Tanzania Journal of Forestry and Nature Conservation, Volume 79(1) January, 2009

BIRD'S NESTING SUCCESS AND EGGS PREDATION WITHIN ARUSHA NATIONAL PARK ARUSHA, TANZANIA

Thadeo, M. C. T.[1], Ladislaus, W. K.[2], Silayo, D. A[1]. and Samson, A. S.[2]

[1]Sokoine University of Agriculture,
P.O. Box 3076, Morogoro, Tanzania[1]

[2]College of African Wildlife Management Mweka,
P.O. Box 3031, Moshi, Tanzania[2]

Corresponding author: thadeotariomo@yahoo.com or ladislauskahana@yahoo.com

ABSTRACT

Nesting success and eggs predation is among the factors that affect the population dynamics of bird species. The study was carried out to determine predation impact on selected bird species population in Arusha National Park, Arusha, Tanzania. Specifically the study assessed the potential predators to ground (Scaly Francolin) and (Ruppell's Robin-Chat, Striped-cheeked Greenbul, Tambourine Dove and Tropical Boubou) to establish if nesting success and eggs predation vary with habitat fragments types and nesting heights. Artificial nests were constructed in three different heights, and both artificial and true eggs were put on the nests in eleven habitat fragments and their associated forests. Identification of predators was obtained indirectly through punched signs left by predators on artificial and true eggs. Observation was done daily and data were analyzed both qualitatively and quantitatively. The study showed no significant difference in predation effect on eggs in glade versus glade edge $X^2 = 3.08$, Df = 1, P > 0 .05, glade edge versus forest interior $X^2 = 0.04$, Df = 1, P > 0 .05, while glade versus forest interior showed to differ significantly $X^2 = 0.08$, Df =1, P < 05). Predation effect on nesting position at three levels showed no significant difference $X^2 = 6.75$, Df = 3, P > 0 .05 in level 1, $X^2 = 3.81$, Df = 2, P > 0.05 at level 2 and $X^2 = 0.67$, Df = 2, P > 0. 05 at level 3. The percentage egg failure was 41.54 % with predation effects contributing 92% of the total impact, followed by floods 5% and trampling 3%. Although habitat predation varied among habitat types and vertical levels, the type of predators did not vary. However, among predators rodents contributed the highest level of predation effects. Nesting failure was a result of predation, trampling and flooding with the later two affecting more the ground nester birds' species.

Key words: Predators, birds' population, edge effects, Tanzania

INTRODUCTION

Predators all over the world eat many species of wild birds including their hatchlings and eggs. Therefore predation and other several factors including habitats fragmentation threaten the populations of birds in the world (Mike, 2000). Nesting success and eggs predation is among the factors that increase or decrease the birds' populations. For example although birds lay a considerable good number of eggs, most of them are not brooded and hatched because some are preyed by predators. The common predators include bush baby,

snakes *(Mungos mungo)* and large mammals like baboons, monkeys and hyenas. In recent years there have been increasing concerns on the needs for conserving birds' species. Unfortunately, most of the attention has been given priority to species that are of economic importance either because of the role they play in the communities, like the fox that they prey on domestic poultry or livestock, or lion due to key role they play in the ecosystems and tourism industry. Monitoring of the trend of the population requires adequate information on birds' behaviour as this is very important in conserving birds' species. Stevenson and Franshawe (2002) reported that good information on the status of birds such as their habits and threats are important in understanding their population dynamics; hence, it can help in conservation efforts. Populations of birds in most areas of the country, ANAPA area being a good example, are affected by several factors including nests and eggs predation. Unfortunately, there has been for many years inadequate or no information documented about nesting success and eggs predation at Arusha National Park. The study was therefore to investigate on nesting success and eggs predation effect on birds at ANAPA and the way they shape the population trend of bird species. The presence of natural and several artificial glades provided good opportunity for the study to determine whether these fragments had different effects on nests success and eggs predation.

MATERIAL AND METHODS

Description of the study area

The study was conducted in Arusha National Park, which is located between latitude 31°5′ and 31°8′ S and longitude 36°45′ and 35°56′ E, 35 km North East of Arusha town in Tanzania (Figure 1).

