

***Phoenix Park Grey Squirrel Project Report:***

***Spring 2008***

- *Population density changes 2007-2008*
- *Trial cull removals over 12 months*
- *Cumulative tree damage changes over three years*
- *Comparison with other parks*

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### **Introduction: Urban Grey Squirrels (*Sciurus carolinensis*)**

Two species of squirrel are found in Ireland, the European red squirrel (*Sciurus vulgaris*) and the eastern grey squirrel (*Sciurus carolinensis*). The red squirrel is considered to be an indigenous Irish species with recent genetic work indicating that the current population may be a mixture of both native and translocated stock from Britain (Finnegan, Edwards and Rochford 2008). The grey squirrel was introduced at Castleforbes, Co Longford in 1911 (Watt 1923). Since then it has spread rapidly and is now found in 26 of the 32 counties (Carey *et al.* 2007). The rapid expansion of grey squirrels has been mirrored by a decline in red squirrel numbers and a contraction of their range within Ireland. This is generally considered to be due to the ability of grey squirrels to out-compete red squirrels.

Grey squirrels were first observed in Dublin in the 1970's. Prior to this, the city supported a large red squirrel population. The spread of grey squirrels throughout the city resulted in a dramatic loss of red squirrels (Madigan 2007). In the Phoenix Park, the first grey squirrel was sighted in 1979 and red squirrels were last seen around 1987. Other city parks have shown similar declines. In the Botanic Gardens, grey squirrels were first seen 30 years ago and it has been 10 years since a red squirrel has been observed there. The first grey squirrels were seen in Marley Park 33 years ago and the last red squirrels were seen 30 years ago. In Bushy Park the disappearance of red squirrels occurred synonymously with the arrival of grey squirrels 10 years ago. Red squirrels are now only to be found in Killiney Hill Park, St. Anne's Park in Raheny and on Howth Head. The status of these remaining populations is under threat with

St. Anne's park also home to an extensive grey squirrel population and the first grey squirrels having reached both Killiney Hill Park and Howth Head.

Grey squirrels not only displace red squirrels, but also frequently cause damage to woodlands by stripping the outer bark from the main stem and branches of trees. This has implications for city parks and gardens and may pose limitations on the types of species grown as tree species, age and silvicultural practices affect the vulnerability of trees to damage. This is a particular threat for the Botanic Gardens with many specimen species at risk.

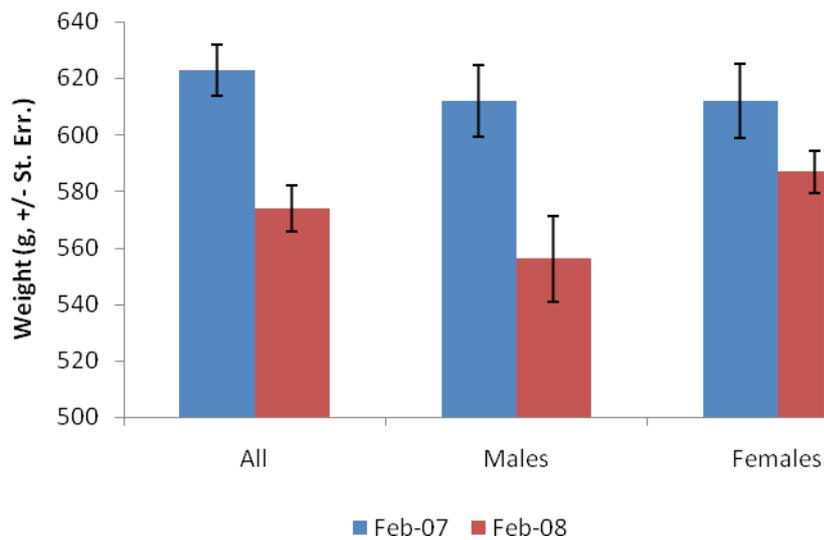
Management plans for the grey squirrel in the Phoenix Park and St. Anne's Park are currently being drawn up. Culling of grey squirrels has also been implemented in both Cabinteely Park and Killiney Hill Park. The following report outlines the results of research on the Phoenix Park grey squirrel population. A comparison with results from other urban parks is also made.

