Spatial ecology of the Scottish wildcat

Interim report

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Introduction

The Scottish wildcat *Felis silvestris grampia* is threatened by introgression with the domestic cat *F. s. catus* and by persecution from gamekeepers (Macdonald et al. 2004). Based on current knowledge, Macdonald *et al.* (2004) calculated that off an estimated 3,500 wild-living cats in Scotland, as few as 400 of these may be pure wildcat, with the remainder consisting of feral domestic cat and cats that are hybrid between domestic cat and wildcat. The wildcat is facing similar threats across its range in mainland Europe (e.g. Nowell & Jackson 1996; Pierpaoli *et al.* 2003). Very little is known about the hybridization process between domestic cat and wildcat. A better understanding of this process will aid conservation of wildcat by targeting efforts to break the link in the causal chain of introgression. If, furthermore, we cannot evict all domestic cat genes from wild-living cats in Scotland (as seems likely, Macdonald *et al.* 2004), we need to establish, on the domestic cat – wildcat spectrum, where a line can be drawn that distinguished domestic cats from functional 'wildcats'. To do this, we need to compare the behavioural ecology of cats from across this spectrum within the same geographical area. The aims of this project are therefore to:

1. To investigate the process of introgression between domestic cat and wildcat.
2. To compare the ranging behaviour of domestic cat, wildcat and their hybrids to identify habitats that are preferential to wildcat over domestic cat.
3. To compare the behavioural ecology of domestic cat, wildcat and their hybrids in order to gain insight into the impact that domestic cats and hybrids have on the ecosystem.
4. To investigate micro-habitat use of wildcat in order to better understand likely impacts of habitat loss and road building and the optimal placement of mitigation strategies to reduce road casualties.

Methods

We are currently working at three sites. These are Gartley moor (Lat/Lon 57.38, -2.73) (along with the neighbouring Clashindarroch forest, 57.37, -2.92) near Huntly in Aberdeenshire (hereafter 'Gartley'), Strathconon near Strathpeffer (57.57, -4.52), Inverness-shire (hereafter 'Conon') and Abernethy, near Nethybridge (57.21, -3.69), also Inverness-shire. Work began in Gartley during August 2013, Abernethy during April 2014, and Conon during May 2014. We additionally attached collars to one cat in the Angus Glens (56.75, -3.27) and one cat in Morvern (56.56, -5.90), both live-captured during an SNH funded wildcat survey between Nov 2013 and April 2014.

Pre –trapping

Camera traps (Reconyx Hyperfire) are used to identify locations used by cats in the survey area. Camera are set out with bait (partridge or quail along with scent lures including Hawbacker's wildcat lure, Valerian tincture (A. Vogel) and, latterly, cat nip (Cat It Design, Hagen)). The Valerian and catnip are sprayed on to roughened wooden posts on which Velcro strips are attached to gain hair samples. Camera times are always set to GMT. If no cats visit the camera within two weeks, the cameras are moved to a new location nearby (<200m distance) unless no alternative locations are available, in which case the cameras are removed and deployed elsewhere at the site. At locations where cats are detected, a cage-trap (approx 30 x 30 x 80 cm) is usually set out, locked open and baited with partridge or quail, valerian and, latterly, cat nip. Hawbacker's wildcat lure is not used in cage traps. On occasion, no pre-bait period is used prior to live-trapping.

Live-trapping

Cage traps are baited as described above, set to trap and checked a minimum of every eight hours during winter. A maximum of 14 traps have been be monitored using this method. During spring-summer, there is a danger that female mammals with dependent young risk loss of offspring if held in the trap for this length of time. Too frequent a checking cycle would however cause increased disturbance and possibly reduced trapping success. Therefore, we monitor traps using multimedia messaging cameras (Acorn LTL-5210), set to send a photo of the trap to the trappers phone at least every four hours. These cameras additionally will send a photo if they detect movement, with the interval between detections set to either 30 or 60 minutes. Four traps are monitored using this method. Since June, we have added cat vocalisation lures to the baiting methods when live-trapping.

GPS collars

GPS collars are constructed from iGotU GT120 or GT600 GPS units, wired to 3.7v Li-Ion batteries (Trustfire, max 4000mAh). The GPS unit is attached to the dorsal surface of the collar and the battery to the ventral surface using heat-shrink plastic. A VHF transponder is also attached to the collar using heat-shrink plastic. Both collar and VHF transponder were built by Skorpa Telemetry. Unit weight is up to 110g, depending on battery size. The collars contains a weak link, a cut in the collar stitched with linen thread, designed to detach after approximately three months. The GPS are programmed with a 10 minute interfix interval.

Cat handling

A trapped cat is transferred to a crush-cage and injected with a combination of ketamine (5mg/kg) and medetomidine (40µg/kg). Time to sedation is general 5-10 minutes and the cat will remain sedated for around a further 30 minutes). Once sedated, the cat is removed from the cage, temperature and heart-rate assessed, eyes are lubricated, measurements take, and a blood sample (max 3ml) extracted from the fore limb. Other samples taken where possible are buccal, ocular and throat swabs and faeces. The collar is attached and the cat is injected with a reversal (atipamezole at the same concentration as medetomidine) before being transferred to the crush cage for recovery. Once recovered (generally 10-20 minutes), the cat is released.

Collars used on domestic house cats consist of an intact GT-120 GPS unit on a fabric collar with a break-open safety catch and a counter weight on the ventral side. Total collar weight ≤70g. Collars are attached to domestic house cats without sedation.

GPS data handling

The IgotU GPS units do not record an estimate of fix accuracy. We therefore use a set of scores to define whether a fix is sufficiently accurate (Campbell et al. In prep). These are:

1. Altitude accuracy: If the fix data provides an altitude value that is >500m different from the map altitude then the fix is removed. Otherwise, if the altitude error was 50-500m, the fix scores 1, if 5-50m it scores 0 and if <5m it scores -1.
2. Mean speed based on the two surrounding fixes: The walking speed of a cat is 0.5 – 1m sec^{-1} while running or trotting begins at greater speeds (Bishop et al. 2008). It is unlikely that a cat could maintain a running pace for a full 10 minutes. If the speed based on straight-line distance is ≥4m sec^{-1}, the fix scores 2, if 0.25 – 4m sec^{-1}, scores 1 and if <0.25 it scores 0.
3. A very sharp angle between successive fix locations may indicate errors in location (particularly associated with fixes that suggest the cat moved some distance away before returning to its previous location by the next fix), whereas a very wide angle suggests that the cat is travelling and therefore the speed (see point 2. above) will tend to be greater. We therefore score fixes with an angle <6˚ 2, 6˚ - 18˚ 1, 18˚ - 100˚ 0 and >100˚ -1.
4. We do not wish to exclude small errors in fix locations that arise when the cat is stationary (resting or sit-and-wait hunting). We therefore score fixes that are ≥40m from the nearest of the previous or following fix locations 0, 10 – 40m -1 and <10m -2.