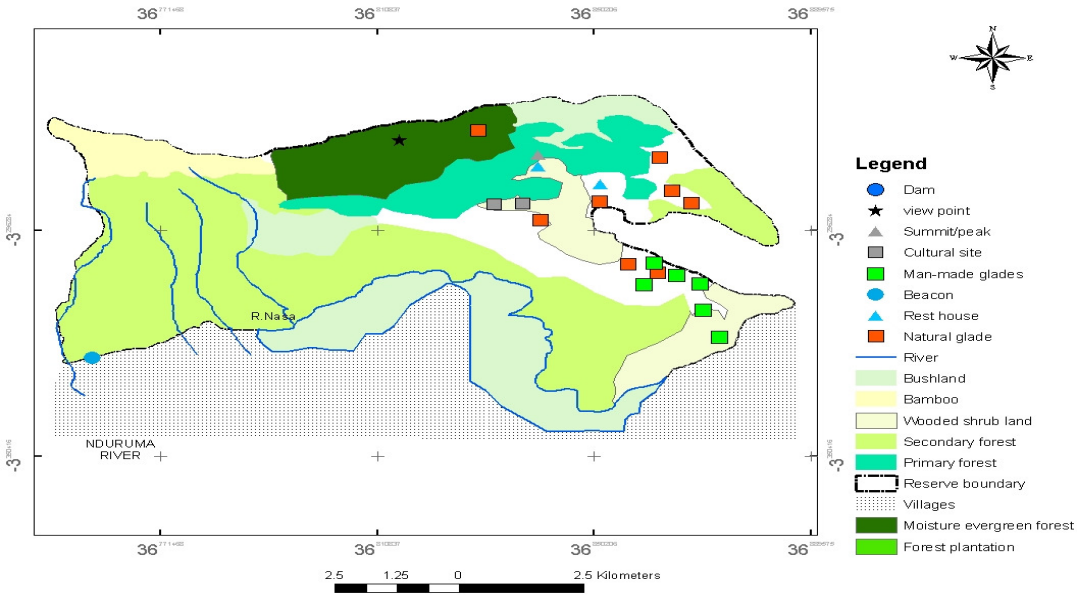

Figure 1: Map of the study area in Arusha National Park showing the natural resources and glade types.

The area has two rainy seasons with the short rains occurring between October and December and the long rains occurring between March and June ranging from 1300 to 2400 millimeters. The area is mountainous and upland ranges from 1500m to 4566m at the peak of Mount Meru. The area encompasses 66km^2 of which 95% are for mountain evergreen forest and 5 % for secondary vegetation. The major habitat features of ANAPA are primary forest, secondary forest, shrub land, glades and wetlands. Wild mammals that are found in the area include herbivores, omnivores and carnivores (except lion).

DATA COLLECTION

Reconnaissance survey

Reconnaissance of the study area for locating and positioning artificial nests and eggs was made in randomly selected glades. Eleven sites were identified and marked with Global Positioning System (GPS).

Nest site selection and Egg location

The location and direction of nest placement was determined systematically by throwing a stick with a pointer upward. The point where the stick dropped indicated the placement of the first nest and direction to follow for subsequent nests positioning. Artificial nests were constructed at three levels: level 1 (on the ground), level 2 (one meter above the ground) and level 3 (two meters above the ground). Ground nests were made by scooping out a depression of leaf litters on the ground whereas the above ground nests were constructed on branches of trees by using twigs and leaf litters of approximately three to five centimeters long. On each ground nests, an artificial egg and a true egg resembling those of scaly francolin eggs were placed in all four habitats. A total of 272 eggs were used for the entire site.

Daily Observation

All nests in all habitats were checked once a day in order to get the frequency and abundance of predator preying on eggs. Missing or broken (destroyed) eggs found either in or out of the nest were classified as predated. Depredated eggs were replaced every day in order to obtain enough data. Prey identification was done indirectly by using signs left by the predators such as predator's teeth punched on artificial eggs. Birds' eggs failure was considered when the entire nests or all eggs contents were removed or when eggs in nests positioned above the ground were found fallen down. A nest was considered successful if eggs were left undisturbed or not preyed. Proportion of nesting success or failure was calculated by taking the number of eggs depredated divided by total number of eggs, times 100.

