SNOW LEOPARDS AND TELEMETRY: EXPERIENCES AND CHALLENGES

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Introduction

The snow leopard Panthera uncia is one of the least studied felids in the world. Little is known about various aspects of the ecology of the snow leopard, which is cryptic in nature and found across 12 countries in Central Asia. Most research on snow leopards has been based on non-invasive methods such as sign surveys for presence (*e.g.* Jackson and Hunter 1996), scat analyses for diet (*e.g.* Chundawat and Rawat 1992; Oli *et al.,* 1993), fecal DNA analyses (McCarthy *et al.,* 2008; Waits *et al.,* 2007) and camera trapping (Jackson *et al.,* 2009; McCarthy *et al.,* 2008, 2010) for population estimation, and studies based on human interviews (Mehta and Heinen 2001; Mishra and Bagchi 2006).

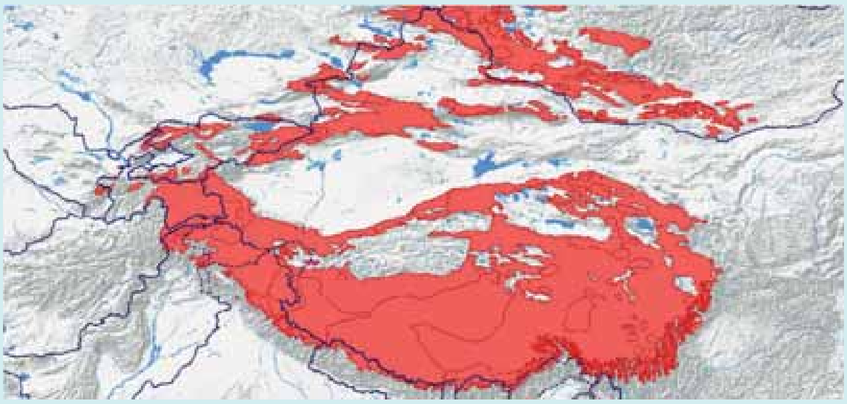
Despite this plethora of studies employing non-invasive techniques, several crucial questions about snow leopard ecology remain unanswered. Information about the animal's home range, dispersal, corridors, pattern of habitat use, movement patterns, hunting frequency, behavior and intra-specific interactions is not available yet. In order to design population monitoring studies using camera traps or DNA analyses, one needs a good understanding of snow leopard ecology, including the home range and movement patterns (Williams *et al.,* 2002). Telemetry is still the best available method and perhaps much less invasive than direct observations for studying the biology and ecology of cryptic animals.

Telemetry studies constrained by limited technology

Telemetry studies on wildlife were pioneered in the 1960s and early 1970s. Receiving radio signals of very high frequency (VHF) from animals fitted with transmitters using specialized receivers and directional antennas and estimating their locations through triangulation is a technique that has been applied broadly over the past four decades to the study of mammals, birds, reptiles, amphibians and even fish. A wide range of transmitters and receivers are available from a large number of manufacturers (Telonics, Lotek, Televilt, Sirtrack, ATS, North Star, Vectronics, *etc.*) to study wildlife remotely.

Snow leopards live in some of the most inaccessible and inhospitable terrains across the mountains of Central Asia (Fig. 1). They are nowhere found in high densities, and with a sparse density of prey, they typically cover large distances over short periods of

Figure 1



Snow leopard distribution range in Asia time (McCarthy *et al.,* 2007, 2010). Despite these obstacles, a few studies were undertaken in the past that attempted to follow snow leopards using VHF telemetry (Chundawat 1990; Jackson 1996; McCarthy 2000; Oli 1997). This method requires being able to cover vast areas on the ground and to obtain a direct line of sight between the transmitting collar and the receiving antenna, neither of which is consistently possible on foot in the extremely rugged terrain of snow leopard habitat. Moreover, VHF radio signals rebound from rocky mountains, making it difficult to confidently locate collared animals even when the signal is acquired. For the above reasons, acquiring the multiple accurate locations that are required for triangulation is particularly difficult in this habitat. Additionally, in the past studies, animals were commonly reported to go out of signal range for many days or even months. These multiple problems made ground-based VHF telemetry largely inappropriate for studying snow leopards (McCarthy *et al.,* 2010).

