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## Characterizing human-tiger conflict in Sumatra, Indonesia: implications for conservation

Philip J. Nyhus and Ronald Tilson

**Abstract** Human-tiger conflict occurs in Indonesia but there is little recent information about the scope of the problem, and adequate policies are not in place to address the conflict. Published and unpublished reports of conflict between Sumatran tigers *Panthera tigris sumatrae*, people and their livestock were collected and analysed to characterize the extent, distribution and impact of human-tiger conflict on the island of Sumatra, Indonesia. Reportedly, between 1978 and 1997, tigers killed 146 people and injured 30, and killed at least 870 livestock. Conflict was less common in protected areas and more common in inter-

mediate disturbance areas such as multiple-use forests where tigers and people coexist. In Indonesia there is a need to develop a definition of problem tigers, a database to track conflicts, and a process to respond immediately to conflicts when they occur. Without a better understanding of human-tiger conflict and a concerted effort to proactively address the problem, future landscape-level tiger conservation and management efforts may be jeopardized.

**Keywords** Human-wildlife conflict, Indonesia, *Panthera tigris sumatrae*, Sumatra, tiger.

### Introduction

During the 20th century the number of tigers *Panthera tigris* surviving in the wild declined dramatically throughout Asia (Nowell & Jackson, 1996; Seidensticker *et al.*, 1999). The four main reasons for this decline are: (1) reduced, degraded and fragmented habitat, (2) diminished prey populations, (3) killing of animals for the illegal trade in tiger parts (Dinerstein *et al.*, 1997; Seidensticker, 1997; Hemley & Mills, 1999; Karanth & Stith, 1999), and (4) persecution by humans in response to real or perceived livestock predation and attacks on people (McDougal, 1987; Nowell & Jackson, 1996; Tilson *et al.*, 2000).

Across much of the tiger's range there is considerable information about the magnitude of human-tiger conflict (McDougal, 1987; Chakrabarti, 1992; Nowell & Jackson, 1996; Helalsiddiqui, 1998). The reasons why conflict occurs and where, and more importantly the long-term conservation implications of this conflict, are less clear and vary from country to country. Conflict with people and their livestock is a significant source of mortality for large carnivores and there is an urgent need to characterize

and develop measures to reduce these conflicts (Nowell & Jackson, 1996; Woodroffe & Ginsberg, 1998; Linnell, 1999).

The need to characterize, monitor and reduce human-tiger conflict is particularly relevant for the *c.* 500 remaining wild Sumatran tigers *Panthera tigris sumatrae* on Sumatra, Indonesia (Tilson *et al.*, 1994). Tigers were once found across most of the island, but today there are relatively few forest patches capable of maintaining viable tiger populations (FWI/GFW, 2002) and much of this habitat is surrounded by a growing human population (Tilson *et al.*, 2001; Linkie *et al.*, 2003). The recent and dramatic deterioration of many of Sumatra's remaining protected areas and forest habitats (Holmes, 2002) presents immeasurable risks to remaining tiger populations.

Little is known about contemporary human-tiger conflict in Sumatra because systematic records are not regularly maintained by government authorities, and what information is available is not accessible in a centralized database. To date there has been no summary of the scattered literature and reports that are available. In the last 50 years the Bali tiger *P. t. balica* and the Javan tiger *P.t. sondaica* have become extinct (Seidensticker, 1987). Human-tiger conflict contributed to the decline and extinction of these two tiger subspecies (Hoogerwerf, 1970; Seidensticker, 1987) and the historical decline of the Sumatran tiger (Boomgaard, 2001). The development of landscape-level conservation initiatives to link protected area networks through corridors and multiple-use buffer areas (Noss & Harris, 1986; Dinerstein *et al.*, 1997; Simberloff *et al.*, 1999)

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may be critical to the survival of these large carnivores but may also increase the risk of conflict with people. In this paper we use 20 years of data to characterize the extent, distribution, and impact of human-tiger conflict in Sumatra. By characterizing contemporary patterns of human-tiger conflict we may be better able to understand the tiger's future conservation needs.

