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ENVIRONMENT AND HERITAGE SERVICE

Recent changes in the distribution of red squirrels in Northern Ireland

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Contents

Executive Summary

This report details the findings of a recent survey of squirrels within Northern Ireland. The relative distribution of red and grey squirrels in the areas of interface in the distribution of the two species was examined. This report compares the current study with the results of O'Teangana (1999). O'Teangana undertook an extensive survey of woodlands throughout Northern Ireland during 1995 and 1996. O'Teangana (1999) concluded that the ecological requirement of the red squirrel, i.e. the absence of the grey squirrel (Gurnell & Pepper, 1993), will not be met in Northern Ireland, as the latter disperses to occupy all suitable habitat throughout the region.

The aim of the current study was to assess the current status of the red squirrel, to update the known distributions of red and grey squirrels and to examine the recent grey squirrel range expansion throughout Northern Ireland in comparison to O'Teangana (1999).

The presence of squirrels in the red squirrel preferred areas (McGhie & Milburne, 2000) and the areas of interface in the distribution of the two species in Northern Ireland (i.e. east and west Fermanagh, Antrim and east Londonderry) was examined during 2002. A total of 80 sites were surveyed. Since the first complete survey of squirrels in Northern Ireland (1995/1996 – O'Teangana, 1999), grey squirrels have undergone continued range expansion, replacing red squirrels in many woodlands. Some conifer dominated upland woodlands, however, still support just red squirrels or both species. Grey squirrels were recorded in previously unoccupied areas, particularly in the Dungiven/Limivady area and in West Antrim. O'Teangana (1999) reported that Antrim remained the only county in Northern Ireland without a large grey squirrel population. This is not now the case. Grey squirrels have moved into woodlands in south and west Antrim. The populations of red squirrels only along the glens in east Antrim are, however, still present. The grey squirrels have been spreading towards these woodlands from the west and the south.

Throughout the 80 sites there has been a net loss of red squirrels from a total of four sites. These sites are concentrated around Londonderry and east Fermanagh, with only one site where red squirrels have disappeared from in Antrim (Carrickfergus). Red squirrels were recorded in seven woodlands where they were unrecorded during the 1995 survey. Of these seven sites, two previously had only grey squirrels while four sites had been recorded as having no squirrels present.

Throughout the survey sites, there has been a greater spread of grey squirrels

than of red squirrels. There has been a net gain of grey squirrels in 14 woodlands. Of these sites nine previously had no squirrels. These sites are concentrated in Limivady and north east Antrim. In general there seems to have been a North West colonisation of previously unoccupied sites. Grey squirrels have replaced red squirrels completely in four sites where red squirrels only were recorded during the 1995 survey. A further four sites which had red squirrels only, now have both species. Since the 1995/1996 survey, grey squirrels have undergone continued range expansion.

The grey squirrel is continuing to expand its range in Northern Ireland. Long term red squirrel survival is probable only in coniferous habitat (O'Teangana, 1999). The areas with the largest number of red squirrel only sites in Northern Ireland is within north-east Antrim. Red squirrels are also still present throughout Fermanagh, Tyrone and Londonderry, but grey squirrels are also widespread in these areas. The areas within north-east Antrim represent the best possibility for conserving red squirrels and should be adopted and managed as red squirrel reserves.

Recommendations for Future monitoring and research

1. Squirrel populations throughout Northern Ireland should be monitored. A resurvey should be carried out in 2004 - as outlined in the Species Action Plan (SAP). It is recommended that all of the original 261 sites (O'Teangana, 1999) are surveyed to assess red squirrel occurrence. Surveys should be repeated at three yearly intervals.
2. Yearly monitoring of red squirrel populations in the potential red squirrel reserves, i.e. north-east Antrim.
3. Possible sites for red squirrel translocations should be assessed to establish their suitability as red squirrel reserves.
4. Further research should be initiated to investigate:

4.1 The co-existence of red and grey squirrels including:

- Differences in territory size and usage by red and grey squirrels.
- Behavioural interactions between red and grey squirrels.
- The mechanisms of red squirrel displacement by grey squirrels.
- The timescale involved in red squirrel displacement by grey squirrels.

These research initiatives could be targeted in Belvoir Forest Park, Tollymore

Forest Park and Castle Archdale Country Park as data is already available regarding when grey squirrels were first observed in these areas.

4.2 The genetic status and population dynamics of the red squirrel in Northern Ireland.

4.3 The prevalence of the Parapox virus in red and grey squirrels throughout Northern Ireland.

1. Introduction

The red squirrel *Sciurus vulgaris* is found throughout most of Europe and northern Russia. It is native to Ireland although it is thought to have become extinct here by the early eighteenth century, probably as a result of deforestation, but was reintroduced in the first half of the nineteenth century. Populations of red squirrels in Great Britain have suffered markedly over the last 50 years with the introduced grey squirrel *Sciurus carolinensis* replacing the species throughout most of England and Wales. Throughout this century successive distribution maps have shown the grey squirrel expand its range in the British Isles at the expense of the red squirrel (Shorten, 1946, 1953, 1957; Lloyd, 1962, 1983; Ní Lamhna, 1979; Gurnell, 1991a, b; Pepper, 1992; O'Teangana *et al.*, 2000). The distribution of the red squirrel in the British Isles is now largely confined to Scotland and Ireland, with small isolated populations elsewhere. Furthermore, in southern Britain, where red squirrels are sympatric with grey squirrels, the former are strictly associated with coniferous woodland (Lloyd, 1983), indicating that they can compete more successfully in this habitat. This has also been the case in Northern Ireland (O'Teangana, 1999).

The grey squirrel was introduced from the USA into England and Wales from 1876 to 1929 and into Scotland from Canada between 1892 and 1920 (Gurnell, 1991b). Subsequently it was introduced from England into Ireland at Castle Forbes, Co. Longford in 1911 (Watt, 1923), where six pairs were released. Distribution surveys have shown its continued increase to date (National Parks & Wildlife Service, 1968, 1973; Ní Lamhna, 1979; Ulster Wildlife Trust & Forest Service, 1993; Gettinby, 1994; Tagney & Montgomery, 1995; O'Teangana *et al.*, 2000). In both its European and North American ranges, the grey squirrel occurs predominately in broadleaved woodland, including parks, gardens and hedgerows (Gurnell, 1991b). Deciduous woodland is the dominant vegetation over most of Ireland. Consequently, the grey squirrel has spread freely since its introduction (MacKinnon, 1978; Reynolds, 1985; O'Teangana *et al.*, 2000).

The grey squirrel was first recorded in Northern Ireland in Co. Fermanagh in 1945 (Henderson, 1947) and Co. Armagh in 1953 (Jackson, 1959-61). Two limited surveys of Northern Ireland (Ulster Wildlife Trust & Forest Service, 1993; Gettinby, 1994) concluded that the grey squirrel had expanded its range and was present in every county, apart from Antrim. Tagney & Montgomery (1995), however, reported that the grey squirrel had increased its range further and extended to a few sites in Co.

Antrim.

Since its introduction, the grey squirrel has greatly increased its range (O'Teangana *et al.,* 2000). It expanded at a rate of approximately 1.5 km per year over the first ten years (Watt, 1923). There have been some natural barriers to the spread of the grey squirrel; the River Shannon slowed its expansion westwards, Lower Lough Erne northward and Lough Neagh/Lower Bann River into the north-east (O'Teangana *et al.,* 2000). In all cases, however, the grey squirrel has overcome these obstacles, or crossed bridges as is the case in the Lower Bann River.

Many reasons for the decline of the red squirrel have been proposed; the spread of and competition with the grey squirrel, disease and habitat loss and fragmentation making some areas less suitable for red squirrels and increasing their vulnerability to displacement by grey squirrels (Skelcher, 1997). References to the timescale of red squirrel replacement by the grey squirrel in woodlands have varied from six years (Skelcher, 1997), eleven years (Reynolds, 1985) to several decades (Lurz *et al.,* 1995). Red squirrels appear to suffer competitive exclusion by a species better adapted to conditions in the fragmented British and Irish woodlands. The competitive advantage of the grey squirrel over the red squirrel is thought to be related to areas with a higher proportion of deciduous tree species in woodland (e.g. Gurnell, 1987; Kenward & Holm, 1989; Kenward & Walls, 1991; Gurnell & Pepper, 1991, 1993; Kenward *et al.*, 1992; Lurz & Garson, 1992; Lurz *et al.*, 1995; Kenward *et al.*, 1998). Lower population densities of red than grey squirrels in deciduous woodlands (Mackinnon, 1978), and the prolonged persistence of red squirrels with grey squirrels without any expansion of range by the red squirrel, suggest that competition is the main factor explaining their loss (Gurnell, 1987).

Grey squirrels are larger then red squirrels and increase survival on a high bulk spring diet of shoots and bulbs (Moller, 1983). Furthermore, grey squirrels also accumulate relatively more fat during the winter, which would prolong survival in deciduous woodlands, when frost or snow reduces access to cached seeds. Conversely, red squirrels are smaller with a more arboreal habitat, which is associated with feeding in the conifer canopy through most of their Eurasian range (Kenward & Tonkin, 1986). In other instances, both species appear to co-occur indefinitely (Tangney & Montgomery, 1995). Yet, the over-whelming circumstantial evidence indicates that grey squirrel presence has a negative effect on sympatric red squirrels (Skelcher, 1997). Red squirrel populations have remained for the longest periods after

the arrival of grey squirrels in areas with extensive conifer woodland (Tittensor, 1977; Gurnell, 1987; Lurz *et al.,* 1995). Furthermore, both species have occurred together for several decades suggesting, that reduced survival of grey squirrels in coniferous woodland may give red squirrels a competitive advantage that enables them to persist (Lurz *et al.,* 1995).

In Northern Ireland coniferous plantation, predominately Sitka Spruce, is the principle woodland resource in the uplands which is managed by the Forest Service, Department of Agriculture and Rural Development (DARDNI) (Cooper *et al.,* 2002). Woodland and scrub habitats composed of broadleaf trees and shrubs such as Ash, Sycamore, Hazel, Birch, Willow, Alder and Gorse are distributed primarily in lowland landscapes as small parcels of usually privately owned land (Cooper *et al.,* 2002). These habitats have a much smaller area than coniferous plantations. Coniferous plantation is the largest woodland and scrub habitat in Northern Ireland with a cover of 4.6% in Northern Ireland, comprising 11% of the upland landscape (Cooper *et al.,* 2000). There has been a 13% increase in this woodland type since 1992 (7,305 ha, Cooper *et al.,* 2000). Broadleaf semi-natural woodland covers 1.7% of the Northern Ireland landscape. Broadleaf plantation has increased by 40%, but covers only 0.4% of the Northern Ireland landscape.

The red squirrel is listed on Appendix III of the Bern Convention and is protected by Schedules 5 and 6 of the Wildlife and Countryside Act and Schedules 5 and 6 of the Wildlife (Northern Ireland) Order 1985. In 1999 the first systematic work on the distribution and ecology of red and grey squirrels in Northern Ireland was completed (O'Teangana, 1999). During this survey, 261 sites in Northern Ireland were classified as being potentially suitable for squirrel activity. These sites are distributed among the counties as follows; Antrim 45, Armagh 29, Down 44, Fermanagh 34, Londonderry 46 and Tyrone 63. Red squirrels only were present in 73 sites, while both species were found in 79 sites. O'Teangana (1999) concluded that a continued decline in red squirrel numbers was likely in Northern Ireland. In the light of this conclusion, it was considered vital to identify the areas still occupied by red squirrels only throughout Northern Ireland. The UK strategy for Red Squirrel Conservation – Action plan for Northern Ireland was completed in 2000 (McGhie & Milburne, 2000), with the aim to ensure the survival of the remaining red squirrel populations in Northern Ireland. This document highlighted five red preferred areas where viable populations could be maintained and protected through habitat

management. These are the areas which have the potential to be conserved as red squirrel habitats. Information on the squirrel species currently present in these areas is, therefore, of key importance if sites suitable for red squirrel survival are to be identified and protected.

2. Objectives of the current study

- To carry out a survey of red and grey squirrel distribution in the red preferred areas and in the areas of interface in the distribution of the two species, i.e. east and west Fermanagh, north east Antrim and east Londonderry
- To establish the change in red and grey squirrel distribution in comparison with the findings of Tangney (1999).

3. Methodology

Fieldwork commenced in May 2002 and continued to August 2002. A list of the sites included in the original survey by O'Teangana (1999) was compiled (Appendix 1) and sites selected from the areas situated at the time of the study in the interface in the distribution of red and grey squirrels and in the red squirrel preferred areas (O'Teangana, 1999; McGhie & Milburne, 2000) (refer to Figures 1, 2 & 3). Figures 1 and 2 show the areas where grey and red squirrels were identified during the original survey (O'Teangana, 1999), while Figure 3 highlights the proposed conservation areas for red squirrels, (red preferred areas), throughout Northern Ireland (McGhie & Milburne, 2000). The current study surveyed the sites within four of the five red squirrel preferred areas and a number of interface woodlands between these four areas, namely north-east Antrim, east Londonderry and east and west Fermanagh. These represent woodlands which are now the highest priority sites for red squirrel conservation within Northern Ireland. It was, therefore, necessary to determine where the red squirrels had survived within these areas and determine the management implications and suitable strategies for red squirrel conservation. Figure 4 illustrates sites surveyed during the current investigation.

