

Home range and movements of male translocated problem tigers in Sumatra

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ABSTRACT

The ranging behaviour of translocated problem tigers is poorly understood. The demand for releasing problem tigers back to the wild increases following the increasing the number of problem tigers that needs to be rescued in Sumatra in the last decade. In this study we estimate the home range size and obtain information on daily range of four translocated problem tigers, as well as discussing some potential factors determining the size of home range and their movement. We translocated four adult males Sumatran tigers (*Panthera tigris sumatrae*) caught after killing domestic animals or rescued from traps set up by villagers for capturing deer and wild boar. The tigers were released following 16-225 days rehabilitation. All were fitted with global positioning system collars and released 74-1,350 km from their capture site. The length of time needed by each tiger for establishing home range was between 6 and 13 weeks. The home range size of each individual tiger estimated with 100% minimum convex polygon varies between 67.1 km² and 400 km², while estimations with a 95% fixed kernel methods were between 37.5 km² and 188.1 km². The difference in home range size established by each translocated tigers indicates the variability of the range size even within a subspecies. The maximum distance moved each tiger in one day was different, the range was 8.5-18.9 km. Although preliminary, these data may be useful for improving future translocation of problem tiger, as this study was the first ever conducted in Sumatra.

Key words: GPS collar, *Panthera tigris*, home range, movement, Sumatran tiger, translocation

INTRODUCTION

Translocation has been used for decades as a tool for alleviating livestock depredation by large carnivores such as brown (*Ursus arctos*) and black bears (*U. americana*) (Armistead *et al.*, 1994; Blanchard & Knight, 1995), wolves (Fritts *et al.*, 1984; Bangs *et al.*, 1998), and wild felids (Rabinowitz, 1986; Stander, 1990; Ruth *et al.*, 1998) including tigers (Seidensticker *et al.*, 1976; Nowell & Jackson, 1996; Goodrich & Miquelle, 2005). The process involves capturing a specific, problem-causing individual alive in the area of conflict, transporting it to another area, and releasing it. Translocation of large carnivores is also believed to be one of potential conservation method to reduce mortality, mitigate conflicts, and supplement or re-establish wild population (Griffith *et al.*, 1989; Wolf *et al.*, 1997). In general, carnivores translocated for conflict management have shown strong homing abilities, poor survival and reproduction, and a tendency to resume predation on livestock (Linnell *et al.*, 1997). Yet despite high mortality of translocated individuals, public perception of translocation as a nonlethal technique makes this a popular management tool that will most likely continue to be used (Craven *et al.*, 1998), especially for species that are rare or endangered (Linnell *et al.*, 1997; Bradley *et al.*, 2005).

The Sumatran tiger (*Panthera tigris sumatrae*) is the last remaining tiger subspecies in Indonesia after both Bali tiger (*P. t. balica*) and Javan tiger (*P. t. sondaica*) went extinct in 1940's and 1980's, respectively (Seidensticker *et al.*, 1999). This sub species also faces many threats for their future survival (Seidensticker, 1986; Seidensticker *et al.*, 1999). Human-tiger conflict in Sumatra has been identified as one of key problem in tiger conservation as this can lead to direct fatalities and reduced support for their long term survival. It is also one of the factor which motivates people to capture or kill tigers (CITES, 1999). Nyhus & Tilson (2004) have collected scattered reports on human-tiger conflict and characterized it according to the victims. They showed that 146 people were killed by tigers in Sumatra with a further 30 people injured during the period of 1978-1997. A total of 870 livestock were killed by tigers during the conflict at same period of time. Further, they also stated that approximately 250 tigers were killed within those 20 years in response to tiger attacks. It has recently been reported that 57 people were killed and another 81 people injured and at least 326 livestock were killed by tigers as a result of human-tiger conflict between 1998 and 2011 (Sumatran Tiger Conservation Forum, unpublished). This conflict also has resulted 69 tigers being removed from the wild and either killed or sent into one of the ex-situ conservation center.