### ***Phoenix Park grey squirrel population estimates 2007- 2008:***

Approximately 28% (~200 ha) of the park contains suitable habitat for grey squirrels; this being stands of mature trees suitable for drey/nest sites. Population estimates during the spring of 2007 using live-capture and release techniques, at two sites (1) the Ashtown Visitor Centre and (2) the north wall of the park between the Ashtown gate and the Hole in the Wall pub, indicated a population density of 12 squirrels per hectare (sq/ha) of woodland. This indicated that there were approximately 2400 squirrels in the park at that time. Population estimates for three sites were conducted in spring 2008. These sites were a section of the Oldtown Woods, the Scot's pine and beech plantation at the top end of the Khyber road and a plantation of Holm oak and Scot's pine near the car park at the cricket grounds. These sites indicated a population density of 2 sq/ha of woodland. This represents a significant decrease in density throughout the park. The estimated population size for spring 2008 was 400 squirrels. The population density at the Ashtown Visitor Centre had decreased from 13 squirrels per hectare to 3 sq/ha. It should be noted that the habitat of the Ashtown population was disturbed during April 2007 resulting in many individuals leaving the area.

This dramatic decrease in overall population size may be related to the poor summer weather and poor autumn acorn crop in 2007. Squirrels were significantly heavier in February 2007 than in February 2008 (see figure 1;  $t = 3.398$ ,  $df = 45$ ,  $p < 0.01$ ). A comparison of seven marked individuals revealed similar findings (see figure 2;  $t = 3.974$ ,  $df = 6$ ,  $p < 0.01$ ). The squirrels were in poorer condition in spring 2008. The breeding season was also delayed in

2008. Eleven marked adult female squirrels were captured on a number of occasions in January and February 2007. All had mated prior to the 6<sup>th</sup> of February. Ten adult females were trapped between the 5<sup>th</sup> and 27<sup>th</sup> of February 2008. All were still in a pre-oestrous condition. This delayed breeding and poorer condition of squirrels suggests that the spring breeding in 2008 period is unlikely to result in a dramatic increase in population numbers. Trapping of adult female squirrels in May 2008 revealed a breeding rate of 16% in comparison with a rate of 84% in 2007.



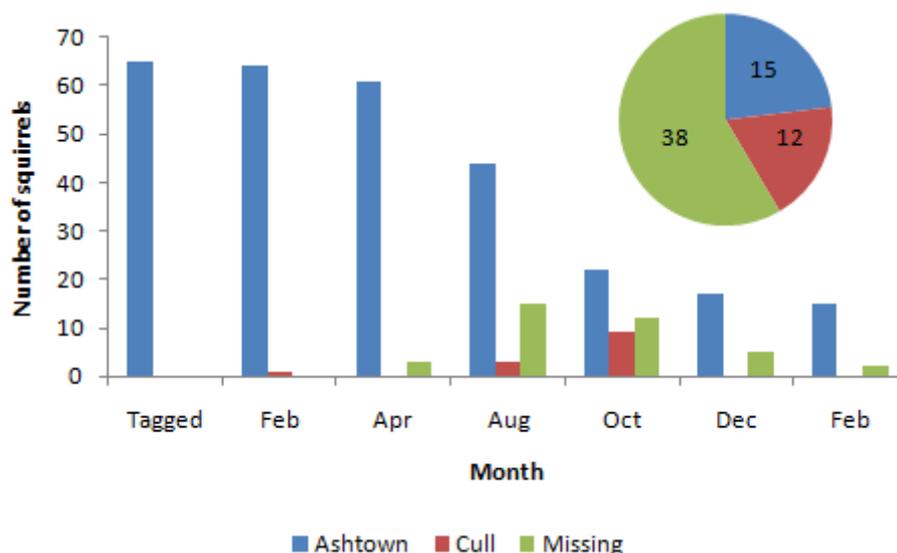
**Figure 1:** Comparison of the weight of adult squirrels between February 2007 and February 2008.