In total 80 sites, concentrated in four of the red squirrel preferred areas and in the areas of interface, were visited. They were distributed amongst the counties as follows; Antrim 24, Down 2, Fermanagh 25**,** Londonderry 22 and Tyrone 7. Each site was visited and walked for a minimum of two hours looking for evidence of squirrel

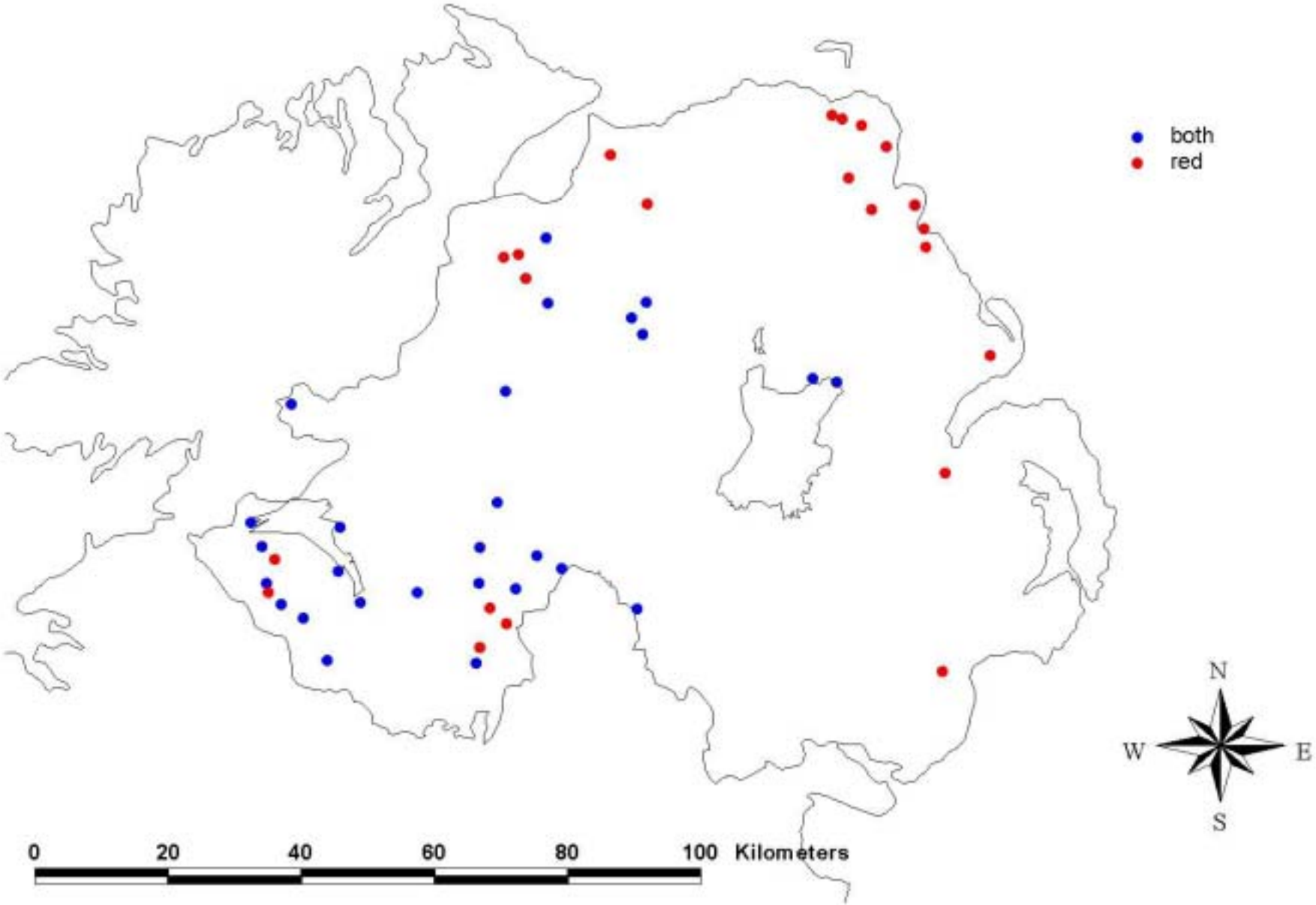

Figure 1. Map showing the location of red squirrel and both species sites recorded by O'Teangana (1999).

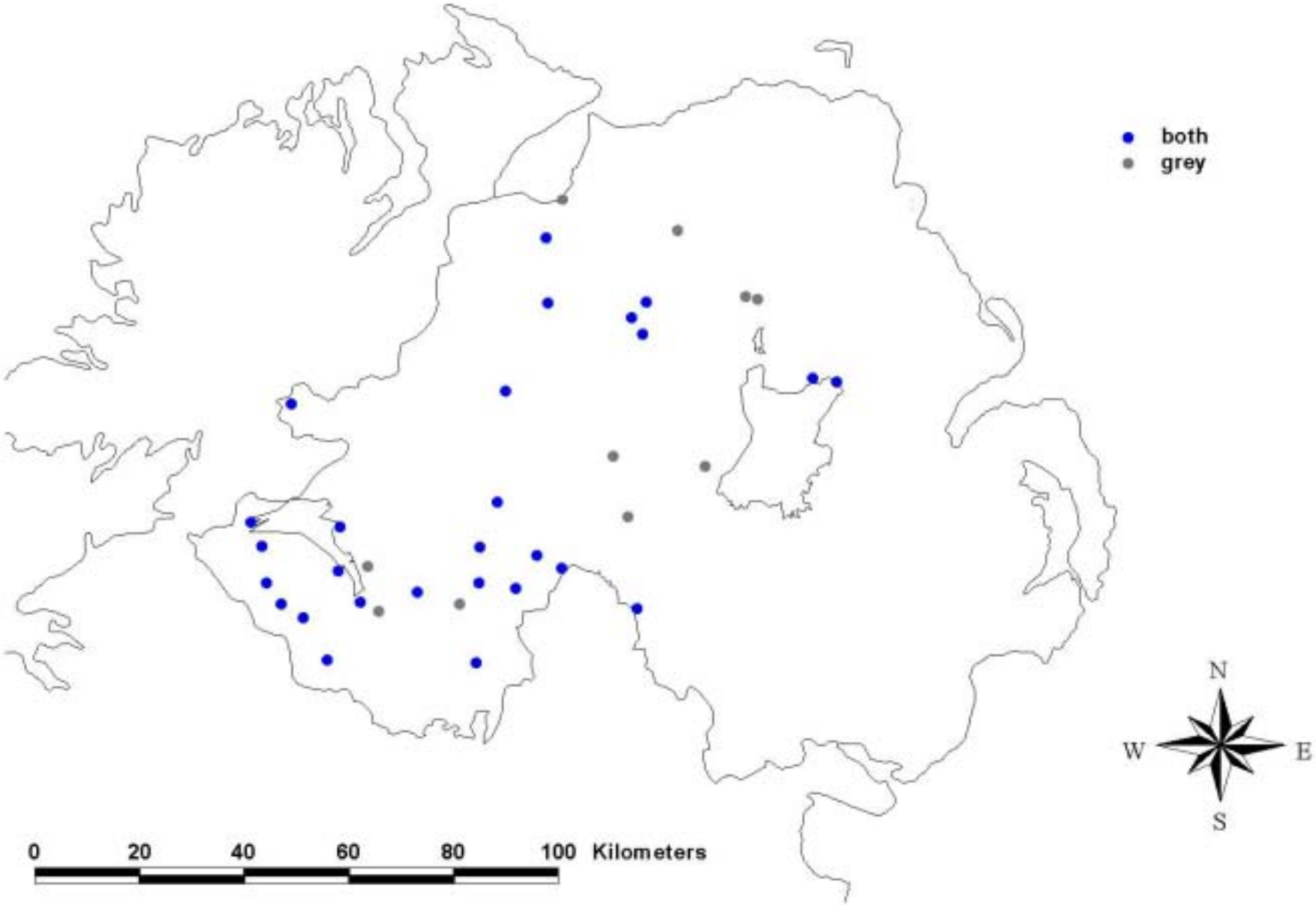

Figure 2.Map showing the location of grey squirrel and both species sites recorded by O'Teangana (1999).

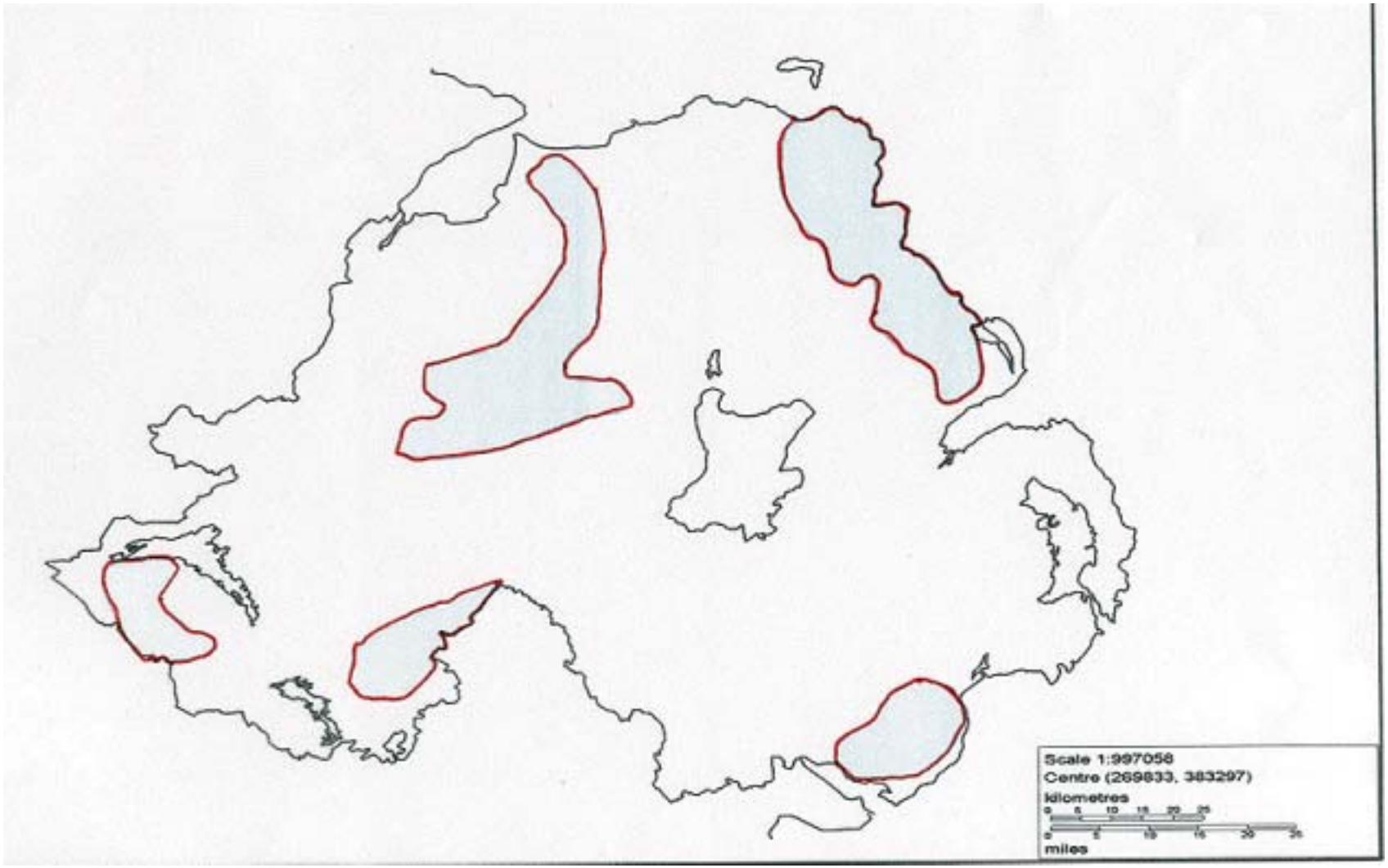

Figure 3. Map showing the location of the proposed red squirrel conservation areas.
Source: UK Strategy for Red Squirrel Conservation – Action plan for Northern Ireland (McGhie & Milburne, 2000).

