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Tiger restoration in Asia: Ecological theory vs. sociological reality

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Large Mammal Restoration

Ecological and Sociological Challenges in the 21st Century

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Chapter 14

Tiger Restoration in Asia: Ecological Theory vs. Sociological Reality

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:t is generally agreed that large mammal conservation requires large inter-zonnected tracts of habitat (Simberloff et al. 1999). Isolated reserves may be ınable to support long-term viable populations of wide-ranging large mammals, whereas a well-connected network of reserves might be a surrogate for ınfragmented landscapes (Harris 1984; Noss and Cooperrider 1994; Noss et ıl. 1996). Large mammal restoration has been mostly attempted in land-;capes where human population densities are low, where land available for :onservation is extensive, where poaching is rare, and where political and inancial support for conservation is strong (Breitenmoser et al. 2001). Many :xamples are in North America—such as panther (*Puma concolor coryi*) habi-:at in southern Florida (Maehr 1997) and Greater Yellowstone Ecosystem grizzly bear (*Ursus arctos*) and wolf (*Canis lupus*) habitats (Noss and Cooper-ider 1994; Fritts et al. 1995; Breitenmoser et al. 2001). Much of the world's biological diversity, however, occurs in fragmented landscapes where human population densities are high, little land is available for conservation, poach-ng is common, and financial and political support for conservation is weak (Table 14.1). How these ecological and sociological considerations are bal-ınced in regions like Asia will determine the future of large mammals.

The Sumatran tiger (*Panthera tigris sumatrae*) highlights what we believe

Table 14.1. Comparison of Factors Influencing Large Mammal Conservation and Restoration in North America and Southeast Asia

Characteristic	*North America*	*Southeast Asia*
Human population density	Low	High
Land available for conservation	Extensive	Limited
Poaching	Rare	Frequent
Political and financial support for conservation	High	Low

are important—and often overlooked—components of restoring large mammals. Our purpose here is to stimulate discussion about the capacity of current ecological paradigms to address the challenges of large mammal restoration in Asia that are caused by pressing sociological realities. Populations of tigers and other large mammals continue to decline across much of Asia, and the success of efforts to conserve and restore them depends in no small part on how human-dominated landscapes are incorporated into conservation plans. As Howard Quigley of the Hornocker Wildlife Institute has often stated, "Good conservation is based on good science" (pers. comm.). Unfortunately for the tiger and other large forest mammals in Asia, we are far from good science and conservation: we lack basic data on their distribution and ecology, we poorly understand their habitat requirements, and we have yet to identify all the threats to their existence (Seidensticker et al. 1999).

Background

Indonesia is the only country to have experienced the recent extinction of two tiger subspecies: the Bali tiger (*P. t. balica*) (Hoogerwerf 1970) and the Javan tiger (*P.t. sondaica*) (Seidensticker 1987). Sumatran tigers still remain, but in the last 20 or 30 years their population has dwindled as habitat has been converted and degraded across the island (Tilson et al. 1994). The future of the Sumatran tiger is far from secure. The situation is no better for many other large mammals that share the tigers' habitat, including the rhino, elephant, orangutan, and tapir. We emphasize this because we are concerned that major tiger conservation management decisions that impact the future of wild large-mammal populations will be made without adequate data or sufficient attention to the interplay of ecological theory and human needs.

Sumatran tigers once numbered in the thousands and were found across the island, but today they are increasingly restricted to a handful of isolated protected areas (Tilson et al. 1994). An estimated 500 Sumatran tigers remain, but their distribution is spread over an unknown number of small, disjunct populations in eight provinces. The decline of these populations and their increasingly isolated distribution is directly related to the rapid human population growth on the island and the large-scale loss and degradation of optimal habitat (Tilson et al. 1994). At a population and habitat viability analysis (PHVA) workshop held in Sumatra in 1992 (Tilson et al. 1994), human population growth, transmigration programs, and agriculture were cited as reasons for the decline in nonprotected tiger habitat. There are two primary threats to the Sumatran tiger: a small population size and the unnatural removal of tigers from small populations. Although poaching and other causes may remove only a few tigers, these losses may be problematic (Seal et al. 1994; Tilson et al. 1994). We still do not know exactly how many tigers remain, their distribution, or the extent of tiger/human conflict in Sumatra (Tilson 1999). Since 1995 we have examined these questions at Way Kambas National Park as part of the Sumatran Tiger Project (Franklin et al. 1999; Nyhus et al. 1999; Tilson et al. 1996, 1997; Tilson 1999) and are now extending our approach and findings to other areas of Sumatra.

