The Fate of Wild Tigers

ERIC DINERSTEIN, COLBY LOUCKS, ERIC WIKRAMANAYAKE, JOSHUA GINSBERG, ERIC SANDERSON, JOHN SEIDENSTICKER, JESSICA FORREST, GOSIA BRYJA, ANDREA HEYDLAUFF, SYBILLE KLENZENDORF, PETER LEIMGRUBER, JUDY MILLS, TIMOTHY G. O'BRIEN, MAHENDRA SHRESTHA, ROSS SIMONS, AND MELISSA SONGER

Wild tigers are in a precarious state. Habitat loss and intense poaching of tigers and their prey, coupled with inadequate government efforts to maintain tiger populations, have resulted in a dramatic range contraction in tiger populations. Tigers now occupy 7 percent of their historical range, and in the past decade, the area occupied by tigers has decreased by as much as 41 percent, according to some estimates. If tigers are to survive into the next century, all of the governments throughout the species' range must demonstrate greater resolve and lasting commitments to conserve tigers and their habitats, as well as to stop all trade in tiger products from wild and captive-bred sources. Where national governments, supported in part by NGOs (nongovernmental organizations), make a consistent and substantial commitment to tiger conservation, tigers do recover. We urge leaders of tiger-range countries to support and help stage a regional tiger summit for establishing collaborative conservation efforts to ensure that tigers and their habitats are protected in perpetuity.

Keywords: tigers, Asia, conservation, habitat, illegal wildlife trade

In less than a century, Asia's largest predator, the tiger (*Panthera tigris*), has been relegated to isolated populations residing in only a small fraction of the animals' historical range, an expanse that once stretched from the Caspian Sea to the island of Bali in Indonesia (figure 1; Seidensticker et al. 1999). Tigers have gone extinct at the extreme ends of their distribution—notably, the Caspian region and the islands of Java and Bali—and are probably extirpated in southern China (Tilson et al. 2004). Loss of habitat and the persistent killing of tigers and tiger prey precipitated these extirpations, a process that continues to leave forests devoid of tigers and other large mammals across South and Southeast Asia. The trend has been uneven, however, with recovery often contingent on the consistency of efforts by both national governments and conservation organizations to conserve tiger habitat and stop trade in tiger parts for medicine, clothing, and decoration.

The warning signs of the tiger's decline are ominous. India, widely considered the stronghold for wild tigers, suffered a shock in 2005 when it was found that intense poaching had eliminated all tigers from what had been considered well-protected sanctuaries, such as the Sariska Tiger Reserve, and had depleted populations in other tiger sanctuaries, such as Ranthambore and Bandhavgarh. The gravity of these losses triggered a loud public outcry that led to a federal investigation initiated by India's prime minister (Project Tiger 2005). In China, the reopening of the trade in tiger parts from animals harvested from "tiger farms" could lead to even greater pressures on wild populations: The body parts of wild tigers are likely to be "laundered" and entered into the government-sanctioned trade, because killing wild tigers is far cheaper than farming them (Bulte and Damania 2005), and because many Chinese who have faith in traditional medicine believe that bones from wild tigers offer a better analgesic effect than do bones from farmed tigers (Ellis 2005). As a consequence of this double jeopardy—the threats of range contraction and a potential reopening of the trade in tiger parts and derivatives—the need for renewed attention to the fate of wild tigers is most urgent.

In a previous study, we estimated the current area that tigers in the wild occupy and compared that figure to occupancy estimates from 10 and 100 years ago (Wikramanayake et al. 1999, Sanderson et al. 2006). We found that the area of tiger occupancy had dropped dramatically from the level estimated just over a decade ago. Here we identify several of

Eric Dinerstein (e-mail: eric.dinerstein@wwfus.org), Colby Loucks, Eric Wikramanayake, and Sybille Klenzendorf work at the World Wildlife Fund, Washington, DC 20037. Joshua Ginsberg, Eric Sanderson, Jessica Forrest, Gosia Bryja, Andrea Heydlauff, and Timothy G. O'Brien are with the Wildlife Conservation Society, Bronx, NY 10460. John Seidensticker works at the Smithsonian National Zoological Park, Washington, DC 20008; Peter Leimgruber and Melissa Songer work at the Smithsonian National Zoological Park, Conservation and Research Center, Front Royal, VA 22630. Judy Mills and Mahendra Shrestha are with the National Fish and Wildlife Foundation–Save the Tiger Fund, Washington, DC 20036. Ross Simons works at Simons and Associates, Alexandria, VA 22302. *© 2007 American Institute of Biological Sciences.*