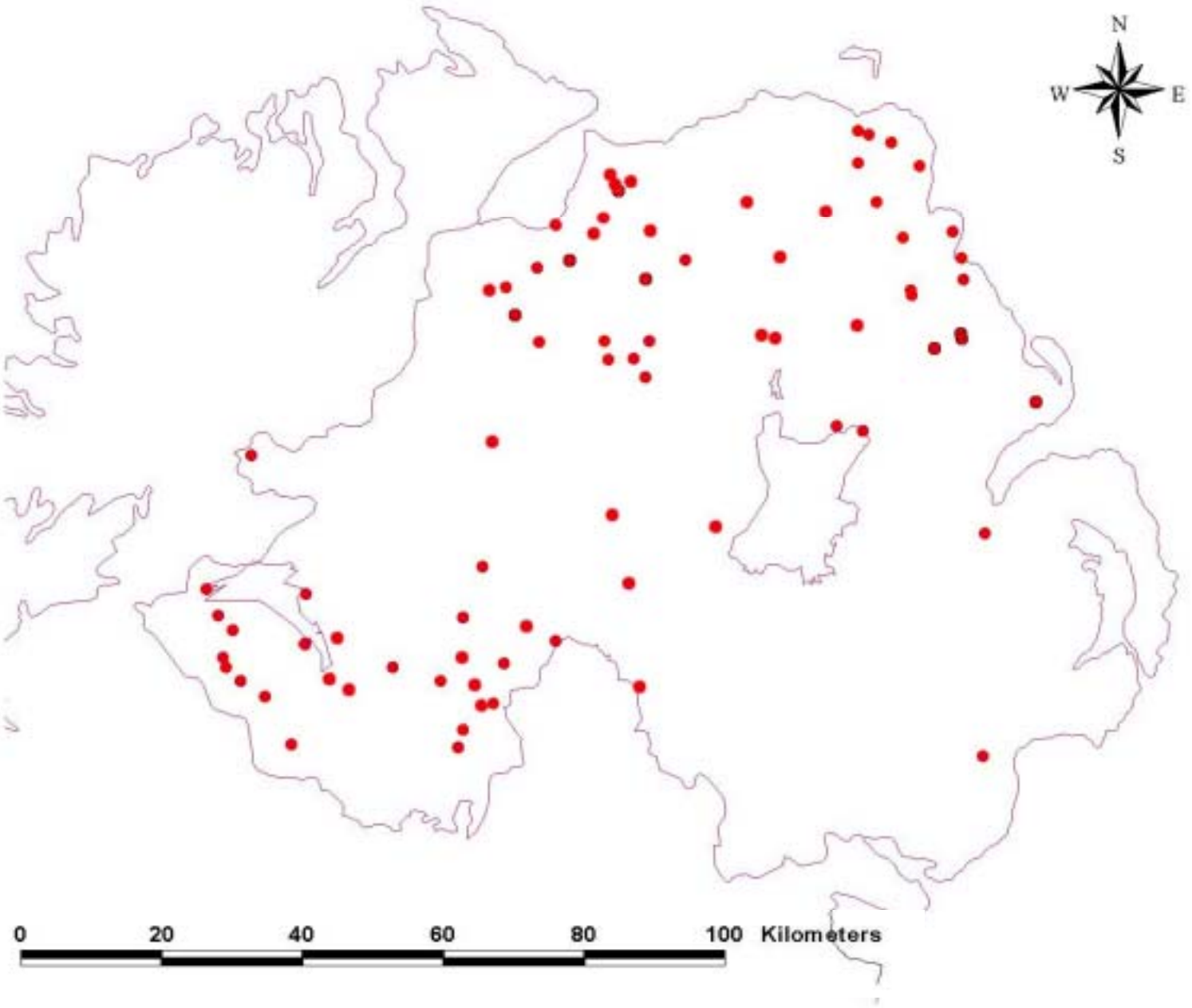

Figure 4. Map showing the location of the sites which were surveyed during the current investigation into squirrel distribution.

occupancy. Four categories of squirrel occurrence were devised for both red and grey squirrel presence at each site visited (O'Teangana 1999):

(1) no squirrels present;

(2) red squirrels only present;

(3) grey squirrels only present; and,

(4) both red and grey squirrels present.

Visual sightings of animals were the best indication of a resident squirrel population. However, the secretive nature of squirrels meant that other forms of verification were also necessary. These included feeding evidence, presence of dreys and bark stripping. Even when species of squirrel presence/absence was known, residents neighbouring each site were interviewed, thereby augmenting our knowledge of each site. Such knowledge is acquired from daily contact with their surroundings and would locally far exceed academic, government or non government knowledge. Such anecdotal evidence, subject to reliability, together with records from staff in the Forest Service (Department of Agriculture and Rural Development, Northern Ireland), The National Trust and The Department of the Environment (Northern Ireland), proved to be a most valuable aid in ascertaining squirrel presence or absence. Great care was taken to ensure that reported presence of squirrels was consistent with the species biology and selected records were checked for accuracy. The use of anecdotal evidence may be challenged but the feasibility of the project, over one field season, would have been considerably more difficult and could have produced less detailed findings. The survey, conducted by two experienced observers, has the merit of consistency.

4. Results

The survey carried out in 1995/1996, (O'Teangana, 1999), concluded that the red squirrel was widespread, though local, throughout Northern Ireland. West Tyrone/Londonderry and upland Fermanagh incorporated the majority of its range. A population in east Antrim occurred along the Glens coastal escarpment and adjacent upland coniferous plantations within this region. Further populations occurred along the Lagan valley, in north Armagh and throughout Down. O'Teangana (1999) concluded that red squirrel replacement had apparently occurred in certain areas and also that the grey squirrel was found to be more widespread than red squirrels

throughout Northern Ireland. Grey squirrels were recorded east to Downpatrick and north virtually to the coast. During the current investigation grey squirrels were recorded in previously unoccupied areas, particularly in the Dungiven/Limivady area and in West Antrim. The area with the largest number of red squirrel only sites is within north-east Antrim within predominately coniferous woodland. Figure 5 illustrates the results obtained by O'Teangana for the sites investigated during the current survey and Figure 6 illustrates the results obtained for these sites during the current survey. Grey squirrels are now present in sites throughout west Antrim and north Londonderry where no squirrels were recorded by O'Teangana (1999). Red and grey squirrels are still present throughout Fermanagh and Tyrone. Grey squirrels have replaced red squirrels from sites in Londonderry, Fermanagh and Tyrone. Table 1 summarises the number of woodlands where red squirrels have been lost from and woodlands which have gained red squirrels in comparison to the results of O'Teangana (1999). There has been a net loss of red squirrel sites from four woodlands and a net gain of grey squirrel sites from 15 woodlands. Red squirrels have been lost from woodlands in all of the counties surveyed, while grey squirrels have replaced red squirrels in woodlands in Fermanagh, Londonderry and Tyrone.

Table 1. The number of woodlands where red and grey squirrels have been lost from or where they are now present.

Sites which have lost red squirrels	**Sites which have gained red squirrels**	**Sites which have lost grey squirrels**	**Sites which have gained grey squirrels**
11	7	1	16

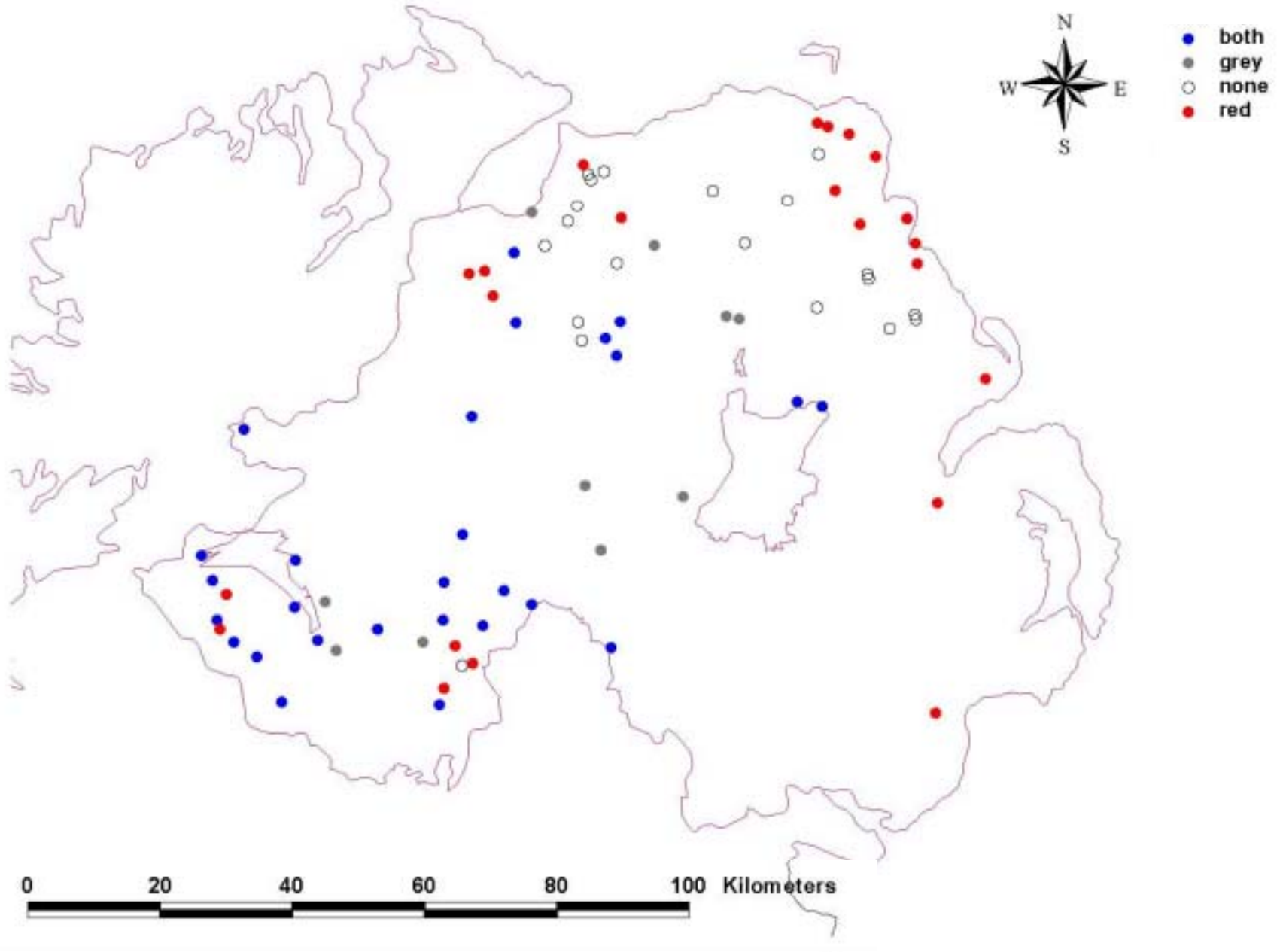

Figure 5. Map showing the distribution of the 80 survey sites and the results obtained for these sites during the 1995 survey (O'Teangana 1999).

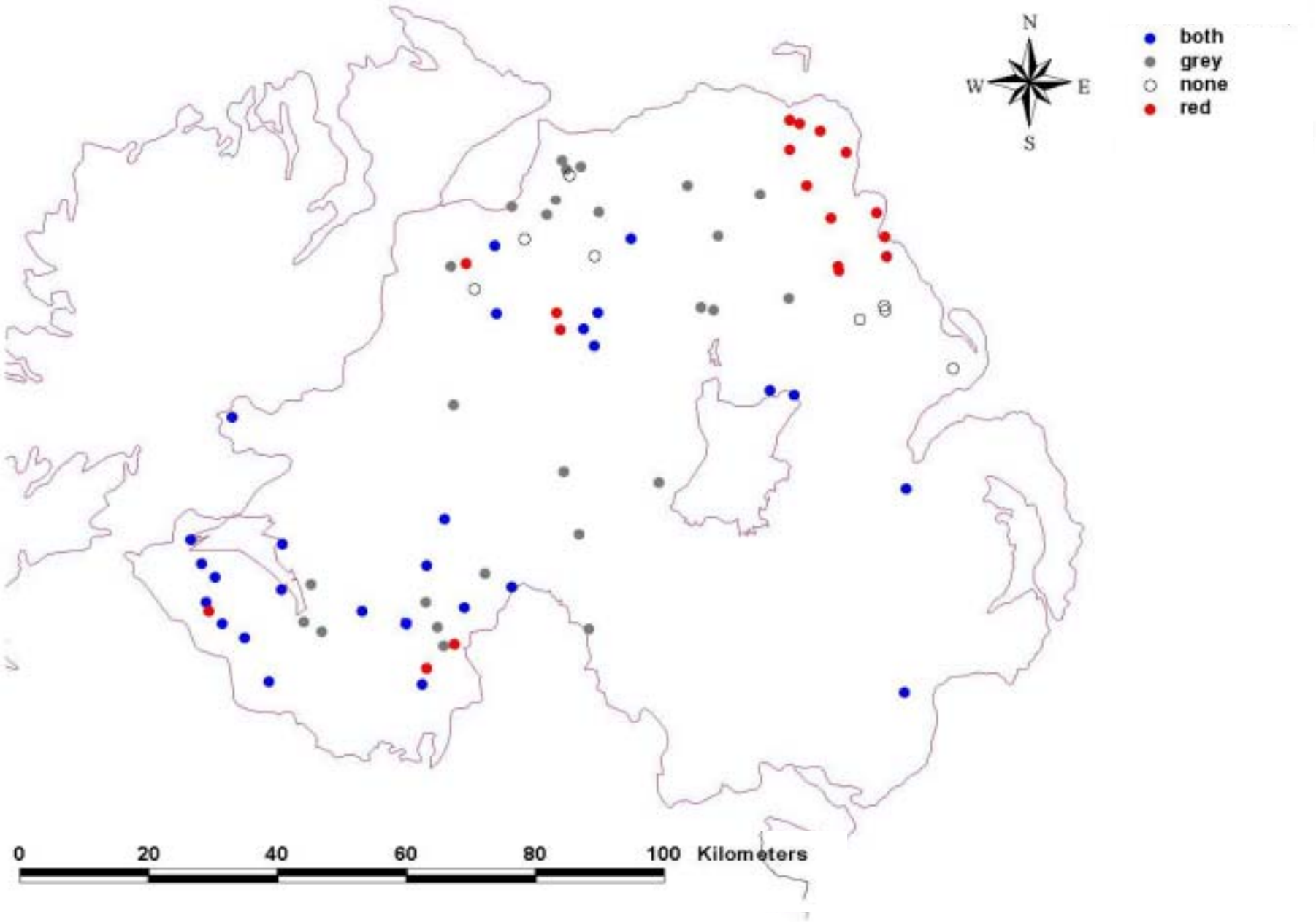

Figure 6. Map showing the distribution of the 80 survey sites and the results obtained for these sites during the 2002 survey.

