Ecography

ECOG-04180
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Supplementary material

Appendix 1. Reintroduction

Wild caught voles were caught during the autumn of the year preceding the reintroduction and kept in captivity over the winter (by Derek Gow Consultancy Ltd). To increase the size of the release cohort, 30 voles were paired up for mating during the spring while still in captivity. Thirteen of those pairs successfully bred, producing a total of 22 litters (82 voles) prior to release. Of the remaining 61 voles, twelve were released as a pair, and 49 released as a sibling group (table A1). All voles were marked with PIT tags (Francis Scientific Instruments Ltd), excluding 18 individuals < 15 g deemed too small to safely tag.

All voles were released using a "soft-release" method, where voles are kept in a release pen (1 m^2 pen containing half a bale of straw) for 5 days before being allowed to leave. This is recommended for captive bred voles (Strachan et al. 2011), and was deemed appropriate for voles that had spent 6 months in 60x30x20 cm cages. During the first year, voles were released in three phased batches (table A1). Phase one consisted of four sibling groups released to each of sites a, b and c (Fig. 1); phase two of 1, 12 and 6 paired voles and their number offspring released to sites d, e and f respectively (though one male escaped during handling) (Fig. 1). Phase three included three breeding pairs with offspring too small to be release site during phase two. One pair and one lone adult were released to site a, and 1 pair, 1 lone adult and 2 sibling groups to site e (Fig. 1). This was followed up by a small reinforcement of 10 males and 4 females during July of the following year of wild caught voles that were caught, transported straight to the release site, and released by a hard release method. Six voles were released in site d and 8 to site e (Fig. 1).

Table A1. The location and date of all release cohorts, where release locations refer to Fig. 1. Water way length is the number of contiguous 200 m habitat sections along which release pens were placed. June and July releases were grouped to calculate density km^{-1} and fine scale density is calculated as No. overwintered (OW) females / water way length. Sub catchments are shown by the dotted outline and study site by the dashed outline in Fig. 1.

Release location	Phase	Date	Release type	No. pens	OW females*	OW males	Off-spring	Total voles	Water way length km	Nearest neighbour km	Fine scale density km^{-1}	Sub catchment density km^{-1}	Study site density km^{-1}
a	1	Jun-15	Sibling group	4	13	12	0	25	0.8	0.4-0.6	16.3	1.3	0.6
b		Jun-15	Sibling group	4	4	6	0	10	0.4	0.3-0.6	10.0	2.3	
c		Jun-15	Sibling group	4	8	6	0	14	0.4	0.4-0.5	20.0	1.5	
e	2	Jul-15	Pair	12	12(10)	11	40	63	1.8	0.2-1.5	6.6	2.3	
d		Jul-15	Pair	1	1(2)	1	4	6	0.4	0.7	2.5	2.3	
f		Jul-15	Pair	5	5(6)	4	21	30	1.2	0.3-1.4	5.0	1.5	
f		Jul-15	Lone	1	1(0)	0	0	1	-	-	-	-	-
a	3	Aug-15	Pair	1	1(1)	1	5	7	-	-	-	-	-
a		Aug-15	Lone	1	0	1	0	1	-	-	-	-	-
e		Aug-15	Pair	1	1(1)	1	6	8	-	-	-	-	-
e		Aug-15	Lone	1	1	0	0	1	-	-	-	-	-
e		Aug-15	Sibling group	2	0	0	6	6	-	-	-	-	-

* OW = Over wintered. Values in parentheses indicate number of litters of offspring

Table A2. The number of voles released by each method, by provenance (wild vs captive bred), and by sex. “Paired early” refers to those voles paired in the spring for mating. “Paired late” refers to voles paired just prior to release. Two females were released alone: wild caught female due to the male dying before reintroduction, and captive female because the male escaped during transfer to release pen.

