Spatial and temporal activity patterns of Golden takin (*Budorcas taxicolor bedfordi*) recorded by camera trapping

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Animal behaviour is an important component of conservation biology. However, quantifying the behavior of wild animals comes with various challenges. New analytical methods enabling researchers to quantify aspects of animal behaviour from time-stamped camera trap data has circumvented some of these difficulties. In this study, we used infrared-triggered camera trapping techniques to survey the activity patterns of golden takin in Changqing National Nature Reserve in Qinling mountains, China, from April 2014 to October 2017. This study consisted of an intensive survey effort of 93, 606 camera days at 620 sites, with a total of 12, 351 photographs of golden takin recorded. The results showed that: (1) Two active peak periods of golden takin in May and November, with an inactive period in February; (2) High rates of activity at dawn (06:00-08:00), dusk (16:00-18:00), and during the daytime, with low activity at night; (3) Two seasonal migration cycles of takin across an elevation gradient, with species habitating high-elevations in summer, low-elevations in spring and autumn, and mid-elevations in winter; and (4) Heightened activity in spring and autumn relative to summer and winter due to seasonal migrations. This knowledge of takin behaviour should be incorporated into management planning. For example, lower-altitude habitats suitable for the species should be incorporated into the national park, human disturbance should be miniminized, forest canopy coverage should be reduced. Continued monitoring of golden takin is necessary for further development of species preservation plans.

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Abstract:

Animal behaviour is an important component of conservation biology. However, quantifying the behavior of wild animals comes with various challenges. New analytical methods enabling researchers to quantify aspects of animal behaviour from time-stamped camera trap data has circumvented some of these difficulties. In this study, we used infrared-triggered camera trapping techniques to survey the activity patterns of golden takin in Changqing National Nature Reserve in Qinling mountains, China, from April 2014 to October 2017. This study consisted of an intensive survey effort of 93, 606 camera days at 620 sites, with a total of 12, 351 photographs of golden takin recorded. The results showed that: (1) Two active peak periods of golden takin in May and November, with an inactive period in February; (2) High rates of activity at dawn (06:00-08:00), dusk (16:00-18:00), and during the daytime, with low activity at night; (3) Two seasonal migration cycles of takin across an elevation gradient, with species habitating high-elevations in summer, low-elevations in spring and autumn, and mid-elevations in winter; and (4) Heightened activity in spring and autumn relative to summer and winter due to seasonal migrations. This knowledge of takin behaviour should be incorporated into management planning. For example, lower-altitude habitats suitable for the species should be incorporated into the national park, human disturbance should be miniminized, forest canopy coverage should be reduced. Continued monitoring of golden takin is necessary for further development of species preservation plans.

Keywords: Wildlife behaviour; Seaonal migration; Remote sensing; Capture rate; Management implications; National Park.

Introduction

Rapid economic development coupled with the impacts of global climate change have produced unprecedented challenges for wildlife and their survival (Pereira et al., 2014). While enjoying material civilization, human beings have also brought serious large-scale environmental problems (Cardinale et al., 2012; Hooper et al., 2012). A number of organisms are facing extinction crises largely driven by anthropogenic disturbances, calling for increase awareness and entry into an era of biodiversity conservation (Jiang & Ma, 2014). Traditional conservation biology focuses on biology, ecology, population structure and genetics, and largely ignores the science of animal behaviour, which can provide vital information for creating solutions that promote long-term population survival (Sutherland, 1998). Animal behavior as a discipline seeks to understand how animals perceive their external environment, and their relationships with surrounding habitat characteristics (Piccione & Giannetto, 2011). The adjustment of behavior is the most direct manifestation of wildlife in response to environmental stimuli, forming a certain regularity of expected behavioral patterns (Giotto et al., 2013). Animal behaviour is an important component of conservation biology (Anthony & Blumstein, 2000; Berger-Tal et al., 2011), and is of considerable interest to researchers and wildlife managers (Caravaggi et al., 2017). For example, behavioural studies can increase our understanding of species' movement and thus the best placements for corridor construction (Lapoint et al., 2013; Gastón et al., 2016), population recovery (Shier & Owings 2006), where nature reserves should be placed (Brooker et al., 2016; Greggor et al., 2016), and how successful animal reintroduction programs may be (Dunston et al., 2017). The application of knowledge gained through animal behavior studies for solving conservation challenges is known as "conservation behavior" (Blumstein & Fernandez-Juricic, 2014).

Quantifying the behaviour of wild animals is challenging (Rowcliffe et al., 2014). For example, metrics such as the date of behavior may be lacking due to the distribution of animals in remote dense mountains that are difficult access. Further, the animals of interest may occur at low densities, actively avoid humans, or are nocturnal or crepuscular (O'Connell et al., 2010). Infrared-triggered camera trapping techniques that automatically record images of wildlife using motion sensor detection provide a solution to these problems (Forrester et al., 2016). Camera trapping is a non-invasive method that generally causes minimum disturbance, and can be left unattended in the field for several months, thus they are ideally suited for studying nocturnal/crepuscular and rare/elusive species (Bowler et al., 2016; Agha et al., 2018). The advantages of camera trapping in comparison to conventional field methods (observations from transect lines, radio telemetry) are that images provide realiable evidence of an animal's presence and identity (Bowler et al., 2016; Potter, Brady & Murphy, 2018), and can record additional details including time, date, location, and temperature (Li et al., 2010).

