Selection of Sumatra Elephants (Elephas maximus sumatranus Temminck, 1847) Toward Habitat Types

By Rizwar -

WORD COUNT 5605
TIME SUBMITTED 01-APR-2020 12:59PM
PAPER ID 57029275

Advances in Environmental Biology, 8(21) October 2014, Pages: 403-410

AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/AEB/

Selection of Sumatra Elephants (*Elephas maximus sumatranus* Temminck, 1847) Toward Habitat Types and Resources in Wildlife Sanctuary of Padang Sugihan, South Sumatra Province

[1]Rizwar, [2]Zulkifli Dahlan, [3]Dwi Setyawan, [3]Indra Yustian

[1]Ph.D student of Sriwijaya University, Palembang and Senior Lecturer of Biology Department, Faculty of Mathematics and Natural Science, Bengkulu University, City of Bengkulu, Bengkulu Province, Indonesia
[2]Biology Department, Faculty of Mathematics and Natural Science, Sriwijaya University, City of Palembang, Province of South Sumatra, Indonesia
[3]Soil Department, Faculty of Agriculture, Sriwijaya University, City of Palembang, Province of South Sumatra, Indonesia

ARTICLE INFO

Article history:
Received 4 September 2014
Received in revised form 24 November 2014
Accepted 8 December 2014
Available online 16 December 2014

Keywords:
Sumatran elephants, habitat sources, elephant feces, Padang Sugihan Sanctuary

ABSTRACT

The wildlife sanctuary of Padang Sugihan in South Sumatra province is the habitat of wild Sumatran elephants that have five types of plant communities (sub-habitats) of lowland wetland ecosystem such as mixed swamp forests, secondary forests, stands of *Melaleuca cajuputi*, inland marsh grasses and swamp grasses permanently waterlogged. This study focuses on a selection of wild elephants toward habitat types and resources including environmental factors such as the availability of food plants, the ratio of feed plant species consumed, the availability of tree barks, availability of trees for swiping body, denseness of canopy cover, presence of competitors, presence of predators, the distance of elephant presences to the water source and to the forest. Line transect method with 20 plots measuring 20 m x 20 m were established along the elephant trails characterized by the presence of traces of footprints and bolus piles of feces left on the soil surface in each habitat type. The number and plant species, the amount of feces each plot including the abiotic factors noted. Regression analysis and correlation test were used to determine the relationship of elephant presence related to the habitat types and resources. The study found that the wild elephants preferred inland marsh grass habitat than habitat of mixed swamp and secondary forests due to the abundant availability of food plants. Habitat of *Melaleuca cajuputi* stands was less chosen because of the relatively high human presence. From nine variable sources in habitat, four variables such as, the availability of food plants, the availability of tree barks, denseness of canopy cover and presence of animals competitors were the most decisive factors in the presence of the wild Sumatran elephants in sanctuary.

To Cite This Article: Rizwar, Zulkifli Dahlan, Dwi Setyawan, Indra Yustian., Selection of Sumatra Elephants (*Elephas maximus sumatranus* Temminck, 1847) Toward Habitat Types and Resources in Wildlife Sanctuary of Padang Sugihan, South Sumatra Province. ***Adv. Environ. Biol., 8(21),*** *403-410, 2014*

INTRODUCTION

The sanctuary of Padang Sugihan in South Sumatra province is a wildlife habitat facing the continuous pressures of local communities living in the surrounding area. Varieties of human activities in the sanctuary had affected on conversion, fragmentation, degradation, loss habitat and exploitation of natural resources. The habitat degradation and destruction have threatened the survival of the Sumatran elephant population, including endangered large mammals such as bears, tapirs and deers. Illegal logging of *Melaleuca cajuputi* stands and land fires in the dry season are a major factor that has degraded the sanctuary ecosystems. Most land fires that occur annually are as a result of local community activities [15,19, 31, 35].

Illegal logging and land fires have reduced the width of lowland swamp forest and opened forest cover so that they gave impact on the daily activities of elephants in sanctuary. The forests are an area for refuging, resting, foraging and socializing for elephants. Drastic changes of the microclimate such as air temperature and humidity reduces the composition of the forest vegetation so that the elephants are difficult to get the some types of food plants. The limitation of species variation and biomass availability in food plants could jeopardize the long-term preservation of elephants because it can reduce the elephant reproductive capacity and population density in habitat [12, 21, 22].

