerial photographs are not available (Skole 1993). A satellite called LandSat is used for this purpose. LandSat orbits the globe photographing the surface as it travels. LandSat 5 and LandSat 7 constantly supply images of the Earth's surface in multiple spectral bands from space. The Carara study region (see map below) totaled 12,415.35 hectares of forest cover.

LandSat 5 Thematic Mapper images from February 1997 and January 2001 to retain similar azimuths (sun angle) and tree shadings that cast shadows on nearby farmland. Images from other years with significant cloud cover made them impossible to use for land use analysis. Ian Shives used two images from LandSat 5, the first from March 8, 1997 (first figure below) and the second from January 30, 2001. These were the only images available to me that are cloud free in my area of interest.

Both images were located in Path 15 and Row 53 capturing an orbital scene encompassing most of the Central Pacific region of Costa Rica but omitting the Nicoya Penin-

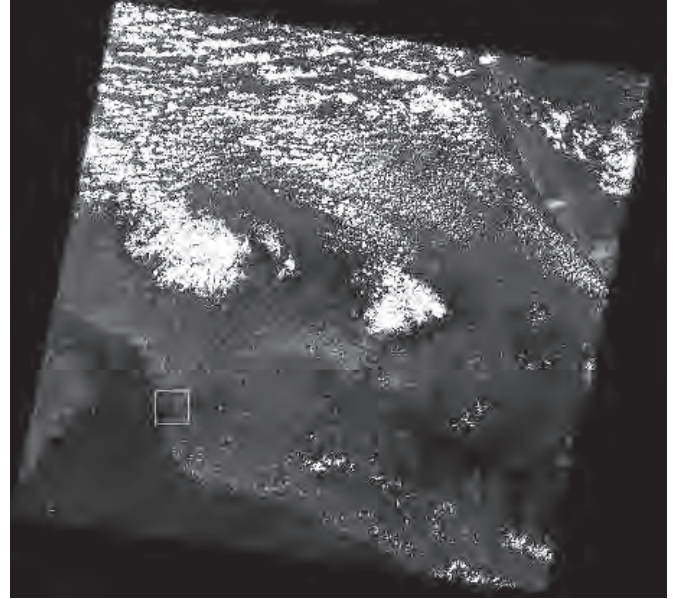


Photo obtained by Ian Shives



sula in the west and the Osa Peninsula south. The study area was within the red square in the Southwest quadrant of the image. The image tilt is caused by the orbit path of the Landsat satellite traveling in a South by Southwest direction.

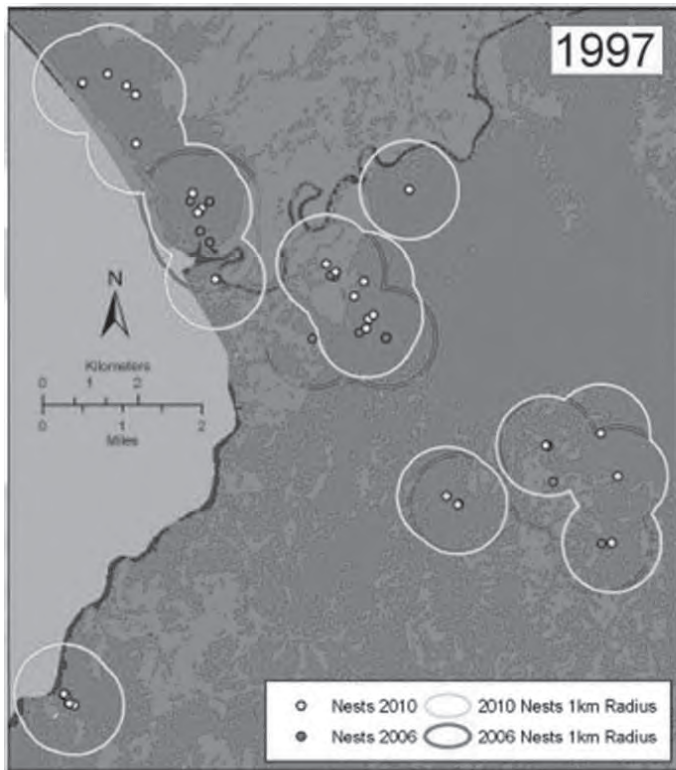
Ian used the remote sensing program ENVI with an unsupervised ISODATA classification on both images to identify forested versus non-forest land cover. He set both ISODATA classifications to create 50 spectral classes from the images using bands one through five and band seven. Band six was omitted because it is not an accurate band to use on land. The spectral classes are created based on pixels of similar spectral reflectance. The spectral classes were then used to create the land cover classifications. However, no ground truth field recordings were completed



so Ian used real color images to create two reclassifications of "forested" and "non-forested" land cover.

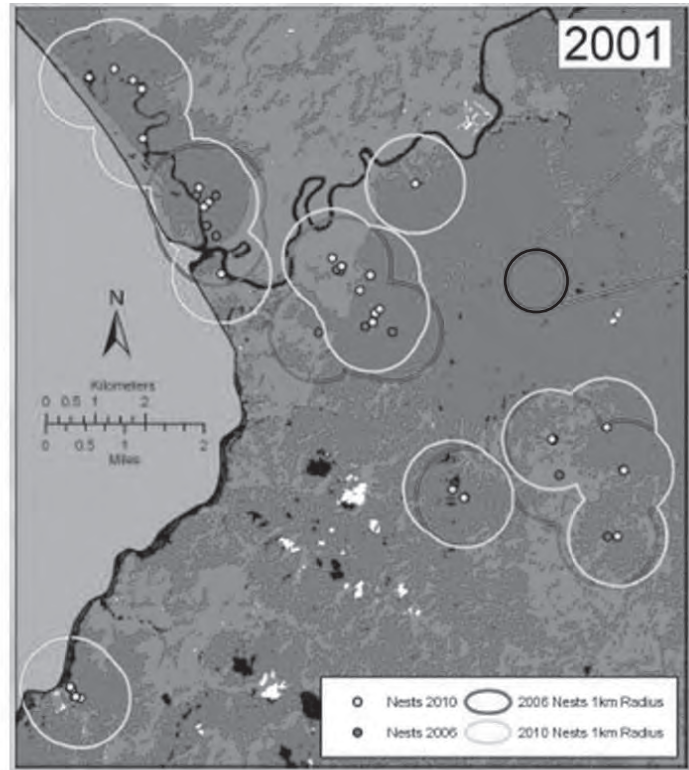
A total of 550 hectares of deforestation was measured in four years, or 4.43% of the 1997 forest cover in 1997. However, when we analyzed land cover changes within 1 kilometer of Scarlet Macaw nesting sites, deforestation totaled 175.76 hectares, or 5.36% of the land cover of 3,276.94 hectares buffering Macaw nests in 1997. Thus, deforestation occurred faster near nest habitat on average than elsewhere.

Another important feature of this data is the amount of cloud cover change between the 1997 and 2001 images. Cloud cover is more significant in the regional analysis data than it was in the 1 km analysis. This can be seen in the 2001 image above.



Percent Land Cover Change within
1 km of nests 1997-2001

% Forest Cover Change 1997-2001	-5.36%
% Cleared Land Change 1997-2001	13.50%
Other	N/A



Total and Percent Land Cover Change in Region 1997-2001

	Forest	Cleared	Other (cloud)
Total Change (ha)	-551.77	465.22	86.72
Percent Change	-4.43%	7.86%	N/A



The total forest lost is spread across the entire study area making it seem almost insignificant when viewed on the entire map. The impact of losing 175 hectares of forest can be better understood when represented in a concentrated area represented by a black circle in the map on the previous page.

Implications

The deforestation outside of the Carara boundaries, and near Macaw nests in particular, demonstrate how important conservation efforts “out of the park” will be. Numerous studies now show how wildlife corridors may mitigate the problems of terrestrial island biogeography as seen in the case of Carara. What remains then, is conservation efforts in the spaces and places between Parque Nacional Carara and the Guacalillio Mangrove Reserve. However, these pose one of the fundamental political challenges known as the collective action dilemma.

Democratic Dilemmas of Ecological Citizenship

In political science, Mancur Olson (1971) first articulated how self-interested individuals were unlikely to cooperate voluntarily to capture joint benefits as the collective action problems. Scholars have developed an extensive literature on the topic (Axelrod 1984; Bendor and Mookerjee, 1987; Ostrom, 1990; Taylor and Singleton, 1993). In particular, environmental policy scholars have explored the ways in which collaborative institutions overcome the collective action dilemma. Trust, institutional mechanisms, and political leadership have all been theorized as key factors in encouraging collective action. Trust is often connected to social capital (Putnam 1995; Fukuyama 1995). In experimental settings, researchers have found that positive interactions in collective action simulations result in players learning to trust one another and tend to be reinforcing (Lubell and Scholz, 2001; Ostrom, 2000). Others have found greater collaboration among individuals who have

experienced a history of cooperation in various institutional settings (Lubell et al., 2002, Schneider et al., 2003, Weber, 1998).

In theory then, the success of a wildlife conservation framework for “out of the park” will depend on a history of stakeholders interacting in collaborative networks that foster reciprocal trust. Likewise, environmental ethicists have been discussing how to stretch civic obligations from the social realm to the natural world under the guise of ecological citizenship (Light, 2003) or environmental citizenship (Dobson & Bell, 2006). Common Pool Resource (CPR) dilemmas like Carara’s face the challenge of enabling residents in and near a resource to see themselves as members of communities encompassing both humans and nature and hence, to recognize their civic responsibility not just to each other, but to ecosystems. But this kind of citizenship in the Carara region is challenging because it simultaneously transcends the park’s borders while being disconnected from any identifiable and legally bounded community.

The final project explored how a participatory monitoring program may cultivate not just trust, but the shared norms that can be activated by institutional arrangements connecting altruistic values and environmental beliefs. Our research group postulated that immersion and action were effective experiences that could activate environmental norms or responsibilities by fostering both empathy and efficacy.

PARTICIPATORY MACAW MONITORING

The third student project was a case study led by geography graduate student Kathryn Mork. Because so much of the habitat for Scarlet Macaws is located outside of Carara National Park’s boundaries, park staff has been working to develop partnerships with local communities and a local non-profit to improve management efforts. Data gathered



Photo credit Adrian Arce



through background research, participant observation and responses to a questionnaire showed the Central Pacific Scarlet Macaw resource system, which includes the local community members along with the Scarlet Macaws and their habitat, shares many of the attributes associated with emergent cooperation in the Common Pool Resource (CPR) framework. Moreover, norm activation was partially consistent with the theory of environmentally significant behavior. In post-testing, project participants expressed interest in future participation, acknowledged the importance of community involvement in conservation and management efforts of the Scarlet Macaw resource system, and reported increasing levels of personal salience. The success of such collaborative resource management strategies is contingent upon their impact on the residents of communities where outreach occurs and this research shows that outreach efforts influenced participant perceptions.

Kathryn's work was situated at the confluence of three influential social science theories shaping the scholarly and practical debate over biodiversity conservation. At the regional and ecological scale, common pool resource management provided the broadest perspective and was described above. Below this resource level is the perspec-

tive of community-based natural resource management and even more small scale is the individual perspective provided by the Value-Belief-Norm theory of environmentally significant behavior.

Participatory Natural Resource Management

Proponents of community-based or participatory resource management see it as an opportunity to empower local citizens, improve planning and decision making, include local knowledge, make political decisions more acceptable, and reduce conflicts (Diduck 1999; Parkins and Mitchell 2005; Sims and Sinclair 2008; Sinclair and Diduck 1995). Many community-based resource management programs are based on the idea that community members have more to gain or lose from the resources and that they have better knowledge about the resources and can manage them more efficiently (Altrichter 2008). Moreover, conserving biodiversity is not just important within park boundaries.

Animals do not recognize human-made boundaries, they range where they need to, making it important for communities that are located in wildlife habitat to be involved in protecting and managing biodiversity. In the Central Pacific Conservation Area in Costa Rica, Scarlet Macaw habitat areas include several protected areas, along with unprotected agricultural land, rivers, recreation properties (privately owned tourist destinations) and areas along the Pacific Ocean beaches.

