Electronic Supplementary Materials

This file contains additional Information on Methods and Results:

1- Tracking data
2- Detailed description of the variables used to estimate habitat suitability models (table S1).
3- The relative contribution of the assessed environmental variables to the daily habitat suitable models (figure S1).
4- Information on microsatellite loci used for caribou and diversity statistics (table S2).
5- Correlation among predictive distances (figure S2).
6- Landscape genetic method validation (figures S3 & S4).
7- Causal modelling (table S3 and figure S5).
8- Landscape genetic results validation (figures S6 & S7).
9- Additional references.

1-Tracking data

To fit the models, we used the locations of 296 caribou (53 males and 243 females) of the Rivière-George herd between 1986 and 2012 and 233 caribou (71 males and 162 females) of the Rivière-aux-Feuilles herd between 1991 and 2012 fitted with ARGOS satellite-tracking collars (Telonics, ARGOS platform, Mesa, Arizona, USA) (Table 1). Most females were captured on the calving grounds at sites separated by several kilometres (*e.g.*, range for 2007 to 2009 (mean (SE)): Rivière-George: 21 (3) km; Rivière-aux-Feuilles: 83 (12) km), therefore we considered individuals to be independent because capture sites within a given year were spread over several thousands of km^2 and representative of the area used by the entire herd. Males were mainly captured on winter areas. All captures used a net-gun fired from a helicopter and physical contention, a standard procedure for ungulates [1]. Anaesthetics were never used during captures, which followed guidelines from the Canadian Council on animal Care. On average, we followed 44 females (SE ± 5) each year and females were monitored on average for 2.0 years (SE ± 0.1) with some individuals followed for up to 10 years. Locations were usually collected every 5 days (65.7% of the database) but frequency ranged from one location every day (1.3%) up to one per 7 days (0.9%). We filtered the data using a similar algorithm as Austin et al. [2] to eliminate aberrant locations: we selected the most accurate location for a given transmission period based on signal quality and we excluded locations leading to movements higher than 50 kilometres per day [3].

2- Detailed description of the variables used to estimate habitat suitability models

Table S1. Description of the variables used to estimate habitat suitability models for caribou in Quebec and Labrador.

Variable	Description
Elevation	Elevation determined from a global digital elevation model (DEM)
Snow	Surface covered by snow [500m]; available every 8 days [1]
NDVI	Normalized difference vegetation index (1km); available every 10 days [2]
Precipitation	Average monthly precipitation (mm) [1km] [3]
Temperature	Average monthly maximum temperature (°C * 10) [1km] [3]
Open area	Disturbed areas (Burnt area, urban or built-up) [400m] [4]
Water	Water bodies (rivers and lakes) [400m] [4]
Lichen	Subpolar needleleaved evergreen forest open canopy - lichen understory [400m] [4]
Grassland	Temperate, subpolar or polar grassland, with sparse shrub or tree layers [400m] [4]
Shrubland	Temperate or subpolar shrubland (Broadleaved evergreen, broadleaved deciduous and/or needleleaved evergreen shrublands) [400m] [4]
Closed Forest	Temperate or subpolar closed forest (Broadleaved evergreen, broadleaved deciduous and/or needleleaved evergreen closed forests) [400m] [4]
Open Forest	Temperate or subpolar open forest (Broadleaved evergreen, broadleaved deciduous and/or needleleaved evergreen open forests) [400m] [4]

Note: Distances in brackets denote the initial resolution at which the variable was acquired

[1] MODIS satellite images [National Snow and Ice Data Center, Boulder, Colorado; http://nsidc.org/; 4].

[2] NDVI data acquired by the National Oceanic and Atmospheric Administration Advanced Very High Resolution Radiometer (NOAA-AVHRR) satellite series [5] and processed by the Canada Centre for Remote Sensing (CCRS, Department of Natural Resources Canada, Ottawa, Ont.)