Any fix whose scores sum to ≥2 is excluded from further analyses. Thus fixes that exhibit a combination of high altitude error, unusually high speed, sharp angle and aren't close to fix locations immediately before or after are more likely to be excluded.

Genetic analyses

Genetic analysis of blood samples from trapped cats is conducted following Littlewood *et al.* (2014, see Appendix 1).

Results & Discussion

Camera trapping

At Gartley cameras have been deployed at 122 locations between Aug 2013 and Apr 2014. These have yielded 15 individually identifiable cats (Fig 1; Appendix 2) as well as an unknown number of similar looking black cats (at least one adult and two kittens along with a tabby kitten), giving a total of ≥19 cats. Forty locations have had cameras deployed in Conon since May 2014, yielding eight cats (Fig 2; Appendix 2) and cameras have been deployed at 34 locations in Abernethy since Apr 2014, yielding two cats (Fig 3; Appendix 2). Pelage scores for cats captured on camera during these three surveys are provided in Appendix 3.

We had some success with the use of scented lures on hair posts, obtaining hair from cats GG (Gartley) using Valerian and CB (Conon) using cat nip. Since blood was later extracted from GG, testing those hairs was unnecessary. Cat CB's hairs have been sent to RZSS WildGenes for genetic assessment.

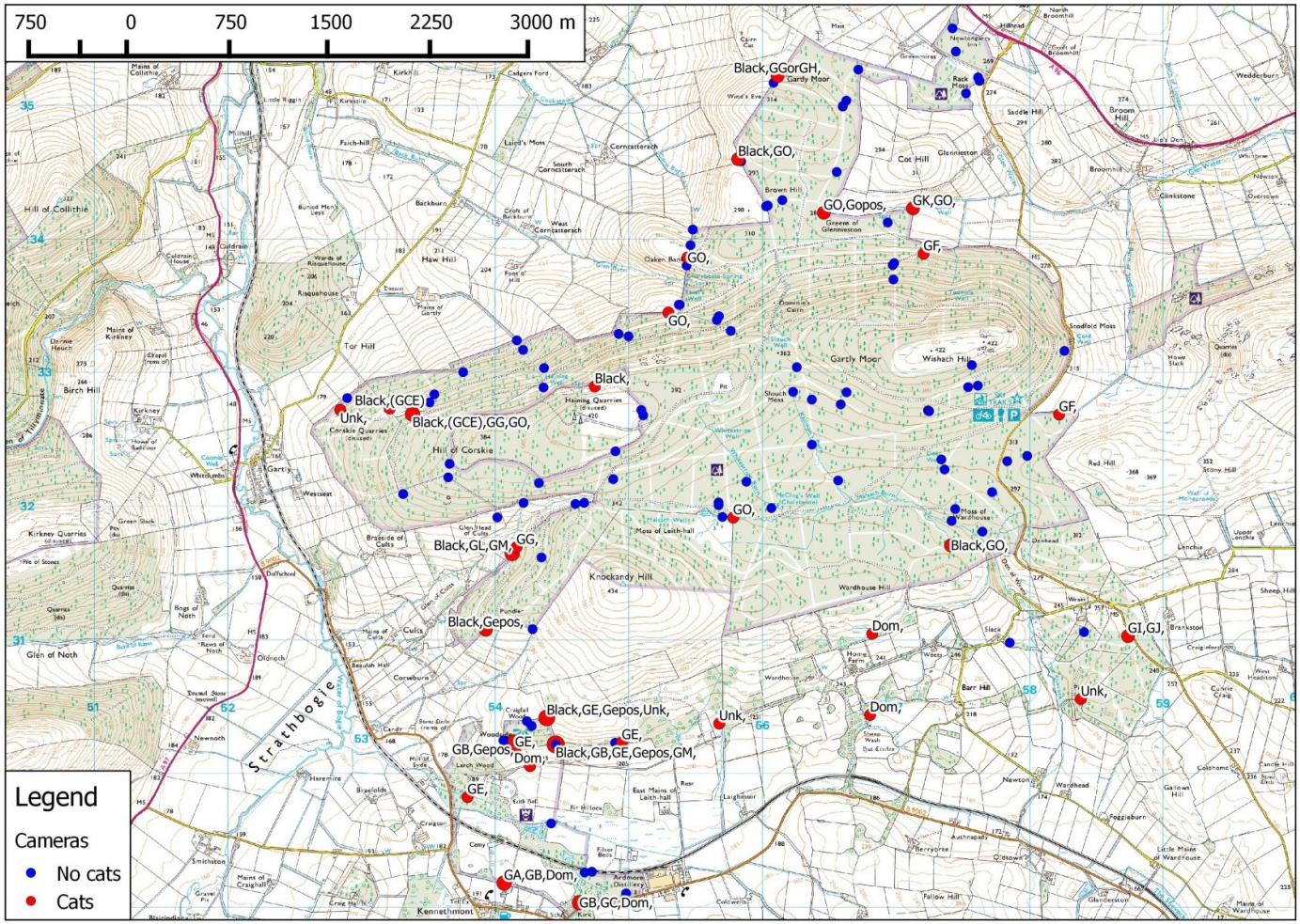

Fig. 1. Locations of cameras around Gartley moor. Where cats have been detected (red), the individual's ID is given if identified. Otherwise, codes are: Unk = unidentified; *XX*pos = possible cat *XX*; Black = black cat (note Black, (GCE) indicates cat GCE); Dom = domestic cat (some of which are identified in Appendix 2).