Community members living near the protected areas, as well as those who work on the hotel properties, own the agricultural land or visit the area and could potentially impact local wildlife. In the case of the Scarlet Macaw, it nests in places that meet its needs: a large tree with a nesting cavity and proximity to food sources, whether this is on a private farm, in a national park or at a vacation resort. Local community members can have an important positive or negative impact on a species through their ac-



tions such as chopping down a tree on their land that contains a nest, or protecting the tree. Community members must be involved in management and conservation efforts because they share habitat with the macaws.

Kathryn implemented an exploratory case study approach with mixed-methods including participant-observation, interviews, and surveys. The case in this study was the Central Pacific Scarlet Macaw population and habitat contained within the Central Pacific Conservation Area, and centered on Carara National Park. As it is a case study and a small pilot project, the results are not generalizable, however, the project could be useful for management decisions in that specific area and could be a model for assessing the potential for collaborative resource management of other resource systems.

In collaboration with staff at Carara National Park and based on management needs, Kathryn designed and im-



Photo credit Kathryn Mork

plemented a mapping and monitoring project to generate data on the locations and habitats of the Central Pacific Scarlet Macaw population to support management efforts, and to allow researchers an opportunity to gain a more in-depth understanding of the resource users associated with the Scarlet Macaw population.

Twelve participants were divided into two sections of six participants and each section participated for five consecutive days. On the first day of each section, the volunteers arrived and listened to a brief presentation that explained the basic objectives of the project. Participants received a written disclosure regarding the objectives of the project but the research objectives were not emphasized during the course of the project in an effort to obtain sincere answers from – and observation of – the participants without them feeling self-conscious about being observed.

Following the presentation, each participant was given a questionnaire that contained questions for each of the five days of the project and asked to respond to the questions for the first day. Next, the participants listened to presentations on the physical characteristics and breeding habits of Scarlet Macaws, as well as the basic operation of Geographical Positioning Systems (GPS) units and other data collection tools. The first afternoon and during the following four days, the volunteers collected geographic locations using the GPS units, observed the nests and wrote down their observations. After the first day, the participants were asked to answer the day's assigned questions in the questionnaire either during lunch or in the evenings.

Local student participants who lived within 5 miles of the park border were identified and contacted through acquaintances of Carara National Park staff and asked if they were interested in volunteering for a mapping and monitoring project during their one month school break. Seven local students agreed to participate. In an effort to get at

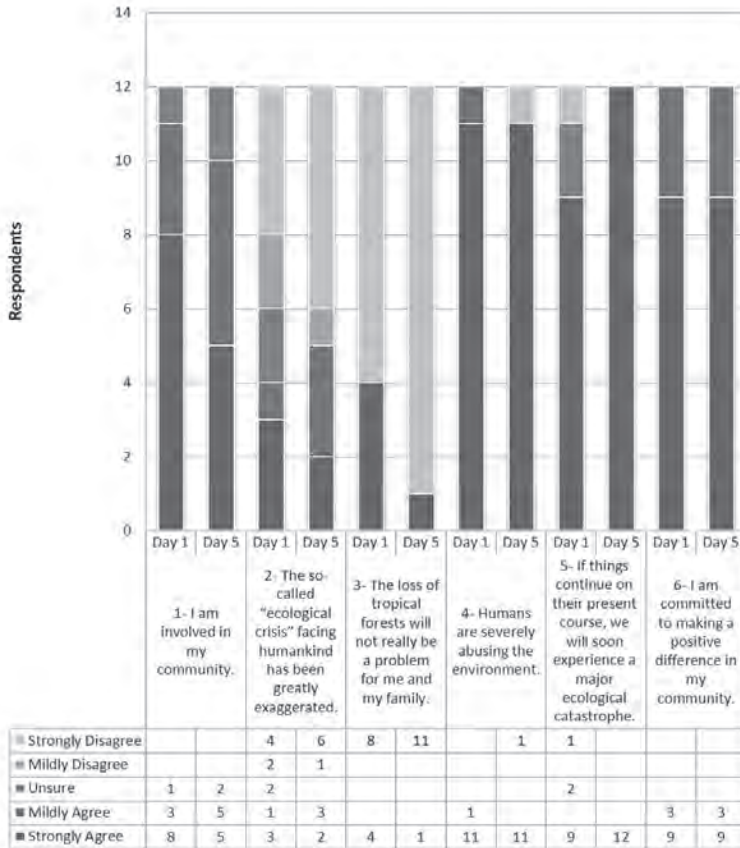


Table credit Kathryn Mork

least 10 participants, additional participants who lived more than 20 miles away were also recruited through personal contacts of the park staff. From these efforts, five additional volunteer university students were recruited, four studying environmental management and one studying tourism. Since the participants were chosen using a convenience sample rather than random sampling, the data is expected to be rich in validity but will lack reliability and will not be suitable for generalizations.

In order for resource users to work together to manage a resource, they must have a shared understanding of that resource. From analysis of the mapping and monitoring project participant's answers to the questionnaire, it was evident that the participants had a good understanding or acquired a good understanding of several of the suggested resource attributes. All of the participants started the project with some basic knowledge of Scarlet Macaw biology and ecology. All of the participants were able to correctly answer questions on the first day of the project about the nesting and feeding habits of Scarlet Macaws. When asked what they had learned midway through the project, many of the participants noted the specific species of trees that Scarlet Macaws nest in, and several also mentioned that they learned that macaws nest at the borders of forested areas to improve the chances of the chick's first flight. On the last day of the project many of the participants included more specific details when answering the questions about the nesting and feeding habits of macaws.

On the first day of the project, in response to a question about the predators of Scarlet Macaws, six of the respondents mentioned humans as the only predator, two said other fauna were the only predator and two included both humans and other fauna as predators.



On the last day of the project, Day 5, nine respondents included humans and other fauna as predators, two mentioned just humans and one mentioned just other fauna. Thus, by the end of their participation in this project, most of the participants were more aware of the dangers to Scarlet Macaws of both human and natural predators.

From participant observations during the mapping and monitoring project, Kathryn found the participants quickly bonded with fellow project participants. They worked together to learn the technical aspects of the project and helped each other in the field. For example, at one point in the project, participants were mapping nests in a swampy area. It was difficult to walk and some participants were having more difficulty than others. In several instances, struggling participants were assisted by the participants who were not having such a difficult time. While it is too early to assess participant's ability to keep promises and relate to one another with reciprocity; however their actions in the field show that they were able to work cooperatively.

When asked who leads the Scarlet Macaw conservation effort and who else participates, all of the project par-



Photo credit Kathryn Mork

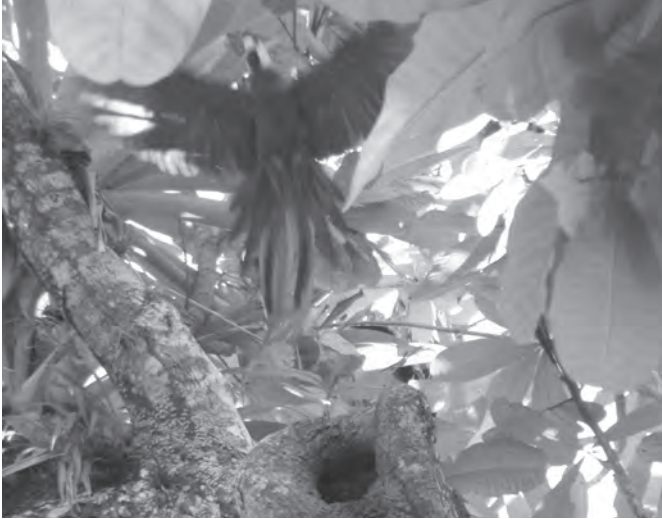
ticipants mentioned MINAE, Carara National Park or the name of one of the park rangers, and many also mentioned LAPP, the local non-profit was formed in the mid-1990s to manage the conservation efforts of the Scarlet Macaw, and community members. The formation of LAPP is an indication of support for community involvement in conservation and resource management efforts, and an example of prior organizational experience and local leadership. Additionally, in the case of a collaborative resource management, there is the potential for collaborations with others, such as national park staff or university researchers, who possess more developed leadership and organization skills. In sum, Kathryn found indicators of all four resource attributes and three of the six characteristics of resource users (common understanding, trust and reciprocity, and prior organizational experience and local leadership).

Value-Belief-Norm Theory

The final theoretical lens utilized in Kathryn's research was the social-psychology of environmentally significant behavior developed by Stern et al (1999) and Stern (2000). Value-Beliefs-Norm Theory (VBN) postulated that, "Individuals who accept a [social] movement's basic values, believe that valued objects are threatened, and believe that their actions can help restore those values experience an obligation (personal norm) for pro-movement action . . ." (Stern et al., 1999, p. 81). Based on VBN theory, Kathryn expected that the environmental service-learning of mapping Macaw nests would activate personal pro-environmental norms. In two papers (Stern et al., 1999; Stern, 2000), researchers built on Schwartz's (1977) norm activation model of altruistic action. Analogously to Schwartz, researchers found that pro-environmental behaviors stem most directly from a felt personal obligation to help. This norm stems ultimately from preexisting values (far left in next Figure) that are activated by beliefs about a state of need, and about the person's ability to help (middle of next Figure). For pro-environmental behav-



Photo credit Kathryn Mork



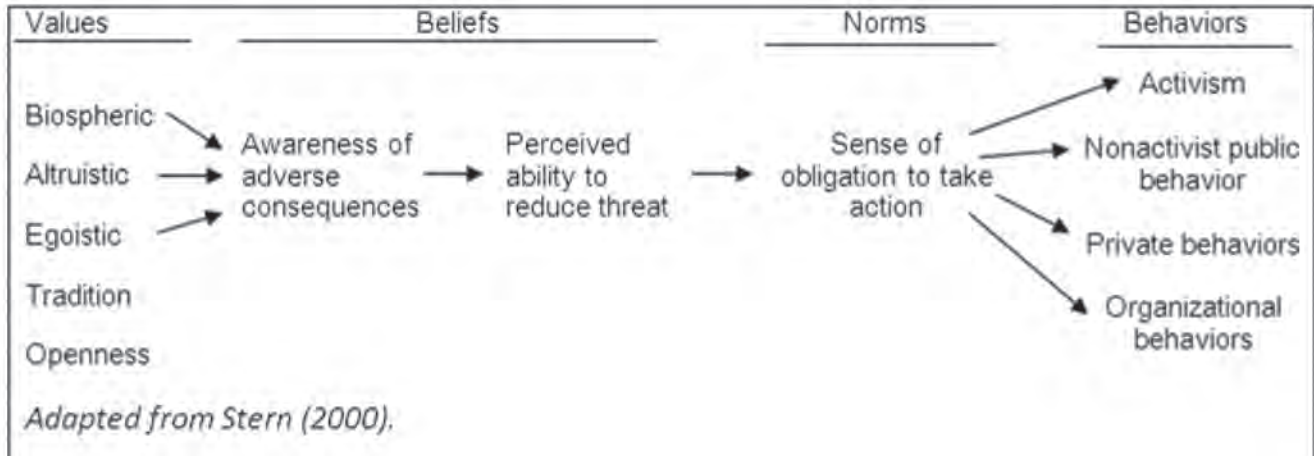
iors, the relevant beliefs include the interconnectedness of the biosphere, which entails, for example, awareness of how deforestation or poaching may have negative consequences for objects of value like the Scarlet Macaw.

The far left in the figure below are relatively stable and central elements of personality and belief structure. In the middle of the figure are more focused beliefs about human-environment relations, threats to those relations, and the self-efficacy to act against threats. Describing the middle of the sequence displayed above, researchers stated: "an individual aligns [environmental] values with their own values, they then realize that those values are under threat, and they believe that individual actions 'can help alleviate the threat and restore the values'" (Stern et al., 1999, p. 83). In other words, norm activation allows an individual to connect his or her own personal values to the values of the environmental movement which would lead to an activation of a norm to act in support of environmental goals. The right side of the figure represents

pathways for action. After problems awareness, the key is to participate in an experience where learners directly act. This forms the basis for pro-environmental normative beliefs. We assert that immersion and action represents a social process activating ecological norms. Due to the small sample size and short time frame, a significant impact was not expected; however the Likert scale questions did show some movement from Day 1 to Day 5 and provided data on participants' beliefs about conservation issues. For example on Day 1, eight of the twelve participants strongly disagreed and four strongly agreed with statement number three: "The loss of tropical forests will not really be a problem for me and my family." However by Day 5, eleven out of twelve participants strongly disagreed and one strongly agreed with the same statement. A similar movement was seen for statement number five: "If things continue on their present course, we will soon experience a major ecological catastrophe." On day one, nine out of twelve participants strongly agreed, two were unsure and one strongly disagreed. However, by Day 5, all twelve strongly agreed with the statement. Most of the other statements did not show significant movement, but there were some substantial conservation intentions. For example, on Day 1 ten out of twelve (there was one missing response), and on Day 5, eleven of the participants strongly agreed with statement number nine: "I feel that I can make a difference in the conservation of biodiversity." Similarly, ten out of twelve on Day 1 and eleven out of twelve on Day 5 strongly agreed with statement number eleven: "I plan to participate in future conservation efforts."