[3] WorldClim Version 1.4 [6]

[4] Determined from landcover layer [GlobeCover 2009 [Global Land Cover Map]; 7]

3- The relative contribution of the assessed environmental variables to the daily habitat suitable models

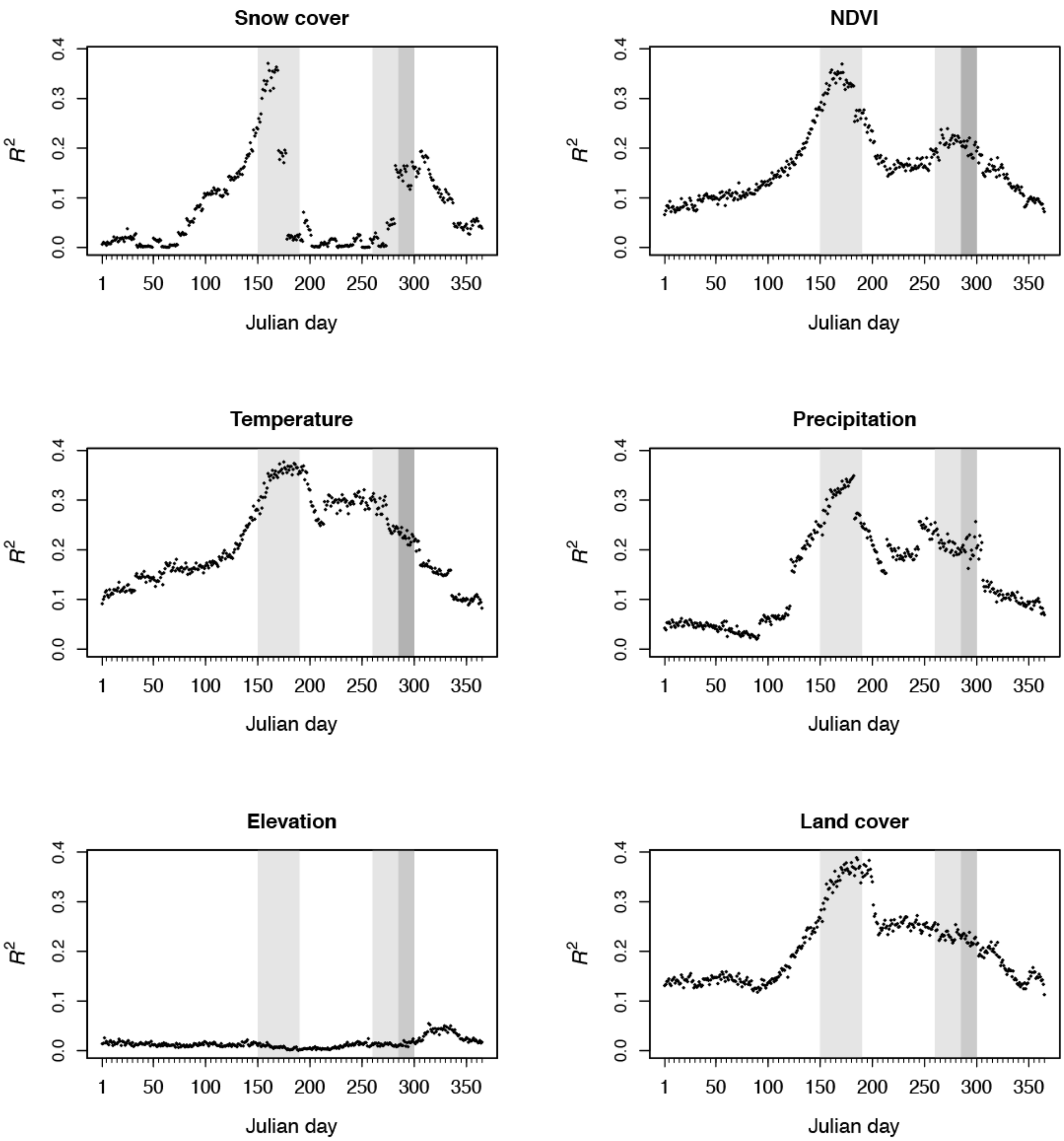

Figure S1. The relative contribution of the assessed environmental variables to the daily habitat suitability models. Grey boxes delimit the calving period (Julian days 155-190) and the rutting period (Julian days 260-300) for forest-dwelling caribou [8] and migratory caribou [3]. Dark-grey boxes show the rutting peak for migratory caribou [Julian days 285-300; 3].

4- Information on microsatellite loci used for caribou and diversity statistics

Table S2. Information on microsatellite loci used for caribou and diversity statistics. Observed heterozygosity (H_O), expected heterozygosity (H_E), and Weir & Cockerham's inbreeding coefficient (F_{IS}) are reported.

