

A Study of Mammals in Neotropical Ecosystems

Toledo District

Bladen Branch

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Results

Common Name	Species	Sighting or Track	Time	Number of animals	Site
Paca	Agouti paca	sighting	9p.m.	1	Canal
Paca	Agouti paca	sighting	8:30 p.m.	1	Canal
Paca	Agouti paca	sighting	10p.m.	1	Bladen Trail
Paca	Agouti paca	sighting	9p.m.	1	Lagoon Trail
Agouti	Dasyprocta punctata	sighting	8:30a.m.	2	Bladen Trail
Collared Peccary	Tayassu tajacu	Sighting	10a.m.	2	Bladen Trail
Collared Peccary	Tayassu tajacu	sighting	5p.m.	2	Lagoon Trail
White-lipped Peccary	Tayassu pecari	sighting	11:30a.m.	2	Entrance Road
Red Brocket Deer	Mazama americana	sighting	5:45P.M.	1	Waha Mill

Red Brocket Deer	Mazama americana	sighting	7:45a.m.	1	Bladen Trail
Tamandua	Tamandua mexicana	sighting	6a.m.	2	Canal
Tamandua	Tamandua mexicana	sighting	8:15a.m.	1	Bladen Trail
Tamandua	Tamandua mexicana	sighting	6a.m.	1	Blue Pool Trail
Armadillo	Dasypus novemcinctus	sighting	9p.m.	1	Waha Mill
Armadillo	Dasypus novemcinctus	sighting	10p.m.	1	Northern Road
Howler Monkey	Alouatta pigra	sighting	10:30a.m.	1	Canal
Howler Monkey	Alouatta pigra	sighting	7:15 a.m.	4-5	Canal
Howler Monkey	Alouatta pigra	sighting	8:15a.m.	2	Bladen
Spider Monkey	Ateles geoffroyi	sighting	8:45a.m.	6-7	Fire Tail Creek

Southern River Otter	Lutra longicaudus	sighting	10a.m.	2	Bladen River
Ocelot	Felis pardalis	sighting	4:30a.m.	1	Entrance Road
Deppe's Squirrel	Sciurus deppei	sighting	8a.m.	1	Kitchen
Yucatan Squirrel	Sciurus yucatanensis	sighting	8a.m.	1	Bladen Trail
		sighting	9a.m.	1	Bladen Trail
Kinkajou	Potos flavus	sighting	9p.m.	2	Canal
Kinkajou	Potos flavus	sighting	8:30p.m.	group	Bladen Trail
Kinkajou	Potos flavus	sighting	9p.m.	group	Blue Pool Trail
Olingo	Bassaricyon gabbii	sighting	10p.m.	1	Bladen Trail
Tapir	Tapirus bairdii	track		1	Canal

Jaguar	Panthera onca	track		1	Trio River
Jaguar/ Puma	Panthera onca/ Felis concolor	track/ scat		1	Blue Pool

Observations and Discussions

Order Rodentia:

Comprised of 1,750 species, rodents are by far the most diverse mammalian order. According to Emmons (1990), their diversity can be attributed to the "wide scope of activities and diets made possible by the rodent anatomy." Specifically, rodents are equipped with incisors that never stop growing and are kept razor sharp. The variety of muscle systems of the jaws as well as skull structures that have evolved within the order are used to divide rodents into three major categories: squirrellike (sciuromorpha), mouselike (myomorpha), and cavylike (caviamorpha) (Emmons 1990).

Family Sciuridae (Squirrellike rodents):

There are eighteen species of squirrels found in neotropical forests. Although they are primarily arboreal, there are a few

species that are known to forage on the ground. Two species of squirrels are found in BFREE and the surrounding area. Deppe's squirrel (*Sciurus deppei*) was seen on several occasions foraging near the kitchen. These squirrels are scansorial and known to feed on berries, acorns, and fungi. The Yucatan squirrel (*Sciurus yucatanensis*) was seen often on the Bladen River Trail. It is known for its characteristic bark, which makes it an easy animal to observe in the forest. This species is primarily arboreal, and has a diet similar to that of the Deppe's squirrel. (Emmons 1990).

Large Cavylike Rodents

Families Agoutidae and Dasyproctidae

These two closely related families are described as "ungulate-like" rodents with "piglike bodies" (Emmons 1990). Most species have low fecundity levels, and their litters usually consist of no more than two individuals.