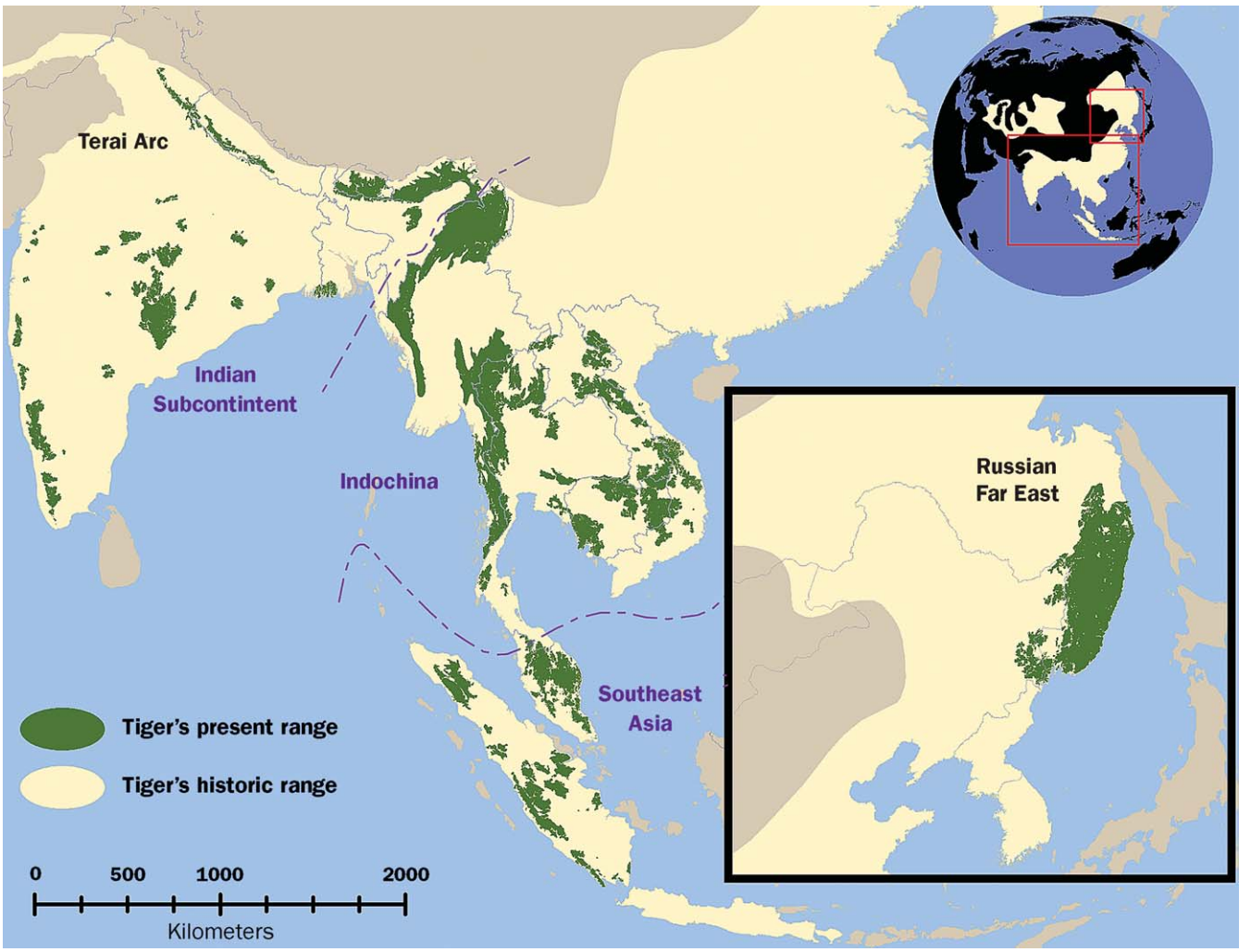

Figure 1. Historic (circa 1850) and present distribution of tigers. Tigers became extinct on the island of Bali in the 1940s and on Java in the 1980s. They once inhabited portions of central Asia around the Caspian Sea (see inset globe) but were extirpated in the 1970s.

the major causes of decline, and recommend a series of on-the-ground efforts and policy recommendations to halt and eventually reverse an ongoing range collapse.