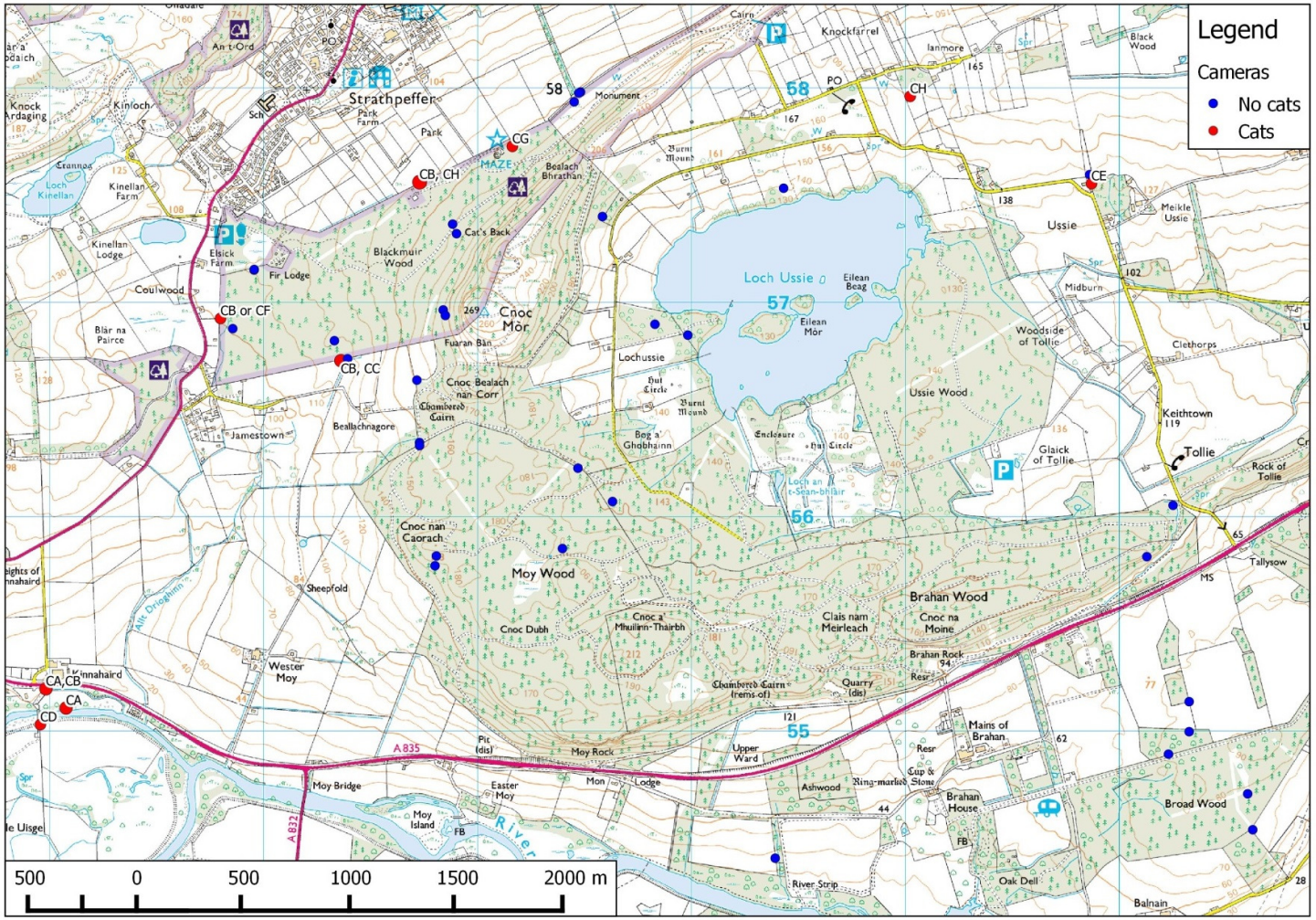

Fig. 2. Locations of cameras in Conon. Where cats have been detected (red), the individual's ID is given (see Appendix 2).

Fig. 3. Locations of cameras in Abernethy. Where cats have been detected (red), the individual's ID is given (see Appendix 2).

Live-trapping and GPS collar attachment

To date, nine wild-living cats have been captured and collared (Table 1). Five of these are at the Gartley site, two at the nearby Clashindarroch site and the remaining two and separate sites (Appendix 4). Three of these have been recaptured and new collars attached. The collars of all the remaining six cats have yet to drop of naturally, despite the collar manufacturer indicating a drop time of approximately 2- 3 months. When it became apparent in March that collars deployed on cats since December remained attached to the cats, we began further weakening the weak-link before placing on the cats. The earliest of these (cat SBO-CB) dropped of naturally after approximately 2 – 3 months. Six domestic house cats have in addition had GPS collars, four at the Gartley site and two and the Clashindarroch site (Table 1). The GPS on cats GO and GE both failed within one week of deployment. This is likely due to a break in the battery connection and later GPS collars have stronger connectors, reducing the chance this will happen in the future.

Overall trapping effort and success has changed with the season. Over winter (Dec – Mar), we accrued 312 trap-nights and captured cats on 11 occasions (0.035 cats / trap-night). During spring (Apr-May), using four traps with MMS cameras, we accrued 16 trap nights and caught no cats, possibly because the cats were less interested in food or because of the low trap effort. After acquiring cat vocalisation lures (Felid-attracting phonic, Westcare Electronics, Bassendean, Australia), out of the 45 trap-nights (Jun – Jul), we captured cats on three occasions (0.067 cats / trap night). These were two cats (GO and GE, the latter captured twice), both lactating females. For GO, we located her second den site using the VHF tag fitted to her collar and placed paired traps (side-by-side) approximately 50m from the den site, one with the meat lure and scent lures and the other with the vocal lure. We used two traps in case we trapped one of her kittens. We trapped the female in the trap containing the meat lure within seven hours of setting out the traps and were aware she had been trapped within an hour of her capture, allowing a very rapid response. It is likely that the vocalisation lures attracted the cats to the trap and the meat bait lured the cat inside since, on all occasions, the meat bait had been consumed. One the second occasion that GE was caught, cat GB (male) was seen investigating the trap containing GE. We intend to use recorded audio of a female cat in season to lure male cats into the traps.

Cat movements

Cat GE remained around Leith Hall, a country house maintained by the National Trust for Scotland, and is denning in a field margin approximately 50m NE from the country house (Figs. 3 & 4). She made use of fence lines when travelling in open habitat and appears to make use of rail track verges, possible for hunting. Her winter range, from five days data (3.04km^2), was larger than reported by Daniels et al. (2001).

Cat GO ventured several kilometres north of her capture sight (and previously known locations gained from camera-trapping) to within a kilometre of the town of Huntly (Fig. 4). She may have been receptive at this time, illustrating the risks imposed of further introgression with domestic cats living some distant from areas thought to be suitable for wildcat. When travelling in open habitat, she also made use of fence-lines and minor roads. She furthermore made use of forest-field edge habitat when located in the forest and spent time in clear-fell forest blocks. Camera-trap data indicated that shortly after her trip north, she returned to Gartley moor before travelling clockwise around the forest and eventually denning in the south of the site, under a pile of dead wood within a

Table 1. Cats captured and collared (including domestic cat) to date. Under column 'sex', N indicates the cat is neutered. Also given are weights of wild-living cats (recorded on first date of capture) and the range (100% MCP) as gained from the GPS collar (if recovered) and camera trap data (where camera locations fell outside the range recorded by the GPS). Cat ANG-CA was neutered prior to release.