Locus	H_O	H_E	F_{IS}
BL42	0.72	0.75	0.022
BM4513	0.69	0.91	0.254
BM6506	0.69	0.69	-0.014
BMS178	0.74	0.81	0.068
BMS745	0.64	0.67	0.070
FCB193	0.77	0.77	0.034
NVHRT1	0.49	0.57	0.167
NVHRT3	0.59	0.76	0.269
OheQ	0.71	0.71	0.018
Rt1	0.76	0.75	0.018
Rt24	0.64	0.68	0.033
Rt27	0.56	0.67	0.198
Rt5	0.60	0.74	0.210
Rt6	0.65	0.67	0.042
Rt7	0.75	0.76	0.075
Rt9s	0.70	0.72	-0.025

5- Correlation among predictive distances

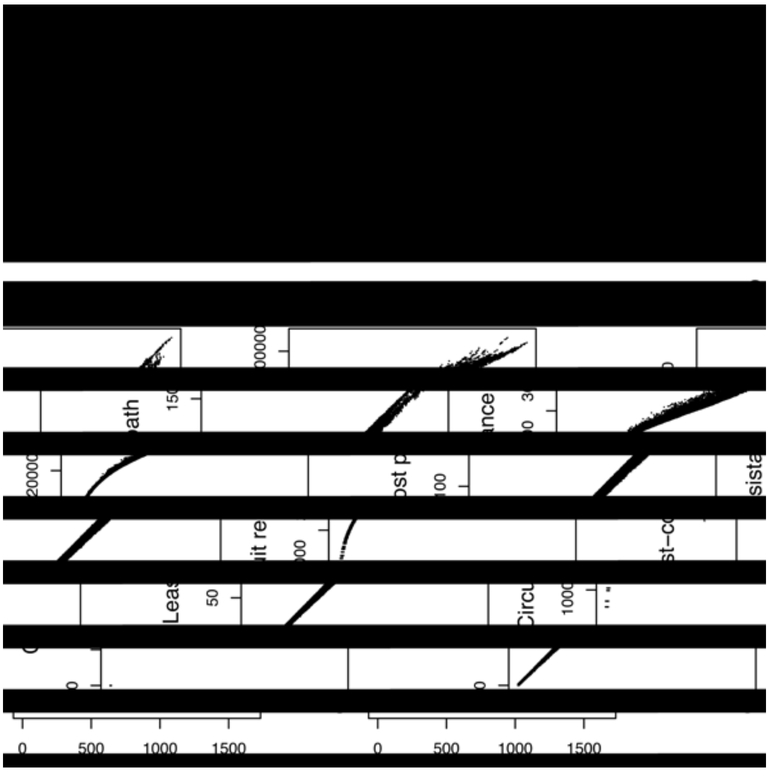

Figure S2. Relationship among the three different predictive distances, *i.e.*, Geodesic distances (in km), Least-cost path and circuit resistance estimated among caribou pairs for the Julian Day 300. The upper right inset shows the Pearson's correlation coefficient among pair of distances.

