

RESEARCH ARTICLE

Distribution and Abundance of Patas Monkeys (*Erythrocebus patas*) in Laikipia, Kenya, 1979–2004

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Patas monkeys may be especially vulnerable to local extinction because they live in relatively small, female-philopatric groups at low densities and are strongly polygynous. We assessed a patas monkey population in Kenya's 9,700 km² Laikipia District over 25 years, using data collected in 1979–1981 and 1992–2004. The data were based on intensive observations of three study groups, "on the ground" counts, and surveys of Laikipia residents. In 1979–1981, a minimum of 415 patas monkeys lived in 14–15 groups. By 2000, the best estimate suggested 310–445 patas monkeys living in 13–17 groups over a greater surveyed area, suggesting that patas monkeys in Laikipia may have undergone a slight decline in numbers over time. Their distribution, however, was similar over time. The relative stability of this population has likely been the result of beneficial co-existence with large-scale cattle ranching. Outside Laikipia, substantial habitat alteration from rising human populations has coincided with the near disappearance of patas monkeys where they were previously more numerous. The small population in Laikipia, probably the largest remaining in Kenya, may therefore be critical to the continued existence of patas monkeys in that country and may be dependent on maintenance of large-scale ranches. Such land use provides patas monkeys with water and broad expanses of *Acacia drepanolobium* woodlands, the habitat to which patas are restricted in Laikipia. *Am. J. Primatol.* 69:1223–1235, 2007. © 2007 Wiley-Liss, Inc.

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INTRODUCTION

Throughout their broad geographic range, patas monkeys (*Erythrocebus patas* Schreber) live in groups of up to 60 individuals, mostly related adult females

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and their young [Chism et al., 1984]. Groups are normally accompanied by one adult male during all but the breeding season months when influxes of males into groups can occur [Carlson & Isbell, 2001; Chism & Rowell, 1986; Harding & Olson, 1986; Ohsawa et al., 1993]. Patas monkeys live in grasslands and woodland-savannahs south of the Sahara Desert and north of the tropical forest belt from northwest Senegal through Sudan to eastern Ethiopia, to northern Uganda, central Kenya, and northern Tanzania. They are clearly separated into three subspecies based on differences in coloration of their pelage: *E. p. patas*, occurring from Senegal to Chad, *E. p. baumstarki*, restricted to northern Tanzania, and *E. p. pyrrhonotus*, occurring from western Ethiopia to northern Uganda and localized areas of Kenya (Isbell, accepted). Although the western *E. p. patas* appears to be common or even increasing, the two eastern subspecies are uncommon [Isbell, accepted]. The rarity of the eastern subspecies is partly a result of naturally low densities, e.g., 0.2–1.5 individuals per km² [Chism & Rowell, 1988; Isbell, unpublished data] in their typical habitat of semi-arid lands with low plant productivity. Their ability to use areas with low productivity is reflected in their extraordinarily large home ranges, long daily travel distances [Chism & Rowell, 1988; Clutton-Brock & Harvey, 1977], and morphological adaptations for covering long distances efficiently [Gebo & Sargis, 1994; Hurov, 1987; Isbell et al., 1998, 1999; Meldrum, 1991; Nakagawa, 2003; Strasser, 1992].

The ability of patas monkeys to thrive in drier habitats has provided them with a buffer against extinction in Kenya because such areas are seldom used by agriculturalists. This tendency by Kenyan agriculturalists to avoid drier habitats has recently begun to change, however. On the Laikipia Plateau, a distinct ecosystem in central Kenya, and one of the few areas left in Kenya where patas monkeys can still be found relatively easily, increasing human demand for land has led to the partitioning of many large cattle ranches into smaller farms onto which people have settled and begun to cultivate. Arid country trees, mainly *Acacia drepanolobium*, have also become an important source of charcoal for small businesses catering to the energy needs of town and city dwellers. There are two potentially significant problems of changing land use for patas monkeys. First, long-term studies have shown that patas monkeys drink regularly from cattle troughs and artificial dams, especially during the dry season, and that much of their daily ranging behavior is centered around moving toward such water sources [Isbell et al., 1999]. When cattle ranches are converted to small-scale farms, patas monkeys no longer have access to water from cattle troughs and artificial dams. Second, *Acacia drepanolobium* provides most of the food for patas monkeys [Isbell, 1998]. When these trees are removed or reduced by farming or charcoal production, they are no longer available as food sources for patas monkeys.