Detecting and measuring range collapse

Our analysis synthesizes a unique data set, beginning with the best land-cover data available, by expanding on Leimgruber and colleagues' (2005) analysis for part of the tiger's range. To that analysis, we added more than 2700 tiger point locations collected by more than 85 researchers over the past 10 years. Tiger dispersal and potential occupancy of isolated fragments were determined using techniques adapted from Wikramanayake and colleagues (2004) for India and Nepal's Terai-Arc Landscape (TAL) and for the Russian Far East (RFE) (Carroll and Miquelle 2006). To identify the extent of potential tiger habitat, we combined these data layers with assessments of the threats that human influence poses (including the human footprint calculated by Sanderson and colleagues [2002]) for the usable habitat of the species. To detect changes in the extent of tiger occurrence, we compared the resulting synthesis with Wikramanayake and colleagues' (1999) earlier analysis of rangewide tiger habitat, which was based on the most widely used spatial data set available at the time (i.e., MacKinnon [1997]). We relied on Nowell and Jackson (1996) for the comparison of current estimates with the tiger's historic range. A full account of the methods and data used to recalculate occupancy can be found in Sanderson and colleagues (2006) and online at *www.savethetigerfund.org/Content/NavigationMenu2/Initiatives/TCL/FullReports/default.htm.*

Our analysis indicates that the current tiger range represents a mere 7 percent of the historic range (figure 1). Furthermore, within the past decade alone, the estimated area known to be occupied by tigers has declined 41 percent. Such a large range contraction in such a relatively short time signals a significant collapse that must be arrested, and efforts toward range recovery—leading ultimately to sustainable tiger populations—must be initiated. These data assess habitat loss rather than population status, which is the information most often sought about tigers. However, tigers are

solitary, territorial animals (Sunquist 1981, Miquelle et al. 1999), and habitat contraction should be a strong indicator of population declines. Further elaboration of regional and national losses in tiger occupancy and full results of the 10-year assessment can be found in Sanderson and colleagues (2006). In the following sections, we focus on the policy implications of this sharp decline and how to reverse it.

Causes of the decline

Tiger populations continue to decline, despite significant regional and international support for conservation of this iconic species. For example, NGOs (nongovernmental organizations)spent more than US$31 million globally for tiger protection from 1998 to 2003 (Christie 2006).

One explanation for the recent rapid decline is that Asian countries' growing affluence has allowed more consumers to purchase products made with tiger parts. China banned domestic trade in tiger products in 1993, which caused most law-abiding practitioners of traditional Chinese medicines worldwide to give up the use of tiger products. However, tiger-bone wines and other self-prescribed health tonics containing tiger parts remain popular among certain segments of the public at large. Despite widespread trade bans, these medicines are still coveted by enough consumers in China, Japan, South Korea, Vietnam, parts of Southeast Asia, and even the United States to pose a grave threat to wild tigers. In Tibet, members of the emerging affluent middle class have begun to adorn their traditional robes with the skins of tigers, leopards, snow leopards, and otters—a practice traditionally restricted to royalty—thus increasing the demand for these products. Tiger skins and parts, and other endangered wildlife, can easily be found for sale in the pan-Tibetan region of China and India. Meanwhile, national law enforcement efforts are insufficient, and cross-border smuggling continues nearly unabated in the absence of international enforcement operations (EIA 2004, Ellis 2005).

Most range states have legislation in place to protect tigers from poachers. Unfortunately, the lack of resources for enforcement and the dearth of functioning antipoaching information networks result in inadequate patrolling, and have hampered protection efforts. Poachers and their buyers are seldom brought to justice and convicted, and when they are, their sentences are unlikely to deter future poaching and smuggling: They serve little or no jail time, and any fines they pay are low.

Continued habitat loss and fragmentation is another major cause for the decline. Many of the remaining habitat fragments are too small, isolated, or degraded to hold viable populations of tigers and their prey (Smith et al. 1999, Kinnaird et al. 2003, Lynam et al. 2006). The trajectory of habitat loss and fragmentation has continued over the last decade; in Sumatra, for example, vast oil palm and acacia plantations are replacing some of the richest lowland rainforests on Earth (Holmes 2002). This threat is not likely to abate: In Indochina, a proposed system of transnational economic corridors would inevitably result in further fragmentation of the remaining habitat and preclude dispersal of wildlife species (ADB 2005), thereby compromising the viability of resident tiger populations.

Successes and cause for optimism

Despite the overall trend, several success stories offer examples that, if replicated, could spark a rangewide recovery. The most promising recovery efforts cover the spectrum, from one of the most fragmented parts of the tiger's range to the most intact.

