Standing Tall for Giraffes

RESEARCH AND CONSERVATION OF AN OVERLOOKED AFRICAN ICON

By Derek E. Lee, Julian T. Fennessy, and Monica L. Bond

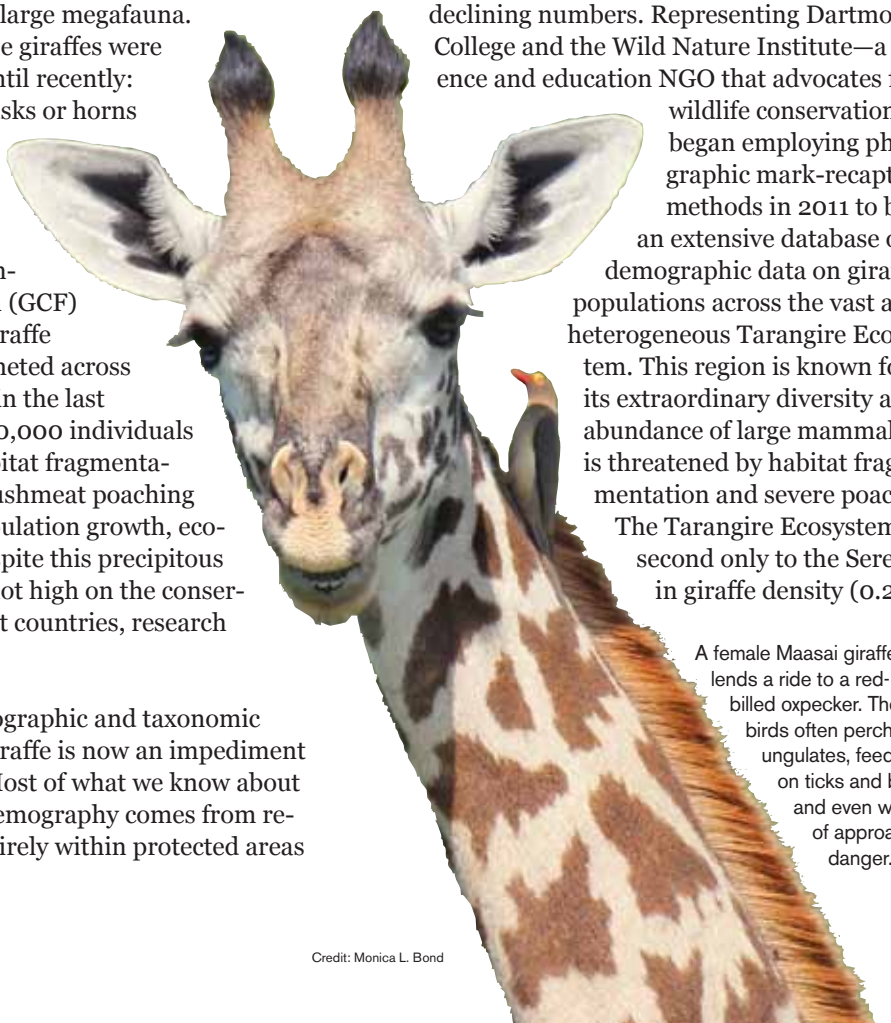
From the shade beneath a flat-topped acacia tree, a tall and elegant Maasai giraffe (*Giraffa camelopardalis tippelskirchi*) serenely chews a wad of cud as she watches our Land Cruiser bump slowly toward her across the savanna. We swing the vehicle around to her right side and stop about 80 meters away to photograph her, record her exact distance with a laser rangefinder, and mark her GPS location. As we drive off, she stares after us, chewing intermittently, but otherwise completely unfazed as we depart with another data point in our growing set of thousands of photographic giraffe "captures" that we are using to investigate the species' demography in the Tarangire Ecosystem of northern Tanzania.

Despite being iconically African, the giraffe remains largely understudied in the wild—unlike most of the continent's other large megafauna. In part, this is because giraffes were not heavily hunted until recently: they don't produce tusks or horns that are coveted as trophies or medicine and they are not an aggressive species. Sadly, the Giraffe Conservation Foundation (GCF) now estimates that giraffe numbers have plummeted across Africa by 40 percent in the last decade to less than 80,000 individuals due to increasing habitat fragmentation and a surge in bushmeat poaching driven by human population growth, economics, and war. Despite this precipitous decline, giraffes are not high on the conservation agenda of most countries, research groups, or NGOs.

