Population status, distribution and conservation needs of the narrow-striped mongoose *Mungotictis decemlineata* of Madagascar

Lance Woolaver, Rina Nichols, William F. Rakotombololona, Anselme T. Volahy and Joanna Durbin

Abstract The narrow-striped mongoose *Mungotictis decemlineata* is a small, endemic carnivore currently known to occur only in the dry deciduous forests of the central and southern Menabe regions of western Madagascar. It is categorized as Endangered on the IUCN Red List and is threatened by rapid habitat loss from deforestation. From live-trapping and village surveys we found *M. decemlineata* to be distributed throughout the largest area of connected forest in central Menabe and most of the larger forest fragments in southern Menabe. We estimated there are a minimum of 2,000–3,400 adults in central Menabe and 6,400–8,650 adults in southern Menabe. Although this represents the total known population, the southern limits of the species' range are still unclear. Fifty-four individuals were live-trapped in central Menabe. *M. decemlineata* abundance was not correlated with forest structure or invertebrate abundance and diversity at the sampled sites. The building of access roads for logging may have a long-lasting effect by increasing the level of human disturbance, predation by domestic dogs, and illegal cutting within the surrounding area. Conservation management efforts to save *M. decemlineata* need immediate implementation, with emphasis on cooperative efforts with local villages to reduce the rate of slash-and-burn agriculture and logging of the remaining dry deciduous forest of the region. Research to determine population trends and status of *M. decemlineata* south of the Morondava and Mangoky rivers is required.

Keywords Distribution, Madagascar, *Mungotictis decemlineata*, narrow-striped mongoose, population status.

Introduction

The narrow-striped mongoose *Mungotictis decemlineata*, or *boky-boky* in Malagasy, is a small carnivore currently known to occur only in the dry deciduous forests of the Menabe region of western Madagascar. This species is categorized as Endangered on the IUCN Red List (IUCN, 2004) and is threatened by the rapid loss of habitat through deforestation. Total forest loss in the Menabe region between 1963 and 1993 was 32%, a result of agro-industrial projects and slash-and-burn cultivation (Tidd *et al*., 2001). Forest loss has continued since 1993 at an accelerated rate (J. Pinder, unpubl. data). There are two currently recognized subspecies, *M. d. decemlineata* and *M. d. lineata*, the latter known from a single immature specimen (Gray, 1848) from an unspecified locality in Madagascar. *M. d. decemlineata* in central and southern Menabe are believed to be two distinct subpopulations (Hawkins *et al*., 2000).

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M. decemlineata is a social animal that lives in family units. Groups of 3–5 adults may be observed together with juveniles during the dry season (June–October). Solitary animals and groups of one adult with one juvenile are more commonly observed during the warmer wet season (Rabeantoandro, 1997). Mating occurs from July to December. A gestation period of 74–106 days is generally followed by the birth of a single infant (Albignac, 1973; Razafimanantsoa, 2003). *M. decemlineata* is primarily insectivorous, but their diet is supplemented by small mammals, reptiles and birds (Rabeantoandro, 1997). Larger prey items such as mouse lemurs (*Microcebus* spp.) may be cooperatively hunted by groups (Albignac, 1976). Specialization on insect larvae may help them survive during the dry season when the availability of other food items is limited (Albignac, 1976).

Field research was carried out during August–November 2002 to address the lack of knowledge of the current distribution and abundance of *M. decemlineata* and to determine threats to the species' survival. This paper reports the findings of this research.