The paca (*Agouti paca*), locally known as the gibnut, is a terrestrial, nocturnal rodent that feeds on fallen fruits, tubers, and browse. (Emmons 1990). Although it is heavily hunted throughout Belize, there seems to be a healthy population in BFREE and the surrounding area. A total of four paca were observed, all between the hours of seven and eleven p.m. Two

were seen along the canal transect, and their behavior was quite similar. Neither were at all scared of the light, however, when approached, they disappeared noisily into the bush. In addition to the pair of sightings, several sets of tracks were found in the canal, and the remnants of a mamee apple, one of the paca's favorite fruits, was found underneath a log. Margarito Sho, an expert hunter and resident of Golden Stream, identified the teeth marks as being the work of a paca. There was a single sighting along the Bladen River Trail in which the animal exhibited similar behavior to the ones observed in the canal. The final, and perhaps most intriguing sighting was along the Lagoon Trail. On this particular night, there were four people, each walking with a light. The paca was sighted just a few meters off the trail, and appeared timid. The animal remained frozen for at least a couple of minutes, giving us the opportunity to observe the intricate markings along the sides and back.

Sometimes referred to as the paca's diurnal counterpart, the Central American Agouti (*Dasyprocta Punctata*) is a somewhat smaller terrestrial rodent that feeds mainly on fruits and seeds (Emmons 1990). I only positively identified a pair of agouti on one occasion along the Bladen River Trail. When they became aware of my presence, the animals stomped their feet, and

retreated further into the bush where I actually had a better view of them. However, with my next movement, they were gone. Although agoutis were never actually observed at the canal, two sets of tracks were found. One set was eighty meters along the transect, and in close proximity to a small burrow.

The importance of rodents in influencing the structure and composition of ecosystems has been well documented by several ecologists. Rodents are primarily frugivorous and although they are notorious seed killers, Janzen has noted that "seed predation is the cost of reliable dispersal" and furthermore, "these actions can ultimately help determine the density of a particular species and also the plant species composition of the habitat" (Fleming 1975). The co-evolved rodent-plant interactions are mutually beneficial. Interestingly, Terborgh believes that the relationship can be extended to include other members of the forest community that are similarly codependent. Although it has not been studied in tropical ecosystems, research done in the Chihuahuan Desert of southeast Arizona has revealed convincing data to validate such a hypothesis (Terborgh 1992). In this particular ecosystem, rodents are known to consume large seeds, while ants consume small seeds of a different plant species. Removal of one element, either rodent or ant, causes takeover by

the vegetation that the eliminated element ordinarily consumes. "The two species mutually assure each other's food supply," and in doing so, maintain the diversity of the ecosystem.

Although such an involved experiment has not been undertaken in BFREE, certain aspects of rodent behavior have been observed that support a similar conclusion. In particular, evidence of the predation of mamee apple fruits and cohune seeds by the paca and the agouti indicate that these animals could be performing important functions in determining plant species composition in BFREE and the surrounding area. Importantly, the agouti is notorious for its habit of burying seeds singly, making it an efficient seed dispersal agent. Moreover, according to Fleming, "trees producing larger fruits...depend on the scatterholding behavior of larger mammals such as agouti and paca for their dispersal, via burial" (Fleming 1975).

Order Edentata:

There are four families of Edentates, but none of them have much in common. The word edentate literally means "without teeth," however, the anteaters, family myrmecophagidae, are the only ones to which the name really applies (Macdonald 1986). The remainder of the families have "simple peglike teeth with no true incisors, molars, or canines." The present day edentates are the

only survivors of a "large group of species that evolved in South America when it was an isolated island continent" (Emmons 1990). It wasn't until the Great Faunal Interchange, about seven million years ago, that members of the group migrated into Central America, and inhabited what is now known as BFREE. Family Myrmecophagidae:

The only representative member of this family found in BFREE was the Northern Tamandua (*Tamandua mexicana*). Typical of most anteaters, the tamandua has a long snout and large foreclaws that are folded inward so that it actually walks on the outside of its hands. Tamanduas are scansorial, but tend to spend most of their time in trees. Their powerful forelimbs and prehensile tail are well adapted for breaking open nests and maintaining balance in order to obtain their primary food source, ants and termites.