The home range and movement of animals are affected by their surroundings and the distribution of the resources they need to grow, reproduce and survive (Begon *et al.*, 1986). The spatial ecology and movement patterns of predators are influenced by key habitat features that determine the distribution of their prey (Valeix *et al.*, 2010). The movement patterns of predators are also affected by competition that for some species results in territoriality (Gordon, 1997). The advantage of defending a territory must exceed the cost of doing so regardless whether it is a solitary or group-living animal (Gordon, 1997). A study conducted by Franklin *et al.* (1999) suggested that the home range of an adult female Sumatran tiger in a lowland area in southern Sumatra varied between 50-70 km² while an adult male around 110 km². Griffiths (1994) stated that the home range of an adult male of Sumatran tiger varies from about 180 km² at the lowland area (100-600 meter above sea level/asl), 274 km² at the area of 600-1,700 meter asl, and 380 km² at the area with elevation beyond 1,700 meter asl. The home range of an adult male can be twice of the home range size of a female (Franklin *et al.*, 1999). The home range of a tiger is largely determined by the prey species availability (Santiapillai & Ramono, 1985; Griffiths, 1994). Similar to the other subspecies, the Sumatran tiger is adaptive to a wide range of environments as long as sufficient prey and water is available (Schaller, 1967; Sunquist, 1981; Seidensticker *et al.*, 1999), and as long as there is a low threat level from humans. The Sumatran tiger mainly preys on large Cervidae and Suidae such as sambar deer (*Rusa unicolor*) and wild boar (*Sus scrofa*) (Wibisono, 2006), but occasionally they are also hunt various alternative prey such as barking deer (*Muntiacus muntjac*), mouse deer (*Tragulus* sp.), pangolin (*Manis javanica*), great argus (*Argusianus argus*) and pig-tailed macaque (*Macaca nemestrina*) as well as sun bear (*Helarctos malayanus*) (Tilson & Nyhus, 2010). Other study in a boreal forest in Russia showed that the average home range size of male Siberian tiger is 1,385 km² while the average of female home range is 390 km², significantly smaller than a male home range (Goodrich *et al.*, 2010). There were some studies on estimating the home range size and the movement of wild Sumatran tigers (Griffiths, 1994; Franklin *et al.*, 1999; Maddox *et al.*, 2007; Tilson & Nyhus, 2010), but a similar study on translocated problem tigers has never been conducted, making the assessment of tiger translocation success difficult to be measured.

In Sumatra, estimation of translocated problem tiger home range and their movement is needed for knowing their ranging behaviour in their new 'home', clearly essential information for considering future tiger translocations. Information on such tiger movement is also required to help design monitoring programmes for the species. Radio or global positioning system (GPS) collars are useful for collecting such information. The objectives of this study were therefore to use GPS collars to acquire preliminary estimates of the home range size and movement of the male translocated problem tiger in Sumatra's forest.

MATERIALS AND METHODS

Tiger translocation data

Between 2008-2010 we worked with the Indonesian Ministry of Forestry of Directorate General Forest Protection and Nature Conservation, as well as with other partners such as Sumatran Tiger Conservation Forum, WCS Indonesia Program, FFI Indonesia Programme, The Taman Safari Indonesia, Artha Graha Peduli, BPKEL, Veswic, and PanEco/YEL to resolve human-tiger conflict in ways that protect citizens' welfare while retaining of-fending tigers in the wild.

To the best of our knowledge, aside from our own four translocations above, there have only been 12 other translocations of problem or rescued tigers in Sumatra. However these 12 releases were not well monitored. Yet we do know that one of the 12 translocated tiger was trapped and killed seven months after release in a steel wire snare set up by local people to capture pests (wild boar) in agricultural land about 25 km from the release site. A second tiger was found dead in a plastic rope snare set up by a poacher to capture serow in the middle of the forest about 10 km from it release site, only six days after released. Finally, a third translocated adult female tiger was recaptured as she was seriously injured after less than 3 months released, and she gave a birth of three cubs in holding facility.

Given the lack of data on the 12 cases describe above, we focus on the four situations in which we translocated these problem tigers that could not be otherwise discouraged from conflicts with people. We translocated the four male problem tigers (Table 1) 74-1,350 km from their capture sites. Three (AM-1, AM-2 and AM-3) were captured after often entering villages and killing livestock's and one (AM-4) after it was rescued from a pit-fall trap set up for capturing deer. AM-1 and AM-2 were rehabilitated in an about 3 ha enclosure at Tambling Wildlife Nature Conservation in southern Sumatra (just only about 5 km from planned release site) for 21 days following 204 and 188 days kept in a 3x2x2 meters iron bars cages at the origin locations, respectively. The enclosure contained natural forested habitat in remote area. To minimize conditioning to human, during rehabilitation period the tigers fed daily by one person, who left the food and vacated the area as quickly as possible. AM-3 and AM-4 were treated in the local forestry office in northern Sumatra and in Sawah Lunto Zoo in West Sumatra for 42 and 16 days, respectively. All tigers were fed mostly chicken. Tiger AM-1 weighed 122 kg and estimated around 6 years old. Tiger AM-2 weighed 73 kg and estimated around 4 years old. Tiger AM-3 weighed 98 kg and estimated around 4 years old. Tiger AM-4 weighed 75 kg and estimated around 2 years old. The age of the tiger estimated by the vets based on canine length and discolouration of the teeth. All tigers were fitted with GPS collars (Televilt, Lindesberg, Sweden and Argos/Sirtrack Ltd., Hawkes Bay, New Zealand) and released at three different time and location across Sumatra island.