One example comes from the TAL, which spans the base of the Himalayan foothills in northwestern India and southern Nepal (figure 1). Here, conservationists in both the public and the private sector are working to restore, reconnect, and manage wildlife corridors to link 12 important wildlife reserves and national parks that harbor wild tigers across the 49,000-square-kilometer (km^2) landscape (Wikramanayake et al. 2004). The goal of this project is to manage tigers as a single metapopulation in which dispersal between core refuges can help maintain genetic, demographic, and ecological integrity.

The TAL has benefited from scientific and financial assistance from governments and from nongovernmental sources. From 2000 to 2002, NGO investments in tigers and related conservation projects in the Terai Arc were just under US$1.4 million, at an average cost of just over US$25 per km^2 (table 1; Christie 2006). These NGO investments include the nongovernmental costs of supporting park management, antipoaching efforts, monitoring, research, and habitat restoration. However, the average annual amount invested by NGOs per km^2 is just one-tenth the annual investment the Nepalese government earmarked for conservation of this region in 2004 (table 1; GoN 2006). The long-term impacts of these efforts for tigers, while encouraging, have yet to be assessed, and in particular, the monitoring of tiger populations needs to be systematically undertaken.

Another emerging success story is in the RFE, where conservation efforts have led to a recovery of tigers in what is by far the most intact and extensive tiger landscape in the species' entire range (Miquelle et al. 1999, Sanderson et al. 2006). In the 50 years after World War II, the tiger population in the RFE increased from an estimated 40 to more than 400 (Miquelle et al. 2005). Over the last decade, the numbers have remained stable, or even increased slightly, despite fairly extensive poaching of tigers and the proximity of the RFE to wildlife markets in East Asia (Kerley et al. 2002).

Between 1998 and 2002, NGOs spent an average of just over US$1.5 million per year on tiger conservation in the RFE for activities ranging from support to park management, antipoaching measures, tiger–human conflict resolution, law enforcement, training of park and enforcement staff, and education and awareness programs. Although this may seem a large sum, the unit cost for this 270,000-km^2 region is less than US$6 per km^2 (table 2). During 2005, the Russian government allocation to the RFE was US$2,040,000, which includes funds to federal nature reserves, provincial wildlife

reserves, state wildlife rangers, and the Academy of Sciences. On average, this government allocation to the RFE adds about US$8 per km^2. Thus, the total NGO and governmental budget to achieve successful tiger conservation in the RFE is about US$14 per km^2.

A comparison of these successes with the situation in some of the 28 tiger reserves of India demonstrates that money is not the limiting factor in successful conservation. Under the flagship Project Tiger program, Indian tiger reserves, which cover about 37,700 km^2 in 17 states, received a budget allocation of US$17.75 million from the central government during the ninth five-year plan (1997 to 2002; Gupta 2005, Project Tiger 2005). The unit cost of US$94 per km^2 per year provided by the government is much higher than the unit cost for the RFE but less than the Nepalese government's expenditure on the TAL, although the TAL occupies a much smaller area. Yet despite these allocations and additional support from NGOs based in India, tiger populations have seen drastic declines, primarily because of mismanagement of available funds and, consequently, inadequate protection (Thapar 1999, Gupta 2005). Most of the monies allocated for conservation by the central government apparently do not percolate to the field, and the little that does reach the field is misspent (Gupta 2005). As a result, the reserves are, in aggregate, poorly managed and protected.

Tiger conservation cannot be achieved with the mere allocation of money. Instead, a genuine commitment to conservation by the government—including the proper channeling and spending of funds, with oversight and follow-up—is essential to meet goals. The success of the TAL in Nepal rests in being incorporated into the government's recent Five-Year Development Plan, which makes the TAL a conservation priority, ensures oversight by a steering committee, and combines multisector and bilateral donors as partners working toward common goals. In October 2006, the government of Nepal created a separate office within the Department of Forests to oversee implementation of the TAL (Anil Manandhar, WWF Nepal, Kathmandu, Nepal, personal communication, 22 November 2006). In Nepal, tiger conservation combines financial commitments with action and oversight by the governmental and nongovernmental sectors. The rapid decline of tigers in India, along with the persistent poaching of tigers and their prey in the RFE, underscores the fact that only high-level political will on the part of tiger-range countries and countries that permit traffic in tiger parts will stop the continued downward spiral of wild tiger populations in many areas.