There is growing agreement among tiger conservationists that a set of basic factors are crucial to the survival of tigers in the wild. These factors include sufficient habitat area, sufficient prey, low human disturbance, and genetic viability (Norchi and Bolze 1995; Nowell and Jackson 1996; Seidensticker 1997; Seidensticker et al. 1999). Where these conditions prevail, tigers can be resilient because their populations can offset losses and their offspring can colonize new areas (Smith 1993; Sunquist et al. 1999). Because of this adaptability and resilience, tigers were among the most widely distributed cat species (Nowell and Jackson 1996). Today, their distribution is increasingly confined to protected areas that are small and fragmented (Dinerstein et al. 1997; Nowell and Jackson 1996). The recent extinctions of the Javan and Caspian (*P. t. virgata*) tigers are reminders that restricted distributions, persecution by humans, and loss of prey populations can be terminal (Seidensticker 1987; Seidensticker et al. 1999; Sunquist et al. 1999).

The rate of land cover change in many areas of Asia is high. In most of Sumatra, little baseline information exists and the status of certain nonprotected forests remains virtually unknown. Government maps frequently identify forests when in fact they have been converted to other uses such as plantations, farms, and settlements. In 1997 alone, an estimated 15,000 km^2 were burned by major fires in Sumatra (Levine et al. 1999). Without field verification or remote monitoring from aerial and satellite imagery, we can only speculate how much land is really available for conservation and restoration. In the meantime, habitat continues to be lost.

Even less is known about the type and extent of other threats facing tigers and many other large mammals. Illegal hunting is a clear and present danger across all of the tiger's range. There is little information about poaching in most of Asia. A growing body of literature suggests that retribution for attacks on humans and livestock may be a significant reason for the tiger's decline (McDougal 1987; Tilson and Nyhus 1998). A review of reports and press accounts suggests that between 1978 and 1997 as many as 146 people were killed by tigers and more than 350 tigers (approximately 17.5 per year) were killed or captured across the entire island of Sumatra (Nyhus 1999).

Study Area and Methods

The island of Sumatra is one of 17,000 islands in the republic of Indonesia—the world's largest archipelago, fourth most populous country, and home to some of the richest biological diversity on the planet (MSPE 1992; Whitten et al. 1987). Sumatra is the fifth-largest island in the world and the second most populous in Indonesia after Java. Covering 474,000 km^2, an area just larger than the state of California, it is also home to 45 million people (BPS 1999)—and rapid deforestation. Today less than 20 percent of its once abundant lowland forest remains (Collins et al. 1991; Whitten et al. 1987).

Sumatra's protected-area system contains many small reserves and few large ones. The total land area managed for protection covers approximately 17 percent of the island. Of its 230 protected areas, 75 percent are smaller than 300 km^2 and only ten (4 percent) are greater than 1000 km^2. Large reserves account for 44 percent of the total protected area in Sumatra. The three largest national parks—Kerinci Seblat (13,680 km^2), Gunung Leuser (7927 km^2), and Bukit Barisan (3650 km^2)—account for 31.3 percent of protected land. More than half of Sumatra's total protected-area system is not managed primarily for ecosystem protection, let alone for tigers. Some 83 percent of the total number and 54 percent of the total area of the island's protected area system is classified as protection forest (*Hutan Lindung*) where management features erosion control, watershed protection, and timber harvest (Table 14.2). The only strictly protected areas of significance are the island's six national parks (*Taman Nasional*), which represent 6.2 percent of the island's total area.