The shortage of demographic and taxonomic information on the giraffe is now an impediment to its conservation. Most of what we know about giraffe ecology and demography comes from research conducted entirely within protected areas such as national parks. Meanwhile, most of the giraffe's historical range—which once encompassed all savanna habitat south of the Sahara Desert—is unprotected and increasingly fragmented due to the conversion of savanna ecosystems into farms and permanent settlements to support growing human populations and booming economies. Disconnected giraffe populations are now sprinkled across the African continent, from Niger in the west, through the northern savannas of Central Africa, east into Ethiopia, Kenya, and Tanzania, and down throughout Southern Africa (see map on page 37). Nearly all of these populations are in decline.

On the Trail of Giants

After decades of almost no research on the wild giraffe, wildlife biologists are showing renewed interest in these gentle giants because of recently declining numbers. Representing Dartmouth College and the Wild Nature Institute—a science and education NGO that advocates for wildlife conservation—we began employing photographic mark-recapture methods in 2011 to build an extensive database of demographic data on giraffe populations across the vast and heterogeneous Tarangire Ecosystem. This region is known for its extraordinary diversity and abundance of large mammals but is threatened by habitat fragmentation and severe poaching. The Tarangire Ecosystem is second only to the Serengeti in giraffe density (0.2 and



A female Maasai giraffe lends a ride to a red-billed oxpecker. These birds often perch on ungulates, feeding on ticks and bugs and even warning of approaching danger.

Credit: Monica L. Bond

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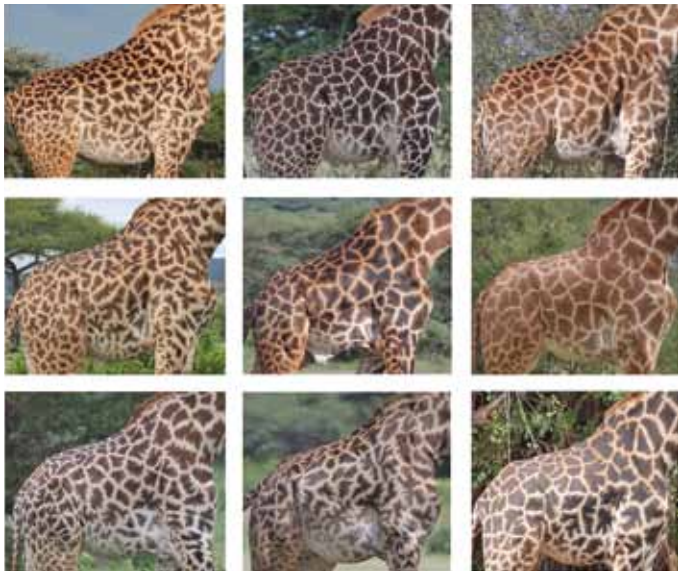
0.32 giraffes per square kilometer, respectively), but unlike the Serengeti, land in the Tarangire Ecosystem is largely unprotected. Hopefully, the new demographic data will allow wildlife managers to pinpoint areas that support high giraffe survival and reproduction, and enable Tanzanian wildlife agencies and lawmakers to protect and connect them.

Demographic studies of species using the photographic mark-recapture method have grown in popularity as digital cameras and pattern-recognition software have improved. Photographic mark-recapture is a non-invasive survey technique that allows scientists to easily identify individuals by differences in their coat patterns, which in giraffes are as unique as human fingerprints. Giraffe population estimates generated from photographic mark-recapture are twice as precise as aerial survey estimates (D. Lee, unpublished data) and individual animals can be tracked over time. Such longitudinal information is immensely valuable to population biologists seeking to understand spatial and temporal factors affecting a species' survival, reproduction, and movements. The method is also much less expensive than physical captures for marking large mammals, so it allows much bigger sample sizes across a much larger area.



Credit: Derek E. Lee

Derek Lee photographs Maasai giraffes at Lake Manyara National Park, Tanzania. Every giraffe has a coat pattern as unique as a human fingerprint. Photos of Maasai giraffes from the Tarangire Ecosystem (above) are fed into Wild-ID, a pattern-matching software program that identifies individuals so they can be tracked without physical capture. The program enables much larger demographic studies than if patterns had be matched by eye.