AM-1, AM-3 and AM-4 were tracked for 7.5 months (224 days), 2.5 months (79 days) and 8 months (238 days), respectively, until their GPS collar stopped working. AM - 2 was tracked for 8.5 months (253 days) until GPS collar dropped off automatically. The frequency of location acquisition by the GPS collars were one location per hour for AM-1, one location per day for AM-2, and one location per 30 minutes for AM-3 and AM-4. The GPS locations from the collars were used to construct minimum convex polygon (MCP) (Southwood 1996; Barlow 2011) and fixed kernel (FK) home ranges using the geographical information system *ArcGIS v. 9.3* (ESRI, Redlands, California) and the *ArcGIS* extension *Hawthstool v. 3.6*. The same extension of *ArcGIS* was also used to determine mean and maximum distance moved per day.

Study site

The first and the second problem tigers (AM-1 and AM-2) were released at the same time and the same location in the southern part of Bukit Barisan National Park (BBSNP), the third one (AM-3) was in the northern part of Gunung Leuser National Park (GLNP), and the fourth (AM-4) was released in the eastern part of Kerinci Seblat National Park (KSNP) (Figure 1). Tigers were released into known tiger habitat but without any analyses of social structure or current estimation on tiger and prey densities in those specific areas.

Bukit Barisan Selatan National Park (BBSNP) release site

Employing hercules and cassa airplanes AM-1 and AM-2 were flown 1,350 km from their origin location in Northern Sumatra to their release site within BBSNP in Southern Sumatra. BBSNP is the third largest protected area (3,568 km²) on the Indonesian island of Sumatra

(O'Brien *et al.*, 2003). Located in the extreme southwest of the island, the park covers more than 150 km of the Barisan Mountain Range, and it is bordered by villages, agriculture and plantation forestry. Rainfall is seasonal, ranging from 3,000 mm to more than 4,000 mm except during ENSO (El Niño-Southern Oscillation) events when droughts occur. Temperatures fluctuate from 22 to 35°C. Both problem tigers were released in a mosaic area of lowland forest, plantation and mixed agriculture. MODIS (Moderate-resolution Imaging Spectroradiometer) land cover classification shows that this area is dominated by regrowth vegetation and plantation. The range of elevation is 0-500 meter asl with mostly flat and hilly terrains. O'Brien *et al.* (2003) found that the tiger density around this area was 1.6 tigers/100 km², and likely the main tiger prey in this area are wild boar (*Sus scrofa*) and sambar deer (*Rusa unicolor*).

Gunung Leuser National Park (GNLP) release site

Using a helicopter AM-3 was dropped at the release site in a remote area in the northern part of GLNP, at about 200 km from the area where he was captured in the same province in northern Sumatra. The GNLP is the largest conservation area in the region, covers forested area more than 10,000 km². It lies within a larger landscape called the Leuser Ecosystem which is covers the area close to 26,500 km². The Leuser and the Ulu Masen Ecosystems which are both connected to each other is a larger tiger conservation landscape in the world (Wibisono & Pusparini, 2011). The park represents several ecosystem types, from coastal and peat swamp forests at 0-5 meter asl through tropical lowland forest, and up to montane forest ecosystems at the altitude of about 3,400 Most of the area of the park is covered by thick dipeterocarp forest and hilly and mountainous terrain. meter asl. As such the other places in

Table 1. Characteristic of male problem tigers captured & translocated in Sumatra during 2008 - 2010.

Tiger	Estimated age (years) ^a	Physical condition ^b	Reason captured	Days quarantined and released date	Translocation distance (km)	Fate after translocation
AM-1	6	Good	Entered village; predated livestock	225 (22 Jul 2008)	1,350	Killed 7 goats in the first 2 weeks; survive 7.5 months & then GPS collar stop working
AM-2	4	Good	Entered village; predated livestock	209 (22 Jul 2008)	1,350	Survive 8.5 months & then GPS collar released automatically
AM-3	4	Good	Entered village; predated livestock	42 (27 Dec 2008)	200	Survive 2.5 months and then GPS collar stop working
AM-4	2	Good	Accidentally trapped	16 (20 Dec 2010)	74	Survive 8 months and then GPS collar stop working

^{a)} At time of translocation; ^{b)} Rated as poor, fair, good, very good, or excellent based on veterinary assessment before released

Sumatra the rainfall is seasonal, annually ranging from 2,000 mm to about 3,000 mm. Temperatures fluctuate from 21°C to 28°C. The release site of tiger AM-3 is a mixture of flat hilly terrain lowland and hilly steep terrain submontane forest up to the elevation of 1,500 meter asl. According to the MODIS land cover classification, this area dominated by lowland forest, regrowth vegetation and lower montane forest. Wibisono & Puspawati (2011) reported that the minimum density of tiger around this area was 0.3 tigers/100 km². They also found that the main prey species within this area were sambar deer (*Rusa unicolor*), wild boar (*Sus scrofa*) and barking deer (*Muntiacus muntjac*).