There were three tamandua sightings, one on each of the Canal, Bladen River, and Lagoon trails. These noisy foragers are not difficult to find, and were often heard from as much as twenty meters off the trail. It is unlikely that tamanduas have too many predators, as they have been known to inflict serious wounds with their foreclaws when threatened.

Like the paca and agouti, tamanduas have small litters, usually just one offspring that rides on the mother's back.

Amazingly, this maternal relationship was observed during the first sighting along the canal. The mother, with an infant clinging to her back, was noisily climbing a cohune palm. Upon my intrusion, she remained still while I observed. The juvenile was a perfect image of its mother, with a black vest and golden arms. Not wanting to panic the mother I broke the contact quickly, and let them resume their search for insects.

Family Dasypodidae:

The family of armadillos is a nocturnal group that is primarily insectivorous, but also feeds on plants, small vertebrates, and some carrion. Their bony armor and wide ranging diet has made them adaptable to a variety of habitats and they are well-suited to their self-constructed subterranean mazes.

The most common armadillo, and the only one observed around BFREE, was the nine-banded long-nosed armadillo (*Dasypus novemcinctus*). This species relies mostly on its sense of smell, but has poor eyesight, and is notorious for its raucous foraging habits. There were two armadillo sightings, both between nine and ten p.m. One was in the Waha Mill, while the other was along the Northern Road. During the sighting at the Northern Road, the animal was actually followed for several minutes until it finally found refuge in a fallen log where it was identified. Peering

into the decaying log, just a few feet from the animal's face, I couldn't believe that armadillos were actually hunted for food.

The Primate Order:

The New World primates are separated from their Old World counterparts by a few miles of ocean, and several distinct morphological and behavioral traits. Primarily, unlike our "close-set downward pointing nostrils" those of the New World primates are "wide apart" and "sideways facing" (Emmons 1990). Another important distinction is that all primates in the New World are arboreal.

The Cebidae family, or capuchin-like monkeys, are the only primates (except humans) found in this region. Of the thirty-one species of Cebids, only two, both of the larger variety, are found in BFREE and the surrounding area. Both the Mexican Black Howler Monkey (*Alouatta pigra*), and the Central American Spider Monkey (*Ateles geoffroyi*) have prehensile tails and spend most of their time high in the canopy feeding on leaves and fruits. Howlers are generally larger, less acrobatic, and distinguished from all other species by their impressive vocals due to their modified hyoid apparatus. The Spider monkeys are fascinating to watch as they swing hand over hand, brachiating through the canopy.

Perhaps the most conspicuous mammals of the forest, howler monkeys were heard almost every day. Hearing them, however, is not always conclusive as their voices are known to carry for miles. There were three sightings of howlers along the transects, two of which were along the canal. Although the first sighting was of a solitary male, the second involved an entire troop (5-6 individuals) that were vigorously defending their territory with their overwhelming calls. Apparently they had been successful, for the second troop that was involved seemed to be retreating to territory deeper in the forest.

The third sighting was along the Bladen River Trail and involved two individuals. This was significant because calls had been heard coming from the direction of Forest Hill, and now the presence of a troop there was verified. Additionally, in early April, a troop was heard passing through camp at 3:00 AM. They even left a gratuitous pile of scat about five meters from the thatches as evidence of their visit. From these observations, it is estimated that a minimum of three troops have territory that overlaps the BFREE property.

Unlike the howlers, spider monkeys are far less vocal in their territorial battles, and seem to be less abundant. There was only one sighting of the acrobatic primates, and that was

along Fire Tail Creek at about ten in the morning. Upon my arrival, a troop of about six individuals was quietly feeding in the canopy. However, my presence was quickly detected, and I was a most unwelcome visitor. The entire troop began barking incessantly and fled, swinging quickly through the trees.

The healthy populations of primates found in BFREE and the surrounding area is important for several reasons. Significantly, howler populations were devastated several years ago by yellow fever, and their strong comeback is indicative of both the resilience of the species and the suitability of the habitat around BFREE. In terms of influencing forest structure, these two species of primates are unparalleled in their ability to disperse seeds. In fact, spider monkeys "were shown to disperse seeds 93.5 % of the times they fed on fruit" (Redford 1992). Emmons (1990) emphatically decreed their importance, stating that "monkeys are important seed dispersers for hundreds of plant species, especially canopy trees and lianas, and they are therefore vital elements of rainforest ecosystems. If they are eliminated from the forests by hunting, the plant species composition of the forest will eventually change" (Emmons 1990).

