

THE CONSERVATION STATUS OF INDONESIA'S TARSIERS

Sharon Gursky¹, Myron Shekelle², & Alexandra Nietsch³

¹Texas A&M University, Department of Anthropology, TAMU 4352, College Station TX 77843-4352

²Center for Biodiversity and Conservation Studies (CBCS-UI), Faculty of Mathematics and Science (F-MIPA), University of Indonesia, Depok 16424, Republic of Indonesia. Email: shekelle@tarsier.org

³Freie Universität Berlin, Institut für Verhaltensbiologie, Haderslebener Str. 9, 12163 Berlin, Germany

ABSTRACT

We present a method for making best guess estimates for the conservation status of 20 Indonesian tarsier taxa and populations listed in the taxonomy of Brandon-Jones *et al.* (2004). Published distribution maps were used to make rough estimates of the extent of occurrence. The accuracy of our estimates is sufficient that nearly all taxa and populations can be confidently assigned to one of the four size-based categories (i.e. 1 - 100 km², 100 - 5000 km², 5000 - 20,000 km², >20,000 km²) in the IUCN Red List guidelines. We used data and reports concerning habitat loss throughout Indonesia, and inferred commensurate range fragmentation, and declines in habitat quality and overall population numbers throughout the range of tarsiers in Indonesia. These inferences were supplemented with other information and personal observations where available. Based on our calculations, we make the following recommendations for the conservation status of Indonesia's tarsiers. One taxon and one population warrant Critically Endangered (CR) status: *Tarsius bancanus natunensis* and *T. sangirensis* Siau population. Three taxa and four populations warrant Endangered (EN) status: *Tarsius pelengensis*, *T. pumilus*, *T. sangirensis*, and four acoustic forms of *T. tarsier* (i.e., the Tinombo form, the Togian form, the Selayar form and the Kabaena form). Indonesian tarsier species that we recommend be listed as Vulnerable (VU) include two taxa and three populations: *Tarsius bancanus saltator*, *Tarsius dentatus* (= *dianae*), and three acoustic forms of *T. tarsier* (= *spectrum*) (i.e., the Manado form, the Gorontalo form, and the Buton form). Indonesian tarsier species that we recommend be listed as Lower Risk include two taxa: *Tarsius bancanus bancanus*, and *Tarsius bancanus borneaus*. Indonesian tarsier species which we regard as data deficient include one taxon and three populations: *Tarsius tarsier* (i.e. *T. tarsier*, the Makassar form), and three other acoustic forms of *T. tarsier* (the Sejoli form, the Palu form, and the Kendari form). The Palu form has since been described as *T. larium*. Several of these taxa / populations are distributed in regions that completely lack conservation areas of any kind. These include the two Critically Endangered forms (*T. b. natunensis*, *T. sangirensis* Siau population), four of the Endangered forms (*Tarsius pelengensis*, *Tarsius sangirensis*, Togian form, and Selayar form), and one Vulnerable form (*Tarsius bancanus saltator*).

Keywords: *Tarsius bancanus*, *T. dentatus*, *T. dianae*, *T. larium*, *T. pelengensis*, *T. pumilus*, *T. sangirensis*, *T. spectrum*, *T. syricta*, *T. tarsier*

INTRODUCTION

Indonesia is one of the richest nations in the world, at least in terms of its biodiversity. Although it covers only 1.3% of the globe, the Indonesian Archipelago accounts for nearly 10% of the world's remaining tropical forest, making it second only to Brazil in the amount of biodiversity it harbors (Cowlshaw & Dunbar 2000; Oates 1999). Unfortunately however, despite the country's extensive system of protected areas, Indonesia's forest cover has declined dramatically in the past decade (Jepson *et al.* 2001; Whitten *et al.* 2000), and is projected to decline still further (see Supriatna *et al.* 2001). Holmes (2002) reported that 20 million ha of Indonesia's forests have been lost since 1989, at an

average annual deforestation rate of 1.7 million ha. Although 57 million ha of forest still remain on the three main islands of Sumatra, Borneo, and Sulawesi, less than 15% of this is lowland forest, which supports the highest biodiversity (MacKinnon 1997; Whitten *et al.* 2000, 2002). The dramatic loss of Indonesia's forest cover is attributed to a variety of factors, including logging (legal and illegal), development of estate crops (primarily oil palm and pulpwood plantations), conversion to agriculture (by opportunistic settlers, refugees from ethnic conflict, and those arriving through Indonesia's official transmigration program), and fires (natural and man-made) (Sunderlin 1999; Barber & Schweithelm 2000; Whitten *et al.* 2000; Robertson & van Schaik 2001; Holmes 2002). A new threat has emerged quite

recently—tree felling to facilitate reconstruction efforts following the devastating tsunami of December 2004. The amount of forest loss attributable to each of these actions is highly contested and quite variable from island to island.

