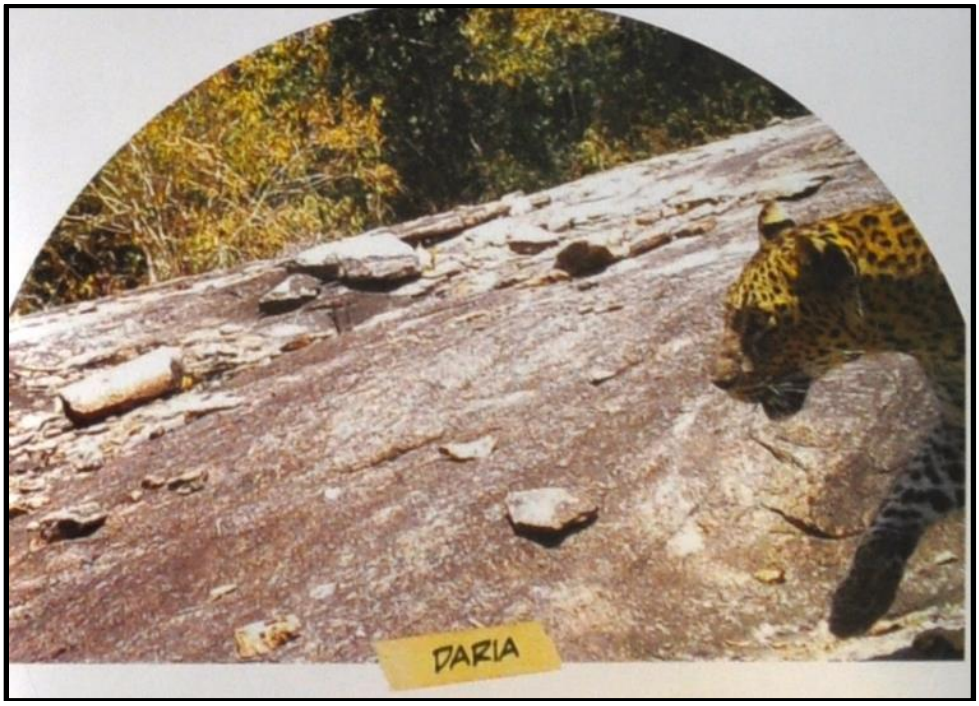
The Leopard Project

Annual Report 2019



February 2020

The Wilderness & Wildlife Conservation Trust
www.wwct.org
130 Reid Avenue, Colombo 04, Sri Lanka
Tel: +94 11 2589468/+94 773 544 382
Email: info@wwct.org

Executive Summary:

The Wilderness & Wildlife Conservation Trust (WWCT) had another full and interesting year in 2019. Our direct conservation intervention was the initiation of the re-planting phase of the Peak Ridge Forest Corridor project. Continued monitoring of the leopards and other wildlife in this Central Highlands landscape has led to new and important findings. Our shift to new areas of the Gal Oya National Park in our efforts to better understand leopard ecology and behaviour in that stunningly beautiful Protected Area is revealing how leopards are using this landscape and is enabling cross study site comparatives which will greatly inform our overall conservation plan for the leopard. By improving our wild cat detection methods in the Sigiriya Patch Forest properties we were able to get long term use patterns by leopards of these patch forests. Towards the end of 2019 WWCTs new project on the investigation of human-leopard interaction in Yala's buffer zone saw the initiation of the targeted leopard monitoring camera array in the area.

Although the Peak Ridge Forest Corridor is yet to be officially declared (plans are for first quarter of 2020), its conservation status is becoming increasingly improved with the active participation of the region's Estate Management companies. The long-term residency of individual leopards in this landscape highlights that this is not a sub-optimal, transitional habitat but part of the leopard's established range in Sri Lanka. Relative abundance indices suggest that the population here is greater than in some of the established dry zone National Parks, a remarkable fact given the high human footprint in the region. In order to improve the available habitat for leopard movement and other resident species, WWCT has started a forest tree nursery at the Dunkeld Conservation Station on Dunkeld Estate. Currently propagation is at the early stages with the first trees to be planted on identified land buttressing the upper ridge, with the onset of rains in 2020. This re-planting phase was preceded by a thorough investigation of current fuelwood trends amongst the existing estate communities.

We enacted a shift of our remote cameras in mid-2019 from the northern forests of Gal Oya NP to the western section of the PA at Nilgala. Activity is slightly higher here than even our active interior Mullegama site, although the number of different individuals detected was slightly lower. The first definitive images of rusty-spotted cats have been obtained by WWCT in this area, with Gal Oya NP being home to all of Sri Lanka's 4 wild cat species.

The Sigiriya Patch Forest sites showed diverging patterns in 2019. We also got the first evidence of a leopard utilizing both sites in 2019, continued monitoring is needed before we can draw conclusions regarding space use here. Small cat sightings increased dramatically in 2019, due to the dedicated monitoring of a key ridgeline, indicating once again how important ridgelines are as landscape features for leopards and wildlife in general.

In the Yala buffer zone, WWCT's collaborative project has identified some key aspects influencing the attitude of pastoralists to the presence and potential threat of leopards to their livestock. Emerging data is that the awareness of the value of the leopard to the region's bustling tourism sector is causing some level of resentment amongst those (including pastoralists) that gain little from this sector. Despite leopard predation being less of a quantitative problem for livestock owners than theft, lost cattle and disease, it appears to be disproportionately perceived as an important issue. This perception, more than the quantitative reality, is what initiates anti-leopard actions. These findings will need to be seriously considered if human-leopard interactions are to be improved here. The factors driving livestock predation appear to be the quality (or lack thereof) of protection methods (i.e. enclosures) and the size of herds, with larger herds more susceptible to predation. In 2020 we hope to initiate some of the recommendations from this initial study and have already set up remote cameras in the region to further quantify actual leopard presence.

WWCT continued with its education and awareness role with various community, school and public lectures, meetings and presentations. International exposure was also gained via a CNN feature on the Peak Ridge Forest Corridor project. A highlight for us was the mural wall painting of the Dunkeld Estate School in August with the eager and skilled participation of the students. A set of 10 specially designed leopard stickers showcasing individual leopards from 5 different sites island-wide – was more popular than anticipated and are due for wide circulation in 2020!

Update of WWCT Activities - January 2019 to December 2019

I. Research

A. Peak Ridge Corridor

Leopard Activity

WWCT has been monitoring the leopard population in the Central Highland's Peak Ridge Corridor area between Castlereigh and Maskeliya reservoirs for over 3 years. Until the end of 2019 we have accumulated 6580 camera trap nights from 24 remote camera locations (Fig. 1). These include 9 new camera locations in 2019, 3 of which were actually re-activations having originally been used during 2016 population density surveys. The number of remote camera days have increased annually (Table 1) with 40% more in 2019 than in 2017. Over this combined period, we have obtained 543 leopard images and identified 28 different individuals in this area, some resident, some transient, some of which still remain and some of which have died. There have been 9 adult males identified with 4 of them being definite residents and 3 having been detected once; 11 adult females of which 7 have been resident for varying lengths, with 2 detected only on one or two occasions. One potential resident female was killed in a snare in 2018. Of the 8 cubs picked up by remote cameras one was born in 2016, 4 in 2017 and 2 in 2018 and 1 in 2019. At least 2 of the most recent cubs are still around, with additional cubs born in the end of 2019 that have yet to be seen (and are thus not included in the 28).

