Schaal Alexandre 28 May 2013

MASTER 1 INTERNSHIP REPORT

Biodiversité Ecologie Environnement, Université Joseph Fourier, Grenoble.

Responsable : Benoit Gossens

Abstract

Throughout Borneo island, the area of oil palm plantation (*Elaeis guineensis*) increase rapidly. The expansion has numerous impacts on the tropical biodiversity. We explored the impacts of these plantations on a common species in South East Asia, *Varanus salvator*. This study compares the body condition, abundance and density of the monitor lizard, *V. salvator,* in two different habitats, a secondary rainforest and an oil palm plantation, in Malaysia. We use a survey method and capture-mark-recapture methods. We found that the lizards living in the plantation are significantly bigger than the ones found in the forest. Also the average abundance of lizard was 0, 53 ind/km in the forest and 1,8ind/km in the plantation. The trapping success is also significantly higher in the plantation. It is of 26% in the plantation and an average of 4,5% in the forest. The reason of this higher abundance and body condition must be the large amount of easy food that the animals can find in the plantation.

Table of Contents:

Introduction 1

Materials and methods 2

- Site description 2
- Sampling 3
- Analysis 5

Results 5

Discussion 9

Acknowledgments 12

Literature 13

A preliminary comparison of monitor lizard, *Varanus salvator*, body condition, abundance and density between a secondary rainforest and an oil palm plantation, in Kinabatangan basin, Sabah, Malaysia.

Alexandre Schaal, Université Joseph Fourier.

Key words: *Varanus salvator*, secondary rainforest, oil palm plantation, capture mark recapture, survey, Kinabatangan basin.

Introduction:

Water monitor lizard, *Varanus salvator*, are the most common lizard species across South East Asia. It is the second-largest lizard species in the world, up to 1m SVL (Snout–Vent Length), 2.5m total and 20kg. This species is heavily exploited by hunters to consumption by local inhabitants. Moreover, the leather trade plays an important role on lizard hunting, as reviewed in an article whose authors estimate between 600 000 and 1.5 million the lizards that are taken from the wild forest each year just in Indonesia (Luxmore and Groombridge, 1990). Actually, the home range of this species is not well known, some studies have found different results varying from 1.4 ha to 31,7 ha on Tulai Island, Indonesia (Traeholt, 1997), to more than 150 ha on Java Island (Gaulke, 1999). In parallel, we know well that its habitat mainly consist of tropical rainforest near streams or swamps and even villages. This is the reason why it is so widely distributed through Asia, from Sri Lanka in the west to the Philippines in the east (Gaulke, 1991). It is known to consume a wide range of prey that can be found in his habitat such snails, insects, crabs, rodents, fish and carrion (Gaulke, 1991).

Actually, the most significant threat to tropical biodiversity, including the water monitor lizard, is the conversion of natural ecosystems to agricultural crops (Sala *et al.* 2000). Malaysia and especially the island of Borneo, face the expansion of oil palm plantations. The

largest part of global palm oil production occurs in Malaysia and Indonesia (80%; Fitzherbert *et al.* 2008). It is one of the world's most rapidly increasing crops. From Africa, *Elaeis guineensis*, has been imported to Malaysia from the beginning of the 19th century. Nowadays, 15% of Sabah land area has been taken up by oil palm plantations and this number is still increasing (Brühl and Eltz, 2009). Just between 1990 and 2005 the area of oil palm increased by 1.8 million ha to 4.2 million ha (http://www.mpob.gov.my), while 1.1 million ha of forest were lost.

Such plantations are a quite important economic source to the local population and the country, but they have numerous negative impacts on the environment. First, because of the deforestation of huge areas, this directly leads to a significant loss of biodiversity. Even more, this also results in loss of biodiversity in other areas due to habitat fragmentation A study suggests that the conversion of primary forests to oil palm plantations decreases species richness of forest butterflies by 83% (Pin koh and Wilcove, 2008). Furthermore these plantations have a well-known impact on global warming. An estimated net amount of 163 t/ha of stored carbon is emitted to the atmosphere when rainforest is converted to oil palm (Danielsen and al, 2008).

