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Promoting community-based bird monitoring in the tropics: Conservation, research, environmental education, capacity-building, and local incomes

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ABSTRACT

Long-term, locally-based biodiversity monitoring programs are essential for understanding and mitigating the effects of global change on tropical biodiversity while providing capacity-building, environmental education, and public outreach. However, these programs are lacking in most tropical countries. Birds are the best-known major group of organism, comprise excellent environmental indicators, are relatively easy to monitor, and are met with enthusiasm and interest by people worldwide. Bird monitoring programs using mist nets and bird banding (ringing) are especially valuable, as these well-established techniques enable the use of capture-mark-recapture (CMR) models to measure population change and other demographic parameters. Equally important for conservation, the ability to capture and release birds makes it possible to provide hands-on ornithological training and educational activities to students, conservationists, villagers, decision-makers, journalists, and other local people. Bird banding programs provide local jobs for research assistants, who often go on to productive careers in conservation, education, research, or ecotourism. Long-term bird banding stations also provide the nuclei, infrastructure, and staff for monitoring, education, and conservation programs focused on other taxa. As successful examples from Costa Rica and Ethiopia show, bird monitoring programs that integrate conservation, ecological research, environmental education, capacity-building, and income generation are cost-effective tools to achieve the goals of community-based biodiversity conservation and poverty reduction in the developing world. Therefore, locally-based and long-term bird monitoring programs should be encouraged, established, and funded throughout the tropics.

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1. Introduction

One of Navjot Sodhi's biggest strengths was his passion to build conservation capacity, to promote environmental education, and to establish locally-based biodiversity research programs in the tropics. He valued tropical conservation education so much that he organized leading conservation scientists to write "*Conservation Biology for All*" (Sodhi and Ehrlich, 2011), the first conservation biology textbook freely available online (http://www.mongabay.com/conservation-biology-for-all.html). Consequently, not only did Navjot have one of the highest-impact publication records in conservation biology, but he also touched the lives of thousands of future conservationists who will keep alive his legacy.

In 2005, I had the good fortune to spend 2 months at the National University of Singapore as a visiting scholar with Navjot, who became a dear friend and collaborator. We talked at length about how to establish and maintain locally-based, long-term tropical biodiversity monitoring programs that not only collect critical conservation ecology data, but also provide environmental education and public outreach, train local people in biodiversity monitoring, build conservation capacity, and develop into self-sustaining centers for biodiversity conservation, research, education, and ecotourism (Sodhi et al., 2010; Bickford et al., in press; Harris et al., 2011). Navjot himself loved to band (ring) birds in threatened tropical landscapes, and a fitting way for the conservation community to honor Navjot's memory will be by promoting long-term, community-based, and integrated biodiversity monitoring programs in the tropics.

2. Monitoring birds for conservation, education, capacity-building, and outreach

The 21st century will be the make-or-break century for the world's biodiversity. Navjot Sodhi understood the critical importance of local education, grassroots organization, and community involvement in biodiversity conservation, especially in developing tropical countries where good opportunities for environmental education are often nonexistent. The sheer magnitude and scope

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of environmental problems (Brook and Bradshaw, in press) can lead conservationists in despair to wish for top-down, large-scale, quick fixes that can actually exacerbate the problems (Sterner et al., 2006) because conservation initiatives that lack local grassroots support and understanding are often doomed from the start. During field work in over 70 countries, mostly in the developing world, I have frequently been surprised at the scarcity of effective, well-funded, and long-term initiatives that integrate conservation, education, research, and capacity-building. As a result, even in many locations with large-scale conservation projects, there is often limited knowledge and appreciation by local people of their local biodiversity and why they should protect it. Many conservation projects do not educate most local people about the value of biodiversity and ecosystem services (Şekercioğlu, 2010; Peh and Lewis, in press). This deficiency of communication, education, and outreach (Bickford et al., in press) often generates local resentment and opposition to initiatives that actually aim to benefit local communities. Biodiversity monitoring programs, especially in the developing world, need to be designed accordingly, and should aim to communicate the passion for biodiversity and its conservation (Bickford et al., in press; Fig. 1).