Participatory Monitoring?

The Central Pacific Scarlet Macaw resource system shared many of the resource and resource user attributes identified by Ostrom (2002) as common to the emergence of cooperation. As far as the resource attributes are con-



cerned, the Central Pacific Scarlet Macaw population and the associated habitat fulfill all of the suggested resource system attributes, especially “feasible improvement.” The resource system is certainly not to a point of deterioration where it is hopeless to try and improve it. The top-down protective measures that the Costa Rican government has implemented over the last 40 years have allowed the Scarlet Macaw population to remain viable; however there is space for improvement. The management goal for the Central Pacific population is to increase the population from an estimated 400 to 1000 by 2020 (Arroyo, et al. 2004). Though researchers were unable to fully evaluate several of the resource user attributes due to the short time frame of the project; Kathryn was able to address most of them, and Ostrom does not identify a particular percentage of resource or resource user attributes that are necessary, nor does she state that sharing these attributes guarantees successful common-pool resource management.

Several of the results from the pre- and post-project Likert scale questions showed a shift in participant answers from the first day to the last day of the project toward a greater

awareness of the consequences of the loss of forests and degradation of ecosystems. This may be indicative of the potential for participation in such a project to impact one's beliefs. This change could be attributed to the participants being more aware of the importance of conservation issues after participating in a conservation project and discussing conservation issues with other participants during the course of the project. Regardless, it also shows that most of the participants are aware that there are consequences to the loss of tropical forests and of biodiversity.

If not for the extensive system of protected areas that exist in Costa Rica along with the regulations protecting wildlife and forests, even more of the Central Pacific Scarlet Macaws' habitat almost certainly would have been destroyed, and more of the species lost. However, many species cannot thrive in small islands of protected habitat that are surrounded by degraded habitat, even with 25% of Costa Rica's land area designated as protected areas. Community participation in management and conservation efforts is essential to expand the reach of protected areas. Community participation can lead not only to additional



habitat areas on private land (such as the trees on agricultural land where Scarlet Macaws build their nests), but also to better protection of a species which could then lead to an increase in the population size. The intersection between biogeography and human geography, or the intersection of where plants and animals are distributed and where humans live, necessitates the involvement of community members in management efforts in order to have the most chance for the successful conservation of species.

The Central Pacific Scarlet Macaw population was able to rebound to the degree that it has since the early 1990s because managers combined the command and control methods of protected areas and regulations with education programs and encouragement to stop poaching. This project supported the decentralization of resource management and the empowerment of participants through hands-on involvement in a mapping and monitoring project. This work was presented at the 2011 Congress of the Society for Conservation Biology and published in their October issue. The citation and abstract follow.

Kathryn Mork, Diana Bermudez, Troy D. Abel and Adrian Arce (2011), "Evaluando el monitoreo participativo de la Lapa Roja en el Parque Nacional Carara, Costa Rica" *Mesoamericana* 15(2): 185.

Resumen

Este proyecto es un estudio de caso del monitoreo participativo de una población de Lapas rojas (*Ara macao*) y su hábitat, tanto en el Parque Nacional Carara (ubicado en el Área de Conservación Pacífico Central de Costa Rica) como en sus alrededores. Debido a que gran parte del hábitat de las Lapas rojas se localiza afuera de las fronteras del Parque Nacional Carara, los funcionarios de dicho parque han venido trabajando en el establecimiento de alianzas estratégicas con comunidades locales y orga-

nizaciones no lucrativas, con el fin de mejorar y aumentar los esfuerzos en pro de la conservación de esta especie. La información obtenida a través de investigaciones, observación participativa y la aplicación de cuestionarios, muestra que el sistema de recursos de las Lapas rojas del Pacífico Central, el cual incluye los miembros de comunidades locales en conjunto con las Lapas rojas y su hábitat, comparten muchos de los atributos asociados con la cooperación emergente, en el marco de los fondos comunes de recursos, o bienes de acervo común (CPR, por sus siglas en inglés). Además, la activación de normas fue parcialmente consistente con la teoría del comportamiento ambiental significativo. En pruebas posteriores, los participantes del proyecto expresaron su interés por colaborar nuevamente en el futuro, además reconocieron la importancia de la participación comunitaria en los esfuerzos de conservación y gestión de recursos de la Lapa roja, también hicieron referencia a los crecientes niveles de prominencia personal. El éxito de tales estrategias de colaboración en la gestión de recursos depende del impacto que alcance en los residentes de las comunidades que abarca y esta investigación muestra que los esfuerzos de divulgación influyen las percepciones de los participantes.



Photo credit Natasha Walker



CONTRAST

Policy Contrasts From Carara to Corcovado

*Written by Lauren Miller, Matt Marquadt,
Steffi Nuereberg, Colin Gaddy, and Bill Sampson.*

Corcovado and Carara National Parks are an extreme contrast. Encompassing 55,000 hectares, Corcovado is ten times larger. The park also sits on the Osa Peninsula with an extensive coastline and was once described by National Geographic as the most biologically intense place on the planet. It's buffered from development by the Golfo de Dulce Forest Reserve and contains some of the last standing, sizeable lowland coastal tropical rainforests in Central America. It is a singularly large icon of the Costa Rican rainforest but actually hosts 13 different ecosystems and over 60% of the nation's biodiversity. I bring Huxley students to the middle of Corcovado National Park to get as deep into the rainforest as one can in the Green Republic of Costa Rica. The Sirena station is where the rainforest immersion truly happens.

The mornings can be especially wild there. One year, our first day in the biological station began at 4 am. My twenty-something and a few late teen students didn't imagine such an early wake-up but the forest's fauna had different plans. The howls began slowly and seemingly in the distance. They grew to a crescendo right above our buildings and most of us were shaken out of a tropical slumber. A troupe of howler monkeys filled the trees over our bunk house and let us know: this was their jungle. After a hearty breakfast of

gallo pinto, the fieldwork begins. In 2009 and 2010, both undergraduates and a graduate student juxtaposed Corcovado's management structure and style with Carara's.

Weighing in at only 5,500 hectares, Carara is like the smaller Pacific cousin to Corcovado. While both hold the only two sustaining wild populations of Scarlet Macaws in Costa Rica, Corcovado is surrounded by forest preserves and little development. Carara's buffer, by comparison, is exploding with development. A United Nation's World Biosphere designation was granted to Corcovado in 2000 while several travel guide books steer tourists away from Carara. Yet, both are managed in the same system of regional conservation organizations. The policy and conservation management contrasts are therefore fruitful laboratories for environmental policy and natural resource conservation students.



Kathryn Eyraud, Ben Gardner, Andrea Thomas and Mackenzie Dolstad formed the 2008 policy team. The 2009 policy team included Skylar Hinkley, Mallory Abston, Sara Hall, Shanley McEntee, and Devon Gilliland. Their objectives were to understand the management practices of each park, compare and contrast the two, and identify opportunities for improvement. These teams also utilized the framework of community-based



conservation as their organizing theory. They particularly recognized this view as proposed by Berkes “(The dilemma between linking conservation and development objectives) as part of the larger debate of preservation versus sustainable use and the participation of rural populations in decisions that affect their lives” (p. 622).

The undergraduate students examined the following questions. How are conservation policies and management diverging and converging in both parks? Is civic ecosystem management becoming prevalent in contemporary policy debates and documents on transboundary wildlife conservation? What institutional arrangements limit and potentially foster more civic ecosystem management?

In 2008, the policy team students conducted five interviews with respondents familiar with both parks and found several convergences. First, both parks struggle with low funding levels, enforcement capabilities, and monitoring resources. However, students observed that both



Photo credit Troy D. Abel

parks benefited from dynamic leadership and a focus on conservation—jaguars in Corcovado and Scarlet Macaws in Carara. Both parks also preferred local businesses for contracting and managing nonessential services instead of non-local businesses. Finally, all interview participants familiar with both parks emphasized the importance of environmental education.

The 2009 team found that both parks also attracted regular collaborations with University researchers and Students from the United States. Moreover, both Carara and Corcovado had well developed networks of relations with Environmental Non-Governmental Organizations (ENGOS). Carara’s network was more place-based with the central Pacific’s Asociación para La conservación de Psitácidos Pacífico Central, or LAPPA (The Association for Parrot Protection). In the Osa, a Jaguar conservation non-profit (Yaguara.org) is an important part of the environmental network but Corcovado’s ENGO relations also had a more international reach. For instance, the Nature Conservancy has been a conservation fixture on the península with their Osa campaign. Both student teams observed several more divergences.

Both teams found Carara and Corcovado’s greatest divergence in the management plans. The former park’s dated to 1994 when Carara was still a biological preserve. Originally established in 1978, Carara had restricted access to researchers and a few tourists. In 1995, Costa Rica began an effort to “deconcentrate, decentralize, and democratize” (Evans, 1999) its centralized conservation bureaucracy, the Servicio Parques Nacionales (National Park Service). The Sistema Nacional de Areas de Conservación (SINAC), or National System of Conservation Areas, was established to move from a strategy of protection and preservation to one of sustainable development, but after more than 15 years Carara’s management plan remained the same.



In Corcovado our students learned of a new management plan under development in 2008. Rather than creating the “Plan de Manejo” internally, Park leaders turned to neighboring communities on the Osa Peninsula. After an election process, seven community members were appointed to the Corcovado Management Committee. Along with shifting to participatory conservation, Corcovado also appeared to be surrounded by communities with more environmental awareness and less development pressure or reward.

In 2010, graduate student Lauren Miller also turned a scholarly eye towards resource and conservation management in the two parks. Her investigation utilized the lens of Common Pool Resource (CPR) theory to analyze the structures of governance of Carara and Corcovado and their progress towards sustainability more than a decade after the decentralization of the national park system. In particular, her analysis examined the extent to which the parks merged two institutional arrangements presented by Elinor Ostrom in her work on Common Pool Resource Theory: (1) collective choice arrangements and (2) networked layers of governance.

A total of nine in-depth, semi-structured interviews were conducted with park rangers, administrators, guides, researchers and a local conservation worker from Carara and Corcovado National Parks in June of 2010. Six of the interviews occurred in Carara and three interviews in Corcovado National Park. Moreover, Lauren observed the annual evaluation meeting between staff and officials from the regional office. Based on methodologies developed by The Nature Conservancy (TNC) and the United States Agency for International Development (USAID), 37 items in five categories (social, administrative, natural and cultural resources, political, and financial) were assessed by park officials with scores between 1 (insufficient) and 5

(sufficient). The results are displayed on the next page.

Developed in the early nineties, the matrix was designed for the Parks in Peril program developed by TNC and US-AID. Launched as an “emergency” response to Neotropical protected areas struggling with biodiversity conservation, the scorecard criteria were intended to measure a park’s progress towards “site consolidation.” This was defined as the point where a protected area was functional and no longer in need of emergency assistance (Brandon et al., 1998). A site is generally considered consolidated by TNC when all the indicators receive a 4 or 5.

Parque Nacional Carara

Satisfactory conservation scores for Carara were only present in nine of the 37 categories and overall, the 2010 park assessment resulted in only 56.8% of the minimum sufficiency score (84 out of 148 possible) which would be represented by a 4 in all 37 table cells. The lowest cluster of scores occurred in the financial category totaling only 7 of the possible 16 points (43.7%) while the political category received the highest proportion (6 out of 8



Photo credit Abel Brothers Photography



points or 75%). Carara’s scores in the natural and cultural resources category were the second highest cluster with 30 points out of 48 (63%) followed by the administrative category (56.3%). The social category received 50.0% of the possible points (14 of 28) ranking as the fourth best category.

