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Home ranges, movements and activity patterns of leopard cats (*Prionailurus bengalensis*) and threats to them in Taiwan

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Abstract. The first radio tracking study on the endangered Taiwanese leopard cat (*Prionailurus bengalensis*) in Taiwan was conducted from November 2006 to April 2008. Average minimum convex polygon home range size for combined sex was 5.0 km^2 ($SD = 3.2$, N = 4). Males had much larger home ranges than females, but only males reduced their ranges significantly in the dry season. Home ranges overlapped a little between individuals, but their core areas were not overlapped suggesting territoriality. Taiwanese leopard cats in our study area tended to avoid large artificial open areas like agriculture land and man-made construction. Movement analyses showed that males were more mobile than females, but females use their home range in a more concentrated manner. They were nocturnal and exhibited crepuscular activity patterns in the wet season, but were arrhythmic in the dry season. Nocturnal activity was low during the dry season. We found 100% mortality of radio-tagged individuals due to anthropogenic reasons within 1 year. Our study found that illegal poisoning and trapping was often overlooked but had a profound effect on the survival of the local Taiwanese leopard cat population.

Key words: endangered species, home range, movement, *Prionailurus bengalensis*, Taiwan.

The leopard cat (*Prionailurus bengalensis*) is a common wild felid distributed widely in East, Southeast and South Asia. Although they adapt to diverse habitats, a combination of factors including human encroachment, habitat loss, and overharvesting have threatened leopard cats in many of their historic ranges (Santiapillai and Supraham 1985; Sunquist and Sunquist 2002; Rajaratnam et al. 2007; Rho 2009). The most critical cases have been found amongst populations on islands, which can be attributed to their isolation (Williamson 1981; Nowell and Jackson 1996). In Japan, there are only about 100 leopard cats (*P. b. iriomotensis*) left on the Iriomote Island, while the Tsushima Island population (*P. b. euptilurus*) has been reduced from between 200–300 individuals in 1967 to 83–115 in 2005 (Izawa et al. 2009). Likewise, leopard cats in Taiwan (*P. b. chinensis*) were once commonly found in lowland regions throughout the entire island (Horikawa 1931; Chen 1956), but the population size has been found to be greatly reduced island-wide in 1970s (McCullough 1974; Ian 1979). They are listed as endangered in the Taiwanese Wildlife Conservation Act since 2009 by Council of Agriculture, due to serious nationwide declining distributions and population reductions (Yang et al. 2004).

Miaoli County in northwestern Taiwan is one of three counties where Taiwanese leopard cats still exist and probably the only area where a viable population of this species can be found (Pei 2008). Recent studies in Miaoli County suggested that habitat fragmentation, degradation, road-kills due to man-made developments, and significant illegal trapping and poisoning due mainly to the retaliatory reactions for poultry loses by farmers, were major concerns of their sustainability (Pei 2008; St. John et al. 2014). Adequate ecological information, such as home range, territoriality and activity pattern, and understanding of their survival challenges are urgently needed for their conservation.

However, available information from other countries,

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usually from small sample sizes, indicates that leopard cats have significant variation in many behavioral aspects among individuals and/or localities. For example, their minimum convex polygon (MCP) home range size varies considerably according to different studies, ranging from 1.5 to 12.4 km^2, with a core area of 0.7–1.2 km^2 (Rabinowitz 1990; Rajaratnam 2000; Austin 2002). Also, while most studies showed that males use larger home ranges than females (Rabinowitz 1990; Izawa et al. 1991; Grassman 2000, 2004; Rajaratnam 2000; Schmidt et al. 2003; Oh et al. 2010), a study conducted in Thailand found no inter-sexual difference in home range sizes (Austin 2002). It has been found in many felids that home range sizes can vary greatly intra-specifically (see review in Kitchener 1991; Sunquist and Sunquist 2002). Home range variation can be influenced by a number of factors, including body mass, sex, foraging activity, density of conspecifics, social organization, habitat characteristics, prey availability, and anthropogenic factors (Litvaitus et al. 1986; Swihart et al. 1988; Sandell 1989; Diffendorfer et al. 1995; Schmidt et al. 1997; Benson et al. 2006; Riley et al. 2010).