By the early 1980s the Argos satellite system was in place and provided a new means of tracking wildlife fitted with satellite transmitters. In contrast to VHF telemetry, where the signal strength is used to triangulate a transmitter's location, the Argos transmitter positions are calculated by computing the Doppler shift, or change in frequency, of the transmitter signals as the satellite passes overhead. This change in frequency of an electromagnetic wave occurs when a transmitter and a receiver are in motion relative to each other. Early Argos transmitters were too large and bulky for use on an animal the size of a snow leopard, in part due to the battery requirements. By the mid-1990s the size and weight of Argos transmitters had been reduced, and the first attempt was made to use them on snow leopards in Mongolia in 1996 (McCarthy 2000). While this technology provided an advantage over VHF telemetry in snow leopard terrain, the best accuracy that could be expected of the location estimates was only about 100 m. The collars used in that first study were programmed to come on twice a day during scheduled overpasses by two different Argos satellites; yet the success rate recorded was as low as 40%, which was in part due to the distance of the collars from the path of the polar-orbiting satellites. Since the devices consumed a lot of power, making the collars' battery life short despite the batteries being bulky and heavy, there was a need to improve on the technology.

GPS telemetry

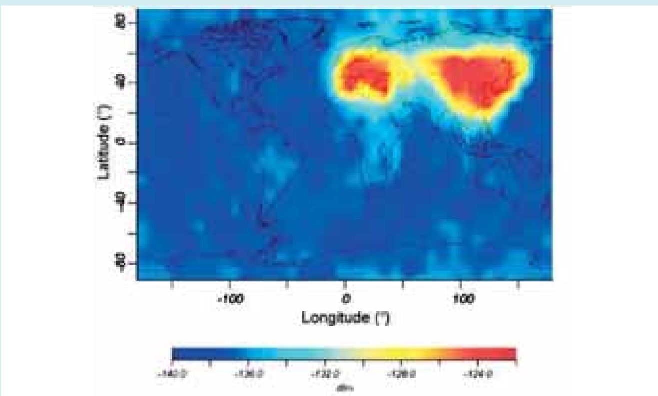
GPS receivers were introduced for non-military use in the 1990s. A GPS calculates its own location by "listening" to a constellation of dedicated satellites orbiting the earth. Soon after small GPS receivers were developed, collars with GPS units followed. These collars obtained their own location and either stored it onboard or transmitted it to a researcher through various options such as handheld devices using ultra-high frequency (UHF) communication, the Argos satellite system or the Global System for Mobile Communications (GSM) or satellite phone technology.

UHF communication is constrained by distance as these signals can only travel relatively short distances. In most field situations, these signals rarely cross the 1 km mark, and that only when the receiver is in the line of sight. Given the rugged terrain where snow leopards live, the choice of UHF is difficult, considering the preceding failures of VHF technology, in which signals travel greater distances than they do with UHF. Since snow leopards rarely live in areas with a high human density, their terrain is usually sans GSM cellular phone coverage.

GPS telemetry using Argos

GPS collars with Argos satellite transmitters were deployed on several Mongolian species including the Gobi bear, Bactrian camel and saiga. Large-scale failures were reported as many or most collars failed to successfully uplink locations (R. Reading and H. Reynolds, *pers. comm.*). Inquiry into such large-scale failures revealed the presence of background radio noise in the frequency band at which Argos communicates in Central Asia and Europe (Fig. 2). The source of this noise was unknown despite its large-scale prevalence.

Figure 2



Plot of known radio interference with Argos reception (red=highest known interference)

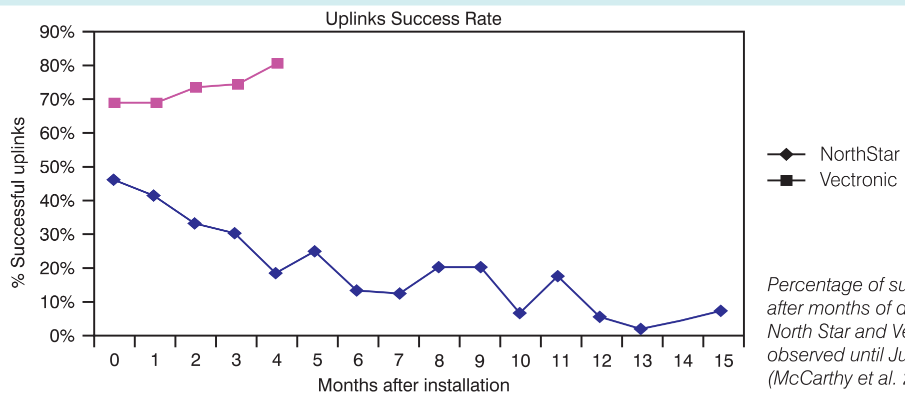
Considering that Argos was the only available technology for communicating data from GPS-collared snow leopards in 2006, the Snow Leopard Trust and the Wildlife Department of Pakistan's Northwest Frontier Province initiated a telemetry-based study of snow leopards in the Chitral Gol region of Pakistan (McCarthy et al. 2007). Chitral Gol was outside the known edge of the noise cloud and therefore expected to provide a better uplink rate. A Telonics Generation 3 GPS-Argos collar (TGW 3481) was installed on a single female snow leopard in November 2006. The collar was programmed to make three GPS fixes per day and upload a sample of those every 2 weeks. No uplinks were received for the first two months, and assuming a defect in the collar, it was replaced in January 2007. Between January 2007 and January 2008, the collar made only three successful uplinks of a total of 11 GPS fixes at a poor rate of 11% of the expected number. However the collar was programmed to store data onboard and was fitted with a programmable drop-off mechanism. In January 2008 the collar dropped off as planned and transmitted the last four GPS fixes it had acquired before falling off the cat; these fixes could not be used to pinpoint the location of the shed collar. The collar dropped off in a remote area with over 3 m snow cover, making the task of retrieving the collar difficult. Since there were no more uplinks, the only way to find the collar was through VHF. Given the rocky, mountainous terrain, with several feet of snow, signal bounce made it difficult to locate the collar for 2 months. In March 2008, our field biologists from Pakistan managed to find the collar using an indigenously customized FM radio instead of a sophisticated antenna and receiver. Field testing revealed that the customized FM radio could only detect signals when the transmitter was within a range of 15-20 m, which required thorough combing of the area but reduced the confusing signal bounces off rocks that were picked up by the much more sensitive telemetry receiver. The radio-collar was eventually found in a crevice where it had dropped off from the snow leopard as programmed. The animal may have rested there during the daytime.