The major interest of this study is to understand the effects of plantations on a common species in South East Asia, *V. salvator*. We already know that generalist species seem to respond positively and may thrive in secondary habitats or managed plantations, while specialists decline and might become locally extinct (Yaap et al. 2010). Our hypothesis is that *V. salvator* would follow a generalist species trend, so its density should increase in the plantation. Furthermore, we expect that in the plantation the lizard should be bigger, due to the limitation of competition. In addition, by using two different methods, survey by boat and capture-mark-recapture, we will be able to compare the efficiency of these methods to study this species and then to discuss about their limitations.

Materials and methods

Site description

Field work has been conducted near to the Danau Girang Field Center in Kinabatangan basin, Sabah region, east coast of Borneo, Malaysia. The Kinabatangan river is Malaysia's second longest river. The study area is composed of tropical rainforest protected within the Kinabantangan Wildlife Sanctuary. Here you can observe one of the most

important densities of orangutan and proboscis monkeys in Malaysia. Numerous endangered endemic species can be found, such as the clouded leopard and the sun bear. This reserve is surrounded by some immense palm oil plantations. There are numerous swamps, oxbow lakes and tributaries, which create numerous microhabitats. The climate is equatorial, meaning the temperature tends to range from 26 to 32 °C all year. Precipitation also plays a key role in the climate, humidity varies between 70% to 90% in the daytime and exceeds 90% at night.

Two areas along the Kinabatangan River have been chosen for our study. The first one is in Lot 6 of the sanctuary. This transect is for us to use as a witness area where the human influence and palm oil impact should be limited. The second area is part of the Kinabatangan sanctuary, Lot 5. On the left bank the forest is pretty well conserved but on the right side, just a 20 metres corridor has been maintained. After these 20 metres there are extensive palm oil plantations.

Sampling

Each transect has been made five times in the morning from 6 to 8 a.m. We chose to carry out the transect in the early morning as it is the time when the lizards are most obvious along the river. We observed most lizards sleeping over the river and sometimes hunting on the river's banks. Each GPS point where we have observed a lizard was marked.

Figure 1 Picture of a trap used during the study

Secondly, to use a capture mark recapture method we had to construct traps to capture lizards. Much research has been done to find the most effective and selective trap. The model (Figure 1) that we chose is a common model used to trap lizards, it constitutes of mesh 5 cm wide. The trap itself is 1.30 metres long and 40cm wide, the back door is fixed and the front door is a falling door. The front door is maintained by an iron stick 30 cm long, tied to a rope connected to the bait. When an animal tries to get the bait, it pulls on the bait, releasing the door and trapping the animal. The bait is held in a fine mesh on the rope, we chose to use chicken guts as bait because it's a very smelly and cheap, furthermore, this bait is the most

selective and attractive for the lizard we have found. We caught almost only lizards by using this bait. We built 10 traps of this sort.

Then, we chose to make two transects of five traps, either side of the river for each area. Each trapping session was conducted over 10 days. Each trap was placed ten meters from the river, between each trap we set 300 metres, to cover the area. We must check the trap twice a day to avoid keeping an animal a long time into the trap. It reduces the risk of self inflicted injury to the animal as it tries to escape. Also to limit the stress endured and the risk of escape. We chose to check in the morning at 7.30 a.m. and in the afternoon at 3 p.m.

To determine the trapping success, the number of lizard captured was divided by the available night times. The trapping success was calculated for each trapping session in each habitat. It gives us good information on the abundance of lizard that there is in each habitat. The trapping failure is the number of lizards that we have capture divide by the number of trap that we have find close. A trapping failure near to 0 indicates that the trap is very effective. A trap closed without a lizard inside can be due to an escape of the lizard, to the fact that the lizard close the door when in try to catch the bait by pushing on the side of the trap, it can be due to another animal like pig, or macaque. However sometimes despite the selective bait we have capture some others animals like Malay civet or pig.