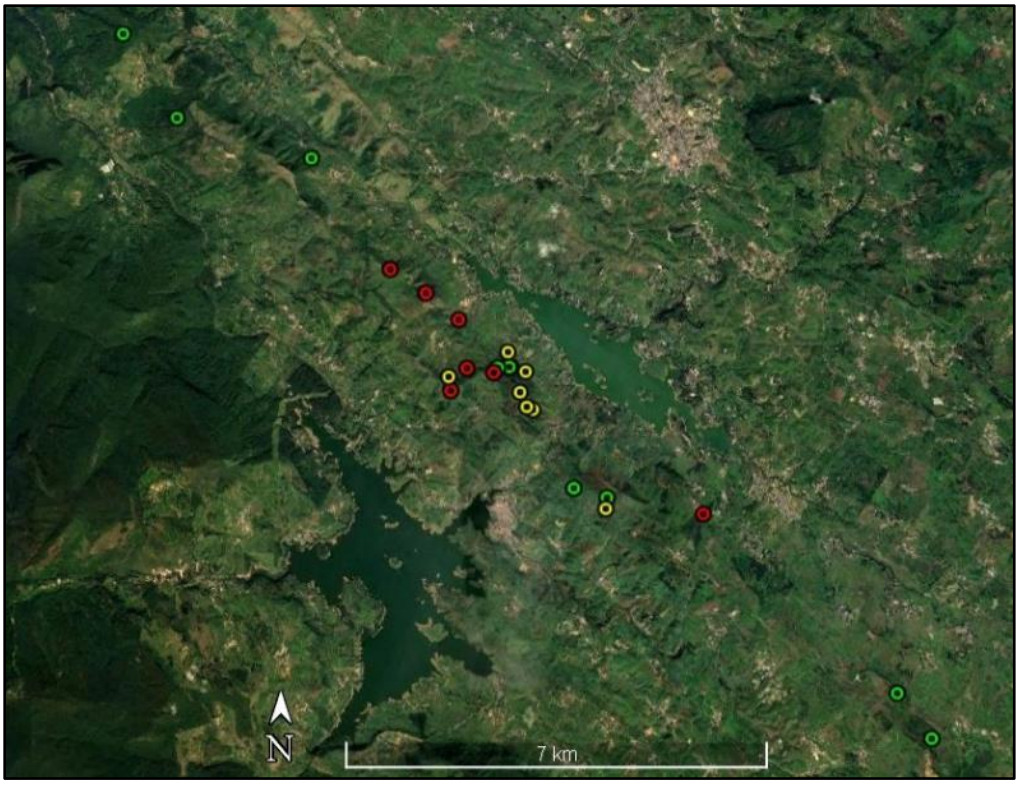


Fig. 1: Peak Ridge Corridor area from above showing remote camera locations. Green circles represent locations that were initiated in 2019 (although 3 of these were originally used during WWCT's population density survey of 2016). Red circles indicate older locations still in use and yellow circles show old locations no longer in use.

Table 1: Relative abundance index (RAI) of leopards in the Peak Ridge Corridor study area from 2016 – 2019. Remote camera monitoring has increased annually. The decrease in RAI from 2017 to 2018 and 2019 is from 2 main causes: 1) WWCT has been expanding coverage in an effort to determine leopard daytime activity given that this population is highly nocturnal and not observed on regular routes in the daytime, and has placed several cameras in less accessible locations accessed by game trails which typically have a lower probability of leopard activity, and 2) we have lost ~10 cameras to vandalism, including 3 of our best locations, which have been vandalized on >1 occasion forcing us to discontinue these productive sites.

	2016	**2017**	**2018**	**2019**
Leopard photos	9	186	126	222
Remote camera days	116	1627	1955	2882
RAI (leopards/100 days)	7.76	11.43	6.45	7.70

Of the males, 2 – Arnold and Ozzie (Fig. 2) – have been frequently detected throughout the study's duration, Arnold on 116 occasions from October 2016 to present and Ozzie on 84 occasions from December 2016 to present. These two males occupied neighboring ranges with some overlap (Fig. 3) but in 2019 another male, Whitley, appears to have established himself in the area between Arnold and Ozzie where he has been detected on 22 occasions between January and December 2019 (Fig. 4). This strategy, of trying to get established in an area of overlap between two existing residents, seems to be typical of male leopards in Sri Lanka as we previously observed this in Yala National Park in the southeast of the country. Areas of overlap suggest parts of the landscape little used

by either resident male (i.e. outside their “core” areas) and are therefore probably sensible places into which new males can attempt to settle. Odin, on the far west of the ridge, appears to be resident there although camera surveys in this area have been curtailed due to Forest Department logging activities.

Fig. 2: Arnold (left) and Ozzie (right), the two adult males that have been residing in the Peak Ridge Corridor study area since project inception.

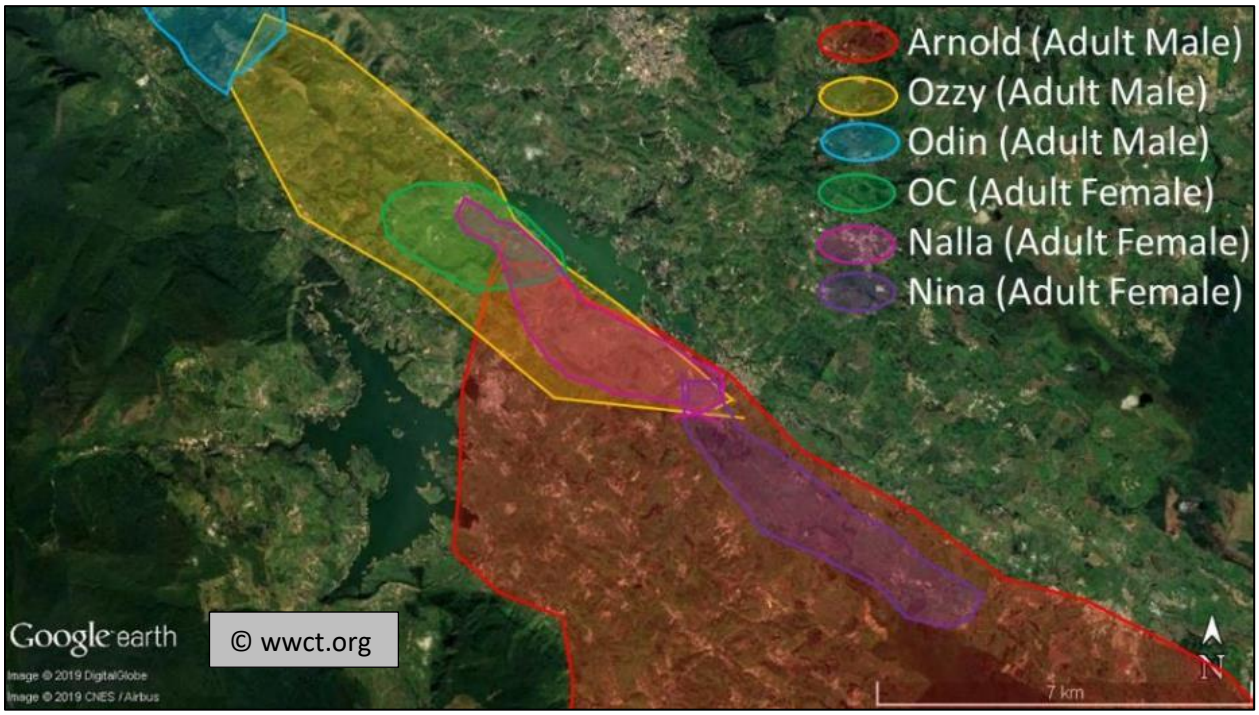


Fig. 3: Approximate ranges of some resident leopards on the Peak Ridge Corridor. Female ranges are typically considerably smaller than male ranges, as suggested above. The area of overlap between Arnold (red) and Ozzy (yellow) is where the new male, Whitley, appears to be settling (see Fig. 4).