Corresponding Author: Rizwar, Faculty of Mathematics and Natural Science, Bengkulu University, Kandang Limun, City of Bengkulu 38371, Bengkulu Province-Indonesia. Fax.+62-73620919. HP.+62-813-77655-081
E-mail: rizwar.sikumbang@gmail.com_& war_ sikumbang@yahoo.com

Elephants are very rarely out of the natural habitat and prefer to stay in that protected area if it is properly maintained and provide the nutrient resources that they need. Because resources are generally not distributed evenly, elephants will always move from one habitat to another habitat. The preferred habitat is indicated to more frequency of certain habitat use by wildlife than other habitats [13, 16; 18]. Preferred habitat can be determined based on the number of signs left by elephants like feces, footprints and the rests of the food plants consumed in place [6, 33]. In contrast to the poor natural habitat, elephants prefer out of preserved area to destroy and raid crops of agricultures, plantations causing conflicts with local communities and plantation companies [4, 5, 30].

Kinnaird *et al*. [11] stated that the Sumatran elephants always avoided from the forest boundary to 3 km into the jungle. Elephant population more preferred undisturbed forest habitat. While study of Rood *et al*. [22] found that population of elephants more preferred habitat of lowland primary forest with dense canopy, about 75% of the food availability, no large herbivores and predators, and away from human disturbance. While Rood *et al*. [23] proved that a group of elephants prefer to stay in the small area of isolated forest on the slopes of the mountain than lowland forests opened continuously to agricultural areas.

Osborn [18] conducted a study of African elephant preferences (*Loxondonta africana*) against four types of habitat that consists of four kinds of habitats represented by four main vegetation like Vellozia-Julbernardia woodland, grassland, Brachystegia-Combretum shrub land and Colo-mopane mix woodland. Results of the study showed that overall; there is no difference to the choice of the elephant population against the four habitat types.

In Sumatra-Indonesia, most studies of elephants more focus on the estimation of elephant densities in the highland forests using a variety of methods to monitor the impact of habitat destruction on the population decline [10, 14, 34] but few analyzing the elephant selection toward habitat types and resources in ecosystem type of lowland wetland. Therefore, the study about this topic is very important to improve the conservation and survival of elephants in the long term [8, 14].

This study aims to assess the elephant selection regarding the habitat types and resources in the Padang Sugihan sanctuary in South Sumatra Province. The study was focused on four habitat types in that reserve area used by Sumatran elephants for daily their activities. This study is expected to contribute in the fields of science, especially in the habitat management of endangered species in lowland-wetland ecosystem. On the practical side, results of study can help the policy makers and the "users" that had been experiencing problems in managing the conservation of Padang Sugihan sanctuary especially in conserving elephant population “in situ".

MATERIALS AND METHODS

Description of study sites:

Padang Sugihan sanctuary is a lowland area with a wetland ecosystem type affected by the tides. This preserved area is located in the East of Palembang city with longitude coordinates between 105^{o} 00' - 105^{o} 20' East and 2° 30' - 3° 00' South and has an area of approximately 71807 hectares. Administratively, sanctuary is under management of the government of Ogan Ilir and Banyuasin Regencies and is located between several surrounding areas [3, 35] as follows:

1. North side of reserve area is adjacent to the transmigration area of Line 21.
2. West side of protected area borders on Air Padang River.
3. South side borders on Air Buntung River.
4. East side is adjacent to Air Sugihan River and Jerambah village.

Five types of vegetation communities that cover the preserve area that is, mixed swamp forests, secondary forests, stands of *Melaleuca cajuputi*, inland marsh grasses and marsh grasses permanently waterlogged such as *Paspalum conjugatum*, *Eleusine sp, Cyperus sp* and *Fymbristylis sp*. While, wild faunas include Sumatran elephant (*Elephas maximus sumatranus*), gibbon (*Symphalangus syndactylus*), deer (*Cervus unicolor*), estuarine crocodile (*Crocodylus porosus*), freshwater turtle (*Tryonix cartilagoneous*), and a variety of rare bird species and kinds of swamp fishes [35]. The study was conducted over 10 months from September 2012 until July 2013.

Elephant selection toward habitat types and resources:

The elephant preference to habitat types and resources in Padang Sugihan sanctuary is determined by the closest several environmental factors that affect elephant’s life such as, kinds of vegetation communities, the availability of food plants, the ratio of food plant species eaten, the availability of tree barks, availability of trees for rubbing their body, denseness of canopy cover, presence of competitors, the presence of predators, the distance from the water source and the distance from the forest canopy to elephant activity areas.