Figure 2 Picture of the mark (lizard number 18)

Once a lizard was trapped, we took different measurements. For each animal we record the weight, the total length, the SVL, the tail length, the head length, the head width. In addition, we collected saliva and scale sample for future genetic study and for the bigger one we took blood sample. Saliva sample have been taken in the mouth by a swab then conserve in a micro tube into a saline solution. Scale have been taken on the tail, on the top of the tail there is a little crest, a piece of scale has been took there on 3 mm deep and 3mm long. We also record all the scars and wounds that the lizard can have on his body, it give us information on the interaction that they can have with others lizards. In addition we collect all the parasite that we find on each specimen as ticks.

To recognize the lizard in case of recapture we have to name and mark each individual (Figure 2). Each specimen is name with an ID, to be mark we used the finger of his right front leg. Each finger is compose of a scale's row, on one finger we marked the unity and on another the dozen. The number one is the first scale near to the nail. For marked we used a nail polish. Adding to this first mark, we used to take a scale sample to make a second mark, for that we took the scale to a certain number of centimetre from the beginning of the tail, the number of centimetre correspond to the ID of the specimen.

Analysis

For the analysis of capture recapture and estimate the density, I used the software Mark. For the statistical analysis I chose to use R.

Results

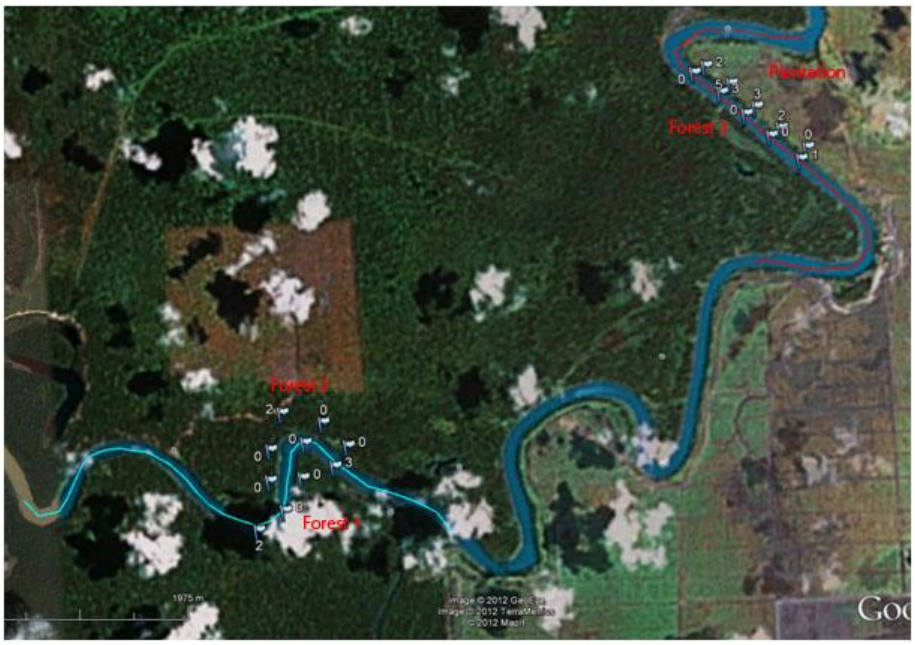

Figure 3 Satellite picture of the study area with the transects, the trap are symbolize by the little flag, the number beside the flag is the number of capture.

Transect were realized five times from the 11 April to the 20 April 2013. On the figure 3, the transect forest is represent by the blue colour and the transect plantation by the red one. The both side of the blue transect are a forest habitat, along the red transect one side is a forest habitat the other side is consist of a little corridor of 20 meters before a huge plantation. Consequently we have a transect with a forest habitat of 15km long and another one with a 5km one with a plantation area.

	Forest	Plantation
2013.05.11	2	0
2013.05.12	4	2
2013.05.13	0	4
2013.05.14	0	0
2013.05.15	2	3
Total	8	9
Abundance (ind/km)	0,53	1,8

Table 1 Results of the transect

For the result (Table 1) of the transect we observe for the forest habitat, the total of observations in the area forest 1, 2 and 3, 8 lizards. For the plantation habitat 9 lizards have been view. Therefore there are an average of 0.53 lizards per kilometres and 1.8 lizards per kilometres, respectively in the forest and in the plantation. We observe a significant variability between each surveillance, some days we have observed 4 lizards and some others 0.