Knowledge of goods and services (social), park boundary demarcation (natural and cultural), level of personal satisfaction (administrative), and available funds (financial) received the lowest score of 1. Of these four categories, there were no community members present in the evaluation meeting to help decide whether the local residents were familiar with the goods and services the park had to offer. Regarding the park boundary demarcation, this is an institutional failure according to Elinor Ostrom’s eight CPR institutional arrangements. To have an increased chance of a successful CPR, Ostrom lists “clearly defined boundaries” as a prerequisite (Ostrom, 1990).



Photo credit Troy D. Abel



..... Top of Costa Rica



Photo credit John Tuxill



Category	Indicator	Score Given	Rational
Social			
1	Interest Group Participation	3	Existence of tours, ecotourism companies
2	Volunteering	2	No official plan
3	Communication Plan: Execution and Evaluation	4	More or less exists between schools, universities, communities
4	Knowledge of Goods and Services	1	-
5	Environmental Education Plan	2	Activities, participation exists, but no plan
6	Tourism Plan	2	-
7	Land Tenure	-	Plan and information exists in great detail
Administrative			-
8	Management Plan: Enforcement	2	-
9	Annual Plan of Work	-	-
10	Park Zones for Management	4	-
11	Analysis of Threats	4	Plan exists
12	Personal Needs of Administration	2	Only basic needs being met for 25%
13	Personal Capacity	4	Plan exists
14	Level of Personal Satisfaction	1	Lacking support
15	Equipment for Management	2	-
16	Maintenance Plan	3	Plan, but not sufficient funds
17	Construction for administration	-	Basic construction
18	Plan for Maintenance of Construction		Plan exists
19	Plan for Labeling	4	-
Natural and Culture		-	
20	Practices Identified and Used	4	-
21		2	
		2	



21	Negative Impact of Use	-	Visitors use 10% of park territory with trails
22	Waste Management Plan	4	Plan exists, not perfect
23	Plan for Control and Protection	2	No Plan,
24	Impact of Control and Protection	2	Still much illegal activity in park
25	Park Boundaries Demarcated	1	Not clearly
26	Plan of Investigation	3	No Plan, but there is ongoing research
27	Systemized Information of Natural	5	Sufficient, but lacking some technology
28	Information of Cultural History	-	Guides can provide
29	Identified and Research of Indicator Species	3	There are investigations of macaws and other monitored species
30	Connectivity between Documentation and Evaluation	4	-
31	Abiotic Factors	2	Lacking advance technology to look at these
Political			
32	Application of the Law	3	There are improvement programs
33	Authority of the Administration	3	-
Financial			
34	Plan for Long Term Finances	2	-
35	Available Funds	1	Not much money
36	Value of Goods and Services	-	-
37	Interest Groups Receive Direct Benefits	4	Local communities, schools and businesses receive direct benefit from ecotourism



In the interviews, park rangers and administrators were concerned specifically that the control and protection of the natural resources and prevention of poaching were significant problems connected to the diminishing number of personnel over the years. Carara employed as many as 20 park rangers in prior years, whereas in 2010 there are 12 employees, including two working at the ticket counter and a cook. The observation that the major obstacle to the park's health is a dwindling number of personnel is consistent with the traditional administrative system of command and control and the perception that the park must be protected from people, i.e., poachers.

Conversely, participants with a more personal, not uniquely occupational, tie to Carara National Park, such as locally hired guides, tended to view the need for resources in a different way. Resources were seen as necessary for the park to be able to provide greater outreach to the local communities. The level of financial investment was not tied to the need for more park personnel. Rather the financial need was considered to be best directed toward more funding for increased environmental education programs and more communication and collaboration between the community and park, with possible economic benefits and the hope that these investments would lead to a reduction in poaching and a better understanding of the importance of Carara National Park. The connections that these local stakeholders made were all based on community involvement with the park and how community involvement would help to alleviate the major problems facing the park. These perceptions supporting a localized approach to management is consistent with the founding principles of SINAC.

Regarding the collective-choice arrangement and multiple layers of governance, there does not appear to be the level of involvement of the local communities that many of the

Photo credit Troy D. Abel



Carara interview participants would like to see. However, there exists some joint effort between local nongovernmental organizations such as LAPPA ROJA, a Scarlet Macaw research and monitoring program, and Pro Parques. Although the relations with some of the surrounding communities still remain somewhat tense, personal ties, stemming from local hires into the park system, have bridged the communication gap with other communities such as El Sur, a small environmentally conscious community dedicated to the conservation of the park. From a visit to a classroom in El Sur, it was obvious that the level of environmental education in the area was relatively high and this could be the basis for why this community chooses conservation over poaching.

On a national level, the funding for salaries and equipment comes from the SINAC central office, or caja unica del estado. Additionally, on the national level, when funding is available, students from around San Jose and other nearby provinces participate in service work. Ironically, much of the funding to bring students and volunteers from around Costa Rica to Carara comes from foreign universities or programs such as the University of Wisconsin at Green Bay, Western Washington University, Southern Illinois University and Ra-



Photo credit Larry Abel



leigh International. Therefore, some of the connections on a regional level are made possible through the involvement of international funding.

Other international involvement stems from the park's reliance on The Nature Conservancy for the Management Plan and the evaluation of this plan. Carara still utilizes the plan that was created in 1994 by experts sent from the Nature Conservancy (Anonymous Administrator, 2007). Although this plan may be outdated, there has not yet been funding to create a new management plan.

SINAC was set up to promote more localized conservation management (Lutz 1996, p21). From the Carara interviews conducted, it appeared that the park struggled to make connections to local communities regarding park management and decision-making and thus, in a ironic twist, the park is insulated both geographically and politically. However, Lauren learned in one interview that there is a law that required some level of community participation in decision-making in the park. In this same interview

there appeared to be some concern over this law and how and why decision-making power should be shared with local communities, as members of the community may not have the same understanding of the importance of the park. While there are some stakeholders in and around the park pressing for the original intentions of SINAC to become a reality, there are also remnants of the command and control park system that preceded the existence of SINAC. These vestiges of command and control in Carara might act as barriers to a more progressive, community-involved park system that is not mostly dependent on foreign contributors, but utilizes local resources.

Parque Nacional Corcovado

In the Corcovado interviews, Obstacles such as minimal access to resources, poverty, poaching, and environmental education were also identified by three interviewees. However, respondents also described two unique challenges: gold extraction and conflicting management objectives. The gold extraction was considered to be attributable to the economic crisis and few job opportunities in communities surrounding the park, rather than due to lack of resources and personnel. All three stakeholders also identified how the conservation focus in the original National Park system was no longer the primary objective.

Tourism, timber extraction, and economic development have ascended as additional, and sometimes conflicting goals according to several of the Corcovado stakeholders. This stems from the union of the National Park System, the General Directorate of Wildlife, and the Forestry Directorate with the creation of SINAC. According to one participant, the idea of SINAC was to have a "mosaic," with complementary agendas and one organization overseeing the coordination of all the conservation activities. However, in practice this doesn't work because, according to one interviewee, their respective ideologies are not



Photo credit Troy D. Abel



compatible. The National Park Service has traditionally focused on conservation while the Forestry Directorate has focused on selective logging and extraction. There is no longer one agency advocating solely for conservation in the SINAC system and it is entangled with tourism, extraction and development; all deemed problematic by the Corcovado respondents.

Interviewees also identified the additional challenges of concession (commodity and food vendors) expansion in the park to employ more local residents and tourism distractions for rangers who are normally responsible for patrol and protection. But the Corcovado interviews again pointed to the starker policy divergence with Carara. The

Osa Conservation Area (ACOSA) had developed a participatory decision-making forum for the peninsula's stakeholders. The Consejo Local, or local council includes six members from communities near Corcovado. Moreover, the park is required to hold regular meetings, sometimes monthly, and present new management proposals that are only implemented with consent of the council. Thus, with actively participating community members in the decision-making process of the park and the headquarters located in the nearby community of Puerto Jimenez; there is some form of co-management more consistent with SINAC's stated intention.

Nationally, Corcovado works with the Corcovado Foundation (Fundación Corcovado), Pro Parques and the Guides Association (Asociación de Guías), though foreigners manage many of the foundations (Anonymous Administrator, 2010). On an international level, there is the Organization for Tropical Studies Station (OTS) at Corcovado. OTS is both a national and international organization because the focus of the research is tropical studies in Costa Rica, but international with the majority of researchers from universities in the US, Australia and Costa Rica. Other international connections are through research and tourism represented by Western Washington University, the University of Texas and visits from numerous foreign tourists. As one of the participants stated, "Corcovado works a lot with locals, but the owners are foreigners" (emphasis added).

Stakeholder interviews in 2011

In the fifth Huxley RICA installment, undergraduates Colin Gaddy, Matt Marquardt, Steffi Nuerenberg, and Bill Sampson again contrasted natural resource management arrangements in Carara and Corcovado. However, this team used a variation on the CPR framework from past work. In 2003, a group of scholars revisited Hardin's tragedy of the commons as not only too simplistic, but also absent

any attention to pressures on ecosystems from multiple scales. Moreover, Dietz, Ostrom and Stern (2003) would argue that critical problems like tropical deforestation are being driven by nonlocal influences that demand consideration to multiple geographic scales like regions and transnational forces.

“These situations often feature environmental outcomes spatially displaced from their causes and hard-to-monitor, larger scale economic incentives that may not be closely aligned with the condition of local ecosystems. Also, differentials in power within user groups or across scales allow some to ignore rules of commons use or to reshape the rules in their own interest, such as when global markets reshape demand for local resources (e.g., forests) in ways that swamp the ability of locally evolved institutions to regulate their use (p. 1908).

Thus, the CPR lessons drawn from years of work on small scale ecologies and institutions have limits. However, there are three transferable lessons according to Dietz,

Ostrom, and Stern. First, interested parties need to be involved in informed discussions and establishment of rules, or what they called analytic deliberation. Second, governance should pursue the distribution of authority and efforts allowing for adaptive governance from local to global venues, or nesting. Finally, institutional variety should be developed through a mixture of institutional types that can be public, private, non-profit, or some combination of the three.

The 2011 policy team conducted 17 stakeholder interviews in both parks. Among the nine Carara interviews, three were Park staff, three were local guides, one a local resident, and one a foreign researcher. An additional interview was the result of a focus group in a local, but rural community neighboring Carara.

Five respondents directly identified poaching as the Park’s main threats; two mentioned funding, another two bureaucracy, and one community involvement. “The small budget Carara receives is the root of all problems. Carara has

Threats and Obstacles in Carara	Explanation of Problem	Number of Interviews Problem is Cited
Poaching	Still exists in park	9
Environmental Education	Needs more in the community and more community connections	9
Financial/Staff Resources	Lacking financial support/not enough personnel	8
Poverty/Economic Opportunity	Need work, leads to poaching	7
Culture/Attitude	Machismo, related to poaching	2
Bureaucracy	Management hierarchy, complexity and fragmentation	2
Island Biogeography	Little connectivity for wildlife	1
Forest Fires	Not many resources to deal with	1
Timber Extraction	Still exists in park	1

Obstacles in Carara according to 15 Stakeholders in 2012 and 2011 (Rangers, Administrators, Local Guides, and Community Residents)



less support than other parks and conservation areas. . . SINAC also doesn't work—the old management plan gave the park more resources and since SINAC came into action 16 years ago, these resources have decreased”, according to one stakeholder. A second said, “we are managed by many laws which are difficult to change. A system needs to be created where the laws are dynamic and adaptive, evolving based on communities— a balance between politics and science based on a country's needs.”

Two guides and two Park staff also indirectly identified the problem of community involvement in three more instances when answering the following questions “What are the community feelings towards the park and how are they involved” and “What could the Park do better/what needs to change?” perceived that community collaboration was ineffective or nonexistent. One guide mentioned that “the perception is mostly that people in nearby towns are the enemy in some cases. Communities should be more involved with conservation rather than being separated

from park activities. There is a need for a system that views local communities and beneficiaries rather than part of the problem, allowing communities to become more involved with park management decisions and feel a part of the conservation areas, rather than excluded.” Likewise, a Carara official stated: “The park focuses on protection and education but does not really work on community involvement” activities. There is a need for a system that views local communities and beneficiaries rather than part of the problem, allowing communities to become more involved with park management decisions and feel a part of the conservation areas, rather than excluded.” Likewise, a Carara official stated: “The park focuses on protection and education but does not really work on community involvement.”