Kerinci Seblat National Park (KSNP) release site

We drove AM-4 during the night to avoid sun heating to the release site in the eastern part of KSNP, at about 74 km from it originally came from in the same province of West Sumatra. The KSNP covers an area of about 13,700 km², includes a highest volcano in the country with the peak reaches 3,800 meter asl and a 10 km² of volcanic lake at the elevation of 2,000 meter asl. It lies within a warm per-humid bioclimate (Whitmore, 1984) that supports four broad forest types: lowland hill (0-300 meter asl), hill (300-800 meter asl), submontane (800-1,400 meter asl) and montane (above 1,400 meter asl) (Linkie et al., 2006). The mean of annual rainfall is about 3,000 mm and the temperatures fluctuate from 7 to 28°C. The park contains large blocks of forest that extend outside to form a larger forest landscape (Linkie et al., 2006). Nevertheless, agricultural expansion has fragmented KSNP into two parts and poaching of tiger prey has degraded habitat quality in sections of KSNP (Linkie et al., 2003). AM-4's release site is a mosaic area of lowland forest, plantation, submontane and montane forests with the range of elevation from 500-3,000 meter asl. The area is dominated by flat and hilly as well as some very steep terrain. The MODIS land cover classification shows that this area mostly covered by lowland forest, regrowth vegetation and plantation and large scale oil palm plantation. Most of eastern side of the park is bordering with oil palm plantation area. Linkie et al. (2006) predicted that the density of tiger in KSNP area was around 1.5-3.3 tigers/km². Dinata & Sugadrjito (2008) identified that the main prey species

in the lowland area of the park were wild boar (*Sus scrofa*), sambar deer (*Rusa unicolor*) and barking deer (*Muntiacus muntjac*).

RESULTS AND DISCUSSION

Straight line distance and maximum distance moved

Using one location per hour (AM-1) the estimated straight mean line distance moved was 4.39 km day⁻¹ (range 0.07-17.83 km day⁻¹), while with one location per day (AM-2) 1.31 km day⁻¹ (range 0.03-9.29 km day⁻¹). Employing one location per 30 minutes (AM-3 and AM-4) the estimated straight mean line distance moved were 2.75 km day⁻¹ (range 0.01-8.47 km day⁻¹) and 3.24 km day⁻¹ (range 0.01-18.85 km day⁻¹), respectively. Maximum distance moved per day was 17.83 km for AM-1, 9.29 km for AM-2, 8.47

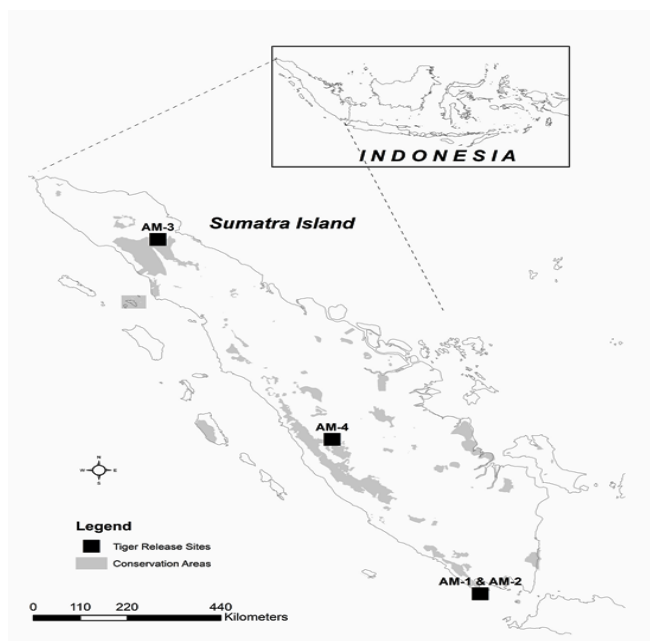


Figure 1. Release sites of four translocated male problem tigers in Sumatra, Indonesia (AM-1 and AM-2 in Bukit Barisan National Park; AM-3 in Gunung Leuser National Park and AM-4 in Kerinci Seblat National Park).

Table 2. Summary of time consumed for establishing home range, home range size and distance moved by each male translocated tiger at their new area.

Tiger	Release location	Age (years)	Time consumed for establishing home range (week)	100% MCP home range (km ²)	95% FK home range (km ²)	50% FK home range (km ²)	Mean of straight line distance (km)	Maximum distance moved (km)
AM-1	BBSNP	6	10	191.2	140.9	27.9	4.4	17.8
AM-2	BBSNP	4	11	67.1	37.5	4.9	1.3	9.3
AM-3	GLNP	4	8	236.0	141.2	28.9	2.8	8.5
AM-4	KSNP	2	17	400.0	188.1	42.2	3.2	18.9

km for AM-3 and 18.85 for AM-4 (Table 2). A similar study in Sundarbans, Bangladesh, reported that the average of daily travelled by female tiger was about 2.9 km, and an average of maximum distance moved per day by adult female was 10.8 km (Barlow *et al.*, 2011).