The trapping session of the forest area have been done from the 22 April to the 1st of May, the one in the plantation area from the 6th to the 15 of May 2013.

	Forest	Plantation
Number of trap closed	26	31
Number of lizard catch	11	13
Trapping failure %	58	58
Trapping success %	7,3	26
Number of recapture	4	1

Table 2 Result of the trapping

Results of the trapping were including in the table 2, we made a total of 24 captures with 20 different lizards. We have caught 11 and 13 lizards respectively in the forest and in the plantation. We captured 8 different lizards in the forest and 12 in the plantation. During the first trapping session, all the traps were in a forest area, with made 10 trap per 10 days either 100 night trapping. The other trapping session was conducted with 5 traps in a forest and in the plantation, either 50 night trapping in each habitat. So we have done 150 nights

trapping in the forest and 50 in the plantation. The trapping success which is the number of lizard cached divide by the number of night trapping. The trapping is significantly higher in the plantation than in the forest. Furthermore, the trapping failure stayed the same between the two trapping session. The number of trap closed follow the trend observes with the number of capture that the number of trap closed increase a lot between the two sessions.

On the figure two, each trap is represent by a little flag, there is the forest area along the blue transect and the plantation along the red one. Beside of each flag, the number of capture is indicate. In the forest 1, 5 captures have been made in two different traps. In the forest 2, we captured two lizards in the same trap. We also captured 2 lizards in the forest 3 but one has been captured 3 times. In the plantation, 12 different lizards were captured.

During the trapping, the longer lizard was captured in the plantation and measured two meters. The bigger have also been capture in the plantation and weighed 8,5 kilograms. In the forest, the bigger that we have capture is also the longer one weighed 3,75 for 148,6 cm.

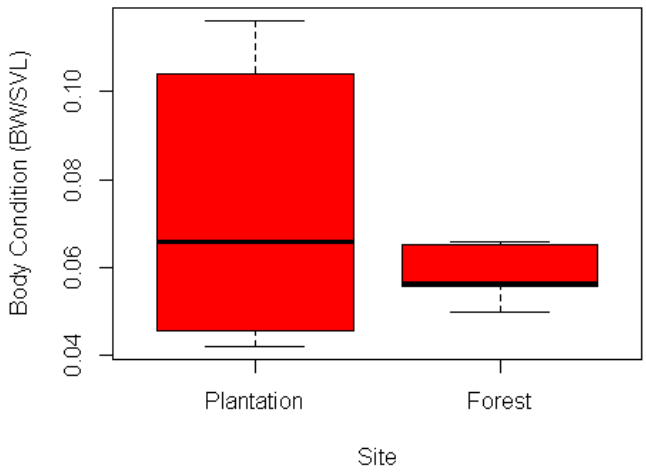

Table 3 Boxplot of the body condition

Results of the body condition have been analyze with R, the boxplot are in the table 3. The body condition indicates the corpulence of the lizard, more the body condition is high more the lizard is big which mean heavy compare to its size. The higher body condition has been found on an individual from the plantation which has a body weight of 8,5 kilograms for a SVL of 73,3. We miss a measurement of an individual in the forest, a lizard cannot be measure because it was in catatonic estate. We thought that it was better to directly release the animal, causing less stress for the lizard. The average of the plantation's body condition is significantly different between the plantation and the forest 0,071 and 0,058, respectively, ($t = 2,22$; $df = 12,61$; p-value = 0,045).

Concerning the capture-mark-recapture, we have one recapture in the forest 1, two in the forest 3 and one in the plantation. The recapture in the forest 1 have been make in the same trap on two consecutive days. In the forest 3, a lizard has been capture 3 times in the same trap during the 10 days of trapping. In the plantation, one recapture has been made in the same trap on two consecutive days. I regret such few recapture but it is due to the little sampling time. We remark that all the recapture that we have done either in the plantation and in the forest were with juvenile lizard. We haven't made any recapture from one side to another side of the river.