Conversely, some optimism was expressed by two other Park staff. “There should be an increase in involvement with local communities and give more education. However, in the past year there has been more action” stated

Threats and Obstacles in Corcovado	Explanation of Problem	Number of Interviews Problem is Cited
Poaching	Still exists in Park	9
Gold Mining	Occurs in the Park	7
Bureaucracy	SINAC has conflicting objectives, too much centralization	7
Poverty/economic Opportunity	Poverty leads to poaching	4
Island Biogeography	Isolation/Wildlife Connectivity	3
Large scale development	Globalization of Resort Tourism	2
Environmental Education	Needs more in the Community	2
Minimal Resources	Lacking financial support/not enough personnel	1

Obstacles in Corcovado According to Eleven Stakeholders in 2010 and 2011
(Administrator, Local Guides, Rangers, and Community Residents) : 42



one official. Another was more specific. “Many people around Carara are interested in improving the park. Sometimes there will be 40-50 locals that volunteer to help collect trash. There is definitely an increased interest than in the past. Just a few months ago the park held an “environmental party” (fiesta ambientales) where around 100 people came and brought small trees to plant. Similar sentiments were evident from the one resident’s interview and the focus group. There is involvement because, according to one respondent: “management plans require that there be community input. The park has to listen and use local communities as partners. There is an organization—natural Resources Community Watchers—that help with patrolling the park for poachers.” In sum, there was an even split between positive and negative views of community involvement with Carara National Park.

In Corcovado, poaching was also the most frequent threat identified by 7 out of 8 respondents. Unlike Carara, gold mining was the second most common threat mentioned by 5 stakeholders. An equal number also described bureaucratic centralization as a problem to Corcovado’s conservation. The park’s isolation, or island biogeography, was identified by 3 respondents. The lack of economic opportunity and conversely, too much development (like resort tourism) were both mentioned by 2 stakeholders. Only one respondent directly mentioned education as one of the main conservation problems.

Perceptions about community involvement were very different in Corcovado however. Six of the eight stakeholder perceived a positive direction for the Park’s efforts to involve the community in conservation management. “Now it is better” said one respondent. “There are committees in each town for helping to make decisions. [The Park] also requires rangers to go into the communities and work with schools and the locals.” Three different respondents

Photo credit Troy D. Abel



identified 2008 as the year of a positive turn. For instance, one interview stated that “In 2008 (approximately) the park is more in contact with the community there local committees. People used to think the park doesn’t belong to them.

Now they feel that they are a part of it.” “Local committees are very important” another said. “Now community involvement programs are official due to the 2008 plan, but they are still working to enact all the programs. . . the committee consists of 7 elected members. Community involvement is important because the original thinking of inside park boarders is a mistake, now they are working more outside of the park.”

Corcovado respondents also stated less concern about environmental education than their Carara counterparts. As one guide put it: “Poaching and gold mining, they are both cultural activities and a sign of manhood. It is declining, but still is a problem. Environmental education is helping.



“Another observed that “education has helped convert many miners into rangers.”

In sum, by all accounts detailed here, Carara exemplified not only a “park-in-peril” when it comes to analytic deliberation, but most management arrangements seem to be regressing instead of stabilizing. There has been no consistent analytic deliberation in Carara. (Yet, there have been promising activities but in an ad-hoc fashion. In short, the institutional arrangements for analytic deliberation are fragmented and uneven in Carara. Corcovado on the other hand appears to be moving in the right direction on community involvement according to most stakeholders we interviewed. While this initiative is still in its infancy, Corcovado is reducing its political insularity.

Interviews from both parks indicated that neither is succeeding in the development of a nest of institutions from the local to the national level that foster adaptive management. Stakeholder responses suggest this is more likely a national problem however, as Costa Rica’s SINAC devolution has not yet been successful. Perhaps this has helped explain both park’s variety in their institutional efforts with global organizations to fill this vacuum.

Overall, there are marked differences between Carara and Corcovado National Parks. These differences transcend biological and geographical considerations. Carara and Corcovado maintain unique management approaches under the same system. The former tends to hold onto traditional management forms and the insularity they foster, but there is opportunity for progress as seen in a few initiatives. Corcovado, on the other hand, is taking steps towards a more integrative, localized approach with meaningful community involvement.

The 2011 policy team engaged in one of the dominant debates in biodiversity conservation and the effectiveness of

preserving Single Large or Several Small (SLOSS) areas of habitat. The next chapter covers the other research projects from 2011 including avian recordings, environmental education, forest transect inventories and, a new initiative examining trail erosion.





EDUCATION

Participatory Ecological Monitoring and Environmental Education in 2011

Written by Troy D. Abel

In the summer of 2011, faculty from Western Washington University's (WWU) Huxley College of the Environment implemented a five week field course in Costa Rica exploring Participatory Ecological Monitoring and the pedagogies of Environmental Education. Faculty and students completed observational studies of tree diversity, soil composition, avian bioacoustics, collaborative conservation management, and environmental education. Comparative observations were conducted at biological stations in Carara and Corcovado National Park in collaboration with Park staff. We hypothesized that significant contrasts will occur between Carara's secondary and Corcovado's primary forests and their neighboring communities. Our results inform Costa Rican conservation and management strategies as well as contribute to the growing field of participatory ecological monitoring. Biodiversity conservation begins inside of Costa Rica's and other nation's protected areas but will be complemented by research, education and outreach in the communities outside National Parks.

Study Sites

Our two field sites were located in Carara and Corcovado National Parks and encompassed ten days of fieldwork at the Quebrada Bonita and Sirena biological stations. Students in our program conducted field studies and evaluated management policy between the ecosystems of a transitional smaller transitional forest (Carara) and a larger tropical wet forest (Corcovado). Data was collected in a gradient of habitats representing relatively pristine to high-

ly disturbed conditions. Individual research activities were united by a common focus on the science and implementation of effective environmental monitoring. Specifically, students worked in one of five complementary research areas: (1) digital recording and analysis of bird species assemblages; (2) observational analysis of soil composition and quality around trails; (3) observational analysis of tree diversity and abundance; (4) observational assessments of participatory conservation policies; and (5) observational assessments of environmental education pedagogies. Students benefited by participating in this conservation-oriented research while park staff and visitors also gained from an increased knowledge of the park's flora and fauna.

Student groups were based near each study site for eight days. The Carara visit began on June 23 and ended July 1 while students lodged in Corcovado's Sirena biological station from July 9 to July 17. Our observational methods required no physical specimen collections; only digitized recordings, photographs, and data notations.

Curating of Material

No collections were made thus no material curating was necessary. No collections were made thus no justification was developed. Our observational methods caused only slight disturbance to soil and vegetation. We observed in small areas (0.01 ha) for several hours, and so the leaf litter and vegetation of that small area was disturbed slightly. Generally, effects of this kind of observa-



Photo credit Kelley Palmer-McCarty



tions are not noticeable a few days after collection. We believe our observational methods had negligible affects to both flora and fauna in these areas.

Avian Field Work

Ashley Allan, Neddy Dondup, Tanika Ladd, and Kelley Palmer-McCarty composed the 2011 avian team which compared bird species richness and abundance in Carara versus Corcovado. They tested the null hypothesis that there will be no difference in species richness or abundance between the Carara and Corcovado sites. Birds are convenient subjects because they are fairly well documented in Costa Rica (Janzen 1983, Stiles and Skutch 1990) and because they are often sensitive to environmental degradation (Morrison 1986, Lambeck 1997, Veneir and Pearce 2004). These taxa certainly do not represent the entire biota, but they are convenient for illustrating variation in environmental conditions and they can be documented consistently by non-professional field observers. Many species of birds also are recognized as important ecological attributes in their own right.

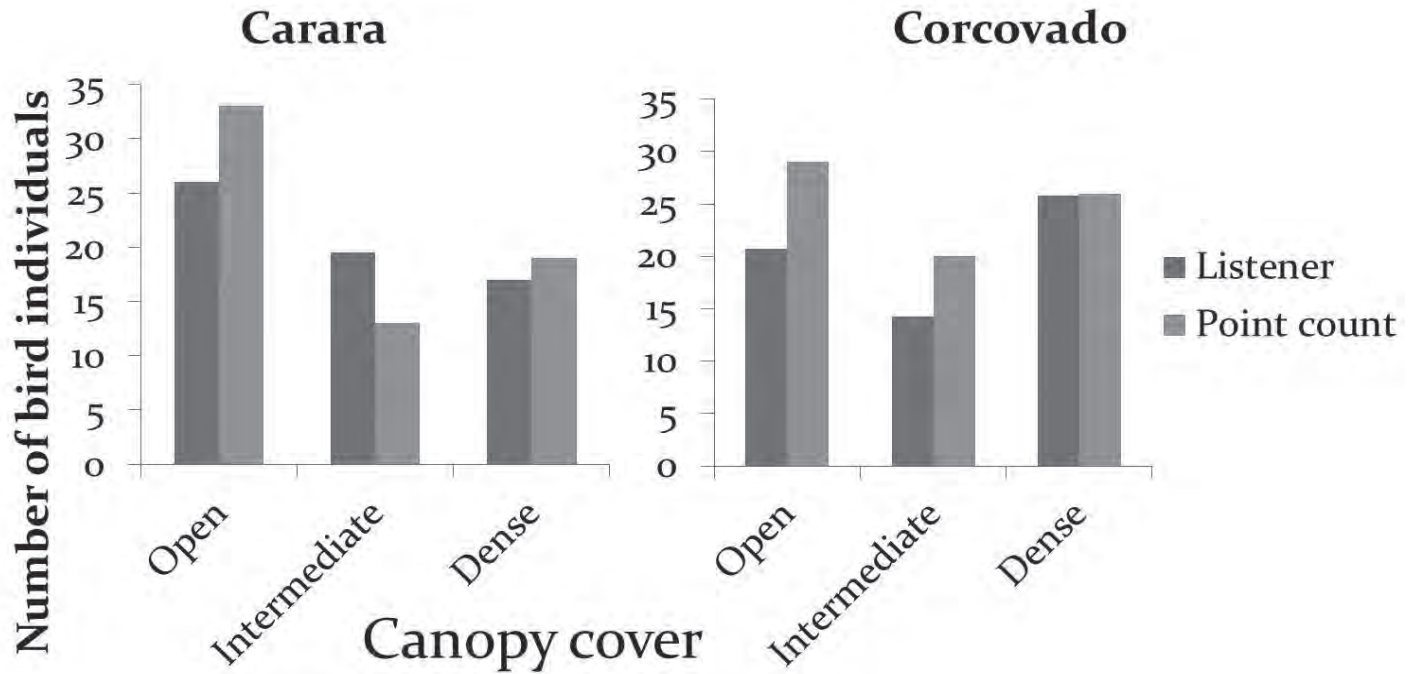
Systematic monitoring of bird and mammal populations is a challenging task that has traditionally required high levels of skill by trained field observers. Undergraduate participants were not expected to possess or acquire these skills. Instead, and following Hobson et al. (2002) and Rempel et al. (2005), we employed acoustic recordings to help document species assemblages in the Costa Rica study areas for two reasons. First we wanted to provide a meaningful field experience for the students during the limited time available and, second, we aimed to explore field methods that are not dependent on highly skilled field observers, which might be difficult to enlist continuously in a long-term biological monitoring program. A method for obtaining reliable data with the help of non-experts is more likely to be sustained by conservation managers on a long-term basis.