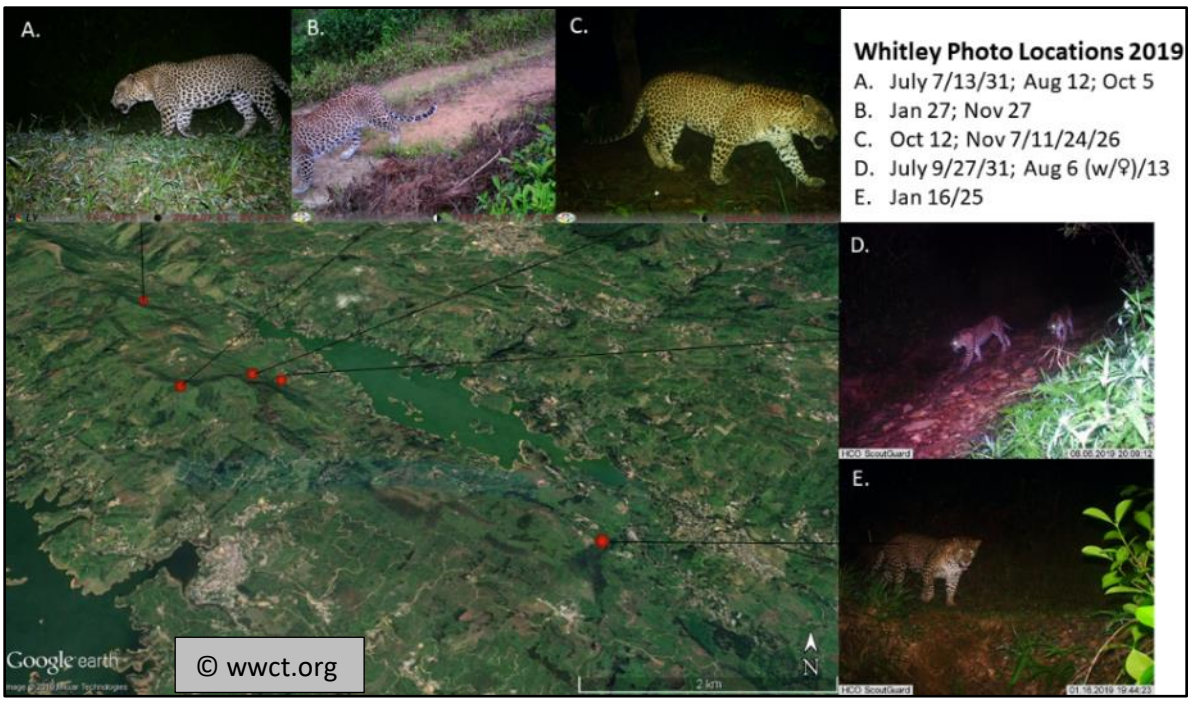


Fig. 4: Locations where new adult male Whitley has been detected in 2019. The first detection was on the eastern portion of the Peak Ridge corridor (E) but has subsequently been observed in the central ridge area where it appears he is trying to settle. He has been observed with the area's resident adult female on multiple occasions (D).

Other males have been seen less frequently and sometimes only once, suggesting transience. An interesting case is Norbert, who first appeared in Arnold's range in October 2016 as a young adult (Fig. 5) before disappearing from the study area in May 2017. Twenty-eight months later, in September 2019, he was back (Fig. 5), again within Arnold's range, before again abruptly disappearing.

Fig. 5: Adult male Norbert first appeared on the Peak Ridge in October 2016 (left) in an area occupied by another adult male, Arnold. He was seen a few times before leaving the study area in May 2017. Over 2 years later he showed up again (right), again in part of Arnold's range. Monitoring is ongoing.

There appears to be higher turnover of adult females in this landscape with only one individual, OC, having been present since the inception of monitoring (142 occasions between January 2017 and December 2019). During this period she has littered on 4 occasions with at least one cub from 2016 (Oliver) and one from 2018 (Oswald) surviving to approximate maturity (Fig. 6). One of OC's 2017 cubs died young while the other has not been definitively photo re-captured since it was ~ 6 months. The 2019 cubs have not been photographed yet, but their presence is inferred from the condition of OC who is clearly nursing. This monitoring is allowing fresh insights into residency time as well as reproduction for leopards in an unprotected, heavily impacted habitat and suggests that these animals are well adapted for this difficult landscape.

Fig. 6: Adult female OC has littered 4 sets of cubs in the past 4 years. At the initiation of the study in 2016 she had an existing male cub (top left – OC on the left and Oliver on the right). In June – July of 2017 she had another set of cubs, of which one died early and the other was not detected again after ~8 months of age (top right). In 2018 she again had a litter (bottom left) of which one male cub is definitely still in the study area. Just recently, in the end of 2019 she was again observed to be nursing, indicating the presence of young cubs (bottom right). With luck we will be able to photo-capture the new cubs in 2020.

Other wild Cat monitoring

We have also been monitoring the Sri Lankan small cats in the region with 12 new fishing cat records in 2019 which is 4x more than we previously had from this ridge area! Eight of the new records come from a single location which was initiated in 2019 (Fig. 7). Rusty-spotted cat observations have also increased with the additional locations, from 10 in 2016, 38 in 2017, 38 in 2018, up to 61 in 2019 (Fig. 7).

Fig. 7: Fishing cat detected at one of the new 2019 remote cameras (left) and rusty spotted cat in a high elevation grassland area.

Habitat Restoration

A key component of WWCTs efforts to maintain and protect the Peak Ridge Corridor, is re-planting areas of released tea and degraded existing forest in order to improve habitat quality and encourage a more effective buffer zone. On this front we were busy in 2019, initially identifying potential areas for re-planting, starting with lands within the Dunkeld Estate, where we are based (Fig. 8). In consultation with the Estate Manager, there may be some alterations to these locations but the first two old tea blocks suitable for the initial planting have been identified. The goal is to re-plant with native forest species interspersed with some viable fuelwood species for community use.

Fig. 8: An image from above of the Peak Ridge Corridor (thick, black lines) and the areas initially identified for re-planting with native forest species and some fuelwood species (red). The Dunkeld Conservation Station is shown as a red star.

This plan was finalized after WWCT conducted extensive interview surveys (N = 64) focused on community forest utilization, with both the Upper (Brookfield) division and Lower division communities on Dunkeld Estate (Fig. 9).

Fig. 9: WWCT team member Sriram Damodaran (right) conducting an interview for the fuelwood survey with a member of the Dunkeld Estate community.

Some interesting insights emerged from these surveys which have been instrumental in formulating the planned re-planting phase. For example, we estimated that Dunkeld Estate, which consists of 275 family units (1209 people) requires 874,348 kg of fuelwood/year for the community, based on a per capita amount of 723.2 kg/person. This is approximately equivalent to 96 mature hardwood trees! Of course only a small portion of fuelwood used is from actual cut trees (as tree felling is not legal) with most in the form of branches, shrubs, twigs and pruned tea bushes (Fig. 10).

Overall, 73% of fuelwood used on Dunkeld comes from the Peak Ridge Corridor with the balance 27% originating from cleared and/or pruned tea fields. The main factors that underlie variation in use amongst families was family size (Fig. 11) and whether or not they used LPG gas to supplement fuel use, with families using gas averaging 1.7kg of per capita fuelwood use/day and those without gas, 2.6 kg/day.

Fig. 10: Fuelwood use on Dunkeld Estate, with saplings/branches harvested from the Peak Ridge Corridor (top left); split sticks stored for home use (top right); tea bush cuttings being transported home for use (bottom right); and a released tea field being harvested for sticks and twigs (bottom left).

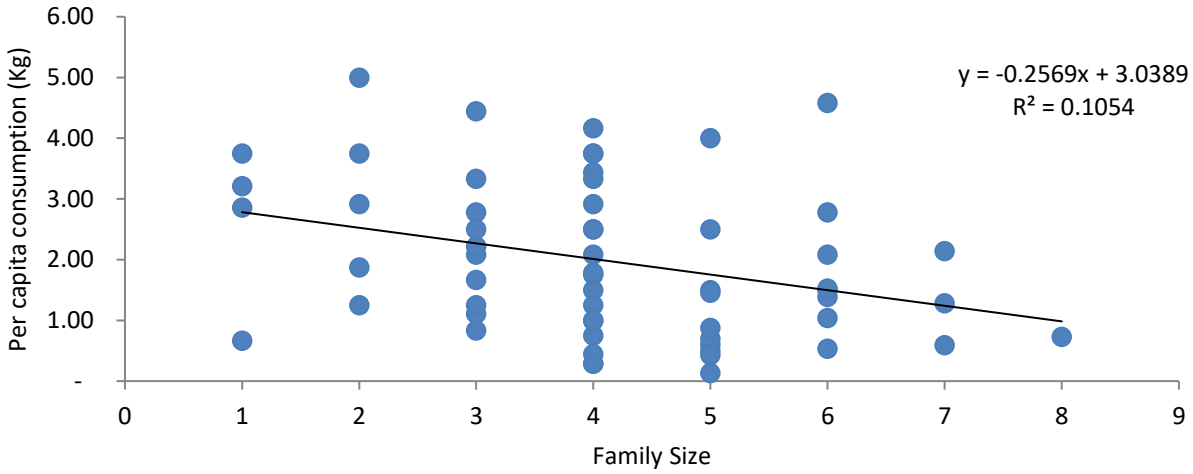


Fig. 11: Relationship between family size and per capita fuelwood consumption showing that larger families require less fuelwood per individual.