Preference of elephants regarding the types of habitat known to some of the differences in the number of feces distribution found in those habitats. The much more number of elephant feces on certain habitat reflect the preferred habitat by the elephants. Twenty (20) plots of 20 m x 20 m in size were established along the elephant trails characterized by the presence of traces of footprints and a pile bolus of feces left on the soil surface at each

habitat type [1, 20, 21]. Next, elephant preference toward the kinds of habitat sources could be determined by calculating the availability of source numbers in habitat and correlates to the numbers of elephants feces counted in that habitat. The availability of elephants food plants in particular habitat was calculated with counting the numbers of food plants divided by the numbers of whole plants in plot multiplied by 100 percent [24].

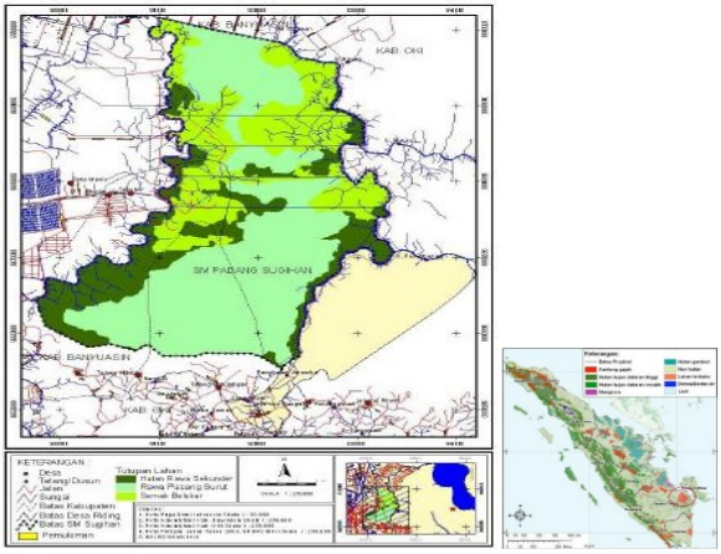

Fig. 1: Map of Padang Sugihan sanctuary in South Sumatra Province, Source: Mahanani [15].

Elephant selection on kinds of the food plant species in a particular habitat type were known with determining the predation index that is the ratio of plant species numbers eaten elephants with the numbers of food plants available in certain areas [5]. Trees consumed were known from the remaining trunks, broken trees and branches while trees for swiping body were indicated on the former mud on trees [1, 20, 21].

Denseness of canopy is estimated related closely to the presence of elephants reflected from the abundance of elephant feces where tighter canopy cover, the more abundant numbers of elephant feces are in certain habitat. Methods to measure the denseness of canopy cover used a mirror 25 cm x 25 cm in size sorted out with a waterproof marker to 25 box plots with size of 5 cm x 5 cm. Each box plot on the mirror has a value of 4%. Furthermore, the mirror is directed to the canopy cover of vegetation in the area of the observation so that the percentage of canopy density can be determined [1].

The number of presence signs of competitor and predator animals in each habitat type was recorded and linked to the abundance of elephant feces in the area. In this study, it was also recorded the distance between the area of feces distribution with a mixed swamp forest and secondary forest and the distance between the area of feces distribution with water sources or rivers.

Data Analysis:

Comparison of the variable value of the habitat sources was analyzed by One-Way ANOVA and if there was a difference "significantly" among the average value of the variable, it would be followed Tukey test. Furthermore, the variable values of habitat sources were correlated with abundance of elephant feces analyzed by simple linear regression. Statistical analysis used SPSS 17 software [28].

RESULTS AND DISCUSSION

Elephants Selection toward habitat types:

Elephant selection toward the certain habitat type can be determined based on the number of feces abundance left on the soil surface [10]. Results of statistical analysis showed that abundance of elephant feces at four types of communities (sub-habitat) in Padang Sugihan sanctuary (community of marsh grass permanently waterlogged excluded because of no elephant feces founded), was significantly different (Sig <0.05). The highest abundance of elephant feces was on the inland marsh grasses (significantly different at the 95% confidence interval) compared with those in the other three habitat types. The lowest abundance of elephant feces was in habitat of *Melaleuca cajuputi* vegetation (Figure 1).