RESULTS

Predation Effect

The study showed that the rate of eggs predation ranged from 21% to 34 % in the glade and the glade edge fragments respectively (Table 1).

Egg predation, when habitat types were separately considered in level one, at the glade and forest interior, was almost equal (about 35%) as compared to about 16% at the glade edge and forest edge (Figure 3). Egg depredation at level two ranged from about 31 % in the glade edge and forest interior to 37.5 % at the forest edge and in level 3 it was the highest (46.2%) at glade edge followed by 30% at the forest edge and 23 % at the forest interior (Figure 3).

Table 1: Predators and eggs preyed in different habitats in ANAPA, indicated in Percentage and number in brackets.

	EGGS PREYED	PREDATORS
Habitat Type	**Percentage**	**Percentage**
Glade	18.6 (21)	19.4 (14)
Glade Edge	30 (34)	30.6 (22)
Forest Edge	25.7(29)	26.4(19)
Forest Interior	25.7(29)	23.6(17)
Total	**100 (113)**	**100(72)**

Also there was no significant difference in predation effect on eggs when all habitats were considered (Table 4).When all the habitat fragments were considered together, egg predation at level one was 49.6%, followed by level three (31%) and level 2 (19.4%) see (Figure 3).

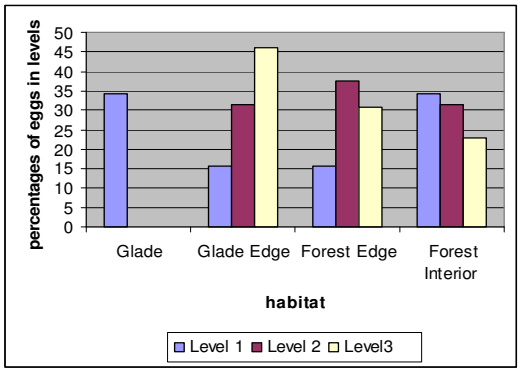

Figure 2: Percent of bird eggs preyed in the three levels in four habitats in ANAPA

When consideration was made separately in each level in different habitat fragments (X^2 = 6.75, Df = 3, P > 0.05 in level 1, X^2 = 3.8, Df = 2 P > 0.05 in level 2 and X^2 = 5.61, Df =2, P > 0.05 in level 3, no significant difference was noted and nesting failure was 41.4 % (Table 5).

Effect of nesting positioning on predation

Predation in different levels was 49.6%, 19.4% and 31% in level 1, 2 and 3 respectively (Table 2). There was no significant difference in predation effect on nesting position and at different levels when consideration was made separately in each level in different habitat fragments (X^2 = 6.75, Df =3, P > 0.05 in level 1, in level 2 X^2 = 0.67, Df =2, P > *0.05* and X^2 = 3.81, Df =2, P > 0.05 (Table 3).

Nest predators' Abundance

Predators' abundance was slightly higher in the glade edge (30.6 %), followed by forest edge (26.4%), forest interior (23.6%) and in the glade (19.4%) (Table 1). However when all habitats were considered together and predators abundance at level 1,2 and 3 were was 44.4%, 22.2%, and 33.3% respectively (Figure 2).

Potential Nest Predators in Different Habitat Fragments

The study found that different habitat fragments did not have different nest predators (Figure 4). The relative abundance of predators in different habitats was 72 predators. The occurrence of the predators is shown in (Table 4). Seven species of small and large mammals were identified in the glade of which 67% were identified as Baboons, various species of rodents, hyenas, mongooses and various species of monkeys. The Glade edge had 22 predators of which 86% were identified as Snakes, Bush babies,

Monkeys, Hyenas, Rodents and Baboons. The Forest edge had 20 predators of which 95% were identified as Mongooses and Rodents. The Forest interior had 21 predators of which 95% were identified as Monkeys and baboons (Figure 5). Some predators were not identified because the whole egg (s) was taken and no signs were left for identification.

Table 2: Predation effect on nesting position in Level 1, level 2, Level 2 and Level 3 on three habitat type of Scaly Francolin, Rupell's Robin-Chat, Tropical Boubou, Tambourine Dove and Striped-cheeked Greenbul.