The population has been difficult to estimate due to the few recapture, using Mark with the best model that I have find which is the null model, the population estimate of the three forest area have been estimate. For the first forest area, the population estimate is 8 with standard error 5.7 approximate 95 percent confidence interval 5 to 35. For the second forest area, the population estimate is 2 with standard error of 0.66 and approximate 95 percent confidence interval 2 to 2. For the last forest area, the population estimate is 4 with standart error of 2.5 and approximate 95 percent confidence interval 2 to 24. Consequently, the average of the population estimate in the forest area is 4,7. In the plantation, the population estimate 70 with standard error 62.9 and an approximate 95 percent confidence interval 23 to 338

		Forest	Plantation
Estimate Population (ind)	Forest 1	8 (±5,7)	70 ±62,4
	Forest 2	2(±0,66)	
	Forest 3	4(±2,5)	
	Average	4,7	
Estimate Density (ind/ha)		0,04	0,60

Table 4 Result of the estimate population and density

Without any good information about the home range of the species in that area, for calculate the area cover by the trapping we use the following assumption that Traeholt have already us which is a radius of 0,5km around the trap (Traeholt, 1996). That led us to an approximate cover area of 1.15 km square for each area. The total area of the forest area is 3.45km square which is 345ha. The area of the plantation is 115ha. To calculate the density in the forest area I use the average of the population estimate divide by one area, we obtain a density of 0.04ind/ha. The density in the plantation is 0.60ind/ha

Discussion

Firstly, the results of the transect, which can be considered as a river-side count, gave us a first indication of the abundance of lizards in the two habitats. We found results significantly different between the two habitats. We observed 8 lizards along the river side with a forest habitat, 9 along the plantation. The transect along the plantation was 5km long, whereas the transect along the forest habitat was 15km long. The observed abundances are 0.53 ind/km and 1.8 ind/km respectively in the forest and in the plantation.

An inconvenience of this survey method is that it's difficult to carry out. Firstly, this method can't be done without using a boat along the river. Secondly, it requires really keen eye with good ability and know how to find the lizards. The lizards can usually been observed on a branch of a tree, between 3 and 10 meters high. In our results, between each transect we found a variance in both habitats from 4 lizards observed to 0. This variance cannot be explained by human error; we have been careful to use the same observer for each transect. The best explanation for this variation seems to be the weather condition. In particular the temperature and the large amount of sunlight, seem to have an effect on the abundance of lizards that we observed. Indeed, during the sunny mornings, we counted more lizards than during the misty mornings. This can be explained by the thermoregulation of the lizards, during the hot night the lizard can sleep on a tree without entering their burrows. A study on the utilisation of the burrows explains that entering the burrows during the night seems to be an effective way of retaining body heat during cooler nights, but a lizard can maintain its body temperature during the night without entering the burrow, by finding sheltered spots (Traeholt, 1995).

Secondly, with the measurements done during the trapping, we obtained an average body condition in each habitat. Our results (Table 3), tend to confirm our hypothesis that the lizards we find in the plantation are bigger than the ones found in the forest. The average body condition of lizards of the plantation is significantly higher than the condition of lizards of the forest ($p < 0,005$). The highest body condition that we found for an individual was 8.5kg and had an SVL of 73.3cm; in contrast the highest body condition that we captured in the forest is

for an individual was 4.75kg and had an SVL of 57.6cm. Furthermore, all the biggest lizards have been captured in the plantation area. Four specimens with a weight of 8kg or more have been captured, whereas the biggest that we caught in the forest weighed 4,75kg. Further reasons could lead to such differences between the size of the lizards in the two habitats. One of the main reasons is the amount of food. We know that the lizards are not very selective about the type of food they eat, they are able to eat many different types of food. The plantations are known to have a large number of rats, relatively easy to catch. Numerous animals are familiar with the plantation; the density of leopard cats is known to be higher in the plantation (Rajaratnam et al, 2007). Moreover, with the people who live in the plantations, there is often a large amount of garbage and leftovers. The lizards must thrive on that easy source of food. The lizards change their diet from fish to garbage and carrion.