Birds are the best-known major group of organism, comprise excellent environmental indicators, are relatively easy to monitor, and as charismatic flagship species, are met with excitement, enthusiasm, and interest by people worldwide. Therefore, long-term bird conservation and monitoring initiatives that integrate community involvement, capacity-building, outreach, environmental education, and local job creation provide some of the best examples of holistic biodiversity-monitoring programs (Latta and Faaborg, 2009). This is particularly the case for programs that involve mist netting and bird banding (ringing), the labor-intensive nature of which actually benefits local communities by providing jobs. Bird research assistantships not only provide local employment and income, but local field technicians can also be valuable sources of traditional ecological knowledge (Berkes, 2004), environmental educators, ecotourism guides (Paaby et al., 1991), and important links between their communities and conservation scientists.

For conservation science, the value of such long-term population studies is irreplaceable. Short-term studies provide variable snapshots in time. The ever-changing dynamics of tropical bird populations (e.g. Newmark, 2006; Kennedy et al., 2011; Stouffer et al., 2011) can only be revealed by systematic, long-term studies that should cover at least 3–5 and ideally 10 consecutive years (Faaborg et al., 2007). Despite some limitations (Remsen and Good, 1996), long-term mark-recapture studies make it possible to estimate survivorship, population change, and other critical variables that not only illuminate tropical bird ecology (e.g. Blake and Loiselle, 2002; Peach et al., 2001; Sodhi et al., 2011), but also provide essential data for conserving tropical birds effectively (Newmark, 2006). This is especially the case with climate change, whose effects on tropical birds and ecosystems are increasingly expected to be severe (Şekercioğlu et al., 2008a; Cox, 2010; Møller et al., 2010; Corlett, in press; Wormworth and Şekercioğlu, 2011; Şekercioğlu et al., 2011), but little research has been done on these long-term effects (Sillett et al., 2000; Harris et al., 2011). Long-term biodiversity monitoring programs are also critical to monitor the environmental sustainability of rapidly-expanding tropical plantations (Edwards and Laurance, in press) and to measure the performance of conservation efforts in human-dominated areas against baseline ecosystems far from human impact (Barlow et al., in press).

Equally important for conservation, bird banding programs are vital for capacity-building, education, public outreach, and raising awareness. The hands-on nature of bird banding makes it possible for children, students, decision-makers, journalists, and other local people to observe birds up close, to learn about the conservation challenges birds and other organisms face, and to make concrete, personal connections to the increasingly-abstract concept of biodiversity (Louv, 2008). This connection is best exemplified by the excitement children experience when releasing banded birds (Fig. 1), the memory of which can last a lifetime. Unfortunately, the remarkable and cost-effective potential of bird banding to combine research, conservation, education, public outreach, and income generation has been mostly neglected by the global conservation community and funding agencies (Latta and Faaborg, 2009).

Fig. 1. Ethiopian primary school students releasing a banded Yellow-fronted Tinkerbird (*Pogoniulus chrysoconus*) in Wondo Genet, Ethiopia. Photo: Cagan H. Şekercioğlu.

3. Barriers and challenges

Even conservation projects on tropical-temperate migrants remain mostly focused on the breeding populations in temperate countries where funding and scientists are concentrated (Latta and Faaborg, 2009). There are not enough studies on the wintering grounds (Faaborg et al., 2007), and tropical research, outreach, and capacity-building projects receive limited funding, despite their cost-effectiveness (Castro and Locker 2000 in Latta and Faaborg, 2009). The disproportionate support for migratory bird research also contrasts with the reality that only 18% of the world's bird species are long-distance migrants, whereas 67% are sedentary and mostly tropical (Şekercioğlu, 2007).

In addition to the growing challenges of funding, the increasing difficulty and complexity of obtaining research permits is a growing problem not only for bird banding, but for biodiversity research in general. In fact, in many countries, if not most, it is easier and faster to get a permit to hunt birds than to study them (though some bird species are off-limits to hunting). In an age when young people are increasingly cut off from nature, when "nature deficit disorder" is a worldwide phenomenon (Louv, 2008), and when it is often faster to publish high impact papers by doing mathematical modeling, meta-analyses, reviews, and studies of existing datasets, we should not be increasing the bureaucratic hurdles for scientists and citizen scientists to do essential field work and to conduct biodiversity education and outreach. The growing bureaucracy of getting and renewing research permits can discourage professional and citizen scientists from undertaking bird banding and related field work, and can steer the career choices of young biologists away from field research to office-based research. The permitting agencies, wary about bad publicity, often yield to the demands of well-intentioned but emotional animal rights activists, whose philosophy is largely incompatible with science-based conservation and management of wildlife (The Wildlife Society, 2011). In fact, some activists oppose bird banding while continuing to

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feed feral cats that kill more than half a billion wild birds annually in the United States alone (Woods et al., 2003; Lebbin et al., 2010; Stracey, 2011). Not only are bird banding impacts negligible (Spotswood et al., 2011), but bird banding research is also essential to bird conservation by providing the key demographic data on long-term bird population declines from climate change, habitat loss, introduced species, and other anthropogenic impacts.