6- Landscape genetic method validation

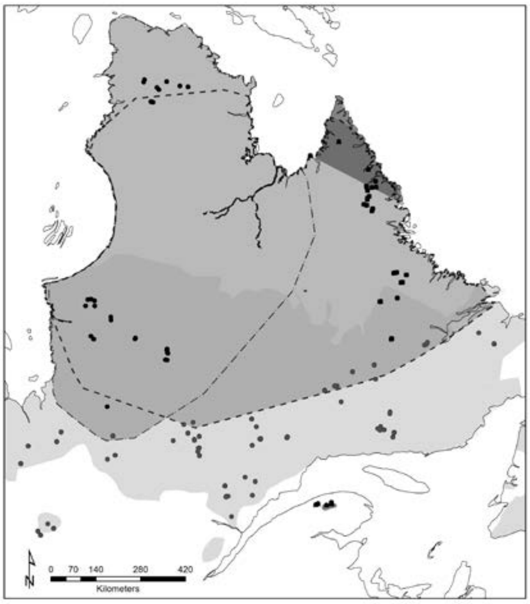

Figure S3. Landscape genetic method validation. Map of sample locations of caribou, showing migratory caribou for which we had both genetic and tracking information and used for method validation (see Methods). Grey squares: Rivières-aux-Feuilles migratory herd; grey dots: Rivière-George migratory herd; black squares: forest-dwelling caribou; black triangles: mountain caribou. The annual ranges of migratory herd are delineated by dotted and dashed contour lines for Rivières-aux-Feuilles and Rivière-George herds, respectively.

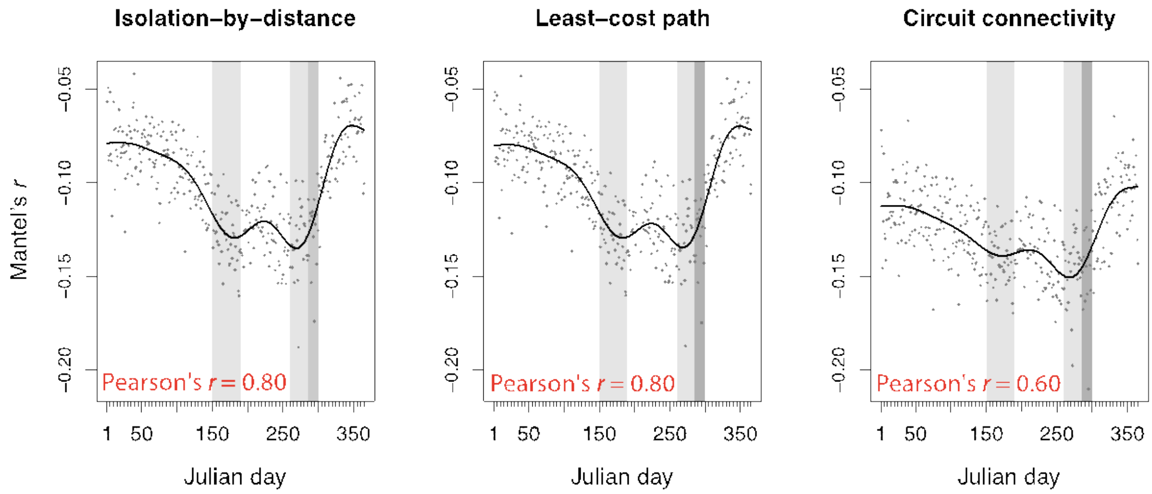

Figure S4. Landscape genetic method validation. Temporal changes in correlation coefficient (Mantel’s r) of genetic relatedness (Lynch and Ritland [9] relationship coefficient) against Geodesic geographic distance (IBD); least-cost path; and circuit resistance, for which we had both genetic and location information for migratory caribou (see Methods). Pearson’s correlation coefficient between the daily Mantel’s r correlations obtained for the models based on the whole dataset and the data subset is indicated. Grey boxes delimit the calving period (Julian days 155-190) and the rut period (Julian days 260-300) for forest-dwelling caribou [8] and migratory caribou [3]. Dark-grey boxes show the rutting peak for migratory caribou (Julian days 285-300; [3]).