One of the major goals of the Indonesian Prosimian Workshop (sponsored by *Pusat Primata Schmutzer* and the *Museum Zoologicum Bogoriense*, and organized by Myron Shekelle, Colin Groves, Helena Fitch-Snyder and Helga Shulze) was to revisit the results of the Indonesian Primate Conservation Assessment and Management Program (Indonesian Primate CAMP) (Supriatna *et al.* 2001) as regards tarsiers, and to re-evaluate the conservation status of Indonesia's tarsier species in light of their newly revised taxonomy (Brandon-Jones *et al.* 2004).

METHODS

According to the IUCN Red List, a species conservation status can be determined based on a variety of different criteria (Cowlshaw & Dunbar 2000; Seal *et al.* 1994; Mace 1995). These include: population reduction, extent of occurrence, area of occupancy, limited population size and or quantitative analysis showing high probability of extinction (PVA and PVHA). Using various levels of these characteristics, a species can be classified as Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Lower Risk (LR).

In evaluating the conservation status of Indonesia's tarsiers, our efforts focused on estimating the extent of occurrence for a given taxon or population. Tarsiers are one of the more poorly known primate species, and we argue that the estimated extent of occurrence is the most easily quantifiable characteristic with which to begin assessing tarsier conservation status. Threats within a given region were assessed based upon observation and / or inference. These represent our best guess estimates, and include the following assumptions, given the well documented and extensive habitat loss in Indonesia over the past 10 years. First, observation and inference indicate that tarsier populations within Indonesia have become fragmented. Second, we infer

steep declines in the area of occupancy, habitat quality, and overall population numbers. Third, given that the social forces that are causing habitat loss appear to be uncontrollable at the moment, we infer continued declines in these variables. Thus, we argue that tarsiers throughout Indonesia are facing conservation threats severe enough to warrant concern, and that—lacking additional quantitative data—best guess conservation status estimates for tarsier species can be based on the estimated extent of occurrence supplemented where possible with additional evidence.

Therefore, following IUCN Red List guidelines, and given that all other necessary conditions are met, populations whose extent of occurrence is between 1 – 100 km² we recommend be given a conservation rating of Critically Endangered. Populations whose extent of occurrence is between 100 - 5,000 km² we recommend be given a conservation rating of Endangered. Populations whose extent of occurrence is between 5,000 - 20,000 km² we recommend be given a conservation rating of vulnerable. Populations whose extent of occurrence is greater than 20,000 km² we recommend be given a conservation rating of low risk.

We estimated extent of occurrence for each taxon and population in Brandon-Jones *et al.* (2004) using a map of Indonesia (scale: 30 cm = 200 km), distribution maps of tarsiers (Hill 1955; Niemitz 1984a; Musser & Dagosto 1987) and a map of tarsier acoustic form distributions compiled from several sources (see Shekelle & Leksono 2004). We used a ruler and basic arithmetic to estimate length, breadth, and area for each distribution. The accuracy of our estimated extent of occurrence, although not high, was nevertheless usually sufficient to confidently classify each distribution within one of the four categories listed above (i.e. 1 - 100 km², 100 - 5000 km², 5000 - 20,000 km², and >20,000 km²).

RESULTS

Tarsius bancanus bancanus was estimated to occur in an area almost equal to 100,000km² (85,000 km² on Sumatra and 13,400 km² on Bangka). We

recommend changing the conservation status from LRLc (Least Concern) to LRLcd (Conservation Dependent). We maintain that given the massive habitat destruction throughout Indonesia, particularly in Sumatra, this species' conservation status is clearly dependent upon future conservation of the remaining habitat.