Cat	Sex	Type	Site	Weight (kg)	First collar				Second collar			
					Date on	Days data	N fixes	Area (km^2)	Date on	Days data	N fixes	Area (km^2)
ANG-CA	F (N)	Wild-living	Angus	-	10/03/2014	NA						
SBO-CA	M	Wild-living	Clashindarroch	5.30	11/12/2013	98	9675	20.12	19/03/2014	37	3254	26.97 (27.38†)
SBO-CB	M	Wild-living	Clashindarroch	4.55	14/01/2014	NA						
Domestic male 2	N	Domestic	Clashindarroch	-	18/04/2014	6	596	0.025				
Domestic male 3	N	Domestic	Clashindarroch	-	18/04/2014	5	513	0.042				
GB	M	Wild-living	Gartley	5.00	11/12/2013	NA						
GE	F	Wild-living	Gartley	3.55	15/01/2014	5	153	3.04	15/07/2014	2**	180	0.50
GG	M	Wild-living	Gartley	5.40	17/01/2014	NA						
GO	F	Wild-living	Gartley	3.80	12/12/2013	7	672	8.21 (19.29*)	09/07/2014	NA		
GCE	F	Wild-living	Gartley	4.20	21/01/2014	NA						
Domestic female 1	N	Domestic	Gartley	-	14/05/2014	14	1088	0.16	18/07/2014	NA		
Domestic female 2	N	Domestic	Gartley	-	25/04/2014	7	402	0.12	28/07/2014	NA		
Domestic female 3	N	Domestic	Gartley	-	12/04/2014	12	620	0.23				
Domestic female 4	N	Domestic	Gartley	-					18/07/2014	NA		
Domestic male 1	N	Domestic	Gartley	-	11/04/2014	21	1714	0.50				
MOR-CB	F	Wild-living	Morvern	3.50	12/02/2014	NA						

** including data from camera traps*

*** collar left on cat after data download*

† combined from both collars

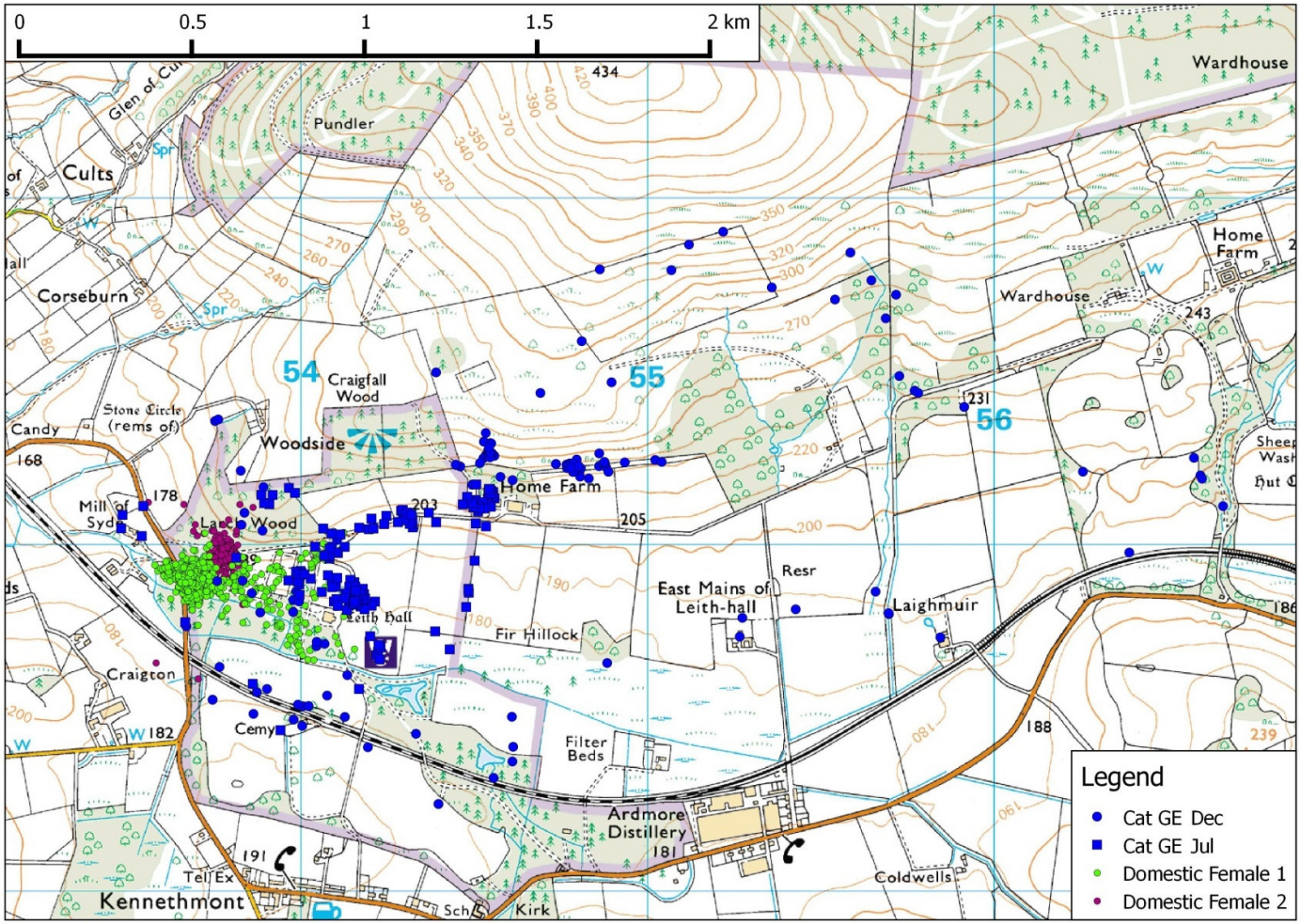

Fig. 3. GPS fix location data from cat GE and two nearby domestic house cats. For GE, data from Dec is over five days and data from Jul is over two days. Fix locations from July suggest that GE is denning 50m NE of Leith Hall under a dense patch of thistles and nettles.