Leopard cats have also been described both as non-territorial (Rajaratnam 2000) and strictly territorial (Austin 2002). Nevertheless, most studies found that both sexes exhibit low to medium levels of intra-sexual territoriality with little inter-sexual territoriality (Rabinowitz 1990; Grassman 2000, 2004). However, Sakaguchi (1994) found that intra-sexual territoriality occurred more clearly among females in the Iriomote subspecies. Variations in land tenure systems within a species has also been found in some felids, e.g., bobcat (*Lynx rufus*), Canadaian lynx (*Lynx canadensis*), Eurasian lynx (*Lynx lynx*), leopard (*Panthera pardus*), puma (*Puma concolor*), and tiger (*Panthera tigris*) (see Sunquist and Sunquist 2002 for review).

Leopard cat daily activity patterns have been documented as arrhythmic (Rabinowitz 1990), arrhythmic with crepuscular and nocturnal peaks (Grassman 2000, 2004; Austin 2002), and crepuscular and nocturnal (Rajaratnam 2000; Mohd Azlan and Sharma 2006; Schmidt et al. 2009; Oh et al. 2010). Despite most felids exhibiting crepuscular and nocturnal behavior (Kitchener 1991), they are capable to adapt to a wide range of light conditions (Sunquist and Sunquist 2002). The aforementioned studies show that leopard cats can be flexible in their activity patterns; in areas with higher human disturbance they are more active at nighttime, whereas in national parks or wildlife sanctuaries, their activities are more evenly throughout the day.

Little is known about the ecology and behavior, apart from the general description of their activity patterns, for the Taiwanese leopard cat. As a contribution to its conservation, the aims of the present study, therefore, were: 1) collecting the important ecological data for the Taiwanese leopard cat within a primary habitat; and 2) identifying the possible threats against their survival.

Study area

This study was conducted in Tongsiao Township, Miaoli County in northwestern Taiwan (Fig. 1). The study area has a hilly landscape with an elevation below 320 m a.s.l. It is comprised of 31.5 km^2 of forests (49.7%), grasslands (12.2%), agricultural land (32.1%), and man-made construction (6.0%) (Fig. 1). The well-developed road system, which includes a primary road (Provincial Highway No. 1, about 25 m wide), secondary roads (County-121 and County-128, about 10 m wide), and tertiary roads (about 5 m wide), along with human encroachment have fragmented wildlife habitat in this rural area. The region has a sub-tropical climate with hot/wet summers and cold/dry winters. The wet season lasts from March to September (mean monthly rainfall = 293 mm; mean monthly temperature = 25.4°C) and the dry season is from October to February (mean monthly rainfall = 72 mm; mean monthly temperature = 19.2°C) (Gungguan Weather Station 2005–2008).

Methods

Animal trapping and radio-tracking

This study was carried out from November 2006 to April 2008. Trapping permit was issued by the Forestry Bureau (Permit number: COA, Forestry Bureau, 0961605260). We used steel-mesh metal box-traps (108-Rigid Trap, Tomahawk Live Trap, LLC., Hazelhurst, Wisconsin, USA) baited with live quails to live-trap Taiwanese leopard cats. Trapped cats were anaesthetized by experienced veterinarians using Medetomidine hydrochloride (50 μg/kg) and Ketamine hydrochloride (3 mg/kg). Sedated Taiwanese leopard cats were aged and radio-collared with 55 g collars, equipped with activity-sensors, for females and 65 g collars for males (Advanced Telemetry Systems, Inc., Isanti, Minnesota, USA). Four age classes were used: juvenile, young adult, prime adult, and old adult (Austin 2002). Young adults are nearly adult-sized (>4.0 kg for male, >2.5 kg for female) with