We also saw some differences between the Upper and Lower divisions (Table 2), with the more isolated Upper division (Fig. 12) more reliant on forest fuelwood for cooking whereas the Lower division, which is farther from the ridge forests, makes far greater use of gas for cooking, although complaints of the expense of this fuel source and the difficulty of re-filling empty cylinders was mooted. Due to almost complete reliance of fuelwood, Upper division community members burned through stocks more quickly as well. Despite this strong apparent need, community members generally do not show concern about the loss of forest area and thus far do not struggle to gather the fuelwood required.

Table 2: Differences between Upper (Brookfield) and Lower division communities on Dunkeld Estate, with regards to fuelwood utilization.

	Upper (Brookfield) Division (N = 32)	Lower Division (N = 32)
Collecting from Peak Ridge Corridor	68.8%	68.8%
Collecting >3 x/week	28.1%	15.6%
Collecting >15 kg/trip	56.3%	65.6%
Collecting wood/shrubs (plus tea stems/twigs)	75.0%	68.8%
Also using gas	56.3%	93.8%
Use fuelwood for ALL cooking	53.1%	34.4%
Use 1 bundle (14 kg) in < 2 days	43.8%	18.8%
Use 1 bundle (14 kg) for < 5 days	15.7%	25.0%
Perceive fuelwood availability ↑	25.0%	93.8%
Perceive fuelwood availability ↓	37.5%	3.1%
Worried about future availability	9.4%	0.0%

Fig. 12: Dunkeld Upper (Brookfield) division community (foreground) with the Peak Ridge Corridor in the back.

A major challenge is sourcing appropriate forest species as the Sri Lanka Forest Department (FD) stocks only timber species. As such we have recruited interested and knowledgeable individuals from the local community to bring seeds from the nearby

forested slopes to attempt to propagate within the first of our planned nurseries (Fig. 13). Early signs are encouraging for several species, although some of the forest species have proven challenging.

Fig. 13: WWCT's Dunkeld Estate forest tree nursery beside the Dunkeld Conservation Station.

B. Gal Oya National Park

The end of 2019 marked 2 years since we first set remote cameras inside Gal Oya National Park in Sri Lanka's south-eastern interior. By the end of the year we had employed a total of 21 remote camera locations in three distinct sections of the National Park: Mullegama, Namal Oya and Nilgala (Fig. 14). Mullegama is classic lowland monsoonal dry zone forest, interspersed with pockets of savanna unique to this part of the island. This area is off-limits to Park visitors, utilized only by Department of Wildlife Conservation (DWC) rangers for patrolling. Cameras here were set along an old, abandoned jeep track running north-south to an extended arm of the Senanayake Samudra reservoir. Namal Oya is the edge of the NP with some cameras set in the Sanctuary to the north of Gal Oya NP. This area is heavily utilized by cattle herders with villagers allowed to enter for the collection of forest products, fishing etc. In 2019 we expanded into the Namal Oya interior, south-west towards the Senanayake Samudra reservoir. Here, cameras were set along an ~8 km walking trail which required armed DWC ranger accompaniment due to the potential of encountering elephants while on foot. In August 2019, we shifted cameras from Mullegama and Namal Oya and moved them

to the south-western section of the National Park at Nilgala. This area is one of only two sections allowing tourist visitation with the jeep track running west-east towards the Gal Oya river and eventually the Senanayake Samudra reservoir.

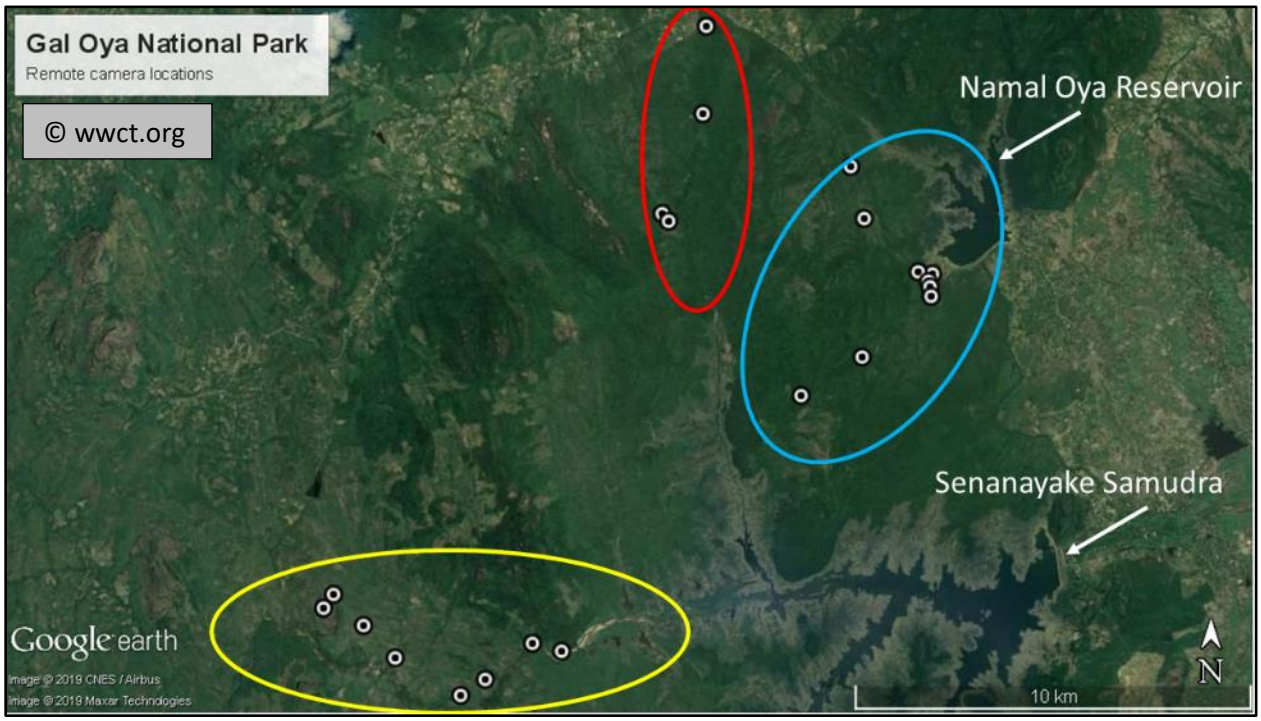


Fig. 14: Remote camera locations in and around Gal Oya National Park. The Red ellipse shows the Mullegama area of dense, lowland, dry zone monsoonal forest; the Blue ellipse shows the Namal Oya area which includes both heavily grazed, open terrain around the Namal Oya reservoir, and tropical dry zone monsoonal forest as one moves southwest towards the Senanayake Samudra ("Sea of Senanayake"); the Yellow ellipse shows the Nilgala area of more open dry zone forest, paralleling the Gal Oya, the river that was dammed to form the massive Senanayake Samudra reservoir.

To the end of 2019 we had conducted 3942 remote camera days and photo-captured 181 leopards (Table 3). We have thus far identified 6 adult males, 7 adult females, 2 sub/young adult males and 4 sub-adult/young females for a total of 19 individuals. The relative abundance index (RAI) for Mullegama and Nilgala are similar (and also quite similar to what we reported above for the Peak Ridge Corridor), whereas the Namal Oya RAI is considerably lower, due mostly to the infrequent leopard activity on the edge of the NP and in the heavily cattle-grazed Namal Oya Sanctuary. Mullegama was the most diverse with 4 adult female leopards, 3 adult males, 2 sub-adult females and 1 sub-adult male (10 total). Nilgala has seen a lot of activity but mostly by the same individuals with 1 adult female, 3 adult males, 2 sub-adult/young females and 1 sub-adult male (7 total). Namal Oya had 2 adult females and 1 adult male (3 total). One of the adult males (M2) was detected at both Mullegama and Namal Oya cameras (Fig. 15). The relative lack of adult females detected so far at Nilgala is puzzling given that females typically have smaller ranges than males and therefore cameras set in a linear pattern such as this are more likely to detect multiple females and fewer males. Monitoring is ongoing.