	Released numbers			
	Wild caught		Captive bred	
	Male	Female	Male	Female
Paired early	13	9	0	5
Paired late	1	0	5	6
Released alone	1	1	0	1
Sibling group	0	0	24	25
Total	15	10	29	37

Appendix 2. Habitat quality

Table A3. Habitat variables recorded at the centre point of all 200 m waterway sections, along with the type of covariate, a description of how the covariate was measured, and the parameter value associated with each covariate. Covariates and parameter values were taken from Telfer et al (2001). The habitat quality score for each section was derived by multiplying covariates by parameters and taking the sum. The bank selected for measurements of cover of vegetation, *Juncus* sp. and *Filipendula ulmaria* was alternated.

Variable	**Covariate**	**Description**	**Parameter**
Width	Continuous (cm)	Width of the waterway in cm	-0.0085
Penetrability	Categorical	Levels: 1) > 37 cm (very penetrable) 2) 25 – 37 cm 3) 12 – 25 cm 4) < 12 cm (un-penetrable) Steel rod (fencing pin: 1.2 x 130 cm) pushed in to bank using a single, firm push that was practiced for consistency beforehand. The depth reached was measured, and one measurement was taken per bank and averaged.	1 = 7.39 2 = 7.20 3 = 4.92 4 = 0.00
Vegetation cover	Continuous (%)	Measured in two contiguous 1 m^2 quadrats along a 2 m transect at a right angle to the water course and averaged.	0.019
Juncus sp.	Continuous (%)	As above	0.069
Filipendula ulmaria	Continuous (%)	As above	-0.095
Tree cover	Continuous (%)	% canopy cover directly above the centre point of the 200 m section	-0.029
Bed substrate	Categorical	Levels: 1) silt, sand & gravel 2) stones & boulders	1 = 0.00 2 = -2.53

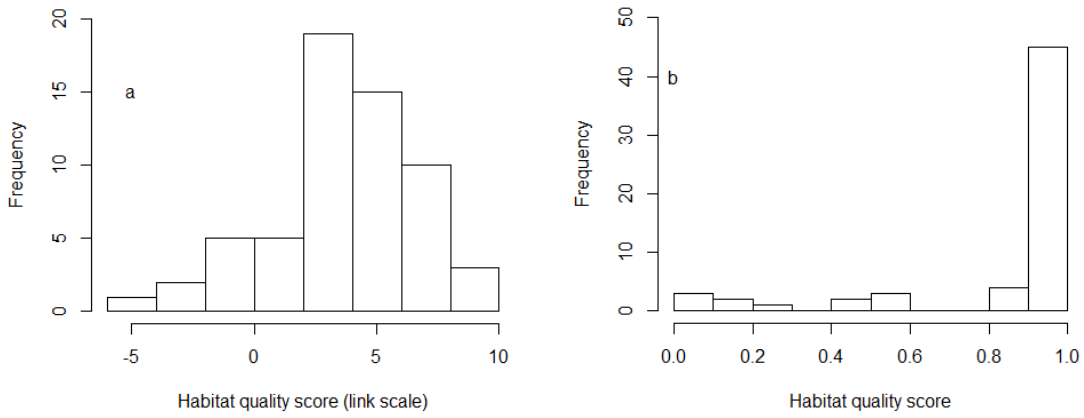

Fig. A1. In order to validate the habitat quality score used, we show the quality score distributions of those sections that were occupied at least once during the entire study period, where the quality score is shown a) on the link scale (logit), and b) as a probability (inverse of the logit).