Tarsius bancanus borneanus was estimated to occur over the entire island of Borneo. It has a huge extent of occurrence. Thus, we recommend maintaining its assessment of LRLc (Least Concern). However, it should be kept under consideration for LRLcd (Conservation Dependent) for the following reasons: One, Borneo is the site of some of the worst habitat destruction in Indonesia, including massive fires, land clearing, and logging throughout the Indonesian portions of the island. Second, as with many nocturnal taxa, there is the possibility that the primary taxonomy of the tarsiers on Borneo has been underrepresented. Western tarsiers have not been the focus of recent taxonomic investigations, as have the Eastern tarsiers of Sulawesi, and one might wonder if a landmass as large as Borneo might not hold more diversity than a single subspecies of a small mammal, like a tarsier. Indeed, the peculiar looking tarsier from the montane forests of Borneo described by Gorog & Sinaga (this volume), as well as the substantial behavioral differences between tarsiers studied Niemitz (1984b,c) in Sarawak and those studied by Crompton & Andau (1986, 1987) in Sabah could be interpreted as clues of unrecognized taxonomic variation. If this were the case, the estimated extent of occurrence would be a massive overestimate if *T. b. borneanus* were reclassified into multiple taxa, such as occurred in Sulawesi.

Tarsius bancanus natunensis is listed by the IUCN as DD (Data Deficient). We estimate the extent of occurrence on Serasan to be a mere 90 km². Thus, we recommend the conservation status for this taxon be changed Critically Endangered (CR B12c.). We note the threat of a continued decline in the extent of occurrence, area of occupancy,

and quality of habitat, particularly with regard to the development of the Natuna gas fields. There are reports of tarsiers on nearby Subi Island, with an estimated size of 180 km². If confirmed, this would give *T. b. natunensis* a total extent of occurrence of 270 km², in which case the conservation status should be reduced to Endangered (ER B12c).

Tarsius bancanus saltator is restricted to the island of Belitung. We estimated its extent of occurrence to be 5,625 km². On this basis, we recommend changing its conservation status from Data Deficient (DD) to Vulnerable (VU B12bc). Note that our estimated extent of occurrence is near the 5000 km² threshold, and this taxon might warrant consideration for Endangered status. Independent surveys by two experienced tarsier field biologists produced similar results, that is, potential tarsier habitat is clearly fragmented, and that tarsiers were only located in a small region on the center of the island (Suroso Mukti Leksono & Indra Yustian, personal communication). Thus, the inference from their surveys is the area of occupancy may be far smaller than the extent of occurrence. We project a continuing decline in the area of occupancy and quality of habitat.

Tarsius dentatus has a very large estimated extent of occurrence (Brandon-Jones *et al.* 2004) that is greater than 20,000 km². On this basis, it would be classified as Low Risk-Conservation Dependent or Near Threatened. However, we recommend that this species be listed as Vulnerable (VU B12ac). Each of us has extensive, first-hand experience in central Sulawesi, and it is difficult to imagine tarsiers there as being LR given the massive habitat destruction, ethnic conflict, and political upheaval throughout the province. Thus, although *Tarsius diana* occurs in two large protected areas, Morowali and Lore Lindu National Parks, these are unlikely to provide effective refuge conservation that would shelter this animal from the threat of extinction. For example, Morowali is home to the Wana, traditional blowgun hunters who practice slash-and-burn agriculture. This practice turns large

swaths of the park into grass (*alang-alang*) which is primarily unused by tarsiers. Similarly, parts of Lore Lindu National Park were overrun by refugees, ostensibly fleeing the ethnic conflict in Poso although anecdotal reports indicate they were simply opportunistic illegal loggers, and entire villages were constructed within the park.

Tarsius pelengensis has an estimated extent of occurrence of approximately 1925 km². On this basis we recommend the Peleng tarsier be given a conservation status of Endangered (EN B1ab). Evidence indicates that the area of occupancy is likely to be substantially less than the extent of occurrence. Mochamad Indrawan (personal communication) conducted a survey on Peleng and estimated that less than 10% of the island is suitable for tarsiers. Thus, it may be necessary to raise the conservation status of this species to Critically Endangered.