Methods

The study was conducted in western Madagascar within central and southern Menabe (Fig. 1). Central Menabe extends from south of the Tsiribihina River to north of the Morondava River (Fig. 2). Southern Menabe extends

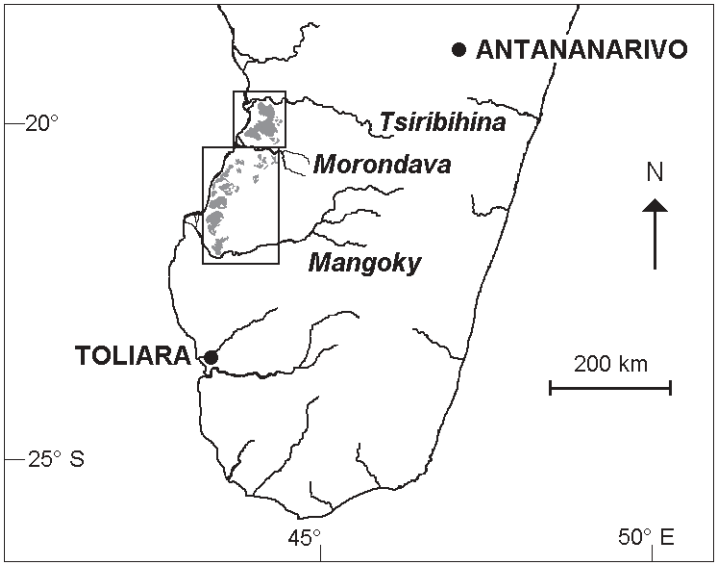

Fig. 1 Southern Madagascar showing the main rivers and study areas of central (see Fig. 2) and southern Menabe (see Fig. 3).

Fig. 2 Central Menabe (see Fig. 1), with locations of study plots and major villages. The distribution of *M. decemlineata* is delimited by the solid black line. Forest quality is shown in shades of grey with dense forest represented by the darkest grey and highly degraded forest represented by the lightest grey. The map is adapted from J. Pinder (unpubl. data) and is based on satellite images from 2000.

from south of the Morondava River to north of the Mangoky River (Fig. 3).

Twenty-eight villages in southern Menabe and five villages in central Menabe were visited over August–November 2002 to determine range limits. A group interview was conducted during a meeting at each village, with participation by 6–14 village leaders. Topographic maps (scale 1:100,000 and 1:300,000) and photographs of Malagasy animals were used as aids. Villagers were asked to name the areas of forest they utilized, describe their activities (honey collection, *Tenrec* hunting or other activities) and name animals they encountered in the

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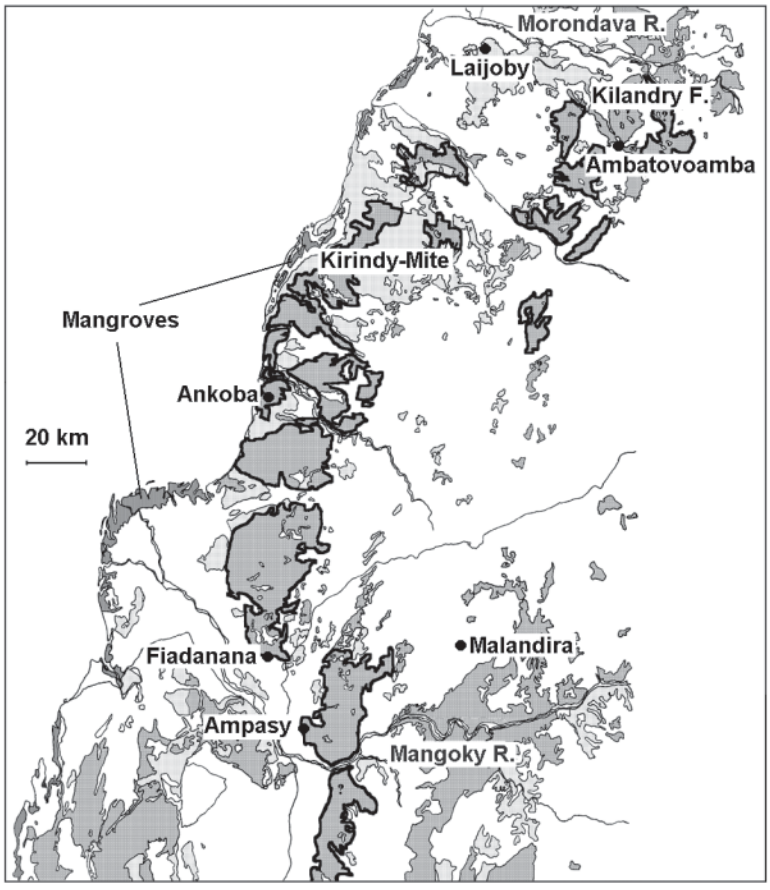