Position (Height level)	**Total**	**df**	**X^2**	**P**
GL1, GEL1, FEL1, FIL1	54	3	6.75	> 0.05
GEL2, FEL2, FIL2	22	2	0.67	> 0.05
GEL3, FEL3, FIL3	33	2	3.81	> 0.05

NB; GL1 = Glade level 1, GEL1= Glade edge level 1, FEL1= Forest edge level 1, FIL1 = Forest interior level 1, GEL2= Glade edge level 2, FEL2= Forest edge level 2 FIL1 = Forest interior level 1, GEL3= Glade edge level 3, FEL3= Forest edge level 3 FIL3 = Forest interior level 3.

Table 3: Comparison of Egg predation in different habitat type for the Scaly Francolin, Rupell's Robin-Chat, Tropical Boubou, Tambourine Dove and Striped-cheeked Greenbul.

Habitat	**Total**	***df***	**X^2**	**P**
G vis GE	55	1	3.08	> 0.05
GE vis FI	63	1	0.04	> 0.05
G vs. FI	50	1	0.08	< 0.05

NB: G vs GE = Glade verses Glade edge; GE vs FI = Glade edge verses Forest interior; G vs. FI = Glade verses forest interior.

Table 4: The number of predators recorded in the four habitats in ANAPA 2006

Species	**Number (Percent)**	**Species**	**Number (Percent)**
Baboon	8 (14.5)	Monkey	11 (20)
Rodent	26 (47.3)	Snake	1 (1.8)
Hyena	3 (5.5)	Bush baby	3 (5.5)
Mongoose	3 (5.5)		
		Total	**55 (100)**

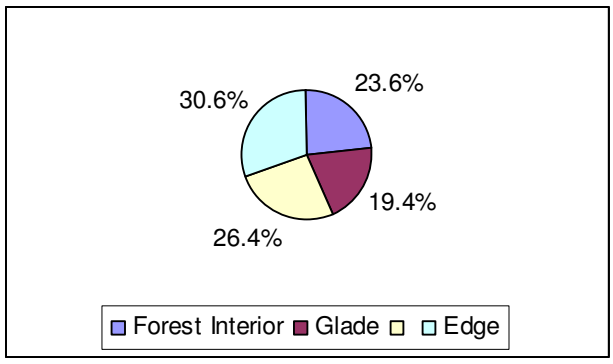

Figure 3: Percentage of predators observed in different habitat fragments at ANAPA

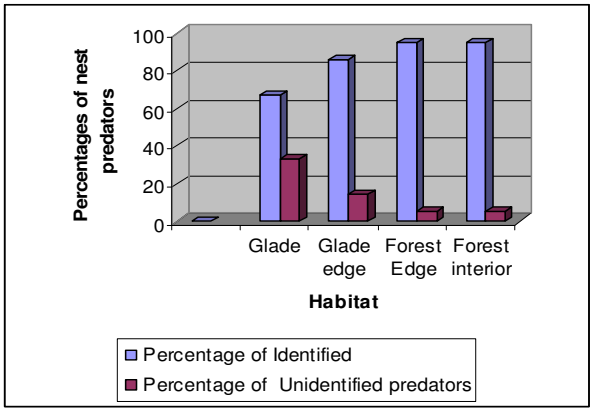

Figure 4: Percentage of identified and unidentified potential nest predators in different habitat fragments in ANAPA

Factors contributing to Nesting Success and Failures

Out of the 272 eggs put in the nests, 92% were damaged by predators, 5.3% by floods and 2.7% due to trampling on the eggs (Figure 6) giving a nesting failure of 41.54 percent (Table 6).