Tarsius pumilus has an estimated extent of occurrence of 4,112 km², estimating montane forests within the region of the three known trapping localities of this species. We recommend a conservation status of Endangered (EN B12c). This conservation status is dependent on the projected disturbance to montane forest throughout central regions of Sulawesi. It is very clear that we need a study of the mountaintops throughout central and southern Sulawesi to confirm that *pumilus* has a distribution anywhere near as large as we have estimated here. Given that this species is known from only three specimens trapped between 1917 and 2000, an area of concern is the lingering question whether the mountain tarsier will be found on the mountaintops of all mountains in this area, or only a limited subset. Low population density is characteristic of many high altitude small mammal populations, and future studies could reveal that pattern will influence this species' conservation status.

Tarsius sangirensis is estimated to have an extent of occurrence of 576 km² on Sangihe and 72 km² on Siau. On this basis, we characterize the conservation status of this species as

Endangered (EN B12bc). One of us (MS) has first-hand experience on both of these islands, and the habitat that is appropriate for tarsiers is clearly fragmented. Bathymetric maps indicate that deep ocean separates Sangihe and Siau Islands, with no apparent means of gene exchange between the two populations. Brandon-Jones *et al.* (2004) listed the Siau population as a priority for future taxonomic research. If it were taxonomically separated from *T. sangirensis*, the Siau tarsiers would be candidates for the rating Critically Endangered (CR B12bc). In addition, we project a continuing decline in the area of occupancy and the area, extent and or quality of habitat, as well as the threat from volcanism.

Tarsius tarsier (= *T. spectrum*), which has been called *Tarsius spectrum* since Hill (1955), is argued to be a subjective junior synonym of *T. tarsier*, both of which have the type locality of Makassar (see Shekelle 2003; Brandon-Jones *et al.* 2004). *Tarsius tarsier* itself is subdivided into numerous allopatric and parapatric populations that are identifiable by their vocalizations. There are no known museum specimens from Makassar, and Makassar today is a large city with no known tarsier populations. The acoustic form that is believed to be representative of this species comes from two closely located conservation areas, Bantimurung and Pattanuang, that were recently joined together into a single park, Bantimurung National Park that lies within 40 km NE of Makassar. From our limited distributional information, we cannot estimate the extent of occurrence of this population. The sympatric macaque, *Macaca maura*, however, is Endangered, so we will not be surprised if this population warrants EN Endangered status, as well.

The "Buton form" (Nietsch & Burton 2002) is estimated to have an extent of occurrence of 5,776 km², inferring that it includes the entire island. On this basis, we recommend that this form be classified with a conservation rating of Vulnerable (VU B12bc). The estimated extent of occurrence is near the 5000 km² threshold, and this population

might warrant endangered status. Press reports identify Buton Island as a center of large-scale illegal logging that is clearing forests on the island.

The “Gorontalo form” has been surveyed from Gorontalo, Panua, Libuo, and Tanjung Panjang (MacKinnon & MacKinnon 1980; Shekelle 2003). We infer that it occupies both coasts of the peninsula from Gorontalo to Tanjung Panjang, and has an estimated extent of occurrence of approximately 8100 km². On this basis we recommend that it receive a conservation status of Vulnerable (VU B12bc). As with other regions of Indonesia, this range of this species is experiencing tremendous habitat loss and fragmentation.

The “Kabaena form” has an estimated extent of occurrence of 1350 km², inferring that it includes the entire island. On this basis we recommend that it receive a conservation status of Endangered (EN B12bc). Little is known of this population, other than that tarsiers occur on this island and that their vocalizations are quite distinct (Nietsch & Burton 2002)

We are unable to estimate the extent of occurrence of the “Kendari form” since the few sites from where it has been surveyed are in a relatively straight line (Nietsch & Burton 2002). We recommend that the Kendari form receive a conservation status of Data Deficient (DD).

The “Manado form” has been surveyed from Tangkoko to Gorontalo (MacKinnon & MacKinnon 1980; Shekelle 2003). We infer that it occupies both coasts of the peninsula from Gorontalo to the northeastern tip of Sulawesi. We estimate the extent of occurrence to be approximately 10,951 km². We recommend a conservation rating of Vulnerable (VU B12bc).

The “Palu form” (MacKinnon & MacKinnon 1980) recently described *T. lariang* (Merker and Groves 2006) is estimated to have a large distribution (Brandon-Jones *et al.* 2004). It is expected to share a parapatric distribution with *T. diana* to the east. However, the known sites of the Palu form are all in a straight line so we cannot estimate

the extent of occurrence. Thus, we recommend that this form be given a conservation rating of Data Deficient (DD).