Table 3: Number of leopards, remote camera days and relative abundance index (RAI = leopards/100 camera days) for the 3 areas of Gal Oya NP surveyed so far.

	Mullegama	Namal Oya	Nilgala	Total
Leopard photos	92	23	67	181
Remote camera days	1315	1803	824	3942
RAI (leopards/100 camera days)	7.0	1.3	8.0	4.6

Fig. 15: Adult male M2 in the Namal Oya region in July 2019 (left) and in Mullegama area in September 2019 (right). The distance between these remote camera locations is ~8 kms.

Again, WWCT's interest extends beyond leopards and we have been monitoring Sri Lanka's other wild cats in Gal Oya NP. In 2019 all of the island's 3 small cats were photo-captured inside the PA (Fig. 16) although infrequently (Table 4). The 2019 Rusty-spotted cat images were the first of this diminutive predator within the NP as we had not managed to get a photo-capture in either Mullegama or Namal Oya (Table 4). We have also photo-documented 42 sloth bear images within the PA with a RAI of 1.7, a positive sign given that this species prefers undisturbed forest (Fig. 17).

Fig. 16: From left to right, Fishing cat at Mullegama, Jungle cat at Nilgala, and Rusty-spotted cat at Nilgala.

Table 4: Relative abundance index (RAI = Number of photo-captures / 100 camera days) for the three Sri Lankan small cats in the Mullegama, Namal Oya and Nilgala sections of Gal Oya NP.

	Mullegama	Namal Oya	Nilgala
Fishing Cat	0.23	0.11	0.00
Jungle Cat	0.08	0.00	0.11
Rusty-spotted Cat	0.00	0.00	0.57

Fig. 17: Sloth bears photo-captured in the Mullegama area of Gal Oya NP.

C. Patch Forest Project

Sigiriya

Monitoring continued at the *Back of Beyond* Dehigahaela and Pidurangala patch forest properties in Sigiriya with a total of 1362 and 1280 remote camera days respectively since 2017. One adult female leopard at Dehigahaela, “Daria”, was photo-captured multiple times in 2019 after we altered our approach and kept one camera permanently stationed along one of her travel routes (Fig. 18). In order to monitor all habitats within the property, we continued to regularly shift the other cameras. Between the two properties, which is ~8 km apart, we have now identified 5 leopards with two other photo-captures of unknown individuals from a total of 25 occasions. This includes one male (“Pilar”) who has been seen on both properties in 2019 (Fig. 19). RAI here is 0.95 in Dehigahaela and 0.94 in Pidurangala, both remarkably similar but also considerably lower than what is observed in both the Peak Ridge Corridor study area and Gal Oya NP.

Fig. 18: Adult female leopard Daria, at *Back of Beyond* Dehigaha ela property in February, April and October of 2019.

Fig. 19: Adult male Pilar at Pidurangala in January and Dehigaha ela in October of 2019.

As usual, Sri Lanka's small cats are also monitored here with 2019 seeing a sharp increase in Rusty-spotted cat and Fishing cat observations in Dehigaha ela, most likely due to the change in approach of remote camera placement (Table 5).

Table 5: Number of photo-captures of Sri Lanka's 3 small cats at Back of Beyond's Dehigahaela and Pidurangala properties in Sigiriya from 2017-19. Relative abundance index (RAI = photo-capture / 100 camera days) is shown in brackets.

	Dehi 2017	**Dehi 2018**	**Dehi 2019**	**Piduru 2017**	**Piduru 2018**	**Piduru 2019**
Fishing Cat	*1 (0.27)*	0 (0.00)	*6 (0.86)*	*1 (0.78)*	0 (0.00)	0 (0.00)
Jungle Cat	0 (0.00)	*1 (0.34)*	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Rusty-spotted Cat	*1 (0.27)*	*1 (0.34)*	*9 (1.29)*	0 (0.00)	*1 (0.19)*	0 (0.00)

With the additional remote camera days the number of total mammal species detected has increased over time with diversity at Pidurangala increasing from 11 species at the end of 2017 to 23 at the end of 2019, underlying the value of long-term monitoring (Table 6, Fig. 20).

Table 6: List of all mammal species detected at the Dehigahaela and Pidurangala properties from 2017 – 2019.

Family	**Common Name**	**Scientific name**	**Dehigahaela**	**Pidurangala**
Cervidae	Axis deer	*Axis axis*	x	x
	Barking deer	*Muntiacus muntjak*	*x*	x
	Sambar	*Rusa unicolor*		x
Bovidae	Buffalo	*Bubalus bubalus*	x	
Canidae	Golden jackal	*Cani aureus*	*x*	x
	Dog	*Canis familiaris*	x	x
Cercopithecidae	Toque macaque	*Macaca sinica*	x	x

	Grey langur	*Semnopithecus priam*	x	x
Elephantidae	Elephant	*Elephas maximus*	x	x
Felidae	Jungle cat	*Felis chaus*	x	
	Leopard	*Panthera pardus*	x	x
	Rusty-spotted cat	*Prionailurus rubiginosus*	x	x
	Fishing cat	*Prionailurus viverrinus*	x	x
Herpestidae	Grey mongoose	*Herpestes edwardsii*	x	x
	Brown mongoose	*Herpestes fuscus*	x	x
	Ruddy mongoose	*Herpestes smithii*	x	x
Hystricidae	Porcupine	*Hystrix indica*	x	x
Lepus	Black-naped hare	*Lepus nigricollis*	x	x
Manidae	Pangolin	*Manis crassicaudata*	x	x
Mustelidae	Eurasian otter	*Lutra lutra*	x	
Scuridae	Common palm squirrel	*Funambulus palmarum*	x	x
	Giant squirrel	*Ratufa macroura*	x	
	Rat	*Rattus sp.*	x	x
	Indian gerbil	*Tatera indica*	x	
Sus	Wild boar	*Sus scrofa*	x	x
Tragulidae	Mouse deer	*Moschiola meminna*	x	x
Viverridae	Palm civet	*Paradoxurus hermaphroditus*	x	
	Golden palm civet	*Paradoxurus zeylonensis*	x	x
	Ring-tailed civet	*Viverricula indica*	x	x
	Total		**28**	**23**

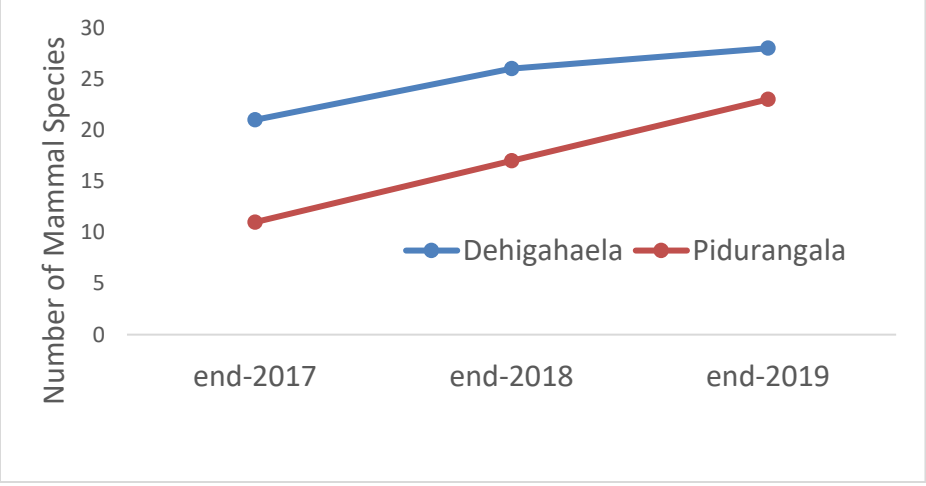


Fig. 20: The increase in mammalian biodiversity detected through time at the Dehigahaela and Pidurangala patch forest locations in Sigiriya.