**Figure 2:** Comparison of the weights of seven individuals between years.

***Effects of disturbance to the Ashtown study population:***

A total of 65 individual squirrels were ear tagged in the grounds of the Ashtown Visitor Centre in January and early February 2007. These consisted of 39 adults and 26 juveniles. Further trapping throughout 2007 monitored the persistence of these individuals within the site (see figure 3). Major disturbance to the habitat surrounding the visitors centre occurred in April 2007 consisting of the clearance of undergrowth and felling of several large trees which had acted as both a food source and location for dreys. Between Apr 07 and Feb 08, 50 squirrels disappeared from the Ashtown site. Twelve of these were accounted for in the cull site. The remaining 38 either died or have moved to other areas of the park. Based on survivorship estimates from the literature (Gurnell 1987) and discounting those culled, 22 adults and 7 juveniles should have survived from 2007 to 2008. The remaining population in Ashtown consists of 11 of the adults and 4 of the 2007 juveniles.



**Figure 3:** Persistence of a sample of tagged squirrels within the Ashtown study site.

The disturbance also had an effect on the breeding success of adult female squirrels in early summer. A smaller percentage of adult females produced litters in the Ashtown Visitor Centre compared to females elsewhere in the park (38% compared to 84%;  $\chi^2 = 8.839$ ,  $df = 1$ ,  $p < 0.01$ ). Only six juveniles survived weaning and were tagged in the study site in August. None have been sighted since. No new juveniles were found in the Oct 07, Dec 07 or Feb 08 trapping sessions. This was most likely due to the poor acorn crop in autumn 2007.

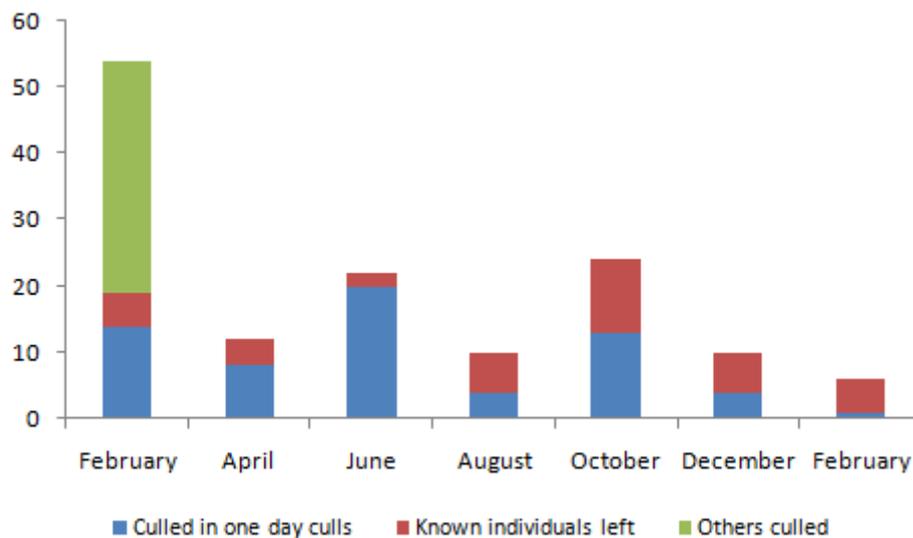
***Results of cull removals from a 5ha area over 12 months:***

*Initial cull:*

Eight culls days were conducted over a 12 day period in a 5 ha cull site (the section of trees along the north wall of the Park between the Ashtown gate and the Hole in the Wall pedestrian gate). This resulted in the removal of 49 individuals leaving an estimated 5 remaining squirrels. Squirrels were euthanized by cervical dislocation.