Order Perissodactyla:

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Order Perissodactyla:

Tapirs are the "only extant native New World odd-toed

ungulates" and more specifically, the Baird's Tapir (*Tapirus bairdii*), is the only Perissodactyla found in BFREE and the surrounding area (Emmons 1990). Members of this order are known to have simple stomachs with a fermentation chamber located in the cecum (Bodmer 1991). Because the fermentation chamber is not pregastric, these large herbivores are unable to detoxify most secondary compounds, and this may account for their habit of swallowing seeds whole. An important consequence of this morphological trait is that tapirs have become important seed dispersing agents, and in an experiment done by Bodmer, 54 % of seeds found in fecal samples survived the trip through the digestive tract unscathed (Bodmer 1991).

Although I was never fortunate enough to actually see a Tapir, tracks of the animal were ubiquitous around the banks of the Bladen River and in the soft substrate of the canal. There was one particular set of tracks, about five hundred meters along the canal transect, that I was able to follow for several yards until they disappeared into the bush. In addition, three piles of scat were found in Fire Tail Creek. The scat was so filled with fibrous organic matter that it didn't seem like scat at all. Apparently, tapirs digest so little, that they must "spend almost 90% of their waking time feeding on browse, grass, and fruits"

in order to maintain their energy level (Emmons 1990).

Order Artiodactyla:

The Artiodactyls, also known as the even-toed ungulates, have two representative families in the neotropics: peccaries (Tayassuidae) and deer (Cervidae).

There are two genera and three species of Tayassuidae, all found in the New World (Emmons 1990). Unlike tapir, peccaries use their strong jaws to chew, and often kill seeds. Fortunately, their sacculated forestomachs usually "detoxify" secondary compounds of seeds prior to intestinal absorption" and importantly, Bodmer found that seeds were completely destroyed in 95% of stomach samples (Bodmer 1991). The two species found in BFREE and the surrounding area are the collared peccary (Tayassu tajacu), known simply as peccaries, and the white-lipped peccary (Tayassu pecari), known locally as warrie. Both species are diurnal and omnivorous, feeding mainly on fruits, browse, nuts, and some animal matter.

Collared peccaries are smaller than their white-lipped counterparts, and form smaller herds, usually consisting of six to nine individuals (Emmons 1990). This species was observed on two occasions travelling in groups of two. Around 10:30 one morning they were spotted along the Bladen River Trail, heading

down Forest Hill. Upon sensing human presence, the animals, stopped, turned back briefly, and then headed in the opposite direction. The second sighting was on the Lagoon Trail at around 5:30 p.m. This time, upon sensing my presence, the peccaries took a few steps in my direction, stopped, and stared. This time I broke the contact and headed back towards the kitchen.

The white-lipped peccaries are large animals that usually travel over huge territories in herds ranging from two to four hundred individuals, although one report from Paraguay included a count of more than one thousand (Peres 1996). There was only one opportunistic sighting of these immense animals that occurred at 11:30 a.m. As Jacob Marlin and I were driving along the Entrance Road, we saw two warrie run in front of us and disappear into the bush. Although we couldn't be certain, it is likely that there were several more in the herd.

Cervidae, the second family of even-toed ungulates found in the Neotropics, consists of three species of deer. There are two species found in Belize, and only one that was positively identified at BFREE (Emmons 1990). The red brocket deer (*Mazama americana*) is a strict herbivore that feeds heavily on fruits. They have a pregastric fermentation chamber in which many secondary compounds of seeds are detoxified. This enables the

deer to swallow seeds whole and still digest them. Significantly, in 94% of stomach samples, seeds were completely destroyed (Bodmer 1991).

Several brockets were observed in BFREE and the surrounding area. I was able to see them on two occasions, and more often heard them running away through the bush with their characteristic whistling grunt. Interestingly, this was the only large herbivore that was observed in the Waha Mill. It is impressive that they are able to maneuver through such thick vegetation.

The most intriguing encounter had with a brocket deer was along the Bladen River Trail, just beyond Fire Tail Creek. The large female stood frozen for about two minutes while being observed from less than ten meters away. It was obvious that her long legs and slender build were well adapted for life in the forest, but the strange behavioral adaptation was confusing and would certainly make her an easy target for even the most amateur hunter. However, in the context of evolution, perhaps the "freeze" response is an effective method for avoiding their lethal felid predators, whose night vision is good, but whose hearing is even better.