Fig. 3 Southern Menabe (see Fig. 1), with major villages. The distribution of *M. decemlineata* is delimited by the solid black line. Forest quality is shown in shades of grey with dense forest represented by the darker grey and degraded forest represented by the lighter grey. The map is adapted from T.H. Andrianandrasana (unpubl. data) and is based on satellite images from 1996.

forest. If *boky-boky* was not mentioned, villagers were asked to identify photographs of forest animals. If *boky-boky* was recognized the conversation was directed more specifically towards *boky-boky* and, if not, villagers were directly asked if they knew of *boky-boky*.

Eight 16 ha plots were live-trapped over October–November 2002 in central Menabe. Plots were divided among four different sites with two plots per site. Within each site one plot was in exploited forest (either commercially cut and/or cut heavily by villagers) and the other in relatively unexploited forest. Sites were located throughout the remaining intact dry deciduous forest (Fig. 2). Trapping was discontinued at the end of November to avoid capturing pregnant females or females with newborns. Trapping could not be carried out in southern Menabe. Trap stations were 100 m apart in a grid pattern of 5 * 5 stations. Edges of each plot were at least 100 m from the nearest road or change in habitat. Two live-traps, one larger Tomahawk 205 (Tomahawk Live Trap Co., Tomahawk, Wisconsin, USA) and one smaller Tomahawk 201, were set at each station. Traps were set continuously for 5 days and 5 nights and baited with fermented, salted fish. Daily trap checks were started at 06.00 and 16.00.

Animals were weighed to the nearest 5 g using a hand-held Pesola balance (PESOLA AG, Baar, Switzerland) and marked by trimming a patch of fur from the body to enable identification of individuals. Sex, age, breeding and general condition, and pelage markings were recorded for each animal. Animals were grouped into three age classes: adults, juveniles (>1 year old but not yet breeding), and young of the year (<1 year old). Animals weighing more than 450 g with yellow, worn teeth were considered adults (Albignac, 1976). Evidence of breeding condition such as large testes or pregnancy and well-developed mammae also identified them as adults. Animals weighing more than 325 g that were not in breeding condition and had sharp, clean teeth with little wear, were considered juveniles. Young of the year were obvious because of their small body mass (generally <325 g) and at least some white milk teeth comprising a portion of their dentition (Albignac, 1976).

Time within each study area was standardized among the eight plots, with *c*. 40 person hours of trap checking and *c*. 72 person hours of habitat and invertebrate sampling per plot. Group sizes and number of *M. decemlineata* encountered in the forest at each plot were therefore considered to be reliable indices of relative abundance. Observations included all animals encountered and

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trapped within the area covered by each trapping grid. Untrapped animals that remained in the immediate area while we handled a trapped animal were considered to be part of the same group. Trapping effort for each 16 ha plot covered an area substantially larger than the plot itself, allowing for immigration from outside the plot (Krebs, 1999). On two separate occasions marked animals were observed *c*. 300 m outside a plot, suggesting that plots were each covering an area of at least 1 km^2 (plot size of 400 m plus 300 m on each side). The actual area of forest sampled by each plot was therefore estimated to be 100 ha (1 km^2). Extent of occurrence and area of occupancy, following IUCN guidelines (IUCN, 2001), were calculated using the geographical information system ArcView v. 3.2 (CSRI, Redlands, USA).

Forested area in central Menabe was calculated, using ArcView, from maps of the region created by J. Pinder (Colorado State University, USA) based on satellite images from 2000. Forest quality assessment followed that suggested by J. Pinder and ranged from dense intact to highly degraded forest. Forested area in southern Menabe was calculated by T.H. Andrianandrasana, using the geographical information system MapInfo Professional v. 5.0 (Troy, New York, USA), and based on satellite images from 1996.