## Methods

During 1995–1997 we methodically searched for Indonesian- and English-language sources concerning human-tiger conflict in Sumatra over the period 1978–1997. We uncovered 89 media reports (all but one in Indonesian), three government reports, one journal article and three reports from non-governmental organizations that identified specific incidents of human-tiger conflict. These data were augmented by >100 informal interviews with government officials, our field experiences in Sumatra and first-hand experiences with human-tiger conflict over a 3-year period (Tilson *et al.*, 1997; Tilson & Nyhus, 1998). While it is likely that additional incidents for the same time period may be uncovered, these data provide a valuable index of the degree of human-tiger conflict (McDougal, 1987).

Cases were coded into categories for location of attacks, information on the human and livestock victims and details about the tigers and the events that followed attacks. To identify the habitat and disturbance patterns in the areas where people were attacked by tigers we first categorized 57 cases that provided information about habitat into three groups: firstly, low disturbance, described as primary, unlogged forest; secondly, intermediate disturbance, described as isolated agricultural or forest use; thirdly, high disturbance, described as logged, degraded, or heavily used. We then independently categorized 66 cases that provided information about the location of attacks into four broad groups: villages, agricultural areas, forest edges, and primarily forested areas.

## Results

### Characteristics of conflict

Over the 20-year period 146 people were reportedly killed and 30 injured by wild tigers in Sumatra (Fig. 1). We recorded 136 fatalities in specific years during this time period and 10 fatalities that reportedly occurred during the late 1980s and early 1990s but were not attributable to a single year. Divided into 5-year intervals, average annual fatalities ranged from 16 in the period 1978–82 to two in 1988–92. Four of the 10 undated fatalities occurred in 1978–82. Fatal attacks were reported in all eight provinces (Fig. 2).