The use of technology in nature studies confers a number of important benefits (Hamel et al., 2012). Camera trapping is becoming increasingly popular survey tool in ecology and conservation for investigating species distributions (Pyšková et al., 2018; Johnson et al., 2019), estimating population abundance (Carter, Potts & Roshier, 2018; Tarugara et al., 2019), and cataloging diversity (Husoda et al., 2019; Oliveira, de Morais & Terrible, 2019). Camera trapping is also well suited for behavioural studies, providing opportunities to undertake extensive and detailed sampling of wildlife behavioural repertoires (Burton et al., 2015; Caravaggi et al., 2017). Studies using camera traps for behavioral applications include those surrounding reproduction (Crawford et al., 2019), corridor construction (Harmsen et al., 2010; LaPoint et al., 2013), dispersal or seasonal migration (Srivastave & Kumar, 2018), foraging (Mengüllüoğlu et al., 2018), predation (Weckel, Giuliano & Silver, 2006; Akcali et al., 2019), and daily activity patterns (Xue et al., 2015).

The takins (*Budorcas taxicolor*) are gregarious bovid herbivores comprised of four subspecies that reside in steep and dense montane regions of central and southeastern China, with two of the four subspecies extending into Bhutan, northeast India and northern Myanmar (Wu, 1986; Sangay, Rajaratnam & Vernes, 2016). The takin is listed as Vulnerable by the IUCN red list due to their limited geographic range, over-hunting, deforestation, and habitat loss (Song, Smith & MacKinnon, 2008). Over the past few decades, the Chinese government has implemented numerous conservation programs including the Grain-to-Green program and the Natural Forest Conservation Program (Li et al., 2013; Zhang et al., 2007) to protect and improve habitat for native wildlife. At present, most pre-existing key threats for the species have been mitigated, and populations are now beginning to increase (Yuan & Sun, 2007). As a species of public interest, takin is a focus of researchers. Previous behavioural studies of the species include home range size (Guan et al., 2015), foraging strategies (Schaller et al., 1986; Zeng et al., 2011), seasonal migration (Ge et al., 2011; Guan et al., 2013), rutting (Wang et al., 2006), and diurnal activity rhythms (Zeng et al., 2001a; Chen et al., 2007). These studies reported behavior on only either a spatial or temporal scale, but were unable to provide the change across spatial or time due to lacking date availability. However, camera trapping allows for the application of analytical methods that enable scientists to quantify aspects of activity patterns by linking capture images with spatial and temporal data. This offers the opportunity to address unresolved questions such as variation in activity patterns along the spatial and temporal niche axis (Frey et al., 2017).

In this study, we used infrared-triggered camera trapping techniques to survey the behaviour of takin with the following obejectives: (1) examine the diel and seasonal activity patterns of golden takin; (2) determine seasonal migration patterns; and (3) assess activity patterns along both spatial and temporal niche dimensions. Our results allow for an accurate description of the spatial-temporal activity pattern of the species, which can be used to guide effective management.

Materials & Methods

Study sites

The study area is in the Changqing National Nature Reserve (107°25′-107°45′ E, 33°26′-33°43′ N). The reserve was established in 1994 and selected as the first global green list of best management protection sites in 2014 and further upgraded to a National Park pilot of China in 2017. This reserve is located on the southern slopes of the Qingling mountains in southwest China, and serves to provide protection for the giant panda (*Ailuropoda melanoleuca*), golden monkey, (*Rhinopithecus roxellarae*) takin and other sympatric species. The habitat diversity supports a large number of wildlife. Among the species present, 10 are listed as Class I state key protected wild animals in China and 52 as class II. The reserve covers an area of approximately 299.06 km^2, with elevations ranging from 800 to 3, 000 m. The average annual temperature is 7.26 °C, and the average annual rainfall is 813.9 mm. The vegetation varies with elevation with the major forest types being broadleaf deciduous (above 2, 300 m), mix coniferous and deciduous (2, 300-2, 500 m), and coniferous forest (2, 500-2, 600 m). Some interspersed subalpine shrubs and meadows are present on mountain peaks (above 2, 600 m). An isolated subspecies of takin, *Budorcas taxicolor bedfordi*, occupies the Qinling mountains (Appendix I). The Qinling mountains serve as the northern most range of the species, and approximately 5, 000 individuals inhabit this area (Forestry bureau of Shaanxi Province, 2001). Approximately 400 individuals inhabit Changqing National Nature Reserve (Yuan & Sun, 2007).