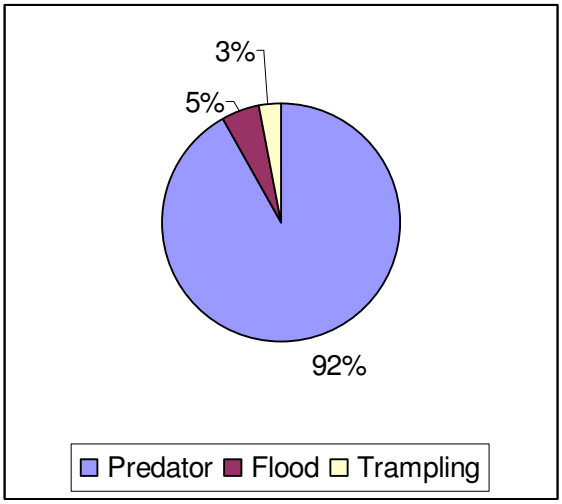

Figure 5: Factors contributing to birds nesting failure in ANAPA

Table 5: Nesting success or failure due to predation, flood and trampling in the ANAPA

Total Eggs placed	**Eggs preyed**	**Eggs not preyed**	**Percentage nest success or failure**	
			Success	Failure
272	113	159	58.48	41.54

Figure 6: Percentage of predators observed in three levels in four habitats of ANAPA

DISCUSSION

Nesting Predation Effect on Different Habitat Fragments

Based on the findings of the study, we have seen that nest failure is attributed by several factors, predation being the major one. This concurs with earlier studies (Danielson, *et al.*1997, Degraaf &Maier 1996) reported: "a high percentage of nests lost of tropical birds to predators are in the order of 80% or more of nest and predation risk often varies with seasonality". Similarly, Ricklefs (1969) reported that predation is the primary cause of nesting failure. Predation was very high because there were high number and diversity of nest predators in most of the area where the nests were located. Higher abundance and diversity of rodents than any other species such as snake contributed much to nest loss because rodents like to live in the grassland due to the availability of seeds and on the edge where it is easy for them to feed and escape from enemies. Mike (2000) reported that "in some habitats sitting of the nest may be compromised between predation risk and other factors affecting breeding success". To reduce predation risk, birds therefore select sites with minimal predation impact. Other studies, that question nest predation rate in the tropics using artificial nest, found that nest loss ranged from 10 -50% (Loiselle and Hopps, 1983; Gibbs, 1991; in bridge J.M. Stutchbury; Eugene S.Morton (2001). Flooding and trampling contributed a little bit because in most areas where nests were located were naturally exclusive of those factors.

The glade had few predators because the vegetation community does not provide adequate cover for most of predator species as one of their searching strategies. The effect of nesting on grasslands has been pointed out by Mike. (2000) who reported that nesting placed on the ground in short grass prairie in Colorado, U.S.A, were at a higher risk of loosing clutches than when nesting were placed beside shrubs because predators prefers cover when hunting.

The predation effect on eggs in four habitats fragments showed that glade edge nesting bird species are of more risk than other habitats; this was influenced by the edge effect due to habitat fragmentation and interspersion. Andren *et al.* (1985) reported that "Fragmented regions with more edge habitat may contain more nest predators than a contiguous region. It should be noted however that the differences between the glade, glade edge and forest, and forest interior in our study were not statistically significant possibly due to the fact that predation occurred in all fragmented habitat independently. The glade edge habitat however had relatively more predators than the other habitat fragments basically because animals prefer to use edges when feeding as

they provide cover during hunting and it is easy for them to escape into the forest once an enemy approaches or wants to attack them.

Birds nesting on the ground in open grassland (glade) were at higher risk from being depredated than those placed at the glade edge forest, and forest interior because baboons and monkeys frequently visited the glades as they preferred to forage on the ground. Our results of artificial nests in level 1 were contrary to those of (King *et al.* 1996) who argued that ground nesting ovenbird (*Seiurus aurocapillus)* reproductive success in New Hampshire nests, nest survival was higher in the forest interior than at the edge. The explanation was not applicable in our case, because as stated above most of the ground predators were baboons and monkeys that did not prefer to forage on the glade edge, forest, and forest interior.

The glade edge level 3 had more predators because of the edge effect and was in a transitional zone between forest and open grassland; this provided better environment for predators to feed and escape into the forest when they were disturbed. The forest interior had a large number of predators probably because the area has a lot of arboreal species like Black and White colobus monkeys.