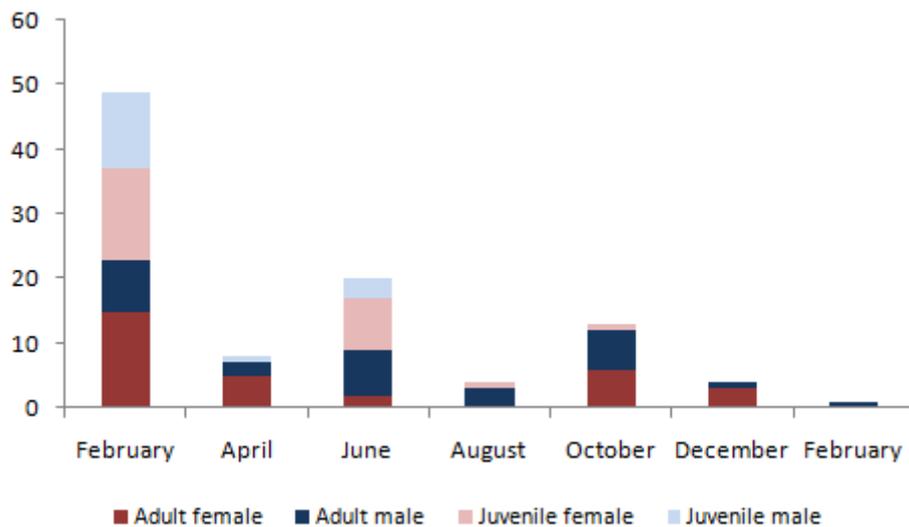
*Subsequent culls:*

A further 6 culls were conducted at approximately 2-monthly intervals. Overall, this removed 99 squirrels from the site over 12 months (see figure 4). Each cull consisted of a one-day cull in each of the three woodland sections of the cull site.



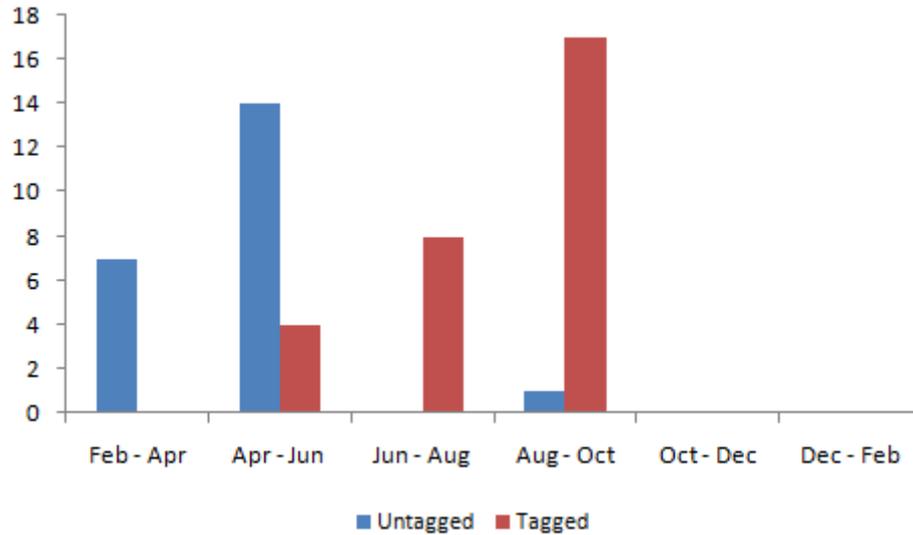
**Figure 4:** Number of squirrels culled and known to remain for each cull period (Feb 07 – Feb 08).

The initial population structure (as indicated by culled animals) was made up of 53% juveniles (see figure 5). All subsequent culls were largely adults, except for the June cull which also contained newly emerged juveniles from some females which has not been culled in the previous cull session.