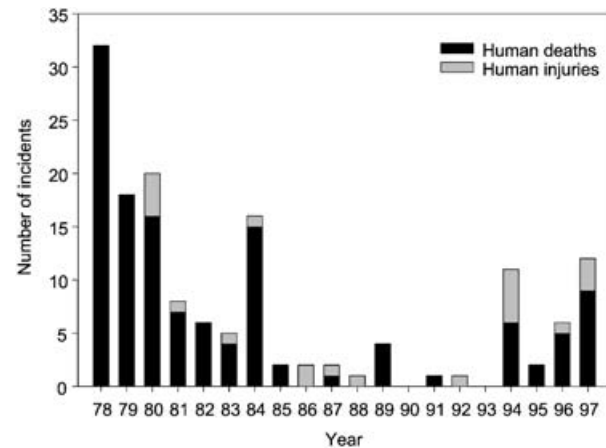


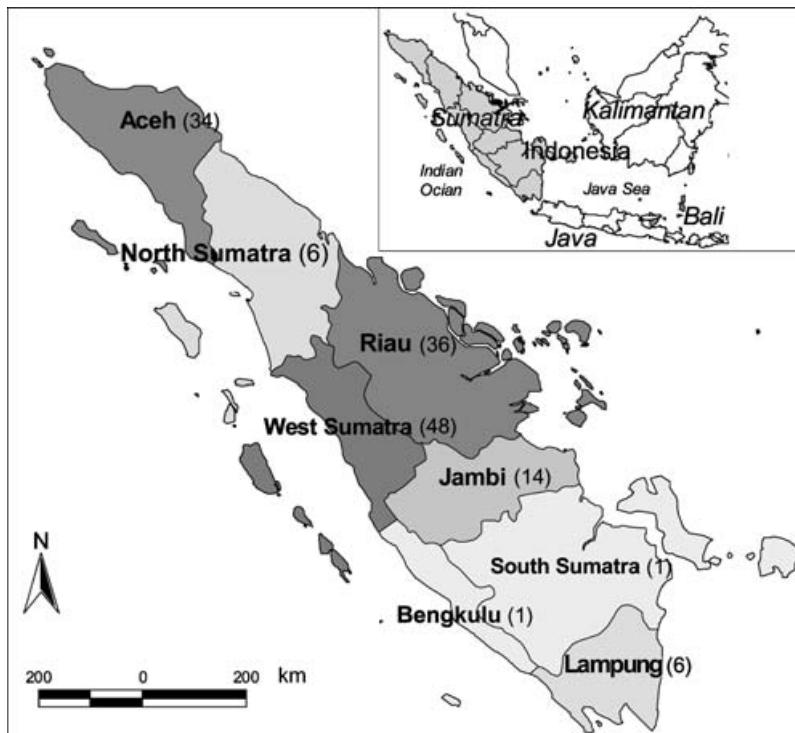
Fig. 1 Number of people reported killed or injured by tigers in Sumatra from 1978 to 1997 (see text for details).

The 'typical' victim was a middle-aged male working during the daytime in his fields near the forest edge. In the 58 cases where age was noted, victims ranged from 6 to 70 years, with a mean age of 37. The majority of attacks occurred while victims worked in their fields or in the forest (Table 1). Four times as many tiger attacks reportedly occurred during daylight than at night. The coding schemes used to categorize habitat and location of attacks (Table 1) provided slightly different outcomes, but the trends were the same: more attacks occurred in intermediate disturbance habitat near the forest edge.

A minimum of 870 livestock were reportedly killed by tigers from 1978 to 1997 (Table 2). Additional reports described livestock losses but used non-quantitative terms such as 'many' or 'frequent' and thus were not considered here. Reported losses peaked in the mid-1980s, but these probably represent only a fraction of livestock losses because isolated attacks are often not sufficiently newsworthy to warrant much attention unless they are linked to attacks on humans.

### Characteristics of tigers

Little information was available about the characteristics of tigers involved in attacks. Almost all attacks were attributed to single tigers. In 15 incidents where more than one tiger was reportedly involved, four included descriptions of groups of four or more, four described groups of three (a tigress and two cubs), and seven described at least two. Out of 11 cases where the estimated age of tigers was reported, seven (64%) were described as young or cubs and four (36%) were described as old. Out of 15 cases where the sex of tigers was noted when the animals were captured or killed, 11 (73%) were reportedly males and four (27%) were females.



**Fig. 2** Political divisions of Sumatra and number of recorded fatal tiger attacks per province from 1978 to 1997. Darker shading corresponds to more attacks.

### Responses to tiger attacks

In 28 cases suspected problem tigers were poisoned or shot. In 20 cases, trapping with a cage (*perangkap*) and/or snare (*jerat*), sometimes with the help of local *pawang harimau* (traditional tiger charmers), were used to capture tigers alive. Military, police and/or conservation authorities were typically involved in live captures. We found at least 265 accounts of tigers killed for profit, retaliation or by accident, and a further 97 were reported captured.

### Discussion

Our use of secondary and historical sources precludes some analyses but nevertheless provides an overview of major patterns of contemporary human-tiger conflict in Sumatra. Based on our sources, the majority of human-tiger interactions in Sumatra can be categorized into three broad scenarios. In the first scenario, tigers and humans overlap little suggesting a low probability of conflict. This scenario represents a 'hard edge' boundary where tigers do not or are unable to leave the forest, and access to the forest by humans is restricted. For example, in Way Kambas National Park tigers rarely leave the park and human-tiger conflict is rare (Tilson & Nyhus, 1998). According to villagers interviewed in 20 village meetings near the park, between 1953 and 1996 only six people were reportedly killed by tigers (one in 1954,