To address the lack of data about tiger ecology, distribution, habitat, and survival threats in Sumatra, we assessed potential habitat and threats by examining 52 mapped tracts of potential tiger habitat (Franklin et al. 1999; Nyhus 1999). First, we consulted forestry officials to eliminate areas that were known to have been converted or otherwise unlikely to contain tigers. Second, we searched the remaining 15 areas for tiger signs (scrapes, footprints, urine sprays, or feces) and set up motion-activated cameras along trails to document tiger presence and prey identity. Third, we interviewed active and former poachers to better understand the extent and rate of illegal tiger losses over the last ten years.

Table 14.2. Number and Size of Protected Areas in Sumatra by Official Indonesian and IUCN Categories

Category	*N*	*% total N*	*Sum area (km²)*	*Mean area (km²)*	*SD*	*% total area*
Grand forest park	1	0.4	222	222.0	0	0.3
Hunting park	4	1.7	1,149	287.3	343	1.4
Recreation park	5	2.2	223	44.6	52	0.3
National park	6	2.6	29,461	4,910.2	4992	36.6
National reserve	9	3.9	567	63.0	76	0.7
Game reserve	13	5.6	5,261	404.7	322	6.5
Protection forest	192	83.1	43,689	227.5	308	54.2
TOTAL	231	100.0	80,572	348.8	1095	100.0

Results and Discussion

Of the 15 sites that supported extensive forest, signs of tigers were found at six, including Sumatra's two national parks and two adjacent areas (Sumatran Tiger Project 1999). At Way Kambas National Park at least 37 tigers were identified (Franklin et al. 1999). Signs of known tiger prey species were found at nine sites and included sambar deer (*Cervus unicolor*), barking deer (*Muntiacus muntjak*), and wild pig (*Sus scrofa*) (Figure 14.1).

The actual tiger density in most of the protected areas in Sumatra is unknown, but it is likely to be between one and four tigers per 100 km^2 (Franklin et al. 1999; Griffiths 1994). Using the more conservative estimate of one tiger per 100 km^2, only two protected areas could have at least 50 tigers and none would have 250—an estimated 100-year minimum viable population (Seal et al. 1994). At four tigers per 100 km^2, all of the national parks could theoretically contain from 50 to 250 tigers (Figure 14.2). These estimates do not consider the effective habitat available, which may be considerably less than the total due to inholdings, disturbance, hunting pressures, and edge effects. Mountainous topography, rivers, roads, and other landscape features further reduce the amount of suitable tiger habitat. Moreover, not all tigers will be of breeding age in a given population (too young or too old). Thus, even the largest protected areas in Sumatra, in isolation, are unlikely to