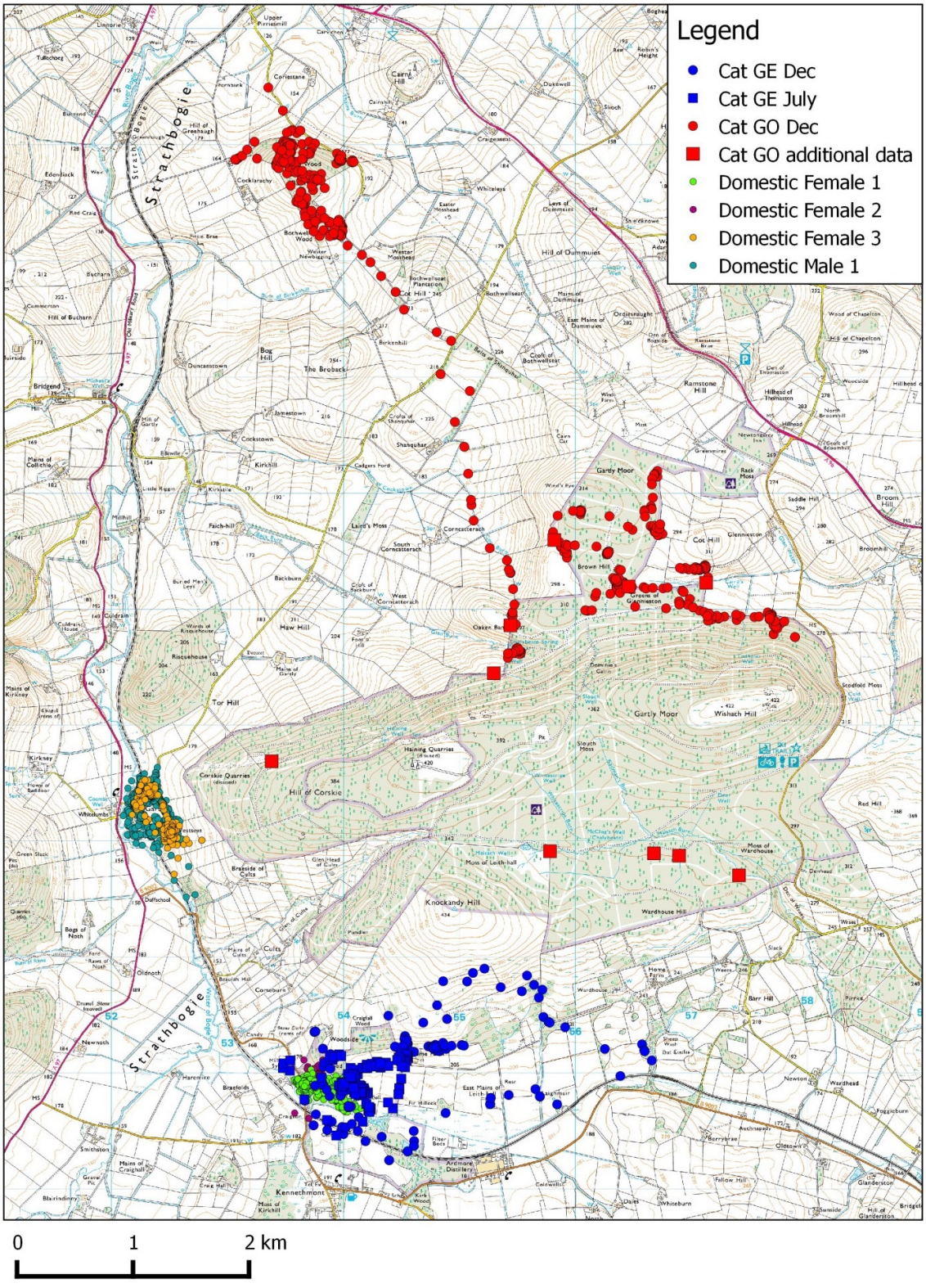

Fig. 4. GPS fix location data from cats GE, GO and four nearby domestic house cats. Cat GO was captured initially at the eastern GPS locations (round points), before moving anticlockwise around the forest over three days and then travelling north to a forest block 1km from Huntly. GO remained in the forest block for at least two days before the GPS failed. Data from cameras and VHF indicate she later returned to the main forest.

clear-fell area. The total range (100% MCP), at 19.29 km^2, was therefore large (cf. 1.77km^2 monthly range median for adult females reported by Daniels et al. 2001). We placed a camera near the den on the 4th June. On the 15th June, GO was caught on camera leaving the den area with at least two tabby kittens (Fig. 5) and she was subsequently located, using the VHF tag, to an area of wind-blow 200m west at the edge of the clear-felled area. It's possible that GO moved into the wind-blow area because it provides more cover for the kittens outside the den.

Fig. 5. Two tabby kittens (only the ear is visible for one) of cat GO leaving their natal den site. Other photos captured at this time show two tabby tails without any sign of a dorsal line, but no images were captured of the lower half of the kittens. Note that the eyes are still blue, suggesting an age of ≤7 weeks.

The first GPS on cat SBO-CA was still working when it was removed from the cat after three months, while the second GPS attached to the same cat contained a smaller battery which lasted five weeks. We thus gained nearly 13,000 fix locations for this cat (Fig. 6). Data from the recovered GPS collars indicate that SBO-CA normally dens very close to farm buildings (94% of fix locations are in the farm yard and adjacent fields), though the farm resident claims not to have seen a wildcat around the farm. Nevertheless, SBO-CA wandered widely, mainly into forestry land to the north and west. The overall range (100% MCP) over the 135 days was 27.38 km^2, which is again larger than the monthly median of 4.59 km^2 that Daniels et al. (2001) reported for adult male cats. Based on camera trap data and VHF location fixes, the area to the south and east is used by cat SBO-CB (another male), with some range overlap. There appears also to be extensive range overlap between SBO-CA and another wildcat (SBO-A, Appendix 2: Clashindarroch), possibly male based on appearance, that has been caught on cameras to the north and west. Again, SBO-CA made use of fence lines when moving through open habitat, as well as forest block edges, rides, forestry tracks and minor roads when travelling in forested habitat. He also frequently spends time, possibly foraging, in clear-felled forestry areas: see, e.g., activity in the forest blocks adjacent to Blackstripes and Moss of Essie in the SW of Fig. 6, all of which has been clear-felled. SBO-CA furthermore appears to spend considerable time in fields in the core area, again probably foraging. In some of these areas, the grass may be long enough to provide suitable cover for the cat to hunt unnoticed.