7- Causal modelling

Causal modelling analyses based on partial Mantel tests showed that all variables explained a significant part of genetic relatedness among individuals (table S3). The respective influences of barriers and distance, however, significantly changed over time. While after controlling for distance (Isolation-by-Distance; IBD) and barriers (Isolation by Barrier; IBB), the circuit resistance models always showed a significant negative relationship to relatedness (table S3), the effect of distance and barrier on genetic relatedness either switched from negative to positive (*i.e.*, r > 0) when the circuit resistance model was controlled for, or was non-significant in 34% and 16% of the IBD and IBB models, respectively (table S3 and figure S3). In particular, IBD and IBB models were not significant during the calving and rut periods, once circuit resistance models were controlled for.

Table S3. Partial Mantel tests used in the causal modelling framework to assess the degree of association between each genetic distance matrix and four cost distance matrices, representing the two null models (Isolation by Distance, Isolation by Barrier), and the two correct landscape resistance models. The expected outcomes are for the situation where the landscape resistance model is a true driver of the observed genetic differentiation.

	Variable						
Test number	**Dependent**	**Independent**	**Covariates**		**Expected Outcome**	**Results***	**mean ± sd Mantel'*r***
#1	Genetic	Circuit	IBD		Significant	100.00	-0.18 ± 0.02
#2	Genetic	IBD	Circuit		Not significant	100.00	0.09 ± 0.02
#3	Genetic	Circuit	IBD	IBB	Significant	100.00	-0.18 ± 0.02
4	Genetic	IBD	Circuit	IBB	Not significant	84.4	-0.09 ± 0.02

- Percentage of significant tests out of 365 Mantel tests.

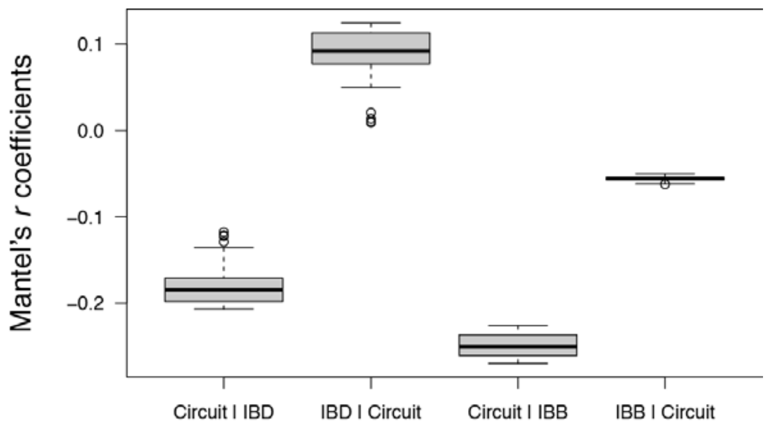

Figure S5. The relative Mantel' *r* coefficients estimated by partial Mantel tests from the correlation of genetic *versus* geographic distances between pairs of caribou, once alternative distances were controlled for (indicated by |). Geodesic distance (IBD), Circuit theory resistance distance (Circuit) and geographic Barrier (IBB), respectively. The solid line in each box shows the median of the Mantel' *r* coefficients distribution, the box shows the 25% and 75% quantiles, and the whiskers show the full range of the coefficients.