Data preparation

We used infrared camera-trapping to systematically survey golden takin in Changqing National Nature Reserve from April 2014 to October 2017. The reserve was divided into 4 km^2 blocks with GIS10.1 (ESRI Inc., Redlands, CA) (totally 118 blocks; cell size 2 km×2 km, Figure 1). Every block was divided into four smaller cells (cell size 1km×1km). One infrared camera was placed in each cell for 4 to 6 months, then moved to an adjacent cell in the same block with >300 m spacing maintained between cameras. Due to difficultly in navigation, remote areas inaccessible to humans did not have cameras. Multiple cameras occasionally occupied one to three small cells at a time. A total 620 sites were obtained. Cameras were attached to trees at an average height of 50 cm above the ground at areas likely to be used by animals (e.g., water holes, trails) at a distance of 3-8 m to maximize detection probability and with the aim of obtaining fully body images.

We used one hundred Ltl-6210 (Shenzhen Ltl Acorn Electronics Co. Ltd) cameras with the mode of “Image+Video”. All images were taken with high-quality full colour resolution of 12 Mpx and 1080p resolution video, 2 images per trigger and 15 sec video length. The cameras were set to operate 24 hours a day with a 2 min delay between photographs. The sensitivity of the infrared sensor was set to moderate. All other default settings were used. A time/date, GPS location, and ambient temperature were taken for every trigger event and automatically stamped on each photograph. SD cards and batteries were replaced upon movement of cameras between cells.

Data analysis

We classified photographs as belonging to independent detection if more than 30-min had elapsed between consecutive photographs of the same species at a given location (Blake et al., 2011; Li et al., 2010). For example, a takin remaining in front of a camera triggering multiple images were only considered a single capture event. We calculated the Capture Rates (*CR*) of golden takin with the following formula (Li et al., 2010; Blake et al., 2014):

$$CR = (N \times 100) / T \quad (1)$$

Where N is the total number of independent detection photographs of golden takin and T is the total effective camera days of all camera sites. At the end of each monitoring session, cameras were confirmed to still be operational; if not, the date on the last photograph was taken as the last date of operation.

We used a Daily Activity Index (DAI) to examine the daily activity level (Zhang et al., 2012: Liu et al., 2013):

$$DAI = (Ni \times 100) / N \quad (2)$$

Where *i* is the 2-h interval, such as 06:00-08:00; *Ni* is the total number of independent detection photographs of golden takin within a 2-h interval; and *N* is the total number of independent detection photographs of golden takin.

We designated seasons as spring (March-May), summer (June-August), autumn (September-November), and winter (December to February) based on the climate of Changqing (Ren, Yang & Wang, 2012). We considered the period of 18:00-06:00 as the night period, and 06:00-18:00 as the day period. A chi-square test was used to assess differences in the selection of altitude in the activity intensity of golden takin. Statistical analyses were performed in SPSS 19.0 (IBM Inc., New York, NY), and data expressed as Mean ± standard deviation (Mean ± SE).

Results

1. Camera-trap survey effort

We used infrared camera-trapping to systematically survey golden takin, with an intensive survey effort of 93, 606 camera days at 620 sites (90 blocks, Figure 2). Of these, 47 sites were lost to camera failure due to camera damage and loss. There were a total of 12, 351 photographs of golden takin recorded at 382 sites cross 90 survey blocks (2×2 km), and 3 323 independent photographs after a 30-min elapse period between consecutive photographs. The activity range of the species were difference over seasons with 234 sites in spring (72 blocks), 115 sites in summer (53 blocks), 244 sites in autumn (69 blocks), and 102 sites in winter (48 blocks). The number of golden takin photograph detections fluctuateed, with a maxima in spring (1088 images) and autumn (1169 images), and a marked reduction in photograph detection over summer (686 images) and winter (380 images).

2. Annual activity pattern of species

There were two obvious active peak periods of golden takin in May (*CR*=5.37) and November (*CR*=5.84), and inactive period in February (*CR*=1.57). The annual activity pattern were as follows: low levels of activity from February to March with a gradual increase in April followed by an activity peak in May and gradual decline until low levels were again reach in August. Activity then began to increase and reach another peak in November followed again by a gradual decline. The average ambient temperature recorded by the infrared camera at the time of the activity showed that the range of preferred temperatures for species activity was between -1.14±4.84 °C in January and 17.05±4.31 °C in August (Figure 3).

3. Daily activities and seasonal differences

High levels of activity during the day were consistently recorded from 06:00 to 08:00 (DAI=11.47%) and 16:00 to 18:00 (DAI=16.16%), while low levels of activity were recorded from 20:00 to 06:00 at night regardless of season. A few takin showed nocturnal activity from 00:00-02:00 (DAI=5.54%). Overall, records were predominantly at dawn and dusk and during the daytime (06:00-18:00, DAI=68.23%), with relatively few records during the night (18:00-06:00, DAI=31.77%). In spring, summer, autumn and winter, golden takin had similar daily activity patterns with two peaks in the time periods of 06:00-8:00 and 16:00-18:00, except the second activity peak in spring presented 2-h later (18:00-20:00) and the first peak in winter 2-h later (08:00-10:00, Figure 4).