An agenda for recovery: Successful models

As territorial top carnivores, tigers require large spaces (Miquelle et al. 1999, Carbone et al. 2001, Karanth et al. 2004). Many of the current protected areas are too small to harbor ecologically, demographically, and genetically viable populations of tigers over the long term (Woodroffe and Ginsberg 1998, Carroll and Miquelle 2006). In response, biologists have created conservation landscapes where protected areas that harbor tiger subpopulations are linked by dispersal corridors, enabling the subpopulations to be managed as metapopulations. Although knowledge of tigers' persistence outside protected areas is inadequate, such corridors could potentially permit behavioral and ecological traits such as juvenile dispersal from natal areas, and allow genetic exchange and maintenance of social structures to persist. These landscapes often cross political boundaries, reflecting the transboundary nature of tiger habitat requirements.

Long-term conservation of tigers and other large wildlife species in Asia will depend on careful land-use planning and zoning of large conservation landscapes to include areas for human use, core habitat, wildlife corridors, and buffer zones (Dinerstein et al. 1999). Enlisting the support and cooperation of local people by providing greater economic incentives and opportunities for political empowerment, and by invoking cultural values that favor attachments to wildlife, will be imperative. Furthermore, trade in tiger products must be further reduced through law enforcement and through efforts to focus the attention of affluent consumers on the crisis facing tiger populations. At the top of this pyramid of com-

Table 1. Tiger investment summary for the Terai Arc Landscape (comprising five tiger conservation landscapes).

Year	Total investment (US$)	Investment (US$) per km^2
NGOs		
2000	509,927	27.61
2001	375,544	20.33
2002	503,310	27.25
Average	462,927	25.06
Nepal government[a]		
2004	2,750,000	240.00

km, kilometer; NGO, nongovernmental organization.
a. Includes only the Nepalese area of tiger conservation landscapes.

Table 2. Tiger investment summary for the Russian Far East (comprising one tiger conservation landscape).

Year	Total investment (US$)	Investment (US$) per km^2
NGOs		
1998	1,656,530	6.14
1999	1,810,606	6.71
2000	1,269,821	4.70
2001	1,145,777	4.24
2002	1,723,754	6.38
Average	1,521,298	5.63
Russian government[a]		
2005	2,040,000	8.50

km, kilometer; NGO, nongovernmental organization.
a. Includes only the Russian area of tiger conservation landscape.

mitment and action must be far-sighted government leadership that is capable of envisioning a system that balances conservation, economic priorities, and development goals.

Projects such as the TAL demonstrate that human communities can coexist with some intact core tiger habitats, a situation that once prevailed in the wildland–village interface of rural Asia. Under this program in Nepal, the local people have been granted stewardship of critical areas within the corridors, notably in areas where local forestry user groups implement community forestry programs to restore habitat between disjunct core areas to increase the dispersal potential of tigers and other wildlife. Within just five years, tigers have begun to use five of the six corridors being restored. These corridors also provide vital forest resources and products on which many local villagers still depend, and maintain the ecological integrity of the watersheds, providing water for consumption and agriculture. In this sense, the tigers would serve as a proxy for intact, healthy ecosystem services of direct and indirect benefit to local people.

In some areas, tourism based on tigers and other wildlife conveys significant economic benefits to local communities. For instance, a project to restore degraded forests in Chitwan National Park in Nepal—an important protected area within the TAL—now brings user groups about US$350,000 annually as part of a 50 percent share of park revenues (Santosh Nepal, WWF Nepal, Kathmandu, Nepal, personal communication, 25 November 2006). Tourism may not be viable across all landscapes, but other mechanisms to finance conservation of tigers and other megafauna can be explored, such as payments for environmental services and even direct payments for supporting focal species conservation for tigers and other megafauna, awarded to local communities in accordance with contracts established with conservation NGOs. Carbon credit trading is another way that governments and local communities can preserve forested areas while earning vital income.

Emerging threats

Just as there is cause for optimism, there are also clear warning signs of a new and pervasive threat returning to undermine *in situ* conservation efforts. Even though the current international and domestic bans on trade in tiger products have helped Russia's tiger population to recover and other wild tiger populations to persist (just as the ban on elephant ivory triggered a comeback in wild elephant populations; Stiles 2004), some government entities and the private sector continue to lobby the Chinese government to allow legal trade in tiger parts.

The pressure to open the trade is mounting. More than 4000 tigers now live on farms in mainland China, and plans are in place to make use of tiger parts harvested from those animals. No existing technique permits biologists or law enforcement officials to distinguish farmed tiger parts from those taken from wild tigers, allowing poached tigers to be sold through even a limited system of legal trade. As mentioned earlier, parts from wild tigers are thought by many consumers to be more potent than those of captive-raised tigers.