A minimum population density was estimated for each study site based on the number of individuals trapped at each of the two plots at the site. For example, one adult was caught at plot N1 and three adults at plot N2 in Ambatomainty. Because each plot sampled an area of 1 km^2, the density at the site of Ambatomainty was 1–3 adults per km^2. The population density for Ambatomainty was then extrapolated to forest of similar quality in that region of central Menabe. It is not likely that all animals were captured within each plot so these estimates should be considered minimum population estimates.

As trapping was not carried out in southern Menabe, minimum densities for the southern region were calculated by extrapolating from the number of animals trapped in forest of similar quality in central Menabe. Although the Schnabel method for estimating abundance (Krebs, 1999) would have been preferable for calculating population estimates, the number of recaptures in the majority of plots were too few to allow for this type of analysis.

Habitat variables were sampled along two transects at each live-trapping plot to describe forest structure (Table 1). Transects were 150 * 4 m and were parallel to and 100 m from the associated plot. Each transect was subdivided into 10 m intervals. All habitat variables (Table 1) were estimated at each 10 m interval, except for the number of trees and pieces of coarse woody debris, which were counted within each of the intervals.

Table 1 Habitat variables measured at *M. decemlineata* study plots in central Menabe (Fig. 2) in 2002.

Code	Variables (adapted from Hawkins & Wilmé 1996)
T < 5	Number of trees <5 m in height
T5–10	Number of trees 5–10 m in height
T10–20	Number of trees 10–20 m in height
T20+	Number of trees >20 m in height
Wd5–20	Number of pieces of coarse woody debris with diameter 5–20 cm
Wd20–40	Number of pieces of coarse woody debris with diameter 20–40 cm
Wd40+	Number of pieces of coarse woody debris with diameter >40 cm
Lianas	Abundance of lianas (abundant, 66–100%; frequent, 33–66%; rare ≤ 33%)
Litter	Leaf litter depth (0–1 cm, 1–2 cm, 2–3 cm, >3 cm)
Canopy	Estimated % of overhead canopy cover to nearest 5%
Herb	Estimated % of herbaceous cover to nearest 5% (projected to ground)
Shrub	Estimated % of shrub cover to nearest 5% (projected to ground)
Visibility	Distance visible through vegetation at eye level (mean of estimates in four directions)

Leaf litter invertebrates were sampled at each live-trapping plot using pitfall traps. Two 150 m transects were sampled at each plot with each trap 10 m apart along each transect. The traps were cups with an aperture diameter of 70 mm, a base diameter of 45 mm and a depth of 110 mm. The top of the cup was placed flush with the soil, 1/3 full with water and detergent, and covered by a leaf. The pitfalls and invertebrates were collected after 72 h. Invertebrates were identified to the level of Order.

Two 500 * 4 m transects were surveyed in each trapping plot to record the number of locally and commercially cut trees. Distance from each plot to the three nearest villages was recorded with a global positioning system. The numbers of villagers and dogs encountered near and within the study plots were also recorded.

All data sets were tested for normality using Q-Q plots and histograms of the standardized residuals. Data that did not conform to a normal distribution were either natural log or square root transformed. SPSS software v. 10.0 (SPSS, Chicago, USA) was used for all analyses. The effect of site and treatment (exploited vs unexploited forest) on number of *M. decemlineata* captured was evaluated using one-way ANOVA. Variation in habitat variables among plots was examined using a Principal Component Analysis (PCA). The three vegetation characteristics of Axis 1 accounting for most of the variability in the PCA analysis were then compared to numbers of *M. decemlineata* captured, using regression analysis. The effect of site and treatment on invertebrate abundance and species richness was evaluated using two–way ANOVA. Regression analysis was used to test the

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relationship between the number of *M. decemlineata* captured and invertebrate abundance and diversity, and the relationship between number of *M. decemlineata* captured and human disturbance (as measured by proximity of the three nearest villages and number of cut trees).