4. Seasonal migration of golden takin

The infrared-camera data of takin ranged in elevation from 985 m to 2 958 m, and exhibited distinct altitude change between months (x^2=698.33, *df*=11, P=0.000). Takin were recoreded at their highest elevations in June (2260.58±492.38 m) and lowest elevations in April (1765.82±413.46 m), and there were two distinct seasonal vertical migration cycles. The seasonal migration patterns were as follows: the first migration occurred from May (1993.15±509.34 m) to October (1841.05±246.04 m), as takin steadily ascended in elevation until reaching their highest elevation during June (2260.58±492.38 m). The second migration occurred from November (1807.91±326.83 m) to February (1849.36±320.11 m), with takin moving up from lower elevations from November through December (1880.67±342.83 m) to mid-elevation where they remain for 2 months in January (1891.26±268.67 m) and February. From March (1788.56±304.00 m) to April, takin gradually returned to lower elevation valleys. Seasonal migrations during the spring and autumn resulted in larger activity range sizes than summer and winter. In spring, autumn, and winter, the elevation of the takin during the daytime (06:00-18:00) was higher than that at night (18:00-06:00), with the reverse pattern occuring in the summer (Figure 5).

Discussion

Traditional methods for surveying animal behaviour depend either on direct observation, or tagging (e.g. radio tracking through attaching telemetry devices to animals) (Nathan et al., 2012). Unfortunately, both methods have limitations for impeding understanding of behavioural ecology (Rowcliffe et al., 2014). Direct observation can be extremely labour intensive and weakened by the influence of human presence on focal animals. Futhermore, only a limited number of species are amenable to direct, field-based observation (Bridges & Noss, 2011; Nowak et al., 2014). Tag-based approaches are invasive applied to only a small sample size, and thus can not be representive of the wider population (Guan et al., 2013; Rowcliffe et al., 2014). An alternative to tagging is placement of infrared sensors in the environment, rather than on the animals, such as is done with camera trapping. The advantages of camera trapping is that it is less time consuming, less costly, minimally invasive, and removes the need for an observer in situ, thereby reducing the potential bias of human presence on behaviour (Caravaggi et al., 2017). Futuremore, animal behaviour events recorded by camera traps are typically a cumulative composition of many individual animals, allowing for population level measures that can be compared through space and time. However, despite the great promise of camera traps, it is important to consider potential limitations. First, camera traps can be triggered by an abrupt change in temperature across a fan-shaped area in front of the unit, thus placing cameras in likely animal-use areas is crucial, as determined by experience in the field. Second, the sound and visible light produced by the camera upon recording may dispurt the animal's natural behaviour (Meek, Ballard & Falzon, 2016); Third, camera failure and theft is common, and can result in the loss of large quantities of data; Fourth, a key limitation of our methods is the need to assume that wider population are active at the peak of activity cycle.

Wildlife activity patterns are evolunarilty adaptive, and are a survival strategy in response to surrounding environmental conditions (Hofmann, 1989). With seasonal changes, most wildlife experience a complete annual activity cycle from estrus, mating, spawning, migration, and wintering. According to our analysis, the annual activity pattern of takin is consistent with seasonal migration, with the capture rate during migration seasons (spring and autumn) significantly higher than during non-migration seasons (summer and winter). This is likely due to an expanded range during migration seasons, while movement becomes more confined during non-migration seasons. From June to August, golden takin were observed in large groups at high altitudes engaging in rutting behaviour. Male takin may take more time to rest druing the rut (Guan et al., 2012), while females must conserve energy for breastfeeding in winter from February to March (Wang et al., 2005, 2006), therefore, the capture rate of species was lower during the non-migration seasons. We found no evidence of a significant direct effect of ambient temperature on the annual activity pattern of the species. However, overall trends show a lower capture rate in January (*CR*=2.52) and February (*CR*=1.57) when it is cold, although higher rates were noted in December (*CR*=5.59), and lower capture rates in July (*CR*=2.84) and August (*CR*=1.88) when it is warm.

Daily activity patterns are often driven by circadian rhythms and periodical changes in environmental stimuli (Aschoff et al., 1966). Animals must optimize the amount of time for different activities, and distribute those activities temporally during a 24-h cycle (Fernandez-Duque, 2003). Golden takin exhibited with the most activity at dawn (6:00 to 08:00 am) and dusk (16:00 to 18:00 pm). This is similar to previous findings from radio-collared studies on the species (Zeng & Song, 2001). Peak activity often occurred in dawn and dusk when temperatures were relatively cool with low humidity, and takin spent this time foraging and moving slowly. Peak rumination often occurred next to peak foraging from 10:00 to 14:00 and rumination was also often accompanied with resting. Takin may lay under tall trees or stone cliffs to keep themselves cool. The species generally reduced movement and activity during this time period (Zeng & Song, 2001; Chen et al., 2007). While most golden takin rested from 00:00 to 02:00 at night, a small portion of individuals were active. Previous studies indicate that there may be a sentry system that exists in some populations (Wu et al., 1990). This indicates the importance of camera trapping studies as mechanisms to capture many individuals and being more wholely presentative of the population, while a limitation of tag-based studies (Guan et al., 2012).