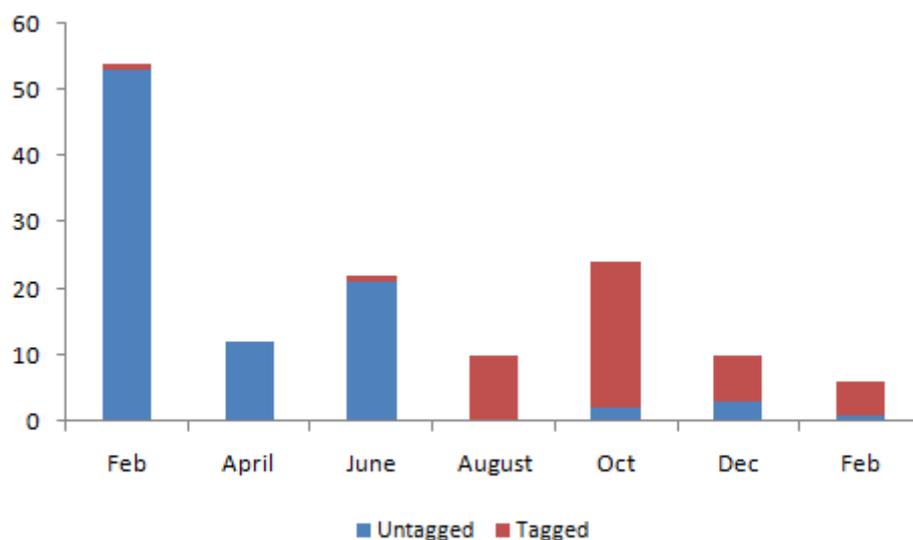
**Figure 5:** Population structure of removed squirrels from each cull.

Two periods of re-population occurred throughout the year, between the Apr – June and the Aug – Oct culls. The first is explained by juvenile recruitment within the cull area. The second is explained by the immigration of adult squirrels (mostly tagged) from the adjacent study site in the Ashtown visitors centre (see figure 6). This immigration was the result of major site disturbance caused by the clearance of undergrowth and several large seed-crop trees with the visitor centre area. There was no increase between Oct 07 – Dec 07 or Dec 07 – Feb 08 cull periods.



**Figure 6:** Status of the immigrating individuals between culls.

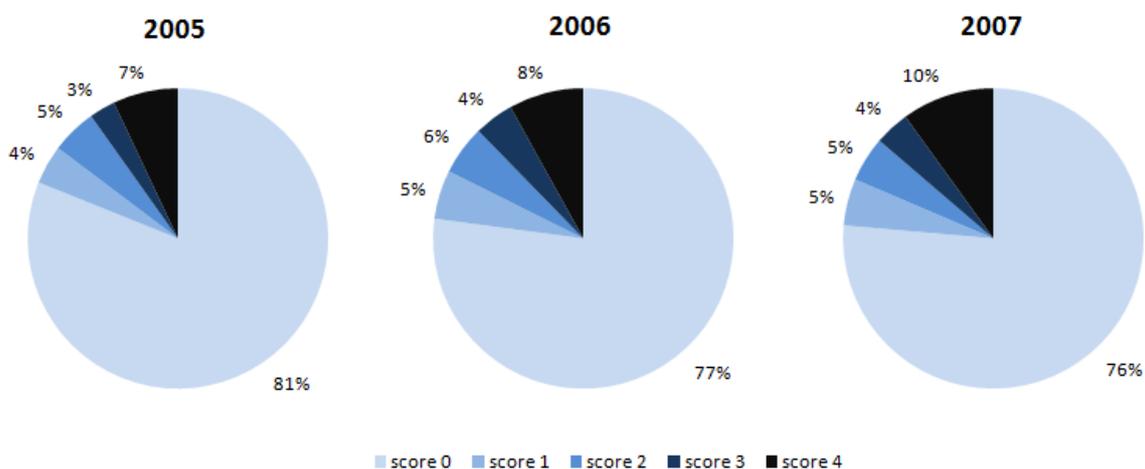
The population was largely made up of tagged individuals (from the visitor centre population) subsequent to the June 2007 cull (see figure 7). There was little movement of individuals from the visitor centre site prior to the disturbance in April and only a few individuals immigrated into the cull area from other areas. It may be that, had the disturbance not occurred, the cull site would have been cleared by August.