The operating assumption of tiger farming proponents (Mitra 2006) is that the farms will supply all of the demand for tiger products at an affordable price. In truth, the economics are not on the side of tiger farming. Raising a farmed tiger to maturity is 250 times as expensive as poaching a wild tiger in India. Therefore, tigers poached from the wild would be a cheap supplement to legal sources (Bulte and Damania 2005), unless, of course, wild tigers go extinct.

More important, reopening any trade in tiger products from any source is sure to ignite consumer interest among more than a billion consumers in countries enjoying some of the fastest economic growth in the world. Wild tigers are clearly too vulnerable to risk any reopening of China's domestic trade in tiger products. Ultimately, China, the range state that probably has the fewest wild tigers, may pose the greatest threat to the tiger's ultimate survival in the wild (Sanderson et al. 2006).

The need for regional cooperation

The trade in tiger parts often transcends national boundaries, as do the drivers of habitat loss. International links require international action and regional cooperation. Thus, to address these overarching threats, we propose that a global forum of range-state leaders at the highest level convene a "tiger summit" aimed at securing a global pledge to protect the wild heritage of Asia. The ASEAN (Association of Southeast Asian Nations) or SAARC (South Asian Association for Regional Cooperation) summit might be an appropriate forum for such meetings, since these two summits draw together most regional governments, along with observers from the United States and the European Union. To be effective, the tiger summit must have the participation of appropriate decision-makers, policymakers, and law enforcement professionals.

Almost four decades ago, at the 1969 IUCN General Assembly, Indira Gandhi, then prime minister of India, boldly proclaimed that her government would save the tiger, which was on the brink of extinction in India and elsewhere. Efforts toward that goal led to a dramatic recovery of India's tigers—for a while. Unfortunately, over time, governmental inefficiency at implementing this landmark program and lack of enforcement have returned India's tigers to the brink of extirpation (Johnsingh and Goyal 2005). Thus, a reaffirmation of this pledge for conservation is urgently needed by all of Asia's leaders if the region's symbol of power is to be saved.

Other examples of regional cooperation exist on which to model the tiger summit. Perhaps the most successful has been the Yaoundé Summit, held in Yaoundé, Cameroon, in 1999, where the heads of state from six central African nations pledged to dedicate at least 10 percent of each nation's forests to a regional network of national and transborder reserves (Kamdem-Toham et al. 2003).

Tigers also need leading public figures to advocate for their conservation. Recent statements by Tibetan leaders condemning the use of tiger skins resulted in many Tibetans

laying down their tiger skins and tiger-trimmed *chubas,* proving how iconic personalities can influence conservation through simple actions. Other religious and civil leaders must join in urging national, regional, and local governments and their populations to make a direct and concerted effort to save the tiger. We suggest that each range state name a "tiger ambassador," selected from among individuals widely perceived as credible, to be a strong and forceful advocate to the nation's citizens and to the highest levels of national government for the protection of tiger lands, the prevention of tiger poaching, and nationwide abstinence from the use of products containing tiger parts. These ambassadors will be similar to the high-profile spokespersons for children's issues from UNICEF (the United Nations Children's Fund), a program that has enjoyed great success over the years.

The tiger summit must serve to reinforce national and international bans on trade in tiger parts. Range states should pledge resources to (a) intensify on-the-ground protection of tigers and their prey; (b) prosecute tiger poachers, break up poaching rings, and mete out stiff penalties for those who kill tigers; (c) finance a range of economic incentives to encourage tiger conservation through community forestry programs, local management schemes, and direct payments to local committees for tiger conservation; (d) integrate tiger conservation programs into regional and national development programs and trade agreements; (e) develop metrics for success and encourage transparency in how program funds are actually spent; and (f) encourage public relations campaigns to promote tiger conservation at all levels, beginning with the Green Olympics in China in the summer of 2008.

Conclusions

While the tiger as a wild species will most likely not go extinct within the next half-century, its current trajectory is catastrophic. If this trend continues, the current range will shrink even further, and wild populations will disappear from many more places, or dwindle to the point of "ecological extinction," in which their numbers are too few to play their role as top predator in the ecosystem (Soulé et al. 2005). Leaving room for wide-ranging mammals such as tigers is vital and must become part of an effort to incorporate wildlife conservation into national and regional development agendas.

Much has changed since conservationists first made plans to save wild tigers. Then the dialogue was between a few dedicated scientists, conservationists, and national park officials on a country-by-country basis. Over the decades, we have realized that this problem is transnational and that science, economics, culture, public policy, and international dialogue all bear on preserving the tiger and its habitat. Conserving tigers, tiger habitat, and the natural capital they encompass must be part of the calculus that will continue to fuel Asia's growing prosperity.