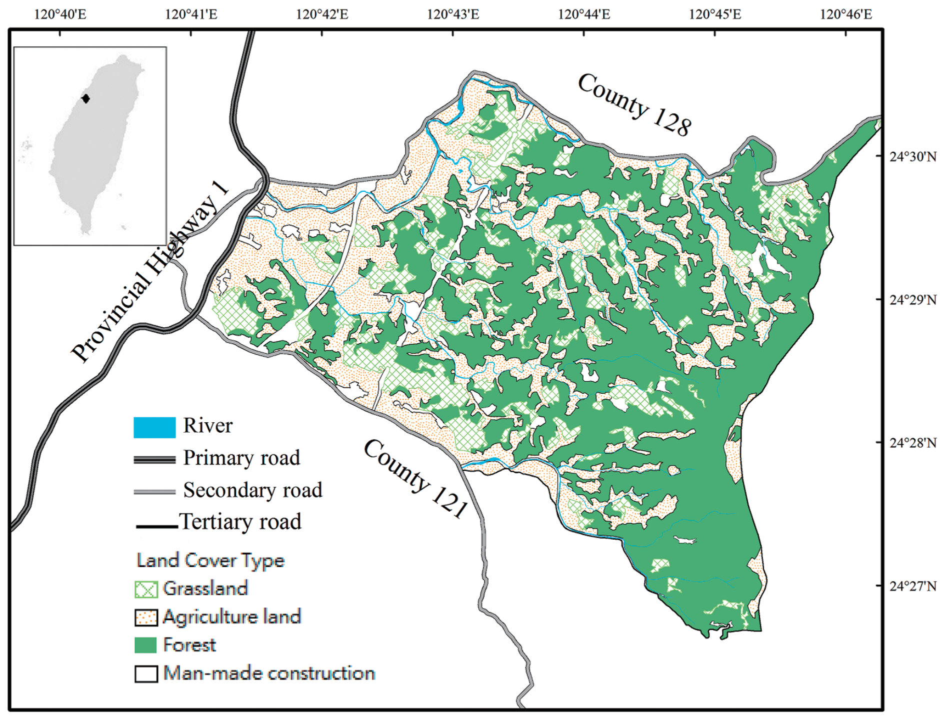

Fig. 1. Location and land cover types of the study area.

sharp, white permanent teeth. Prime adults are reproductively mature with evidence of previous births for females or descended testicles for males, with slightly dulled and yellowish teeth. Old adults often have worn or missing teeth. All individuals were injected with an anathesia antagonist and released at the capture site after full recovery.

Each collared Taiwanese leopard cat was located by triangulation, from at least 2 points, at least 3 times per week during the study period. In addition, each cat was located continuously with a 30- to 60-min. interval from 17:00 to 7:00 for 3 or 4 times every 3 months. To reduce error, only those locations that were determined from azimuth angles of 60–120° were used in our analysis (Kitchings and Story 1979). The accuracy of the triangulation was pre-estimated, using a hidden transmitter (Grassman 2004), to be 42.4 m (n = 20, SD = 50.2 m) in the study area. For the determination of the daily activity pattern, each cat was monitored continuously for 3–4 times 24-hr cycles per season, and active or in-active radio signals were recorded for each minute during the 24-hr cycle.

Home range and core area

Independence of radio locations had been concerned (Swihart and Slade 1985a, b). Thus, some researchers used only one location each 24-hr period for leopard cat (Austin 2002; Grassman 2004). However, it was noticed that increasing the length of time intervals between observations under-estimated the true distances travelled and the areas with autocorrelated observations were often associated with important resources (Reynolds and Laundre 1990; De Solla et al. 1999). In this study, home range (HR) was estimated with locations taken over 2-hr interval using 3 estimators: 100% minimum convex polygon (MCP100), 95% minimum convex polygon (MCP95) (Mohr 1947), and fixed kernel at the 95% contours (FK95) (Worton 1989). Core areas were calculated using the 50% minimum convex polygon (MCP50) and the fixed kernel at the 50% contours (FK50). The estimators were obtained using the Home Range Tool of ArcGIS 9.3 (Environmental System Research Institute, Inc. Redlands, CA).

