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CAMERA TRAPPING FOR JAGUAR (*PANTHERA ONCA*) IN THE TUICHI VALLEY, BOLIVIA

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ABSTRACT. Camera trapping techniques, in combination with robust mark-recapture statistics, have been used extensively in Asia to provide tiger population density estimates and relative abundance information. Here we present the results of a first attempt to use these methodologies to determine jaguar abundance. Results suggest a relatively low jaguar population density. Nevertheless, it is hypothesized that previous human disturbance at the site may be responsible for this situation, thereby underlining the need for further studies of this nature.

RESUMEN. Trampas de cámara para jaguares (*Panthera onca*) en el Valle del Tuichi, Bolivia. La tecnología de trampas de cámara ha sido ampliamente utilizada en Asia, en combinación con modelos de captura recaptura, para proveer información de estimaciones de densidad poblacional y abundancia relativa de tigre. Aquí nosotros presentamos los resultados del primer intento de usar estas metodologías para determinar la abundancia poblacional de jaguares. Los resultados sugieren una densidad poblacional relativamente baja. Sin embargo, es probable que las actividades humanas que previamente se realizaron en el área sean las responsables de esta situación, siendo evidente la necesidad de más estudios de esta naturaleza.

Key words: Carnivore, Madidi, relative abundance, camera traps, jaguar, *Panthera onca*, Bolivia

Palabras clave: Carnívoros, Madidi, abundancia relativa, trampas de cámara, jaguar, *Panthera onca*, Bolivia

INTRODUCTION

The jaguar (*Panthera onca*) is the largest felid in the Neotropics (Seymour, 1989) with a broad distribution encompassing a wide variety of habitats including various forms of tropical forests, mangroves, tropical savannas, montane forests and dry scrub forests (Aranda, 2000). Historically, the jaguars range extended from the southern portions of United States of America to the south of Argentina, but today this range has decreased considerably from northern Mexico to northern Argentina and jaguars are considered threatened across much of this range (Eisenberg and Redford, 1999; Rabinowitz, 1999; Aranda, 2000; Sanderson et al., 2002).

The general ecology of the jaguar has been summarized on several occasions (de Olivera, 1993), and surveys and studies conducted for conservation planning purposes at varying scales (des Clers, 1986; Quigley and Crawshaw, 1992; Rabinowitz, 1995; Nowell and Jackson, 1996; Ortega-Huerta and Medley, 1999), including at a regional level (Sanderson et al., 2002). Nevertheless, despite fairly extensive distributional information, to date few long-term ecological studies have been undertaken

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on this flagship species (but see Schaller and Crawshaw, 1980; Rabinowitz and Nottingham, 1986; Emmons, 1987; Crawshaw and Quigley, 1991; Taber et al., 1997) even in comparison with other large felids such as the puma (*Puma concolor*) or tiger (*Panthera tigris*), and robust population density and relative abundance information is non-existent.

Recently, camera traps have become an important tool for monitoring terrestrial rare and cryptic species in tropical forests (Griffiths and van Schaik, 1993; Karanth, 1995; Karanth and Nichols, 1998; Cuttler and Swann, 1999; Carbone et al., 2001). This technology has been demonstrated as particularly useful for species that are individually identifiable, and with appropriate mark-recapture experimental design and analysis it permits relative abundance and population density estimates, as well as providing information on ranging behaviour, activity patterns, and dispersal/migration (Karanth and Nichols, 2000). In this note we present the first data on jaguar relative abundance in Bolivia gleaned from camera trapping efforts in the Tuichi valley within the Madidi Protected Area in northern La Paz Department, Bolivia.

STUDY SITE

The Tuichi, a tributary of the Beni River, lies in a large (ca 2000 km^2) valley enclosed by the final escarpments of the foothills of the Andes. Superficially, the vegetation of the Tuichi valley appears similar to that of the Beni alluvial plain forests found at the base of the Andes in this region. This forest is characterized by a relatively open canopy and a large proportion of palms such as *Scheelea*, *Astrocaryum*, *Socratea*, and *Jessenia*. For eight years before 1995 the Tuichi valley was exploited for high value commercial timber species. Nevertheless, in 1995 the Madidi protected area was created and logging and associated intensive hunting was effectively stopped in the Tuichi. Recent mammal surveys suggest that wildlife populations are recovering well in the valley.