The Laikipia patas monkeys have been subjects of two long-term field studies, the first conducted in 1979–1983 by Chism and colleagues, and the second, in 1992–2004 by Isbell and colleagues. Both sought to document the distribution and abundance of patas monkeys in the region demarcated governmentally as the Laikipia District, virtually all of which is on the Laikipia Plateau. Here we evaluate the status of the patas monkey population in the Laikipia District over the past two decades to determine whether there has been a change in their population and to illuminate their needs for continued survival in Kenya. Our longitudinal survey covered approximately 4,800 km² of potentially suitable habitat for patas monkeys, i.e., it included only acacia woodlands and scrublands and excluded forested and urban areas.

It is rare to have data for a single primate population over such a long, continuous period. These kinds of data are, however, widely regarded as key to both preserving particular species or populations and to understanding population dynamics of larger taxa of primates [Cowlshaw & Dunbar, 2000]. Long-term population monitoring has been central to conservation efforts for several primate species, for example, mountain gorillas (*Gorilla gorilla berengei*) [Harcourt, 1996] and muriquis (*Brachyteles arachnoides*) [Strier, 1999]. Patas monkeys, along with many forest guenons and possibly gorillas, are at increased risk of local extinction because they live at low densities, in relatively small groups that are female philopatric and that have high levels of polygyny [Chesser, 1991; Cowlshaw & Dunbar, 2000]. As such, patas monkeys are of particular interest for conservationists seeking to determine the viability of similar primate populations. In addition, these data come from an area where patas monkeys have historically occurred, from an area larger than any National Park or Reserve in Kenya, yet which is not protected by the government. Most long-term data on primate populations have come from parks and reserves where the animals receive at least token protection. Thus, this analysis provides an opportunity to gauge the long-term viability of a vulnerable population with no protection except that provided by the interest and tolerance of the local inhabitants, a key factor in any conservation effort whether inside or outside a protected area [Western, 1994]. It thus provides a useful contribution to primate conservation.

METHODS

The 1979–1981 Study

The distribution and abundance of patas monkeys in Laikipia were assessed during the course of a 2.5-year field study of two patas monkey groups living in and around ADC Mutara Ranch (0°9'N, 36°40'E; no. 6 in Fig. 1) carried out by Chism and D.K. Olson. In addition to intensive observations of these two groups, data were collected during chance encounters with groups other than the two main study groups. When these encounters occurred, the total number of individuals in the group and its age-sex composition were recorded (if possible), and careful descriptions were made of the adult male(s) in the group for future identification. The location of any non-study group was noted as accurately as possible in notes or on field maps. Chism and Olson also collected data on the location and composition of non-study groups during periodic mammal surveys of the area of Laikipia from the Pesi Swamp area (0°10'N, 36°35'E; no. 4) to the intersection of the Nyahururu–Nanyuki and Nanyuki–Naibor/Dol Dol Roads (approximately 0°5'N, 37°E). The location of all patas monkey groups sighted were logged and transferred to a master map of sightings.

In the second half of 1980 and the first half of 1981 managers of large ranches in the Laikipia area were contacted and asked for information on presence and relative abundance of patas monkeys on their ranches or in their areas. This information was used to confirm the “on-the-ground” counts of Chism and Olson. In June 1981, Chism and Olson carried out a 2-day census of patas monkey groups in the Loldaiga Hills area (nos. 23–25). During this same period letters were sent to current and former senior game wardens in Kenya’s national parks and reserves asking about the presence and relative abundance of patas monkeys in the parks and reserves and adjacent areas both at the time of the survey and in the past. In 1981, Chism and Olson also spent approximately a week conducting an “on-the-ground” survey of areas of western Kenya where patas monkeys were reportedly abundant in the 1950s and 1960s.