Movements and daily activities

We calculated the following movement parameters according to the definitions provided by Schmidt et al. (2003), including 1) consecutive daily movement distance (CMD): the sum of straight line distances between consecutive locations during continuous radio-tracking sessions within a day; 2) daily straight line distance (SLD): the straight line distances between the first location and last location during continuous radio-tracking sessions within a day; 3) SLD/CMD ratio: calculated to describe variation in the movement manner in particular groups of Taiwanese leopard cats; it could theoretically range from 0 to 1; this index was to describe numerically the manner of Taiwanese leopard cat movement; higher values indicated that the animal moved in a more 'direct' fashion and tending to stay far from the location of a previous day, lower values indicated that the animal moved in a more 'concentrated' fashion, making a winding routes and remaining close to the location of a previous day; 4) consecutive daily movement range (CMR): the area encompassing the consecutive daily movement route (DMD); 5) consecutive daily movement range as a percentage of the home range of the animal (CMR%): home range (HR) was the 100% minimum convex polygon for each individual; 6) intensity of movements (IM): length of the route (m) the Taiwanese leopard cat moved per 1 km^2 of its total home range per day, calculated as DMR/HR; this index describes how intensively Taiwanese leopard cats searched their home ranges—it shows if the daily routes were concentrated or loosely distributed; and 7) speed of travel: calculated as a distance moved/h when Taiwanese leopard cats moved continuously. Because the signals were lost occasionally, calculation of CMD, SLD, and speed of travel was excluded on those days when cats could not be located for a continuous period of >7 hr. Hourly activity levels (= % active signals for each hour) were first calculated for each cat, and their averages were used to present the activity pattern of the Taiwanese leopard cat in this paper.

Results

A total of 3,448 trapping-night was conducted. Three Taiwanese leopard cats (M/14, F/37, and F/39) were trapped by our box-traps, and 3 (M/29, M/32, and M/33) additional cats were rescued from foot traps set illegally by farmers or hunters during the study period (Table 1). Except F/37, all other 5 individuals were found trapped by hunters or killed by farmer's poison baits after various radio-tracking periods; for F/37, we retrieved the collar in her home range and the state of the collar suggests it was removed by a hunter (Table 1). M/33 was an unfortunate case, he was first trapped by a snare and rescued by us in January, 2007. After recovering from a minor injury and released for radio-tracking, he was found trapped again 11 months later and seriously injured this time. He was sent to the Pingtung Rescue Center for Endangered Wild Animals (PTRC) for medical treatment and care. After his second recovery and release, he was found dead due to poisoning 15 days later (Table 1). M/32 and M/14 were excluded from the analysis due to short tracking periods (for 49 days and for 60 days, respectively).

Home range and core area

Average MCP home range (MCP100) and core area (MCP50) sizes for combined sex were 5.0 km^2 (*SD* = 3.2, N = 4) and 0.7 km^2 (*SD* = 0.5, N = 4) respectively, while FK home range (FK95) and core area (FK50) were 4.7 km^2 (*SD* = 2.1, N = 4) and 1.0 km^2 (*SD* = 0.5, N = 4) respectively (Table 2). Both males had larger home range and core area sizes than both females (Table 2). The home range sizes for males were smaller during the dry season (Table 3), although the seasonal change could not be analyzed for females due to the lack of data. A little overlap in home ranges between individuals, both inter- and intra-sexually, was observed. However, there was no core area overlap among those individuals (Fig. 2).

Although there were considerable variations among individuals in land use type coverage in their home ranges, they covered more forest and less agricultural land and man-made construction (Table 4). It should be noted that these 4 home ranges are all found within the boundaries of the secondary roads County-121 and County-128 (Fig. 2). These were bitumen paved roads about 10 m wide, with little traffic during the nighttime.

Daily movements and daily activities

A total of 273 locations of Taiwanese leopard cats were obtained during 23 sessions of continuous radio-tracking with locations taken at 30- to 60-min. intervals. The cats moved an average CMD of 2.31 km/day, ranging from 1.07 to 6.63 km (Table 5). The consecutive daily movement range (CMR%) covered for 0.38%–18.98% of their MCP100 home range during a single day (Table 5). During the longest recorded daily trips (6.63 and 5.09 km), M/29 was able to cover up to 18% of his home range, whereas M/33 was able to cover up to 9% of his home range during the longest recorded daily trip (3.42 km). On average, the daily movements of all cats covered a CMR area of 0.27 km^2, which comprised an average of 5.62% of their home range.