As a result, it can be stated that the population of Sumatran elephants in the Padang Sugihan sanctuary tend to more prefer habitat of inland marsh grasses as areas of feeding activity than habitat of the mixed swamp forest and secondary forests. Grass availability (Graminae, Poaceae) is an important factor in this habitat type because grasses fill most of the elephant diet [1, 32]. Through microscopic observation, more than 25% of plant species that eat elephants are from the family of Poaceae [24]. While habitat of mixed swamp forest and secondary forests is likely to be chosen as a place of refuge and rest while stands of *Cajuputi melaleuca* stands may be less selected by elephants due to the level of human disturbance is relatively high and the availability of variations of food plant species is low.

The results of these studies are relatively different from the findings of Kinnaird *et al*. [11]; Rood *et al*. [22] and Abdullah [1] which stated that the elephant population preferred to daily activities in primary forest than in secondary forest and shrub communities dominated by grass vegetation in protected forest areas. Results of Kumar *et al*. study [13] in the Anamalai hills, India also discovered the phenomenon that elephants preferred habitats of riparian forest, plantations of tea, coffee and Eucalyptus plantations but they avoided from the marsh habitat and shelter of residents. The difference in the findings of the three studies presumably because elephants can readily adapt to a variety of habitats and can also be as a result of the response to an environmental disturbance or alteration of habitat as a result of human activities.

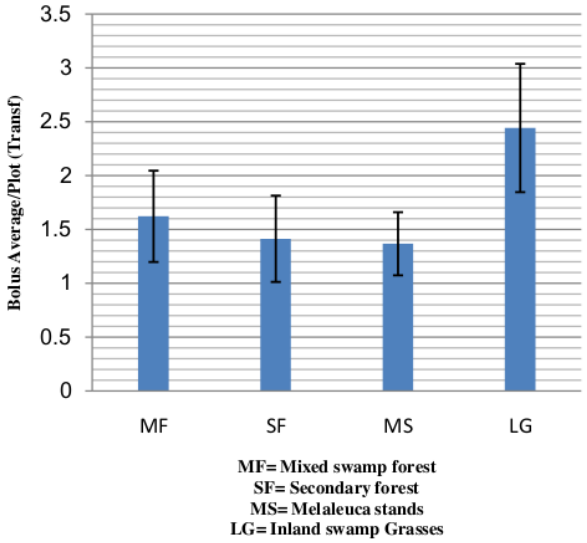

Fig. 2: Abundance of elephant feces bolus on four habitats in the Sanctuary of Padang Sugihan.

The existence of resources and environmental factors in the habitat:

Availability of food plants with ratio of plant species eaten that are abundant in the habitat is an important determinant of life that determines the sustainability and development of the elephant population in a habitat. Table 1 shows that the availability of food plants and their ratio in four habitats of the sanctuary were the "significantly different (Sig <0.05).

Table 1: Tukey test against the some variable values of habitat resources and environmental factors.

No	Habitat Sources and Environmental Factors	Tukey Test			
		MF	SF	MS	LG
1	Availability of food plants (%)	61,31^{a}	62,41^{a}	54,55^{b}	73,46^{a}
2	Ratio of food plants eaten (%)	44,49^{a}	46,48^{a}	32,94^{b}	49,50^{a}
3	Availability of Tree barks (Individuals/plot)	2,01^{a}	1,63^{a}	1,07^{b}	-
4	Availability of trees for rubbing body (Individuals/plot)	1,36^{a}	1,14^{a}	1,07^{a}	-
5	Denseness of canopy cover (%)	50,68^{a}	42,06^{b}	24,44^{c}	-
6	Presence of competitors (individuals/plot)	1,14^{a}	1,15^{a}	1,07^{a}	1,11^{a}
7	Presence of predators (individuals/plot)	1,18^{a}	1,29^{a}	1,50^{b}	1,12^{a}
8	Distance of elephants to water body (meters)	9,82^{a}	5,76^{b}	27,85^{c}	6,36^{b}
9	Distance of elephants to forests (meters)	1,07^{a}	1,39^{a}	27,19^{c}	5,25^{b}

The average values followed by the same letter are not significantly different at 5% level

Results of Tukey test showed that habitats of the inland marsh grasses and secondary forests have availability of food plants with ratio of food species consumed that were much larger (highly significant in p =

0.05). The lowest availability and ratio of food plants were in habitat of the *Melaleuca cajuputi*. Santiapillai & Jackson [25]; Abdullah [1] suggested that inland grasses and secondary forests with a relatively opened canopy more provide types of elephant food plants. Herbaceous plants more vary and are abundant so that they can support the daily needs of elephants. They spent much of their time in the morning and evening to browse and consume types of grasses, roots, bulbs that are available in abundance in those habitats.