Appendix 3. Survey effort

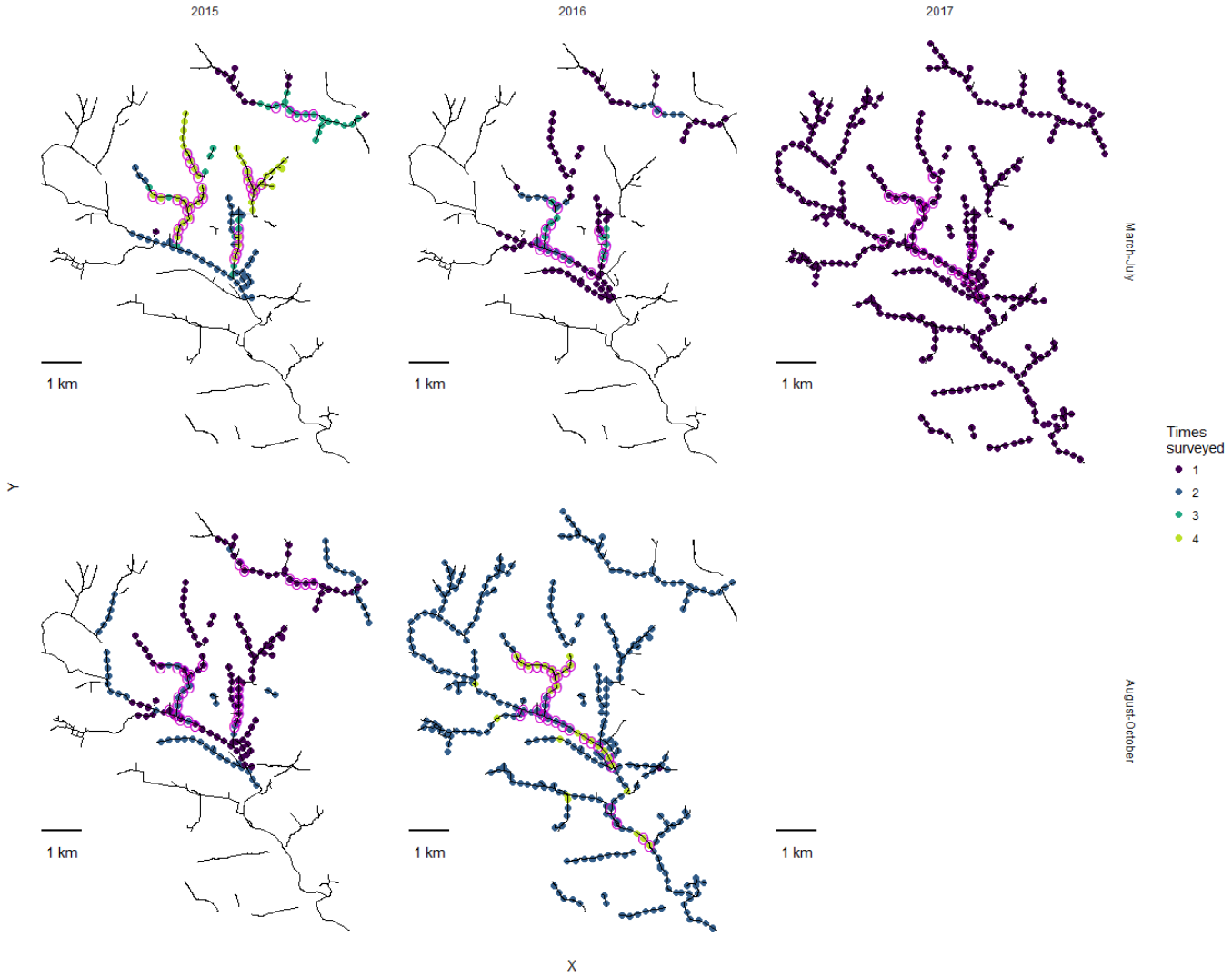

Fig. A2

Maps showing which 200 m sections that were surveyed and the number of times they were surveyed during different time periods. Pink circles show those cells that were found to be occupied at any time during the survey period, and as such we show how the surveyed area always extended beyond the known range of the population.

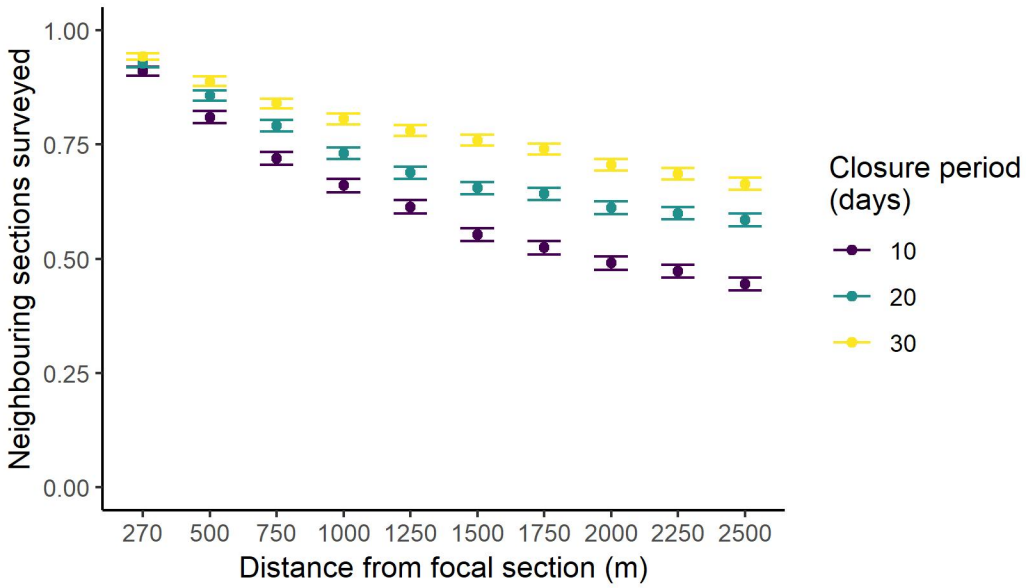

Figure A3. The mean proportion of neighbouring sections of that were surveyed in each concentric ring surrounding a focal section, within each closure period. Error bars show the 95 % confidence interval around the mean.

Appendix 4. Uncertainty around smoother

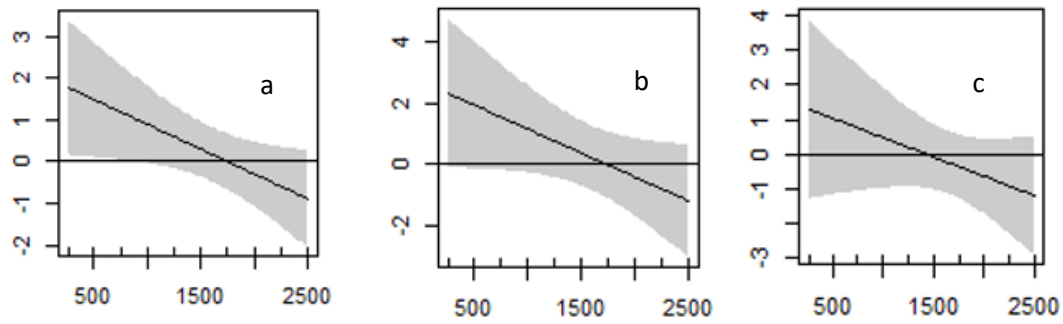

Fig. A4

The distance dependent effect of proportion occupancy in surrounding waterways on probability of persistence for the three assumptions of closure period: a) 10 days, b) 20 days, and c) 30 days. This model included a main effect of mean habitat quality in a radius of 500 m around the focal patch, and the interaction between this main effect and the mean occupancy in a radius of 1000 m. For all three closure period assumptions this model has a ΔAICc > 2 and < 4.

References

Strachan, R. et al. 2011. Water Vole Conservation Handbook, third ed. Wildlife. - Conservation Research Unit, Oxford University.

Telfer, S. et al. 2001. Metapopulation processes and persistence in remnant water vole populations. - Oikos 95: 31–42.