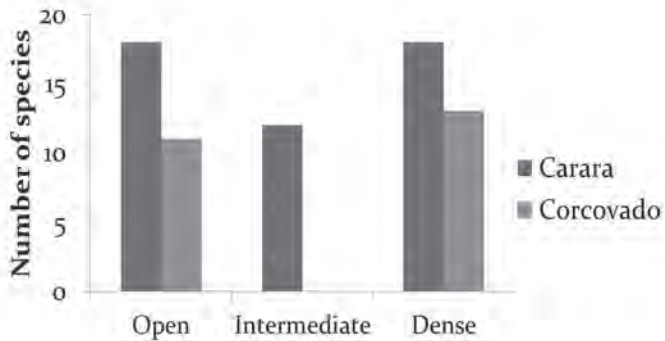
Avian methods

Measuring and quantifying the diversity of avifauna in tropical jungles can be a difficult task that is confounded by dense vegetation and bird species that look nearly identical to others. Bioacoustic monitoring is a method for quantifying birds by using sensitive microphones to record bird sounds. A Compression Zone Microphone (CZM) from Riverforks.com seen below was utilized with a Marantz Professional Portable Recorder, Model PMO690 mounted on a camera tripod. Simultaneous four person point counts and ten minute recordings were collected in open, intermediate, and dense canopy cover determined with a densitometer. Local guides from each park helped count different birds based on recorded calls.

Recording results

The highest abundance of 33 observed birds and 25 recorded individuals was found at the low canopy density site at Carara. Five fewer individuals were found in Corcovado's open density site with 29 observed and 20





identified in recordings. Bird abundance declined in the intermediate sites in both parks, with only 13 observed at Carara, 20 seen in Corcovado, 20 identified in the Carara recording, and 14 heard in Corcovado's recording. Dense canopy cover produced a few more birds than intermediate with Carara registering 19 birds observed and 17 identified from recordings. 26 were both observed and recorded in Corcovado's dense canopy site. The figure above displays these differences.

Overall, Carara only exceeded Corcovado bird abundance in the open density site and on average, the student team found more birds in the bigger park. Conversely, when local guides with birding experience counted the number of unique species recorded at each site, Carara registered higher diversity than Corcovado. 18 species were identified in Carara's open and dense canopy recordings compared to only eleven and thirteen respectively in Corcovado. An intermediate canopy density recording comparison was not completed due to the lack of the experienced birding guides availability.

Avian Discussion

Through the lens of island biogeography, Carara's avian species richness was unexpectedly greater

than Corcovado's. Students concluded that Carara's transitional forest types probably explained the greater diversity as bird species from the Mesoamerican and Amazonian ecosystems overlap here. Moreover, Carara's small size should not necessarily be used as justification to direct conservation resources to other and larger parks. The 2011 team recommended that future studies should combine point and recorded counts with an experienced local birding guide to identify species richness. Also, they suggested that future point counts be combined with botany plots to allow comparisons of avian abundance with tree diversity.

Forest Transects

Our botany group of students included Danny Goertz, Kellianne Lane, Reed McIntyre, and Katie McNett who inventoried the contrasting tree diversity in the two parks. Biological complexity and species richness are the hallmarks of lowland neotropical rainforests (Forsyth and Miyata, 1984; Kricher, 1999; and Terborgh 1992) and exposed these students to biodiversity unmatched by any



Photo credit Kelley Palmer-McCarty



other ecosystem. Though generally high, species richness exhibits variability. For instance, Knight (1975) found more tree species in the mature forest of Barro Colorado Island, Panama than in a younger forest, 151 in the former versus 115 in the latter. Likewise, Lieberman et al. (1996) found species composition varying by altitude in Costa Rica's La Selva reserve. Therefore, the 2011 botany team's null hypothesis was that no difference in forest structure and composition would be discernible between the two park sites. Their alternative and primary hypothesis was that Corcovado's forest will be more diverse than Carara's. Moreover, they expected that there would be fewer trees in the 10–50 cm diameter at breast height (dbh) range and more in the >50 cm class in 1992).

Therefore, the 2011 botany team's null hypothesis was that no difference in forest structure and composition would be discernible between the two park sites. Their alternative and primary hypothesis was that Corcovado's forest will be more diverse than Carara's. Moreover, they expected that there would be fewer trees in the 10–50 cm diameter at breast height (dbh) range and more in the >50 cm class in Corcovado than in Carara.

Transect Methods

Following one set of methods commonly used in Dr. Da-

vid Wallin's Forest Ecology class (ESCI 407), students constructed two forest inventory plots by nesting circular plots within the bounds of two concentric circles, the inner circle having a projected area of 0.1 ha and the outer circle having a projected area of 0.2 ha (1 ha = 10,000 m²). On level terrain, the smaller inner circle will have a radius of 17.8m and the larger outer circle will have a radius of 25.2m. To lay out each plot, students used a compass and 30m tape to flag eight points, 90 degrees apart at distances of 17.8 and 25.2m from the plot center.

Students first calculate canopy height with tape measure and a clinometer. Second, all small trees between 10 and 50 centimeters in diameter are measured within the inner circle (diameter = 17.8 m). For large trees, students measured the width of all trees over 50 cm in the circular plot (diameter = 25.2 m) because they are less abundant and require a larger sampling area to ensure more representative measurements.

Tree species identification was led by biologist and guide Alberto Herrera who walked students through an identification key developed for Costa Rican forests as seen here. Students first identify a tree's family by examining the color of the sap that takes them through the key's first branch, then leaf structure, stipule presence, and then leaf



Tree Identification Key



texture as the second, third, and fourth respective branches. Often, leaves from large trees are not readily apparent on the ground, so a spotting scope is used to help with leaf classification (see photo below). After the family is determined, an additional identification book is used to key the species.

Transect Results

Thirty-six individual trees and 24 species were identified in the Carara secondary forest with half (18) falling between 10 and 20cm. The Corcovado plot had 43 individuals and 30 species. As expected, more trees and more species were inventoried in the Corcovado transect with more in the 20-30 and > 40cm classes. Carara also had a lower Shannon-Wiener diversity index than Corcovado; 1.337 compared to 1.563 respectively. The composition of the two forests were also stark; only 7 with only 7 species found in each. The results indicate that the primary forests of Corcovado are more structurally and biologically diverse due to ecological succession, conservation prac-

tices and geography of the park.

Soil Tracts

Sean Cooper, Katlynn Schauberg, Scotty Seren, and Alexander Smalldon made up our 2011 soil team who contrasted erosion from trails at both study sites with the mentoring of Dr. Andy Bach. Strategies for the sustainable development of tropical rainforest environments frequently promote ecotourism and small-scale extractive activities as having important economic benefits and only minimal environmental impacts. Trail-dependent forest activities, however, risk accelerating soil erosion and degrading aquatic environments with eroded sediments (Wallin and Harden, 1996). Water runoff from trails in exacerbated by increased slope, increased trail length, and by soil compaction. All three variables can be easily measured by non-damaging methods, then statistically related to examine the potential for better trail design, as well as relating erosion to existing erosion control devices such as stairs, gravel cover, and other surface covers. Through qualitative observations and quantitative measurements the soils team assessed the importance of trails to surface storm flow and soil erosion in tropical rainforests, where trail



Photo credit Alberto Herrera

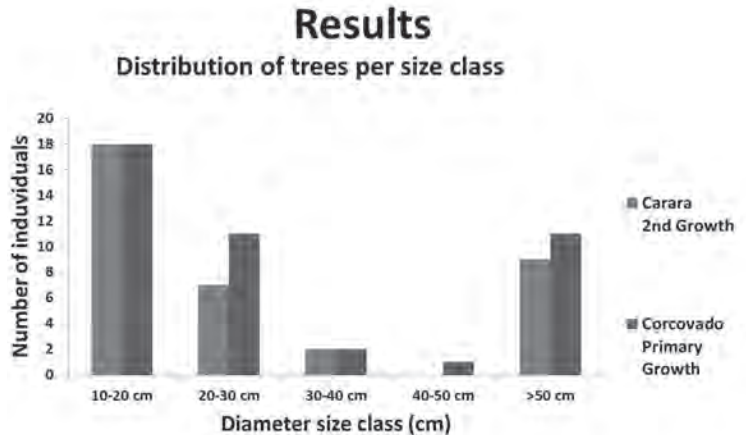




Photo credit Andy Bach



erosion might degrade ecotourism trails and negatively affect the terrestrial and aquatic habitats the trails otherwise help to support.

In selecting sites in Carara and Corcovado, students injected some randomness into their sampling by walking down a trail approximately one fourth of a kilometer and choosing the middle of the sample site to be a tree at the side of the trail. The soils team collected data from both flat and sloped sites at both parks, so the only consideration in section selection was to satisfy this component. The site was then logged on the GPS and a picture was taken for the record. After choosing a site observers then marked

off a three-meter long trail site using a measuring tape with the tree in the middle. Twenty random measurements were taken along the trail length, while twenty more were recorded at a distance of three meters perpendicular from the trail. Students then assessed a trails visual appearance for signs of erosion using a trail condition class method explained in Mark C. Jewell and William E. Hammitt's study (2000), "Assessing Soil Erosion on Trails: A Comparison of Techniques." Following their evaluation, researchers rated each trail from Class 0-5, with class 0 being a trail that is barely distinguishable while a Class 5 entails obvious soil erosion with exposed roots, rocks and or gullying.

Students measured slope with a clinometer, length with a tape measure, and compaction with a pocket penetrometer. The pocket penetrometer is less damaging to the soil surface than pushing a nail vertically into the soil surface. These measurements can be related to visible evidence of erosion downslope and trail characteristics such as width, depth, root exposure and other impacts.

Horizons (Depth)	Description
Q (Leaf Litter)	1-2 leaves thick
A (0-14cm)	Granular structure Few stones <5%. Roots-larger ones concentrated near surface. Many fine roots. Color 7.5 YR 3/2 = Dark Brown
AB (14-42cm)	Weak angular blocky structure. Few stones <5%. Roots-less roots than in A horizon, fine roots, very few large roots. Color 10 YR 3/4 = Dark Yellowish Brown
B1 (42-63cm)	No obvious structure. Stones 10-20%. Roots-very few roots, only fine roots.
B2 (63-72cm)	No obvious structure. Stones 25%. Very few roots- fine roots. Color 10YR 4/4 Dark Yellowish Brown
B3 (72-101cm)	No obvious structure. Stones 50%. Very few roots- fine roots. Color 7.5 YR 4/6 Strong Brown. (AGE=thousand to tens of thousands years old) Abundant Mn staining on stone surfaces- Related to fluctuating ground H ₂ O.



In order to gain a better understanding of Costa Rica's soil, students also undertook two side projects. The first project was digging a soil pit in Carara to evaluate tropical soil horizons and their contents. The pit was approximately one meter by two meters and was dug until ground water was reached at 101 cm. After digging the pit, horizons were labeled using a Munsell Soil Color Chart, which involved matching color swatches on the chart to the color of soil in each of the horizons. Then a qualitative analysis was completed where students looked at structure and the presence of roots and or rocks. The second project included collecting pH data from the botany team's plot in both Carara and Corcovado. A pH meter was planted on the north and south side of each tree in the botany plot, left to sit for three minutes, and the average was then recorded.

Soil Tract Results

As shown in the two graphs here, the off-trail compaction measurements between Carara and Corcovado were very similar; 1 and 0.75 kg/cm² respectively. However, when comparing on trail compaction Carara's trails are clearly more compacted than Corcovado's. The significantly greater population of visitors that hike Carara's trails can



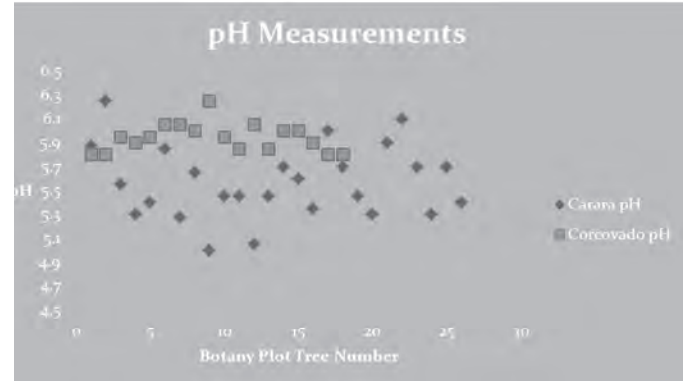
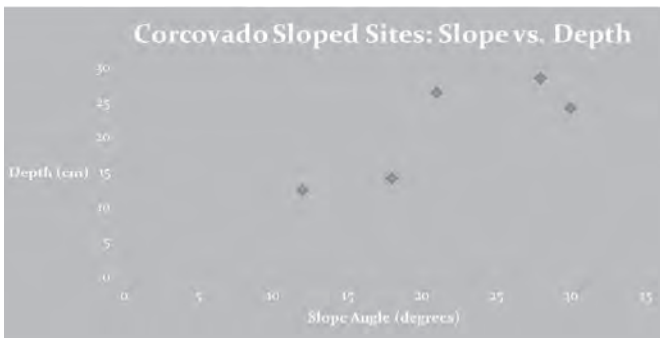
explain this difference in compaction level. The soil team hypothesized that there would be: (1) a difference between soil erosion; (2) a positive correlation between trail depth and trail slope; and (3) a negative correlation between trail width and trail depth. Data from both sites supported the second hypothesis and the Corcovado results appear on the next page. The data was too inconclusive to support the third hypothesis. Also, pH measurements differed between the two sites.