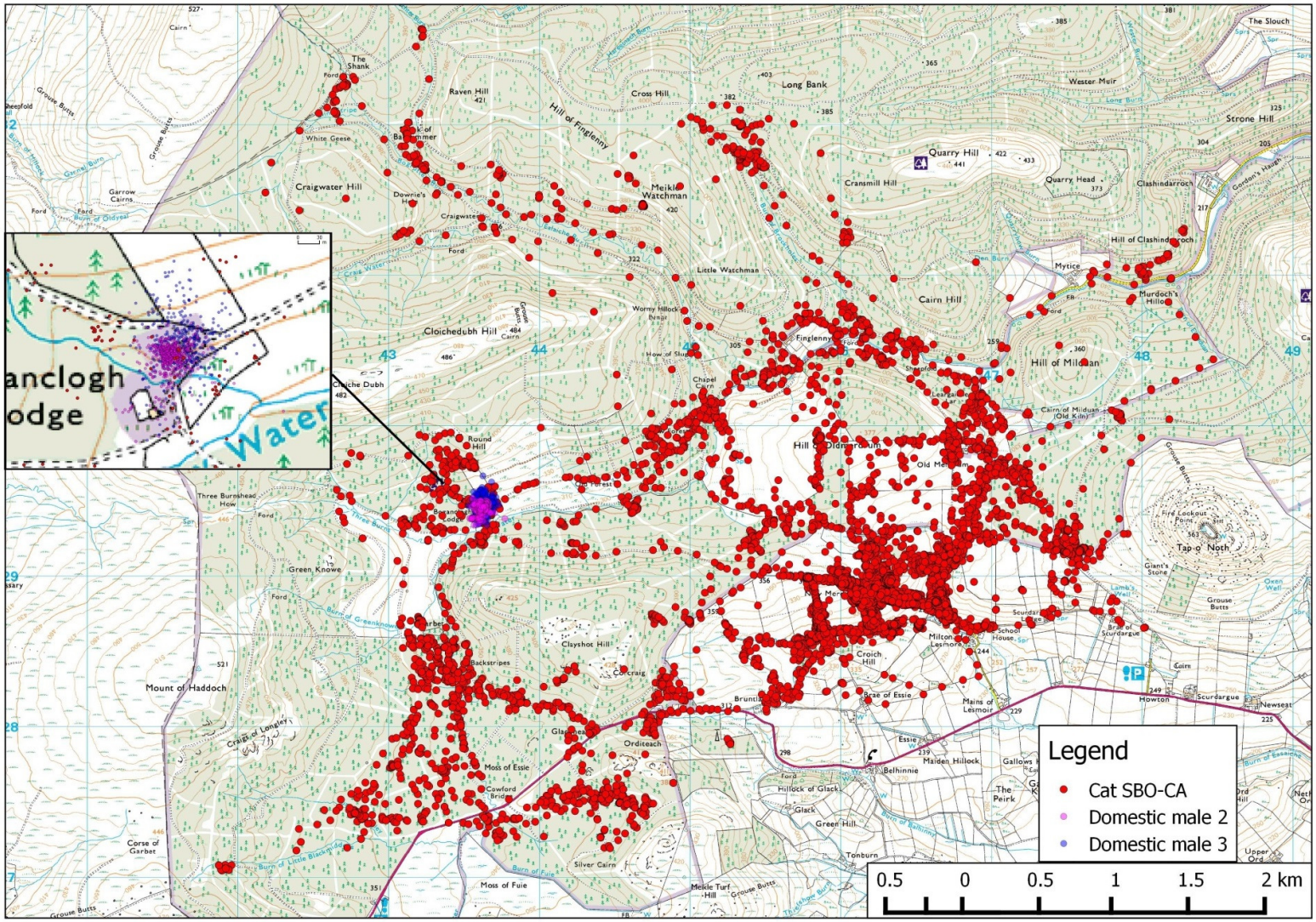

Fig. 6. GPS fix locations from cat SBO-CA and two nearby domestic house cats. Inset is a close-up showing the overlap between SBO-CA and the domestic cats.

Of the six domestic house cats which we have GPS data for, all were neutered. They all also showed much smaller ranges (100% MCP) than the wild-living cats (mean 0.18 km^2 ± 0.17 SD, Table 1). This was expected since all these cats are fed by their owners. Four of these cats also exhibited complete range overlap with the wild-living cats (Figs. 4 & 6), indicating that they do not maintain exclusive territories. The two remaining domestic house cats (Domestic female 3 and Domestic male 1) do not show range overlap with wild-living cats for which we have data, but other wild-living cats for which GPS collars have not yet been recovered are located closer to these two cats and may show range overlap.

Genetics

Of the wild-living cats captured, genetic purity as assessed by 14 SNP markers indicated all ranged from 50 – 79% wildcat with three males of 50 – 64% purity also exhibiting domestic cat mtDNA (Table 2). Notably, the two black female cats tested were, at 61% and 79% wildcat, at least as pure as the tabby cats we tested.

Table 2. Results of genetic testing on mtDNA and 14 SNP markers. W = homozygous wildcat, D = homozygous domestic cat and H = heterozygous (a combination of W and D).

Cat	Sex	Pelage	mt-DNA	Nuclear DNA SNP markers														% wildcat
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	
ANG-CA	F	Black	W	D	H	H	H	H	H	W	H	D	W	W	H	W	W	61%
GB	M	Tabby	D	H	H	H	H	W	D	W	W	W	H	H	W	H	H	64%
GCE	F	Black	W	H	W	W	W	H	W	W	H	H	D	W	W	W	W	79%
GE	F	Tabby	W	H	W	H	D	W	W	W	D	W	D	W	W	W	W	71%
GG	M	Tabby	W	H	W	D	D	H	H	W	D	H	H	H	W	H	H	50%
GO	F	Tabby	W	W	W	W	W	H	W	H	W	H	H	D	H	W	H	71%
MOR-CB	F	Tabby	W	W	H	H	H	H	H	H	H	H	H	H	H	H	H	54%
SBO-CA	M	Tabby	D	W	H	D	D	W	H	H	H	H	D	H	H	W	H	50%
SBO-CB	M	Tabby	D	H	D	W	H	H	H	H	H	W	D	H	D	H	W	50%

Assignment to hybrid classes (Table 3) using New Hybrid (see Appendix 1) indicated that most (6/9) of the cats were likely to be at least second generation hybrids (≥F2), one cat a likely first generation hybrid (F1) and the remaining two cats (including the black cat GCE) back-crosses between hybrids and wildcat.

Table 3. Hybrid class assignment using NewHybrid.

Cat	Sex	Pelage	Wildcat	Wild Back-X	F1 hybrid	F2 Hybrid	Dom Back-X	Domestic
ANG-CA	F	Black	0.000	0.014	0.000	0.984	0.002	0.000
GB	M	Tabby	0.000	0.586	0.001	0.413	0.000	0.000
GCE	F	Black	0.007	0.883	0.000	0.111	0.000	0.000
GE	F	Tabby	0.001	0.064	0.000	0.935	0.000	0.000
GG	M	Tabby	0.000	0.002	0.000	0.996	0.001	0.000
GO	F	Tabby	0.000	0.438	0.000	0.562	0.000	0.000
MOR-CB	F	Tabby	0.000	0.099	0.600	0.281	0.020	0.000
SBO-CA	M	Tabby	0.000	0.007	0.002	0.977	0.014	0.000
SBO-CB	M	Tabby	0.000	0.001	0.000	0.977	0.001	0.000

The genetic scores gained from the 14 SNP markers do not show clear correlation with the 7PS pelage score (Spearmans rho = -0.355, N = 9, P = 0.349, Fig. 7).