METHODS

In July 2001, an exploratory team visited both the Tuichi and the adjacent Hondo rivers (100 km^2) for one month, and documented over 200 ‘probable jaguar sites’ based on tracks, scats and fresh kills. This prospecting included walking the few existing trails in the area, as well as rivers, streams, and dry river/stream beds. A number of trails were opened running perpendicular to the rivers in order to provide better access and coverage to the area. Following the exploration, the ‘probable jaguar sites’ were divided into three classes; Excellent sites (where sign had been recorded), Good sites (similar to excellent sites in terms of location but without sign), and Poor sites (animal trails from other terrestrial species where no jaguar sign was recorded). These points were then analysed in a GIS Arc View project and sites selected using a 1.6 km minimum distance between points (based on 10 km^2 jaguar female minimum home range estimate – Rabinowitz and Nottingham, 1986). This was to ensure that no jaguars within the sampled area had a zero probability of being captured, thereby adhering to a major assumption of the mark-recapture model. During selection, preference was given to ‘excellent’ sites where we had previously observed fresh jaguar sign (n=32), the remaining points were all ‘good’ sites (n=13).

The first camera trapping campaign was realized in the dry season (early August to early November 2001). Unfortunately, an early onset of the wet season in September 2001 prevented our use of the second block on the smaller Hondo River where waters were able to rise too quickly to safely place camera traps. We therefore elected to conduct the second half of the campaign on the Tuichi River, thereby sampling an area of approximately 50 km^2 twice for a total of 60 days (**Fig. 1**). Camera trap stations were placed at different points during the two sets of 30 days, such that for analysis purposes 45 camera trap stations were sampled for 30 days for a total of 1350 camera trap station nights sampled. This arrangement ensured adherence to the mark-recapture model assumption of demographic closure of the sample population (Karanth and Nichols, 1998; 2000). Camera traps were distributed over a 53.8 km^2 area, however, once a buffer distance (1.6 km) equivalent to the radius of the minimum jaguar home range (10 km^2) was added (Otis et al., 1978), the total sample area equalled 127.3 km^2.

The second camera trapping campaign was realized again during the dry season (August to September 2002). Camera trapping stations were placed in similar points to the first campaign, 32 camera trap stations were placed for 29 days for a total of 928 camera trap station nights sampled. Camera traps were distributed over a 77.04 km^2 area, again using 1.6 km as buffer distance between stations, generating 169.58 km^2 as the sampling area.