Males moved longer distances daily than females (Table 5). The longest SLD (2.67 km) was from a male. The ratio SLD/CMD was higher in males (Table 5) which indicated that males moved more 'directly' as they traveled longer routes and tended to end up far from

Table 1. Characteristics and trapping details of the 6 radio-tracked leopard cats (*Prionailurus* bengalensis) in Tongsiao Township, Miaoli County in northwestern Taiwan, in November 2006–April 2008

Sex/Code no.	Age group	Body weight (kg)	Tracking starts	Tracking ends	Tracking days	Reason for tracking ends
M/33	Prime adult	4.7	2007/2/3	2007/12/31	331	Trapped by foot trap with seriously injury
		5.1	2008/2/25	2008/3/11	15	Poisoned
M/32	Prime adult	4.1	2007/2/23	2007/4/13	49	Poisoned
M/29	Prime adult	4.5	2007/3/17	2007/12/29	287	Trapped by hunter
F/37*	Young adult	3.1	2007/5/25	2007/9/28	126	Collar dropped, possibly trapped by hunter
F/39	Old adult	3.0	2007/11/29	2008/4/2	125	Killed by a snare
M/14	Young adult	4.1	2007/12/3	2008/2/1	60	Trapped by hunter

* Pregnant when collared.

Table 2. Home ranges (km^2) of leopard cats (*Prionailurus bengalensis*) using 100% minimum convex polygon (MCP100) and 95% fixed kernel (FK95) estimators, and core area (km^2) using 50% minimum convex polygon (MCP50) and 50% fixed kernel (FK50) estimators in Tongsiao Township, Miaoli County in northwestern Taiwan, in November 2006–April 2008. Showing the time elapsed (days) to gain the number of radio locations (N) used for estimators.

Sex/Code no.	Time (days)	N	Home range		Core area	
			MCP100	FK95	MCP50	FK50
M/29	287	123	6.5	5.9	0.7	0.9
M/33	346	107	9.5	7.6	1.4	1.8
F/37	126	70	1.8	2.4	0.1	0.5
F/39	125	56	2.0	2.9	0.6	0.7
		Mean	5.0	4.7	0.7	1.0
		SD	3.2	2.1	0.5	0.5

Table 3. Comparison of leopard cats (*Prionailurus bengalensis*) home ranges (km^2) between seasons using 100% minimum convex polygon (MCP100) and 95% fixed kernel (FK95) estimators, and core areas using 50% minimum convex polygon (MCP50) and 50% fixed kernel (FK50) estimators in Tongsiao Township, Miaoli County in northwestern Taiwan, in November 2006–April 2008

Sex/Code no.	N	Wet season				N	Dry season			
		Home range		Core area			Home range		Core area	
		MCP100	FK95	MCP50	FK50		MCP100	FK95	MCP50	FK50
M/29	97	5.9	5.9	0.7	0.9	26	1.8	2.7	0.3	0.7
M/33	73	9.0	7.6	1.4	1.9	34	4.6	4.7	0.5	0.9
F/37	70	1.8	2.4	0.1	0.5	–	–	–	–	–
F/39	–	–	–	–	–	56	2.0	2.9	0.6	0.7

places visited on the previous day. On the other hand, the IM was much lower in males in comparison to females (Table 5), which demonstrates that the females moved (or explored) intensively within their home ranges. Their movements were more ‘concentrated’ and they stayed relatively close to the places visited on the previous day. The averages of CMR% were similar between males and females, although the CMR was larger in males than females (Table 5). The Taiwanese leopard cats moved with an average speed of 186 m/h. Males moved faster than females (Table 5).

Activities of the radio-collared cats were monitored for a total of 654 hours. They showed a clear nocturnal and crepuscular active pattern during the wet season, but not in the dry season (Fig. 3). The mean activity level were also higher during the wet season (31 ± 10%, N = 3) than in the dry season (18 ± 3%, N = 2) (Fig. 3).