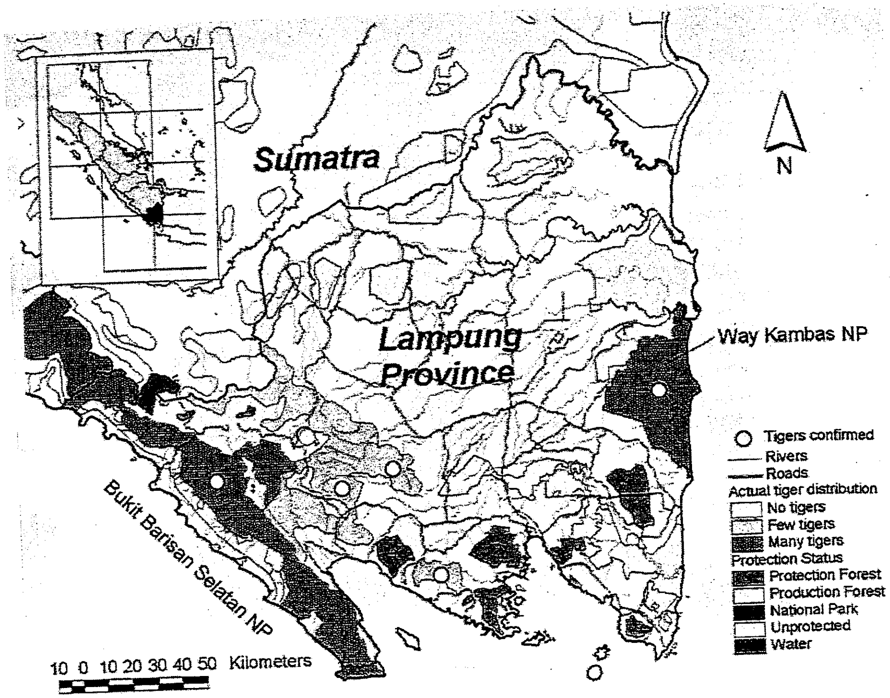

Figure 14.1. Forest habitat in Lampung province, Sumatra, and distribution of tigers based on preliminary field assessments.

contain 100 breeding tigers. Based on the results of a population viability analysis, only two of Sumatra's national parks are capable of supporting a viable population of tigers for more than 100 years. Each of the remaining protected areas is unlikely to support a viable population for more than 100 years, even if poaching, habitat loss, and disturbance are controlled (Seal et al. 1994).

The actual area available for tiger conservation in Sumatra is almost certainly more isolated, fragmented, and degraded than is suggested on paper. In Lampung province, for example, more than 11,456 km^2 is theoretically available for conservation. Many of these reserves appear to be linked on paper to other protected areas to form a connected network of protected habitat (Figure 14.1). But the low occupancy rate in these reserves suggests that this paper tiger metapopulation is only that. All of these areas, large and small, are close to or bisected by road networks, towns and cities, and agriculture. Further, none of them is effectively protected from poaching. In 12 of the 15 areas where tigers were found, we observed signs of illegal hunting. Even in

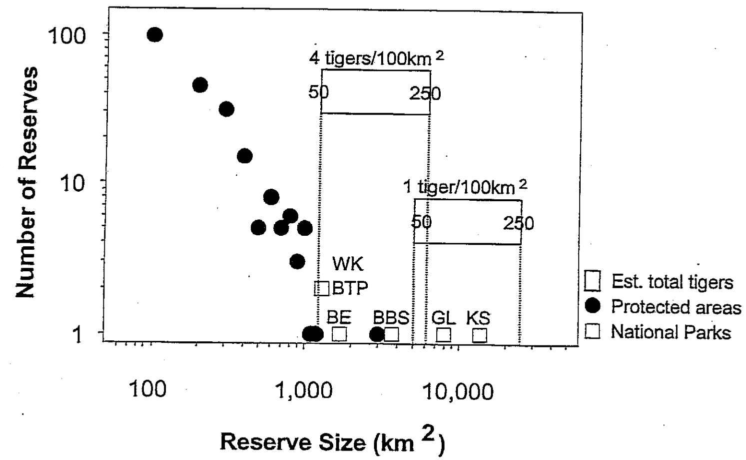

Figure 14.2. Number and size of protected areas in Sumatra and hypothetical tiger populations.

the national parks, game hunting, fishing, bird collecting, and other exploitation is common (Nyhus 1999; O'Brien et al. 2000). Interviews with 35 active and retired poachers revealed that close to 400 tigers have been killed over an eight-year period in southern Sumatra—and that the number of tigers killed each year has increased.

Sociological Considerations

The status of tigers and tiger habitat in Sumatra becomes clearer when examined in the context of recent social and political crises. The human population increased by at least 3.5 percent between 1971 and 1980 and 3 percent between 1981 and 1990 to over 75/km^2 on the island of Sumatra and 200/km^2 in Lampung (Nyhus 1999). This rapid growth comes from government-sponsored immigration of largely poor, rural people (Fearnside 1997). And most new settlement has occurred in fertile lowland forests adjacent to national parks (Whitten 1987). This development in tiger habitat is expected to continue for several decades. Expansion of cultivation, estate crops, and tree plantations has had a dramatic impact on Sumatra's landscape. Oil palm (*Elaeis guineensis*) alone accounts for at least 1.8 million hectares and is increasing due to Indonesia's efforts to become the world's largest producer of palm oil (Potter and Lee 1998).