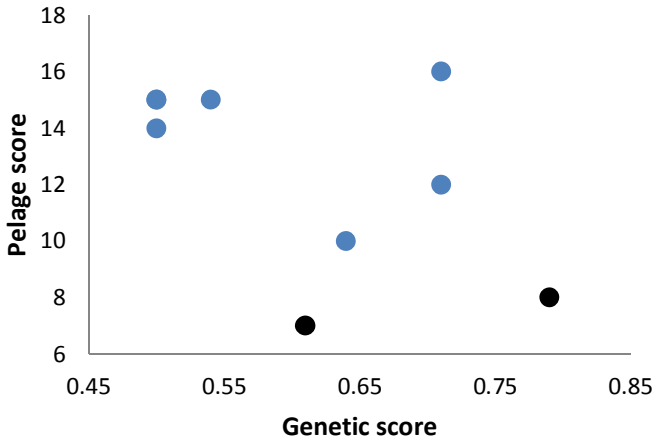

Fig. 7. Relationship between genetic scores from the 14 SNP markers and 7PS pelage scores (Kitchener et al. 2005) for the nine collared cats. Black indicates black cats and tabby cats are indicated with blue points.

Additional notes

During autumn 2013, a family of cats consisting of a black mother, at least two black kittens and at least one tabby kitten were caught on a camera at the northern end of the Gartley moor site (see grid square 5534 in Fig. 1, and Fig. 8). These kittens are not included in Appendix 2 as they were not seen again after October. A black kitten (cat GM, Appendix 2) was furthermore caught on camera near Leith Hall and a tabby-white kitten (cat GI, Appendix 2) on a camera in the SE of the Gartley moor site.

Fig. 8: Two kittens from a family run past a camera in the north of Gartley moor.

Overall, the winter of 2013 – 2014 and the following spring have been unusually mild. This will likely have reduced our trapping success. I have furthermore noticed that rabbit populations are increasing along with large number of voles, possible as a result of the mild winter. I therefore predict that the reproductive success of wild-living cats in the study areas will be high this year and we may see a resulting increase in cat populations in the study areas.

Further work

GPS collars

We are currently working to recover the remaining GPS from the cats collared over the winter by re-trapping the cats. Once trapped, we plan to attach new collars to these same cats to obtain data on summer ranges and habitat use. New collars will have a much weaker link to ensure that the collars drop-off naturally before October. We plan to additionally collar cats in Conon, where our winter survey yielded two pelage-pure wildcats (Littlewood et al. 2014), possibly Abernethy (if more cats are found over the next few weeks) as well as cat SBO-A in Clashindarroch since its pelage suggests it may be a pure wildcat. Our trapping technique has improved over the course of the project and we therefore aim to trap several of these target cats over the next month. Where we trap wild-living cats, we will also attach GPS to those domestic cat for which we obtain owner's consent. Notably, in the Conon area we have observed a house cat that displays pelage characteristics typical of a hybrid. We furthermore hope to obtain further funding to collar more wild-living cats in the Clashindarroch area, as our survey in this area over the winter showed a wide range of cats from possibly pure wildcat to possibly pure domestic (Appendix 2). Finally, we are currently examining funding options to survey, and possibly capture cats, in the area around Loch Laggan (Glen Spean). Overall, an additional winter season would allow us to greatly enhance the sample size of collared cats, improving our analyses on habitat use and the interactions between cats during the mating season.

Habitat use and activity patterns

Alongside OS map data and data on planting in Forestry Commission blocks, we have been conducting ground-truthing of broad habitat details (habitat type, tree species) in Gartley and will expand this to Conon when we trap cats there. We are furthermore collecting data on microhabitat use using fix locations from GPS collars. For this, we are randomly selecting GPS collar fix locations, visiting each one, photographing the location and recording % cover, height and dominant species for ground cover vegetation, mid-story vegetation and canopy vegetation along with details of linear features such as animal trails, human made paths, tracks and roads and fences. We will compare these with an equal number of points randomly selected from a 10 × 10m point grid within each cat's range (100% MCP). We are also gathering or calculate data on physical attributes (altitude; slope; aspect) temporal variables (time; season) and ephemeral variables (precipitation; wind speed and direction; temperature; cloud cover; moon phase). Examining the effects these have on the distance the cat travelled between fixes, direction taken and the angle between successive fixes will provide insight on the behaviour of cats under different environmental conditions.

Cat interactions

Once we have recovered more GPS collars, we will examine spatial and temporal interactions between cats. In particular, we will compare overlap of home ranges using kernel density estimators; examine temporal activity patterns inside and outside areas of overlap; examine movement patterns

(habitat use, travel distance and angles between fixes) inside and outside areas of overlap; and look for direct interactions between cats during periods of overlapping GPS collar deployment.

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Appendix 1: Genetic methods

From Littlewood, N.A., Campbell, R.D., Dinnie, L., Gilbert, L., Hooper, R., Iason, G., Irvine, J., Kilshaw, K., Kitchener, A., Lackova, P., Newey, S., Ogden, R., Ross, A. 2014. Survey and Scoping of Wildcat Priority Areas. *Scottish Natural Heritage Commissioned Report No. - TBC*

Assessment of individual identity in wild-living cats

Individual identity of wild-living cats was evaluated using the same 14 SNP marker DNA profiles used for assessing genetic purity.

Statistical methods

Evaluation of hybrid status was undertaken using the computer software packages STRUCTURE (Pritchard *et al.,* 2000) and NewHybrids (Anderson and Thompson 2002). Both programmes employ Bayesian approaches to calculate the posterior probability of membership to different groups. In the case of STRUCTURE, samples are assigned to putative populations, while in New Hybrids, samples are assigned to a range of possible hybrid classes (pure, F1 cross, F2, backcross etc.).

Sample data from the current project were analysed in combination with available Scottish and continental Wildcat reference data, as well as reference domestic cat sample data. Scottish reference samples were obtained from the National Museums Scotland, collected between 1931 and 1958 (mean pelage score = 20); continental wildcats samples were obtained from the Senckenberg Research Institute, Germany, following both photographic and genetic identification; domestic cat samples were obtained from the Royal (Dick) Veterinary School at the University of Edinburgh; samples of known introgressed ancestry were obtained from the RZSS Highland Wildlife Park.