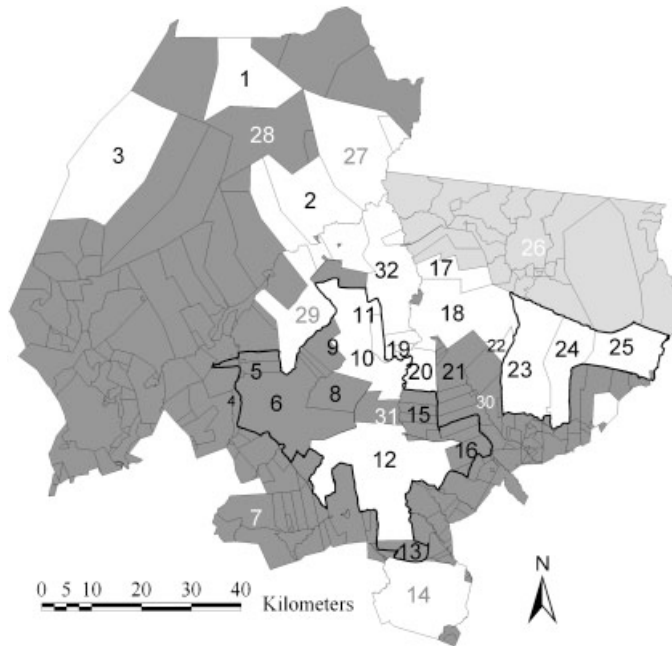


Fig. 1. The known distribution of patas monkeys in 1992–2004, within two distinct polygons demarcated by thick black lines. The distribution is course-grained in that it follows, for the most part, property boundaries, which are indicated by thin black lines. Numbers refer to surveyed (numbers in black) and unsurveyed (numbers in gray or white) properties that are mentioned in the text or in Table I. Properties are white if they are generally “wildlife friendly”, dark or light gray if not (N. Georgiadis, unpublished). Patas monkeys can range in both types of properties as long as the properties include substantial *Acacia drepanolobium* habitat (note that as this study was completed property #6 has gone from cattle ranching only to large-scale charcoal harvesting; it is unlikely that patas monkeys will continue to exist on that property). Map adapted from a template provided by Nick Georgiadis, Mpala Research Centre, and the Laikipia Research Program/CETRAD.

The 1992–2004 Study

Isbell assessed the distribution and abundance of patas monkeys over a 12-year period through intensive study of one group on Segera Ranch (0°15'N, 36°50'E; no. 10), encounters with groups coming onto Segera from neighboring ranches (nos. 9 and 11), sightings along roads and tracks traveled regularly between Nanyuki and three ranches (Mpala (no. 32): 1992–1995, Eland Downs (no. 8): 1995–1998, and Segera: 1998–2002), travel within those three ranches (Mpala: 1992–1995, Eland Downs: 1995–1998, and Segera: 1992–2002), and verbal reports from local informants. These sightings were recorded onto a master map of Laikipia.

Additionally, in July 2000–August 2000, Isbell sent out questionnaires to 31 members of the Laikipia Wildlife Forum, residents of Laikipia whose interest in wildlife conservation and preservation made it highly likely that they could identify patas monkeys reliably. Isbell's methods of assessing the patas population were independent of, but nearly identical to, those of Chism. We converged on the same methods because those were the best methods possible given the environment and low densities of patas monkeys. In other words, it was not possible to conduct repeated line transects as is commonly done in forest surveys. Although the questionnaires gave less precise numbers of individuals in groups than the longitudinal studies of a few groups, the owners and managers

had greater depth of knowledge of their properties than we did, and we are confident that the questionnaires, in conjunction with our own observations, provide the best estimates possible in this particular environment given our additional constraints of time and finances.

In the questionnaires, Isbell requested information on the number of patas monkey groups, the estimated number of individuals in groups, and the percentage of black cotton soil on each property (because *Acacia drepanolobium* is typically found on black cotton soils [Taiti, 1992]). To determine whether the extent of *A. drepanolobium* woodlands can be used as an environmental correlate of abundance of patas monkey groups and therefore the sustainability of patas monkey populations, we conducted a one-tailed, Mann–Whitney *U* test after ranking all surveyed, non-forested properties according to the coverage of *A. drepanolobium* woodland as described in Taiti [1992]. The property with the most extensive *A. drepanolobium* woodland was ranked first whereas the property with the least extensive *A. drepanolobium* woodland was ranked last.

Areas not covered by the 2000 survey included agricultural areas in southwest Laikipia, urban areas, and most forested areas, because agricultural and urban areas are not compatible with continued existence of patas monkeys, and forested areas are not suitable habitat for them. Some potentially suitable areas were not covered in the survey. These included the Mukogodo Reserve in the northeast (no. 26), Colcheccio/Loisaba (no. 27) and P & D (no. 28) in the north, Ngorare (no. 29) in central Laikipia, and many smaller holdings (e.g. Kimungandura (no. 30) in the east and Northern Approaches (no. 31) in central Laikipia). Even with such gaps, both surveys were extensive and covered more area than many other published surveys of primate populations elsewhere [e.g., Chapman et al., 2003; Glessner & Britt, 2005; references in Harcourt & Doherty, 2005; Haugaasen & Peres, 2005].