Seasonal migration is a common survival strategy that allows herbivores to optimize living conditions throughout the year (Pettorelli et al., 2007). We found a complicated seasonl migration of golden takin that progress from high-elevation meadows in summer to mid-elevation arrow bamboo and fir forest in winter, and low-elevation valleys in spring and autumn, this migration pattern was similar to previous reported (Zeng et al., 2008). We believe seasonal temperature change and change in plant phenology and its influence on food resources are the key driving forces in the evolution of migration of golden takin (Zeng et al., 2001b). For golden takin, the climate became warmer at low elevation areas in spring, gradually descended to the low-elevation in response to the first greening of vegetations within the valley to replenish their energy after the cold winter. Takin next ascend to high-elevation because more nutritious foraging is available. This is in conjunction with a cooler environment, fewer biting insects and safer mating (Wu et al., 1990; Zeng et al., 2010). The climate then becomes colder, and the decrease and senescence of vegetation at high-elevation areas forces the species to return to low-elevation in autumn in search of unwithered forage to accumulate energy for the coming winter. However, the takin's seasonal migration from autumn to winter was not consistent with temperature changes. Takin moved up to mid-elevation bamboo and fir forest to use the bamboo as food resource and the forest as thermal shelter from heavy snow and cold wind. In addition, selection for mid-elevation areas with high solar radiation and could be a strategy of thermal adaptation during winter (Zeng et al., 2008; Zeng et al., 2010; Guan et al., 2012). The underlying mechanisms and signals that initiate seasonal migrations are not yet fully understood and require further study, especially in regards to migration patterns during winter.

Camera trap rely on a passive infrared sensor to detect a differential in heat-and-motion between a subject and ambient temperature. A limitation of sensors is the way they detect differences between the animal and the ambient temperature (Rovero et al., 2013). Optimum conditions for camera trap triggering is 2.7 °C greater than ambient temperature (Meek, Ballard & Falzon, 2012). Despite the minor errors, ambient temperature at hand ranges from -1.14±4.84 °C in January to17.05±4.31 °C in August, could be a preferred reference temperature for species management guide.

Management implications

As a flagship species in China, golden takin is a focus of conservation effort. The government of China has listed the golden takin in the key program of biodiversity conservation, and will establish a national park specially for protecting species in the Qinling mountain range. Behvioural studies using camera traps are in their infancy, data taken from of a still image or video of golden takin can provide a wealth of information that is of conservation value. Based on our results, we propose the following conservation strategies for takin in the Qinling mountains of China.

1. Include lower-altitude habitats suitable for takin into national park plans.

Many studies have documented that golden takin only reside in suitable habitat >1350 m (limited by traditional agriculture) in Qinling mountain. Most nature reserves were established decades ago without considering lower parts of mountain regoins. With the implementation of conservation programs, many lower-altitude farmland returned to forests, and these areas now constitute suitable habitat. Conssequently, the range of proposed national parks should include these areas, particularly in regard to new knowledge of takin migration in spring and autumn.

2. Reduce the negative impacts of human disturbance.

Poverty is still prevalent for those living around the nature reserve. Residents rely on local forests for firewood and construction material. The daily life of local villagers is closely linked to reserve resources (e.g. collecing bamboo, mushrooms in spring, and herbs in autumn). These disturbances negatively affect the seasonal altitudinal movement of species. Consequently, we recommend that anticipatory actions might focus on idenitfying areas at risk for high levels of human disturbance, and establish early-detection and rapid response protocols to discourage humans from sensitive areas during migration periods. All issues relating to both nature conservation and community development must be addressed to promote sustainability of both wildlife and local livlihoods.

3. Reduce the forest canopy coverage.

The Qinling mountains is considered as a natural boundary separating temperate and subtropical zones where the temperature and rainfall are suitable for plant growth, making vegetation in the these regions quick to recover. Vegetation succession has changed the habitat of golden takin, since most of the vegetation was evergreen and covered the neighboring plants, resulting in understories becoming impoverished by takin feeding. As effective approaches for management of vegetation, fire-maintained and selectively logged forests have been widely used in habitat management. Thus, we suggest that burning or selective logging methods should be conducted in evergreen forests. Both of these approaches can increase species diversity and biomass.

4. Strengthen golden takin monitoring efforts.

In recent years, the Chinese government has implemented many conservation programs to protect and improve habitat for wildlife, and many wild animal populations in the Qinling mountains have begun to recover. Human-wildlife conflict has intensified around Qinling mountains, and the potential for golden takin to cause agricultural damage in lower elevation has curbed the enthusiasm of local villagers to support the national park. Camera traps detected domestic dogs frequently the forest, which may result in predation pressure on takin calves. In addition, diseases such as pinkeye and tumour growth were seen in video of golden takin (Appendix I). Thus, long-term monitoring programs should be carried out to regularly assess the advancement and mitigation of ongoing threats to the species.