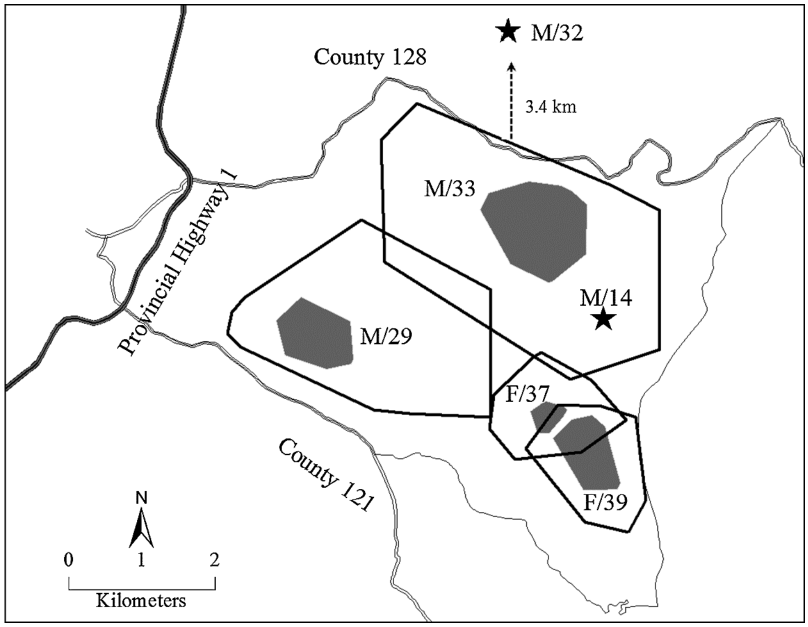

Fig. 2. Home ranges (MCP100) and core areas (MCP50, gray area) of 4 radio-tracked leopard cats (*Prionailurus bengalensis*) (M/29, M/33, F/37, and F/39) in Tongsiao Township, Miaoli County in northwestern Taiwan, in November 2006–April 2008. M/32 and M/14 were showed only by locations where they were captured due to short tracking periods.

Table 4. Percentage habitat composition within each minimum convex polygon home range (MCP100) for leopard cats (*Prionailurus bengalensis*) in Tongsiao Township, Miaoli County in northwestern Taiwan, in November 2006–April 2008

Sex/Code no.	Forest (%)	Grassland (%)	Agriculture land (%)	Man-made construction (%)
M/29	47.5	19.7	28.4	4.4
M/33	53.7	11.2	31.0	4.2
F/37	73.1	13.5	10.8	2.6
F/39	86.0	0	13.2	0.7
Mean	65.1	11.1	20.9	3.0

Table 5. Movement characteristics of leopard cats (*Prionailurus bengalensis*) in Tongsiao Township, Miaoli County in northwestern Taiwan, in November 2006–April 2008

Sex/Code no.	N	CMD	SLD	SLD/CMD	CMR	CMR%	IM	Speed
M/29	9	3.63 ± 1.41 (2.02–6.63)	0.92 ± 0.54 (0.10–1.67)	0.24 ± 0.13 (0.05–0.41)	0.59 ± 0.43 (0.11–1.23)	9.00 ± 6.55 (1.68–18.98)	540 ± 209 (301–987)	279 ± 103 (156–491)
M/33	8	2.35 ± 0.81 (0.12–3.42)	1.03 ± 0.77 (0.05–2.67)	0.43 ± 0.27 (0.02–0.78)	0.33 ± 0.25 (0.04–0.88)	3.43 ± 2.66 (0.38–9.31)	243 ± 84 (126–353)	200 ± 59 (129–297)
F/37	4	2.16 ± 0.47 (1.50–2.79)	0.16 ± 0.07 (0.05–0.25)	0.08 ± 0.05 (0.02–0.17)	0.15 ± 0.06 (0.09–0.24)	8.31 ± 3.10 (5.19–13.45)	1229 ± 268 (854–1588)	165 ± 19 (143–186)
F/39	2	1.10 ± 0.03 (1.07–1.13)	0.30 ± 0.11 (0.19–0.40)	0.27 ± 0.11 (0.16–1.38)	0.03 ± 0.02 (0.01–0.06)	1.75 ± 1.03 (0.72–2.78)	557 ± 15 (542–571)	100 ± 7 (93–107)
Mean	4	2.31 ± 0.90	0.60 ± 0.38	0.26 ± 0.12	0.27 ± 0.21	5.62 ± 3.10	642 ± 361	186 ± 65
Male	2	2.99 ± 0.64	0.98 ± 0.06	0.34 ± 0.09	0.46 ± 0.13	6.21 ± 2.79	391 ± 149	240 ± 39
Female	2	1.63 ± 0.53	0.23 ± 0.07	0.18 ± 0.09	0.09 ± 0.06	5.03 ± 3.28	893 ± 336	133 ± 33