The results from our Trail Condition Class method analysis were almost unanimous throughout both Carara and Corcovado Park. Every site was a Class 5 in Corcovado meaning roots and rocks were exposed, while there were only two fours with the rest Class 5 in Carara. Unfortunately, Class 5's not only indicate a significant amount of soil erosion that can harm aquatic life, but also means bare roots are exposed leaving trees vulnerable. Roots act as lifelines for nutrients as well as an anchor for support and bare roots quickly become damaged by hikers stepping on them to avoid muddy conditions putting the trees themselves in jeopardy.

The pH of the Corcovado botany plot was higher on average than Carara's plot. The average was 5.95 pH in

Corcovado while Carara's average was 5.55 pH. There is a lot more rain in Corcovado and in the 2011 trip, an exceptional amount of precipitation occurred within the few days prior to testing which could explain the more alkaline soil character. Conversely, Carara's rainforest used to be a coffee plantation within the last century and this could partly explain the more acidic soil found in the Central Pacific site.

From the data the soils team collected as well as the qualitative observations made while walking the trails and examining the soil pit, it is clear that trail system erosion in Costa Rican National Parks is an issue that needs further consideration, research, and mitigation efforts. The soil team results were similar to other research. Thomas R. Wallin and Carol P. Harden (1996) found that, "at La Selva, runoff coefficients for trail sites were, on average, more than 40 times greater than those for off-trail sites." They concluded that compaction appears to be the main culprit. "Compaction due to trail use, as evidenced by higher on-trail bulk densities, appears to play a major role in increasing runoff from trail surfaces at La Selva" they said. In conclusion, although Costa Rica has a delicate soil environment that is vulnerable to erosion caused by high rainfall and high visitation rates, with proper assess-



ment and management strategies, trail degradation can be limited by targeting problem areas and Costa Rica's beautiful forest ecosystems can be preserved.

Experiential Education

The fourth group of students explored the pedagogy of environmental service-learning and its impacts on learners. Participants in 2011 included Sara Allen, Pat Chappelle, Dana Christenson, Patrick Connors, and Rachel Youngberg. Their work built upon the 2010 environmental education team made up of Zane Beall, Connor Harron, Lisa Karsen, and Andrea Magnuson. Extensive research has found that learners participating in service-learning not only improve their sense of efficacy or perceived ability to make a difference (Cone 2009; Moely et al. 2002; Simons and Cleary 2006), but service-learners are also more likely to become civically engaged (Billig 2000; Gallini and Moely 2003). Finally, the rare study of environmental service-learning found better critical thinking performance among high school seniors treated with service-learning versus a control group (Ernst and Monroe 2004).

However, research also finds that learner impacts can vary



Photo credit Connor Harron



significantly across service-learning pedagogies and serve to reinforce the assumptions that students initially brought with them into the program. (Boyle- Baise & Sleeter, 2000; Dutton & Heaphy, 2003; King, 2004; Maher, 2003; Miller & Stiver, 1997). Our education teams explored how variations in not only the pedagogies, but in different communities may influence learner outcomes.

In 2010, students developed and delivered an experiential and experimental environmental education program that focused on trees and their ecosystem services towards bird habitat. Materials include two clear plastic containers, soil, coffee filter, two clear plastic catchments, and tree saplings. Educators then supervised a learner comparison of water filtration between a soil filled bottle versus a similar bottle but with the addition of a coffee filter. Trees and their roots were described as functioning like the filter. Student educators also conducted a pre-assessment by asking learners to draw trees and their role in the environment. A formative assessment included requests for learners to share their observations from the experi-

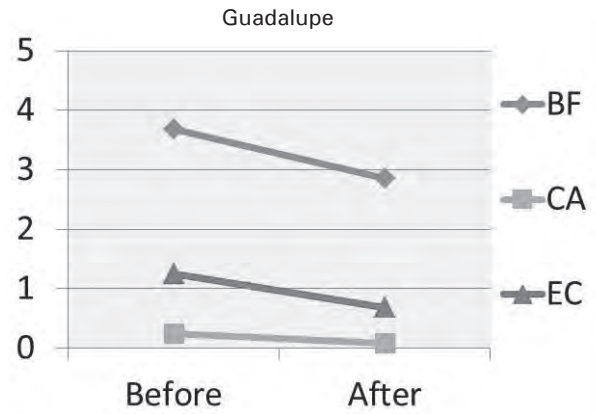
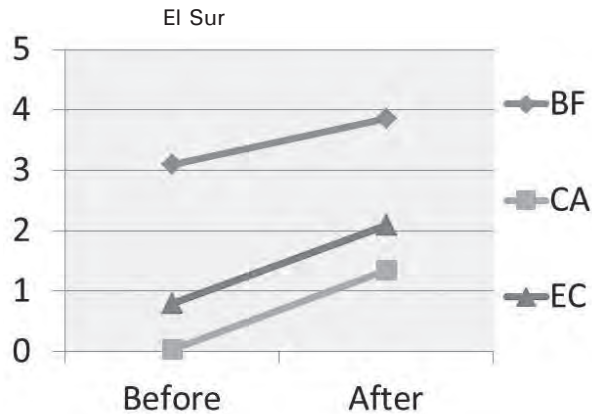
ment. A post assessment involved learners drawing trees as educators look for images representing clearer biological, emotional, and conservation connections.

In the 2011 iterations, students adopted an avian education program from Cornell University's Lab of Ornithology called Bird Sleuth, or Detectives de Pájaros in Spanish.

Educational results

Two different communities and their school children participated in our curriculum; El Sur near Carara and Guadalupe near Corcovado. Both are rural agricultural communities with a prominent lodge in the town that provides benefits from ecotourism for many residents. However, a major pedagogical variation arose between the two towns because trees to plant were available for a service project in El Sur but not in Guadalupe. The 2010 El Sur group was slightly smaller with nine students ranging in





age from 7 to 11 compared to the 12 students from 5–13 participating from the Guadalupe community. Moreover, the El Sur activities were more structured in both years because students were still in school. When we arrived for our service-learning in Guadalupe, students were on a short break. Similar to the other projects, our students hypothesized that no differences would be observable in the contrast between the Carara and Corcovado student outcomes. But in both years, our students observed more movement between the pre and post-test results in El Sur across three categories; biological representations, conservation actions, and emotional referents.

Unexpectedly, the post-tests for Guadalupe dropped in all three categories assessed in student drawings. Students offered several speculations about the trends. First, the absence of a structured learning experience in Guadalupe struck both students groups in

2010 and 2011 as a major factor. Second, our students also attributed a lot of influence to the presence of trusted and authoritative community member in El Sur. Third, students found that the starkest contrast between the two groups was the variation in the students' depiction of human action. Student drawings from the tree planting group had twice as many examples of conservation action than the other group in the 2010 post assessment. Our students cautiously concluded that the tree planting component was a major factor in the observed differences and demonstrated the influence of environmental service learning.





The 2011 Student participants appear below with the El Sur students and teacher. In the first row kneeling or sitting from left to right are Ashley Allen, Reed McIntyre, and Katlynn Schauberg. In the second row standing from right to left are Pat Chappelle, Dana Christenson, Sarah Allen, Rachel Youngberg, Steffi Nuerenberg, Matt Marquardt, and Tanika Ladd. In the back from left to right are Kellianne Lane, Danny Goertz, Alexander Smalldon, Kelley Palmer-McCarty, Scotty Seren, Professor Troy D. Abel, Katie McNett, Graduate Assistant Kathryn Mork, Sean Cooper, Bill Sampson, Patrick Connors, Colin Gaddy, Neddy Dondup, and Professor Andy Bach.



ECOTOPIA

Footprints from Ecotopia

Written by Connor Haron

El Sur: Where Local is trying to Find a Home in a Global World

Blog by Connor Harron (2010)

Situated in the foothills of the Central Pacific, El Sur is a small community of agriculturalists living on the northern edge of Carara National Park, Costa Rica. We visited the town in order to get a taste of Costa Rica pre Huggie Billboard signs and Nativa resort communities, where the only sign of tico's (Costa Ricans) can be found in the kitchen or maintenance facilities. In El Sur everyone is local, and several of the families are related. The village consists of several family homes, a community center where everyone shares their meals together, a church, one school (with nine students), a pulperia or general store complete with a rustic pool table where nightly games can be shared with the local population of giant moths and disco-teca music, and a generous set of accommodations for visitors called Eco Sur. El Sur has been around for generations, and the families there were almost all subsistence farmers. That is until the creation of Carara National Park.

During the formation of Costa Rica's National Park system much of the land needed in order to create these reserves had to be taken from people who already inhabited them. El Sur was one of them. A large portion of El Sur's agricultural land used to grow sustenance crops were designated as National Park, no say was given to the community in this process, and to my awareness no compensation has yet to be given. However, the people at El Sur have dealt

with hardships before, and while some families left, those who stayed tried to make the best of things by growing new crops that could better suit the communities diminished lands. But along with the creation of the National Park came the animals, and many crops were destroyed by grazing omnivores seeking food that El Sur sought to claim. These animals, under new laws were protected from the community, and killing those that attacked their crops was forbidden. So again, in the name of preservation, this sustainable community was thwarted in their attempts to preserve their way of life.

Once again more families left in order to find an easier way of life. However, those who stayed desired more than ever to preserve their community so that their children and their children's children would have the chance to live as purely as they felt they had. In a last ditch attempt to generate enough communal income to support their needs, El Sur created a partnership with an NGO called Global Aware in order to create Eco Sur. This partnership has provided El Sur with a tourism industry which acts to give people like us the chance to see how real tico's live and an idea of what it takes to be part of a cooperative community.

During our short stay we had the opportunity to eat as a community with these people. We went to school with their children, taught them about the environment, learned that they were already more connected to the forest than we could have imagined, and planted trees together as a group. We saw their sugar cane plantation and witnessed



Photo credit

Troy D. Abel



first hand the ox driven process of extracting the sweet liquid from the stalk, and then the 10 hour process of boiling down and extracting the “good stuff” before tasting and buying much of their days work. In El Sur the excess sugar product is used to feed the pigs, and the leftover stalk acts as the only organic fertilizer they use/need to create some of the finest brown sugar that has ever met my palate.

In a world dominated by globalization, El Sur has managed, at least for now, to take ownership of their land and preserve their way of life while still interacting with the outside world. Many places have not been so fortunate, and in a place like Costa Rica where tourism competes for the title as the nation’s largest economic sector, Americanization is everywhere. There is a fine line to play when integrating societies so that we can maintain our cultural identity while interacting on a multi-international scale.

I have heard one of the greatest atrocities of the 21st century being described as “the sense of being homeless in your own home.” This is something that many tico’s are



experiencing on a daily basis and will be a major struggle for Costa Rica in this century, but I believe that places such as El Sur are examples of good partnerships that can develop without the marginalization of locals. If Costa Ricans can take back ownership of their development and industries, they may be able to preserve a semblance of what was the Green Republic while creating a society that is more “glocal” than the corporate dream of expanding the Great Wall of condominiums and McMansions unbroken from the Baja peninsula, to Costa Rica and beyond.