Results

Distribution

It is not yet known whether *M. decemlineata* north and south of the Morondava River are the same or different subspecies. For this reason their distributions and population estimates have been considered separately. Results of live-trapping and village interviews indicate that in central Menabe *M. decemlineata* occurs throughout the largest area of connected forest from Kiboy in the north to the southern limits of the Réserve Spéciale d'Andranomena and the forest south of Marofandilia (Fig. 2), and in the west near the villages of Lambokely and Ampataka. The species does not extend into the smaller fragments east of the main area of connected forest in central Menabe, apart from the forest of Longo, south-west of the village of Antsoha. The larger forest fragments north and east of the village of Antsetaka have not supported animals in recent memory (>70 years). The south-eastern limit of the distribution in central Menabe extends to the forests north of Antsondroka but does not continue to the forests south of the village, around Ankiliabo (Fig. 2).

M. decemlineata was reported by villagers to be found in most of the fragmented forest in southern Menabe (Fig. 3), although it was considered to be rare in the smaller fragments in the east. *M. decemlineata* was reportedly common in the largest areas of forest in the west near the villages of Ankoba, Fiadanana and Ampasy, but was not found to the south and east of Malandira. *M. decemlineata* was not present in the fragment of forest north of the village of Ambatovoamba, although it was reported to be in the adjacent forest of Kilandry to the north-east. Most of the large fragments of forest around the village of Laijoby have been cut since 1996 and what does remain is highly degraded. Villagers were not surveyed near Kirindy-Mite as *M. decemlineata* has recently been trapped in this area by other researchers (S. Goodman, unpubl. data). The villagers in Ampasy stated that *M. decemlineata* could be found in the forest immediately south of the village on the other side of the Mangoky River. This represents the first evidence of the existence of *M. decemlineata* south of the Mangoky.

Live-trapping and demography of trapped population

Fifty-four *M. decemlineata* were trapped in central Menabe. The number of animals captured varied significantly among the four sites ($F_{3,4} = 15.33$, P = 0.01). Number of animals captured was not significantly different between treatments ($F_{1,6} = 0.33$, P = 0.59). The greatest numbers were caught in the forestry concession of the Centre de Formation Professionelle Forestière (CFPF) in the Kirindy Forest, with decreasing numbers trapped in the northern and southern limits of the range (Table 2).

Twenty-two of the trapped animals were female (13 adults, 5 juveniles and 4 young) and 30 were male (23 adults and 7 juveniles). The sex of two young animals was not determined. Adult males weighed 475–625 g (mean 539 ± SD 43 g). Adult females weighed 450–740 g (520 ± SD 71 g). Eighty-five percent of the adult females captured were pregnant. Juvenile *M. decemlineata* weighed 350–490 g (411 ± SD 43 g). Young of the year weighed 265–335 g (300 ± SD 30 g).

There was considerable variation in group sizes (Table 3), with the largest groups observed in Kirindy/CFPF and Amboloando. Single animals were most commonly encountered at the northern and southern sites of Ambatomainty and Joie Roger. Only at Kirindy/CFPF and Amboloando were groups commonly trapped together or observed travelling within the forest. A group of >10 individuals was observed at Kirindy/CFPF.

Minimum population estimates

The minimum number of *M. decemlineata* remaining in central Menabe, including adults, juveniles and young, was estimated to be 3,750–4,350, and the number of adults 2,000–3,400 (Table 4). The area of occupancy was 900.22 km^2 and the extent of occurrence 1,524 km^2. The minimum number of *M. decemlineata* in southern Menabe was estimated to be 7,100–13,150 and the number of adults 6,400–8,650 (Table 4). These estimates are tentative, having been extrapolated from the trapping results in central Menabe. The area of occupancy was 1,871 km^2 and the extent of occurrence 8,729 km^2.

Table 2 Number of *M. decemlineata* live-trapped in central Menabe in October–November 2002. See Fig. 2 for locations of plots.