Elephants are generalist herbivores that consume varied plant organs such as leaves, fruits, twigs, and tubers including barks [30]. From experiments further showed that the availability of tree barks in a mixed swamp forest was much more abundant ($p = 0.05$) followed by secondary forest. While the lowest availability of tree barks was in *Melaleuca cajuputi* stands. World Wildlife Fund [36] stated that the elephants will be moved to the forest habitat as forest provides the tree barks which are one of the plant organs that are favored by elephants and are always included in the daily diet because these organs contain high fiber, mineral salts and essential vitamins that they need.

Elephant movements rubbing their body on the trees in the forest relate to the presence of blood-sucking ectoparasites. These animals also smear their bodies with dirt and mud because various types of elephant ectoparasites stuck in their body organs such as the ears, groins and skins. Ectoparasites cause skin infections and itchy so that elephant behavior rubbing their body against the tree trunk is intended that ectoparasites can be separated from the body and can relieve itching [1, 37]. Results of test proved that the number average of trees for rubbing the elephant body in three habitat types were not significantly different ($p = 0.05$). As a result, elephants in sanctuary are not difficult to find types of certain trees in the three habitats in order to release the parasites in their body.

In the reserve area, there are three communities of forest stands where the percentage of canopy denseness in each type of forests varied. Mixed swamp forest as elephant habitat had an average of the highest canopy cover that was significantly different from those in secondary forest and in *Maleleuca cajuputi* stands. Inland marsh grasses do not have a canopy for the leaves of Poaceae and Cyperaceae grasses which dominate in that region because they just have a maximum height of 1.5 meters. Consequently, this is not enough for elephants to take refuge from the heat in the daytime. Forest canopy cover is an important environmental factor for elephants to avoid from the hot temperatures during the day and excessive rainfall. The area under the canopy cover is an ideal refuge for elephants to stabilize body temperature, to take a rest and a nap [36].

Elephants always face with different kinds of competitors that compete for habitat resources such as food plants, space, area below canopy, and place for bathing, water body for drinking and mineral salts. Main competitor animals against elephants include rhino, wild pig, elk/deer, tapir and livestock. In Padang Sugihan Wildlife, footprints of wild pigs as the main competitor of elephants are much more found except in community of marsh grasses permanently waterlogged. Swamp buffalos are more found that were maintained by the local community in waterlogged marsh grass habitat. The presence of animal competitors can reduce the presence of elephants in a preserve habitat [1, 9]. The results of the analysis and the statistical test showed that the average number of competitors in four habitats were not significantly different ($p = 0.05$). Therefore, the spread of wild pigs in sanctuary was relatively found in all habitat types.

Predator is an important biotic component in balancing the abundance of elephant population in an ecosystem. In the tropical forests of Sumatra, tigers and leopards are the main predators of elephants, especially for infant and juvenile of elephants. Tiger kills ¼ of all elephant infants during the first year of their life. While elephants that are mostly healthy adults and adolescents are more resistant to predation of big cats like tigers and lions. Tigers killing elephant adults are only a few cases known. Humans also include important predators for elephants since the Pleistocene era so that wild elephants are always shy away from settlement and the presence of humans [9, 27].

In sanctuary of Padang Sugihan, signs of predator presences (tigers and leopards) as footprints, scratches on wooden trees or feces were not found. While the signs of human presence in habitat as the footprints were much more found. Tukey test showed signs of human presence were highest in area of *Melaleuca cajuputi* stands than the other three habitat types while the marks of human presence in the mixed swamp forest, secondary forest and inland swamp grasses were not significantly different. Human presences that were relatively higher in habitats of *Melaleuca cajuputi* vegetation could be predicted because of related to the economic value of that wood species.

Elephants are not resistant to heat during the day so that the air temperature and the distance to the water source can be a limiting factor. Preference of elephants on habitat use is likely to increase with the presence of water sources [7, 9]. Elephants drink and take a bath every day because water is used to cool their body. Elephants often mix water with mud, dust, soil or sand to grease their body as a way of controlling body temperature [2]. The presence of water sources in Padang Sugihan sanctuary is relatively large in the form of two major Rivers (Air Padang and Air Sugihan) and some primary channels. Distance of water sources to elephant activities measured based on the position of the elephant feces found in four types of habitats is quite varied. Statistical test indicated that the farthest distance from water sources (27.85 meters) were in habitats of *Melaleuca cajuputi* ($p = 0.05$). Kumar *et al*. [13] reported that the water body could determine the presence of

elephants in certain habitat. His study proved that the elephant population was generally concentrated along the major river systems in the central suburb of habitats, especially during the dry season.