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Figure 1

The geographical location of Changqing National Nature Reserve in the Qinling mountains of China.

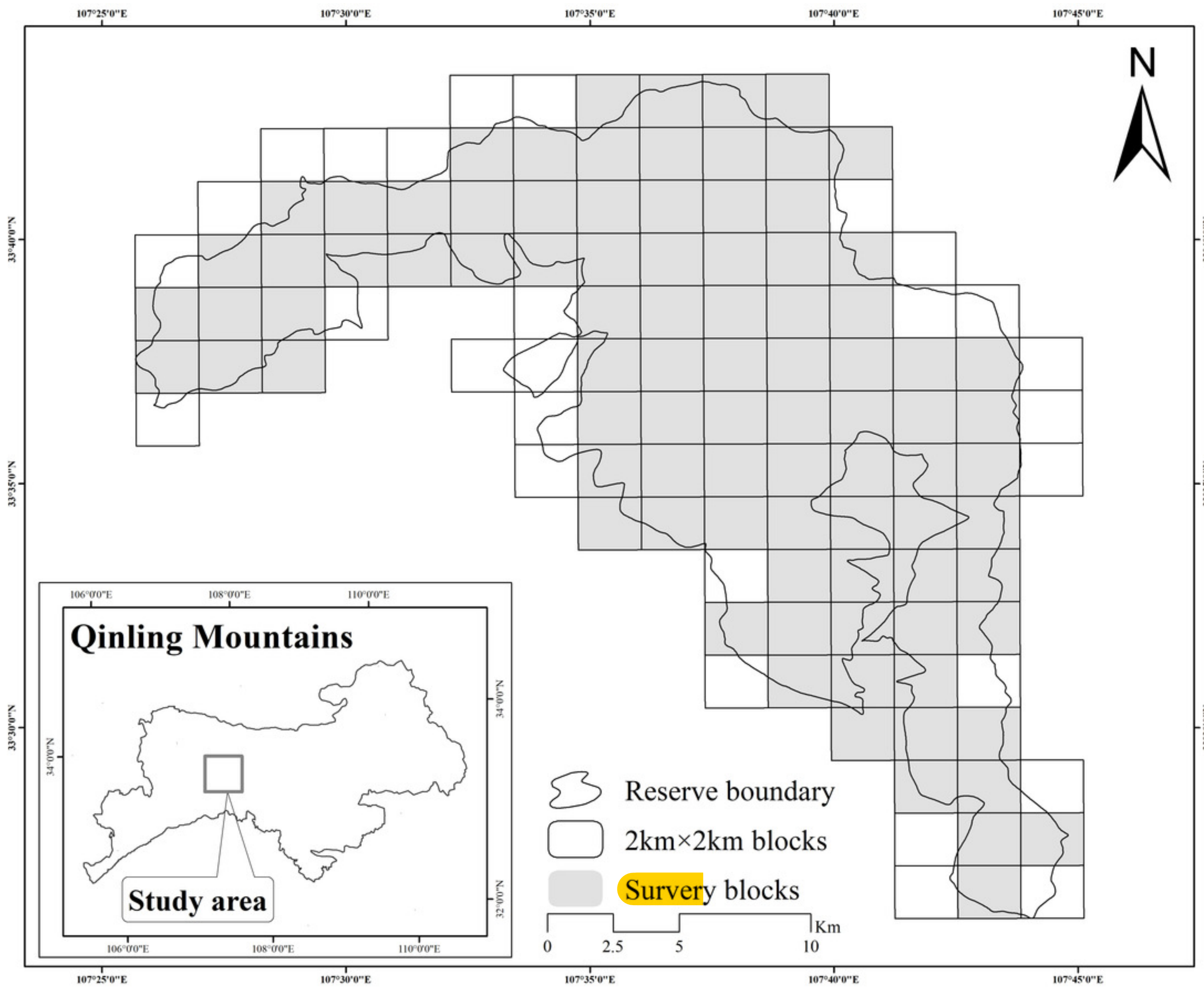

Figure 2

The seasonal activity range and detected number of golden takin via camera traping in Changqing National Nature Reserve