Consecutive daily movement distance (CMD; km), straight-line distance (SLD; km), consecutive daily movement range (CMR; km^2), consecutive daily movement range as a percentage of the total home range (CMR %), index of intensity of movements (IM; m/km^2), and speed of travel (m/hr). Values are mean ± *SD* (range).

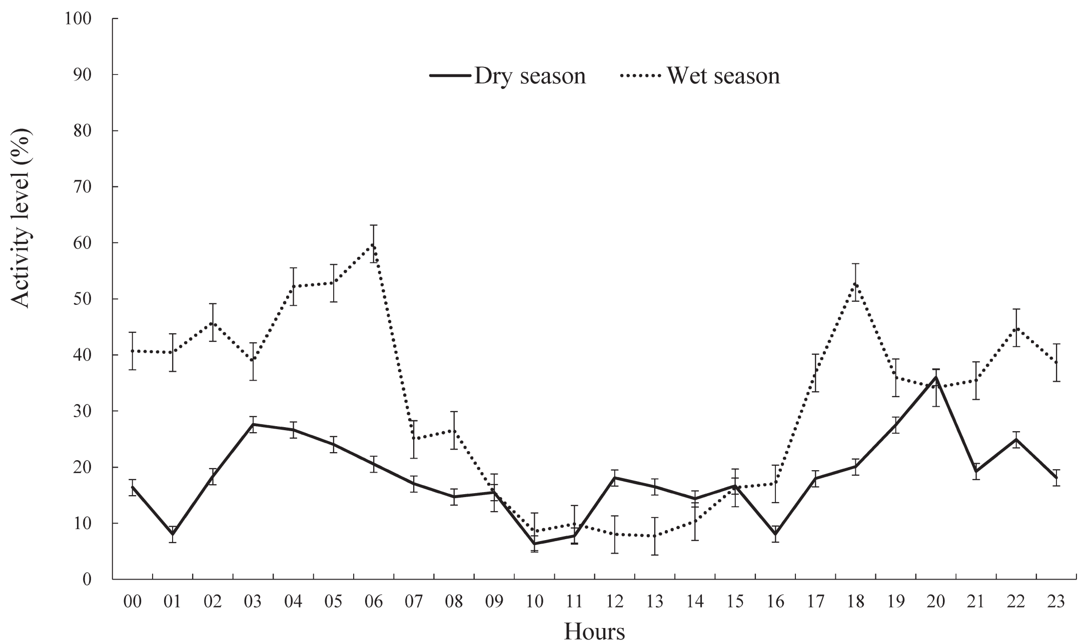

Fig. 3. Seasonal activity patterns of 4 radio-tracked leopard cats (*Prionailurus bengalensis*) in Tongsiao Township, Miaoli County in northwestern Taiwan, in November 2006–April 2008. Error bar showed *SD*.

Discussion

Spatial and temporal ecology of the Taiwanese leopard cats

Our study has uncovered that MCP home range and core area size of male Taiwanese leopard cat were 4 and nearly 3 times larger than those of females, respectively (Table 2). Core areas are only around 15% of the home range (Table 2), which indicates a concentrated usage within the home range. A little overlap in home ranges has been observed for both inter- and intra-sex, but clear territoriality exists for their core areas toward other individuals despite the sex (Fig. 2). The short tracking period of M/14, a young adult male, demonstrated this pattern as well; it stayed within M/33's home range, but was never found in M/33's core area. Moreover, camera-traps had photographed other Taiwanese leopard cats without radio collars in the home ranges of those radio-tracked individuals but not in their core areas (Chen unpublished).