two in 1960 and one each in 1961, 1962 and 1995). Only one fatal tiger attack has occurred in the park in the last 20 years, even though tigers are relatively abundant (at least 4.9 tigers per 100 km<sup>2</sup>; Franklin *et al.*, 1999) and the Park is surrounded by 27 villages with >90,000 people within 2 km and c. 500,000 people within 10 km of the park (Nyhus *et al.*, 1999). People and tigers are separated by rivers along more than two-thirds of the boundary, and forestry guards discourage illegal human activity within the park. A unique combination of physical and biological buffers discourage tigers from leaving the park: tiger prey are abundant within the core area (Franklin *et al.*, 1999) and *Imperata cylindrica* grassland and scrub forest extends in some locations 2–10 km into the park from its boundary. Livestock regularly graze at the forest edge and are abundant in many villages, where they are not attacked. In Bukit Barisan Selatan National Park, Kinnaird *et al.* (2003) found that tigers avoided forest boundaries with high levels of disturbance up to 2 km from the forest edge.

In the second scenario, people have access to forest resources but habitat quality is sufficient to maintain a moderate tiger population. As a result, coexistence of tigers and people is high within part of the forest and the probability of conflict is therefore higher. This situation represents protection forests (*hutan lindung*) where protection is low, agroforestry areas, and multiple-use forests where prey and people can be abundant. We witnessed several cases of human-tiger conflict in protection forests

**Table 1** Numbers and characteristics of attacks by tigers on people in Sumatra during the period 1978–1997.

Category	Victims	
	N	%
Gender		
Male	62	87.0
Female	9	13.0
Total	71	100
Victim's activity		
Working in fields	34	51.5
In forest	22	33.3
Near homes	6	9.1
On roads	4	6.1
Total	66	100
Time of attack		
Morning	10	27.8
Midday	11	30.6
Late afternoon	8	22.2
Night	7	19.4
Total	36	100
Habitat type		
<sup>1</sup> Low disturbance	13	22.8
<sup>2</sup> Intermediate disturbance	29	50.9
<sup>3</sup> High disturbance	15	26.3
Total	57	100
Location of attack		
Villages	4	6.0
Agricultural fields <sup>4</sup>	17	25.8
Forest edge	31	47.0
Primarily forested areas	14	21.2
Total	66	100

<sup>1</sup>Low disturbance described as primary, unlogged forest (e.g. *hutan primer, rimba, utuh, perawan*).

<sup>2</sup>Intermediate disturbance described as isolated agricultural or forest use.

<sup>3</sup>High disturbance described as logged, degraded or heavily used (e.g. *telah dibuka atau dirambah, sedang dibuka, reboisasi, semak belukar*).

<sup>4</sup>Agricultural fields typically described as *ladang*.

(Tilson & Nyhus, 1998), where logging generally occurred within the last quarter of a century, scattered smallholder cultivation was common, and natural forest regeneration and government reforestation efforts had until recently improved habitat quality in those areas.

**Table 2** Numbers and characteristics of animals attacked by tigers in Sumatra during the period 1978–1997.

Animal	N	%
Livestock (general)	392	43.8
Goats	354	39.6
Cows and water buffalo	95	10.6
Dogs	27	3.0
Horses	27	3.0
Total	895	100

In the third scenario, isolated human settlements are surrounded by extensive tiger habitat. This case represents a situation such as the creation of a village in the middle of a forest with a large tiger population. The rapid creation of transmigration settlements, roads and plantations in primary forests in the late 1970s and early 1980s across much of Sumatra (Whitten, 1987; Collins *et al.*, 1991), and the resulting high number of incidents of human-tiger conflict may in part be explained by these events. The three provinces with the most fatal attacks, West Sumatra, Riau, and Aceh (Fig. 2), also had the most remaining forest cover of any provinces in Sumatra in 1997 (46.8, 52.5 and 63.7%, respectively) and three of the lowest deforestation rates from 1985–1997 (FWI/GFW, 2002; Holmes, 2002). Alternatively, given the large number of tigers killed for the illegal trade in tiger in recent decades (Mills & Jackson, 1994), a decline in tiger populations resulting from illegal poaching and forest loss might have contributed to the lower rate of human-tiger conflict in later years.