Table 2. List of the woodlands where red squirrels only were found during the current squirrel survey and the area (ha) and species composition of each woodland.

County	Site name	% Coniferous	% Deciduous	Area (ha)
Antrim	Cleggan Lodge	0	100	25
Antrim	Clady Bridge/ Craigagh wood	50	50	28
Londonderry	Ness Wood Country Park	0	100	14
Antrim	Binabanan	5	95	69
Antrim	Longmore Wood	50	50	53
Antrim	Glenarm	97	3	172
Antrim	Breen	99	1	531
Fermanagh	Mullaghfad	99	1	795
Londonderry	Altbrittain	100	0	395
Londonderry	Banagher	100	0	989
Antrim	Ballycastle	100	0	310
Antrim	Ballypatrick	100	0	1273
Antrim	Coolavelly Wood	100	0	47
Antrim	Glenariff	100	0	924
Antrim	Slieveanorra Forest	100	0	2375
Antrim	Straidkilly	100	0	27
Fermanagh	Carrigan	100	0	1277
Fermanagh	Doon	100	0	506

Red squirrels were recorded in large state managed coniferous woodland, but also in smaller deciduous woodlands. The majority (72.22%) of sites where red squirrels only were found were dominated by coniferous woodland (>95% coniferous species in the woodland), while 11.11% of the sites contained a mixture of coniferous and deciduous woodland. 16.67% of the sites were dominated by broadleaved woodland.

Table 3. List of the woodlands where both red and grey squirrels were found during the current squirrel survey and the area (ha) and species composition of each woodland.

County	Site name	% Coniferous	% Deciduous	Area (ha)
Londonderry	Derrynoyd	46	54	102
Antrim	Randalstown	69	31	163
Fermanagh	Ely Lodge	78	22	223
Fermanagh	Seskinore	82	18	100
Fermanagh	Coolebrook	0	100	132
Fermanagh	Florencecourt	88	12	632
Antrim	Shanes castle	90	10	149
Londonderry	Learmount	90	10	108
Down	Belvoir forest	92	8	79
Down	Tollymore	95	5	582
Fermanagh	Castle Caldwell	95	5	198
Fermanagh	Pubble	97	3	84
Tyrone	Knockmany	97	3	382
Londonderry	Moydamlaght	98	2	248
Fermanagh	Castle Archdale	98	2	403
Londonderry	Garvagh	99	1	197
Fermanagh	Conagher	100	0	726
Londonderry	Glenshane	100	0	432
Londonderry	Loughermore	100	0	1126
Fermanagh	Ballintempo	100	0	1553
Fermanagh	Belmore	100	0	821
Fermanagh	Big Dog	100	0	907
Fermanagh	Glenderg	100	0	2312
Fermanagh	Loch Navar	100	0	1958
Fermanagh	Tully	100	0	707
Tyrone	Fardross	100	0	637
Tyrone	Favour Royal	100	0	491

85.19% of the sites where both red and grey squirrels were recorded were dominated by coniferous woodland (>80% coniferous species in the woodland). 11.11% of the sites were dominated by mixed woodland. One site consisted of 100% deciduous species (3.70%).

Table 4. List of the woodlands where grey squirrels only were found during the current squirrel survey and the area (ha) and species composition of each woodland.

County	Site name	% Coniferous	% Deciduous	Area (ha)
Antrim	Leslie Hill	0	100	29
Antrim	Rabbit Hill	0	100	28
Fermanagh	Castle Coole	0	100	37
Londonderry	Clady, Portglenone	0	100	1
Londonderry	Roe Valley Country Park	0	100	37
Tyrone	Augher	0	100	21
Tyrone	Boorin Wood	0	100	13
Tyrone	Fivemiletown	0	100	49
Antrim	Lisanoure Estate	50	50	76
Londonderry	Drenagh, Limavady	50	50	89
Londonderry	The Oaks	50	50	1
Fermanagh	Parkanaur	68	32	181
Londonderry	BallyKelly	86	14	96
Fermanagh	Portoa Royal School	90	10	15
Fermanagh	Drumcairne Forest	91	9	203
Fermanagh	Pomeroy	93	7	167
Fermanagh	Riversdale	93	7	118
Tyrone	Caledon/ Lemnagore Wood	96	4	207
Londonderry	Binevenagh Forest	97	3	677
Antrim	Portglenone	99	1	292
Antrim	Portglenone	99	1	292
Antrim	Craigs	100	0	237
Fermanagh	Crocknagrally	100	0	583
Fermanagh	Jenkin	100	0	1282
Londonderry	Ballyhanna Forest	100	0	100
Londonderry	Cam	100	0	963
Londonderry	Grange Park	100	0	1098

Grey squirrels were recorded in both large state managed coniferous woodlands, but also smaller sites dominated by deciduous and mixed woodland. 55.56% of sites where grey squirrels only were recorded were in woodlands dominated by coniferous

species (>86% coniferous species in the woodland). 29.63% of grey only sites were in woodlands dominated by deciduous woodlands. 14.81% of grey sites were in mixed woodlands.

The sites where red and grey squirrels were recorded during the current investigation are illustrated in Figures 7 and 8, respectively, and described on a county basis below.

4.1 County Antrim

A large county (304,277 ha.), its geographical position affects squirrel type and distribution. The county's physical characteristics are dominated by the Antrim Plateau along its eastern side (highest point of 550 m., Trostan D179 237) which delimits four regions: (a) the Glens along the east coast; (b) the undulating plain between the plateau and the Lower Bann river, (c) south Antrim, i.e. between Lough Neagh and Belfast Lough, including the Belfast hills, and (d) the plateau itself. Antrim has 9,215 ha of woodland, the vast majority of which (7,580ha) is state-managed conifer forestry (Cooper *et al.*, 2002). The relatively high percentage of seminatural vegetation in the Antrim coast and glens is related to the presence of coastal cliff, dune and saltmarsh habitats (Cooper *et al.*, 2002). Both red and grey squirrels are present in Antrim, the former established whilst the latter has colonised the county since around 1991 (O'Teangana, 1999). In 1999 O'Teangana reported that Antrim remained the only county in Northern Ireland without a large grey squirrel population. Since that survey grey squirrels have colonised from the West into the plains between the plateau and the lower Bann River. Grey squirrels have also been reported on Cavehill in North Belfast (Montgomery, pers comm.).

The area surveyed covered 7,635 ha. and a total of 24 woodlands were visited. Two sites had both species present. A further 12 sites had just red squirrels whilst grey squirrels alone were found at just six sites. Four sites had no squirrels present. The majority of red squirrel records were contained along the east coast from Ballycastle southwards. The grey only sites were predominately estates, with some sites dominated by conifer state managed woodland. The majority of grey only sites in Antrim are situated between the River Bann and the Antrim plateau.

No squirrels were recorded in Glenwherry and Capanagh Forests. These are isolated and consist predominately of Sitka Spruce. However, even a commercial plantation consisting primarily of Sitka Spruce can contribute to red squirrel

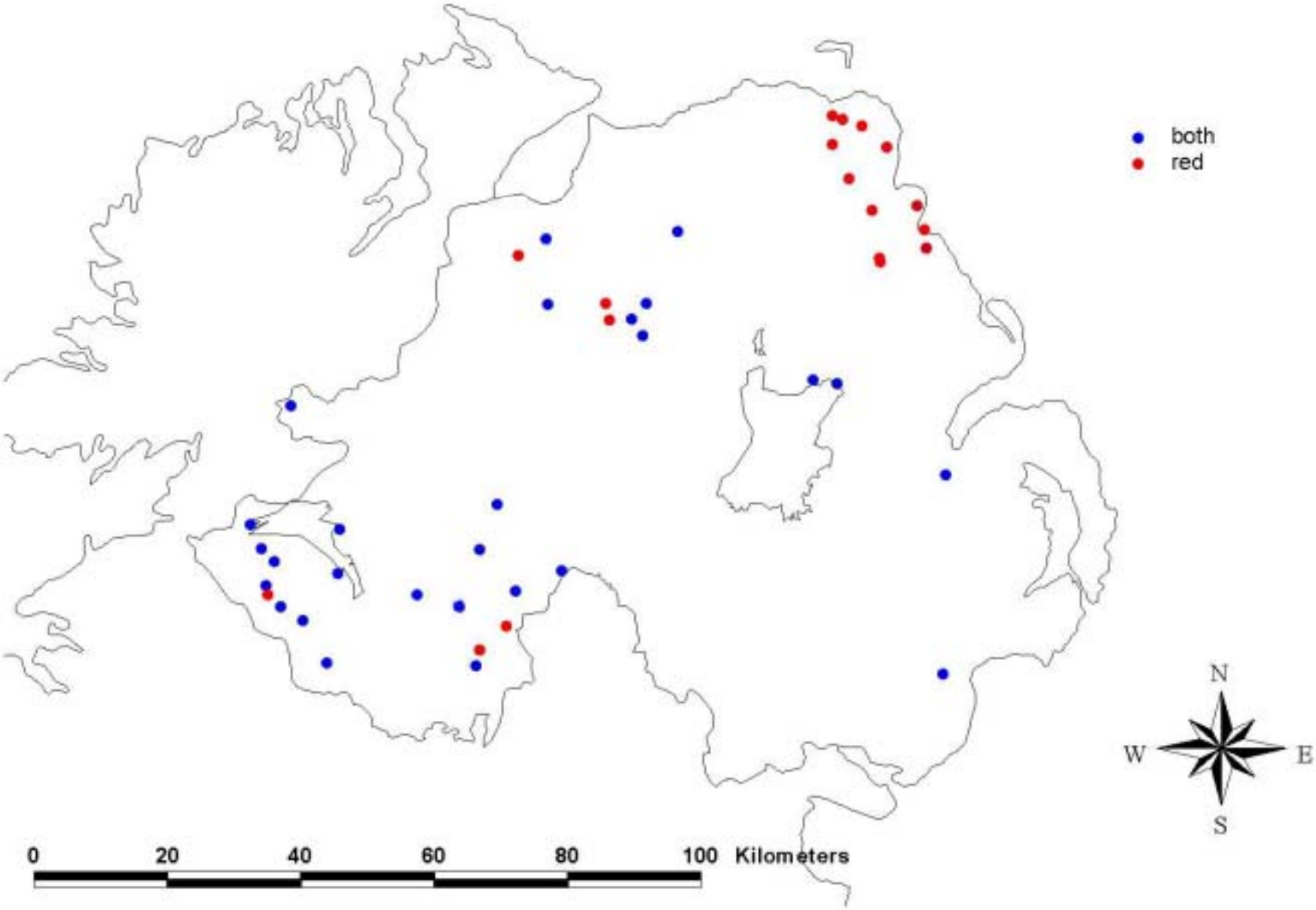

Figure 7: Map showing the location of red squirrel and both species sites recorded during the current squirrel survey.

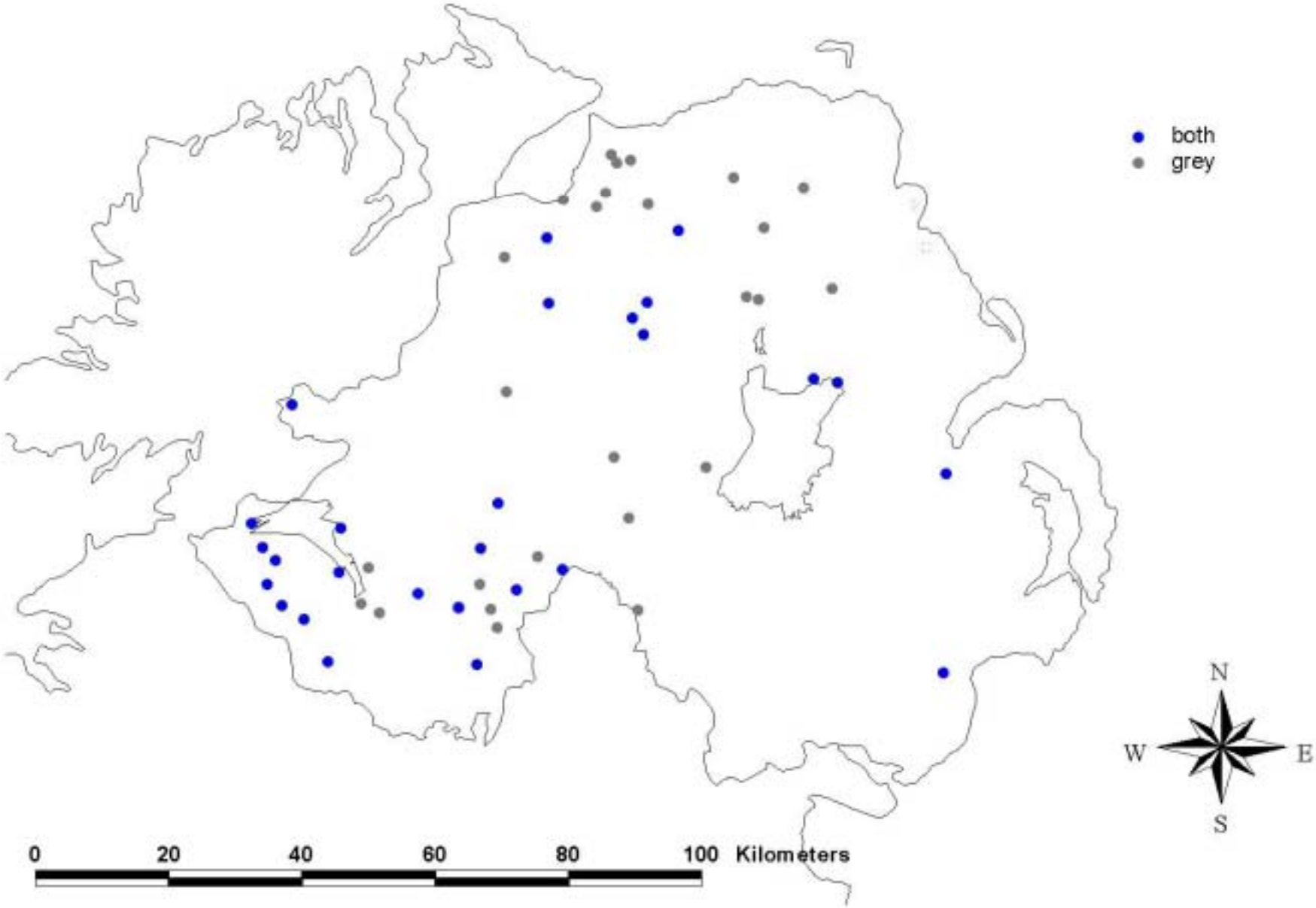

Figure 8: Map showing the location of grey squirrel and both species sites recorded during the current squirrel survey.

conservation, providing that 20% of the tree cover consist of favourable species, including Scots Pine, Larch, Norway Spruce, Lodgepole Pine, Douglas Fir, Yew and Hawthorn (McGhie, pers comm.).

Red squirrels were recorded in Glenarm. O'Teangana (1999) stated that red squirrels had colonised the Sugarloaf Hill area (mainly scrub Hazel) around 1991. Red squirrels were recorded in Straidkilly which is a small coniferous site at the base of Glenarm close to the Glenarm estate. Red squirrels only were recorded on the coastal escarpment at Binabanan. This site consists of 95% deciduous woodland. Red squirrels only were also recorded in Glenariff. This site, with both its Forest Park and natural hillside scrub, provides abundant habitat for red squirrels. Red squirrels were recorded in Slieveanorra Forest, further up the glen. This is a large forest (2,375 ha.) consisting mainly of Sitka Spruce. Red squirrels were also recorded at Ballycastle (310 ha.) and at Coolavelly (47 ha.). These forests are both 100% coniferous and Sitka Spruce dominant. Breen Wood (531 ha.) a broadleaved semi-natural woodland adjacent to Slieveanorra Forest also contains red squirrels.

Grey squirrels were recorded at Lissanore estate, the last red was sighted here two years ago. Cleggan Lodge, in contrast to the findings of 1999 now has red squirrels, this wood lies between Carnlough and Ballymena, with Longmore Wood adjacent to the north. Binabanan, 4.6 km. away, is the nearest red squirrel site.

The mixed woodland at Clady Bridge, at the base of Glendun, also supports red squirrels. Glendun and Glenshesk are separated by a shoulder of the Antrim plateau, around 300 metres at its highest point. Ballypatrick Forest (1,273 ha.) at this location also supports a population of red squirrels.

Along the lowland plain west of the Antrim plateau, from Lough Neagh in the south to the north Antrim coast suitable woodland is characteristically small in area, scarce and fragmented, with estate gardens the main suitable habitat available (O'Teangana, 1999). Typical of this habitat type is Craigs Wood (237 ha.) which now contains grey squirrels. Some coniferous plantations are, however, present. The Lower Bann River, however, with only seven bridges crossing it, had proved a considerable barrier to grey squirrel colonisation eastward into Antrim. However, grey squirrels were recorded throughout west Antrim, east of the River Bann during the current survey and appear to have completely overcome this barrier.

Populations of red squirrels were recorded on the northern shore of Lough Neagh in Randalstown Forest (163 ha.) and Shane's Castle Park (149 ha.). Grey

squirrels are now also present in both of these woodlands. In Shane's castle there is an extensive control programme (Storek, pers comm.). A total of 78 grey squirrels were culled between April-June 2002 (Milburne, pers comm.). A much larger number of grey squirrels (612) were culled during 2001 (Milburne, pers comm.). It would appear that this programme may be preventing or slowing the movement of grey squirrels throughout north east Antrim. The grey squirrels which are now evident throughout West Antrim may have spread from the west rather than from the south.

4.2 County Down

The two woodlands surveyed within County Down are not situated within a red squirrel preferred area nor are they within an interface region of red and grey squirrels. These two woodlands were not, therefore, included in the original list of sites. These two woodlands were surveyed as they were believed to be large important woodlands, (totalling 661 ha), where red squirrels only were present during the O'Teangana survey. Tollymore and Belvoir Forest Parks were surveyed. These two woodlands have only become colonised by grey squirrels since the 1995/1996 survey. Red and grey squirrels are now found in both of these woodlands. These are important areas as they are large woodlands dominated by conifer species where grey squirrels have now become established. There are deciduous tree species in both of these woodlands which will provide suitable habitats for grey squirrels. It will be vital to establish whether these woodlands can sustain both species in sympatry because the approximate year the greys were first observed is known and it may be possible, therefore, to determine how long red squirrels can survey after the arrival of grey squirrels.

4.3 County Fermanagh

This is a county (185,094 ha.) of drumlin terrain dominated by the Erne system with upland and mountainous areas to either side. 14.5% (26,802 ha) of the land area in Fermanagh is covered by woodland (Cooper *et al.*, 2002). Suitable habitat varies from upland coniferous plantations to fen carr and broadleaf woodland within estates (Cooper *et al.*, 2002). Both red and grey squirrels are present throughout this county. Many areas of red and grey squirrel sympatry have existed in Fermanagh for 30 years or more (O'Teangana, 1999). 25 sites, totalling 15,920 ha., were surveyed.

Only three woodlands in county Fermanagh were found to have red squirrels

only present (Mullaghfad, Carrigan and Doon). All of these woodlands are large and predominately coniferous (99%, 100% and 100% respectively), dominated by Sitka Spruce. The continued survival of both red and grey squirrels at Castle Archdale (403 ha.), Tully (707 ha.), Ely Lodge Forest (223 ha.), Crom (607.5 ha.) and Pubble (84 ha.) suggest that red squirrel replacement by grey squirrels is not always rapid.

The grey squirrel was first reported at Belleek in 1945 (Henderson, 1947). Despite this, the main colonisation of Fermanagh occurred 10 to 20 years later. It is now ubiquitous throughout most of the county, particularly in the broad-leaved estates of the lowlands. Lower Lough Erne's obstruction to grey squirrel expansion has resulted in certain areas, e.g. the Kesh region, not being colonised until 1993 (O'Teangana, 1999). Furthermore, neither evidence nor local sightings of grey squirrels have been reported about the Pettigo region (north Fermanagh). In the Fermanagh/Tyrone border region the grey squirrel is ubiquitous whilst the red squirrel is only found in isolated woodlands. In Crocknagrally (583 ha.) the red squirrels have been completely replaced by grey squirrels. O'Teangana (1999) noted grey squirrels only in the estate of Coolebrook (132 ha.), both red and grey squirrels are now present within this predominately broadleaf estate.

Fifty years after the grey squirrel was first recorded in Fermanagh the red squirrel remains widespread in the county. Red squirrels are now absent from Portora Royal School. Sites with red squirrels only include Carrigan, Doon and Mullaghafad. Sites where red and grey sympatry exists include Coolebrook, Ely Lodge, Castle Archdale, Castle Caldwell, Florence Court, Lough Navar Forest, Seskinore, Tully, Glenderg, Conagher, Big Dog, Belmore, Ballintempo and Pubble. The future of red squirrels at such sites and the factors promoting sympatry are unknown. Total extinction in the county is unlikely by virtue of the amount of coniferous habitat present.

4.4 County Londonderry

The topography of Londonderry (211,783 ha.) consists of flat undulating lowlands and uplands, e.g. the Sperrins. 8% of this county is covered by woodland. This consists of coniferous plantations in the uplands, semi-natural broadleaved woodland in the river valleys and fragmented woodland within agricultural land (Cooper *et al.*, 2002). 22 sites were surveyed, totalling 7,716 ha. Records of red squirrels were confined to the area south of Londonderry city, being absent from the

Lower Bann plain and the north-central region. The grey squirrel is now common throughout this county.

Red squirrel distribution is associated with the uplands. Red squirrels only were recorded in just three sites (Ness Wood Country Park (14 ha), Altbrittain (395 ha), and Banagher (989 ha). Grey squirrel sites have increased since 1999. The Faughan Valley no longer supports red squirrels only. Grey squirrels are now common throughout this region. Red and grey squirrel sympatry was recorded at Moydamlaght (248 ha.), Garvagh (197 ha.), Glenshane (432 ha.), Loughermore (1126 ha.), Derrynoyd Wood (102 ha.) and Learmount (108 ha.).

Banagher (989 ha.) now has red squirrels in contrast to no squirrels present during the O'Teangana survey. O'Teangana (1999) found an unexplained void in red squirrel distribution north of Dungiven. Since 1999, the Limavady area has become colonised by grey squirrels. Grey squirrels only are now found within Ballykelly Forest (96 ha.), the semi-natural woodland along the Roe valley and its Country Park (37 ha.) and Drenagh estate. Loughermore Forest (east) (333 ha.), Gortnamoyagh forest (698 ha.), Claudy (8 ha) and Stradreagh (4 ha) still contains no squirrels.

Red squirrels are now absent and grey squirrels present in Cam (963 ha), Binevenagh (677 ha.), Ballyhanna (100 ha.) and Grange Park Wood (1,098 ha.). O'Teangana (1999) stated that the red squirrels in these areas consisted of sparse populations, which have now disappeared.

The rate of grey squirrel colonisation in County Londonderry has varied as upland areas hinder progress. South-east of the county was first colonised 25-30 years ago and expansion has been quickest through the lowland areas immediately west of Lough Neagh and northwards between the Sperrins and the Lower Bann (O'Teangana 1999). O'Teangana (1999) suggested a maximum expansion rate northward of 2.7 km/yr. Expansion west encompasses Derrynoyd (102 ha.) which still contains both species. Moydamlaght (248 ha.) and Glenshane (432 ha.) also still contain both species. These forests have all been colonised within the last 5-10 years. It is from this direction that the grey squirrel probably colonised north-west Londonderry (O'Teangana 1999). Expansion westwards through Gortnamoyagh Forest (currently has no squirrels) has lead to grey squirrel colonisation of the Roe valley as predicted by O'Teangana (1999), who suggested that the grey squirrel is colonising in the north-west of the county. O'Teangana (1999) concluded that the presence of grey squirrels at Learmount Forest would lead to their expansion north-west down the Faughan

valley, thus invading the last principal region, outside of Antrim, where the red squirrel is found outside the range of grey squirrels in Northern Ireland. This appears to have already happened.

4.5 County Tyrone

Tyrone, the largest county surveyed (326,548 ha.), is generally bisected upland with flat/undulating terrain only in the extreme east. 6.6% of its land area is covered by woodland, consisting of coniferous plantations in the uplands and fragmented semi-natural woodland in farmland (Cooper *et al.*, 2002). Only seven sites (1800 ha) were surveyed and they are situated predominately in south Tyrone within the area of interface of the two species. The red squirrel is more commonly recorded in the west of the county. O'Teangana (1999) recorded both red and grey squirrels at all of these seven sites. Four of these sites now contain grey squirrels only; Augher (21 ha.), Boorin wood (13 ha.), Fivemiletown estate (49 ha.) and Lemnagore Wood (207 ha.). All of these woods apart from Lemnagore Wood contain 100% deciduous species, while Lemnagore wood is 96% coniferous.

The grey squirrel has been present in Tyrone for 30 years or more and as it shares its southern border with Monaghan, the latter was the likeliest direction of colonisation (O'Teangana, 1999). In this area there are no topographical barriers to prevent the spread of the grey squirrel. Expansion appears to have been quickest northwards and the grey squirrel is now ubiquitous in the south of the county and the lowland region west of Lough Neagh. In contrast, range expansion westward has been temporarily or almost completely inhibited by the Sperrins (O'Teangana, 1999).

Large coniferous plantations are a feature of Tyrone. Favour Royal (491 ha.), Fardross (17 ha.) and Knockmany (382 ha.) in the south are state owned coniferous forests and are important areas for red squirrel distribution and survival. All of these forests are now also colonised by grey squirrels, red and grey squirrels occurring in sympatry.

5. General Discussion

Grey squirrels were introduced to the Republic of Ireland approximately 85 years ago and from the records of previous surveys they had colonised Northern Ireland by 1945 (Crichton, 1973; Ní Lamhna, 1979). The survey carried out by O'Teangana (1999) was the first intensive survey of the distribution of both species throughout Northern Ireland from which future changes in squirrel range may be compared. His study found that the red squirrel was widespread, though local, in Northern Ireland, while the grey squirrel was continuing to increase its range and was more widespread than red squirrels (O'Teangana, 1999). Grey squirrel distribution in the current survey has shown a large expansion eastward through west Antrim and northward through east Londonderry, previously unoccupied sites in both counties are now occupied by grey squirrels (refer to Figures 5 and 6 and Appendix 2).

The red squirrel sites in Antrim are largely situated within upland coniferous and deciduous woodlands along the east coast from Ballycastle southwards. O'Teangana (1999) reported that grey squirrels were less frequent than expected in upland conifer plantations and more frequent than expected in parkland and gardens. The grey squirrel sites in the current investigation were noted in woodlands dominated by deciduous species, but also in large coniferous woodlands (Refer to Table 4). The theory that red squirrels have greater survival rates and reach highest densities in coniferous habitat has been reported by many authors (e.g. MacKinnon, 1978; Kenward & Holm, 1989; Gurnell, 1991a; Garson & Lurz, 1992). In contrast, the grey squirrel's aversion to coniferous woodland is apparent in North America (Barkalow & Shorten, 1973) and in Britain grey squirrels only occur in pure coniferous woodland if broadleaved habitat is nearby (Gurnell, 1987) or if supplementary food is available (Gurnell, 1987). O'Teangana (1999) concluded that red only sites were predominantly coniferous in nature, while grey only sites were more often deciduous and both species sites were more likely to be coniferous than deciduous. In the current survey red squirrels were associated with predominately coniferous woodland (72.22%), but also with deciduous (16.67%) and mixed woodlands (11.11%). In contrast to the prevailing theory, 55.56% of grey only sites were in coniferous dominated woodland. 29.63% of grey only sites were in deciduous woodlands and 14.81% in mixed woodland. The current survey, however, only surveyed 80 sites (30.65% of the original sites). The smaller number of sites surveyed may not, therefore, give a true indication of overall red and grey squirrel habitat

preference in Northern Ireland. O'Teangana (1999) concluded that habitat variables alone were not a reliable means of estimating which squirrel species are most likely to occur in woodland in Northern Ireland. This would certainly be the case in the current survey which found both red and grey squirrels in coniferous and deciduous woodland.

During the current survey it was noted that grey squirrels were present in nine woodlands where no squirrels had previously been recorded. Furthermore grey squirrels have replaced red squirrels from woodlands in both Londonderry and Fermanagh, four woodlands in total. Some form of interspecific competition has been suggested for the decline of the red squirrel in Britain (Shorten, 1957; MacKinnon, 1978; Gurnell, 1987; Kenward & Holm, 1989). O'Teangana (1999) suggested that grey squirrel populations are more transient than sedentary in coniferous habitat. This may be explained by their ability to exploit a temporal food supply elsewhere, particularly peripheral broadleaved species when occupying conifer plantations (Kenward & Walls, 1991; Smith & Gurnell, 1997).

O'Teangana (1999) concluded that woodlands where both squirrel species were recorded were conifer dominated, largest in area and found at higher altitudes than grey only sites. In the current survey 85.19% of sites where red and grey squirrels were found were dominated by coniferous woodland as predicted by O'Teangana (1999). 11.11% of the sites with both red and grey squirrels were dominated by mixed woodland, while only one site (3.70%) consisted of 100% deciduous woodland. The continued presence of grey squirrels at these sites may be explained by grey use of upland conifer plantations when more suitable habitat is already occupied by conspecifics i.e. interspecific competition leads to the use of sub-optimal habitats. Continued grey expansion in Northern Ireland may lead to a situation similar to Britain where red squirrels are restricted to areas where grey squirrels are unable to colonise or have yet to colonise or areas of habitat that maintain the red's competitive advantage over grey squirrels e.g. conifer plantations with a low proportion of large seeded broadleaved trees (Smith & Gurnell, 1997). O'Teangana (1999) and the current investigation have, however, highlighted that the grey squirrel is still under-represented in coniferous habitat throughout north-east Antrim. Grey squirrels are known to favour areas predominately deciduous in character, i.e. parks and gardens. Similar habitat preferences in Ireland (Reilly, 1997) and Britain (Gurnell, 1987, 1991b) have been recorded. The majority of coniferous

plantations in Northern Ireland are situated on uplands and are significantly larger in area than deciduous woodland (O'Teangana 1999).

Few studies have attempted to determine the rate of spread of grey squirrels (e.g. Williamson & Brown, 1986 - 5 to 10 km/yr). Grey squirrels have been reported to have dispersed 17.6 km within 10 years of their introduction giving a mean dispersal of 1.76 km/yr. (Watt, 1923). O'Teangana (1999) calculated a rate of between 2.88 km/yr (±-0.53) to 3.73 km/yr (±-0.53). These estimates vary greatly. The two studies did, however, illustrate a constant movement with infrequent major advances (Williamson & Brown, 1986; O'Teangana, 1999). Such major advances may account for patchy and pioneer populations of grey squirrels detached from the main distribution of the species (Lloyd, 1983; Reynolds, 1985). O'Teangana (1999) noted that the greatest grey squirrel expansion in Northern Ireland was northward at around 2.7 km/yr through east Tyrone and into Londonderry immediately west of the lower Bann and eastwards at around 2.3 km/yr through north Armagh into north Down. The slowest expansion in range occurred in west Tyrone, where for 20 years there was virtually no expansion eastwards. The effect of natural barriers such as mountains, loughs and rivers on the long term distribution of grey squirrels is illustrated by this variation. Since O'Teangana (1999), grey squirrels have spread further and appear to have overcome the natural barriers, Lough Erne, Lough Neagh and the River Bann and have spread throughout west Antrim and north through Londonderry.

6. Forestry in Northern Ireland

The Forestry Service in Northern Ireland has a role to play in the conservation of red squirrels. The UK Forestry Standard (1998) stated that forestry is expected to contribute to nature conservation through; helping to deliver habitat and species action plans, wider diversification measures in woodlands, avoiding planting on valuable open habitats and restoring some which have been planted in the past. The conservation of biodiversity already represents an essential objective of sustainable forest management (DARD, 2002). A consultation paper prepared by the Department of Agriculture and Rural Development (2002) stated that coniferous forests have proved that they can accommodate those elements of our native flora and fauna that are adaptable to shady woodland conditions and the mosaic of forest clearings and open space that occurs in managed forests. This paper acknowledged that in the case

of the red squirrel, the presence of extensive areas of coniferous forest is critical to its survival in Northern Ireland (DARD, 2002).

The UK Woodland Assurance Standard (UKWAS, 2000) outlines what must, overall, be achieved in UK woodlands, but leaves it to the owner/manager to decide how this is best done in each situation. It recommends that new planting be designed to ensure the creation over time of a diverse woodland/forest by, for example, planting mixed stands, the use of a diversity of species, clones and provenances and the use of phased planting (UKWAS, 2000). The Standard also recommends that species planted are suited to the site and matched to the objectives for the particular woodland, such as the planting of conifers in red squirrel preferred areas. Also new woodlands are located and designed in ways that will maintain or enhance the visual, cultural and ecological value and character of the wider landscape (UKWAS, 2000). The UKWAS (2000) also recommends that the areas and features of particular significance for biodiversity including sites important for endangered but mobile species are been identified through field survey and marked on a map (UKWAS, 2000).

Table 5. Forest service planting data for the public sector (Schaible, pers comm.).

Year	Hectares planted	New planting (ha)
1997-98	725	94
1998-99	663	109
1999-00	735	187
2000-01	991	87
2001-02	912	61

In the Public sector, the planting is predominately replanting and consists of coniferous species, as listed in Table 6.

Table 6. List of species planted by the Forest service for the public sector (Schaible, pers comm.).

Year	% Species Planted					
	Sitka Spruce	Lodgepole Pine	Larch	Norway Spruce	Other conifers	Broadleafs
1997-98	77	3	8	0	4	8
1998-99	77	1	6	1	6	9
1999-00	73	1	6	2	6	12
2000-01	71	1	7	5	6	10
2001-02	73	1	7	7	5	7

Table 7. Forest service planting data for the private sector (Schaible, pers comm.).

Year	Hectares planted	New planting (ha)
1997-98	617	519
1998-99	697	628
1999-00	725	639
2000-01	783	588
2001-02	677	630

In the private sector the planting is predominately new planting and consists predominately of broadleaf species.

Table 8. Species selection in woodlands (UKWAS, 2000). The proportion of different species in new planting, or planned for the next rotation of an existing plantation.

Where 2 species are suited to the site & matched to the objectives	**Where 1 species is suited to the site & matched to the objectives**
% of different species planted	**% of different species planted**
< 65% primary species > 20% secondary species > 10% open space > 5% native broadleaf	< 75% primary species > 10% open space > 5% native broadleaf > 10% other areas managed for biodiversity as a major objective

Table 9. Grant-aided planting (ha) from 1997/98 to 2001/02 (Schaible, pers. comm.).

YEAR	**New Planting (ha)**		**Replanting (ha)**		**TOTAL (ha)**	
	Broadleaf	Conifer	Broadleaf	Conifer	Broadleaf	Conifer
1997/8	271	248	29	69	300	317
1998/9	353	275	13	56	366	331
1999/0	423	216	21	65	444	281
2000/1	407	181	31	164	438	345
2001/2	474	156	7	40	481	196

Afforestation is subject to the environmental impact (forestry) regulations (Northern Ireland) 2000. Afforestation within red squirrel preferred areas may have a significant impact depending on the species planted (Schaible, pers. comm.).

7. Future conservation and management of red squirrels in Northern Ireland

The grey squirrel is continuing to expand its range in Northern Ireland. It is likely that the red squirrel will ultimately be restricted to areas that grey squirrels are unable to colonise, have yet to colonise or contain habitat that maintains the red squirrel's competitive advantage over the grey squirrel, e.g. conifer plantations with a low proportion of large seeded broadleaved trees as is the case in mainland Britain (Smith & Gurnell, 1997). However, Northern Ireland differs from Great Britain in many environmental factors, including climate, topography and vegetation (Cox & Moore, 1985). These differences may render a more general advantage on the red squirrel than the grey squirrel (O'Teangana, 1999). Nevertheless, long term red squirrel survival is probable only in coniferous habitat (O'Teangana, 1999). Therefore, it will be necessary in the future to establish the viability of grey squirrel populations, and the affect on red squirrel populations, in predominately coniferous habitat of differing age and species composition.

With red squirrel replacement by the grey squirrel having occurred in certain areas of Northern Ireland (O'Teangana, 1999), a regional approach to conserving the red squirrel, the Northern Ireland Squirrel Strategy (McGhie & Milburne, 2000), was produced. The aim of this document was to ensure the survival of the remaining red squirrel populations in Northern Ireland. This document also identified proposed conservation areas in five red squirrel preferred areas where viable populations of red squirrels could be maintained and protected in the long term through habitat management. These are areas where woodlands could be managed as reserves for red squirrels. With this in mind the current investigation was undertaken. Conservation tactics for these proposed red squirrel conservation areas will be comparable to Gurnell & Pepper (1993) who listed strategies, not mutually exclusive, for red squirrel conservation, depending on the effort to control the grey squirrel population. Within Northern Ireland five areas have been adopted as proposed conservation areas for red squirrels (Figure 3). Four of these areas were included in the current survey. The results of this survey have indicated that grey squirrels are continuing to spread throughout Northern Ireland and it is important that sites are chosen which can be targeted for red squirrel conservation. These sites could then be managed to prevent grey squirrels from colonising these woodlands. The area with the largest number of red squirrel only sites in Northern Ireland is within north-east Antrim. Red squirrels

are also still present throughout Fermanagh, Tyrone and Londonderry, but grey squirrels are also widespread in these areas. The areas within north-east Antrim represent the best possibility for conserving red squirrels and should be adopted as red squirrel reserves. A determined effort is required to ensure the survival of the species within these areas. Squirrel reserves should, where possible, be in grey-free areas in upland coniferous woodlands which are separated from other areas to minimise the likelihood of grey squirrels reaching these woodlands. The removal of broadleaved species within these areas and any hedgerows which connect these areas to suitable sites for grey squirrels should be initiated if possible. It is important to note that species rich hedgerows are an important habitat and consideration should be given to all possibilities prior to the removal of such a habitat. The use of supplementary food is widely advocated as a means of aiding the survival of red squirrels in woodland. In the long-term this method may not, however, be sustainable. It may be possible to initiate a translocation program of red squirrels into woodlands where no squirrels are currently present. Possible sites could include Capanagh in County Antrim, Gortnamoyagh Forest and Loughermore Forest (east) in County Londonderry. These three woodlands contain 100% coniferous woodland. It will be necessary to survey these sites to determine whether they would be suitable sites for red squirrel reserves.

8. Recommendations for Future monitoring and research

1. Squirrel populations throughout Northern Ireland should be monitored. A resurvey should be carried out in 2004 - as outlined in the Species Action Plan (SAP). It is recommended that all of the original 261 sites (O'Teangana, 1999) are surveyed to assess red squirrel occurrence. Surveys should be repeated at three yearly intervals.

2. Yearly monitoring of red squirrel populations in the potential red squirrel reserves, i.e. north-east Antrim.

3. Possible sites for red squirrel translocations should be assessed to establish their suitability as red squirrel reserves.

4. Further research should be initiated to investigate:

4.1 The co-existence of red and grey squirrels including:

- Differences in territory size and usage by red and grey squirrels.
- Behavioural interactions between red and grey squirrels.
- The mechanisms of red squirrel displacement by grey squirrels.
- The timescale involved in red squirrel displacement by grey squirrels.

These research initiatives could be targeted in Belvoir Forest Park, Tollymore Forest Park and Castle Archdale Country Park as data is already available regarding when grey squirrels were first observed in these areas.