The conspicuous presence of large herbivores is fascinating

in itself, but more importantly, is indicative of forest health. The four species of ungulates that were observed are critical not only to the dispersal and predation of seeds, but also to the promotion of understory diversity through such behaviors as herbivory and trampling. The positive effects that herbivorous vertebrates have on tropical ecosystems has been documented by Dirzo and Miranda (1990, 1991) in a comparative study between the forests in Las Tuxtlas, and those in Chiapas, Mexico. Although both were protected areas, the mammal populations had been devastated in Las Tuxtlas because of overhunting in the surrounding area. The most significant features of the two forests in terms of faunal composition were that Las Tuxtlas had an absence of tapirs, white-lipped and collared peccaries, and deer, while Lacandon had a well represented fauna that included the four species mentioned above. Interestingly, the two forests had distinctly different vegetative patterns that are thought to be correlated with absence of large herbivorous vertebrates. For example, several areas in Las Tuxtlas were noticeably covered with "seedling carpets" that were described as "virtual monocultures," had no evidence of "vertebrate herbivory," and had piles of rotting fruits and seeds (Dirzo and Miranda 1990). More concretely, an analysis of the vegetation of both regions

revealed that the understory diversity in Lacandon was three times that of Las Tuxtlas. In addition, 67% of the quadrats surveyed in Las Tuxtlas had one dominant species, while the same was true for only 10% of the quadrats in Lacandon (Dirzo and Miranda 1991). The evidence strongly supports the conclusion that herbivorous vertebrates, in particular, tapir, peccaries, and deer, play a crucial role in determining vegetative diversity in the understory.

Order Carnivora:

As a group, "carnivores are adapted to find, catch, and kill animal prey," however, many are also known to rely heavily on insects, leaves and fruits (Emmons 1990). This order is so diverse that there are few characteristics that can be used to categorize an animal as a carnivore. According to Macdonald (1996), the unifying trait is the "possession of the four so-called carnassial teeth." In some species, these teeth that were adapted for shearing flesh, have since "reverted to grinding surfaces" as diets have expanded and in certain cases, become primarily vegetarian (Macdonald 1986).

As a result of predatory behavior, many species have become notoriously powerful, precise, efficient hunters, and are often elusive. Concurrently, as their habitat has dwindled, they have

often been reviled by humans, and particularly livestock owners, as fierce and bloodthirsty rogues. The reality is that meat is food, and the carnivores have all the necessary qualifications for fulfilling their biological needs.

Family Procyonidae:

The procyonids are thought to have evolved from the dog family at a time when Europe and North America were joined. According to Macdonald (1986), the family separated along with the continents and the subfamily procyoninae was left in the New World, while the subfamily ailurinae was relegated to the Old World. By most classification schemes, the procyonids are strictly a New World family.

The most commonly seen procyonid in the BFREE area was the kinkajou (*Potos flavus*). The kinkajou is a nocturnal, canopy dweller with a prehensile tail and a long tongue used to reach nectar. According to Emmons (1990), fruit constitutes 80% of their diet, and insects the other 20%. They seem to be sociable animals, often congregating in fruit trees, and are not afraid to react noisily when startled. Their yellow, or at certain angles, green eyeshine was seen on several occasions on the Canal and Bladen River transects, and once on the Blue Pool Trail. Notably, kinkajous were never seen in the Waha Mill.

The olingo (*Bassaricyon gabbii*) is very similar in outward appearance to the kinkajou, and they are sometimes even found foraging together in trees (Macdonald 1986). Unlike kinkajous, olingos do not limit themselves to fruit and insects, but feed on birds and small mammals as well. One of the most noticeable distinguishing characteristics is that olingos have bushy non-prehensile tails. Unfortunately, they are difficult to observe and the one unconfirmed sighting was along the Bladen River Trail at about 10 p.m. Yellowish-orange eyeshine was seen and a glimpse was caught of the tail as the animal disappeared into the dense canopy above.

One of the advantages of arboreal life is that kinkajous and olingos usually get first pick of the ripening fruit, and for that reason, these animals play an important role as seed dispersing agents. Furthermore, they are good indicators of a healthy forest as they require a dense canopy with a wealth of fruiting trees, and do not "adapt readily to disturbed or secondary forests" (Emmons 1990).