Gal Oya

Although WWCT has shifted emphasis from the patch forest at Gal Oya Lodge (after a full year of biodiversity monitoring including bird, butterfly, reptile and amphibian monitoring) to the Gal Oya NP (see above), a number of remote cameras remain on the

Lodge property to track mammalian wildlife, with a focus on the small cats. This is being coordinated now by the Gal Oya Lodge naturalists. Due to problems with the ageing cameras there was limited data in 2019 although fishing cats were not infrequently captured (Fig. 21). Continued monitoring will be conducted.

Fig. 21: A Fishing cat photo-captured on the Gal Oya Lodge property in August 2019.

Biodiversity studies

Mammals are not the only Class of interest and although bird, butterfly, reptile and amphibian surveys were not conducted in 2019, we continue to monitor opportunistic sightings to add to the biodiversity database for patch forest locations (Figs. 22 and 23). We have been encouraged to note that the globally endangered Indian pangolin (*Manis crassicaudata),* a member of the Family *Manidae* which is the most trafficked wildlife species on the planet, has been detected in all of our current study areas – the Peak Ridge Corridor (Fig. 24), Gal Oya NP and Lodge patch forest, Sigiriya's patch forest locations, and Yala buffer. Perhaps less encouraging is the repeated sightings in 2019 of peafowl in the Peak Ridge Corridor region, an area outside of the currently understood range of the species (Fig. 24). This might be an indication of how climate change is altering species ranges globally.

Fig 22: Left: An Orange-headed Thrush (*Zoothera citrina*), which is a rare winter visitor to Sri Lanka, photographed at Pidurangala, Sigiriya in December. Centre: An Endangered Scaly Thrush (*Zoothera dauma imbricate*) photographed on the Peak Ridge Corridor at Dunkeld Estate. Right: A Ruddy-breasted Crake (*Porzana fusca*), a rare resident and winter visitor, on Osborne Estate on the lower slopes of the Peak Ridge Corridor

Fig. 23: Left: Dumeril's kukri snake (*Oligodon sublineatus*) was found at the Dunkeld Conservation Station (DCS; ~1100m asl) which is near the maximum elevation for this endemic reptile. Right: Upendra's day gecko (*Cnemaspis upendrai*) is another endemic reptile found at DCS.

Fig. 24: A peacock (*Pavo cristatus*; left) and Endangered pangolin (*Manis crassicaudata*; right) photo-captured at 1520m asl. Peafowl are known as lowland dry zone species and their presence in the Central Highlands is unusual. Pangolins were long thought to range in all habitats below ~1400m, but more recent data has extended their elevational range to ~1850 masl, which is supported by this higher elevation observation.

D. Human-leopard Co-existence

i. Central Highlands

Although the DWC recorded 49 "incidents" between humans and leopards in the Central Highlands in 2019, the vast majority of these (73.5%) were minor events (Fig. 25). Of the 5 leopards reported killed, 80% were due to snaring with the other death from poisoning. One animal was successfully released from a snare. One 'attack' on people was recorded. Of these incidents, two were within the Peak Ridge Corridor study area – once with a leopard "frequently visiting a village" and one report of "preying on domestic species". The domestic species more impacted by leopards in this region are dogs which are typically not owned by any individual but more community dogs that live in and amongst estate workers. Scat analysis from the region shows that domestic dogs (and cats) comprise ~15% of leopard diet (a little less when converted to biomass; Fig. 26). Despite this relatively low proportion, there is some evidence to suggest that leopards do preferentially prey on these domestic species, especially when young cubs are present as dogs are a source of mobile prey for leopards. This maybe reinforced by the fact that leopards and domestic dogs rarely overlap temporally in this landscape (Fig. 27).

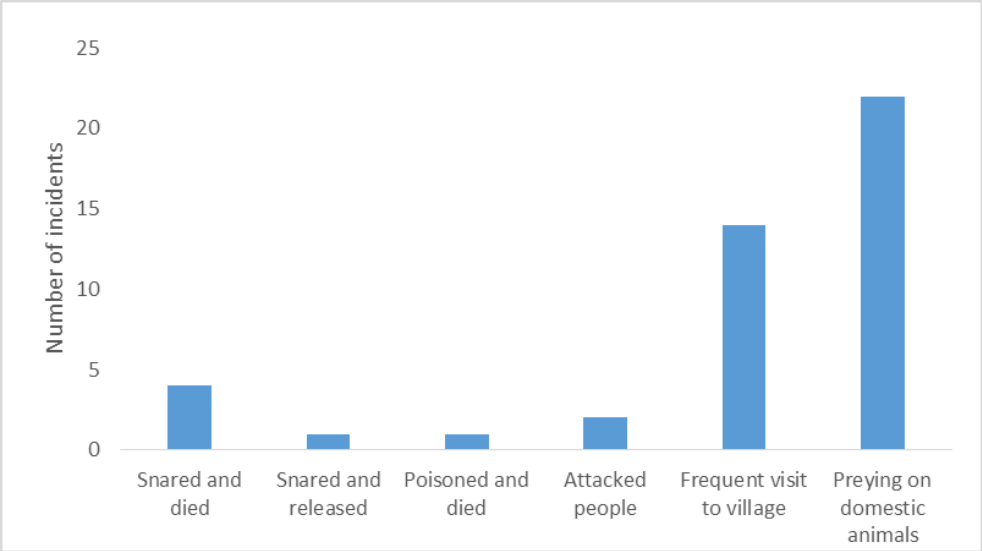


Fig. 25: Human-leopard interactions in the Central Highlands reported to the Department of Wildlife Conservation (DWC) / WWCT in 2019. In total 5 leopards were reported killed by human activity, 4 caught in snares and 1 poisoned.

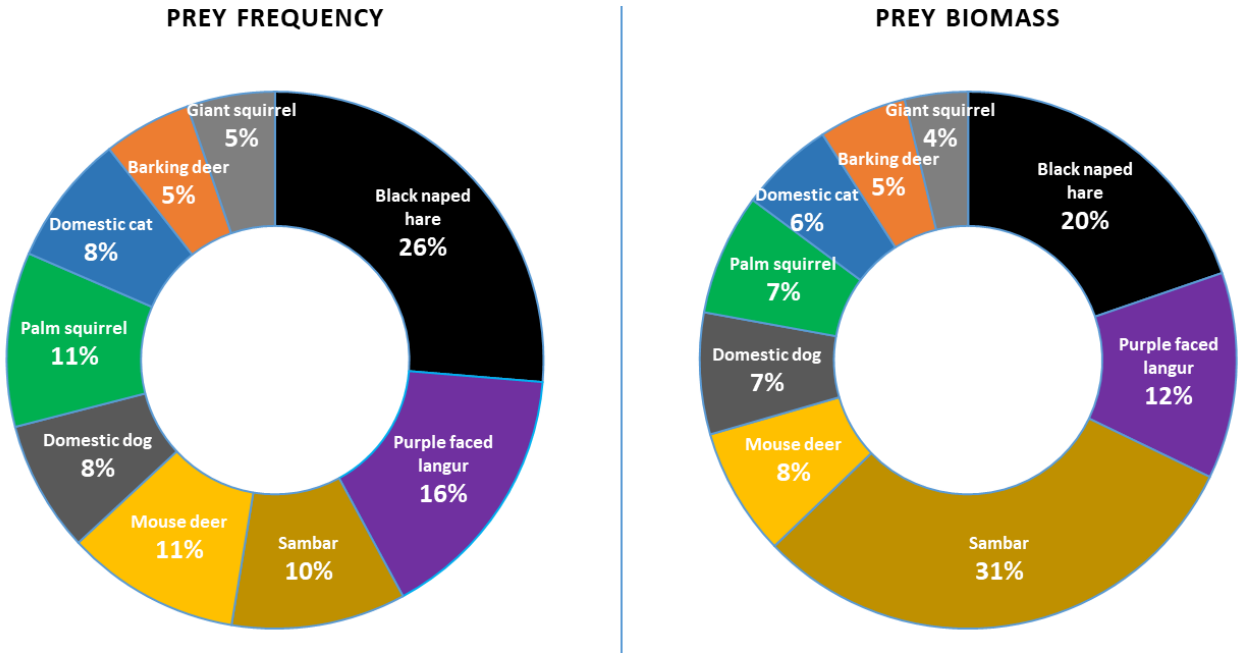


Fig. 26: Left: The frequency with which various prey species appear in leopard scat in the Peak Ridge Corridor study area (n = 13). Right: The proportion of overall prey biomass that each species contributes. Although sambar deer are consumed less frequently than some other species (i.e. black-napped hare, purple-faced langur etc.), they form the bulk of leopard diet here.