Home range size

The GPS collars recorded 3,469 locations for AM-1 during July 2008-February 2009, 253 locations for AM-2 during July 2008 - March 2009, 1,486 locations for AM-3 during December 2008 - March 2009, and 7,007 locations for AM-4 during December 2010 - August 2011. Location-area curves indicated that 100% MCP home range were acquired after about 10, 11, 8 and 13 weeks for AM-1, AM-2, AM-3 and AM-4, respectively. The cumulation of weekly home ranges established by each translocated tiger is shown in Figure 2. The MCP technique was used for home range size calculation, because this is one of the oldest techniques for home range estimation and comparable between species globally (Sankar *et al.*, 2010). The individual 100% MCP home ranges were 191.2

km² for AM-1, 67.1 km² for AM-2, 236 km² for AM-3 and 400 km² for AM-4. The 95% and 50% FK home ranges size of each tiger were 140.9 and 27.9 km² for AM-1, 37.5 and 4.9 km² for AM-2, 141.2 and 28.9 km² for AM-3, 188.1 and 42.2 km² for AM-4 respectively (Figure 3).

AM-1 and AM-2 were released at the same time and same site in Selatan, but interestingly the 100% MCP home range constructed by both tigers was seen significantly different where AM-1's (191.2 km²) at almost three times larger than AM-2's (67.1 km²). During 7.5 months observation almost 100% home range of AM-2 overlap with AM-1's or AM-2 established its home range within the home range of AM-1. This indicates that the male tiger home range is not exclusive, by means that an area occupied by one male tiger might also be used by another male at different time. But, in this case probably AM-1 more dominant than AM-2 as AM-1 could explore much larger area and has more opportunity to find females, while AM-2 often roaming around the village, but there was no report from the people about livestock depredation by the tiger after two weeks post release.