The probability of human-tiger conflicts appears to be highest in 'soft' or 'diffuse' edge areas where tigers and humans most overlap, and lowest when there is little overlap, either due to a small number of tigers or 'hard' edges that encourage spatial separation of tigers and people. Similar carnivore-human conflict patterns have been identified elsewhere. In 19th century Sumatra high conflict commonly occurred in regions where human populations densities were low (Boomgaard, 2001). A global study evaluating 10 species of large carnivores, including tigers, identified conflict with people on reserve borders as the most significant cause of carnivore mortality (Woodroffe & Ginsberg, 1998). In the Sundarban mangrove forests of Bangladesh and India, home to some of the highest levels of human-tiger conflict in the world, human and tiger populations share the same habitat and resources (Siddiqi & Choudhury, 1987; Chakrabarti, 1992).

Beyond the social crisis caused by human-tiger conflict is the unquantified biological impact on wild populations. Illegal killing of tigers as retribution for attacks on people, livestock or just for profit can have significant demographic impacts on small populations (Seal *et al.*, 1994; Kenney *et al.*, 1995). In Sumatra limited data about the extent of these killings confound efforts to model and monitor the impact on isolated metapopulations. Initial estimates of tiger mortality by Tilson *et al.* (1994) probably underestimated the total killed (Plowden & Bowles, 1997; Tilson *et al.*, 2001), suggesting a need for further research to better estimate illegal harvesting rates.

Proactive steps to address human-tiger conflict need to be implemented as part of Indonesia's wider tiger conservation efforts (Tilson & Nyhus, 1998; Tilson *et al.*, 2000). Firstly, a legal definition of a 'problem tiger' and a formal policy to guide responses to different types of human-tiger



interactions is needed. A problem tiger protocol and decision tree would help to address differences between isolated incidents and repeated incidents involving the harassment, injury and killing of people and their livestock, differences in the location of these incidents (e.g. inside or outside national parks), or the type of animals involved (e.g. dogs, goats or chickens). Secondly, a systematic process is needed to enable villagers to report and government officials to verify and respond to reports of tiger conflicts. Rigorous, scientifically-based fact finding following reported tiger conflicts would ensure accurate documentation to reduce the risk of false reports (Mishra, 1997). To date much accessible information comes from the media and second-hand sources. A database would enable the Directorate-General of Forest Protection and Nature Conservation and collaborating conservation organizations to track the number, location and type of human-tiger conflicts across Sumatra and facilitate efforts to distribute resources and respond appropriately when conflict occurs. Such a database could identify the location and geographic coordinates of the incidents, relevant dates, habitat type, details about the victims (age, sex, activity) and the tiger or tigers (age, sex, obvious health problems or injuries), and details about what happened after these attacks (e.g. how the animal was killed, captured, or translocated). This information would also provide the foundation for predictive spatial modelling to identify potential high risk areas. Thirdly, there is a need to continue developing mechanisms to respond rapidly to tiger attacks. The government's 1994 *Sumatran Tiger Conservation Strategy* (PHPA, 1994) calls for the development of teams to rapidly respond to and mediate conflicts, obtain accurate and timely information, engender greater support of people living near tiger protected areas, and if necessary to remove the tigers to captive breeding programmes or to euthanize them. Several tiger range states have attempted programmes to compensate farmers who lose livestock to tigers, with various levels of success (Karanth & Madhusudan, 2002). If carried out effectively, compensation can shift economic responsibility for carnivore conservation away from farmers towards supporters of carnivore conservation (Nyhus *et al.*, 2003).