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Appendix 2: Cats captured by camera

Gartley

GA (domestic, black with white tail tip)

GB

GC (Domestic)

GD

GE

GF

GG

GH (or GG)

GI (juvenile)

GJ

GK (black)

GL

GM (juvenile)

GN (or GE)

GO

GCE (short tail)

Conon

CA

CB

CC

CD

CE

CF (or CB)

CG

CH

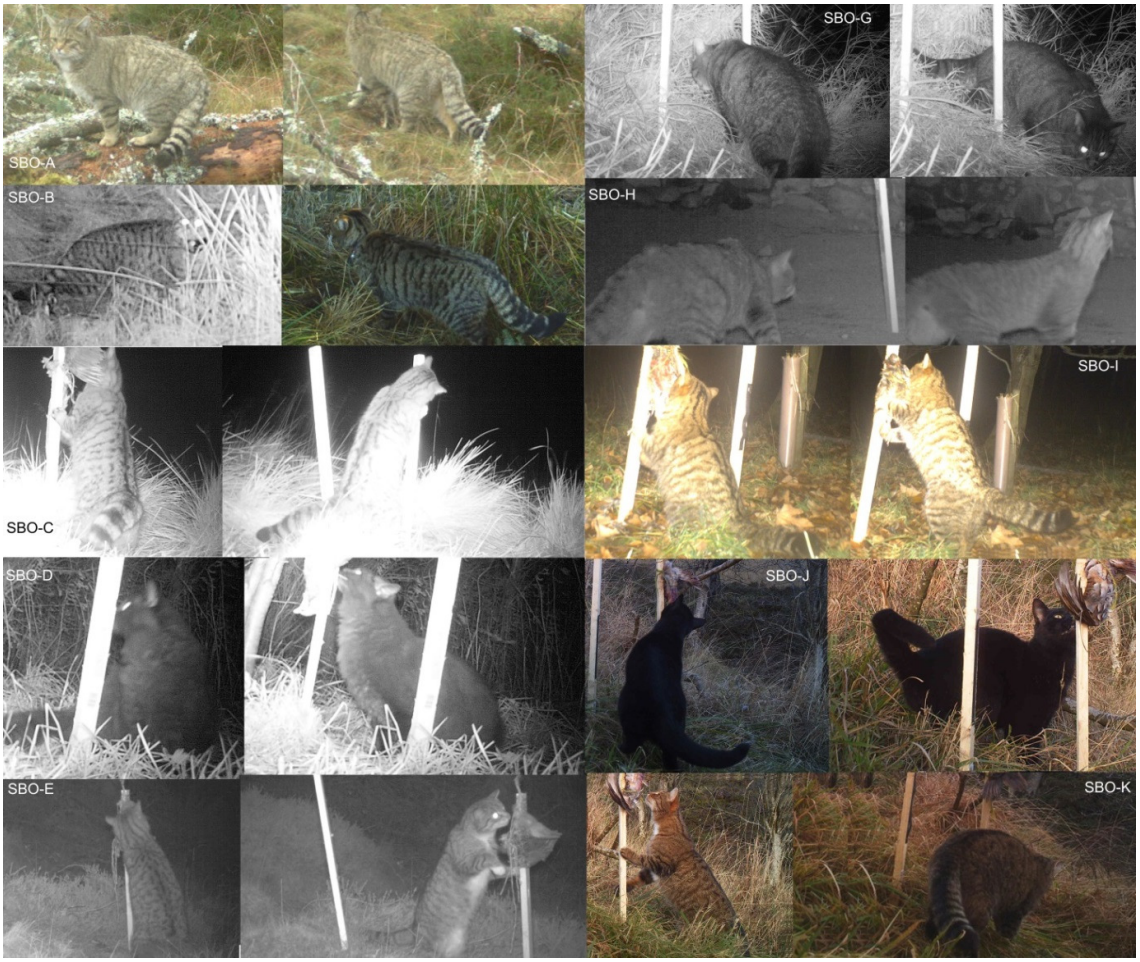
Abernethy

AA

AB

Clashindarroch

From Littlewood et al. (2014). Note that SBO-B is the same as collared cat SBO-CA and SBO-C is the same as SBO-CB.



Appendix 3: Pelage scores

Seven point pelage scores of cats captured on camera during the three surveys at Gartley, Conon and Abernethy, along with the two additional cats collared in Angus and Morvern (Appendix 4), following Kitchener et al. (2005).

Cat ID	Dorsal line	Tail tip shape	Tail bands	Broken stripes flank	Spots flank & HQ	Stripes nape	Stripes shoulder	Total	Strict ID	Relaxed ID
GA (Black)	1	1	1	1	1	1	1	7	DOM	DOM
GB	1	2	1	1	1	2	2	10	DOM	DOM
GC	1	1	2	1	1	2	2	10	DOM	DOM
GD (Black)	1	1	1	1	1	1	1	7	DOM	DOM
GE	2	2	2	1	1	2	2	12	HYB	HYB
GF	3	2	2	2	2	3	2	16	HYB	WILD
GG	2	3	2	2	2	2	2	15	HYB	WILD
GH	3	3	3	NA	NA	3	NA	>12	-	WILD
GI	NA	2	2	2	2	NA	NA	>8	-	HYB
GJ	3	3	2	2	2	2	NA	>14	-	HYB
GK (Black)	1	1	1	1	1	1	1	7	DOM	DOM
GL (Ginger)	1	1	1	1	1	1	1	7	DOM	DOM
GM (Black)	1	1	1	1	1	1	1	7	DOM	DOM
GN	2	2	2	2	2	3	2	15	HYB	WILD
GO	3	2	2	3	2	3	1	16	HYB	HYB
G-CE (Black)	1	2	1	1	1	1	1	8	DOM	DOM
MOR-CB	2	2	3	2	2	2	2	15	HYB	WILD
SBO-CA	2	2	2	2	2	2	2	14	HYB	WILD
SBO-CB	3	2	3	2	1	2	2	15	HYB	HYB
ANG-CA	1	1	1	1	1	1	1	7	DOM	DOM
CA	2	2	1	1	1	2	1	10	DOM	DOM
CB	3	3	3	2	2	3	NA	>16	-	WILD
CC	NA	2	NA	1	1	2	1	>7	-	DOM
CD	3	3	2	1	1	3	NA	>13	-	HYB
CE (Ginger)	3	2	1	1	1	1	1	10	DOM	DOM
CF (or CB)	2	2	2	2	2	NA	NA	>10	-	HYB
CG	3	3	3	NA	NA	NA	NA	>9	-	WILD
CH (Ginger)	NA	2	1	1	1	1	1	>7	-	DOM
AA	3	2	3	2	3	3	2	18	HYB	WILD
AB (Grey)	1	1	1	1	1	1	1	7	DOM	DOM

Appendix 4: Additional cats collared

We opportunistically attached GPS collars to two cats outside the main study areas, one in Glenisla, Angus (ANG-CA) and one in Morvern (MOR-CB).

ANG-CA (black)

MOR-CB