8- Landscape genetic models validation

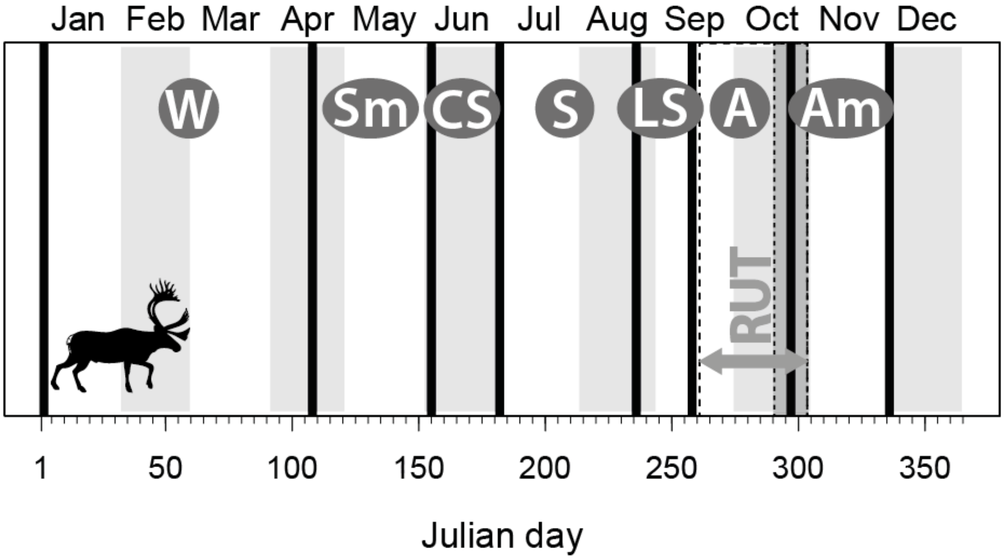

Figure S6. Landscape genetic method validation. Schematic representation of the biological seasons for migratory caribou in Québec/Labrador. The vertical black lines indicate the seasonal periods independently defined on the base on the rate of travel (First Passage Time analysis; M. Le Corre, C. Dussault and S.D. Côté, unpublished data). Legends: W winter, Sm spring migration, CS calving season, LS late summer, A autumn, Am autumn migration. The dashed-lines delimited the overlapping rut period for boreal forest caribou [8] and migratory caribou [3]. Dark-grey box shows the rutting peak for migratory caribou [3].