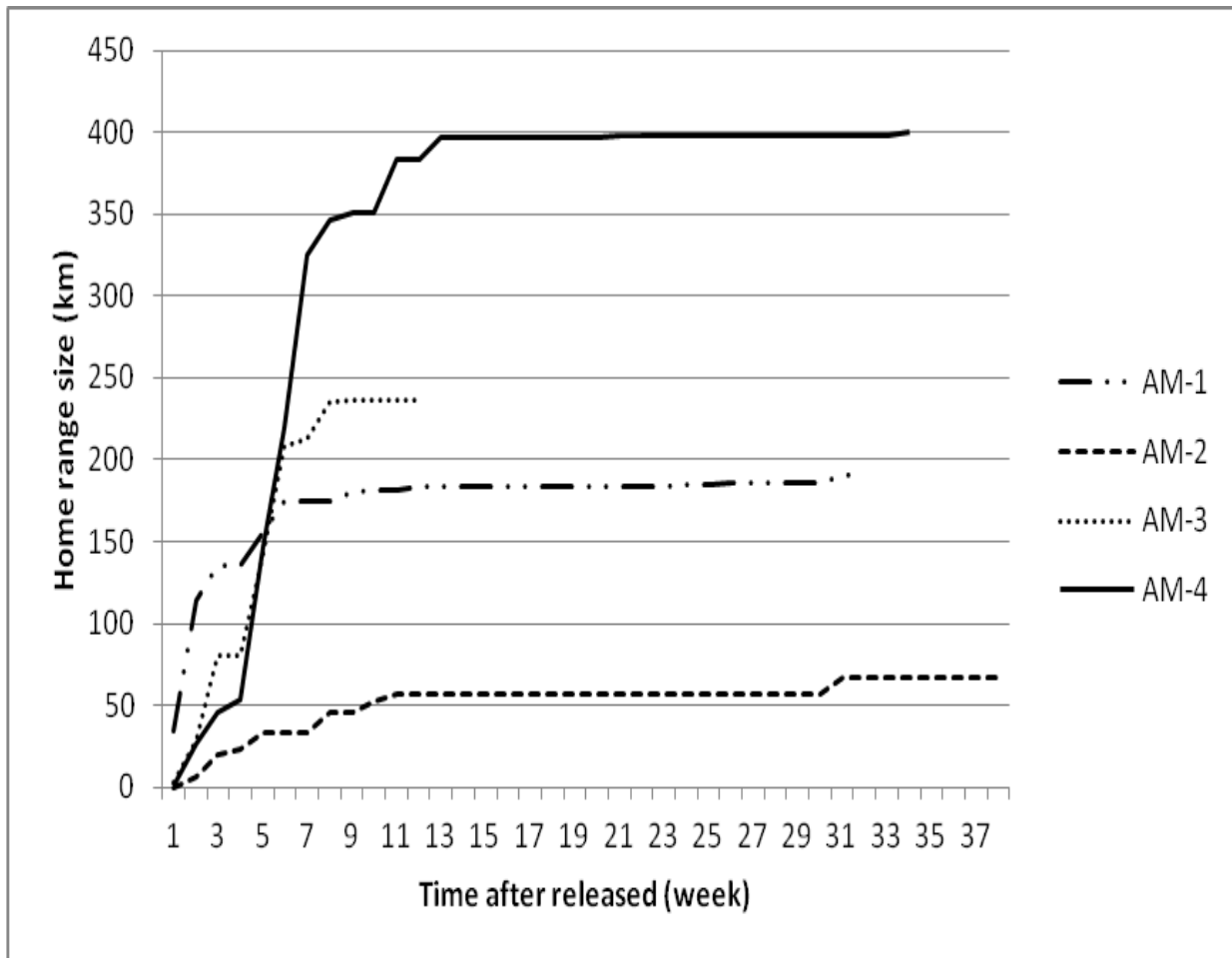


Figure 2. The cumulation of weekly home ranges established by each translocated tiger in their new areas.