Family Mustelidae:

Mustelids are a notoriously shy family that are known to "occupy nearly every habitat, including fresh and salt water" (Macdonald 1986). The only species that was identified at BFREE

was the southern river otter (*Lutra longicaudis*), which is known to subsist mainly on fish and crustaceans. From the banks of the Bladen River, downstream from the camp, two otters were observed swimming upstream. It was an amazing sight as they were not only exceptionally graceful in the water, but seemed to be playful as well. Ironically, their best effort on land is an awkward waddle.

Family Felidae:

The cat family is perhaps the most elusive group of mammals in the forest. Most are solitary hunters that feed exclusively on vertebrate prey. Formidable predators, every aspect of their morphology seems well-suited to a carnivorous lifestyle. Importantly, felids are equipped with binocular and color vision that rivals that of humans during daylight, but is up to six times more acute during poor illumination at night (Macdonald 1986).

There was only one felid observed in the field, and although its identity was not certain, it was most likely an ocelot (*Felis pardalis*). The ocelot is one of the smaller cats, is primarily terrestrial, and feeds on rodents, birds, snakes, lizards, and other small vertebrates (Emmons 1990). The single encounter occurred at 4:30 a.m. along the Entrance Road. The pale yellow

eyeshine was first observed from about twelve meters away, just as the stealthy felid made its way across the road. Upon being approached, the animal faced the intruder, took a couple of steps forward, and then disappeared into the bush. Because of a dim headlamp, no patterns were discerned, and although it was likely an ocelot, it is possible that it was the cat's more arboreal, dark-coated counterpart, the jaguarundi (*Felis yagouarundi*), also known to occur in this region.

Although none of the larger cats were ever observed, there were signs of their presence found in BFREE and the surrounding area. Although the dry season left few opportunities to find tracks, the sand along the banks of the Bladen River was soft enough to capture imprints, even if they were often obscure. On one occasion, in close proximity to the Blue Pool, scat was found along with two footprints that were large, but the intricacies of which could not be discerned. By the size and approximate shape, the tracks clearly belonged to one of the two large cats found in the region: the jaguar (*Panthera onca*) or the puma (*Felis concolor*). Additionally, tracks were found in the muddy substrate of the Trio River to the east of Bladen, and were positively identified as belonging to the jaguar.

Signs and sightings of the various cats were rare but

reassuring aspects of the mammalian survey. In general, felids require large tracts of undisturbed habitat in order to maintain stable populations. For example, according to Terborgh (1992), one reproductive unit in a jaguar population requires five thousand hectares of land. As a result of human development, suitable habitat has become rare and populations are dwindling. The wildlife corridor, of which BFREE is a part, has become one of the few remaining refuges for these elusive predators.

Results of this study indicate that there is a diverse representation of carnivores in the area, and significantly, they occupy several different niches in the ecosystem. Not only does this eliminate direct competition, thereby increasing potential diversity within the order, but it also serves a purpose to the forest as a whole. Indeed, by exploiting a wide range of diets, the carnivores of the area directly affect several different trophic levels. For example, kinkajous fill a frugivorous and insectivorous niche, and therefore are important in seed dispersal, as well as perhaps stabilizing insect populations. More importantly, by focusing on insects and fruits, other carnivores, such as olingos and the smaller felids, are able to freely exploit, and to some extent, maintain small vertebrate populations. Analysis is shown in appendix 4.

Similarly, predators that occupy the uppermost link in the trophic chain are critical to the maintenance of stable populations of the larger herbivorous vertebrates. The jaguar and puma, for example, perform this function so well that they have been called "ideal searchers" who take prey "nonselectively in strict proportion to their availability" (Terborgh 1992). Significantly, rodents such as the paca and the agouti who have low fecundity levels, are taken less frequently when animals with larger litters, such as peccaries, are abundant. Ultimately, the relationship is circular, and each species depends on the other in order to maintain populations that are viable in the context of the ecosystem. Terborgh (1992) has taken this concept a step further with respect to the top carnivores, and referred to their role as a "stabilizing function." That is, these predators not only affect populations of their own prey, but also influence ecosystem diversity through indirect effects. He defines these indirect effects as "the propagation of perturbations through one or more trophic levels in an ecosystem so that consequences are felt in organisms that may seem far removed both ecologically and taxonomically, from the subject of the perturbation" (Redford 1992). His schematic analysis is shown in Appendix 4.