Coexistence of tigers and people will require conservation authorities to control hunting and poisoning of tigers and their prey in the primary tiger conservation areas of Sumatra, reduce further fragmentation and disturbance of tiger habitat, and separate tigers and people as much as possible. Karanth & Madhusudan (2002) argue that proactively separating humans and wildlife may be an effective strategy to reduce conflict in circumstances where alternative land and positive incentives are available. Translocation of villagers out of Way Kambas National Park ultimately contributed to the creation of

the park's 'hard' edge and its low levels of tiger conflict, and separation of tigers and people probably resulted in reduced conflict in areas of Sumatra a century ago (Boomgaard, 2001). Efforts should be made to identify other tiger habitat where incentives (rather than coercion) could be used to encourage spatial separation. Educating forest-edge villagers about methods to reduce the risk of conflict (e.g. reducing hunting pressure on tiger prey species and better livestock husbandry practices) and better intelligence about and control of illegal wildlife forest resource extraction are also needed. Where appropriate, local knowledge could inform practices to reduce conflict.

A framework for priority tiger conservation areas in Sumatra has been identified (Dinerstein *et al.*, 1997). However, the successful implementation of this scheme faces tremendous obstacles, including the realities of rapid land use change, human population growth, and economic and political volatility (Tilson *et al.*, 2001). Those priority tiger conservation areas with 'soft' edges and overlap of tigers and people are likely to be future locations for conflict. Thus adequate attention to understanding risks of conflict, methods to minimize conflict and processes to address conflict when it occurs is paramount if future landscape-level conservation plans are to succeed.

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### References

- Boomgaard, P. (2001) *Frontiers of Fear: Tigers and People in the Malay World, 1600–1950*. Yale University Press, New Haven, USA.
- Chakrabarti, K. (1992) *Man-eating Tigers*. Darbari Prokashan, Calcutta, India.