Site	Plot	Treatment[1]	Individuals trapped	Recaptures
Ambatomainty	N1	Exploited	3	0
	N2	Unexploited	3	0
Amboloando	C1	Exploited	7	2
	C2	Unexploited	8	1
Kirindy/CFPF	K1	Exploited	10	3
	K2	Unexploited	13	7[2]
Joie Roger	JR1	Exploited	4	0
	JR2	Unexploited	6	0

[1]See text for details
[2]One individual was recaptured twice

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Table 3 Group sizes of *M. decemlineata* observed at the study sites in central Menabe (Fig. 2) in October–November 2002. Each group is presented within separate parentheses. Sex and age is given for animals that were trapped and handled. Unknown refers to animals that were observed at a distance but not handled. See Fig. 2 for locations of plots.

Site	Plot/Location	Group size & demography
Ambatomainty	N1	(1 juvenile ♂) (1 adult ♀ & 1 young ♀)
	N2	(1 adult ♀) (1 adult ♂) (1adult ♂)
	On road	5 lone animals seen at different times on the road between the two plots
Amboloando	C1	(1 adult ♀) (1 juvenile ♀) (1 adult ♂) (1 young unknown) (2 adult ♀ & 1 juvenile ♀)[1] (4 unknown)
	C2	(1 adult ♀) (1 adult ♂) (1 adult ♂) (1 juvenile ♂) (1 adult ♂ & 1 juvenile ♀) (3 unknown) (1 adult ♀, 1 juvenile ♀ & 2 unknown)
	Road	(1 unknown) (3 unknown)
Kirindy/CFPF	K1	(1 adult ♀) (1 young ♀) (1 adult ♂) (1 adult ♂) (1 adult ♂) (1 unknown ♂) (2 adult ♂)[2] (2 adult ♂)
	K2	(1 young ♀) (1 adult ♂) (1 adult ♂) (1 adult ♂) (1 adult ♂) (1 juvenile ♂) (1 juvenile ♂) (1 adult ♀, 1 young ♀, 1 juvenile ♂, & 1 unknown) (4 unknown) (5 unknown) (1 adult ♀, 1 juvenile ♂, 1 young unknown & 2 unknown)
	Road	(1 unknown) (10 unknown)
Joie Roger	JR1	(1 adult ♀) (1 adult ♂) (1 adult ♀ & 1 adult ♂)
	JR2	(1 adult ♀) (1 adult ♂) (1 adult ♂) (1 adult ♂) (1 juvenile ♂) (1 juvenile ♀ & 2 unknown)
	Road	4 lone animals seen at different times on the road between the two plots

[1]The two adult females were pregnant
[2]These two adult males were caught together on 31 October and were recaptured again together on 1 November. They joined up and left together upon release on both occasions.

Table 4 Minimum population estimates of *M. decemlineata* in central (Fig. 2) and southern Menabe (Fig. 3) in 2002.

Region	Study site	Animals km^{-2}	Adults km^{-2}	Area of forest of similar quality in region (km^2)	Population estimate	
					All age classes	Adults
Central Menabe	Ambatomainty	3	1–3	577.45	1,732	577–1,732
	Joie Roger	4–6	4	137.80	551–827	551
	Amboloando	7–8	4–5	125.14	876–1,001	500–626
	Kirindy/CFPF	10–13	6–8	59.83	598–778	359–479
Total				900.22	3,757–4,338	1,987–3,388
Southern Menabe	Ambatomainty	3	1–3	363.41	1,090	363–1,090
	Amboloando & Joie Roger	4–8	4–5	1,507.59	6,030–12,061	6,030–7,538
Total				1,871	7,120–13,151	6,393–8,628

Forest structure

There was little variation in habitat variables among plots, with Axis 1, 2 and 3 of the PCA accounting for 16.3, 14.4 and 10.2% of the variance, respectively. For Axis 1, the abundance of lianas (Loading = 0.767), visibility (–0.738), and number of trees <5 m in height (–0.622) accounted for most of the variability. However, these three variables had no linear relationship with the number of animals captured at each plot (liana abundance $r^2 = 0.11$, P = 0.43; visibility $r^2 = 0.16$, P = 0.33; trees <5 m $r^2 = 0.43$, P = 0.09). Soil structure and litter depth, two variables considered important for *M. decemlineata* because of their reliance on insect larvae as a food source (Rabeantoandro, 1997), did not vary among the plots. Soil was primarily ferruginous, sandy and either yellowish brown or greyish beige. Humus was poorly developed and leaf litter depth <2 cm at all sites.