Many other studies on felids have also found that males have larger home ranges than females (Tewes 1986; Weisbein and Mendelssohn 1990; Johnson and Franklin 1991; Ferreras et al. 1997; Newbury 2013). Besides of the larger body mass of males, this common pattern suggests that females are more efficient foragers since they also need to provide food for their young, whereas males have to allocate time and energy for finding female mates (Sandell 1989; Kitchener 1991; Nakanishi et al. 2005).

We found males reduce their home range size in the dry season (Table 3), which might be due to the seasonal change in prey availability and/or shifts in their diet (Johnson and Franklin 1991; O'Donoghue et al. 1998; Oh et al. 2010). The density of the spinous country rat (*Niviventer coninga*), the main prey species for Taiwanese leopard cats (Chuang 2012), has been found to be the highest in the dry season (Tsai 1997). Also, local farmers traditionally raise poultry during the dry season for holiday uses, and these were an additional food source for some Taiwanese leopard cats (St. John et al. 2014). For females, seasonal flexibility probably would not be beneficial if a small but more efficient home range is more desirable; further study on females is required.

Land use type composition within their home ranges showed that Taiwanese leopard cats tended to avoid man-made large open areas such as large and continuous agricultural land and human settlements, although the prey abundance could be fine for them (Table 4). However, human activities would not be the major reason for this avoidance because, in our study area, farmers' daily routine is usually diurnal, while Taiwanese leopard cats acted more nocturnally (Fig. 3). Other environmental factors, such as illumination, shelter availability, or even the existence of domestic dogs, might also be important factors.

Our study showed that males were more mobile than females, i.e., higher CMR and faster travel speed (Table 5). This is in accordance with other studies (Rabinowitz 1990; Rajaratnam 2000; Austin 2002; Schmidt et al. 2003; Grassman 2004), and is similar to other carnivores (Servin et al. 1991; Jackson 1996; Jedrzejewski et al. 2002; Dillon 2005; Helon 2006; Newbury 2013). On the other hand, females seem to use their home range more effectively with lower SLD/CMD and higher IM (Table 5). These results coincide with their home range utilization patterns mentioned above.

The Taiwanese leopard cats in our sample clearly raised their crepuscular and nocturnal active levels in the wet season and maintained low activity levels throughout daytime hours year-round (Fig. 3). Taiwanese leopard cats in this study area preyed mainly on small mammals (56.1%), mostly murids, followed by birds (26.4%), insects (10.2%), and reptiles (5.8%) (Chuang 2012). The crepuscular and nocturnal pattern is likely correlated with the activity patterns of their prey (Rabinowitz 1990; Crawshaw and Quigley 1991; Grassman 2000; Rajaratnam 2000; Austin 2002). Nocturnal and crepuscular activities could benefit leopard cats preying upon murids, other small mammals, and birds. In addition, the high number of farming-related activities during the daytime in our study area might also contribute to shape their activity pattern, because even predators may be influenced by human activities (Kitchen et al. 2000; Riley et al. 2003; Baker et al. 2007). Although the lower over-all activity level in the dry season in our study might be due to the colder weather, it may also be possible that there is more prey available, as mentioned earlier, so that Taiwanese leopard cats do not need to spend long hours searching for food.

Conservation implications

The high incidence of illegal poisoning and trapping found in this study just within a small area, i.e., total 10 incidents involving 6 individuals monitored, indicated that this anthropogenic mortality may be the profoundest mortality threatening the survival of this endangered species in Taiwan. Most of these incidents were pest-control measures carried out by local farmers who believe that Taiwanese leopard cats are pests and will continue to prey on their poultries (St. John et al. 2014). Furthermore, the dense road system in Taiwanese leopard cat country not only impedes their movement (Fig. 2), hence creating isolation, but also increases the risk of road-kill when they cross the road. At least 15 road-kill cases were reported by the media or online communities from 2012 to 2014 (personal and Taiwan Endemic Species Research Institute collected data). These losses should be evaluated carefully as part of the conservation scheme. How these mortality causes affect the survival of Taiwanese leopard cats should be re-evaluated for effective conservation of this endangered species, particularly the often unseen and overlooked illegal trapping and poisoning.

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