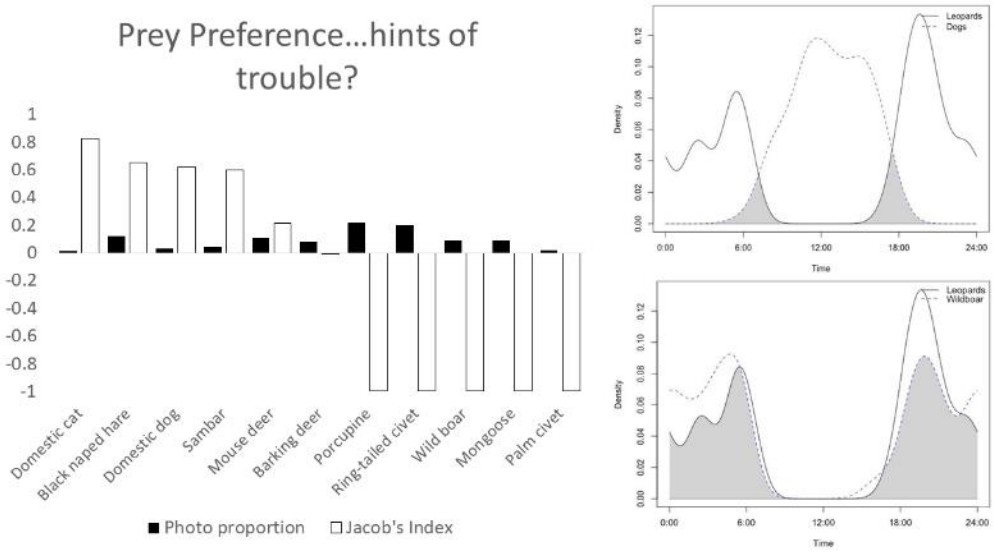


Fig. 27: Although not figuring highly in overall leopard diet, both domestic dogs and cats appear to be favoured by leopards (as are black-napped hare and sambar) based on Jacob's selection index which measures the frequency with which a species is found in leopard scat against its availability. This is despite there being relatively little temporal overlap between domestic dogs and leopards in the Peak Ridge Corridor study area (top right graph). In contrast, wild boar overlaps almost completely with leopards in this region (bottom right graph), but are not selected for and are in fact avoided (main graph).

WWCT had an MSc. student working in two of our study areas -Yala National Park southern buffer area and Peak Ridge Corridor in 2018 and 2019. The focus of work was on understanding the influence of the growing dairy industry on leopards. In the Peak Ridge Corridor it was found that leopards are essentially never a problem for livestock rearing because families keep only 1 or 2 cows which are maintained in closed pens and provisioned with fodder by their owners (Fig. 28). Needless to say this lack of conflict in this sector helps foster human-leopard co-existence here as people are less resentful of leopards since they are not impacting livelihoods. The biggest issues that were faced by cattle owners in this area were logistical: difficulty in getting milk to market and accessing veterinary services, and lack of land ownership (the estate holds the land) and therefore are limited in their ability to construct new sheds.

ii. Yala buffer zone

In the southern buffer zone of Yala National Park, the story is quite different with 93% of respondents (N = 61) reporting some level of livestock depredation. The pastoral system is very different in this area with large herds of cattle (avg. herd size = 87) grazing freely (Fig. 28) in the buffer which is separated from the National Park by an electric fence, which is effective for blocking elephant movements but not those of most other species. Here livestock predation is considered a significant problem with general attitudes towards leopards fairly negative. Interestingly, the more respondents seemed to be aware of general leopard ecology/behaviour and the regional financial impact of tourism from leopard-centric safaris, the more negative their attitudes towards leopards. This may be

linked to a resentment that tourism revenue is by-passing this community as they gain no direct benefits from it. It is also worth noting that the proportion of cattle loss reported by pastoralist here was mainly from theft (~30%), cattle wandering off (~21%), disease (~14%) and then leopard predation (~11 %). The main factors influencing leopard depredation in this landscape was the size of the cattle herd with larger herds suffering greater levels of predation, and the quality of the cattle pen. Steel enclosures, which have been donated to certain pastoralists by a local luxury hotel chain, have proven very successful in reducing predation incidents. However these enclosures are very expensive so pastoralists cannot construct them on their own and furthermore, often dismantle the enclosures in order to expand them and encircle more cattle. This dismantling often results in less secure pens (i.e. pens without roofs; pens with steel on 3 sides and wire on the fourth side etc.) and higher incidences of predation. Another longer term issue with the provisioning of pens is that most herders that benefit invest their increased revenue or additional savings into procuring more cattle which acts to exacerbate the original problem. These results are interesting and provide some useful quantitative information on which to base possible future interventions to improve co-existence here.

Fig. 28: Left: Cattle shed in the Peak Ridge Corridor area. Cattle are rarely released from these sturdy enclosures which essentially eliminates livestock predation by leopards (although this clearly fuels animal welfare questions). Right: Freely grazing livestock in the southern buffer zone of Yala National Park.

To further understand the dynamics between cattle herders and leopards in this complex, fragile system, WWCT has set up remote cameras in the buffer area including on border hotel properties and the neighboring Nimalawa sanctuary. The cameras were only set up in December so there is currently not enough data to analyze but 2020 should provide some useful additional insights.

II. Education and Awareness

A. Events

One of the most vivid events of the WWCT year in the Peak Ridge Corridor study area, was the painting of the Dunkeld school wall by Colombo-based artist Geshani Boulder in August (Fig. 29). With the eager participation of the school kids, the entire front wall of the main school building was painted with a vibrant hill country forest scene complete with

the relevant animals, including the leopard. This has the dual effect of beautifying the school and highlighting and normalizing the wilderness and wildlife that inhabit the ridge that looms above.

From the high level of interest apparent amongst school children at the Dunkeld school during the wall painting project, we decided it was time to launch a new initiative, the **Forest Guardians** programme. Together with the school authorities and with permission of parents, we have recruited 20 children from the school (grades 6 to 11) to be Forest Guardians. What this means is that they will take part in the Peak Ridge Corridor conservation initiative by creating and maintaining the new butterfly garden (Fig. 30) and Forest Plant Nursery, cleaning various parts of the Estate of plastic waste, taking part in programs aimed at teaching ecology and conservation theory and methods, and potentially be responsible for overseeing some of the permanent remote camera stations on the Dunkeld Estate. They will also be involved in the re-planting and monitoring of trees from the plant nursery to the selected ridge locations.

Fig. 29: The main wall of the Dunkeld Estate school was painted by Colombo-based mural artist Gehsani Balder, ably and eagerly assisted by the school kids themselves. Typical wildlife from the area including sambar, leopard, hares, jungle fowl and butterflies were included.

Fig. 30: The new butterfly garden situated beside the forest plant nursery (left) at the Dunkeld Conservation Station. Close-up of some of the newly planted butterfly host plants (right).

During the time of the wall mural painting at the Dunkeld school, supporting organizations to the project, Alliance Finance PLC and Dilmah Conservation also visited the location. Media coverage via a New Zealand breakfast television programs tea story was also realized (Fig. 31).