Assessment of the Effect of Nest Position on Different Habitat Fragments

Our data suggested that ground nests may be particularly vulnerable to predators that spend more time foraging on the ground than on shrubs or trees, as argued by (Martin, 1995, Eliot, 1978). The glade edge was mostly the preferred site for predators because it is areas where they can feed, sun burst and, at the same time, it is easy for the animal to escape into the forest once attacked by a predator.

The Relative Abundance of Predators at different habitat fragments

The overall abundance of predators and distribution at the glade, glade edge and forest, and forest interior were almost similar to most small predators such as rodents and bush babies. In this study we counted a predator as an animal making any sort of disturbance to the eggs, such as preying, trampling or even just destroying the nest. Since the size of eggs used in this study were small in size it therefore allowed rodents to be the most potential nest predators to open small eggs, and their use should result in high predation rate because small-mouthed predators are more abundant than large nest predators, as it was reported by Roper, (1992) that "nest survival of natural nests was lower than that of experimental nests containing quail eggs in Panama because of the abundance of small-mouthed nest predators. However, the predation activity from reptiles as predators was very minimal, possibly because they are unlikely to respond to eggs that are not attached to a parent bird.

The movement of mammals resulted into trampling of eggs on the nests and therefore contributed to the bird's nesting failure. Large mammals had different foraging strategy from small mammals that resulted into different predation on the fragment types.

Potential Nest Predators in Different Habitats

Different habitat fragments did not have significant different nest predators contrary to other studies that indicated habitat heterogeneity has an influence on predation pressure and tends to increase at forest edge (Martini *et al*. (1995), Hanski *et al*. (1996); and has been found even among similar heavily forested areas (Reitsma *et al*. (1990), Leimgruber *et al*. (1994). Thus, spatial heterogeneity in predation pressure is common in most fragmented and contiguous landscapes.

The movements of predators from one habitat to another being their hunting strategies left out the variation of the diversity of predators in different habitat. It should be noted that preys are not static they move from one place to another; looking for food and not limited to one place. Again, the identified predators were not territorial so they had to move for search of food; consequently interacting in all habitat fragments. However, other studies have argued that nesting predation in the tropical is likely to vary with habitat types (Andren *et al*. 1985).

A few identified species were more identified in the glade than other habitat types because the majority of predators in the glade were large mammals like baboons, monkeys and hyenas that were depredating the whole egg or disappearing with it without leaving any sign as it was expected. A few unidentified species were found in the forest interior because most of the predators were small mammals such as rodents which did not have ability either to depredate the whole egg or to disappear with it away from the nesting site, but rather to prey on the nest.

The size of the eggs used had a positive impact to the frequency of rodents in abundance and diversity than other predators. Snakes had few frequencies because habitat preference in most areas where artificial nests were set were not good habitat for reptiles. It has also been argued by Ropper (1992) that snakes are not the primary nest predators instead of high abundance and diversity of small mammals. The results from the study showed that predators occurred by chance in all habitats as this was due to the fact that prey are not static as they move. Most of the eggs on the glade and glade edge were preyed by baboons because they prefer to forage in the glade and glade edge for security reasons and go into the forest interior when escape from predator and foraging strategies. Potential nest predators are not localized in a certain habitat type, but rather they move in all habitat fragmentations. Eggs placed in the glade were eaten more than others because most of the ground predators roam in many areas as their feeding strategies so as to compensate for the optimal energy lost The glade edge and forest edge level 1 vegetation community helped to camouflage the nest; hence a few predators were recorded. Predators are distributed in all habitats but the impact to the nest differs from one level to another and from one habitat to another.

Nesting Success and Failure

The study noted that ground nesters are highly subjected to floods than those nesting above the ground. The study considered nesting success when eggs were left undisturbed or unpredated and the success and failure of a nest depended on the proper nesting selection and absence of predators.

CONCLUSION

Predation was highest in the glade edge than in other habitats due to edge effect; Rodent contributed the higher part of predation due to their feeding by searching strategy. Apart form predation, floods and trampling from large mammals also contributed to egg and nesting failure. However predation varied among habitat types and vertical levels. Similar species of predators were observed to have preyed on nests at different habitat fragments. The study concluded that different habitat fragment does not have different nest predators since the same species of predators were recorded in more than one habitat; for example rodents were found from the glade, glade edge and forest, and forest interior.