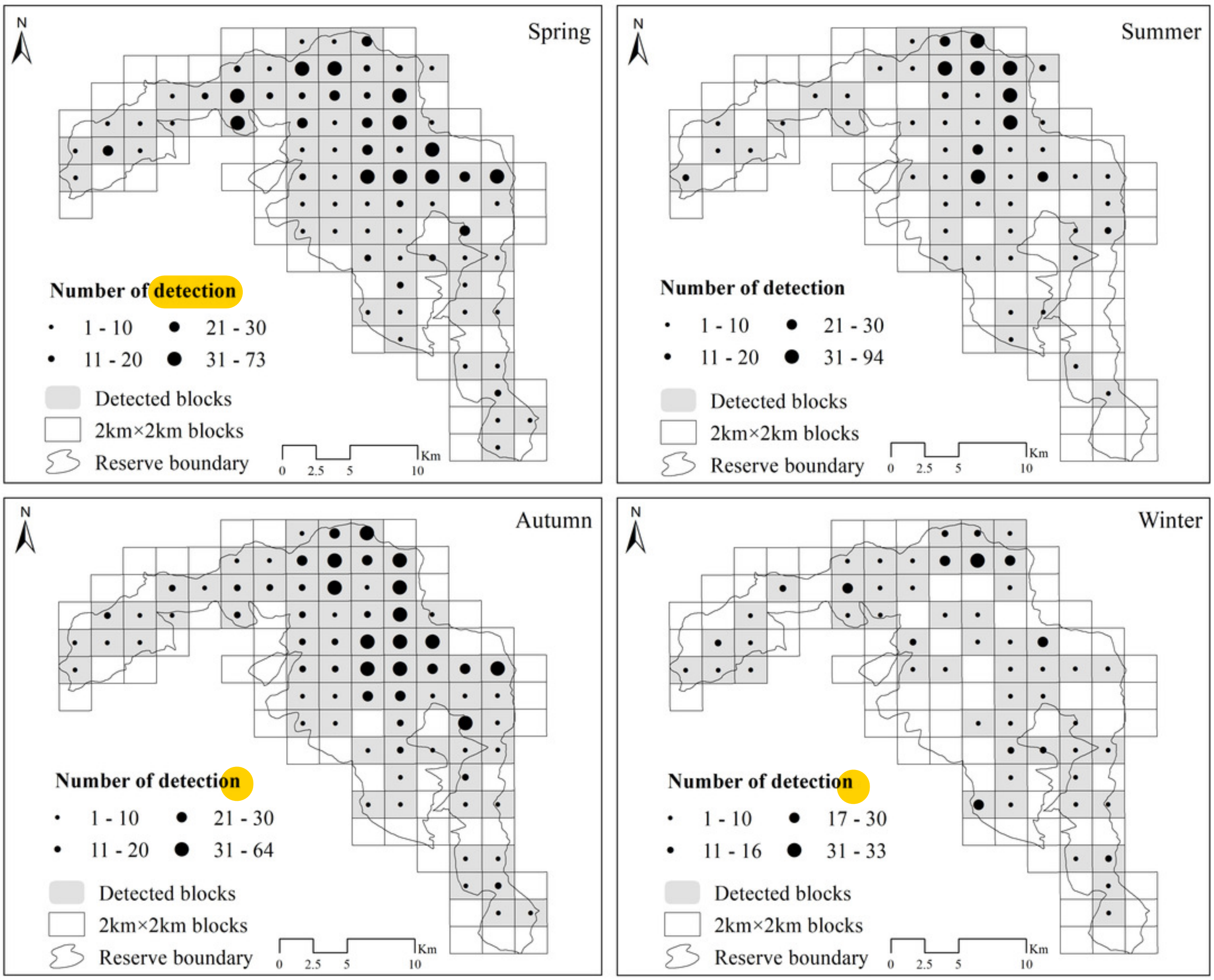

Figure 3

The annual activity patterns over a period of 12 months of golden takin and the environmental temperature change s through time in Changqing National Nature Reserve.