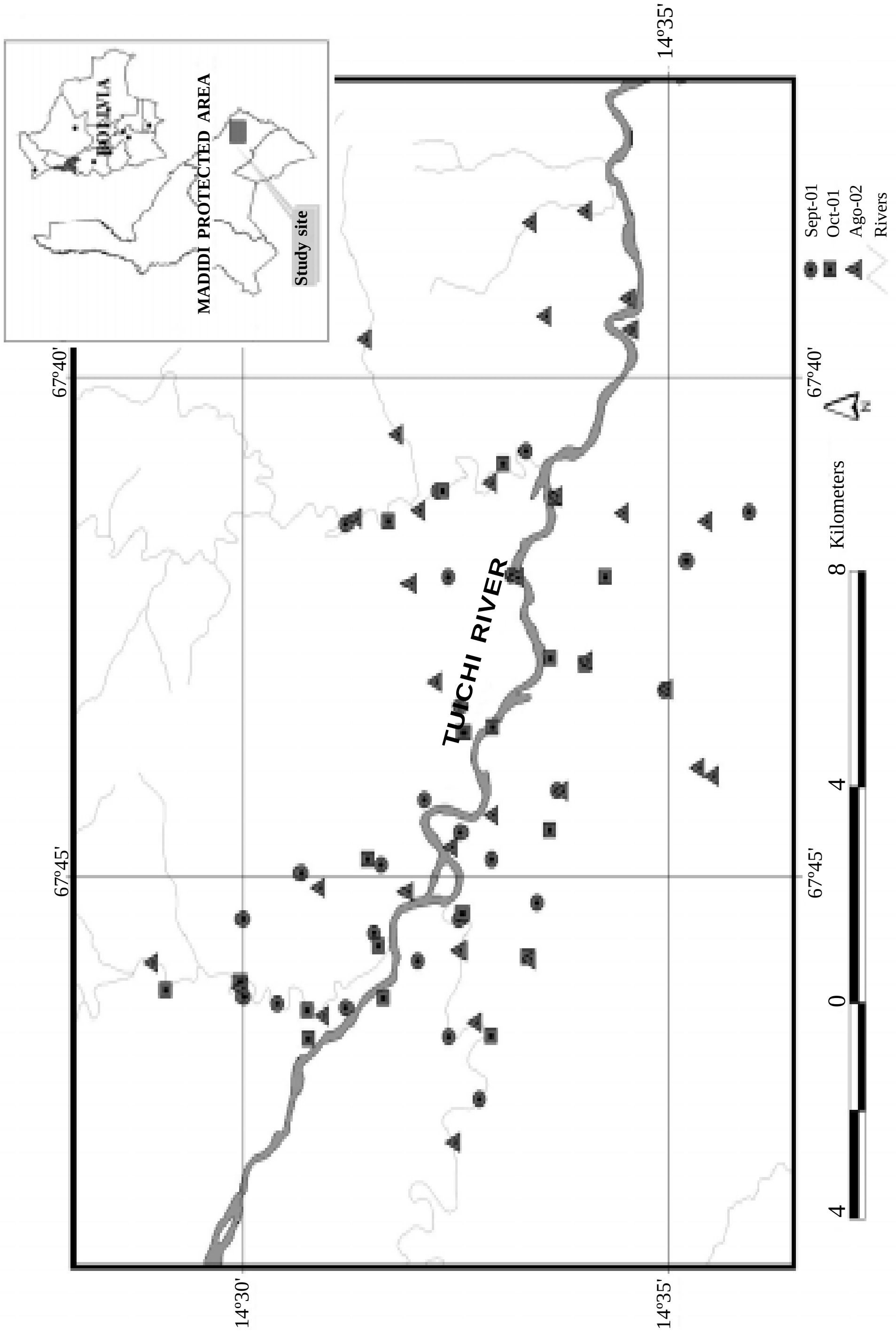

Fig. 1. The lower Tuichi valley study area showing trails and camera trap stations.

In both campaigns, CamTrakker™ and TrailMaster™ camera traps were placed in pairs at each camera trapping station in order to photograph both sides of the jaguar for individual recognition purposes (Karanth and Nichols, 2000) and were set continually with a three-minute minimum interval between photographic events.

RESULTS

The camera trapping campaigns yielded twelve jaguar events, representing six individually recognizable jaguars, four adult males (see **Fig. 2**), one adult female, and an unsexed adult. The data from the first campaign were insufficient for estimating density with capture-recapture models. In the second campaign we were able to estimate the density using the program CAPTURE (1.68 jaguars per 100 km^2, ±0.78).

In order to compare results between the two campaigns we present results (see **Table 1**) using the standard # of individuals/1000 camera trap station nights (Karanth and Nichols, 1998; Carbone et al., 2001). The reported encounter rates are low when compared to tiger camera trap capture frequencies (Karanth and Nichols, 2000; Carbone et al., 2001). Capture frequencies for tigers from 19 survey sites across Asia ranging from 83.3 to 836 km^2 in area sampled, ranged from 1.01 to 41.99 individuals/1000 camera trap station nights (Carbone et al., 2001). Karanth and Nichols (2000) and Carbone et al. (2001) found strong correlations between tiger density estimates and both the number of photographic tiger events in a camera trapping campaign and the number of individuals photographed. Assuming that jaguars do not behave significantly differently towards camera traps, the data reported here lie at the bottom end of tiger density estimates, and a comparison of the data reported in Carbone et al. (2001) suggests a density of around 2 jaguars per 100 km^2. This compares favourably with the density estimate generated using mark-recapture techniques during the second campaign.