More than the Green Republic

Costa Rica. A name that to many is synonymous with “green republic,” “the last country the god’s made,” and many others that describe the eco friendly nature of this beautiful land. Since landing here and meeting the people as well as seeing many of the forests and animals which call this place home it is easy to see why. However, the picture portrayed by many of these descriptions is incomplete. Costa Rica, like the rest of Central and South America has been subject to the cruel hands of fate as



Photo credit Troy D. Abel



colonizers from the west claimed much of its territory and economies, harnessing them for comfort goods that by now we accept as natural. Costa Rica has been one of the luckiest, preserving 25% of their land as protected areas with the help of international organizations and countries around the world through their “debt for nature” program. Even so, Costa Rica is experiencing faster rates of deforestation than any other country in Central America as banana and coffee plantations fill the countryside in order to fulfill the increasing demand from developed nations. As with many developing countries, a disconnect exists here between the raw goods produced as export commodities and the people who eventually consume them in their home or mug. The farmers who till the land here receive less than 1 cent for every dollar made from the goods they produce, and trade agreements with the IMF and World Bank have constricted these countries economies in a vice grip so that only the most highly valued exports can be grown to insure that international debts can be paid. In order to do so social spending has largely been cut and the large expansive forests that are “protected” in many ways can only be described so on paper. Please do not take me the wrong way, Costa Rica is very much the tropical paradise that many envision when they here the word. But there is a complex dynamic between the people here and the forests and animals that which travelers from around the world come to see.

Love with Respect

We have heard that humans need to love and be loved, but one of the most moving individuals I have met so far claimed that we need to learn to “love with respect.” An example of this can easily be found in one of Costa Rica’s most famous birds, the scarlet Macaw. Many people love this bird, so much so that a huge black market exists for poachers to sell them as pets to wealthy individuals globally. This depicts the lack of respect for the Macaw as well as many animals around the globe. If we truly love these animals, then we should show them the respect they deserve by allowing them to be free. The same is true for our environment and ourselves, for while we seek to love and be loved, it is imperative that we ensure the same is possible for all others. Just as many of the people and animals in Latin America have been marginalized by our need to seek fulfillment and happiness, so have we marginalized our own lives by creating a society dependent on material satisfaction. If we do not love ourselves responsibly, then we cannot share that love with others, and thus we will continue to ignore the suffering of others so that we can ignore our own. However, if we seek to bear each other up then we can reverse our status as consumers, and be providers of the most amazing gift of all; life.



Photo credit Adrian Arce Arias



Photo credit Clarrisa Ernst



Spoon and Boat Bills

Blog by Clarrisa Ernst (2010)

Everything about this Carara place is beautiful and the best part is it never gets old! This is now the third day in a row I have woken up at 5:30 a.m. and had to be ready for a days work by 6 and I have yet to find it hard to get up and go. Even though I don't have an alarm clock it is easy to determine the time to wake up because like clock-work, the howler monkeys are out and howling at 5:20 every morning.

Its exciting to get up with the rain forest, you never know what you'll see throughout the day and that is why I'm always sure to have the camera ready to fire. It is an amazing feeling of integration when the animals and birds allow you to see them in action. Although it has already happened many times, whenever the monkeys cross over head or a bird lands just in sight it is an exciting experience. Everyday is different and everyday is an adventure. Two days ago we walked right under a pack of spider monkey and the day before that a pack of white faced monkeys. Today we were ambushed from a bird throwing fruit down on the trail. You just never know what will happen on the trails of Carara. We have only been here eight days and i can see now that we have only begun to scratch the surface of the amazing life of the rain forest.

The Monkeys Fling Poo

Blog by Andrea Magnuson (2010)

The number one reason I wanted to come to Costa Rica

was to see monkeys in the wild. The first day everyone found out that the only Spanish I learned in preparing for this trip was "Donde esta los monos?" (Where are the monkeys?). At our first location in Monteverde we saw white-faced monkeys in the trees before we even had lunch. Even the cafeteria workers somehow found out I was the monkey fan and pulled me aside to show me more white-faced in the trees behind the building. After a few days of staying at our station in Carara National Park it seemed like every study team had seen monkeys in the jungle but ours. I went out with part of the biogeography team yesterday afternoon out of boredom and the desire to see some jungle creatures. We got far enough into the jungle to see a full and digesting bird-eating snake but the ominous thunder forced us out before our equipment got soaked by a tropical downpour (nothing like the rain in Bellingham). I've taken two showers in the rain so far but that's another story. We were no more that 30 feet from the trail exit when Sam called out "hey spider monkeys!" I was ecstatic! There were 4 or 5 skinny-limbed brown monkeys swinging from the trees right above our heads; it was like something off Planet Earth but it was real and right there! I started taking pictures and quickly learned that the flash couldn't reach them so I took a couple of videos of them stretching from tree to tree. I started to follow them down another path when I heard Louis behind me call out "AHH they pooped on me!!" and he came running and gagging with poop on the shoulder of his shirt and on the screen of the YUMA satellite monitor he was trying to take pictures with. "Ohh it smells so bad!" he screamed between gags. He then ran off down the trail to our station for a shower and Sam followed him back to make sure he was ok. I continued to follow the spider monkeys a few more feet down the path until a large stick fell through the trees and vines at an alarming rate, nearly hit my head as I screamed and landed right in front of me. The monkeys were throwing things at me!



BIRDS

Costa Rican Bird List

Compiled list by Kelley Palmer-McCarty in 2011

166 species in 2011

Tinamidae

Little Tinamou
Great Tinamou

Anatidae

Black-bellied Whistling-duck

Cracidae

Black Guan
Crested Guan
Great Curassow

Sulidae

Brown Booby

Pelecanidae

Brown Pelican

Phalacrocoracidae

Neotropic Cormorant

Anhingidae

Anhinga

Fregatidae

Magnificent Frigatebird

Ardeidae

Fasciated Tiger-heron
Bare-throated Tiger-heron
Great Blue Heron
Great Egret
Snowy Egret
Little Blue Heron
Tricolored Heron
Cattle Egret
Green Heron
Yellow-crowned Night-heron
Boat-billed Heron

Threskiornithidae

White Ibis
Roseate Spoonbill

Ciconiidae

Wood Stork

Cathartidae

Black Vulture
Turkey Vulture

Accipitridae

Osprey
Bicolored Hawk
Common Black Hawk
Roadside Hawk
Crane Hawk

Falconidae

Yellow-headed Caracara
Crested Caracara

Rallidae

Gray-necked Wood-rail
White-throated Crake
Purple Gallinule

Aramidae

Limpkin

Scolopacidae

Whimbrel

Columbidae

White-winged Dove
Gray-chested Dove
Mourning Dove
Band-tailed Pigeon
Red-billed Pigeon
Ruddy Ground-dove
Inca Dove
Buff-fronted Quail-dove
White-tipped Dove



Costa Rican Bird List Cont'd

Psittacidae

Crimson-fronted Parakeet
 Mealy Parrot
 White-crowned Parrot
 Orange-chinned Parakeet
 Scarlet Macaw
 Cuculidae
 Groove-billed Ani
 Squirrel Cuckoo

Trochilidae

Rufous-tailed Hummingbird
 Band-tailed Barbthroat
 Scaly-breasted Hummingbird
 Long-billed Hermit
 Stripe-throated Hermit
 White-necked Jacobin
 Violet Sabrewing
 Green Violet-ear
 Purple-throated Mountain-gem
 Green-crowned Brilliant
 Coppery-headed Emerald
 Stripe-tailed Hummingbird
 Long-billed Starthroat

Trogonidae

Slaty-tailed Trogon
 Baird's Trogon
 Violaceous Trogon
 Orange-bellied Trogon
 Black-throated Trogon
 Resplendent Quetzal

Momotidae

Turquoise-browed Motmot
 Blue-crowned Motmot

Alcedinidae

Green Kingfisher
 Amazon Kingfisher

Ramphastidae

Fiery-billed Aracari
 Chestnut-mandibled Toucan
 Prong-billed Barbet

Picidae

Pale-billed Woodpecker
 Hoffmann's Woodpecker

Furnariidae

Plain Xenops
 Streak-headed Woodcreeper
 Spotted Barbtail
 Cocoa Woodcreeper
 Ivory-billed Woodcreeper

Thamnophilidae

Chestnut-backed Antbird
 Black-headed Antshrike
 Dusky Antbird
 Black-hooded Antshrike
 Bicolored Antbird

Formicariidae

Black-faced Antthrush
 Streak-chested Antpitta

Tyrannidae

Tropical Kingbird
 Streaked Flycatcher
 Common Tody-flycatcher
 Great Kiskadee
 White-ringed Flycatcher
 Royal Flycatcher
 Northern Bentbill
 Golden-crowned Spadebill
 Bright-rumped Attila
 Social Flycatcher
 Dark Pewee
 Ochre-bellied Flycatcher
 Yellow-bellied Elaenia
 Dusky-capped Flycatcher

Genera INCERTAE SEDIS

Rufous Piha
 Rose-throated Becard

Cotingidae

Three-wattled Bellbird

Pipridae

Long-tailed Manakin
 Orange-collared Manakin

Vireonidae

Yellow-green Vireo
 Lesser Greenlet
 Tawny-crowned Greenlet

Costa Rican Bird List Cont'd

Corvidae

Brown Jay

Hirundinidae

Mangrove Swallow

Purple Martin

Northern Rough-winged Swallow

Troglodytidae

Black-bellied Wren

Rufous-breasted Wren

Rufous-naped Wren

Riverside Wren

Whistling Wren (*endemic to CR,
in Carara bird book, not in my
field guide*)

Rufous-and-white Wren

Gray-breasted Wood-wren

Sylviidae

Long-billed Gnatwren

Turdidae

Clay-colored Robin

Slaty-backed Nightingale-thrush

Black-faced Solitaire

Parulidae

Yellow Warbler (resident)

Buff-rumped Warbler

Masked Yellowthroat

Tennessee Warbler

Three-striped Warbler

Slate-throated Redstart

Genus INCERTAE SEDIS

Bananaquit

Thraupidae

Blue-gray Tanager

Tawny-crested Tanager

Cherrie's Tanager

Blue-gray Tanager

Palm Tanager

Bay-headed Tanager

Crimson-collared Tanager

Common Bush-tanager

Golden-hooded Tanager

Flame-colored Tanager

Silver-throated Tanager

Green Honeycreeper

Blue Dacnis

Emberizidae

Orange-billed Sparrow

Blue-black Grassquit

Variable Seedeater

White-eared Ground-sparrow

Yellow-faced Grassquit

Black-striped Sparrow

Cardinalidae

Grayish Saltator

Buff-throated Saltator

Icteridae

Great-tailed Grackle

Montezuma Oropendola

Bronzed Cowbird

Melodious Blackbird

Red-winged Blackbird

Yellow-billed Cacique

Other animals

Two-toed Sloth

Variegated Squirrel

Brown Squirrel?

Owl-eyed Butterfly

Eyelash Pit-viper

Salmon-bellied Racer

Ground Anole

Yellow-tailed Gecko

Orange-headed Gecko

Central American Whiptail

Black Iguana

Green Iguana

Green-and-black Poison Dart

Marine Toad

White-faced Capuchin Monkey

Spider Monkey (type?)

Squirrel Monkey

Howler Monkey

Agouti

Coatimundi

Northern Tamandu

Tapir (tracks only)



A New Perspective

By Connor Harron

So many wealthy faces,
Still dominated by gloomy traces,
But laughter and smiles abound,
Smothering those where money rarely comes
round.

Simple pleasures through and through,
No distractions to break the glue.

How do we justify our lives,
If we consume enough to destroy our hive,
But self report,
That we no longer have cohorts.

How do we learn from our mistakes,
And create something beautiful for our children
to take?

Many call our society individually driven,
But the commons only thrive when we have
given,

Our cooperation,
Not corporation.

Altruism is a false label,
Which exhausts motivation before we are able,
To change more than the cable.

However, a new perspective will show,
That our success's are linked more than we know,
So maybe to truly be egoistic,
We need to be more realistic.

Our system is broken,
With so much, our lives are still tokens,
Pawns in a transnational corporate battle,
We need citizens not cattle.

There may not be a simple solution,
But if we focus on a local notion,
A Grameen model for a new revolution,
Support for any creative resolution.

We can work together on these issues daunting,
For we share desires to promote clotting,
Of wounds long unhealed,
A new perspective can bring us together sealed.

In a world so bright,
The darkness is surprisingly tight,
But so quickly can it turn light,
A prism in the night,

Needs but one shaft to arc,
A million separate sparks.



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Naturally, I assume responsibility for any errors or omissions that escaped my attention during the writing, editing and production of this book. Pura vida.

Dedication.

Para mis hermanos Tico (For my Tico brothers) Adrian, Alberto, and Giovanni.



Photo credit Natasha Walker



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