The “Sejoli form” was surveyed by Shekelle in 1996 (Shekelle *et al.* 1997; Shekelle 2003). It is known from only one site, so it’s not feasible to estimate the extent of occurrence. Thus, we recommend this population be listed as Data Deficient (DD).

The “Selayar form” (see Groves 1998; Nietsch & Babo 2001) has an estimated extent of occurrence of approximately 820 km², inferring that it includes the entire island. On this basis we recommend conservation status of Endangered (EN B12bc). Selayar Island is the proposed site for a large oil refinery, and presently has no protected areas, so the conservation status of this tarsier population could be a candidate for Critically Endangered in the near future.

The “Tinombo form” was surveyed by Shekelle in 1996 (Shekelle *et al.* 1997; Shekelle 2003) and again by Merker in 2001 (see Brandon-Jones *et al.* 2004). We infer that it occupies both coasts of the peninsula from Tinombo to the Ampibabo. From these surveys we estimate the extent of occurrence as approximately 3150 km². On this basis we recommend conservation status of Endangered (EN B12bc).

The “Togian form” tarsiers have been surveyed on both Batudaka and Malenge Islands (Nietsch & Niemitz 1993; Shekelle 2003). Assuming that they are distributed on all the islands in the chain except for the geologically unrelated volcanic island, Una, we estimate an extent of occurrence of 1980 km². On this basis we recommend conservation status of Endangered (EN B12bc).

DISCUSSION

In her recent discussion of future conservation action for tarsiers, Wright (2003) argued that “the first step in tarsier conservation is to change their ‘Data Deficient’ status. Within the next few years we should prioritize a survey for all tarsiers.” This is an admirable goal that we agree with, in principle, but one of us (MS) remarked ironically that the number of tarsier

taxa is greater than the number of active tarsier field biologists (Shekelle 2005), such that the goal is unrealistic within the time frame of 'a few years.'

There are three major types of data that we believe need to be obtained in order to more accurately determine the conservation status of the Indonesian tarsier populations (Table 1). First and most importantly, we believe that satellite maps capable of detailing the different types of habitat should be compared for 2003, 1998 and then 1993. This will provide quantifiable data on the change in available habitat over 10 years that will add rigor to our

assumption of habitat loss. Such maps could also provide more accurate information on the estimated area of occupancy, which we expect will probably be substantially less than the extent of occurrence. The use of satellite maps will also provide a quantifiable rate of habitat destruction over time. We will not be surprised, for example, if the rate of habitat destruction observed in satellite images over the last ten years turns out to be greater than the rates reported by the Indonesian Primate CAMP based on "visual estimates": 1.87% estimated to be occurring in Sulawesi, 2.47% in Kalimantan and 2.5% in Sumatra.

Table 1. Conservation status recommendations for 20 Indonesian tarsier taxa and populations in Brandon-Jones *et al.* (2004)