Nesting failure was found to have been contributed by three factors; namely, predators trampling and floods with the later two affecting specifically ground nesters bird species, this was mostly noted at Glade number 3 and Uwanja wa Ngiri Flooding in other areas has been also reported by (Ricklefs, 1969). The study was however conducted during wet season and we used manual identification using sign left by predators. Despite of other birds' nesting contributing factors, the studies concludes that Bird population dynamics in ANAPA is affected seriously by predation as in other tropical regions

RECOMENDATIONS

Conduct similar study during dry and wet season because predators during dry season are free to move in a broad area than if compared during the rain season when their activity are hindered by the floods. Other studies should be improved by using automatic trap camera for capturing images of nocturnal and as well as diurnal predator species

REFERENCES

Andren, H. P. Angelstaman, E. Lndstrom, and P. Widen. (1985). Different In Predation Pressure in Relation to Habitat Fragmentation: An Experiment. *Oikos* 45: 273-277.

Degraaf, R., M. and T. J Maier,(1996). Effect of Egg Size on Predation by White-Footed Mice. Wilson Bull 108:535-539.

Danielson W., R .M. Degraaf, And T.K Fuller. (1997) Rural and Suburban Forest Edge; Effect on Egg Predators and Nest Predation Rates .*Landscape Urban Plan* 38:25 –36.

Eliot, L. (1978). Social Behavior and Foraging Ecology of The Eastern Chipmunk (*Tamis Striatus*) In the Adirondack Mountain. Smithson. Contrb.Zool.265: 1-107

Graves,S., .J. Maldonado, And J.O.Wolff, (1988). Use of Arboreal And Microhabitats By P*eromyscus Leucopus and Permyscus Maniculatu.S Can.J.Zool*.66:277-288.

Hanski, I. K., T.J. Frensk, and G.J. Neimi, (1996) Lack of Edge Effect in Nesting Success of Breeding Birds in Managed Forest Landscape. Press Washington D C.

King, D.I, Griffin, C.R and Degraaf, R.M (1996). Effect on Clear Cutting on Habitat Use and Reproductive Success of the Ovenbird in Forested

Landscapes. Conserv. Biol. 10:-1386-1380

Leimgruber, P.W., J. Mc Shea and K. H. Rappole. (1994). Predation on Artificial Nesting Large Forest Block. *Journal of Wildlife Management* 58:54-260.

Madison, D.M. (1977). Movement and Habitat Use Veiled By Radio Telemetry. Can. Field-Nat. 91:273-281.

Martin, T. E... (1988). One the Advantage of Being Deferent Nest Predation and the Coexistences of Birds Species. *Proc.Nat.Acad.Sci*.85: 2196-2199.

Martin, T.E. (1995) Avian Life History Evolution In Relation to Nest Sites, Nest Predation and Food. *Ecological Monographs* 65:101-127.

Mike, H, (2000) Birds Nests and Construction Behavior. Cambridge University Press

Reitsma, L .R, .R T. Holmes, And T .W. Sherry, (1990) Effect of Removal of Red Squirrels. Tamias Striatus, On Nest Predation: An Artificial Nest Experiment. *Oikos* 57:375-380.

Roper, J. J. (1992). Nest Predation Experiments With Quail Eggs: Too Much To Swallow? Oikos 65:528-530.

Ricklefs, R.E. (1969).An Analysis of Nesting Mortality in Birds. Smithson. Contrib.*Zool.*9: 1-48.

Stevenson T. & Franshawe, J. (2002) Field Guides Birds of East Africa, Kenya, Tanzania, Uganda, Rwanda and Burundi. T&Ad Poyser Ltd, UK.

Appendix 1: Definitions of Terms

An edge is the area between the forest and open grassland.

A glade is natural or man-made open grassland in the forest.

Glade edge is an area of transition between the glade and the forest

Forest edge is an area measured ten meters from the glade edge.

Forest is an area with trees more than five meter high and with interlacing canopy.

Forest interior is the inner place ten meter away from the forest edge.

Level 1 means on the ground

Level 2 means one meter above the ground.

Level 3 means two meters above the ground.