Credit: Monica L. Bond

The photographic mark-recapture method is now being employed in a large-scale study of Tarangire giraffes. To date, Wild Nature Institute has conducted seven surveys using the method, and four more are planned through the end of 2014. We conduct one-month-long fixed-route transect surveys at the end of the three annual precipitation seasons (short rains, long rains, and dry season). Each survey covers more than 1,700 square kilometers including parts of the Tarangire and Lake Manyara national parks, Manyara Ranch (a private ranch conservancy), and two game-controlled areas containing village wildlife management areas and hunting blocks. During the surveys, we collect thousands of photographs of more than 1,500 known individual giraffes (approximately 65 percent of the total Tarangire Ecosystem population), photographically capturing each individual several times throughout the year in order to monitor their seasonal survival and reproduction as well as their movements throughout the study area.

The data are used to test hypotheses about how factors including sex, age, location, vegetation phenology, predators, and density of giraffe and other ungulate populations affect survival, reproduction, and movement rates. We use a free, pattern-recognition software program called Wild-ID developed at Dartmouth College to match our photographs with those from previous surveys. The program has the lowest pattern identification error rate (less than or equal to 0.007) of any photo-identification system currently available (Bolger et al. 2012). The photographic mark-recapture system easily processes large sample sizes across large geographical areas, making it possible to conduct complex statistical analyses for metapopulation studies that include multiple sites and covariates.

Using these techniques, our research has uncovered evidence for interesting spatial variation in birth rates, death rates, and movement rates of individuals, which may indicate source-sink dynamics in the Tarangire Ecosystem. For example, we found that mean survival rates were positively correlated with giraffe density, but movements tended to be from high survival areas (sources) toward areas of lower survival, where populations may not be self-sustaining (sinks). Preliminary data also show higher calving rates outside of the national parks, but higher adult survival within the parks. These findings emphasize the importance of maintaining and improving connective corridors among all areas that giraffes use. Additional data will help us identify possible reasons for the dynamics we've observed, as well as identify important calving grounds outside parks that may require protection.

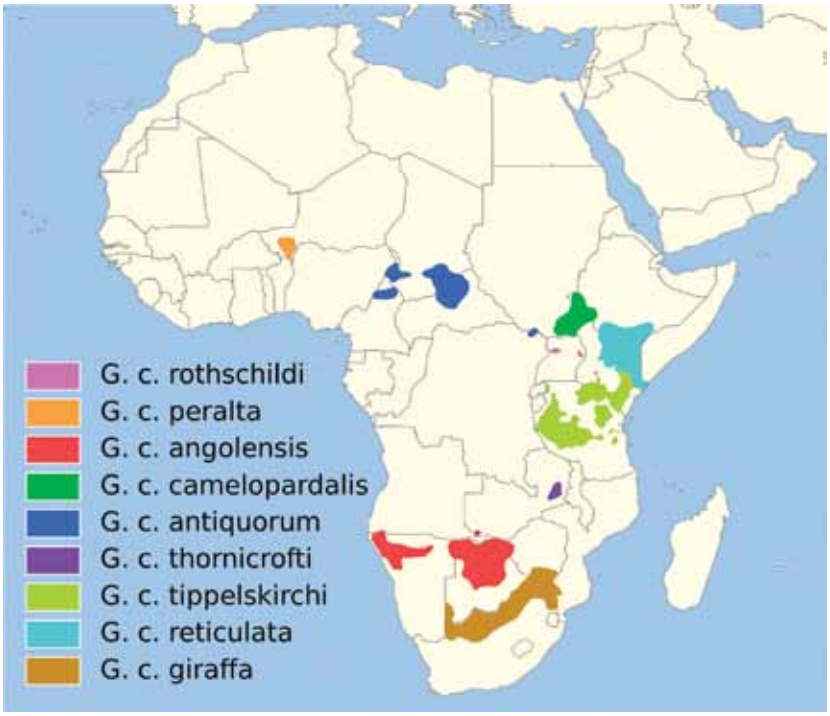
The Taxonomic Puzzle

In addition to demographic research, scientists from GCF and the LOEWE Biodiversity and Climate Research Centre in Germany are working to unravel giraffe taxonomy as a way to inform conservation, management, and policy decisions for giraffe conservation. Giraffe taxonomy has been confusing and sometimes contradictory for more than 100 years as debate has raged over whether populations were members of the same subspecies or hybrids of different subspecies. Historically, nine subspecies within the species *G. camelopardalis* were recognized, but today some researchers have proposed that as many as eight of these should be recognized as distinct species (Brown et al. 2007, Groves and Grubb 2011). Recent efforts using molecular genetics techniques are providing valuable insight into the evolutionary history of the species and may soon settle the debate.