- Collins, N.M., Sayer, J.A. & Whitmore, T.C. (eds) (1991) *The Conservation Atlas of Tropical Forests: Asia and the Pacific*. Macmillan, London, UK.
- Dinerstein, E., Wikramanayake, E., Robinson, J., Karanth, U., Rabinowitz, A., Olson, D., Mathew, T., Hedao, P., Connor, M., Hemley, G. & Bolze, D. (1997) *A Framework for Identifying High Priority Areas and Actions for the Conservation of Tigers in the Wild*. WWF-US and Wildlife Conservation Society, Washington, DC, USA.
- Franklin, N., Bastoni, Sriyanto, Dwiatmo, S., Manansang, J. & Tilson, R. (1999) Last of the Indonesian tigers: a cause for optimism? In *Riding the Tiger: Tiger Conservation in Human-dominated Landscapes* (eds J. Seidensticker, S. Christie & P. Jackson), pp. 130–147. Cambridge University Press, Cambridge, UK.
- FWI/GFW (2002) *The State of the Forest: Indonesia*. Forest Watch Indonesia and Global Forest Watch USA, Bogor, Indonesia and Washington, DC, USA.
- Helalsiddiqui, A.S.M. (1998) Present status of wildlife, human casualties by tiger, and wildlife conservation in the Sundarbans of Bangladesh. *Tigerpaper*, **25**, 28–32.
- Hemley, G. & Mills, J.A. (1999) The beginning of the end of tigers in trade? In *Riding the Tiger: Tiger Conservation in Human-dominated Landscapes* (eds J. Seidensticker, S. Christie & P. Jackson), pp. 217–229. Cambridge University Press, Cambridge, UK.
- Holmes, D. (2002) *Indonesia: Where Have All the Forests Gone?* The World Bank, Washington, DC, USA.
- Hoogerwerf, A. (1970) *Ujung Kulon: The Land of the Last Javan Rhinoceros*. E.J. Brill, Leiden, The Netherlands.
- Karanth, K.U. & Madhusudan, M.D. (2002) Mitigating human-wildlife conflicts in Southern Asia. In *Making Parks Work: Strategies for Protecting Tropical Nature* (eds J. Terborgh, C. van Schaik, L. Davenport & M. Rao), pp. 250–264. Island Press, Covelo, USA.
- Karanth, K.U. & Stith, B.M. (1999) Prey depletion as a critical determinant of tiger populations. In *Riding the Tiger: Tiger Conservation in Human-dominated Landscapes* (eds J. Seidensticker, S. Christie & P. Jackson), pp. 104–113. Cambridge University Press, Cambridge, UK.
- Kenney, J.S., Smith, J.L.D., Starfield, A.M. & McDougal, C.W. (1995) The long-term effects of tiger poaching on population viability. *Conservation Biology*, **9**, 1127–1133.
- Kinnaird, M.F., Sanderson, E.W., O'Brien, T.G., Wibisono, H.T. & Woolmer, G. (2003) Deforestation Trends in a Tropical Landscape and Implications for Endangered Large Mammals. *Conservation Biology*, **17**, 245–257.
- Linkie, M., Martyr, D.J., Holden, J., Yanuar, A., Hartana, A.T., Sugardjito, J. & Leader-Williams, N. (2003) Habitat destruction and poaching threaten the Sumatran tiger in Kerinci Seblat National Park, Sumatra. *Oryx*, **37**, 41–48.
- Linnell, J.D. (1999) Large carnivores that kill livestock: Do “problem individuals” really exist? *Wildlife Society Bulletin*, **27**, 698–705.
- McDougal, C. (1987) The man-eating tiger in geographic and historical perspective. In *Tigers of the World: The Biology, Biopolitics, Management, and Conservation of an Endangered Species* (eds R.L. Tilson & U.S. Seal), pp. 435–448. Noyes Publications, Park Ridge, USA.
- Mills, J.A. & Jackson, P.A. (1994) *Killed for a Cure: A Review of the Worldwide Trade in Tiger Bone*. TRAFFIC International, Cambridge, UK.
- Mishra, C. (1997) Livestock depredation by large carnivores in the India trans-Himalaya: conflict perceptions and conservation prospects. *Environmental Conservation*, **24**, 338–343.
- Noss, R.F. & Harris, L.D. (1986) Nodes, networks, and MUMs: Preserving diversity at all scales. *Environmental Management*, **10**, 299–309.
- Nowell, K. & Jackson, P. (eds) (1996) *Wild Cats: Status Survey and Conservation Action Plan*. IUCN, Gland, Switzerland.
- Nyhus, P., Sumianto & Tilson, R. (1999) The tiger human dimension in southeast Sumatra, Indonesia. In *Riding the Tiger: Tiger Conservation in Human-dominated Landscapes* (eds J. Seidensticker, S. Christie & P. Jackson), pp. 144–145. Cambridge University Press, Cambridge, UK.
- Nyhus, P.J., Fisher, H., Madden, F. & Osofsky, S. (2003) Taking the bite out of wildlife damage: the challenges of wildlife compensation schemes. *Conservation in Practice*, **4**, 39–41.
- PHPA (1994) *Strategi Konservasi Harimau Sumatera [Indonesian Sumatran Tiger Conservation Strategy]*. Direktorat Jenderal Perlindungan Hutan dan Pelestarian Alam, Departemen Kehutanan, Republik Indonesia, Jakarta, Indonesia.
- Plowden, C. & Bowles, D. (1997) The illegal market in tiger parts in northern Sumatra, Indonesia. *Oryx*, **31**, 59–66.
- Seal, U., Soemarna, K. & Tilson, R. (1994) Population biology and analyses for Sumatran tigers. In *Sumatran Tiger Population and Habitat Viability Analysis Report* (eds R.L. Tilson, K. Soemarna, W. Ramono, S. Lusli, K. Traylor-Holzer & U.S. Seal), pp. 45–70. IUCN/Species Survival Commission Captive Breeding Specialist Group, Apple Valley, USA.
- Seidensticker, J. (1987) Bearing Witness: Observations on the extinction of *Panthera tigris balica* and *Panthera tigris sondaica*. In *Tigers of the World: The Biology, Biopolitics, Management, and Conservation of an Endangered Species* (eds R.L. Tilson & U.S. Seal), pp. 1–8. Noyes Publications, Park Ridge, USA.
- Seidensticker, J. (1997) Saving the tiger. *Wildlife Society Bulletin*, **25**, 6–17.
- Seidensticker, J., Christie, S. & Jackson, P. (eds) (1999) *Riding the Tiger: Tiger Conservation in Human-dominated Landscapes*. Cambridge University Press, Cambridge, UK.
- Siddiqi, N.A. & Choudhury, J.H. (1987) Maneating behavior of tigers (*Panthera tigris* Linn.) of the Sundarbans—Twenty-eight years’ record analysis. *Tiger Paper*, **14**, 26–32.
- Simberloff, D., Doak, D., Groom, M., Trobulak, S., Dobson, A., Gatewood, S., Soulé, M.E., Gilpin, M., Martinez del Rio, C. & Mills, L. (1999) Regional and continental conservation. In *Continental Conservation: Scientific Foundations of Regional Reserve Networks* (eds M.E. Soulé & J. Terborgh), pp. 65–98. Island Press, Covelo, USA.
- Tilson, R. & Nyhus, P. (1998) Keeping problem tigers from becoming a problem species. *Conservation Biology*, **12**, 261–262.
- Tilson, R., Nyhus, P. & Franklin, N. (2001) Tiger restoration in Asia: Ecological theory vs. sociological reality. In *Large Mammal Restoration: Ecological and Sociological Challenges in the 21st Century* (eds D.S. Maehr, R.F. Noss & J.L. Larkin), pp. 277–291. Island Press, Washington, DC, USA.
- Tilson, R., Nyhus, P., Jackson, P., Quigley, H., Hornocker, M., Ginsberg, J., Phemister, D., Sherman, N. & Seidensticker, J. (2000) *Securing a Future for the World’s Wild Tigers*. Save The Tiger Fund, National Fish and Wildlife Foundation, Washington, DC, USA.