DISCUSSION

Given the current abundance of jaguar prey base species such as *Tayassu*, *Pecari*, and *Mazama* that are found at high densities compared to 25 other line transect sampled sites in lowland tropical Bolivia (Wallace et al., pers. obsv.), as well as direct observations of jaguar and an apparent abundance of sign, we expected relatively high densities of jaguar at this site. If the capture frequencies reported here genuinely reflect a healthy jaguar population, then this obviously has serious implications for jaguar conservation, given that even relatively large conservation areas will not be sufficient to support viable populations.

However, it is critical to consider the history of the Tuichi valley and three consecutive events that may have affected jaguar abundance in the recent past. Firstly, during the 1970's until the mid 80's Bolivia was renowned as a major source for the animal skin trade and jaguar was one of the target species. The accessibility of this area (3-5 hours in an outboard motor from a significant human population) would leave jaguar populations extremely vulnerable to this activity.

Secondly, considerable anecdotal information suggests there was a major white-lipped peccary (*Tayassu pecari*) population crash during the mid eighties with this species disappearing from lowland northern La Paz and adjacent area of Peru for fifteen years. Several researchers have suggested that peccaries may be one of the few prey types that jaguar actively select for in dietary terms (Emmons, 1987), and the sheer biomass loss of this social ungulate would render the forests considerably poorer in terms of available jaguar prey base.

Finally, the remaining prey base of the jaguar was intensively hunted during logging operations between 1987 and 1995 until the creation of the Madidi National Park. This hunting, resulted in a massive reduction of the local fauna by 1995-1996 (Pacheco et al., 2001; Espinoza, pers. obsv.), and even now hunting prone species such as black spider monkeys (*Ateles chamek*) are found in relatively low densities in the floodplain forests, suggesting that the area is still in a recuperation phase (Wallace et al., in prep.). In addition, armed loggers had a 'shoot on sight' policy for jaguar (Espinoza, pers. obsv.), even though skins had little commercial value by the late 80's. Dur-