Economic and political upheaval in Indonesia and the Asian economic collapse have resulted in high unemployment in some rural areas. In early

1998, massive student protests in Jakarta brought down Indonesia's president of more than 30 years and plunged the country into political confusion. This political and economic turmoil coincided with drought caused by the El Niño Southern Oscillation (ENSO) events of 1997–1998 (Levine et al. 1999). Fires set to clear new areas for cultivation often burned out of control. As a result, at least 15,000 km² of forest were consumed (Levine et al. 1999). Even in Way Kambas National Park, thousands of villagers were encouraged by a lucrative seafood market to illegally enter the park near the southwest boundary to dig waterways for shrimp farms. More than 400 people moved into the park and occupied 1225 ha before they were evicted by park staff, military, and police. In Lampung, several of the protection forests were cleared during 1998–1999, and more are likely to follow in the wake of political and economic instability.

Conservation and Restoration Challenges

Sumatra is typical of Asia, where protected areas are small (Dinerstein and Wikramanayake 1993). Compared to large reserves in North America, many of Sumatra's protected areas are unlikely to maintain viable populations of large mammals and are too small to be considered for ecosystem restoration. If size alone is considered, only two reserves are likely to maintain demographically and genetically viable populations of tigers over the next 100 years. Potential tiger habitat could be expanded if the 50 largest (more than 300 km²) of Sumatra's protection forests could be secured immediately. If tiger hunting is sustainable and prey is abundant, demographically viable tiger populations can survive in reserves as small as 300 km² (Karanth and Stith 1999). The magnitude of this task, however, is daunting and the obstacles are tremendous because of the great number of people living adjacent to these forests and extracting resources from them.

Small reserves may be easier to protect than large reserves (Peres and Terborgh 1995). At Way Kambas National Park, a small reserve, 70 percent of the reserve is surrounded by water and boat patrols can monitor most of the boundary. Land patrols can easily traverse the park and its upland border. In the large Kerinci Seblat National Park, law enforcement is more difficult due to inholdings along access roads, poorly demarcated boundaries, and easy entry (MacKinnon 1997). Future management of an expanding tiger reserve system will need to incorporate effective regulation of access (Kramer et al. 1997).

In keeping with modern conservation theory (Harris 1984; Noss and Harris 1986; Noss and Cooperrider 1994; Dobson et al. 1999), landscape linkages are needed to facilitate the movement of animals and their genes

within a metapopulation. Ideally, with adequate restoration of forest corridors between and among core protected areas, tigers would colonize new areas. The most likely location of such a network would be along the island's western Barisan Mountain chain connecting three of Sumatra's largest national parks (Gunung Leuser, Kerinci Seblat, and Bukit Barisan Selatan) and stretching east through the center of the island to Bukut Tigapuluh and Berbak national parks.

The reality of Sumatra's rapidly changing landscape, however, is that few protected areas today can be connected effectively by habitat corridors. Way Kambas National Park, for example, is surrounded by 27 villages that support nearly 500,000 people within 10 km (Nyhus 1999). A corridor linking Way Kambas National Park to Bukit Barisan Selatan National Park would need to cross 100 km of densely populated and developed lands with human densities averaging 200/km² (Nyhus 1999). Such landscape retrofitting would involve the relocation of thousands of families and the restoration of heavily used farmlands.

Such challenges do not obviate the need to restore connectivity to tiger habitat and tiger populations. But where habitat connectivity is not currently feasible, gene flow can be maintained with "virtual corridors." By this we mean that tigers can be moved among core protected areas or, in extreme cases, among captive facilities and wild populations. Translocation of tigers from one area to another could create gene flow among small but demographically healthy populations (Dobson et al. 1999). The global captive breeding community has already made significant progress in managing small populations of tigers through managed reproduction to maximize genetic diversity (Tilson and Christie 1999). Further convergence of ex-situ and in-situ programs is possible. With proper monitoring and safeguards in place, for example, captive tigers could be returned to the wild. While reintroduction of problem tigers is unlikely, the reintroduction of their offspring may be more acceptable. Such links may forestall the effects of human population growth and continued habitat loss and allow for the development of tiger habitat restoration strategy.