RESULTS

Status of Patas Monkeys in Laikipia, 1979–1981

There were at least 416 patas monkeys living in 14–15 groups on eight ranches in the parts of Laikipia surveyed during 1979–1981 (Table I). This estimate is based on many counts of some groups and one or a few counts of other groups. In addition, patas monkeys were seen but not systematically counted on three other large ranches. Two of these ranches (Suguroi Estates [no. 7], now partitioned, and Solio [no. 14]) were known to have patas monkey groups living on them at the time.

Status of Patas Monkeys in Laikipia, 1992–2004

Of the 31 questionnaires sent out in 2000, there were 22 responses (a 71% return rate). Twenty-one properties in and bordering Laikipia were covered by the questionnaires and personal observations (Table I), i.e., about half of the approximately 9,700 km² Laikipia District [Khaemba et al., 2001].

The regular presence of patas monkeys was confirmed for nine (43%) and their absence confirmed for 12 (57%) of the 21 properties surveyed. In addition to these properties directly accounted for by residents on those properties, eight other properties or areas were reported as locations at which patas monkeys had been seen during 1998–2000 (Table I).

Two estimates based on different considerations reveal a population size ranging from ca. 310 to 520 individuals. The first estimate, on the basis of the

TABLE I. Estimated Number of Patas Groups, Estimated Numbers of Animals per Group, and Sightings of Patas Based on Personal Observations and Questionnaires in 1979–1981 by J. Chism and D.K. Olson, and in 1992–2004 by L.A. Isbell

Property	Number of groups		Number of individuals/group	
	1979–1981	1992–2004	1979–1981	1992–2004
Northern Laikipia (north of Ewaso Nyiro and Ewaso Narok Rivers)				
1. Mugie		0		0
2. Ol Pinguone (Kisima)		0 ^a		0
Western Laikipia (west of Ewaso Narok River)				
3. Ol Ari Nyiro		0		0
Central Laikipia (bounded by Ewaso Narok River in north and west, and Ewaso Nyiro River in east)				
4. Pesi Swamp	1		23	
5. Lombala Farm	1 (MIV) ^b		39	patas seen ^c
Farms adjacent to Lombala	1 (MIV)		39	patas seen
6. ADC Mutara	4 (MI-MIV)	2–3 ^d	19, 49, 29, 39	ca. 100 (total)
7. Suguroi Estates	≥1			
8. Eland Downs	1 (OP #1)	(1) ^e	20–35 (x = 28)	patas seen; ~20
9. Thome B/Segera		1		20
10. Segera/Jessel		1 (LP)	patas seen	15 ^f
11. Mpala/Segera		1 (SP), extinct in 1995		0 after 1995
Southern Laikipia (south of Ewaso Nyiro and Nanyuki Rivers)				
12. Ol Pejeta (including Kamok and Sweetwaters)	3–4 (NR #2, OP #2–4)	2–3	32, 28, 56, 44	30–50
13. Lewcetia (Tharua)	1	1	20	10
14. Solio	≥1			
15. Endana/Kimuri/Jessel Naibor Rd.	1 (NR #1)		13 patas seen	patas seen 6–8
16. Nanyuki Ranching		1		≥8
Allus Farm				patas seen
Laikipia Air Force Base Reserve Land				patas seen
Eastern Laikipia (east of Ewaso Nyiro River)				
17. Chololo		0 ^g		0
18. Ol Jogi		0		0
19. Kihoto		0		0
20. El Karama	0	0	0	0
21. Mogwooni		0		0
22. Enasoit				rarely seen
23. Loldaiga Hills	2 (LH #1, 2)	1–2	17, 19	50
24. Ole Naishu (Kamwaki)		1		50

TABLE I. Continued

Property	Number of groups		Number of individuals/group	
	1979–1981	1992–2004	1979–1981	1992–2004
25. Borana/Ngare Ndare		2–3		2–20
Dol Dol area		(1) Outlying areas		patas seen; ~20
Lewa Wildlife Conservancy/ Lewa Downs			0	(1 several yr ago)
Wingu Kenda (Mt Kenya Game Ranch)		0		0

Numbers before properties indicate their locations in Figure 1.