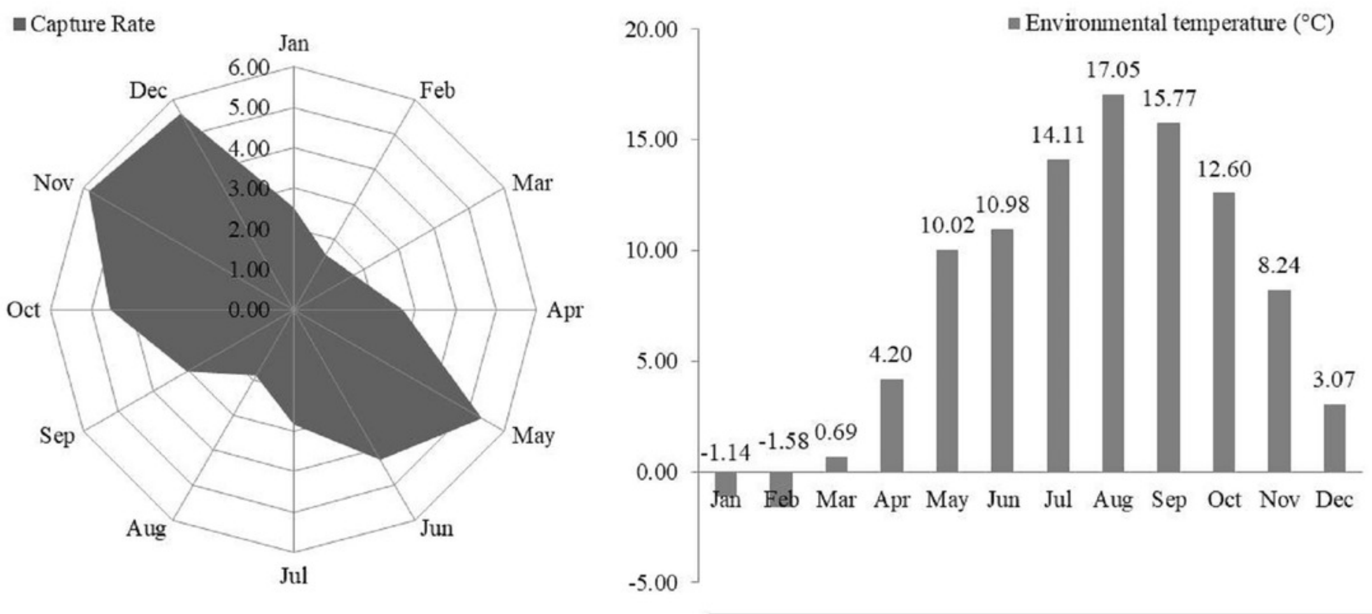

Figure 4

The seasonal activity patterns over a 24h period of golden takin using camera traps in Changqing National Nature Reserve.

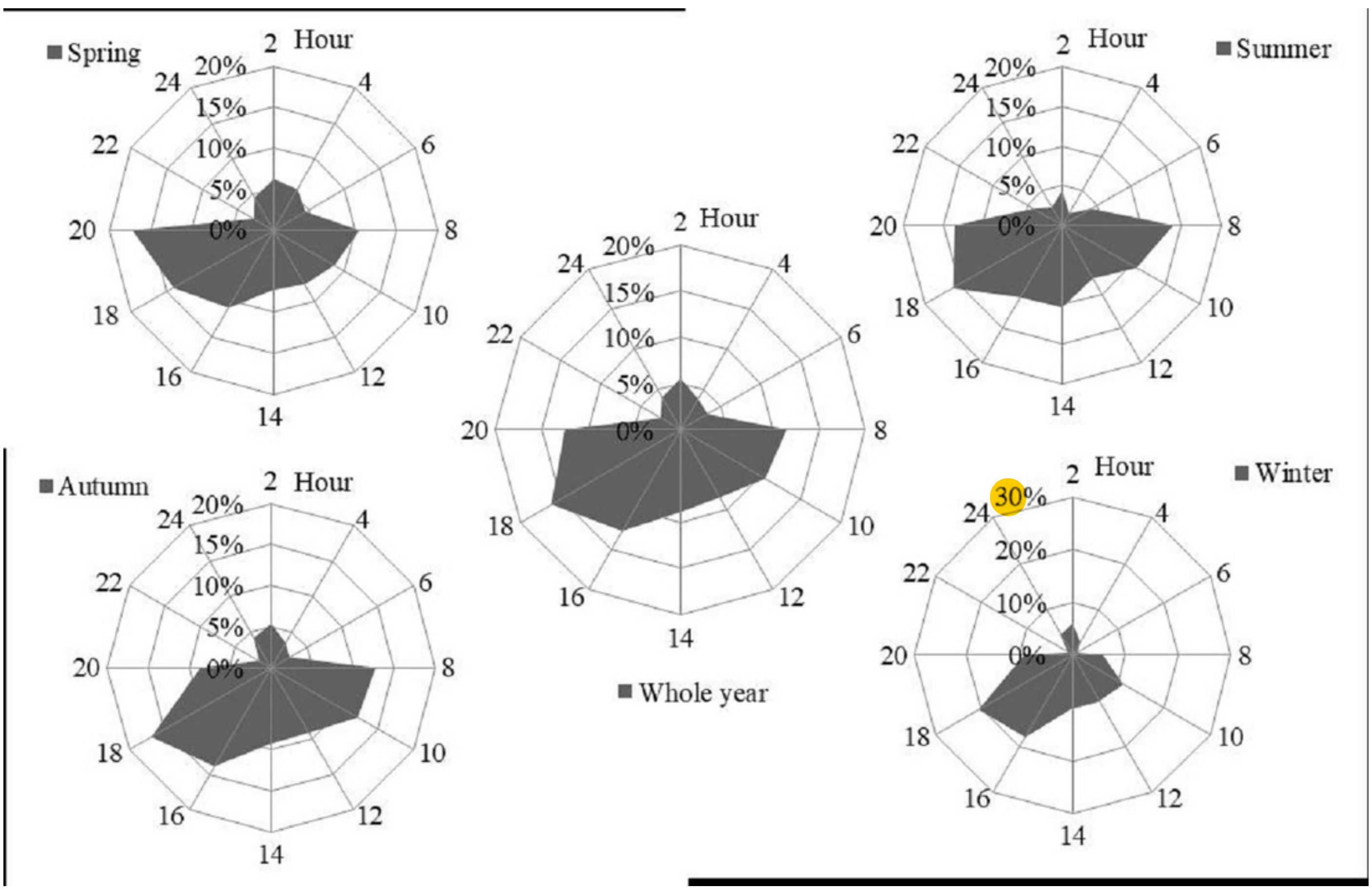

Figure 5

The seasonal altitudinal migration of golden takin in Changqing National Nature Reserve as monitored from camera traps s 0���-=_