Taxon / Population	Location	Est. Extent of Occurrence (km ²)	Conservation Status		
			Current (IUCN, 2004)	Indonesian Primate CAMP (Supriatna <i>et al.</i> , 2001)	These recommendations
<i>Tarsius bancanus bancanus</i>	Sumatra/Bangka	98,400	LR/lc	LRlc	LR (cd)
<i>T. b. borneanus</i>	Borneo	>100,000	DD	LRlc	LR
<i>T. b. natunensis</i>	Serasan Is. (Subi Is.)	90 (180)	DD	VU (C2a ⁱⁱⁱ)*	CR (B12c)
<i>T. b. saltator</i>	Belitung Is.	5,625	DD	EN (B2ab)*	VU (B12bc)
<i>Tarsius diana</i>	Sulawesi: E. central	>20,000	LR/cd	LRlc	VU (B12ac)
<i>Tarsius pelengensis</i>	Peleng Is.	1,925	DD	EN (B1ab)	EN (B12ab)
<i>Tarsius pumilus</i>	Sulawesi: central montane (1800-2200 m)	4,112	DD	DD	EN (B12c)
<i>Tarsius sangirensis</i>	Sangihe & Siau Is. (Sangihe only)	648 (576)	DD	EN (B1abc)	EN (B12bc)
Siau population	Siau Is.	72	<i>not listed</i>	NL	CR (B12bc)
<i>T. tarsier</i>	Sulawesi: near Makassar	?	LR/nt	VU (B1ab)	DD
Buton Form	Buton Island	5,776	<i>not listed</i>	VU (B1ab)	VU (B12bc)
Gorontalo Form	Sulawesi: N. peninsula, Gorontalo to Tanjung Panjang	8,100	<i>not listed</i>	LRnt	VU (B12bc)
Kabaena Form	Kabaena Is.	1,350	<i>not listed</i>	<i>not listed</i>	EN (B12bc)
Kendari Form	Sulawesi: near Kendari	?	<i>not listed</i>	EN (B1ab)	DD
Manado Form	Sulawesi: N. peninsula, Gorontalo to northeastern tip	10,951	<i>not listed</i>	LRlc	VU (B12bc)
Palu Form	Sulawesi: W. central	?	<i>not listed</i>	LRnt	DD
Sejoli Form	Sulawesi: N. peninsula, near Sejoli	?	<i>not listed</i>	LRnt	DD
Selayar Form	Selayar Is.	820	<i>not listed</i>	EN (B1ab)	EN (B12bc)
Tinombo Form	Sulawesi: N. peninsula, Tinombo to Ampibabo	3150	<i>not listed</i>	LRnt	EN (B12bc)
Togian Form	Togian Islands	1,980	<i>not listed</i>	EN (B1ab)	EN (B12bc)

Second, we believe it is imperative that we obtain accurate and detailed data on population density and distribution for all tarsier species and subspecies. Although estimating the extent of occurrence (and assuming massive declines in habitat, habitat quality, and overall population throughout Indonesia) is a quantifiable method for making a best guess estimate of conservation status, it should be considered as nothing more than a handy shortcut compared with actual demographic data. For example, Gursky (1998) found a substantial decline in the density of tarsiers within Tangkoko Nature Reserve (*Tarsius tarsier*) from the time of the MacKinnons' study in 1980 in comparison to her own study, 15 years later. Thus, even though the extent of occurrence may have remained the same, the population density for this species declined. At present we only have population density data for three populations of tarsier within Indonesia *T. dentatus* (Gursky 1998; Merker & Muhlenberg 2000), the "Manado form" (MacKinnon & MacKinnon 1980; Gursky 1998) and *T. bancanus borneaus* (Niemitz 1984b; Crompton & Andau 1986).

It should be self-evident that the more criteria that are used for determining a species' conservation status, the more accurate the estimate. Thus, in addition to using criteria B (extent of occurrence), using criteria A (quantified reduction in population) should be employed. Additionally, it is important that not only should we obtain data on density, but also distribution. Specific tarsier species / populations for which distribution data is lacking (and we were therefore unable to determine the extent of occurrence) include: the Kendari form, the Palu form, the Sejoli form, the Tinombo form, and *Tarsius tarsier* (the Makassar form). Thus, more field surveys are required. Additionally, GIS data could provide more accurate estimates of extent of occurrence than we used in this study.

Third, we should perform PHVA (Population Habitat Viability Analyses) for each tarsier species. Although there are many assumptions made by PVHA (Cowlishaw & Dunbar 2000), the results of such studies will provide the conservation community with a quantifiable measure of the threat of extinction for each tarsier species. This analysis has already been

conducted for the Philippine tarsier (Neri-Arbodela 2001), but not yet for any Indonesian tarsier population.