If giraffe subspecies become recognized as separate species, the most at-risk among them could enjoy stronger protections. Currently, the giraffe is designated a species of "least concern" on the International Union for the Conservation of Nature's (IUCN) Red List. Several subspecies are at greater risk than the species as a whole, but it is unusual for subspecies to achieve a higher conservation status than the species itself. In 2008 and 2010, the GCF and the IUCN's Species Survival Committee's (SSC) Antelope Specialist Group's International Giraffe Working Group (now the IUCN SSC Giraffe and Okapi Specialist Group) overcame the odds by getting two giraffe subspecies listed as "endangered"—the West African (*G. c. peralta*) and Rothschild's (*G. c. rothschildi*). It was the end result of enormous effort to gather and analyze demographic data, conduct baseline taxonomic research, and hold discussions with all stakeholders. The government of Niger, home to the West

Credit: Derek E. Lee

Giraffes gather at a watering hole on Manyara Ranch, a private conservancy in northern Tanzania. Nine subspecies of giraffe are scattered throughout Africa (map), two of which–*G. c. rothschildi* and *G. c. peralta*–are declared endangered by the International Union for the Conservation of Nature. Some research suggests that several of the subspecies may actually be distinct species.



Credit: Julian T. Fennessy

Tall Tales

Giraffe Evolution and Ecology

Around eight million years ago, more than 10 genera of the giraffid family roamed throughout Eurasia, and some of these eventually spread into Africa. Fossil records indicate that long-necked species characteristic of the modern giraffe arose five to seven million years ago. Climate and other changes caused the extinction of the Eurasian giraffids, but several African genera survived. About one million years ago, the modern long-necked giraffe (*Giraffa camelopardalis*) arose. Today, it and the much smaller and short-necked okapi (*Okapi johnstoni*) are the only two giraffid species that remain (Mitchell and Skinner 2003).

There is no mistaking a giraffe for any other species. Towering more than five meters high, it is the tallest animal in the world. Their incredible height and a host of other curious physical traits have enabled giraffes to exploit a nearly inaccessible niche. With long legs and a nearly two-meter-long neck, giraffes can feed from the upper canopy of acacia trees, avoiding competition with all other browsers except elephants (Estes 1991).

Possibly as a result of competition with other browsing species, the giraffe evolved cervical (neck) vertebrae that are each more than 28 centimeters long (Cameron and du Toit 2007). These seven vertebrae now make up more than half of the entire length of the spine, in contrast to other large ungulates in which these vertebrae make up one-third of their length (Badlangana et al. 2009).

Height as a Defense

Adult giraffes enjoy relatively little threat from predators because of their size and height. They can also fend off attackers with their dinner-plate-sized hooves (Dagg 1971). Young calves, on the other hand, are more vulnerable to attack by lions and hyenas. Even though giraffes measure 1.8 meters tall at birth and double in height during their first year of life, only an estimated 27 to 42 percent survive that first year (Pellew 1983, Dagg and Foster 1976). Hiding in the undergrowth for the first few weeks of life and growing as quickly as possible are the young giraffe's main strategies to survive. Speed also helps: giraffes can run up to 60 kilometers per hour, and juveniles can run even faster than adults.

In an evolutionary arms race, as acacia trees evolved spines, hooks, and galls to protect their leaves from browsers, giraffes co-evolved the means to get around these defenses (Estes 1991, Kingdon 1997). The giraffe's 50-centimeter-long tongue and upper lip are both prehensile and can grasp and strip leaves off branches or select individual leaflets between sharp thorns. To protect against the thorns, the giraffe's lips, tongue, and inside of the mouth are covered in thick papillae and saliva (Dagg 1971).