^aNot seen on that property for at least the past 40 years.

^bCodes in parentheses indicate known groups.

^c“patas seen” indicates sightings by non-residents of the properties.

^dNumber of groups extrapolated from the total number of individuals reported.

^eNumber in parentheses estimated from broad statement of sightings.

^fBased on known individuals in a group studied for 10 years; this group had increased to 51 and then declined to 7 by July, 2002. After periodic fusing of Thome B/Segera with LP, some members of Thome B/Segera permanently budded off to join LP by June, 2004.

^gNot seen on that property for at least the past 23 years.

number of groups seen by Isbell or reported by respondents and their estimates of group size (2–50) (Table I), produced 12–16 groups and 331–521 individuals in Laikipia. This maximum may be an overestimate, however, because it does not consider the ranging behavior of patas monkeys, which includes very large home ranges (up to 4,000 ha) and in some areas, little home range overlap with other groups [Isbell, unpublished data]. It is likely that some of the sightings, particularly on smaller properties, were of the same group. Our own observations confirmed that at least some groups, i.e., MIV in the 1979–1981 study, and LP, SP, and Thome B in the 1992–2004 study, readily crossed fencelines separating properties (Table I).

The high stability of the home ranges of intensively studied groups over 12 years suggests the group MIV of 1979–1981 continued to range across ADC Mutara (no. 6), Lombala Farm (no. 5), and farms adjacent to Lombala, and was the group sighted during Isbell’s time. Only one group likely ranges in the area included in the smaller holdings of Nanyuki Ranching (no. 16), Laikipia Air Force Base Reserve Land, Allus Farm, Jessel, and the recently partitioned Erere, which includes Endana, Naro Moru, Hohwe, and N. Tetu (no. 15). This may also be the same group that was seen along the Naibor/Dol Dol Road in 1979–1981 and 1992–2004. At least one group appears to range on both Kamwaki (no. 24) and Borana/Ngare Ndare (no. 25). Taking these shared groups into account, and assuming (1) that patas monkey sightings on Eland Downs (no. 7) and the Dol Dol area were of functional groups rather than solitary males and (2) that these groups have about 20 individuals, the second estimate suggests 13–17 groups totaling 310–445 individuals.

Population Estimates Compared

The estimate of a minimum of 416 monkeys in 1979–1981 is within the range of both estimates derived from 1992 to 2004. Both studies revealed two population

clusters of patas monkeys, one in central and southern Laikipia and a more restricted one in northeastern Laikipia (Fig. 1). Three properties or areas in the 1979–1981 study that had patas monkeys were not included in the 1992–2004 study, whereas eight properties or areas in the 1992–2004 study that had patas monkeys were not included in the 1979–1981 study. The two studies overlapped with 11 properties. Patas monkeys were seen on ten of the 11 properties in 1979–1981 and again in those same ten properties in 1992–2004. Although the distribution and abundance of patas monkeys appear to be similar between the two time periods, greater coverage of Laikipia in the later study could indicate that the earlier study underestimated the population size. If this is the case, then it is possible that there has been a decline in the population since that earlier study. To address this issue, we compared estimated numbers of individuals over time on all properties for which estimates of numbers of individuals were available for both surveys. The sample size is small: three suggested a decrease in numbers (ADC Mutara [no. 6], Eland Downs [no. 8], and Ol Pejeta [no. 12]) and one suggested an increase (Loldaiga Hills [no. 23]). Thus, although these changes are not uniformly negative, a trend for a decline in numbers does exist. Nevertheless, it is important to note that while the size of the patas monkey population has perhaps declined slightly over the past 25 years, it has always been small and has remained stable in its distribution.

Correspondence Between Patas Monkeys and *Acacia drepanolobium* Woodlands

The questionnaires indicated a clear association between *Acacia drepanolobium* woodland and the presence of patas monkeys, at least south of Ol Pinguone (no. 2). This is consistent with our own observations that patas are largely restricted in Laikipia to *A. drepanolobium* woodlands on black cotton soils. Properties reported as having patas monkeys had significantly more *A. drepanolobium* woodland (mean rank: 7.3) than the properties that were reported as having no patas monkeys (mean rank: 12.4; Mann–Whitney *U* test: $U = 69$, $P = 0.03$). Moreover, properties having the largest tracts of *A. drepanolobium* woodlands, e.g., ADC Mutara (no. 6) and Ol Pejeta (no. 12), tended to have the largest numbers of patas monkey groups. These results suggest that populations of patas monkeys are healthiest when they have access to large expanses of *A. drepanolobium* woodland.