Additional Concerns

While determining the conservation status of Indonesia's nocturnal prosimians, such as tarsiers, is clearly important, actually conserving these primates is, of course, far more important. Specifically, it is critical that we identify the major threats to each of the tarsier species and identify ways to minimize these threats. Our discussions have highlighted that the major threat to all tarsier species is habitat destruction. For example, when Tangkoko Nature Reserve was set up in 1980 it contained approximately 8000 ha with an equivalent sized buffer zone surrounding the reserve (MacKinnon & MacKinnon 1980). By 1990, the buffer zone was completely destroyed and was replaced by coconut plantations (SG, MS, pers. obs.). The lushness of the coconut plantations fools many tourists concerning the actual threat of deforestation. In 1995, Yopie Muskita (personal communication) while working for WWF measured the boundaries of Tangkoko. He found that the boundaries of the reserve had been encroached upon substantially by neighboring communities, such that the reserve was less than 6000 ha. A few years later the Indonesian government downgraded the status of half of Tangkoko from *kawasan konservasi* (conservation area) to *hutan wisata* (recreation forest), a move that allowed greater legal exploitation of the reserve. The useful area of the reserve was reduced still further by forest fires, which the local people were unwilling to fight owing to a political struggle in which they saw their right to profit from ecotourism within the park being encroached upon by outside interests. (Unpublished, interviews with locals). It needs to be emphasized that, in spite of this, Tangkoko of this the more successful protection areas at limiting explorations and habitat destruction, when such activities are feasible. Unfortunately, there is no end in sight to this destruction. Additional lobbying of the government regarding its policies toward forest concessions and conservation needs to be conducted.

Also, it is imperative that nature reserves be set up in areas where tarsiers exist, but there are no protected areas. Tarsier species / populations that presently lack any protected areas include: *Tarsius bancanus natunensis*, *T. b. saltator*, *T. pelengensis*, *T. sangirensis*, Togian form, and Selayar form. Of these six species / populations that do not occur within a protected area: one is Critically Endangered (*Tarsius bancanus natunensis*), four are Endangered (*Tarsius pelengensis*, *Tarsius sangirensis*, Togian form, and Selayar form) and one is Vulnerable (*Tarsius bancanus saltator*), but near the threshold for Endangered.

While the development of nature reserves is important, more efforts need to be expended toward enforcing these protected areas. At present we do not know of a single protected area (nature reserve or national park) that is not being exploited by the community—local regional, and/or national—in ways that are incompatible with the legislation for protected areas. These include: mines in Dumoga Bone (that use very primitive techniques with toxic runoff into the watershed), 5000 traditional slash and burn horticulturalists in Morowali, rattan harvesters and squatters in Lore Lindu and Tangkoko being downgraded to recreation forest from a protected area following years of extensive harvesting. It is our opinion that, in the short run, the health and vitality of the tarsier populations will be dependent upon actual enforcement of the rules governing protected areas in Indonesia, although the outlook for this is not good at present. At some point, we hope that public compliance with conservation laws will be the norm and actual enforcement will no longer be as critical.

In the meantime, we recognize that these protected areas do not have the resources for patrolling and maintaining these areas. Following John Oates' (1999) publication, "Myth and Reality in the Rain Forest," we would like to suggest that a trust fund be set up for each nature reserve / national park within Indonesia. The dividends earned from these funds could then be used to pay guard's salary and materials / equipment needed to protect the boundaries and contents of the reserve. Imagine if one million dollars were put into a trust fund for

Tangkoko. The dividends invested conservatively accruing a meager 5% annual would bring in \$50,000 per year. That is more than sufficient to provide the resources to protect it.

Efforts need to be made to minimize the pet trade of tarsiers. During this workshop, some participants went to the animal markets. Several tarsiers were for sale. They found that the cost for a single tarsier was approximately one million rupiah, or slightly less than \$100. However, our own experience is that local people may try to sell tarsiers for as little as 5,000 rupiahs (\$0.50). The mortality rate between the trapper and the market in Jakarta is thought to exceed 75%. Efforts to encourage confiscation of these animals at the markets needs to be made by the Indonesian police, not just rescue centers. Also, additional penalties to discourage the pet trade need to be developed.

If all efforts to conserve tarsiers within Indonesia come up wanting in the short and medium term, then the only hope for some of the more threatened species is *ex situ* conservation. Although all previous efforts have failed (Fitch-Snyder 2003), reports by Severn et al. (this volume) and Dahang et al. (this volume) offer some promise that *ex situ* conservation of tarsiers will be feasible in the near future. Critical for this to happen will be either a sincere desire by Indonesian authorities to work in cooperation with foreign centers of expertise and funding, or a concerted and determined effort to develop such a project on their own.

In summary, tarsier species / populations vary greatly in their respective threat of extinction. Some small, insular populations, such as those on Serasan and Siau Islands are probably at imminent risk of extinction. What is most troubling is that, while we are able to estimate with some degree of precision those populations at greatest risk, we know of no solution in operation that is effectively reducing that risk.

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