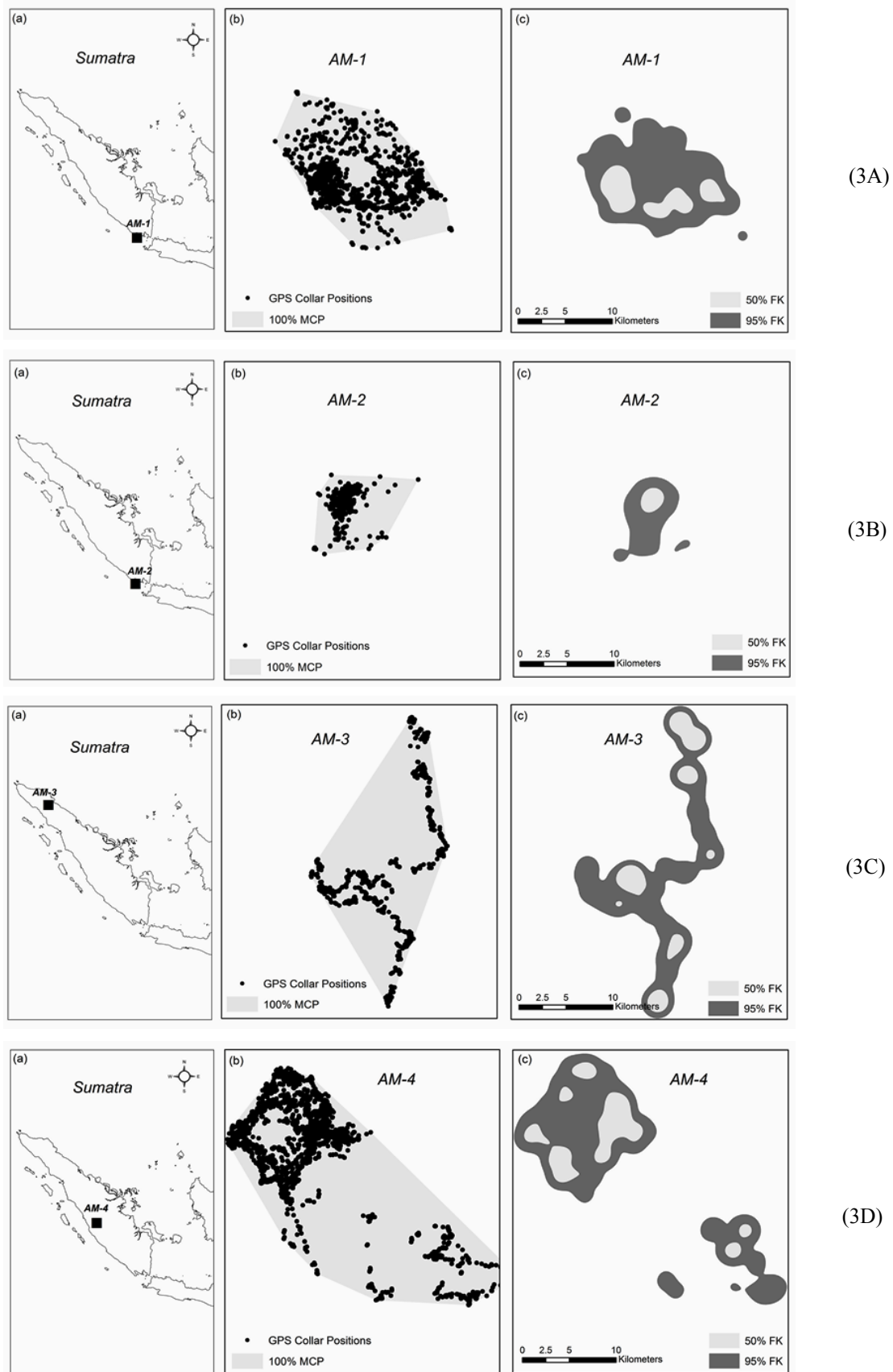


Figure (3A—3D). (a) The island of Sumatra with showing each release site and the estimates of home range of each translocated male problem tigers (AM-1, AM-2, AM-3 and AM-4) in their new area constructed by (b) 100% minimum convex polygon (MCP) and (c) 50% and 95% fixed kernel (FK) methods.

The one 100% MCP home range constructed by studied male tiger (AM-4 the one in KSNP) is the largest among recorded male tigers home range, compared with all other earlier estimation in Sumatra and the other subspecies, except Amur tiger (Table 3). This indicates that the home range size of the tiger varies greatly within a subspecies. The home range size is not only determined by the abundance of prey species but also by the density of local tigers that already occupy the area as well as their social structure. It will be difficult, especially for male translocated tiger, to establish its permanent home range while in the area there is a resident adult male roaming around. Either the resident one or a translocated one must be shifted or eliminated from the area. Looking to the other factor, the size of AM-4 home range probably affected by the density of tiger in KSNP, which was higher compare to other locations in Sumatra, and also affected by the low of the abundance of prey species (Table 4). The abundance of prey species plays an important role in determining the home range size of a tiger (Ahearn *et al.*, 2001). A male tiger translocated to a local tiger-empty area successful establishing 168.6 km² area for its home range within a high density of prey species and biomass (Sankar *et al.*, 2010). Although it may not have sufficient data, on this study we also found an indication that home range size established by those translocated tigers closely related to the relative abundance (RA) of main prey species in each area. AM-4 established a 400 km² MCP home range at the area with prey species RA of 0.31 km⁻¹, AM-3 established a 236 km² MCP home range at the area with prey species RA of 0.45 km⁻¹ and AM-1 and AM-2 established a 191.2 and 67.1 km² MCP home range, respectively, at the area with highest prey species RA of 0.80 km⁻¹. In addition, the mean of 100% MCP home range size generated from AM-1 and AM-2 (129 km²) which were released in the lowland forest of BBSNP (Table 3), almost the same size with previous estimation (Franklin *et al.*, 1999). He predicted that the male tiger home range size in lowland forest of Way Kambas National Park was 110 km².

Distance to water sources

Three of four tigers spent more than 60% (75% for AM-1, 95% for AM-2, 60% for AM-3 and 36% for AM-4) of their time always close (at a distance of less than 500 meters) to water sources (Figure 4). This finding supports previous statements that water is one of important component for tiger survival (Schaller, 1967; Sunquist, 1981; Seidensticker *et al.*, 1999). Basically, tigers will choose the habitats that can support their survival, that is the habitat with adequate prey species and the availability of water sources (Sunquist & Sunquist, 1989). Dinata & Sugardjito (2008) stated that there is a positive correlation between tiger abundance and the distance to river, where the abundance of tiger is higher in the area close to the river. They argued that the area close to the river is the area where tiger prey like ungulates occurs. Such area is an alluvial that very rich with nutrients which is needed by the ungulates. Lynam *et al.*, (2000) suggested that the tigers rely heavily on

dense vegetation and sufficient prey as well as access to the water sources. It means that very important to link between the watershed conservation management with a tiger conservation. Beside that, also important to ensure the water sources availability when considering and assessing an area for tiger translocation.

RECOMMENDATIONS

Further estimates of home range size and movement distance of translocated tigers in Sumatra are required to improve tiger future translocation and to help designing monitoring approaches for translocated tigers across the whole island. Despite being preliminary the finding of this study highlight the conservation value of tiger translocation and have provide valuable information for evaluating the effectiveness of tiger translocation activity.

Thus, the conservation implication of this study is it might be best to translocate tigers to the areas where there are very low tiger density, lowest possible human threats, and sufficient prey base, as well as a lot of access to water sources. Future research can focus on assessing the best areas in Sumatra to release tigers based on these variables.

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Table 3. Comparison of estimates of mean home range sizes of adult male among tiger studies, with data collection technique, number of tigers (n) and references.