The data stored onboard provided unmatched information about the ranging patterns of the snow leopard. Her home range was found to extend across the Pakistan-Afghanistan border, the MCP encompassing 1,206 km^2. The data stored onboard were found to be more comprehensive in terms of numbers and daily movements over a long period of time compared with those yielded by any previous study. However, limitations in the form of practically non-existent uplinks during the time of deployment made the Argos-based technology highly unreliable in this part of the world, thereby calling for a look for better options.

GPS-satellite phone telemetry

In 2008, the first ever long-term study on snow leopards was initiated in the Tost-Toson Bumba Mountains in South Gobi province of Mongolia. Aimed to extend over at least 15 years, the study had telemetry as one of the key research methods to be used. Preliminary test surveys were conducted with GPS collars fitted with satellite phone transmitters by installing them on livestock and carrying them around in cars and in backpacks for about a month. The collars were taken to canyons, ridgelines and concrete houses to test the rate of successful uplinks. With a collar installed on a goat and programmed to uplink every 2 hours, 39 successful uplinks were obtained in a period of 10 days, with a 30% success rate. This was promising as the success rate was more than three times that of the previous study, carried out in Pakistan, though field conditions and rugged use on a snow leopard were still to test the collars. North Star C-cell model collars were used on seven animals. These collars were equipped with a GPS receiver, a satellite phone transmitter to communicate GPS locations remotely, onboard storage, a VHF transmitter for tracking down dropped off or malfunctioning collars, and a programmable drop-off device. The collars used the Globalstar satellite phone service, which relies upon ground-based stations for enabling communication with satellites. The small size and low weight of the transmitter as compared with that of Iridium (c. 700 g including the battery casing and the collar material) made it a reasonable choice after initial field testing proved that the Globalstar satellite phone service did have coverage in the study area. A total of 11 collars were fitted on seven snow leopards until April 2010. Other than two collars that were installed on one snow leopard successively, no other collar lasted the entire period of 12 months without malfunctioning. Fig. 3 (McCarthy *et al.,* 2010) shows a deterioration in the rate of uplinks almost within a month after the date of installation. The average uplink success of these collars

Figure 2

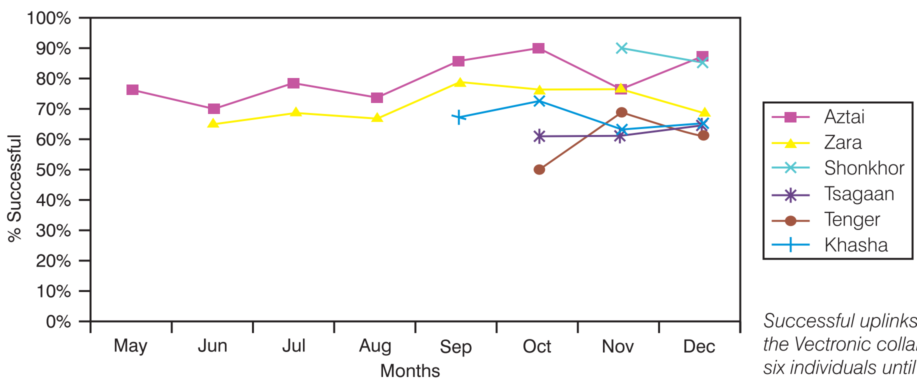


Percentage of successful uplinks after months of deployment for North Star and Vectronic collars as observed until July 2010 (McCarthy et al. 2010) was 40% though time series analysis shows a marked deterioration over time from about 80% in some collars to 0-20% by the end of 11 months. Physical examination of each of the collars showed physical damage that may have resulted in reduced efficiency or a sudden loss of power. Some collars were even found with missing components, exposed wiring or battered casings.