DISCUSSION

Studies conducted up to 25 years apart suggest that the population of patas monkeys has not changed appreciably in Laikipia over that period. The 1979–1981 estimate of 415 individuals was within the estimate derived from 1992 to 2004, but with smaller coverage. Patas monkeys, as best as can be determined, are currently at about 300–450 individuals, in 13–17 groups. This population size may be cause for concern because it may put the population at greater risk of extinction from demographic factors, such as disease and climatic events, and (perhaps) genetic factors [Primack, 2004]. In addition, the social and breeding structure of patas monkeys with their female-philopatric groups and strongly polygynous mating system [Carlson & Isbell, 2001; Chism et al., 1984] may make the effective genetic population size considerably smaller [see Chesser, 1991]. Under these conditions, Franklin [1980] and Cowlshaw and Dunbar [2000] have estimated that the effective genetic population size will be only about 25% of the census population, which in this case would be about 100 animals.

Accounts of game wardens and residents interviewed during the 1981 survey indicated that historically the Laikipia patas monkey population was probably continuous with other, more extensive, patas populations in western Kenya and Uganda and exchanged genes through, at least, male dispersal and migration with these populations. Our own observations (and anecdotal reports from primatologists in other areas of Kenya) of solitary male patas sighted far from our study areas strongly indicate that patas males can disperse over very long distances. Nevertheless, the Laikipia population may now be effectively genetically isolated. Although male patas monkeys may continue to disperse out of the area, at least since the early 1980s and possibly as long ago as the 1960s, it is unlikely that there has been significant immigration of patas into the area.

The distribution of patas monkeys in Laikipia has remained much the same over the past 25 years (Table I). The absence of patas monkeys in northern Laikipia is apparently natural; the residents on the ranches Mugie (no. 1), Ol Pinguone/Kisima (no. 2), and Chololo (no. 17) reported never having seen patas monkeys on their properties for as long as they have lived there (up to 40 years). This suggests that there is a northern boundary, perhaps marked by the Ewaso Nyiro and Ewaso Narok Rivers, beyond which patas monkeys have never occurred. If this is the case, more northerly properties that were not surveyed, e.g., Colcheccio/Loisaba (no. 27) and P & D (no. 28), may never have had patas monkeys.

There are several gaps in our current knowledge. It is unknown, for instance, whether there are still patas monkeys on Solio (no. 14) and Ngorare (no. 29), and whether a corridor exists for gene flow between the two population clusters. Finally, though Fig. 1 includes Northern Approaches (no. 31) within the present distribution of patas monkeys, much of it is currently being converted to treeless habitat through charcoal processing and is unlikely to support patas monkey groups.

Farming and large-scale charcoal manufacture, which removes or reduces sources of water and *A. drepanolobium* [Okello et al., 2001], the major source of food for patas, are clearly incompatible with the continued existence of patas monkeys in Laikipia. Though cultivation and charcoal manufacture have expanded into Laikipia over the past several decades, much of Laikipia where patas monkeys occurred two decades ago continues to be used for livestock ranching today. Large-scale ranching thus appears to be compatible with the continued existence of patas monkeys. Indeed, the future of patas monkeys may depend on such land use because livestock water tanks and troughs provide them with crucial access to water.

Evidence that water is highly important to patas monkeys in this semi-arid climate is revealed by intensive study of the daily movements of patas monkey groups showing that they incorporate water tanks and troughs in their daily travel, especially during the dry season when ephemeral pools of rainwater have dried up [Isbell et al., 1999]. Two cases further illustrate the importance of ranch-provided water to patas monkeys. In 1992, a group that ranged on Segera and Mpala (the SP group, no. 11) had 8–15 individuals. Three years later, SP was last seen with three members (an adult male, an adult female, and a juvenile). Around this time, a water tank/trough for cattle on Segera was shut down, and a strange adult female and juvenile joined the main study group. The strange animals were suspected of being the remnants of the SP group. The SP group's home range had included the water trough to the south on Segera and a dam to the north on Mpala. That the Segera water trough was important to the SP group is suggested

also by the fact that the group traveled to it despite the risk of aggression from another, larger group, and was never observed to venture further into the home range of this other group than the water trough. Similarly, when the Jessel/Segera group (LP group, no. 10) declined substantially in size (Table I), the Thome B/Segera group (no. 9) began to range into LP's core area, but only as far as the nearest water trough.