Buffer zones (Sayer 1991; Shafer 1990) extend the available habitat for plants and animals (extension buffering) and provide resources and services to people (socio-buffering) (MacKinnon et al. 1986). The challenge is to identify land use that fills both roles (Salafsky 1993). In the Tropics—and particularly in Southeast Asia—buffers that incorporate complex (multispecies) agroforestry systems into forest preserves are a promising approach. (See Siebert 1989; Michon and d'Foresta 1990; Salafsky 1993; Van Shaik and Terborgh 1993; Potter and Lee 1998; Vandermeer et al. 1998; Johns 1999.)

But complex agroforestry creates conditions that may increase conflict between wildlife and people (Tilson and Nyhus 1998). Our observations (Nyhus 1999) support those of Woodroffe and Ginsberg (1998) who found that conflicts with people on reserve borders are the major cause of large-carnivore mortality. If large carnivores are to survive, more attention must be given to reducing human/wildlife conflicts at the edges of protected areas. Although the role of conflict in conservation planning has not received as much attention as habitat loss and poaching (Tilson and Nyhus 1998), it may need to play a more central role in efforts to expand or restore corridors and buffer zones adjacent to protected core tiger habitat.

Many specialist, forest-interior species in the tropics are vulnerable to logging, edge effects, and other disturbances (Bierregaard et al. 1992; Lovejoy et al. 1986). Tigers, however, can thrive in secondary growth and edges where primary productivity supports a high ungulate biomass (Nowell and Jackson 1996). Way Kambas National Park is a good example of this. It was commercially logged between 1954 and 1974, resulting in the clearing of at least 75 percent of the reserve (ANZDEC and AMYTHAS 1995; Ministry of Forestry 1995). Today the park's secondary-growth forest and mixed forest–grasslands contain what may be some of Sumatra's highest densities of ungulates and tigers (Franklin et al. 1999). This suggests that degraded tiger habitat in Sumatra can in fact recover from intensive human uses. Given that many primary forests are being intensively used and converted to early successional stages, we suggest that future tiger management integrate secondary forests into an islandwide system of preserves and multiple-use areas (Noss and Harris 1986).

Managers hoping to restore degraded habitats face considerable obstacles: cost, evicting and moving illegal settlers, and lack of political will. Sites that now have permanent settlements are unlikely to recover sufficiently to support large mammals, let alone tigers. Recently cleared areas can revert to forest, but each day without protection increases restoration costs and enhances the likelihood of conversion to farms and settlements. Nevertheless, some areas such as agricultural and tree plantations, if left to revert to forest, could support tigers within decades. Although such a scenario may seem optimistic, declines in the value of palm oil, rubber, timber, and other Sumatran agricultural products could create opportunities for restoring tiger habitat.

Incorporating Social and Political Considerations

Ecological theory and reserve design are important aspects of large mammal conservation and restoration. But successful restoration of wide-ranging species such as the tiger must also address many social and political chal-

nges, especially in regions such as Southeast Asia (Seidensticker et al. 999). Although field researchers are expected to give policymakers conser-ıtion recommendations that are based on good science, ecological decision aking is often made in a vacuum or against long odds. The feasibility of onnecting large reserves to form a connected network currently pales in the ce of an economy that encourages forest settlement and conversion to cul-vation.

We believe it is time to find out whether restoration theory in areas like orth America is—or is not—appropriate to the challenge of restoring rge-mammal habitat in the human-dominated landscapes of Asia. When e most ecologically appropriate options are not available, what is the next st option? This is a central dilemma in the fight to save the tiger in Indone-a. While law enforcement, real and virtual corridors, buffer zones, restora-on of degraded habitat, and better integration of social and political con-derations are all components of successful tiger management, a paradigm at incorporates them all has yet to be implemented. The foundation for fective tiger conservation must synthesize ecological theory, sociological ality, and accurate field data. How we address this challenge today will pre-rve the Sumatran tiger—or seal its fate with the extinct tigers of Java and ali.

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