Invertebrate sampling

A total of 322 invertebrates comprising 76 different species were captured in the pitfall traps. The most abundant and diverse groups of invertebrates caught were crickets and cockroaches (Orthoptera) and spiders (Araneida). No significant differences were found among sites or between treatments for abundance (site $F_{3,12} = 0.10$, P = 0.95; treatment $F_{1,14} = 0.10$, P = 0.76; site * treatment $F_{3,12} = 0.78$, P = 0.54) or diversity (site $F_{3,12} = 0.42$, P = 0.74; treatment $F_{1,14} = 0.92$, P = 0.37; site * treatment $F_{3,12} = 0.42$, P = 0.74). There was no linear

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relationship between number of *M. decemlineata* captured and invertebrate abundance ($r^2 = 0.03$, P = 0.71) or diversity ($r^2 = 0.03$, P = 0.48).

Human disturbance

Proximity of the three nearest villages ($r^2 = 0.03$, P = 0.99) or number of cut trees ($r^2 = 0.01$, P = 0.91) had no linear relationship to the number of *M. decemlineata* captured. However, the greatest densities of *M. decemlineata* were found in the two study plots at Kirindy/CFPF, which was the only site where neither people nor dogs were observed during the trapping session.

Discussion

M. decemlineata was found throughout the larger fragments of dry deciduous forest in central and southern Menabe, and the number of animals trapped did not appear to be related to variation in forest structure or leaf litter invertebrate abundance and diversity. Significant differences in numbers of *M. decemlineata* were not found between treatments (exploited and unexploited areas), but were found between study sites with differing levels of human disturbance. The building of access roads for logging may have an effect that extends beyond the immediate period and locality of commercial activity by increasing the level of human activity within the surrounding uncut areas.

In central Menabe there is little likelihood that *M. decemlineata* is to be found in viable population numbers in the smaller fragments east of the remaining larger area of connected forest. Even this larger area is under extreme pressure from slash-and-burn agriculture and is being reduced to smaller fragments, particularly in the south-east and in the area east of Beroboka. In southern Menabe *M. decemlineata* still occurs in the smaller fragments of forest in the east, but this forest is rapidly disappearing. The only substantial populations remain in the larger western fragments. A report that *M. decemlineata* is being hunted for food in southern Menabe (Goodman & Raselimanana, 2003) could indicate that the rate of decline will increase.

The number of animals captured in central Menabe varied significantly among the four sites but not between treatments, suggesting that geography (i.e. the site) was more important than the presence or absence of exploitation (i.e. the treatment). The greater number of recaptures in Kirindy/CFPF and Amboloando suggests that these represent populations resident within the study plots, whereas the lack of recaptures in the northern and southern study plots implies that non-resident animals were being trapped. The healthiest populations (i.e. with the largest number of animals and largest group sizes) were within the least disturbed areas of Kirindy/CFPF. Increased human disturbance may be disrupting the social dynamics of *M. decemlineata* at the limits of its range. The gregarious nature of this animal is one of the distinguishing features of the species (Albignac, 1973, 1976). The lack of recaptures and observations of social units in the northern and southern limits of central Menabe suggests that individuals in these areas were transient and solitary. *M. decemlineata* at the edges of its range or in relatively small forest fragments may be under increased levels of stress and exist in low densities.

The absence of variation in forest structure among plots was not unexpected as the plots were within intact, dry, deciduous forest of similar overall structure within the limited range of *M. decemlineata*. These results suggest that the forest at all sampled sites was of adequate quality to support *M. decemlineata*, and that neither variation in forest structure nor number of individuals or species of invertebrates in leaf litter accounted for differences in numbers of *Mungotictis* caught.