As exemplified by the Costa Rican and Ethiopian case studies below, birds have a universal appeal and are excellent environmental indicators. Long-term bird banding programs are ideal for combining community-based conservation, research, education, outreach, and income generation, regardless of the variation among tropical countries in ecology, income, education, awareness, and other socio-economic circumstances.

4. Case study: Population dynamics of Costa Rican birds

In 1999, when I initiated a long-term bird banding program at the Las Cruces Biological Station in southern Costa Rica, I could not imagine that my Ph.D. and postdoc research would grow into one of the biggest tropical bird population studies, with the 60,000 + birds captured and over 450 individuals radio-tracked so far improving our understanding of how tropical forest birds deal with the fragmentation and agricultural conversion of their habitats (Şekercioğlu et al., 2002, 2007, 2008b; Mendenhall et al., 2011). Multi-year, constant-effort banding at 18 sites in six different habitats (8640 net-meter-hours/site/year) ranging from a primary forest reserve to sun coffee plantations revealed long-term population changes, including declines in some forest-dependent species (Şekercioğlu et al., 2008b). This includes some species in the Las Cruces Forest Reserve that initially seemed to be a haven for forest-dependent species based on a short-term banding study (Şekercioğlu et al., 2002). Long-term banding and radio-tracking also showed the critical importance of remnant trees and narrow riparian strips for forest birds trying to survive in a mostly agricultural landscape (Şekercioğlu, 2006; Şekercioğlu et al., 2007), with only a 6% decrease in tree cover in sun coffee plantations spelling the difference between declining versus stable or increasing populations of various bird species (Ç.H. Şekercioğlu, unpublished data).

Even though my initial focus at Las Cruces was purely research-oriented, the routine requests I received from school teachers to bring students to our banding stations and the tremendous excitement I saw in these students led me to make environmental education and public outreach a regular part of my ornithological research. Learning from these teachers that many of their students had given up their slingshots after "feeling the heartbeat of a banded bird" and releasing it back to nature is a prime example of the direct conservation impact of bird banding outreach and education efforts (Fig. 1).

A number of factors make Costa Rica distinctly suitable for integrated, long-term biodiversity conservation, research, and education programs. Having abolished its military in 1949, Costa Rica has invested heavily in education, health care, conservation, and ecotourism. Costa Rica ranks #3 among 163 countries in the global Environmental Performance Index (Yale Center for Environmental Law and Policy, 2010), and the average Costa Rican is well-educated and environmentally aware. Unlike dozens of other tropical countries I worked in, I never had to explain to a Costa Rican the value and significance of our bird conservation research. The response is always positive, there is genuine sympathy towards birds, and the local communities always greet us with enthusiasm and interest. This environmental awareness, combined with Costa Rica's progressive environmental laws, also means that we have been able to conduct long-term, undisturbed research on private lands, whose vegetation cover, on average, remained remarkably stable for more than a decade. Equally important was the logistical support provided by the Las Cruces Biological Research Station of the Organization for Tropical Studies (www.ots.org), underlining the critical role of well-managed tropical research stations for tropical conservation, education, research, outreach, and capacity-building. Even though Las Cruces is a small station and many days I was the only researcher there, the hard-working and friendly staff, excellent logistical support, good local relations, and conditions that are luxurious for a research station enabled us to focus on research and to collect far more data than would have been possible otherwise.

Costa Rica's education level is also reflected in the quality of the research technicians. Almost everyone we worked with was highly literate, enthusiastic, and interested. They learned rapidly, and after one research season, most were able to collect data efficiently and accurately. Combined with their physical stamina and astonishing knowledge of the local landscape, the local farmers, with few exceptions, were better research assistants than most of the undergraduate volunteers from the USA. Some of our local assistants became banders themselves, and some went on to successful careers in education, ecotourism, and research. One of the best examples of the capacity-building value of such a tropical bird banding project is provided by one of our Costa Rican assistants, whose experience in banding and radio-tracking birds with us led her to do a Ph.D. in the USA on the birds of Las Cruces (Ruiz-Gutierrez et al., 2008).