**Figure 7:** Population make-up during each cull period (culled and known animals remaining after each cull).

***Changes in tree damage over three years - overall damage scores:***

Between 2005 and 2007, the cumulative percentage of damaged trees rose from 19% to 24% (see figure 8). Most of this increase occurred in 2006 with only a 1% increase in the percentage of damaged trees in 2007. The percentage of trees suffering significant damage (score 2, 3 and 4) rose from 15% to 19%. There was a significant decrease in the number of trees damaged in 2007 (404 compared to 863:  $\chi^2 = 178.341$ ,  $df = 1$ ,  $p < 0.001$ ). This may reflect the poor growth conditions in the summer of 2007. However, in both years, new damage (current year) was significantly more likely to occur to trees which had been previously damaged than to undamaged trees (2006:  $\chi^2 = 998.074$ ,  $df = 1$ ,  $p < 0.001$ ; 2007:  $\chi^2 = 884.548$ ,  $df = 1$ ,  $p < 0.001$ ). The number of trees damaged for the first time decreased from 375 in 2006 to 66 in 2007.

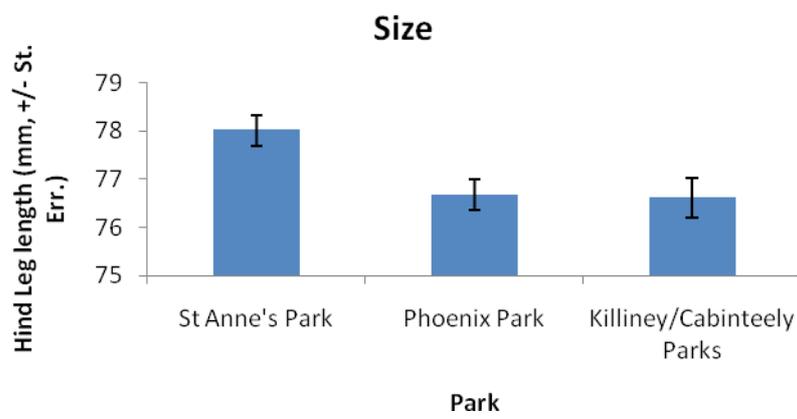


**Figure 8:** Changes in tree damage over three years.

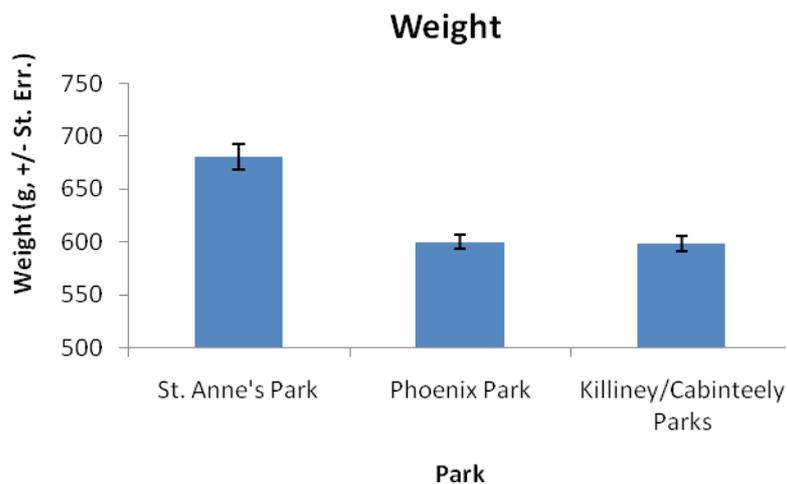
### ***Comparison with other parks:***

The density of grey squirrels in St. Anne's park in February was significantly greater than both the Phoenix Park and Marley Park ( $F_{2,20} = 3.826$ ,  $p < 0.05$ ). The mean density of squirrels per hectare of woodland in each of the parks were; St. Anne's park: 4 sq/ha; Phoenix Park: 2 sq/ha and Marley Park: 1 sq/ha. The grey squirrels caught between Nov 2007 and Feb 2008 in St. Anne's park were also significantly larger ( $F_{2,111} = 5.066$ ,  $p < 0.01$ ) and heavier ( $F_{2,111} = 26.119$ ,  $p < 0.001$ ) than those caught in both the Phoenix Park and Killiney/Cabinteely parks (see figures 9 and 10). This is most likely due to the high level of feeding of squirrels by the public known to occur in St. Anne's Park. While this would suggest that the grey squirrels in St. Anne's should be breeding at a higher rate, this is not the case. Based on a sample of 45

grey squirrels trapped between Nov 2007 and Feb 2008 in St. Anne's, the population was made up of 90% adults, 10% juveniles with an adult sex ratio of 1.3:1, females:males. This population structure suggests that the park has reached its carrying capacity. None of a sample of nine adult females trapped at the end of April 2008 showed any signs of breeding. Line transect survey results throughout St. Anne's Park indicated there were an estimated 212 grey squirrels within the park in February. St. Anne's Park is the second largest in Dublin covering 107 ha.



**Figure 9:** Comparison of body size (hind leg length).



**Figure 10:** Comparison of body weight.

### ***Removal of grey squirrels from Killiney Hill Park and Cabinteely Park:***

Grey squirrels were first sighted in Killiney two years ago. Trapping of grey squirrels in December 2007 and January 2008 resulted in the removal of 22 grey squirrels. The last grey squirrel was removed on the 29<sup>th</sup> of January and no grey squirrel has been sighted in the park since. In total, 53 grey squirrels have been removed from Cabinteely Park in the last year. The current grey squirrel population is believed to be <5 individuals based on staff estimates. Cage trapping and removal is therefore a successful method of removal of squirrels in Dublin parks. Monitoring of both these parks is ongoing to determine the rate of immigration of animals from the surrounding areas.

### ***Conclusions and recommendations:***

These results indicate that the grey squirrel population in the Phoenix Park suffered a significant decline in density in 2007 due to a combination of poor summer weather and a poor autumn acorn crop. The poorer condition of those remaining coupled with the delay in breeding is unlikely to result in any dramatic recovery in the short term as indicated by the low rate of breeding observed in May trapping results. Previous studies have indicated that following a year in which tree seed crops fail, > 90% of females in a population may forego reproduction and litter sizes decrease to less than 2 squirrels (Barkalow 1967; Nixon and McClain 1969).

Results from the trial cull area indicate that the removal of squirrels from an area does not result in a vacuum into which surrounding squirrels move. Prior to the disturbance of the nearby study site, there was little movement into the newly cleared cull site. Given this lack of movement and the low density of squirrels remaining in the Park, once an area has been cleared, it may now remain clear for an extended period. This would allow time for the surrounding areas to also be cleared. Combining these results with those from culling within Killiney and Cabinteely Parks indicates that this method of squirrel control is successful at eradicating squirrels from an area.

The decline in tree damage was due to the poor growth conditions in 2007 and not the decline in squirrel density. Tree damage is at its peak in July and this was prior to the decline in squirrels. It is predicted that tree damage for the forthcoming year should decrease.

### ***Recommendations:***

- (1)** It is recommended that a concentrated effort to catch and remove squirrels be made prior to the autumn breeding period. The spring breeding season is unlikely to result in many surviving juveniles and the removal of adults will further decrease the potential for recovery.
  
- (2)** The density estimate of 2 sq/ha does not include the zoo. Unlike the remainder of the Park, the squirrels within the zoo have access to year round food either from bin raiding or from stolen animal feed. They are unlikely to have been affected by the poor weather or acorn crop in 2007 and are likely to still be at high density. The zoo may therefore contain up to 200 squirrels and is likely to act as a source population for density recovery in the remainder of the Park if left alone. It is a priority to have these animals removed before they begin to disperse into the Park. Trapping in May 2008 at eight locations throughout the Park with equal effort in each site revealed the highest density of squirrels at the two sites beside the Zoo at the back of the Polo grounds. This site is the most likely emigration route for squirrels from within the Zoo grounds.
  
- (3)** Given the success of the current methodology, it is recommended to extend the culling programme into other Dublin parks. The Botanic Gardens and surrounding area contains a high density population of grey squirrels. Not alone are these squirrels posing a threat to the trees within the Botanic Gardens, they are also posing a threat to humans with several people having been bitten in the past year. The high degree of hand feeding of squirrels within the Botanic gardens has resulted in the animals losing their fear of humans and is likely to result in more injuries to the public if they are not controlled. Cage trapping and removal could alleviate the problem in a relatively short period of time.

### ***Acknowledgements:***

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