Generally, elephant daily activities were not far from densely canopied forest. The distance is measured from the position of the elephant activities signed by feces left on soil surface to the canopied forests. Farthest distance of elephant activities to densely canopied forest was 27.19 meters. Their activities were under the stands of *Melaleuca cajuputi*. The above results proved that the elephants at sanctuary always move not too far from densely canopied forest because they are not resistant with hot air temperature in opened areas. The air temperature during the day in this area was hot enough where the results of air temperature measurements at 11.00 am-02.00 pm in habitat of the inland marsh grass ranging from 36-38 °C in dry season and 30-34 °C in the rainy season.

Relationship between the presences of elephants in habitat with resource availabilities and environmental factors:

Simple regression analysis followed by correlation test was conducted to determine the closeness of the relationship between the presence of elephants in the habitat with the presence of habitat sources and environmental factors.

Table 2: The relationship between the presence of the elephants with resources and environmental factors in habitat.

No	Habitat resources and environmental factors	Correlation Test		
		R count	R Table (Pearson)	
			α= 0.05	α= 0.01
1	Availability of food plants (n=80)	0,404**	0,217	0,283
2	Ratio of food plants eaten (n=80)	0,222*	0,217	0,283
3	Availability of Tree barks (n=60)	0,480**	0,250	0,325
4	Availability of trees for rubbing body (n=60)	0,108^{ns}	0,250	0,325
5	Denseness of canopy cover (n=60)	0,538**	0,250	0,325
6	Presence of competitors (n=80)	0,442**	0,217	0,283
7	Presence of predators (n=80)	0,245*	0,217	0,283
8	Distance of elephants to water body (n=80)	0,341**	0,217	0,283
9	Distance of elephants to forests (n=80)	0,231*	0,217	0,283

**. R count was significantly different at the 5 and 1% level

There are five variables that most determines the presence of Sumatran elephants in sanctuary that is the availability of food plants, the availability of tree barks, denseness of canopy cover and the presence of competitor animals in habitat (R count > R table with a confidence level of 5 and 10%, Table 2). Three other variables such as the ratio of consumed plant species, the presence of predators and distance activities with the densely canopied forest also determines the presence of an elephants in habitat but relatively low confidence level (5%) while the presence of trees for rubbing elephant body was not be the deciding factor.

Thus, the presence of elephants in the habitat of inland marsh grasses and secondary forests because of the availability of abundant food, while elephant presence in habitats of mixed swamp forest and secondary forests due to the availability of tree barks, least competitors, the availability of shelter and rest area. This phenomenon is consistent with the study of Abdullah [1]; Hedges *et al*. [10]; Sukumar [29] that the densely canopied forests such as primary forests are more often used as a rest area, sheltering their selves from the sun, keeping infants and juveniles from predators, social interactions, reproduction and feeding activity. Similarly, the findings of Nyhus and Tilson [17] showed that elephants more selected primary forests than secondary forests, plantations and bushes for their activities. Secondary forests are only used for feeding activity due to food abundance of under stands while shrubs and land grasses were used for migration routes and foraging. The presence of water sources also determined the presence of elephants in a habitat. Research of Kumar *et al*. [13] found that the presence of elephants was always concentrated along the outer edge of the main river systems in habitat because they were relative easy to access Rivers when their bodies become dehydrated during the dry season.

Conclusion:

Wild Sumatran elephants at sanctuary of Padang Sugihan more prefer habitat of inland marsh grasses than mixed swamp forests and secondary forests because of abundant availability of food plants. Habitat under the stands of *Melaleuca cajuputi* was less been selected because of the relatively high human presence. From 9 variables of habitat sources and environmental factors in sanctuary, five variables that is the availability of food plants, the availability of tree bark, denseness of canopy cover and the presence of competitor animals were the most decisive factors of the presence of Sumatran elephants in Padang Sugihan sanctuary.

REFERENCES

[1] Abdullah, 2008. Strategies and use of resources habitat by the Sumatran elephants (*Elephas maximus sumatranus* Temminck, 1847). PhD Dissertation, Bandung Institute of Technology. Bandung, Indonesia.