Credit: Doug Bolger

Researchers Monica Bond, Tom Morrison, and Derek Lee (left to right) hold up the skull and neck vertebrae of an adult male Maasai giraffe that appeared to die of natural causes in the Mtowambu Game Controlled Area of northern Tanzania. Giraffes have seven cervival vertebrae, the same number as humans.

The giraffe's distinctive brown-and-white coat pattern helps scientists identify individuals in demography studies. One study suggests that the patterns may also provide some camouflage in the dappled sunlight of savanna woodlands (du Toit 2001). Individuals of a subspecies share certain coat-pattern characteristics. For example, the Rothschild's giraffe (*G. c. rothschildi*) has the fewest spots (usually none) below its knees, while the dark spots of the reticulated giraffe (*G. c. reticulata*) are separated by the narrowest white stripes.

The unique, elongated neck and limbs of a giraffe come with certain physiological difficulties, for which the animal has evolved some remarkable adaptations. A giraffe's blood pressure, for example, is twice that of a typical large mammal, an adaptation that maintains blood flow to the brain against gravity. When the giraffe lowers its head to drink, a complex net-like pressure-regulation system in the upper neck called the "rete mirabile" regulates blood flow to the brain and prevents loss of consciousness (Dagg 1971, du Toit 2001). In order to prevent edema in the long legs, a tight sheath of thick skin covers their lower limbs like a sock.

The giraffe has long fascinated humans around the world, but its future is threatened. Hopefully, through research and targeted conservation efforts, our grandchildren will have the opportunity to witness the magnificence of a wild giraffe.

– By Monica L. Bond

Credit: Derek E. Lee

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An adult male Maasai giraffe wanders through the savanna feeding on acacia trees in Tarangire National Park. The park supports the second-largest giraffe density in Tanzania after the Serengeti. Giraffes have evolved to feed from the tops of trees, inaccessible to most other browsing animals. All giraffes have two horn-like structures called ossicones, but males also grow knobby protruberances along the bridge of their nose (visible at right) that may be used during fights for dominance.

African subspecies, has now produced the first-ever national giraffe conservation strategy for the country. A conservation strategy for Kenya, which is home to some Rothschild's giraffe populations, is in process. Other countries will hopefully follow suit as more results and findings come to the fore.

If taxonomic research concludes that giraffes are indeed one species, the challenges facing different subspecies may continue to be masked. However, even as a single species, giraffes are obviously in trouble. In comparison with another charismatic mega-herbivore, the 450,000 remaining African elephants vastly outnumber the 80,000 remaining giraffes (Blanc et al. 2007). And yet, the elephant's Red List designation as "vulnerable" garners it massive global attention while giraffe research and conservation remain underfunded and unknown.

Much remains to be done to safeguard a future for wild giraffes in Africa. Our limited knowledge regarding the current status of the species and its various subspecies poses a threat to their long-term sustainability. To strengthen efforts towards fundamental research, the IUCN SSC formed the Giraffe and Okapi Specialist Group in March 2013, which is co-chaired by Julian Fennessy of the GCF and Noelle Kumpel with the Zoological Society of London. The group aims to attract international support for the giraffe and okapi by improving knowledge of the species' distribution, abundance, ecology, habitats, and the threat posed by hunting and human conflict, and by assessing connectivity and relatedness of populations and the importance of habitat fragmentation. Another goal is to provide an official forum to support implementation of much-needed conservation strategies across the African continent by providing advice on conservation issues of giraffe and okapi to interested parties, including international bodies such as CITES, African governments, and management authorities.

At the continental level, GCF's Africa-wide assessment project works to evaluate the status of all giraffe populations and subspecies throughout Africa in order to inform giraffe conservation and management. The GCF collaborates with African governments, NGOs, universities, and researchers to gather demographic data across the species' range. The project's end goal is to publish a comprehensive analysis of census and anecdotal data on the giraffe including individual country profiles, conservation recommendations, and recommendations for future research. It is time to stand tall for giraffe conservation—as we have for elephants—and save a symbol of wild Africa. ■

This article has been reviewed by subject-matter experts.

Watch a video about Wild Nature Institute's research and conservation efforts for the Maasai Giraffe at http://www.wildnatureinstitute.org/giraffe.html. And visit www.giraffeconservation.org for more information about the Giraffe Conservation Foundation.