It was difficult to show empirically within the scope of the present study how commercial forest cutting may be affecting *M. decemlineata*. There are confounding variables such as the number of roads created by commercial cutting, dependence on forest products by local villages, and level of unregulated activity by non-local villagers, primarily the cutting of trees for construction and building of pirogues. Commercial cutting may be having an impact on the surrounding forest that extends beyond the immediate period and locality of commercial activity. In particular, building of new roads may accelerate illegal cutting within the surrounding forest, and increase the level of human disturbance and activity by domestic dogs. Roaming dogs are suspected to have a significant impact on terrestrial endemic animals in the Menabe region, including the Malagasy giant jumping rat *Hypogeomys antimena* (Sommer *et al.*, 2002). Although no empirical study has yet been carried out, sightings of *M. decemlineata* increased significantly at the CFPF Kirindy field station following the removal of dogs from the area (F. Hawkins, pers. comm.). An evaluation of the impact of predation by dogs on *M. decemlineata* should be a priority.

The healthiest population of *M. decemlineata* was found within the least disturbed forest of Kirindy/CFPF, suggesting that human activity is a critical factor limiting numbers within the remaining areas of intact forest in the Menabe region. If this is the case, *M. decemlineata* will require areas that are protected from unregulated use by both local and non-local villagers.

Based on our findings we identify three main conservation needs for the survival of the narrow-striped mongoose *M. decemlineata*:

1) The rapid loss and fragmentation of forest habitat is the most immediate threat. Conservation organizations must increase cooperative efforts with local villages to reduce the rates of slash-and-burn agriculture and commercial logging in the remaining dry deciduous forest of Menabe. Emphasis must be placed on halting the deforestation east of Beroboka, which is dividing the largest remaining area of intact forest. There are two legally protected areas within the current range of the species, the Réserve Spéciale d'Andranomena (64 km^2) in central Menabe and the Parc National de Kirindy-Mite (722 km^2) in southern Menabe. Together they represent 7.7% of the estimated area of occurrence of *M. decemlineata*. Unfortunately, Andranomena consists entirely of secondary and degraded forest and Kirindy-Mite has been significantly affected by hunting (Goodman & Raselimanana, 2003). A protected area needs to be established that encompasses Kirindy/CFPF, the remaining corridor of forest east of Beroboka, and the forest of Ambadira north of Beroboka. This would also benefit the other species endemic to the Menabe region.
2) In southern Menabe the remaining deciduous forest is disappearing rapidly and is increasingly fragmented, and more information is required on the distribution and status of *M. decemlineata* in this region. A live-trapping study should be carried out to determine population trends and subspecific status of *M. decemlineata* in the remaining forest fragments, and the degree of threat posed by hunting of *M. decemlineata* for food requires evaluation.
3) The full distribution and taxonomic status of *M. decemlineata*, and in particular whether *M. d. lineata* is a distinct subspecies and if its range is south of the Mangoky River, requires investigation. If a population (or subspecies) does exist south of the River, it is probably facing pressures similar to those facing *M. decemlineata* in Menabe.

The Durrell Wildlife Conservation Trust (DWCT), the Malagasy NGO Fanamby, Conservation International and WWF-Madagascar continue to work with local villages in Menabe to halt the current rates of slash-and-burn agriculture through community awareness programmes and implementation of methods of sustainable resource use. Fanamby and the DWCT have worked with the new regional authorities and local people to agree on a protected area covering 100,000 ha of forests and wetlands in central Menabe. This protected area, which should receive legal protection by the end of 2005, includes a priority conservation zone with no extractive use of 30,250 ha covering Kirindy/CFPF, the remaining corridor of forest east of Beroboka and the forest of Ambadira north of Beroboka. Research is currently underway at the Department of Ecology and Evolutionary Biology, Yale University, to determine the subspecific status of *Mungotictis* and examine gene flow between populations in central and southern Menabe and to investigate the taxonomy and conservation status of *Mungotictis* south of the Mangoky River.

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