Fig. 31: Alliance Finance PLC's Managing Director Mr. Romani De Silva and Mrs. De Silva together with artist Geshani Balder and WWCT's Anjali Watson and Dr. Andrew Kittle in front of the completed wall mural. Some images from the Peak Ridge Corridor project being shown to Mr. Merrill J. Fernando, Chairman of Dilmah Tea (centre) and New Zealand television host (left, with garland).

B. Presentations/Training Sessions

Overview

As always WWCT continues to conduct a variety of awareness programmes on the ground at our various study site locations, ranging from over dozens of talks and programmes to tea estate communities and border schools in the Central Highlands, public lectures and general talks and invited guest lectures for a variety of audiences. A few examples are elaborated on below:

For the 3rd year in a row WWCT participated in Dilmah tea's international tea marketers' event held at the Dunkeld Estate. Over 100 participants from around the world gathered at the Dunkeld Tea Factory to learn about the tea production and packaging process. As part of their day-long education, they visited the Dunkeld Conservation Station in four groups of ~25 where they watched a short video documenting the Peak Ridge Corridor leopard study and had a question and answer session with WWCT's Dr. Andrew Kittle.

In January WWCT presented at a forum on Corporates in Conservation which was organized by supporting organization Olu Waters/Rockland Conservation where we presented our ongoing Gal Oya work (Fig. 32).

Fig. 32: WWCT's Andrew Kittle and Anjali Watson participate in Olu Waters/Rockland Conservation's "Corporates in Conservation" evening.

In March WWCT were happy to host Dr. Peter Gerngross from Biogeomaps in Austria, Dr. Jennifer Hautlef from Vienna's University of Natural Resources and Life Sciences, and Mr. Jannis Gottling, a veterinarian and vice chief of Neumunster Zoo in Germany. They were visiting Sri Lanka and very interested in learning more about WWCT's work around the island. Jennifer is an expert on the Golden jackal (*Canis aureus*) and was keen to learn about WWCT's many incidental records from our various camera projects island-wide.

In August WWCT introduced to the Chairman of the Sri Lanka Tourist Board, the concept of the proposed Yala Wilderness Conservancy and Leopard Research Station, at a day-long meeting at Wild Coast Lodge in the southern Yala buffer zone. We focused on the benefits of a Conservancy-style approach to land management and how it has worked in many other parts of the world and is why it is appropriate for the Yala buffer region. The presentation was well received and the Tourist Board has subsequently given permission to release some of its land for the construction of the Research Station which is to be hosted by Wild Coast lodge.

A training program to Wild Coast Lodge naturalists with a focus on Sri Lankan leopard ecology, behaviour and land use structure was conducted with a round-table discussion about the status of the species on the island and previous studies we have conducted. This provided valuable context for the Lodge naturalists, some of whom are new to Sri Lanka, and is important for them to be able to effectively transfer accurate information to Lodge guests and Park visitors.

A summary presentation to the Gal Oya Lodge naturalists was held to update them on the ongoing leopard study within Gal Oya NP. This presentation necessarily included some fundamental aspects of leopard ecology and behaviour as not all current naturalists were on site during WWCT's earlier training presentations.

In September WWCT presented 3 talks at the Association of Tropical Biology and Conservation's Asia-Pacific Conference, held at Thulhiriya in Sri Lanka. Anjali Watson gave a talk at the informal lunch series entitled "Assessing Human Leopard Interactions across Sri Lanka and targeted solutions" and Dr. Andrew Kittle presented some of the results from the Peak Ridge Forest Corridor leopard study – entitled "Unravelling the complexities of human-leopard co-existence in unprotected landscapes" - in one of the scientific sessions. They both presented another session entitled "Partnerships for Conservation: A way forward with the Sri Lankan leopard" which focused on how conservation and research-based organisations can link up with private sector organizations in a synergistic manner.

In October CNN filmed Anjali Watson for a short but influential program featured in their Call to Earth series, which focused on the Peak Ridge Forest Corridor establishment project (Fig.33).

Fig. 33: WWCT's Anjali Watson being interviewed for CNN Internationals Call to Earth series at the Dunkeld Conservation Station

B. Awareness Materials

In an effort to raise awareness on the distribution of the leopard in Sri Lanka, WWCT designed and released a series of 10 leopard stickers showcasing individually known animals from 5 different study areas island-wide (Fig. 34). The locations were the Peak Ridge Corridor (southern Central Highlands; sub-montane wet zone; unprotected), Gal Oya NP (south-eastern region; dry to intermediate zone and savanna; protected), Wilpattu NP (north-western coastal; arid to dry zone; protected), and two sites at Sigirya – Dehigahaela and Pidurangala (north-central region; dry zone; unprotected/private).
One of the goals of this initiative is to expose people to the fact that leopards are extant in areas other than Yala NP and Wilpattu NP and are also found outside protected areas (Fig. 35).

Fig. 34: Close-up of one of the 10 leopard stickers designed and printed by WWCT for awareness programs (left) and the other 9 depicting leopards from 5 different study areas across Sri Lanka.


Fig. 35: Dunkeld Estate schoolboys with their leopard stickers. Also pictured Geshani Balder, the mural artist, Anjali Watson, WWCT PI and her daughters.

C. Staff/Students/Interns

In December one of our earlier Research Assistants, Emad Sangani, returned to WWCT to undertake an internship for the final year of his undergraduate degree in Ecology at the University of Adelaide in Australia. Emad was put in charge of remote camera set up and monitoring in the southern buffer zone of Yala National Park, regularly checking the cameras and liaising with the Wild Coast Lodge naturalists with whom we are undertaking part of the project.

From July to December we had Sriram Damodaran join the WWCT team. He designed and conducted the fuelwood use interview surveys of the Dunkeld Estate communities and participated in remote camera monitoring and training of the Forest Guardians.

Geshani Boulder, a talented mural artist from Colombo, donated her time to paint - with the eager participation of numerous schoolchildren – the Dunkeld school Peak Ridge forest wall mural. So energized was Geshani by the project that she has subsequently shown a strong interest in leopard conservation and has even conducted a follow-up awareness campaign with WWCT on social media which included the auction of her leopard painting.

MSc. student Aisha Uduman returned to Sri Lanka in June 2019 to conduct her 2nd field season in the southern buffer zone of Yala National Park. Aisha set more remote cameras targeting the potential leopard prey base as this was one of her key variables in her efforts to understand the complexities of human-leopard interactions in the region.

Krishna Kumar continued to be the on-ground manager of the Dunkeld Conservation Station in 2019, maintaining and updating the ever-expanding database, talking to visitors about the project and helping to co-ordinate all of the estate-based activities (e.g. school wall painting; Forest Guardians).

WWCT hired Dunkeld Estate resident Rajaram as a gardener to oversee the Peak Ridge Corridor forest plant nursery. Rajaram collected seedlings/seeds and propagated them in the new meshed nursery, which he was also responsible for repairing and maintaining.

D. Media

Digital / Television / Radio:
She takes on the World series - Cosmopolitan TV
Call to Earth series feature & Quest means business – CNN International
Cats in Coexistence - Rupavahini National TV Saturday morning show
Living with Wildcats - Sri Lanka Broadcasting Station (SLBC) Coffee with Dan show

Print / Newspapers:
How CITES impacts leopard conservation. Daily Mirror. April 6, 2019.
Secure future for leopards: how CITES impacts leopard conservation. Daily News. April 23, 2019.

E. Publications

Kittle A. M. & Watson A. C. 2018. Small wildcats of Sri Lanka – some recent records. *CatNews* 68:9-12. (Was printed and released in 2019)

Kittle A. M. & Watson A. C. 2019. The spotted king of the Sri Lankan jungle. *Loris* 28(5):31-35 (125th Anniversary Edition)

III: Acknowledgements:

All WWCT work within Sri Lanka is with the permission of the Department of Wildlife Conservation (DWC) and the Forest Department (FD) and we sincerely thank them for continued collaboration.

Funding support has been provided by Whitley Fund for Nature, Oxford University's WildCRU, Alliance Finance PLC, Resplendent Ceylon, Dilmah Conservation, CERZA Conservation, Zoo de la Barben, Olu Waters/Rockland Conservation & Back of Beyond. We thanks these partners without whose support the extent of WWCTs work would not be possible.

Additional Partner: