SAVING SCOTLAND'S RED SQUIRRELS

RESULTS OF SPRING 2014

SQUIRREL SURVEYS

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RESULTS OF SPRING 2014 SQUIRREL SURVEYS

1. SUMMARY

This report details the results of monitoring of red and grey squirrels organised by Saving Scotland's Red Squirrels (SSRS) in Spring 2014. The results for the northern half of Scotland were compared to similar surveys undertaken in Spring 2013, 2012 and 2011, while those in South Scotland were compared to the first set of surveys carried out in Spring 2013.

Taking the tetrads in the northern project areas together, the Spring 2014 results for grey squirrels show a large and statistically significant decline in the occurrence of grey squirrels in the tetrads since the first survey in Spring 2011. There was also significantly lower detection of grey squirrels in 2014 when compared with 2012. The decrease in detected distribution continued between 2013 and 2014, although the change was no longer significant. Overall, the trend is one of a reducing grey squirrel distribution sustained over the sample period 2011 to 2014. With continual recolonisation of the Central Lowlands control zone by grey squirrels from the south, the rate of decrease in detected range in this region can be expected to level out over time until a balance is reached between a small number of remaining squirrels removed and the number immigrating and reoccupying some of the tetrads each year.

The significant increase in detected distribution of red squirrels in the northern project areas that initially occurred between 2011 and 2012 was followed by small decreases in red squirrel detection between 2012 and 2013 and between 2013 and 2014. 2014's results showed this as a small decrease when compared with the two preceding years 2013 and 2012. Over the whole period between 2011 and 2014 there was a small increase of 6.9% in the number of tetrads in the sample where red squirrels were detected, which, however, was not significant.

The trend for red squirrels detected by the surveys is suggestive of a combination of the effects of the removal of grey squirrel competition and wider population fluctuations triggered by environmental conditions. The explanation for the poorer detection of red squirrels in 2013 and 2014 following the initial gain between 2011 and 2012 can probably be attributed to the very poor mast crop of Autumn 2012, leading to poor overwinter survival and poor breeding in 2013. In 2014 the red squirrel populations appear to be recovering to former levels, but it will need further years of monitoring to confirm this. This kind of population fluctuation is well-known in both red and grey squirrels, and its effects can also be seen in the annual fluctuations in grey squirrel distributions detected here, where poor overwinter survival likely assisted the project in its effort to decrease grey squirrel occurrence.

For South Scotland, the results revealed that the situation has remained similar to that of the previous year with no statistically significant differences in the proportions of red or grey squirrels occupying tetrads. This is good news as red squirrels remain very widespread across the region and grey squirrel detection in the surveys continues to be limited.

2. AIM OF THIS REPORT

Saving Scotland's Red Squirrels (SSRS) is a project to stop the decline of Scotland's core red squirrel populations. North of the Central Belt we aim to prevent the further replacement of red squirrels by grey squirrels by working to progressively reduce the geographic range and abundance of grey squirrels in and around Aberdeen, and by preventing their spread northwards from the Central Lowlands. This is achieved through a co-ordinated network of grey squirrel control at the interface between the red and grey squirrel distributions. In Aberdeenshire grey squirrel control began in 2007, 2010 for the Central Lowlands. South of the Central Belt the aim of the last 7 years has been to try to prevent the spread of squirrelpox (SQPV) northwards into the SQPV-free grey squirrels in the Central Belt. Grey squirrel control has focussed in areas where grey squirrel blood samples have tested SQPV-positive, rather than at trying to reduce the grey squirrel population overall, although this has sometimes followed the intensive trapping.

Monitoring in the North East and the Central Lowlands was set up in 2011 to provide evidence on which to assess the effects of grey squirrel control on both red and grey squirrel populations. This document reports the results of the Spring 2014 surveys and compares them to results obtained in 2011, 2012 and 2013. We provide estimates of the level of change and assess whether the results suggest that our Red Squirrel Protection Network is achieving benefits for red squirrels.

In South Scotland, distribution monitoring was carried out for the first time in Spring 2013, with a view to detecting the relative distributions of red and grey squirrels. The Spring 2014 surveys provide the first opportunity to compare distributions from one year to the next.

3. METHODOLOGY

To determine whether red and grey squirrels are present or absent in a particular area, monitoring tetrads (2 x 2km squares) were set up in 2011 for the North East and Central Lowlands, and in Spring 2013 for the Scottish Borders and Dumfries & Galloway. In each tetrad four feeder-boxes were positioned to sample right across the square, each with a sticky pad to collect hair-samples from visiting animals. Each feeder-box was checked by volunteers a total of three times over a period of six weeks and three hair samples collected from each box. Hairs were identified under a microscope. Each tetrad was then allocated to one of the following four categories: red squirrels only, grey squirrels only, both species or neither species.

In Spring 2011 the Project set up 48 tetrads in North East Scotland and the Central Lowlands. We continued to add further tetrads during the following years so that by Spring 2014 there were 124 tetrads set up across these areas, of which 112 were completed. This allows a comparison with three previous Spring surveys at a similar point in the life-cycle of the squirrel populations (adult winter survivors before young born in the early spring breeding season leave the drey and become available for survey).

In South Scotland 102 tetrads were set up in both Spring 2013 and Spring 2014. Of the 86 completed in 2014, 75 were complete in Spring 2013 and could therefore be directly compared.

For the analyses we have treated the North East and Central Lowlands samples combined and the South Scotland results separately.

The Spring 2014 surveys

Project Area	Completed tetrads	Incomplete tetrads
North East Scotland	46	4
Central Lowlands	66	8
South Scotland	86	13

The table above shows the number of tetrad surveys set up in Spring 2014. Of the 226 tetrads set up across project areas, 12 of the tetrads in the north and 13 in the south were incompletely surveyed: in some cases the sticky pads went missing or the volunteer was unable to complete the survey for some reason. A number of samples were returned stuck firmly to the wrong side of the backing paper so that the hair sample could not be properly analysed under the microscope, which is a shame after all the effort the surveyor put in to collect the samples. Finally 3 tetrads set up in the South were not surveyed at all.

Although some of the incomplete tetrads detected squirrel presence, the incomplete data were unsuitable for inclusion in the analysis. This partial data is, however, included in the maps.

4. RESULTS

The following table sets out the number of tetrads detecting either squirrel species, both species or neither species in each year.

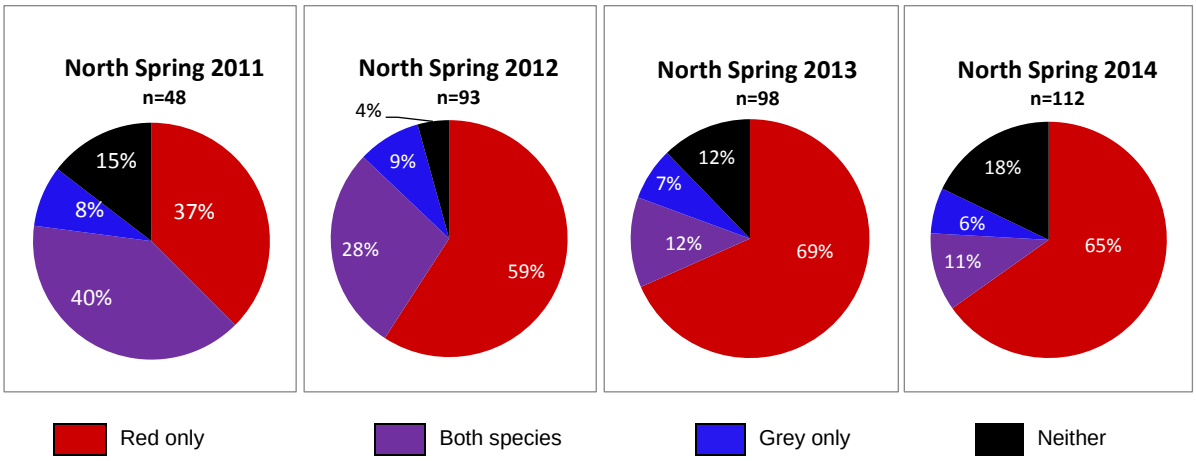
Project Area	Survey season	Red squirrels only	Grey squirrels only	Both Species	Neither species	Total no. of tetrads completed	(Total including incomplete tetrads)
North	Spring 2011	18	4	19	7	48	48
	Spring 2012	55	8	26	4	93	112
	Spring 2013	67	7	12	12	98	120
	Spring 2014	73	7	12	20	112	124
South	Spring 2013	41	15	7	25	88	102
	Spring 2014	44	16	8	18	86	99

Figures 1 a and b display this information graphically for visual comparison.

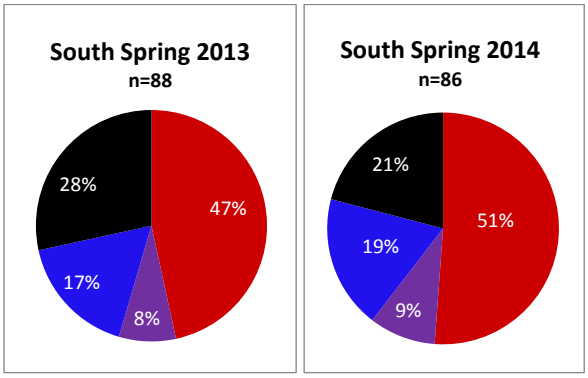
For those people in the northern half of the project who are interested to see the results obtained closer to home, we have split the tables into North East and Central Lowlands. Maps and tables showing the 2014 results for individual tetrads appear at the back of this report.

Figure 1. Proportions of tetrads with both species, either species or none detected.

a. North East Scotland and the Central Lowlands.



b. South Scotland



n= the number of tetrads completed

North East Scotland

Survey season	Red squirrels only	Grey squirrels only	Both Species	Neither species	Total no. of tetrads
Spring 2011	3	2	7	3	15
Spring 2012	19	5	6	1	31
Spring 2013	20	5	2	8	35
Spring 2014	26	5	2	13	46

Central Lowlands (Tayside and Argyll & Trossachs)

Survey season	Red squirrels only	Grey squirrels only	Both Species	Neither species	Total no. of tetrads
Spring 2011	15	2	12	4	33
Spring 2012	36	3	20	3	62
Spring 2013	47	2	10	4	63
Spring 2014	47	2	10	7	66

Replacement Index

In order to compare the results of pairs of tetrad surveys we calculated a Replacement Index (RI) using a table showing the changes that occurred in each tetrad between two surveys. This index was devised by Usher *et al*. (1992) who used it to examine the dynamics of two species within 10km grid squares for the whole of Britain from 1973 to 1988. In this report we have adopted this index in order to summarise the complex of changes in the presence/absence of either red squirrels, grey squirrels, both species or neither species in each of the tetrads. For this analysis we could only use tetrads that had been sampled in both years being compared.

For North Scotland we compared survey results first between Spring 2014 and Spring 2013, then between Spring 2014 and Spring 2012 and lastly Spring 2014 and Spring 2011. For South Scotland, results were compared between Spring 2014 and Spring 2013.

North East and Central Lowlands Combined: Spring 2013-Spring 2014

To compare the 2014 results with those from 2013, we compared 86 tetrads that were sampled in both years and looked at the changes in each tetrad. The following matrix table summarises the results.

Replacement Index Table: North East and Central Lowlands Combined: 2013-2014

		Spring 2014				
		Red	Both	Neither	Grey	*Total*
Spring 2013	Red	50	2	5	0	57
	Both	4	5	2	0	11
	Neither	3	1	7	1	12
	Grey	0	1	1	4	6
	Total	57	9	15	5	**86**

The table above presents all the possible changes to the tetrads and how many fall into each of four categories: red squirrels only, both red and grey squirrels, neither species, grey squirrels only. The rows describe the state of the tetrad in the Spring 2013 survey and the columns the tetrads in the Spring 2014 survey. For example, 4 tetrads had both species of squirrel in Spring 2013 but only reds in Spring 2014; and 5 tetrads had both red and grey squirrels in both the 2013 and 2014 surveys. Two tetrads gained grey squirrels where in 2013 only red squirrels were detected: these were Comrie in Tayside and Carnie in the North East. Neither of these results are surprising; in Comrie the feeder box that detected grey squirrels is located near a woodland known to support a significant grey squirrel population where the owner does not allow any trapping. The result for the tetrad in Carnie Wood reflects a change in the survey methodology from a single isolated transect in 2013 to the installation of four feeder boxes covering a more representative area of the woodland in 2014.

The shaded diagonal represents no change. Above the shaded diagonal, the figures represent changes in favour of grey squirrels; below the diagonal they represent changes in favour of red squirrels. We calculated a Replacement Index as follows:

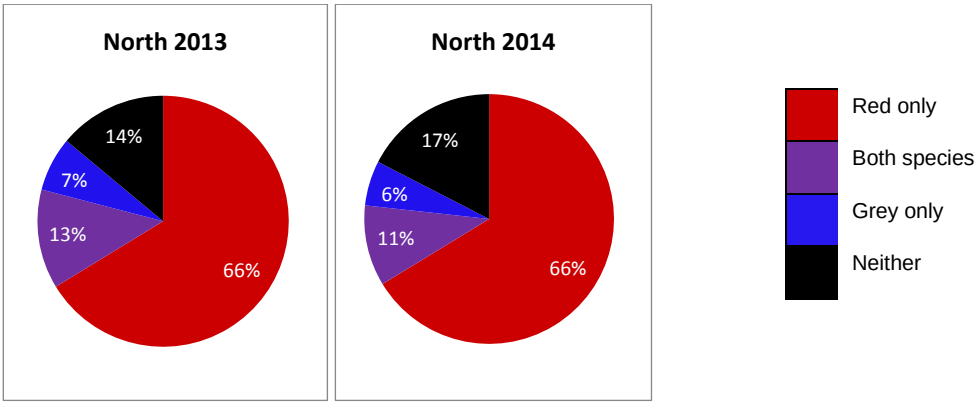
$$\frac{\text{(sum of values above the diagonal) - (sum of values below the diagonal)}}{\text{(the sum of all values in matrix except the “neither-neither” value)}}$$

A negative index represents a change in favour of red squirrels and a positive index represents a change in favour of grey squirrels.

The Replacement Index comparing Spring 2014 with Spring 2013 is calculated to be 0. This is an index showing no change in favour of either red or grey squirrels.

A visual representation of the results is shown in Figure 2

Figure 2. Proportions of the 86 matched tetrads with either species, both species or none detected in North East Scotland and the Central Lowlands, comparing 2014 with 2013



North East and Central Lowlands Combined: Spring 2012-Spring 2014

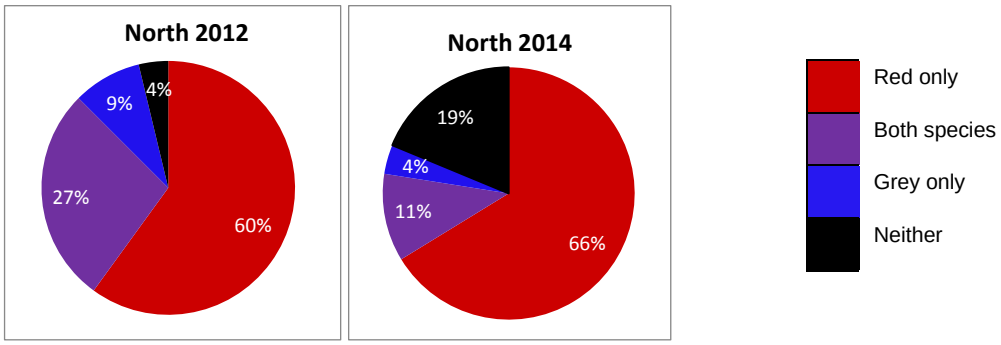
For the comparison between 2012 and 2014, there were 80 tetrads that were surveyed in both years.

Replacement Index Table: North East and Central Lowlands Combined: 2012-2014

		Spring 2014				
		Red	Both	Neither	Grey	*Total*
Spring 2012	Red	35	4	9	0	48
	Both	16	2	4	0	22
	Neither	1	1	1	0	3
	Grey	1	2	1	3	7
	Total	53	9	15	3	**80**

The greatest number of changes (22) were beneficial to red squirrels, mostly through a loss of grey squirrels from tetrads previously with both species (16). It is concerning to note that nine tetrads appear above the shaded diagonal, with a change from “red only” to “neither species”. The Replacement Index for this survey period was calculated as -0.06, representing a small change in favour of red squirrels.

Figure 3. Proportions of the 80 matched tetrads with either species, both species or none detected in Aberdeenshire and the Central Lowlands, comparing 2014 with 2012



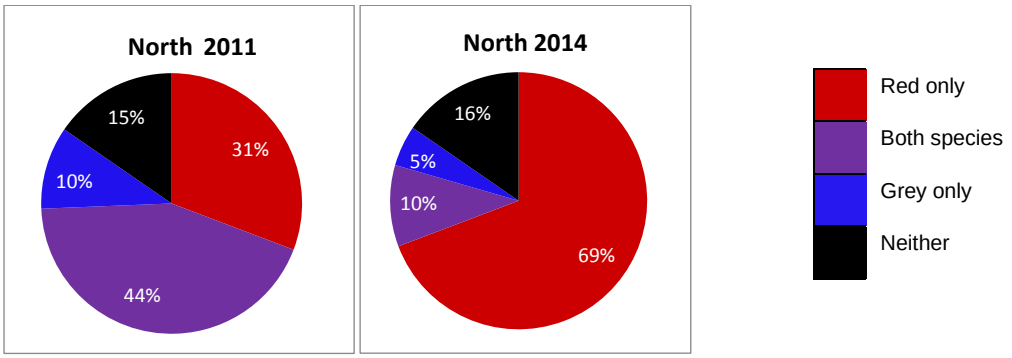
North East and Central Lowlands Combined: Spring 2011-Spring 2014

Replacement Index Table: North East and Central Lowlands Combined: 2011-2014

		Spring 2014				
		Red	Both	Neither	Grey	*Total*
Spring 2011	Red	11	1	0	0	12
	Both	11	2	4	0	17
	Neither	4	0	1	1	6
	Grey	1	1	1	1	4
	Total	27	4	6	2	**39**

For the comparison between 2011 (our first survey) and 2014, a smaller sample of 39 tetrads were surveyed in both years.The larger numbers of changes (18) were beneficial to red squirrels, mostly through a loss of grey squirrels from tetrads previously with both species (11), or red squirrels now being detected in squares that had previously not detected any squirrels (4). It is interesting to note that only two tetrads appear to have gained grey squirrels, changing from “red only” to “both species” and “neither species” to “grey only”. The Replacement Index for this survey period was calculated as -0.32, which represents a large positive change in favour of red squirrels.

Figure 4. Proportions of the 39 matched tetrads with either species, both species or none detected in North East Scotland and the Central Lowlands, comparing 2014 with 2011



South Scotland: Spring 2013-Spring 2014

The two annual samples for South Scotland allowed us to compare 75 tetrads that were sampled in both years.

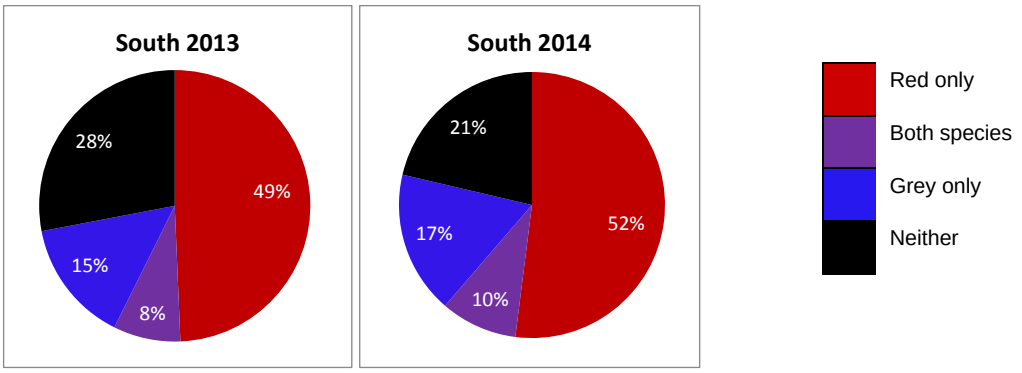
Replacement Index Table: South Scotland: 2013-2014

		Spring 2014				
		Red	Both	Neither	Grey	*Total*
Spring 2013	Red	32	3	2	0	37
	Both	1	4	0	1	6
	Neither	4	0	13	4	21
	Grey	2	0	1	8	11
	Total	39	7	16	13	**75**

In this case, 10 changes were beneficial to grey squirrels but a similar number, 8, were in favour of reds. The changes beneficial to greys occurred where the detection of "greys only" in tetrads that previously had neither species (4), but the same number of tetrads (4) changed from "neither species" to "red only". Three squares changed from "red only" to "both species" and 2 changed from "grey only" to "red only".

The Replacement Index for this survey period was calculated as +0.03, representing a very small change in favour of grey squirrels.

Figure 5. Proportions of the 75 matched tetrads with either species, both species or none detected in South Scotland, comparing 2014 with 2013



5. DISCUSSION

The changes that the North Scotland surveys have detected over the year Spring 2013 to Spring 2014 suggest that the situation has remained fairly stable across the region with no significant change in favour of either red or grey squirrels over the period.

On the other hand, when compared with Spring 2012, our 2014 data shows a small positive change in favour of red squirrels with a large significant decrease in the number of tetrads detecting grey squirrels. An even more positive result for red squirrels was found between

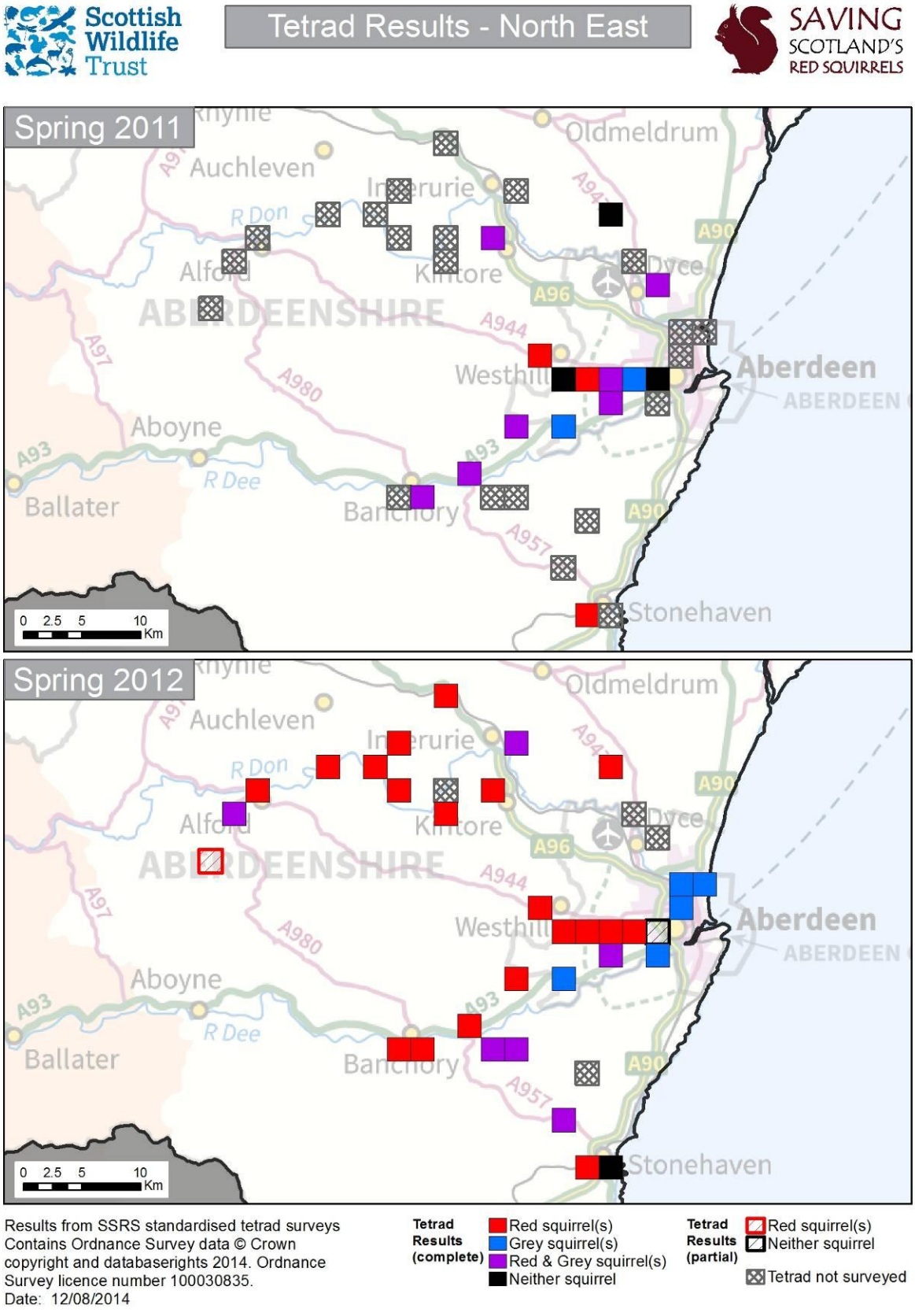
the Spring 2014 and the Spring 2011 baseline data, suggesting that early changes in occupancy of the two squirrels have been sustained.

In South Scotland the first systematic tetrad survey was conducted in 2013, and repeated in Spring 2014. As for the northern half of the project, the data suggested a stable situation overall, with the replacement index for South Scotland showing only a tiny change in favour of grey squirrels, partly balanced by a tiny increase in the percentage of tetrads with red squirrels detected (5%). In order to properly evaluate the stability of squirrel distribution over time in South Scotland it will be necessary to repeat these surveys in coming years.

We plan to repeat the surveys in Spring 2015, which after an apparently good breeding year, may reveal greater changes than those we picked up this year.

Saving Scotland's Red Squirrels wishes to thank all the volunteers who gave up their time to help us collect this data, and all those landowners who co-operated by allowing us access to their land, without which this research would not be possible.

Figure 6. Maps comparing the results of tetrads for North East Scotland for Spring 2011-2014



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Tetrad Results - North East

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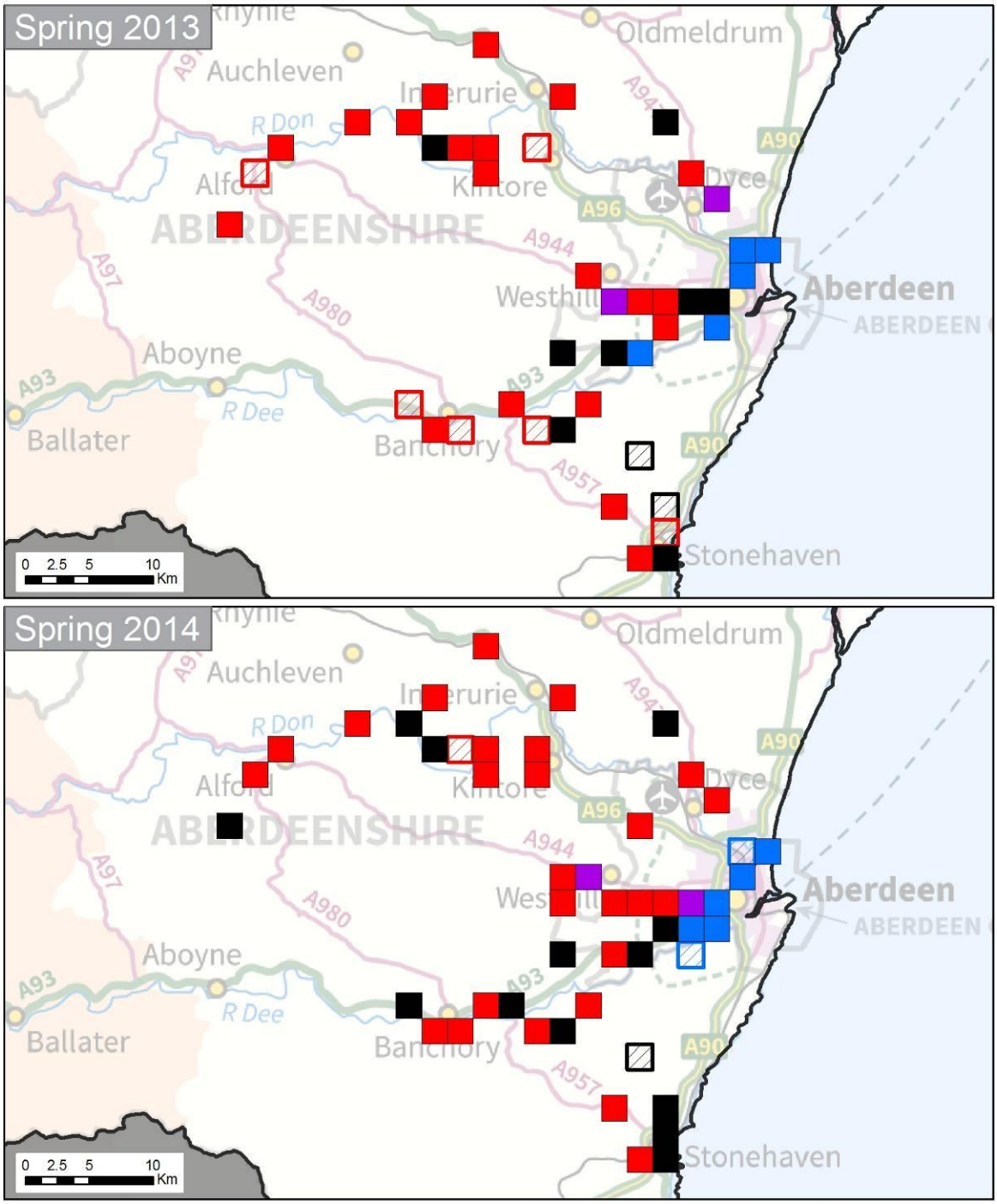

Results from SSRS standardised tetrad surveys
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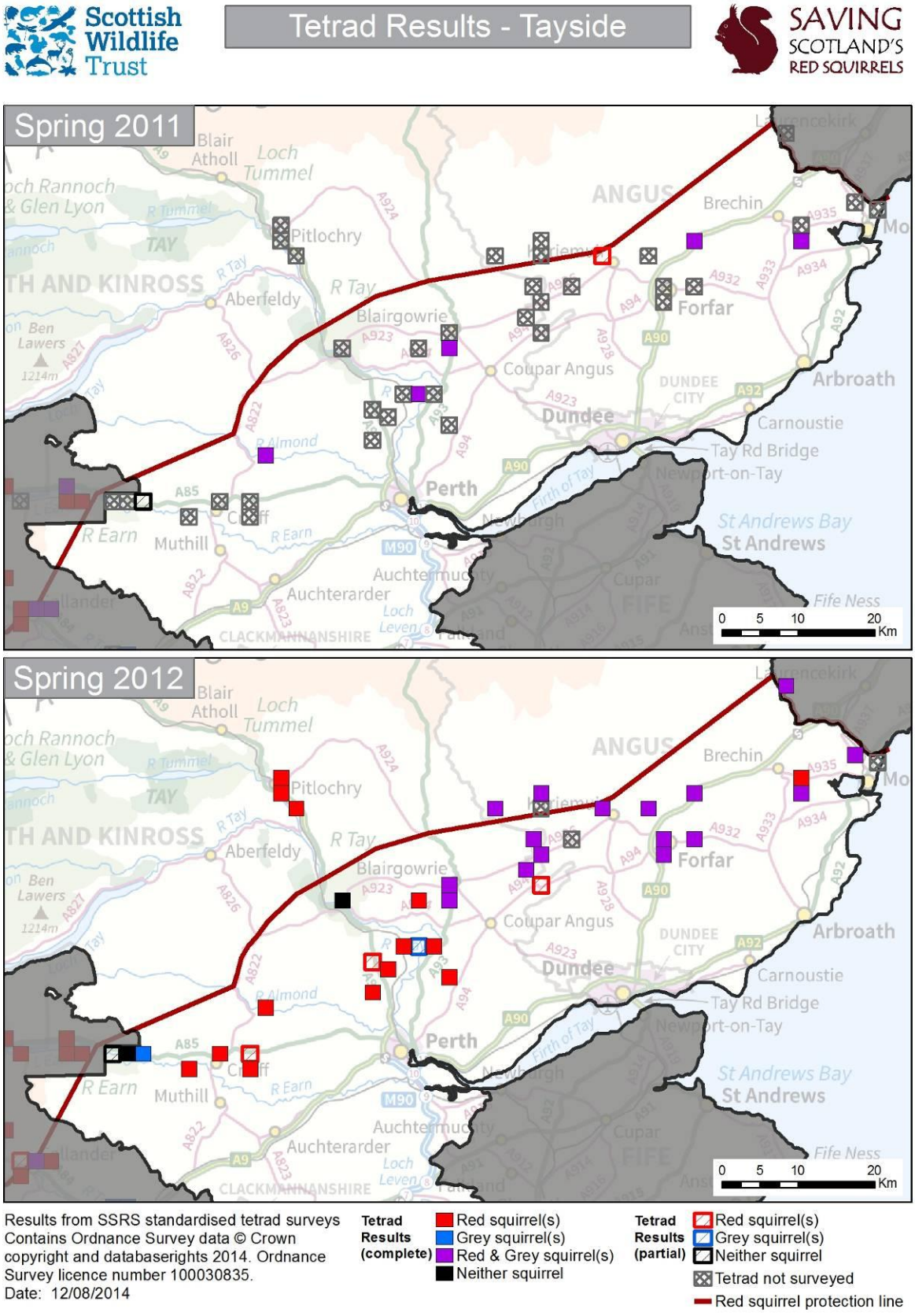
Date: 12/08/2014

Tetrad Results (complete)
- Red squirrel(s)
- Grey squirrel(s)
- Red & Grey squirrel(s)
- Neither squirrel

Tetrad Results (partial)
- Red squirrel(s)
- Grey squirrel(s)
- Neither squirrel

Figure 7. Maps comparing the results of tetrads for Tayside for Spring 2011-2014



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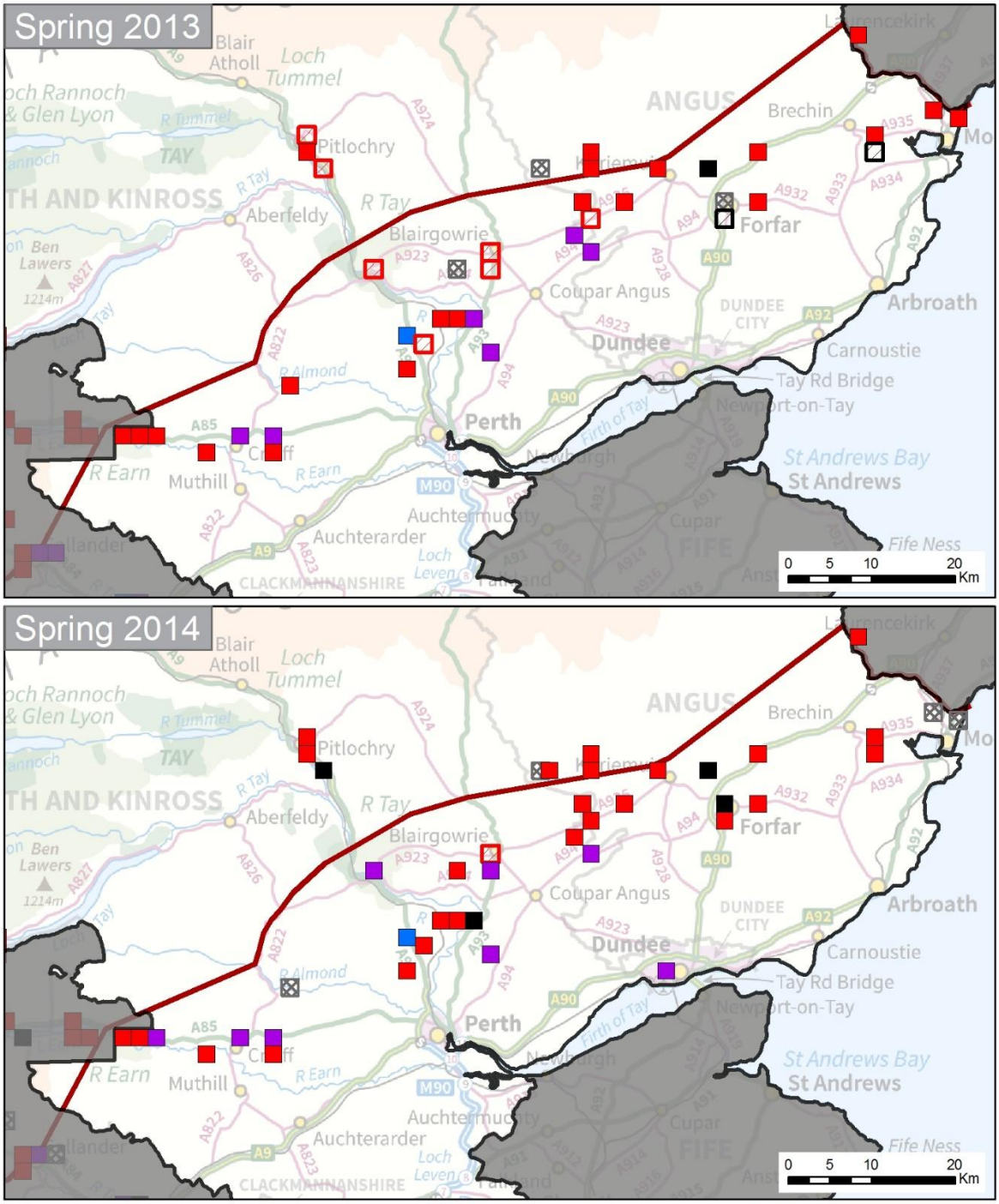
Tetrad Results - Tayside

SAVING SCOTLAND'S RED SQUIRRELS



Results from SSRS standardised tetrad surveys
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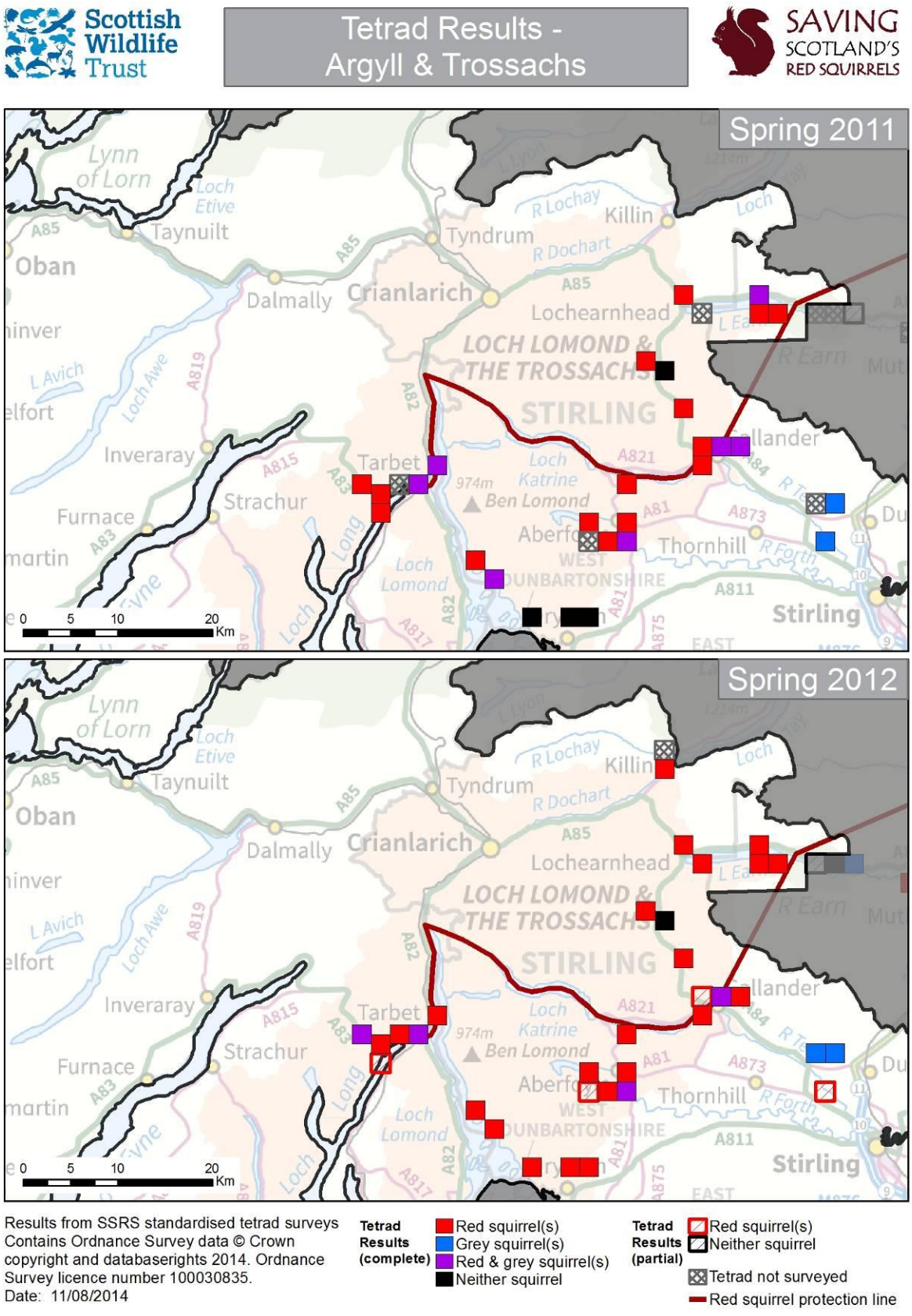
Date: 29/09/2014

Tetrad Results (complete)
- Red squirrel(s)
- Grey squirrel(s)
- Red & Grey squirrel(s)
- Neither squirrel

Tetrad Results (partial)
- Red squirrel(s)
- Neither squirrel
- Tetrad not surveyed
- Red squirrel protection line

Figure 8. Maps comparing the results of tetrads for Argyll & Trossachs for Spring 2011-2014



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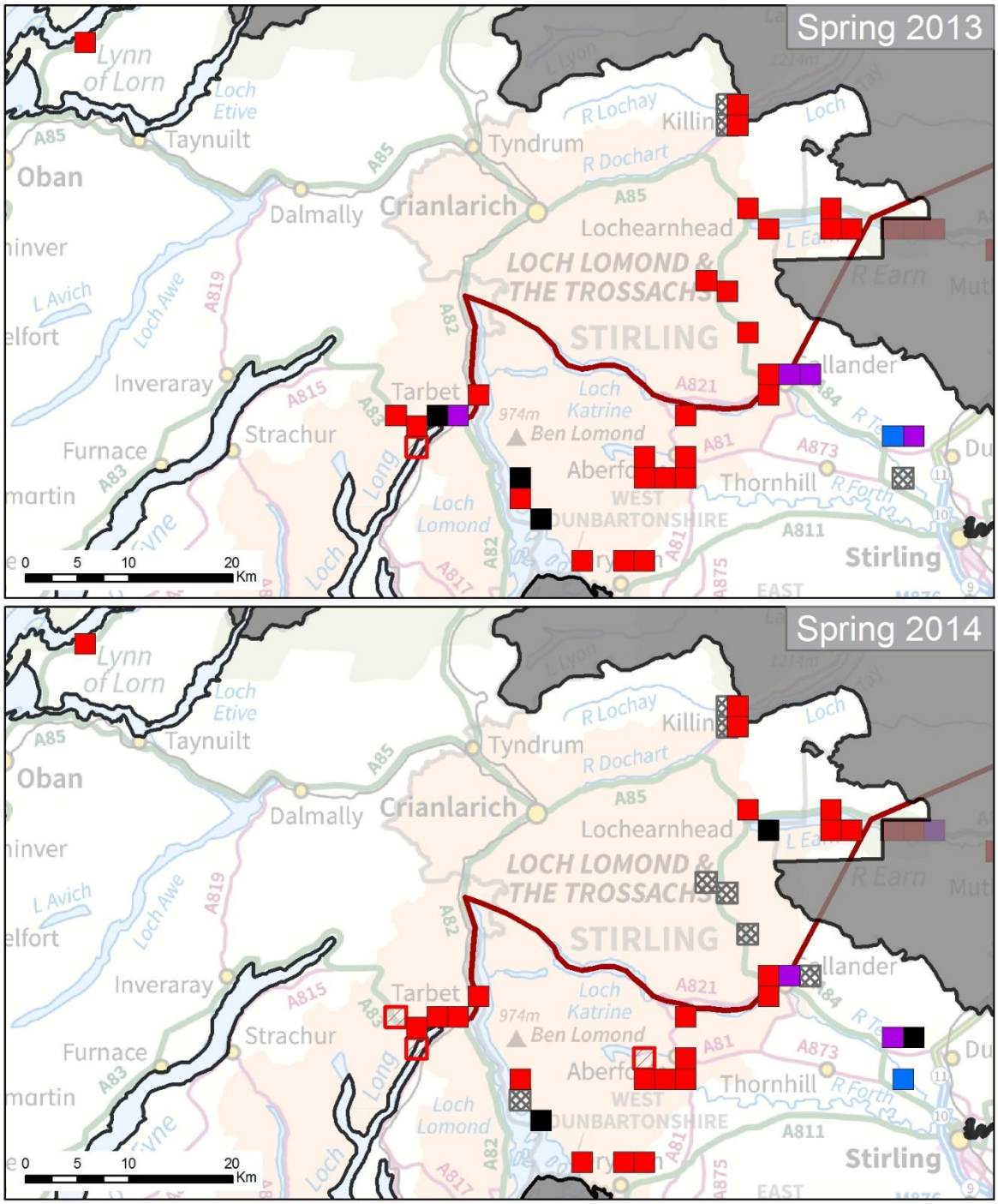
Tetrad Results - Argyll & Trossachs

SAVING SCOTLAND'S RED SQUIRRELS



Results from SSRS standardised tetrad surveys
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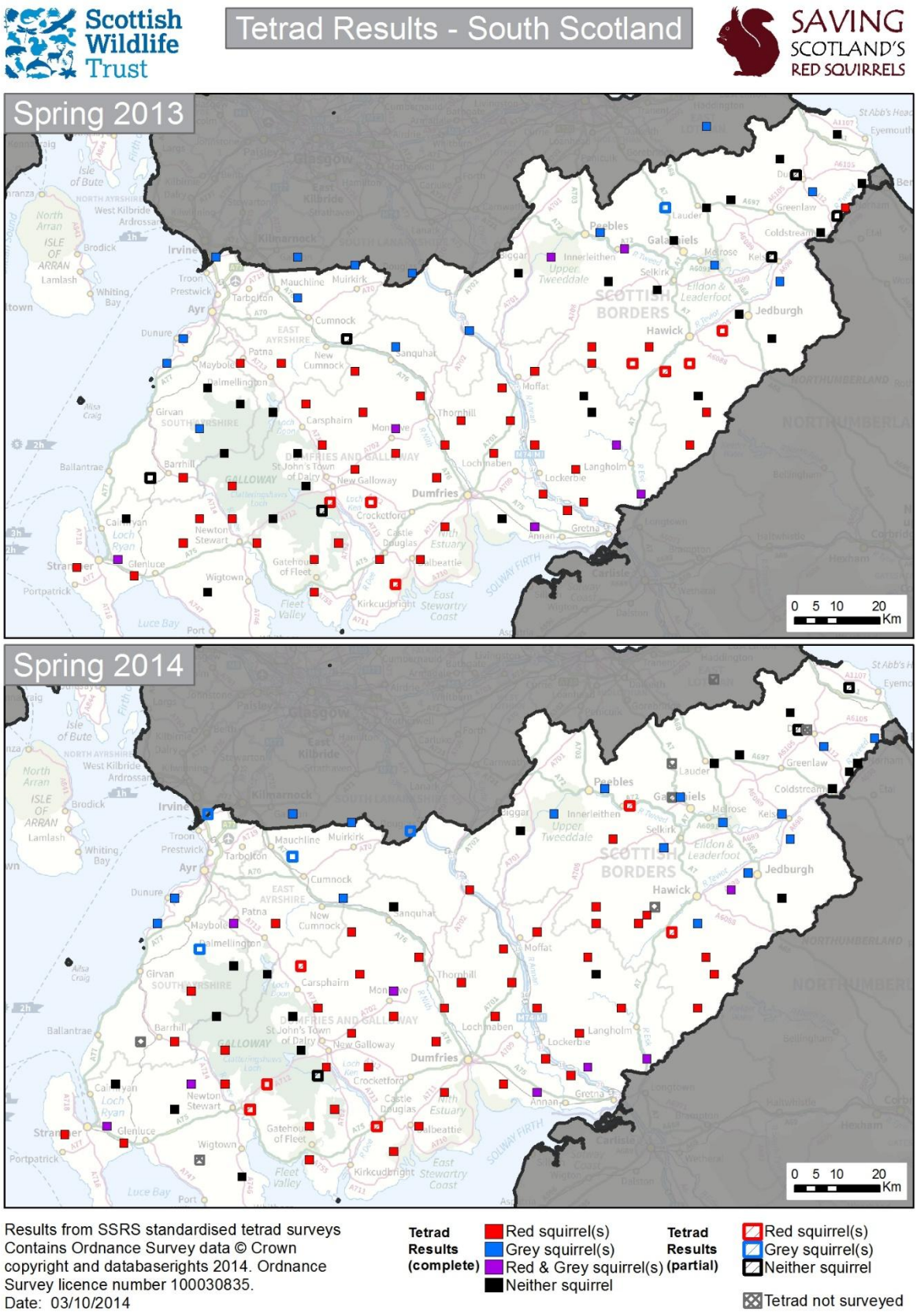
Date: 29/09/2014

Tetrad Results (complete)
- Red squirrel(s)
- Grey squirrel(s)
- Red & Grey squirrel(s)
- Neither squirrel

Tetrad Results (partial)
- Red squirrel(s)
- Tetrad not surveyed
- Red squirrel protection line

Figure 9. Maps comparing the results of tetrads for South Scotland for Spring 2013-2014



Tetrad Results 2014

North East		Argyll & Trossachs		Tayside	
Tetrad	**Species**	**Tetrad**	**Species**	**Tetrad**	**Species.**
NJ5210	Neither	NM9440	Red only	NN7222	Red only
NJ5414	Red only	NN2404 *	Red only	NN7422	Red only
NJ5616	Red only	NN2601 *	Red only	NN7622	Both species
NJ6218	Red only	NN2603	Red only	NN8220	Red only
NJ6618	Neither	NN2804	Red only	NN8622	Both species
NJ6816	Neither	NN3004	Red only	NN9020	Red only
NJ6820	Red only	NN3206	Red only	NN9022	Both species
NJ7016 *	Red only	NN4800 *	Red only	NN9456	Red only
NJ7214	Red only	NN5200	Red only	NN9458	Red only
NJ7216	Red only	NN5204	Red only	NN9654	Neither
NJ7224	Red only	NN5732	Red only	NO0242	Both species
NJ7614	Red only	NN5734	Red only	NO0630	Red only
NJ7616	Red only	NN5824	Red only	NO0634	Grey only
NJ7800	Neither	NN6006	Both species	NO0833	Red only
NJ7804	Red only	NN6008	Red only	NO1036	Red only
NJ7806	Red only	NN6022	Neither	NO1236	Red only
NJ7820	Red only	NN6208	Both species	NO1242	Red only
NJ8006	Both species	NN6622	Red only	NO1436	Neither
NJ8200	Red only	NN6624	Red only	NO1632	Both species
NJ8204	Red only	NN6822	Red only	NO1642	Both species
NJ8400	Neither	NN7202	Both species	NO1644 *	Red only
NJ8404	Red only	NN7402	Neither	NO2354	Red only
NJ8410	Red only	NS3698	Red only	NO2646	Red only
NJ8602	Neither	NS3894	Neither	NO2750	Red only
NJ8604	Red only	NS4290	Red only	NO2844	Both species
NJ8618	Neither	NS4690	Red only	NO2848	Red only
NJ8800 *	Grey only	NS4890	Red only	NO2854	Red only
NJ8802	Grey only	NS4898	Red only	NO2856	Red only
NJ8804	Both species	NS5098	Red only	NO3250	Red only
NJ8814	Red only	NS5298	Red only	NO3654	Red only
NJ9002	Grey only	NS7398	Grey only	NO3730	Both species
NJ9004	Grey only			NO4254	Neither
NJ9012	Red only			NO4450	Neither
NJ9206	Grey only			NO4448	Red only
NJ9208 *	Grey only			NO4850	Red only
NJ9408	Grey only			NO4856	Red only
NO6696	Neither			NO6070	Red only
NO6894	Red only			NO6256	Red only
NO7094	Red only			NO6258	Red only
NO7296	Red only				
NO7496	Neither				
NO7694	Red only				
NO7894	Neither				
NO8096	Red only				
NO8288	Red only				
NO8484	Red only				
NO8492 *	Neither				
NO8684	Neither				
NO8686	Neither				
NO8688	Neither				

South Scotland					
Tetrad	**Species**	**Tetrad**	**Species**	**Tetrad**	**Species.**
NS2208	Grey only	NT5632	Grey only	NX5698 *	Red only
NS2614	Grey only	NT5816	Both species	NX5852	Red only
NS3202 *	Grey only	NT6048	Neither	NX5860	Red only
NS3434 *	Grey only	NT6220	Grey only	NX6072 *	Neither
NS4008	Both species	NT7014	Neither	NX6088	Red only
NS5008	Red only	NT7034	Grey only	NX6274	Red only
NS5424 *	Grey only	NT7228	Grey only	NX6464	Red only
NS5434	Grey only	NT7258	Neither	NX6882	Red only
NS6614	Grey only	NT7454 *	Neither	NX7096	Red only
NS6806	Red only	NT8050	Grey only	NX7274	Red only
NS6832	Grey only	NT8240	Neither	NX7460 *	Red only
NS7812	Neither	NT8644	Neither	NX7854	Red only
NS8230 *	Grey only	NT8664 *	Neither	NX7886	Red only
NS8400	Red only	NT8846	Neither	NX7892	Both species
NS9616	Red only	NT9252	Grey only	NX8460	Red only
NT0402	Red only	NX0058	Red only	NX8880	Red only
NT0830	Neither	NX1060	Both species	NX9068	Red only
NT1206	Red only	NX1270	Neither	NX9088	Red only
NT1634	Grey only	NX1456	Red only	NX9494	Red only
NT2400	Red only	NX2664	Neither	NY0286	Red only
NT2608	Red only	NX2680	Red only	NY0470	Red only
NT2612	Red only	NX3070	Both species	NY0694	Red only
NT2840	Grey only	NX3092	Red only	NY1268	Both species
NT3028	Red only	NX3686	Neither	NY1288	Red only
NT3436 *	Red only	NX3870	Red only	NY1476	Red only
NT3608	Red only	NX3878	Red only	NY2072	Red only
NT3810	Red only	NX4098	Neither	NY2282	Red only
NT4226	Grey only	NX4248	Neither	NY2474	Both species
NT4406 *	Red only	NX4464 *	Red only	NY2696	Neither
NT4638	Grey only	NX4870 *	Red only	NY3288	Red only
NT5008	Grey only	NX4896	Neither	NY3876	Both species
NT5200	Red only	NX5486	Neither	NY5088	Red only
NT5446	Neither	NX5678	Neither	NY5496	Red only

* Tetrad only completed partially so not included in analysis