Since April 2010, a new design of collars made by Vectronics™ is being used. Seven collars have been installed on snow leopards since then, and six of these collars are still installed on different snow leopards. One collar was lost in October 2010 due to a drop-off device that misfired and dropped the collar about 6 months too soon. Fig. 4 shows a relatively high rate of uplink success and consistency in performance until December 2010 for each of the installed collars. These collars are c. 700 g in weight and are programmed to uplink locations every 5 hours. So far the average uplink success rate on all collars has been 72% (minimum 62%, maximum 87%). Various factors including individual behavior and terrain usage patterns could be responsible for the variation in the uplink success rate of the different collars, though this is yet to be verified. Camera trap pictures of snow leopards in the study area shows one consistent difference between the Vectronics and North Star collars. While the North Star collars had an equal weight distribution across the circumference of the collar, the Vectronics collars have two component boxes diametrically fitted on the collar ring. The heavy battery casing hangs down, ensuring that the antenna and the casing of the other components face the sky, probably enabling a high rate of uplinks. In about five physical recaptures and more than 100 camera trap photos taken to date, none of the Vectronics collars have shown physical damage that will reduce their ability to record or uplink data.

While these are still early days to decisively showcase the merits of one collar design over the other, the results so far are promising. Improvements in the collar may include the use of newly developed, lighter Iridium satellite phone transmitters, which have better coverage across snow leopard countries where Globalstar does not operate currently, and further reducing the weight by improving the energy consumption of the devices being used in the collar.

Figure 2



Successful uplinks for each of the Vectronic collar deployed on six individuals until December 2010.

References

Chundawat, R.S. 1990. Habitat selection by a snow leopard in Hemis National Park, India. *International Pedigree Book of Snow Leopards* 6:85-92.

Chundawat, R.S. and G.S. Rawat. 1992. Food habits of snow leopard in Ladakh, India. *Proceedings of the International Snow Leopard Symposium.* 127-132.

Jackson, R.M. 1996. Home range, movements and habitat use of snow leopard (*Uncia uncia*) in Nepal. Dissertation, University of London. 233 pages.

Jackson, R. and D.O. Hunter. 1996. *Snow Leopard Survey and Conservation Handbook.* Second edition. International Snow Leopard Trust, Seattle, WA.

Jackson, R., B. Munkhtsog, D.P. Mallon, G. Naranbaatar and K. Gerlemaa. 2009. Camera-trapping snow leopards in the Tost Uul region of Mongolia. *Cat News* 51.

McCarthy, K.P., T.K. Fuller, M. Ming, T. McCarthy, L. Waits and K. Jumabaev. 2008. Assessing estimators of snow leopard abundance. Journal of Wildlife Management. 72(8):1826-1833.

McCarthy, T., J. Khan, J. Ud-Din and K. McCarthy. 2007. First study of snow leopards using GPS-satellite collars underway in Pakistan. *Cat News.* 46:22-23.

McCarthy, T., K. Murray K., K. Sharma and O. Johansson. 2010. Preliminary results of a long-term study of snow leopards in South Gobi, Mongolia. *IUCN Cat News.* 53:15-19.

McCarthy, T.M. 2000. Ecology and conservation of snow leopards, Gobi brown bears, and wild Bactrian camels in Mongolia. Ph.D. dissertation, University of Massachusetts, Amherst, MA. 133 pages.

Mehta, J.N. and J.T. Heinen. 2001. Does community-based conservation shape favorable attitudes among locals? An empirical study from Nepal. *Environmental Management.* 27(5):165-177.

Mishra, C. and S. Bagchi. 2006. Living with large carnivores: predation on livestock by the snow leopard (*Uncia uncia*). Journal of Zoology. 268(3):1-8

Oli, M.K. 1997. Winter home range of snow leopards in Nepal. *Mammalia.* 61:355-360.

Oli, M.K., I.R. Taylora and M.E. Rogers. 1993. The diet of the snow leopard (*Panthera uncia*) in the Annapurna Conservation Area, Nepal. Journal of Zoology. 23(1):365-370.

Waits, L.P., V.A. Buckley-Beason, W.E. Johnson, D. Onorato and T.M. McCarthy. 2007. A select panel of polymorphic microsatellite loci for individual identification of snow leopards (*Panthera uncia*). *Molecular Ecology.* 7:311-314.

Williams, B.K., J.D. Nichols and M.J. Conroy. 2002. *Analysis and Management of Animal Populations.* Academic Press. 817 pages.