The trapping success confirms the first results obtained from the survey methods. The results show a significantly higher abundance of lizards in the plantation. We captured 11 lizards in the forest, where we have done a trapping effort of 150 nights, which made a trapping success of 7,3%. In the plantation we captured 13 lizards with a trapping effort of 50 nights. The trapping success is 26%. The average estimated population is 4.7 in the forest and 70 in the plantation. The density in the plantation (0.70/ha), is significantly higher than the forest density (0,04/ha). Traeholt, which used the same method, estimated the density in an oil palm plantation in Malaysia of 0.33 lizards/ha. Our results in the plantation are two times what Traeholt found, although this could be biased by the small sampling time we had.

The reasons of this higher abundance in the plantation must be due to the large amount of food. Moreover in the plantation there is less biodiversity than in the forest. It has already been reported that in a plantation habitat there are fewer species, this makes the interspecific competition pressure lower (Traeholt, 1998). This tends to lead to an increase in the density of some general species. The results of our abundance and density studies confirm this hypothesis.

The recaptures have all been made in the same trap, this result can give us a first idea on the home range of this species. The fact that the recaptures have been made in the same trap shows us that they have a small home range. Indeed we can imagine that if an individual has a large home range, he shouldn't have been recaptured in the same trap. Some earlier studies, using GPS collars, on the movement of lizards report that individuals move an average of 271m per day (Traeholt, 1997). Furthermore, all the recaptures that we made were of juveniles. No adult lizards have been recaptured. This absence of recaptures of adult lizards

could be due to the fact that the adult lizard has a larger home range than a young one. Actually the different studies on the water monitor's home range gives us different results from 1.4ha on an island, to more than 150ha in a nature reserve on the mainland. Furthermore it's also possible that the adult lizards are wiser than the young ones and become more reticent to enter the trap after a first capture.

Contrarily to one hypothesis, the lizards don't seem to swim across the river. The fact that they feed in the plantation and sleep in the forest must be wrong. Actually no recaptures have been made from one side to another, this result is surprising because during the study we saw some lizards swim across the river. Obviously due to our results, the river must be considered as a geographic border. In addition to the recapture results, the differences between the forest area 3 and the plantation area confirm that border effect. Firstly, the number of captures are significantly different, 2 on the forest side and 12 on the side of the plantation. Moreover the two lizard captures on the side of the forest were smaller and lighter lizards, whereas the lizards captured in the plantation are bigger. The river is 100 meters wide, which may be too great for the lizard. It's a surprising result because we know that the lizards can easily swim. Maybe this river is too large to be part of a home range.

Our results show some intrahabitats variations. We find a difference of the number of capture between each trap. In the forest we captured, six different lizards in three trap with two lizard in each one. Besides any lizard have been captured in the seven others traps. The same result has been observed in the plantation area with some trap with two different captures and the trap next to it count any capture. It can be explain by the environment surrounding the trap which can decrease the catch potential of the trap. We observe that the trap in presence of an considerable luminosity and a lot of grass seems to have less capture. The traps with the most of capture seem to be the ones with some high tree, a great cover vegetable, a ground cover of leaf without any grass. The fact that the lizard are reticent to go outside their home range have already been report by Traeholt, 1996. Furthermore it seems that despite the smelly bait, the lizards are reticent to go in a habitat they are not use to.

An effect of this high density should be observed on the intraspecific interaction. This high density must have an effect on increasing the number of interaction. An obvious interaction easily observable is the mark of fight that we can examine on the body of the lizard captured. Wounds and scars can be found on the tail of the animal and on the body; generally in ventral face. In the plantation we have observed numerous scars and wounds on

the lizards. We haven't done this kind of observation during the trapping in the forest. There are the witnesses of the numerous interactions in the plantation due to the elevated density of lizard.

The methods of river-side count and the mark-recapture show the same tendency. The both show a higher abundance of lizards in the plantation. The survey can be considered as a rapid and cheaper method to have an idea of the lizard's abundance along a river. In an other hand, due to the difficulty of observation, the observers need to be good. The trapping method is a really methods great but requests a lot of time and some money. In our case, the trapping have been done on a sampling time too short.