4.2 The genetic status and population dynamics of the red squirrel in Northern Ireland.

4.3 The prevalence of the Parapox virus in red and grey squirrels throughout Northern Ireland.

9. Red Squirrel Reserve management

Guidelines for red squirrel reserves are listed below – taken from The Durham Trust for Nature Conservation (2001) and the Best Practise Guidelines for Forest Management in Red Squirrel Preferred areas (McGhie, pers. comm.).

9.1 Tree species which are suitable for red squirrels

Selecting the tree species that favour red squirrels but are unlikely to encourage grey squirrels into the red squirrel reserve is vital (McGhie, pers. comm.). Gurnell & Pepper (1991) suggested that Scots Pine and Norway Spruce are the best trees to plant in red squirrel reserves as they extend the period of food available and improve the amount of food available. Sitka Spruce does not encourage grey squirrels nor does it encourage red squirrels (McGhie, pers. comm.). Even a commercial plantation consisting primarily of the North American conifer Sitka Spruce could contribute to red squirrel conservation, providing that 20% of the tree cover consists of the species listed below and where suitable conditions prevail (McGhie, pers. comm.). Tree species should be planted in a mixed stand which would reduce the impact of poor cone years of a particular species (McGhie, pers. comm.).

Trees and shrubs that favour red squirrels over grey squirrels
(The Durham Trust for Nature Conservation 2001 & McGhie, pers. comm.).

Scot's Pine (*Pinus sylvestris*)
European Larch (*Larix decidua*)/Japanese Larch (*Larix kaempferi*)
Norway Spruce (*Picea abies*)
Lodgepole pine (*Pinus contorta*)
Firs (*Abies* spp.)
Yew (*Taxus baccata*)
Hawthorn (*Crataegus monogyna*)
Douglas Fir (*Pseudotsuga menziesisi*)

Trees and shrubs that favour neither red squirrels nor grey squirrels
(The Durham Trust for Nature Conservation 2001 & McGhie, pers. comm.).
The species listed below would be possibilities where woodland managers require broadleaves for landscape or biodiversity reasons. These species produce small seeds

and although they are not a favoured food source for the red squirrel, they do not encourage grey squirrels (McGhie, pers. comm.).

Downy birch (*Betula pubescens*)/Silver birch (*Betula pendula*)
Rowan (*Sorbus aucuparia*)
Ash (*Fraxinus excelsior*)
Willow (*Salix* spp.)
Aspen (*Populus tremula*)

Sitka Spruce (*Picea sitchensis*)

Trees and shrubs that favour grey squirrels over red squirrels
(The Durham Trust for Nature Conservation 2001 & McGhie, pers. comm.).
Large seeded deciduous tree species favour grey squirrels. It may be appropriate to fell individual trees of these species if they bear large quantities of seed, and encourage grey squirrels into the core area (McGhie, pers. comm.).

Oaks (*Quercus* spp.)
Beech (*Fagus sylvatica*)
Chestnuts (*Aesculus hippocastanum*, *A. carnea*)/(*Castanea sativa*)
Hazel (*Corylus avellana*)

9.2 Squirrel reserve management

The current survey has highlighted sites within north-east Antrim as possible squirrel reserves. The preferable conditions for red squirrel reserves are summarised below (Taken from: The Durham Trust for Nature Conservation, 2001; McGhie, pers. comm.).

Conifer woodlands could be selected as reserves when they:
a) Contain a healthy red population and no grey.
b) Cover 200 ha or greater area.
c) Contain < 5% productive large-seeded broadleaves (particularly Oak, Hazel, Beech and Sycamore). Small-seeded producing deciduous trees such as Birch, Alder, Willow species and Rowan are not important food sources for grey and can be overlooked

when selecting reserves.

d) Contain a variety of species (e.g. Pines, Spruces, Firs, Larches).

e) Are not connected to other broad-leaved woodland areas.

f) Have a buffer zone of at least 1 km.

g) The planting of berry bearing shrubs such as Hawthorn, Dog rose and Guelder will provide additional food sources for red squirrels.

h) A range of age classes is important to ensure a continual supply of food for red squirrels. The woodland should preferably consist of tree cover within the following age classes in roughly equal proportions: 0-15 years, 15-30 years and 30+ years.

For a woodland not to be directly connected there must either be a barrier, e.g. a major river with no bridges, or a buffer zone up to 5 km wide, depending upon how unsuitable the buffer habitat is for grey squirrels, for example, open ground with few trees. Habitats that do not form good buffers include lowland farmland with hedgerows and river corridors, and suburban areas with gardens or parks. A buffer zone is an area around the reserve that is actively managed to keep grey squirrel numbers absent or low. The buffer zone has an important role to play in protecting the red squirrel reserve.

The occasional felling of a narrow belt of mature broadleaves or hedgerow species may be justified where grey squirrel incursions are known to occur. These trees can be replaced with other broadleaves or mixed woodland which are more beneficial to red squirrel conservation, such as Birch, Rowan, Ash, Willow, Aspen or Alder. Avoid felling before the young squirrels have been weaned, i.e. between late September and mid-February. The establishment of red squirrel reserves would be a contingency against the displacement of the red squirrel from the wider countryside between. If this were to happen, the red would become genetically isolated, and there may be a requirement to move animals between reserves. This should be done in Early Autumn. Translocation of red squirrels to reinforce populations elsewhere or to create new populations may be an option in some circumstances, but should not become regarded as suitable mitigation for ignoring red squirrels in forestry management elsewhere. If grey squirrel control is required, the preferred method is by shooting or cage trapping. The Forestry Commission is currently researching a new hopper designed to be selective in poisoning grey but not red squirrels. Shooting or trapping should be undertaken between April and July. Supplementary feeding using grey-proof hoppers may be useful in situations when mature seed bearing conifers are

in short supply. This is, however, a labour intensive method and may not be practical over the long term. Further incentive to control the grey squirrel is provided by the damage that they do to woodlands, they strip the bark from the trunk and the main branches of the tree, between May and July (McGhie, pers. comm.). Regeneration in Hazel woodlands is reduced because they strip nuts in September, before they are ripe enough to germinate.

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Appendix 1: List of woodlands surveyed by O'Teangana (1999).

County	Site name	Grid Ref.	%Conifer.	%Decid.	%Mix	Area (ha)
Antrim	Antrim Town Park	J 145870	0	0	100	21
Antrim	Ballybogy	C 911318	100	0	0	66
Antrim	Ballyboley	J 304983	100	0	0	666
Antrim	Ballycastle	D 124383	100	0	0	310
Antrim	Ballydivity	C 958363	0	0	100	22
Antrim	Ballygalley Golf Course	D 382073	0	0	100	22
Antrim	Ballypatrick	D 180364	100	0	0	1273
Antrim	Ballywillin	J 403961	0	100	0	12
Antrim	Binabanan	D 286210	5	95	0	69
Antrim	Breen	D 125329	99	1	0	531
Antrim	Capanagh	D 298037	100	0	0	319
Antrim	Carmanus (Duffs Hill)	J 426921	100	0	0	59
Antrim	Carnduff	D 403010	0	100	0	17
Antrim	Castle Dobbs	J 444908	0	0	100	31
Antrim	Cave Hill	J 323797	0	0	100	79
Antrim	Clady Bridge	D 228324	0	0	100	28
Antrim	Clare	D 070413	100	0	0	1002
Antrim	Cleggan	D 210114	100	0	0	1183
Antrim	Cleggan Lodge	D 215102	0	100	0	25
Antrim	Collin Glen	J 277713	0	0	100	16
Antrim	Coolavelly Wood	D 143377	100	0	0	47
Antrim	Craigs	C 992166	100	0	0	237
Antrim	Crumlin Glen	J 138768	90	10	0	18
Antrim	Douglas Top	D 253012	100	0	0	3
Antrim	Dundarave	C 950417	0	100	0	40
Antrim	Garry	C 944308	100	0	0	323
Antrim	Glenariff	D 200200	100	0	0	924
Antrim	Glenarm	D 304128	97	3	0	172
Antrim	Glenoe	J 393973	0	100	0	19
Antrim	Glenwherry	D 300029	100	0	0	154
Antrim	Glynn Hill	J 408994	0	100	0	17
Antrim	Leslie Hill	C 935263	0	100	0	29
Antrim	Lisanoure Estate	D 069245	0	0	100	76
Antrim	Longmore Wood	D 214110	50	50	0	53
Antrim	Malone Golf Course	J 313675	0	100	0	32
Antrim	Muckamore	J 143855	95	5	0	51
Antrim	Portglenone	C 983028	99	1	0	292
Antrim	Rabbit Hill	D 122050	0	100	0	28
Antrim	Randalstown	J 088878	69	31	0	163
Antrim	Shanes Castle Park	J 133871	90	10	0	149
Antrim	Slieveanorra Forest	D 156263	100	0	0	2375

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Antrim	Straidkilly	D 300164	100	0	0	27
Antrim	Sugarloaf Hill	D 333124	0	100	0	17
Antrim	Tardree	J 183942	99	1	0	320
Antrim	Woodburn	J 362898	99	1	0	817
Armagh	Anne Mount House,	H 845342	0	100	0	3
Armagh	Armagh City	H 875450	0	100	0	9
Armagh	Ballymoyer	H 971308	96	4	0	33
Armagh	Bessbrook	J 053283	0	100	0	7
Armagh	Camlough	J 034225	100	0	0	251
Armagh	Carnagh	H 825295	100	0	0	121
Armagh	Carrickbrackan Wood	J 051264	100	0	0	20
Armagh	Carrigatuke	H 905320	100	0	0	373
Armagh	Castle Dillon House	H 906483	0	100	0	62
Armagh	Clare Glen	J 020440	0	100	0	27
Armagh	Dromintee	J 035172	0	100	0	37
Armagh	Drumbanagher	J 059355	100	0	0	69
Armagh	Fathom	J 108203	100	0	0	137
Armagh	Fathom Strip	J 094236	0	100	0	5
Armagh	Glassdrumman	H 964147	0	100	0	2
Armagh	Glendooey	J 040146	90	10	0	71
Armagh	Gosford	H 965406	66	34	0	223
Armagh	Jonesborough	J 060168	0	100	0	1
Armagh	Killery Church	J 039221	0	100	0	1
Armagh	Loughgall	H 922523	76	24	0	70
Armagh	Peatlands Country Park	H 903609	50	50	0	139
Armagh	Rich-Hill	H 942482	0	100	0	2
Armagh	Seagahan	H 908383	100	0	0	60
Armagh	Slieve Gullion	J 030190	100	0	0	581
Armagh	Slievebrack	H 998165.	100	0	0	41
Armagh	The Argory	H 868582	0	100	0	87
Armagh	The Fews	H 930318	99	1	0	1,050
Armagh	The Rectory, Creggan	H 931160	0	100	0	16
Armagh	Tievecrom	J 025153	90	10	0	64
Down	Annalong	J 341237	100	0	0	257
Down	Ballysallagh	J 448772	81	19	0	162
Down	Ballywalter	J 620683	0	0	100	80
Down	Ballywhite House	J 589530	0	100	0	88
Down	Belvoir	J 340696	92	8	0	79
Down	Bohill	J 395460	100	0	0	86
Down	Cabbragh Towers	J 260340	0	100	0	1
Down	Castleward	J 577494	53	32	15	221

Appendix 1: List of woodlands surveyed by O'Teangana (1999).

Down	Castlewellan	J 373325	98	2	0	527
Down	Clandeboye	J 479795	10	90	0	275
Down	Clarkhill Wood	J 338389	100	0	0	103
Down	Copeland View	J 427777	100	0	0	17
Down	Crocknafeola Wood	J 276221	100	0	0	64
Down	Donard	J 373297	100	0	0	287
Down	Dromantine College	J 080360	0	100	0	45
Down	Drumkeeragh	J 333466	100	0	0	184
Down	Eleven Acres Wood	J 389454	100	0	0	28
Down	Finnabrogue Estate	J 485473	0	0	100	73
Down	Florida Manor	J 475617	0	100	0	12
Down	Greystown	J 482483	0	0	100	64
Down	Hillsborough	J 243584	88	12	0	177
Down	Hollymount	J 469439	75	25	0	83
Down	Hyde Bank Wood	J 341681	30	70	0	35
Down	Moneyscalp Wood	J 321328	100	0	0	68
Down	Montalto House	J 365517	0	100	0	66
Down	Mount Stewart	J 550704	35	28	37	515
Down	Mourne	J 273172	96	4	0	245
Down	Narrow Water	J 119206	94	6	0	133
Down	Newcastle	J 364321	100	0	0	5
Down	Ormeau Park	J 348728	0	0	100	26
Down	Portaferry House	J 593518	0	100	0	39
Down	Portavo House	J 564821	0	100	0	38
Down	Rademon House	J 440523	0	0	100	85
Down	Redburn	J 402776	0	0	100	22
Down	Rostrevor	J 202197	97	3	0	1176
Down	Rowallen	J 413576	0	0	100	78
Down	Saintfield House	J 400605	0	100	0	202.5
Down	Seaforde Estate	J 403433	0	0	100	143
Down	Silent Valley	J 305210	100	0	0	41
Down	Stormount	J 405750	0	0	100	17
Down	Tievenadarragh Wood	J 403465	100	0	0	5
Down	Tipperary Wood	J 369315	0	100	0	5
Down	Tobar Mhuire	J 459520	0	100	0	12
Down	Tollymore	J 336317	95	5	0	582
Fermanagh	Ballintempo	H 073446	100	0	0	1553
Fermanagh	Belmore	H 115419	100	0	0	821
Fermanagh	Big Dog	H 044486	100	0	0	907
Fermanagh	Boa Island	H 100629	0	100	0	13
Fermanagh	Carrigan	H 048468	100	0	0	1277

Appendix 1: List of woodlands surveyed by O'Teangana (1999).