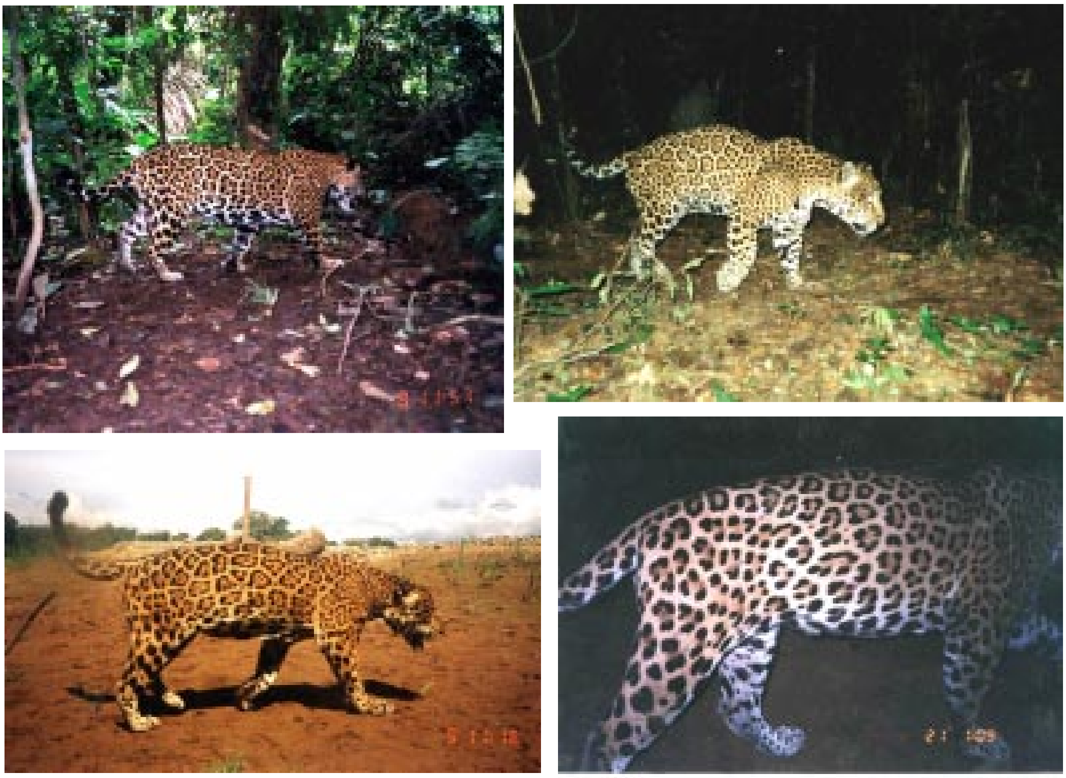

Fig. 2. Individually recognizable jaguar photographed during camera trapping efforts in Madidi between 2001 and 2002.

ing this period, petroleum exploration activities were also being conducted in the area and this involved hundreds of dynamite explosions that are also thought to have influenced wildlife populations.

Local guides report that a noticeable recuperation of ungulate populations has only occurred in the last two to three years (Espinoza, pers. obsv.; Cáceres, pers. comm.). In this light it would be instructive to return to this site in 2-3 years time and monitor jaguar population changes, given that they may be recuperating with a time-lag in relation to corresponding ungulate populations. In fact, the number of photographed jaguar increased during the second year of camera trapping in Tuichi, albeit

Table 1

Jaguar capture frequencies (# of individuals/1000 camera trap station nights) in the lower Tuichi valley.

Campaign	Dates	# of nights	# stations	# trap nights	# of individuals	Capture Frequency
1 - 2001	27/08 - 26/09	30	24	720	2	2.78
2 - 2001	04/10 - 04/11	30	21	630	1	1.59
3 - 2002	05/08 - 01/09	28	32	896	4	4.46
Overall*		88	77	2246	6	2.67

* 2 individuals were captured in 2001.

in a slightly larger sample area, providing additional though inconclusive support to this hypothesis. Intriguingly, both jaguar photographed in 2001 were apparently absent from the Tuichi in 2002 suggesting a fluidity in jaguar residence that would also fit a recuperating population model.

Further studies at Tuichi will allow us to monitor the population over time as well as investigate individual jaguar survivorship and ranging behaviour, both critical data sets from a management perspective. Studies at further sites across the Madidi landscape will also enable us to assess jaguar population size across the region identified as a priority in a recent geographic range analysis (Sanderson et al., 2002).

Finally, independent puma camera trap events were twice as abundant than jaguar events during the first campaign (n=11), especially along human trails. Whilst not individually recognizable these data suggest that puma may be more abundant than jaguar in the area. However, during the second campaign the number of jaguar and puma events was more similar with slightly less independent puma camera trap events (n=4) as compared to jaguars, suggesting dramatically fluctuating puma abundances. Again, the reasons for this situation are unclear: Is it a normal situation in Amazonian forests? Or could it be due to the more adaptive nature of puma following a prey-base crash, for example a reliance on a less hunter-vulnerable prey base? Are pumas now returning to more normal levels, as jaguar populations recover? Whatever the answer, this further underlines the importance of seriously considering the role of puma in the ecology of jaguar at any long-term jaguar study site (Taber et al., 1997).

In conclusion, the preliminary data presented here highlight the importance of considerable further study regarding jaguar abundance across a range of habitats and monitoring populations over time, as well as how little we know in general regarding the large carnivores of the tropical Americas.

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