[2] AZA (Association of Zoos and Aquariums), 2011. AZA Standard for elephant management and care; p.1-35.
[3] BKSDA, 2000. Management plan for twenty-five years of Padang Sugihan wildlife area. Board of Natural Resource Conservation of South Sumatra Province. Palembang, Indonesia.
[4] Cai, J. and Z.G. Jiang, 2006. Human-large mammal's conflicts: A new challenge of wildlife conservation [J]. Acta Theriologica Sinica, 26(2):183-190.
[5] Chen, J., X. Deng, L. Zhang and Z. Bai, 2006. Diet composition and foraging ecology of Asian elephants in Shangyong. Xishuangbanna, China. Acta Ecologica Sinica, 26(2): 309-316.
[6] Dawson, S., 1993. Estimating elephant number in Tabin Wildlife Reserve, Sabah Malaysia. Journal of the Asian Elephant Specialist Group, WWF/SSC no.7., Gajah, 1: 16-28.
[7] Eisenberg, J.F., Seidensticker, 1996 Ungulates in Southern Asia. a Consideration of biomass estimates for selected habitats. Biological Conservation, 10: 293-308.
[8] Gaucherel, C., M. Balasubramanian, P.V. Karunakaran, B.R. Ramesh, G. Muthusankar, C. Hely and P. Couteron, 2010. At which scales does landscape structure influence the spatial distribution of elephants in the Western Ghats (India). Journal of Zoology, 280: 185-194.
[9] Harris, G.M., G.J. Russel, R.I.C. Aarde and S.L. Pimm, 2008. Rules of habitat use by elephants *Loxodonta africana* in Southern Africa: insights for regional management. Oryx, 42: 66-75.
[10] Hedges, S., M.J. Tyson, A.F. Sitompul, M.F. Kinnaird, D. Gunaryadi and Aslan, 2005. Distribution, status, and conservation needs of Asian elephants (*Elephas maximus*) in Lampung Province, Sumatra, Indonesia. Biological Conservation, 124: 35-48.
[11] Kinnaird, M.F., E.W. Sanderson, T.G. O'Brien, H.T. Wibisono and G. Woolmer, 2003. Deforestation trends in a tropical landscape and implications for endangered large mammals. Conservation Biology, 17: 245-257.
[12] Kitamura, S., T. Yumoto, P. Poonswad and P. Wohandee, 2007 Frugivory and seed dispersal by asian elephant in a moist evergreen forest in Thailand, Journal of Tropical Ecology, 23: 373-376.
[13] Kumar, M.A., D. Mudappa and T.R.S. Raman, 2010. Asian elephant *Elephas maximus* habitat use and ranging in fragmented rainforest and plantation in the Anamalai Hills, India. Tropical Conservation Science, 3(2): 143-158.
[14] Leimgruber, P., J.B. Gagnon, C. Wemmer, D.S. Kelly, M.A. Songer and E.R. Selig, 2003. Fragmentation of Asia's remaining wildlands: implications for Asian elephant conservation. Animal Conservation, 6: 347-359.
[15] Mahanani, A.I., 2012. Conservation strategy of Sumatran elephant (*Elephas maximus sumatranus* Temminck) in wildlife sanctuary of Padang Sugihan, South Sumatra Province based on the carrying capacity of the habitat. M.S. Thesis, Diponegoro University., Semarang, Indonesia.
[16] Manly, B.F.J., L.L. McDonald, D.L. Thomas, T.L. McDonal and W.P. Ericson, 2003. Resources selection by animals-statiscal design and analysis for field studies. London: Kluwer Adademic Publishers.
[17] Nyhus, P.J., R. Tilson and Sumianto, 2000. Crop-raiding elephants and conservation implications at Way Kambas National Park, Sumatra Indonesia. Oryx., 34: 262-274.
[18] Osborn, F.V., 2005. Habitat selection by bull elephants in central Zimbabwe. Pachyderm, 39: 63-66.
[19] Purnasari, 2011. The strategy of community-based forest fire prevention (biophysical, economic, social and cultural studies around the area of Padang Sugihan Sanctuary in South Sumatra Province). M.S. Thesis, Diponegoro University., Semarang, Indonesia.
[20] Rizwar, Darmi and Zulfian, 2001. Population density and habitat condition on the sumatran elephants (*Elephas maximus sumatranus*) in fragmented tropical rainforest around Kerinci Seblat National Park, North Bengkulu. Final Report of the Small Research Grant From Integrated Conservation Development Project 2000-2001, KEHATI Foundation, Jakarta; Indonesia. TF 28312; Ln 4008-IND.
[21] Rizwar, Darmi and Zulfian, 2002. Population study and habitat conditions of Sumatran elephants (*Elephas maximus sumatranus*) in Kerinci Seblat National Park region, North Bengkulu. Final Report of the Small Research Grant from Integrated Conservation Development Project 2002, KEHATI Foundation, Jakarta; Indonesia. TF 28312-Ln 4008-IND.
[22] Rood, E.J.J., A.A. Ganie and V. Nijman, 2010. Using presence-only modelling to predict asian elephant habitat use in a tropical rainforest landscape: implications for conservation. Diversity and Distributions, 16: 975-984.
[23] Rood, E.J.J., 2006. The status and distribution of the Sumatran elephant in Aceh, Indonesia. WWF Netherlands, Zeist.
[24] Samansiri, K.A.P. and D.K. Weerakoon, Feeding behaviour of Asian elephants in the Northwestern region of Srilanka. the Asian Elephant Specialist Group, WWF/SSC no.7. Gajah, 27: 27-34
[25] Santiapillai, C. and P. Jackson, 1990. The asian elephant: An action plan for its conservation. IUCN/SSC Asian Elephant Specialist Group. Gland. Switzerland.
[27] Shoshani, J. and J.F. Eisenberg, 1982. *Elephas maximus*. Mammalian Species, 182: 1-8.