Costa Rica is a special case and Las Cruces is even more so. I have yet to find another tropical human-dominated landscape that combines all the advantages of Las Cruces, and most tropical countries, especially outside Latin America, lag behind Costa Rica in education, environmental awareness, and conservation enforcement. However, this does not mean that long-term biodiversity research and education projects outside Costa Rica are not worthwhile. My long-term experience in Ethiopia has shown that a biodiversity research project that prioritizes local involvement, education, and capacity-building can succeed even in a substantially more impoverished country that ranks #141 in the same Yale Environmental Performance Index (2010).

5. Case study: Ethiopia Bird Education Project (EBEP)

In 2006, I initiated a long-term ornithological research, conservation, education, and capacity-building program in Ethiopia, a unique, highly biodiverse, but little-studied country that hosts many important resting and feeding areas for birds (Edwards, 1996), including millions of birds that migrate across the Sahara Desert. Ethiopia's average income of $934 (GDP per capita based on purchasing power parity) is 1/12th of that in Costa Rica ($11,106; UNESCO, 2009). Literacy rates are 42% and 18% in Ethiopian men and women, respectively, compared to 96% in Costa Rica (UNESCO, 2009). A search for the keywords "Ethiopia*" and "bird*" in the Web of Science reveal only 16 articles focused on the wild birds of Ethiopia since 1930 versus hundreds of studies for Costa Rica. Consequently, an integrated bird conservation, research, education, and outreach program can potentially impact a country like Ethiopia far more than in an ornithology-rich country like Costa Rica.

Nearly 860 bird species are known from Ethiopia, about the same as in Costa Rica. This number is likely to approach 900, as most of the periphery of Ethiopia near Eritrea, Sudan, Kenya, and Somalia is rarely visited by ornithologists or birdwatchers due to remoteness and security problems. These border regions may even contain birds new to science. Currently, about 20 bird species are considered endemic to Ethiopia. Over a dozen species are shared with Eritrea only, and together about 32 species are endemic to the Abyssinian highlands, including globally threatened birds such

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as Harwood's Francolin (*Francolinus harwoodi*), Salvadori's Serin (*Serinus xantholaema*), and Prince Ruspoli's Turaco (*Tauraco ruspolii*).

EBEP exposes students, youth, and other local people to the world of birds, their migrations and conservation. We seek young people passionate about birds, train them in bird research and conservation, work with them as our links to local communities, and prepare them for careers in conservation, ecological research, and ecotourism. Our hands-on ornithological education also enables us to learn from students and other visitors about the local ornithological knowledge. Where possible, we establish our banding sites near schools, and reach as many as 60 students in a day (Figs. 1 and 2). We also work with the local tourism bureaus to train any interested local staff in bird conservation and bird watching, so that they can become birdwatching guides and promote locally-based birding tourism.

Ethiopia's low income levels also mean that one can achieve more with the same budget, reach more people, and provide much-needed environmental education and conservation awareness. Unlike Costa Rica, Ethiopian schools, including most universities, cannot provide their own transport to our bird banding sites, necessitating that we either transport students with our vehicle or establish study sites within walking distance of a school. For example, at our Tukur Waha bird banding station near Lake Awassa, we were able to shuttle interested students and faculty collaborators from the nearby Hawassa University. At Wondo Genet, on the other hand, we found the ideal location at the ecotone between montane forest and a shade coffee plantation that was also on the grounds of the Wondo Genet Forestry Institute and 300 m away from a primary school with 1000 students (Fig. 1). Consequently, every morning we were visited by 20–60 students (Fig. 2), mostly from the primary school but also including undergraduate and M.Sc. students in wildlife biology. One of our Ethiopian field assistants, trained in bird banding and identification, works with students and other station visitors. Birds are banded and measured rapidly by the banding team, and handed over to the educator when appropriate, for example when a bird in excellent condition represents a species not yet seen by the students. Our educator demonstrates the bird to the students, answers their questions, and teaches a different student each time how to properly hold and release a bird (Fig. 1).