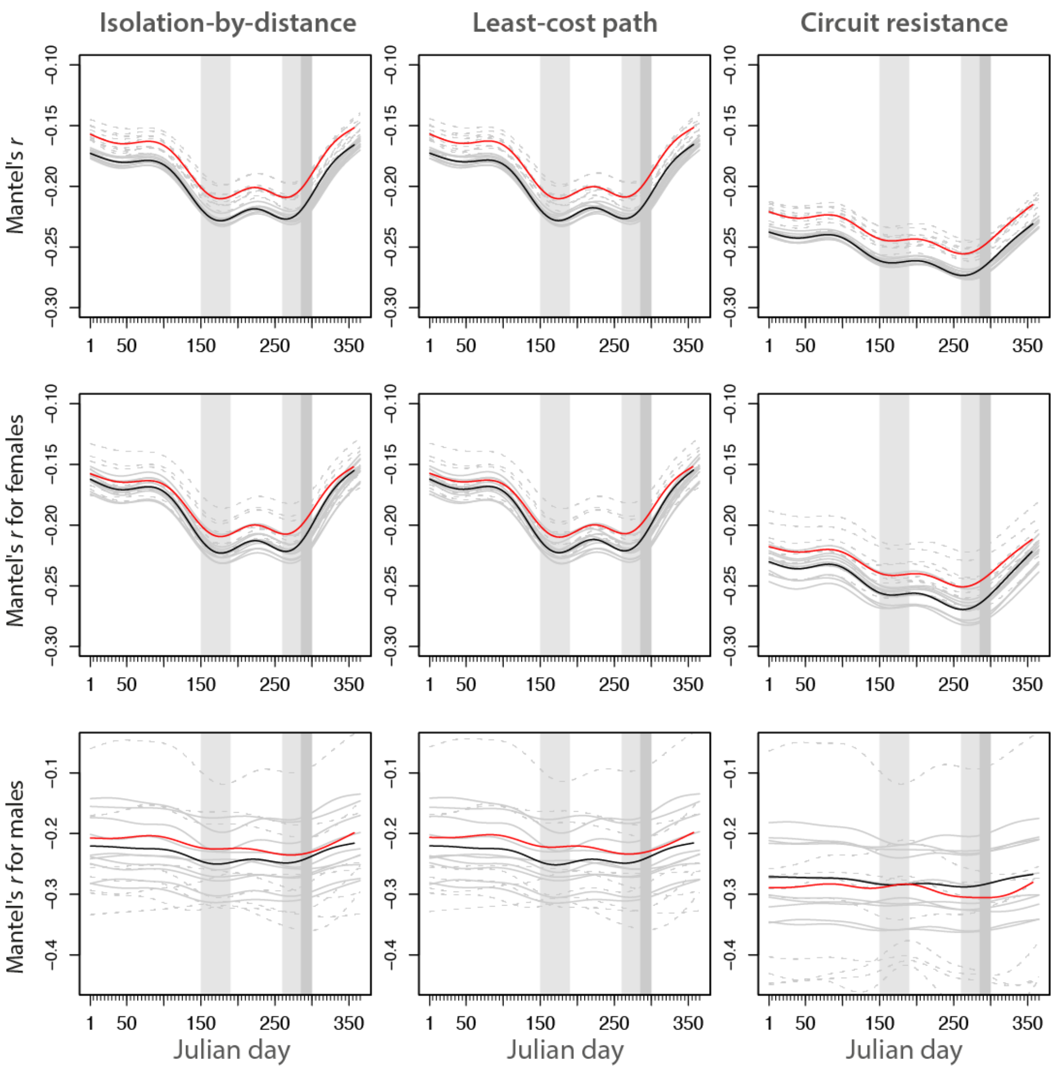

Figure S7. Landscape genetic models validation. Temporal changes in correlation coefficient (Mantel's r) of genetic relatedness (Lynch and Ritland [9] relationship coefficient) against Geodesic geographic distance (IBD); least-cost path; and circuit resistance, obtained using a repeated split sampling approach in which models were calibrated over 70% of the data (n[total]=336, n[female]=281 and n[male]=55; black line=average over 10 replicates) and evaluated over the remaining 30% (n[total]=144, n[female]=129 and n[male]=15; red line=average over 10 replicates). Grey boxes delimit the calving period (Julian days 155-190) and the rut period (Julian days 260-300) for forest-dwelling caribou [8] and migratory caribou [3]. Dark-grey boxes show the rutting peak for migratory caribou (Julian days 285-300; [3])

Table S4. Repeated split sampling testing the effect of the distances (*i.e.,* geodesic distance, least cost-path or circuit connectivity) and the seasons (see figure S6) on the Mantel's r coefficients. rho corresponds to Spearman correlation coefficient between values predicted by the training data set and values observed in the testing data set, average ± se over 10 repeats obtained using a repeated split sampling approach in which models were calibrated over 70% of the data (n[total]=336, n[female]=281 and n[male]=55) and evaluated over the remaining 30% (n[total]=144, n[female]=129 and n[male]=15); and R^2 the proportion of variance explained by the training models.

		Whole data		Male		Female	
Model		*rho*	R^2	*rho*	R^2	*rho*	R^2
#1	~Distance + Season	0.95±0.01	0.92	0.53±0.09	0.83	0.94±0.02	0.92
#2	~Distance	0.70±0.01	0.63	0.52±0.05	0.63	0.69±0.04	0.63
#3	~Season	0.48±0.02	0.29	0.16±0.06	0.19	0.48±0.05	0.29

9- References

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