Fermanagh	Castle Archdale	H 184593	98	2	0	403
Fermanagh	Castle Caldwell	H 015601	95	5	0	198
Fermanagh	Castle Coole	H 258431	0	100	0	37
Fermanagh	Conagher	H 060531	100	0	0	726
Fermanagh	Coolebrook	H 414446	0	100	0	132
Fermanagh	Corlaght East	H 241695	100	0	0	40
Fermanagh	Crocknagrally	H 472439	100	0	0	583
Fermanagh	Crom	H 362244	50	50	0	607.5
Fermanagh	Curraghmore	H 130653	100	0	0	112
Fermanagh	derrylin & Naan isl.	H 260274	92	8	0	103
Fermanagh	Doon	H 452362	100	0	0	506
Fermanagh	Dooneen Forest	H 382533	100	0	0	41
Fermanagh	Drumbane Wood	H 210533	100	0	0	8
Fermanagh	Edenclogh Wood	H 254666	0	100	0	9
Fermanagh	Ely Lodge	H 182509	78	22	0	223
Fermanagh	Florencecourt	H 160338	88	12	0	632
Fermanagh	Jenkin	H 483404	100	0	0	1282
Fermanagh	Kesh	H 160670	100	0	0	1680
Fermanagh	Knockninny	H 275305	0	100	0	25
Fermanagh	Loch Navar	H 035556	100	0	0	1958
Fermanagh	Lowery	H 109650	100	0	0	15
Fermanagh	Marble Arch	H 124345	0	100	0	101
Fermanagh	Mullaghfad	H 503408	99	1	0	795
Fermanagh	Necarne Forest	H 233566	61	39	0	90
Fermanagh	Portora Royal School	H 224448	90	10	0	15
Fermanagh	Pubble	H 332468	97	3	0	84
Fermanagh	Riversdale	H 238518	93	7	0	118
Fermanagh	Tully	H 444333	100	0	0	707
Fermanagh	Tullychurry	H 043635	100	0	0	416
Londonderry	Altbrittain	H 699991	100	0	0	395
Londonderry	Ashbrook House	C 462142	10	90	0	8
Londonderry	Aughnagalvin Hospital	C 454157	0	100	0	17
Londonderry	Ballybogy Plantation	C 911313	100	0	0	71
Londonderry	Ballyhanna Forest	C 711292	100	0	0	100
Londonderry	BallyKelly	C 610220	86	14	0	96
Londonderry	Banagher	C 692023	100	0	0	989
Londonderry	Binevenagh Forest	C 702308	97	3	0	677
Londonderry	Cam	C 771211	100	0	0	963
Londonderry	Campsey	C 512221	99	1	0	31
Londonderry	Carndaisy Glen	H 835859	0	100	0	20
Londonderry	Carndaisy Wood	H 830870	100	0	0	30

Appendix 1: List of woodlands surveyed by O'Teangana (1999).

Londonderry	Castledawson Course	H 924937	0	100	0	86
Londonderry	Clady, Portglenone	C 959034	0	100	0	1
Londonderry	Claudy	C 540069	0	100	0	8
Londonderry	Londonderrynoyd	H 763961	46	54	100	102
Londonderry	Downhill Wood	C 755355	90	10	0	77
Londonderry	Drenagh, Limavady	C 690234	0	0	100	89
Londonderry	Garvagh	C 830161	99	1	0	197
Londonderry	Glenbrook, Magherafelt	H 911914	0	100	0	3
Londonderry	Glenshane	C 769024	100	0	0	432
Londonderry	Gortnamoyagh Forest	C 762130	100	0	0	698
Londonderry	Grange Park	C 738298	100	0	0	1098
Londonderry	Iniscarn	H 825902	97	3	0	151
Londonderry	Learmount	C 581021	90	10	0	108
Londonderry	Loch Fea	H 757875	100	0	0	40
Londonderry	Loughermore	C 578147	100	0	0	1126
Londonderry	Loughermore Forest E	C 632161	100	0	0	333
Londonderry	Lower Campsey	C 501215	50	50	0	14
Londonderry	Maghera Town	C 855001	0	100	0	4
Londonderry	Mountsandel Wood	C 853308	0	0	100	22
Londonderry	Moybeg Road	H 811973	0	100	0	1
Londonderry	Moydamlaght	H 742994	98	2	0	248
Londonderry	Moyola	H 931944	100	0	0	47
Londonderry	Muff Glen	C 523179	99	1	0	37
Londonderry	Ness Wood C. P.	C 525114	0	100	0	14
Londonderry	Prehen	C 419138	0	100	0	7
Londonderry	Roe Valley Country Park	C 674206	0	100	0	37
Londonderry	Rusky	C 879233	0	0	100	5
Londonderry	Somerset	C 845303	86	14	0	137
Londonderry	Springhill	H 864826	0	0	100	8
Londonderry	Springwell	C 775268	99	1	0	1067
Londonderry	St. Columb's Park,	C 454161	0	100	0	4
Londonderry	Stradreagh	C 716282	0	100	0	4
Londonderry	The Oaks	C 497110	0	0	100	1
Londonderry	White Water Glen	H 770915	0	100	0	12
Tyrone	Aghyaran	H 174810	100	0	0	414
Tyrone	Aghyaran Church Yard	H 189812	100	0	0	5
Tyrone	Altamullan Glen	H 170819	0	100	0	3
Tyrone	Altdarragh Glen	C 498027	0	100	0	7
Tyrone	Altmore	H 646667	100	0	0	550
Tyrone	Augher	H 560538	0	100	0	21
Tyrone	Barens Glen	H 550901	0	100	0	2

Appendix 1: List of woodlands surveyed by O'Teangana (1999).

Tyrone	Baronscourt	H 365828	100	0	0	702
Tyrone	Boorin Wood	H 501852	0	100	0	13
Tyrone	Bradkeel	H 512938	100	0	0	98
Tyrone	Brantry	H 756539	100	0	0	58
Tyrone	Caledon/ Lemnagore	H 753436	96	4	0	207
Tyrone	Camus House	H 350927	0	100	0	1
Tyrone	Carnagat	H 453528	100	0	0	276
Tyrone	Carrickaholten	H 201762	100	0	0	442
Tyrone	Cavanlee Glen	H 374963	0	0	100	12
Tyrone	Church Hill	H 490857	100	0	0	13
Tyrone	Claragh Wood	H 360757	0	100	0	14
Tyrone	Clogherny Glebe	H 572912	0	100	0	5
Tyrone	Coniferous Plots	H 642913	100	0	0	136
Tyrone	Creevagh School	H 771825	100	0	0	4
Tyrone	Creggan	H 613794	100	0	0	582
Tyrone	Davagh	H 719853	100	0	0	1063
Tyrone	Drum	H 760778	71	29	0	60
Tyrone	Drumcairne Forest	H 882708	91	9	0	203
Tyrone	Drumlea Wood	H 542879	0	100	0	38
Tyrone	Drummond Wood	H 828760	0	100	0	18
Tyrone	Dunamanagh	C 449035	0	100	0	5
Tyrone	Dungannon Town Park	H 805620	0	100	0	16
Tyrone	Ecclesville	H 445605	100	0	0	45
Tyrone	Fardross	H 521475	100	0	0	637
Tyrone	Favour Royal	H 609513	100	0	0	491
Tyrone	Fivemiletown	H 450485	0	100	0	49
Tyrone	Glacken's Wood	H 390990	0	100	0	24
Tyrone	Glenderg	H 092829	100	0	0	2312
Tyrone	Goles Forest	H 681933	100	0	0	393
Tyrone	Gortin Glen	H 488805	99	1	0	1235
Tyrone	Killens	H 523778	100	0	0	76
Tyrone	Killens Wood	H 532785	100	0	0	36
Tyrone	Killins Glen	H 531783	0	100	0	2
Tyrone	Knockmany	H 451554	97	3	0	382
Tyrone	Legnavadder Glen	H 432984	0	100	0	8
Tyrone	Ligfordrum	H 411933	100	0	0	591
Tyrone	Liscloon	C 476038	0	100	0	6
Tyrone	Lissan House	H 797823	0	0	100	71
Tyrone	Loch Bradan	H 244731	100	0	0	1824
Tyrone	Mountjoy Forest	H 435760	0	100	0	60
Tyrone	Old Mountjoy Wood	H 462769	0	100	0	50

Appendix 1: List of woodlands surveyed by O'Teangana (1999).

Tyrone	Owenkillew Glen	H 461883	0	100	0	47
Tyrone	Parkanaur	H 734612	68	32	0	181
Tyrone	Pigeon Top (Dromore)	H 350668	100	0	0	306
Tyrone	Pomeroy	H 706728	93	7	0	167
Tyrone	Sawelabeg Forest	H 652937	100	0	0	82
Tyrone	Seskinore	H 485640	82	18	0	100
Tyrone	Silverbrook Bridge	C 453004	0	100	0	8
Tyrone	Silverhill, Strabane	H 397988	0	100	0	10
Tyrone	Slievedoo	H 078803	100	0	0	993
Tyrone	Strabane Glen	H 359986	0	100	0	33
Tyrone	Stuart Hall	H 896721	0	100	0	60
Tyrone	Tullaghoge Fort	H 824740	0	100	0	19
Tyrone	White Glen	H 297732	100	0	0	22
Tyrone	Wood Hills	H 380859	100	0	0	27
Tyrone	Woodside, Killeter	H 214803	0	100	0	3

Appendix 2: Summary table comparing the results of the survey carried out by O'Teangana in 1995/1996 (O'Teangana, 1999) and the current survey.

Site Name	***Grid Ref***	***1999 Survey***	***2002 Survey***
Binabanan	D 286210	red	red
Belmore	H 115419	both	both
Big Dog	H 044486	both	both
Castle Archdale	H 184593	both	both
Castle Caldwell	H 015601	both	both
Ely Lodge	H 182509	both	both
Florencecourt	H 160338	both	both
Glenderg	H 092829	both	both
Loch Navar	H 035556	both	both
Portora Royal School	H 224448	both	grey
Pubble	H 332468	both	both
Seskinore	H 485640	both	both
Tully	H 444333	both	both
Augher	H 560538	both	grey
Boorin Wood	H 501852	both	grey
Caledon/ Lemnagore Wood	H 753436	both	grey
Fardross	H 521475	both	both
Favour Royal	H 609513	both	both
Fivemiletown	H 450485	both	grey
Knockmany	H 451554	both	both
Randalstown	J 088878	both	both
shanes castle	J 133871	both	both
Derrynoyd	H 763961	both	both
Glenshane	C 769024	both	both
Learmount	C 581021	both	both
Loughermore	C 578147	both	both
Moydamlaght	H 742994	both	both
Ballintempo	H 073446	both	both
Portglenone	C 983028	grey	grey
Portglenone	C 983028	grey	grey
BallyKelly	C 610220	grey	grey
Clady, Portglenone	C 959034	grey	grey
Garvagh	C 830161	grey	both

Appendix 2: Summary table comparing the results of the survey carried out by O'Teangana in 1995/1996 (O'Teangana, 1999) and the current survey.

Castle Coole	H 258431	grey	grey
Coolebrook	H 414446	grey	both
Drumcairne Forest	H 882708	grey	grey
Parkanaur	H 734612	grey	grey
Pomeroy	H 706728	grey	grey
Riversdale	H 238518	grey	grey
Breen	D 125329	none	red
Capanagh	D 298037	none	none
Cleggan Lodge	D 215102	none	red
Craigs	C 992166	none	grey
Douglas Top	D 253012	none	none
Glenwherry	D 300029	none	none
Leslie Hill	C 935263	none	grey
Lisanoure Estate	D 069245	none	grey
Longmore Wood	D 214110	none	red
Rabbit Hill	D 122050	none	grey
Altbrittain	H 699991	none	red
Ballyhanna Forest	C 711292	none	grey
Banagher	C 692023	none	red
Drenagh, Limavady	C 690234	none	grey
Gortnamoyagh Forest	C 762130	none	none
Grange Park	C 738298	none	grey
Loughermore Forest (east)	C 632161	none	none
Roe Valley Country Park	C 674206	none	grey
Stradreagh	C 716282	none	none
Jenkin	H 483404	none	grey
Carmanus (Duffs Hill)	J 426921	red	none
Clady Bridge/ Craigagh	D 228324	red	red
Coolavelly Wood	D 143377	red	red
Glenariff	D 200200	red	red
Slieveanorra Forest	D 156263	red	red
Glenarm	D 304128	red	red
Straidkilly	D 300164	red	red
Binevenagh Forest	C 702308	red	grey
Cam	C 771211	red	grey
Claudy	C 540069	red	none

Appendix 2: Summary table comparing the results of the survey carried out by O'Teangana in 1995/1996 (O'Teangana, 1999) and the current survey.

Ness Wood Country Park	C 525114	red	red
The Oaks	C 497110	red	grey
Belvoir forest	J 340696	red	both
Tollymore	J 336317	red	both
Carrigan	H 048468	red	red
Conagher	H 060531	red	both
Crocknagrally	H 472439	red	grey
Doon	H 452362	red	red
Mullaghfad	H 503408	red	red
Ballycastle	D 124383	red	red
Ballypatrick	D 180364	red	red