- Tilson, R., Siswomartono, D., Manansang, J., Brady, G., Armstrong, D., Traylor-Holzer, K., Byers, A., Christie, P., Salfifi, A., Tumbelaka, L., Christie, S., Richardson, D., Reddy, S., Franklin, N. & Nyhus, P. (1997) International co-operative efforts to save the Sumatran tiger *Panthera tigris sumatrae*. *International Zoo Yearbook*, **35**, 129–138.
- Tilson, R.L., Soemarna, K., Ramono, W., Lusli, S., Traylor-Holzer, K. & Seal, U.S. (1994) *Sumatran Tiger Population and Habitat Viability Analysis Report*. IUCN/Species Survival Commission Captive Breeding Specialist Group, Apple Valley, USA.
- Whitten, A.J. (1987) Indonesia's transmigration program and its role in the loss of tropical rain forests. *Conservation Biology*, **1**, 239–246.
- Woodroffe, R. & Ginsberg, J.R. (1998) Edge effects and the extinction of populations inside protected areas. *Science*, **280**, 2126–2128.

### Biographical sketches

Philip Nyhus has been associated with the Sumatran Tiger Project since 1995 and The Tiger Foundation, Canada, since its inception. His research interests include interdisciplinary approaches to biodiversity risk assessment and human-wildlife conflict.

Ronald Tilson initiated the Tiger Information Center (<http://www.5tigers.org>) and the Minnesota Zoo's Adopt-A-Park program, which provides *in situ* support for both Javan and Sumatran rhino conservation in Indonesia. Tiger conservation and tiger-human conflict, both in the wild and the private sector, are his major interests.