To ameliorate the results of the density we should have trap during at least 1 month in each area to be able to give a got estimation of the density. Furthermore, the trapping failure of 58% means that we miss more than one lizards on two escape from the trap. We should have built stronger trap.

The use GPS collar will provide us important information on the movement of the lizard and especially on their home range. Also the sample of blood and saliva will be use to study the serology and toxicology between the plantation and the forest.

In conclusion these results are important because they put the light one an important trend. Despite the large confidence interval of the estimate density, due to the success trapping, is appears clear that the density of lizards is higher in the plantation. Furthermore it seems evident that there are bigger lizards in the plantation. These results are the initial data for future study and complementary study.

Acknowledgements

I would like to thank Dr. Paco for is help during all the study period without whom that study will not be possible. I also want Sergio Guerrero Sanchez for his help and advice and Benoit Gossens. Moreover thanks to Fendi, Budin and Max for their help during the construction of the trap. Special thanks to Doyo for his precious vision during the transects, and also his help all along the trapping session.

Literature review

- Brühl, C. A., & Eltz, T. (2010). Fuelling the biodiversity crisis: species loss of ground-dwelling forest ants in oil palm plantations in Sabah, Malaysia (Borneo). *Biodiversity and Conservation*, *19*(2), 519-529.
- Danielsen, F., Beukema, H., Burgess, N. D., Parish, F., Brühl, C. A., Donald, P. F., ... & Fitzherbert, E. B. (2009). Biofuel plantations on forested lands: double jeopardy for biodiversity and climate. *Conservation Biology*, *23*(2), 348-358.
- Deforestation : Forest Loss in Borneo". *Mongabay : Borneo*. Retrieved September 14, 2011. Rhett A. Butler
- Gaulke, M. (1991). Systematic relationships of the Philippine water monitors as compared with Varanus s. salvator, with a discussion of dispersal routes. *Mertensiella*, *2*, 154-167.
- Gaulke, M., Erdelen, W., & Abel, F. (1999). A radio-telemetric study of the water monitor lizard (*Varanus salvator*) in North Sumatra, Indonesia. *Mertensiella*, *11*, 63-78.
- Iskandar, D. T., & Erdelen, W. R. (2006). Conservation of amphibians and reptiles in Indonesia: issues and problems. *Amphibian and Reptile Conservation*, *4*(1), 60-87.
- Koh, L. P., & Wilcove, D. S. (2008). Is oil palm agriculture really destroying tropical biodiversity?. *Conservation Letters*, *1*(2), 60-64.
- Luxmoore, R., & Groombridge, B. (1990). Asian Monitor Lizards: A Review of Distribution, Status, Exploitation, and Trade in Four Selected Species. Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora.
- Rajaratnam, R., Sunquist, M., Rajaratnam, L., & Ambu, L. (2007). Diet and habitat selection of the leopard cat (Prionailurus bengalensis borneoensis) in an agricultural landscape in Sabah, Malaysian Borneo. *Journal of Tropical Ecology*, *23*(2), 209-217.
- Trætholt, C. (1995). A radio-telemetric study of the thermoregulation of free living water monitor lizards, Varanus s. salvator. *Journal of Comparative Physiology B: Biochemical, Systemic, and Environmental Physiology*, *165*(2), 125-131.
- Traeholt, C. (1998). Population dynamics and status of the water monitor lizard *Varanus salvator* in two different habitats in Malaysia. *Wetlands International,1998*, 147-160.

- UYEDA, L. (2009). Garbage appeal: relative abundance of water monitor lizards (*Varanus salvator*) correlates with presence of human food leftovers on Tinjil Island, Indonesia. *Biawak*, *3*(1), 9-17.

- Uyeda, L. T., Iskandar, E., Kyes, R. C., & Wirsing, A. J. (2012). Proposed research on home ranges and resource use of the water monitor lizard, *Varanus salvator*. *The Forestry Chronicle*, *88*(5), 542-546.