Acknowledgments

We would like to thank the many people and organizations who contributed to this work by providing data, ideas, and information. Thanks go to Yuri Darman, Taylor Ricketts, and three anonymous reviewers, who provided valuable comments on early versions of the manuscript.

We dedicate this paper to our friends and colleagues, Mingma Norbu Sherpa, Chandra Gurung, Harka Gurung, Tirtha Man Maskey, Narayan Poudel, Yeshi Choden Lama, Jennifer Headley, Jill Bowling Schlaepfer, and Matthew Preece, who died in a helicopter crash in the Kangchenjunga Conservation Area in Nepal on 23 September 2006. They were deeply committed to conservation of the biodiversity in the eastern Himalayas and played key roles in the success of the Terai Arc Landscape. We are grateful for their spirit and direction.

References cited

[ADB] Asian Development Bank. 2005. Greater Mekong Subregion (GMS) Biodiversity Conservation Corridors Initiative: Strategic Approaches and Priorities. Manila (Philippines): ADB. Regional Technical Assistance 6213.

Bulte EH, Damania R. 2005. An economic assessment of wildlife farming and conservation. Conservation Biology 19: 1222–1233.

Carbone C, et al. 2001. The use of photographic rates to estimate densities of tigers and other cryptic mammals. Animal Conservation 4: 75–79.

Carroll C, Miquelle DG. 2006. Spatial viability analysis of Amur tiger *Panthera tigris altaica* in the Russian Far East: The role of protected areas and landscape matrix in population persistence. Journal of Applied Ecology 43: 1056–1068.

Christie S. 2006. NGO investment in tiger conservation units, 1998–2003. Pages 116–119 in Sanderson E, et al., eds. Setting Priorities for the Conservation and Recovery of Wild Tigers: 2005–2015. The Technical Assessment. Washington (DC): WC S, WWF, Smithsonian, and NFWF-STF.

Dinerstein E, Rijal A, Bookbinder M, Kattel B, Rajuria A. 1999. Tigers as neighbours: Efforts to promote local guardianship of endangered species in lowland Nepal. Pages 316–333 in Seidensticker J, Christie S, Jackson P, eds. Riding the Tiger: Tiger Conservation in Human-dominated Landscapes. Cambridge (United Kingdom): Cambridge University Press.

[EIA] Environmental Investigation Agency. 2004. The Tiger Skin Trail. London: EIA.

Ellis R. 2005. Tiger Bone and Rhino Horn: The Destruction of Wildlife for Traditional Chinese Medicine. Washington (DC): Island Press.

[GoN] Government of Nepal. 2006. Terai Arc Landscape Implementation Plan. Kathmandu (Nepal): Ministry of Forests and Soil Conservation.

Gupta R. 2005. The Sariska scam. Down to Earth 13 (20). (15 April 2007; *www.downtoearth.org.in/cover.asp?foldername=20050315&filename=anal&sid=3&page=5&sec_id=7&p=1*)

Holmes D. 2002. The predicted extinction of lowland forests in Indonesia. Pages 7–9 in Wikramanayake E, Dinerstein E, Loucks C, Olson D, Morrison J, Lamoreux J, McKnight M, Hedao P, eds. Terrestrial Ecoregions of the Indo-Pacific: A Conservation Assessment. Washington (DC): Island Press.

Johnsingh AJT, Goyal SP. 2005. Tiger conservation in India: The past, present and the future. Indian Forester 131: 1279–1296.

Kamdem-Toham A, Adeleke AW, Burgess ND, Carroll R, D'Amico J, Dinerstein E, Olson DM, Some L. 2003. Forest conservation in the Congo Basin. Science 299: 346.

Karanth KU, Nichols JD, Kumar NS, Link WA, Hines JE. 2004. Tigers and their prey: Predicting carnivore densities from prey abundance. Proceedings of the National Academy of Sciences 101: 4854–4858.

Kerley LL, Goodrich JM, Miquelle DG, Smirnov EN, Quigley HB, Hornocker MG. 2002. Effects of roads and human disturbance on Amur tigers. Conservation Biology 16: 97–108.

Kinnaird MG, Sanderson EW, O'Brien TG, Wibisono HT, Woolmer G. 2003. Deforestation trends in a tropical landscape and implications for endangered large mammals. Conservation Biology 17: 245–257.