Subspecies	Site	Data collection technique*	n	Mean home range size (range; km ²)	Reference
Bengal	Chitwan	RT (MCP)	2	52.5 (44.7-60.2)	Sunquist (1981)
	Panna	RT (MCP)	1	243	Chundawat <i>et al.</i> (1999)
	Nagarahole	RT (95% MCP)	4	43 (25.7-57.8)	Karanth & Sunquist (2000)
Amur	Shikote-Alin	RT (MCP)	5	1,385	Goodrich <i>et al.</i> (2010)
Sumatran	Way Kambas	CT (MCP)	1	110	Franklin <i>et al.</i> (1999)
	BBSNP	GPS (100% MCP)	2	129 (67.1-191.2)	This study
	Jambi	RT (95% MCP)	1	12.2	Maddox <i>et al.</i> (2007)
	KSNP	GPS (100% MCP)	1	400	This study
	GLNP	CT (MCP)	3	278 (180-380)	Griffiths (1994)
	GLNP	GPS (100% MCP)	1	236	This study

Table 4. Estimates of tiger density and the relative abundance of tiger and prey species and physical characteristics within each locations of translocation.

Tiger	Release location	100% MCP home range (km ²)	Tiger density (tiger/100 km ²) ^{a)}	Tiger RA (sign/km) ^{b)}	Prey species RA (sign/km) ^{b)}	Majority of land cover ^{c)}	Elevation (m asl)	Dominant terrain
AM-1	BBSNP	191.2	1.6	0.05	0.8	Mosaic plantation/ regrowth vegetation and lowland forest	0-500	Flat
AM-2	BBSNP	67.1	1.6	0.05	0.8	Mosaic plantation/ regrowth vegetation and lowland forest	0-500	Flat
AM-3	GLNP	236.0	0.3	0.01	0.45	Mosaic plantation/ regrowth vegetation and lowland to lower montane forest	0-1,500	Steep-very steep
AM-4	KSNP	400.0	1.5 to 3.3	0.09	0.31	Mosaic plantation/ regrowth vegetation and lowland forest and large scale oil palm	500-3,000	Flat-rather steep

MCP, minimum convex polygon; RA, relative abundance; a) BBSNP (O'Brien *et al.*, 2003), GLNP (Wibisono & Pusparini, 2011), KSNP (Linkie *et al.*, 2006); b) Calculated from raw data collected by WCS Indonesia, LIF and FFI Indonesia; c) MODIS land cover classification.

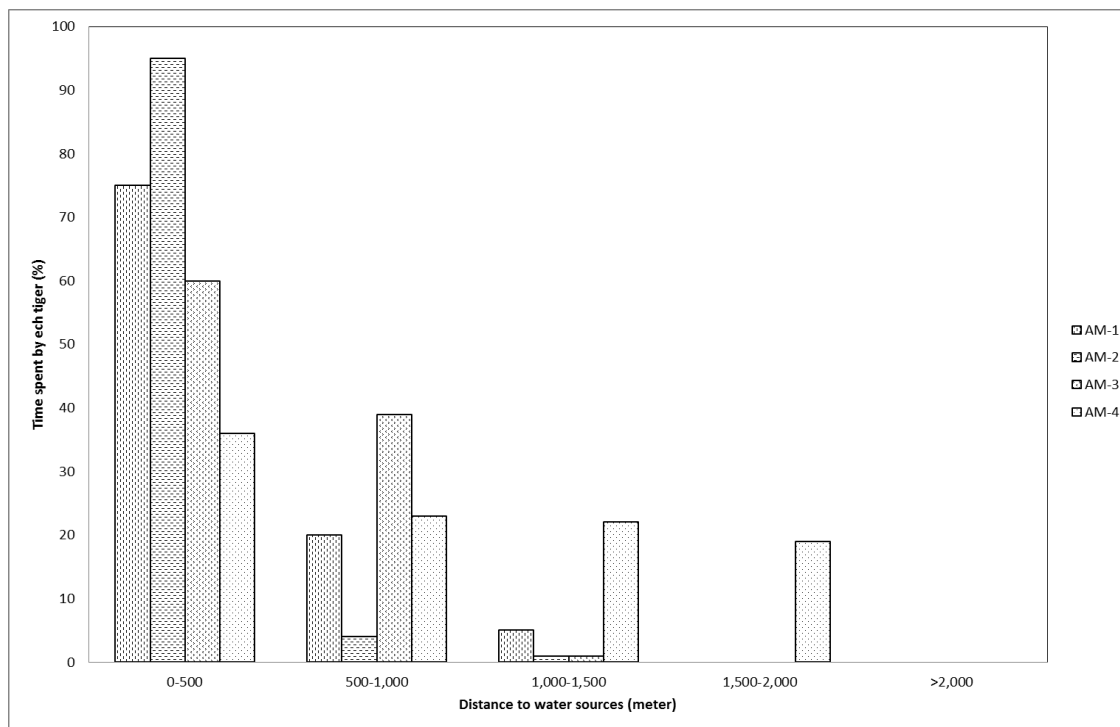


Figure 4. The percent (%) of time spent by each translocated male tigers in relation with the distance to the water sources in their new area.

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