As a consequence of our emphasis on both research and education, between 2006 and 2011 not only were we able to collect valuable data on Ethiopian bird communities in a diversity of habitats, including groundwater forest, montane and pre-montane forest, traditional shade coffee plantations, migrant-rich savanna-scrub, and wetlands, but we also exposed more than a thousand primary school students and dozens of undergraduate and graduate students to ornithology (Fig. 2). Some of the latter have joined our team. In fact, one of them became the first Ethiopian to receive a banding license, thanks to a Klamath Bird Observatory internship supported by the US Forest Service International Programs. Now leading her own bird conservation project focused on the critically endangered Ethiopian endemic Liben (Sidamo) Lark (*Heteromirafra sidamoensis*), she is starting a Ph.D. in the UK on the conservation ecology of this species (Abdu, 2011), which, without immediate conservation action, may become the first recorded bird extinction on mainland Africa (Spottiswoode et al., 2009).

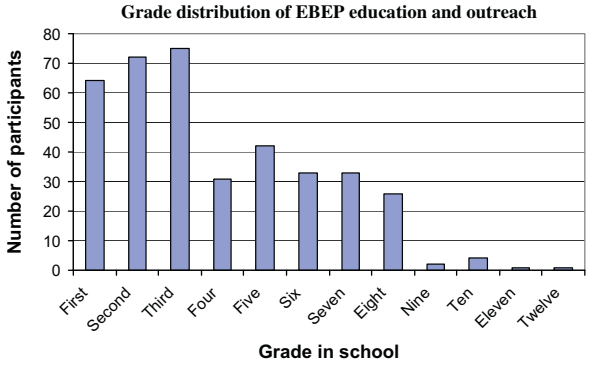

Fig. 2. Number of primary and secondary school students who visited the Wondo Genet bird banding station of EBEP in 2008. The primary school within walking distance was for students in grades 1–8.

6. Conclusion

Long-term, locally-based biodiversity monitoring programs are critical for measuring and arresting the loss of tropical biodiversity, but these programs are greatly lacking in the tropics and the developing world. It is imperative for bird banders, conservationists, ornithologists, and other concerned citizens to constantly communicate to the public and decision-makers the conservation value of bird banding and its negligible impacts to birds (Spotswood et al., 2011), especially in comparison to far bigger sources of mortality and population decline, such as feral cats, window strikes, habitat loss, and climate change (Woods et al., 2003; Lebbin et al., 2010; Stracey, 2011). Bird banding projects are especially valuable for conservation, as they enable scientists to estimate population change and other demographic parameters accurately (e.g. Newmark, 2006; Stouffer et al., 2011), while the ability to capture and release birds makes it possible to provide hands-on ornithological training, capacity building, environmental education, local jobs, and public outreach activities to students, conservationists, villagers, decision-makers, journalists, and other local people (Figs. 1 and 2). Long-term bird banding stations also provide the nuclei, infrastructure, and staff for monitoring, education, and conservation programs focused on other taxa. The costs involved are modest and most of the money is spent locally on salaries, room, board, and services. For example, a 3-month field season with 4–6 local assistants costs ~$40,000 in Costa Rica and ~$20,000 in Ethiopia, including daily 4WD rental and my expenses. In contrast, a US-based scientific consultant charges $75–$300/h (Mascarelli, 2011), plus expenses. Despite tropical biodiversity monitoring programs' cost effectiveness, and their clear benefits for capacity-building, poverty reduction, and biodiversity conservation, maintaining long-term funding for these programs has been extremely challenging (Latta and Faaborg, 2009). For example, the US National Science Foundation (NSF) recognizes the value of scientists reaching broader communities, encourages public outreach activities by scientists, and provides funding for "broader research impacts" in some of its grants. However, the NSF grants are difficult to get for tropical biodiversity monitoring programs and fund a tiny fraction of such programs worldwide.

Major donor organizations, including multilateral organizations (e.g. IUCN, UN, World Bank), major NGOs (e.g. CI, TNC, WCS, WWF), and G20 governments, foundations, research institutions and universities that spend billions of dollars on biodiversity conservation must allocate far more funds for biodiversity monitoring. Locally-based and long-term bird monitoring programs that integrate conservation, ecological research, environmental education, capacity-building, and income generation should be encouraged, established and supported throughout the tropics.

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made my conservation ecology work possible. I thank the universities of Stanford and Utah, the Christensen Fund, National Geographic Society, and Wildlife Conservation Society for their support of my tropical conservation ecology work. I thank Tom Sherry and an anonymous reviewer for their comments. This paper is dedicated to the memory of my dear friend and colleague Navjot S. Sodhi, whose impact on conservation biology will be everlasting.

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