[28] Singgih, S. 2002. Complete manual control of the statistics with SPSS 17. PT Elex Media Komputindo Publisher, Kompas-Gramedia, Jakarta Indonesia.
[29] Sukumar, R., 1989. The asian elephant: Ecology and management. Cambridge University Press, New York, pp: 21-40.
[30] Sundaram, B., S. Varma, A. Venkatatar and R. Sukumar, 2003. Asian elephant research and conservation centre (a division of the Asian Nature Conservation Foundation), Centre for Ecological Sciences (CES) Indian Institute of Science, Bangalore 560., India. Journal of the Asian Elephant Specialist Group, WWF/SSC no.7. Gajah, 22.
[31] Suyanto, U. Chokkalingam and P. Wibowo, 2003. Fires in peat lands in Sumatra: Problems and Solutions Proceedings Published by Center for International Forestry Research. Palembang, South Sumatra, 10-11.
[32] Syarifuddin, 2008. Analysis of habitat carrying capacity and population dynamics modeling Sumatran elephant (*Elephas maximus sumatranus*): A case study in North Bengkulu Seblat region. Ph.D Dissertation, Faculty of Forestry., Institute of Agriculture in Bogor, Indonesia.
[33] Teuerkauf, J. and R. Gula, 2010. Toward stadardisation of population estimates: defecation rate of elephant should be assessed using a rainfall model. Ann. Zool. Fennici, 47: 398-402.
[34] Walsh, P.D., L.J.T. White, C. Mbina, D. Idiata, Y. Mihindou, F. Maisels and M. Thibault, 2001. Estimates of forest elephant abundance: projecting the relationship between precision and effort. Journal of Applied Ecology, 38: 217-228.
[35] Windarti, 2008. Economic analysis of ecotourism development in area of Padang Sugihan sanctuary, District of Banyu Asin, South Sumatra Province. M. S. Thesis, Sriwijaya University., Palembang, Indonesia.
[36] World Wildlife Fund, 2005. Asian elephant in the wild. Species Status Report. WWF International Gland Switzerland.
[37] Wyatt, J. and L. DiVincenti, 2012. Eradication of Elephant Ear Mites (*Loxoanoetus bassoni*) in Two African Elephants (*Loxodonta africana*) Journal of Zoo and Wildlife Medicine, 43(1): 141-143.

Selection of Sumatra Elephants (Elephas maximus sumatranus Temminck, 1847) Toward Habitat Types

ORIGINALITY REPORT

13%

SIMILARITY INDEX

PRIMARY SOURCES

1	repository.unib.ac.id Internet	458 words — 10%
2	www.aensiweb.net Internet	138 words — 3%

EXCLUDE QUOTES	ON	EXCLUDE MATCHES	< 1%
EXCLUDE BIBLIOGRAPHY	ON		