Although water is clearly important to patas monkeys, droughts in Laikipia do not appear to affect them as severely as they affect other animals. When intensive observations began on one study group in 1992, Laikipia was experiencing a severe drought. Though cattle and herbivorous wildlife had access to water from the troughs, they had little food and were lethargic and thin. In contrast, the major foods of patas monkeys (gum of *A. drepanolobium* and ants housed inside the swollen thorns of *A. drepanolobium*) were readily available, and patas monkeys were not lethargic or thin. Below-average rainfall also occurred in 1993–1994, during which time the group increased from 28 to 41. On the other hand, too much water may be detrimental to them. Following the heavy rains of the El Niño event of 1997–1998 which inundated Kenya, several patas monkeys in the study group developed a neurological illness that was never observed before and that resulted in high mortality and, for those who survived, poor reproduction the following year [Isbell, unpublished data]. These adverse demographic events caused the group to decline from its maximum of 51 in March, 1998 to 20 in August, 1999.

Livestock do not appear to suffer from the presence of patas monkeys because patas monkeys do not eat the foods that livestock eat and they occur naturally at densities too low to compete for water with livestock. There is no incentive for ranchers to exterminate patas monkeys on their ranches. We suggest that as long as patas monkeys are undisturbed and large cattle ranches, with their water tanks and troughs and their extensive tracts of *A. drepanolobium*, remain connected in Laikipia, it is likely that the monkeys will also remain, because such ranches provide essential resources for patas monkeys.

Despite the seemingly favorable conditions for patas monkeys in that area created by the presence of large-scale cattle ranching, however, the population may be at the edge of viability. A major change in the economic base in the area (for example a large shift from ranching to subsistence farming, as is indeed occurring in some parts of the district) or any other change which reduces the habitat of acacia woodland, upon which our work over the last 25 years clearly indicates that the population depends, could easily reduce the patas monkey population to the point where local extinction could occur.

The small population in Laikipia may be critical to the continued existence of patas monkeys in Kenya. Game wardens and residents reported patas monkeys as being common to abundant in western Kenya in the 1950s and 1960s [J. Chism & D.K. Olson, unpublished data]. However, a survey conducted in 1981 found no patas monkeys in areas along roads near Eldoret, Soy, Moi's Bridge, Kitale, as far north as Kapenguria and the Cherangani Hills, and as far west as Busia and Siaya, and, in Uganda, Tororo [J. Chism & D.K. Olson, unpublished data], and a more recent survey conducted in 2003 found only one group of patas monkeys in western Kenya [Y. de Jong, personal communication]. This is an area where rainfall is sufficiently reliable both for consistent agricultural use [Hance, 1975, p 390] and for patas monkeys without access to artificial sources of water.

As no other area in Kenya appears now to support as many patas monkeys, the Laikipia population may be the best hope for preserving the *pyrrhonotus*

subspecies in Kenya. Any plan for conserving patas monkeys in Kenya would be most successful if it were to maintain an *A. drepanolobium* corridor between the two subpopulations in Laikipia, discourage charcoal production, and encourage retention of large-scale ranching. Whether large cattle ranches will continue to exist in Laikipia over the long run will likely depend on conditions that are difficult to control or predict, e.g., cattle costs and beef prices, political and population stability, and weather. All of these can influence the decision of large cattle ranch owners to keep or sell their land. Therefore, it is important that politicians, ranch owners, charcoal producers, and other decision-makers understand that the future of patas monkeys in Laikipia depends upon their decisions, and we recommend, as a first effort, that this be made known to them.

The Laikipia population and, in fact, all known patas monkey populations in Kenya, lie entirely on private, multi-use lands, as do many other wildlife species. This highlights the need for conservationists, including primatologists, to consider the special risks and needs of such populations [Western, 1989; Young et al., 1998]. Additionally, we recommend establishing basic conservation education elsewhere, e.g., Baringo and Turkana Districts, where patas monkeys are often killed by people [K. Ngece, personal communication]. With their high reproductive rates [Chism et al., 1984; Isbell, unpublished data], patas monkeys could fairly quickly increase in numbers in these areas, if such an effort is made.

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