Leimgruber P, Kelly DS, Steininger MK, Brunner J, Muller T, Songer M. 2005. Forest cover change patterns in Myanmar (Burma) 1990–2000. Environmental Conservation 32: 356–364.

Lynam AJ, Khaing ST, Zaw KM. 2006. Developing a national tiger action plan for the Union of Myanmar. Environmental Management 37: 30–39.

MacKinnon J, ed. 1997. Protected Areas Systems Review of the Indo–Malayan Realm. Canterbury (United Kingdom): Asian Bureau for Conservation.

Miquelle DG, Smirnov EN, Merrill TW, Myslenkov E, Quigley HB, Hornocker MG, Schleyer B. 1999. Hierarchical spatial analysis of Amur tiger relationships to habitat and prey. Pages 71–99 in Seidensticker J, Christie S, Jackson P, eds. Riding the Tiger: Tiger Conservation in Human-dominated Landscapes. Cambridge (United Kingdom): Cambridge University Press.

Miquelle DG, Stephens PA, Smirnov EN, Goodrich JM, Zaumyslova OY, Myslenkov AE. 2005. Tigers and wolves in the Russian Far East: Competitive exclusion, functional redundancy and conservation implications. Pages 179–207 in Ray JC, Berger J, Redford KH, Steneck R, eds. Large Carnivores and the Conservation of Biodiversity. Washington (DC): Island Press.

Mitra B. 2006. Sell the tiger to save it. New York Times. 15 August, p. A19.

Nowell K, Jackson P, eds. 1996. Wild Cats: Status Survey and Conservation Action Plan. Gland (Switzerland): IUCN.

Project Tiger. 2005. Joining the Dots: The Report of the Tiger Task Force. New Delhi (India): Government of India, Union Ministry of Environment and Forests.

Sanderson EW, Jaiteh M, Levy MA, Redford KH, Wannebo AV, Woolmer G. 2002. The human footprint and the last of the wild. BioScience 52: 891–904.

Sanderson E, et al. 2006. Setting Priorities for the Conservation and Recovery of Wild Tigers: 2005–2015. The Technical Assessment. Washington (DC): WCS, WWF, Smithsonian, NFWF-STF.

Seidensticker J, Christie S, Jackson P. 1999. Preface. Pages xv–xix in Seidensticker J, Christie S, Jackson P, eds. Riding the Tiger: Tiger Conservation in Human-dominated Landscapes. Cambridge (United Kingdom): Cambridge University Press.

Smith JLD, Tunhikorn S, Tanhan S, Simcharoen S, Kanchanasaka B. 1999. Metapopulation structure of tigers in Thailand. Pages 166–175 in Seidensticker J, Christie S, Jackson P, eds. Riding the Tiger: Tiger Conservation in Human-dominated Landscapes. Cambridge (United Kingdom): Cambridge University Press.

Soulé ME, Estes JA, Miller B, Honnold DL. 2005. Strongly interacting species: Conservation policy, management, and ethics. BioScience 55: 168–176.

Stiles D. 2004. The ivory trade and elephant conservation. Environmental Conservation 31: 309–321.

Sunquist ME. 1981. The social origination of tigers (*Panthera tigris*) in Royal Chitwan National Park, Nepal. Smithsonian Contributions to Zoology 336: 1–98.

Thapar V. 1999. The tragedy of the Indian tiger: Starting from scratch. Pages 296–305 in Seidensticker J, Christie S, Jackson P, eds. Riding the Tiger: Tiger Conservation in Human-dominated Landscapes. Cambridge (United Kingdom): Cambridge University Press.

Tilson R, Defu H, Muntifering J, Nyhus PJ. 2004. Dramatic decline of wild South China tigers *Panthera tigris amoyensis:* Field survey of priority tiger reserves. Oryx 38: 40–47.

Wikramanayake ED, et al. 1999. Where can tigers live in the future? A framework for identifying high-priority areas for the conservation of tigers in the wild. Pages 255–272 in Seidensticker J, Christie S, Jackson P, eds. Riding the Tiger: Tiger Conservation in Human-dominated Landscapes. Cambridge (United Kingdom): Cambridge University Press.

Wikramanayake E, McKnight M, Dinerstein E, Joshi A, Gurung B, Smith D. 2004. Designing a conservation landscape for tigers in human-dominated environments. Conservation Biology 18: 839–844.

Woodroffe R, Ginsberg J. 1998. Edge effects and the extinction of populations inside protected areas. Science 280: 2126–2128.

doi:10.1641/B570608
Include this information when citing this material.