

Analysis of scientific research with regard to the effect of squirrels on forest regeneration

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| Analysed research – titles | Research team | Research site |
|---|---|--|
| Caching and feeding decisions by <i>Sciurus carolinensis</i> : responses to weevil-infested acorns. | M. A. Steele*, L. Z. Hadj-Chick** and J. Hazeltine* | *Department of Biology, Wilkes University **Department of Biology, Princeton University |
| Food-hoarding behavior of gray squirrels and North American red squirrels in the central hardwoods region: implications for forest regeneration | J.R. Goheen and R.K. Swihart | Department of Forestry and Natural Resources, Purdue University |
| Feeding and hoarding behaviour of the Eurasian red squirrel <i>Sciurus vulgaris</i> during autumn in Hokkaido Japan | T. H. Lee 1*,2* | 2* National Yunlin University of Science and Technology 1* SHU-TE University |



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The effect of squirrels on forest regeneration

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For a long time the scientific world has deemed squirrels one of the most important animals responsible for forest regeneration (Steele et al. 1993, Vander Wall 1990). **Scientific studies conducted by researchers** from universities Wilkes, Princeton (Steele et al. 1996) and Purdue (Goheen & Swihart 2003) **have shown that the unrivalled leaders in seed dispersion – and subsequently in forest regeneration – are grey squirrels (*Sciurus carolinensis*).**

There are many factors contributing to high efficiency of forest regeneration by grey squirrels (*Sciurus carolinensis*). The first factor in the grey squirrels' success in forest regeneration is the **huge amount of tree seeds they bury**. Research has shown that grey squirrels store most (**96.9%**) of seeds in this way (Goheen & Swihart 2003). Scientists also managed to establish that **about 30% of the buried seeds will never be recovered by grey squirrels. These buried and unrecovered seeds are the basis for the future forest regeneration** (Steele 1998, Goheen & Swihart 2003).

Another factor of grey squirrels' (*Sciurus carolinensis*) high efficiency in forest regeneration is the **quality of seeds** they bury. The study results have shown that **grey squirrels eat first the seeds which are damaged** (infested, rotting, etc. – which would not germinate for the most part anyway) **and they bury healthy seeds "helping forest regeneration to even greater extent than it was thought so far (1)"** (Steele et al. 1996 (1), Steele 1998, Smallwood et al. 2001).

The researchers also point out the fact that **grey squirrels (*Sciurus carolinensis*), by eating larvae and insects that attacked seeds, prevent in a very important way the negative effect of seed damage (by larvae, insects, etc.) on forest regeneration and condition** (Steele et al. 1996, Steele 1998).

Most of the scientific research on trees dispersal note the fact that **the quality of distributed seeds has a paramount influence on a successful process of tree dispersal** hence the **selective burying of healthy seeds (and eating the damaged ones) makes this animal an unrivalled leader in forest regeneration** (Steele et al. 1996, Smallwood 1998, Vander Wall 2001, Goheen & Swihart 2003, Swihart 2003).

Grey squirrels (*Sciurus carolinensis*) also surprised scientists with the efficiency of recognising damaged seeds from healthy ones. It turned out that grey squirrels were in over 45% of cases more efficient in detecting infested and healthy seeds than scientists equipped with laboratory instruments SIC! (Steele et al. 1996).

Scientific research are also getting support from environmentalists (Crook 2004, Hanrahan and Belair 2015) who observe a **significant increase in young trees in the areas inhabited by grey squirrels (*Sciurus carolinensis*).**

Unfortunately due to inconsiderate human activities in many areas the grey squirrel population is quite seriously threatened. Already many environmentalists and scientists bring our attention to the fact that **there is significant deficiency in natural forest regeneration in those areas where grey squirrel population has declined in the recent decades** (Steele et al. 1996, Swihart 2003).

Experiment conducted by ICSRS

Using the methodology of researchers from Purdue University (Goheen & Swihart 2003), ICSRS conducted in 2015-2016 a similar experiment in three UK locations, from 9th December 2015 to 14th April 2016 (ICSRS 2016b). The results of this experiment were congruous with the findings of scientists from Purdue University (Goheen & Swihart 2003).

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Influence of other squirrel species on forest regeneration

Apart from grey squirrels (*Sciurus carolinensis*) scientists also studied other squirrel species with regard to their potential for forest regeneration (Lee 2002, Goheen and Swihart 2003).

Red squirrel *Tamiasciurus hudsonicus*

The results of research (Goheen & Swihart 2003) of this squirrel species behaviour have confirmed the environmentalists observations saying that red squirrels (*Tamiasciurus hudsonicus*) store most of their supplies (88.9%) in larders (mostly placed in the trees – those seeds won't be used for forest regeneration) and they bury little over 11% of seeds (Goheen & Swihart 2003). The studies didn't observe in red squirrels either "the habit of selectively burying healthy seeds" nor eating damaged seeds first.

The research results made some environmentalists – quite unjustly in our opinion – start to classify red squirrels (*Tamiasciurus hudsonicus*) as "seeds predators", minimising their effect on forest regeneration. Such opinions don't take into account that the natural habitat of red squirrels are mostly coniferous forests where "regeneration needs" differ significantly from "regeneration needs" of deciduous forests. It should also be pointed out that red squirrels start to look for buried seeds only after using their suppliers in the "larder" – so after a couple of months, when their "efficiency in recovering seeds" will be much lower and the forgotten seeds will aid the future forest regeneration. That's why red squirrels are still seen by most environmentalists not only as a "seed predator" but also as seed dispersers and forest regenerators.

Red Squirrel *Sciurus vulgaris*

In comparison to the above studies, quite interesting are the research results (Lee 2002) about seed hoarding – and, what follows, possible effects on forest regeneration – by red squirrels (*Sciurus vulgaris*) occurring in Asia and Europe. The research showed that red squirrels ate but didn't hoard seeds of most of tree species (15 out of 25 tree species growing in the studied area). Those remaining seed species that red squirrels both ate and hoarded were predominantly (95%) buried underground – although for many tree seeds species it were small quantities (Lee 2002). This study also didn't report observing the "habit of burying only healthy seeds" or "eating damaged seeds first" in red squirrels.

Summary:

The analysed research clearly show that squirrels play very important role in the process of forest regeneration although some squirrel species (grey squirrels *Sciurus carolinensis*) have more positive influence on forest regeneration than other squirrel species (red squirrels: *Tamiasciurus hudsonicus* from North America and *Sciurus vulgaris* from Asia and Europe). In neither of analysed studies have researchers noted removing seeds embryos by squirrels – which confirms that this behaviour is incidental in some areas (and in some groups mostly of 2 years old and older squirrels). The most recent research about this behaviour showed that the problem usually affects marginal number of the seeds buried by squirrels (Steele et al. 2005). Only one from studied squirrel species (red squirrel *Sciurus vulgaris* from Asia and Europe) turned out to be mainly "seed predator" – not showing positive behaviour like hoarding seeds – for most of the seed species occurring in the studied area.

Notes:

Before anyone, based on the scientific research results, puts forward an inconsiderate hypothesis that "red squirrels occurring in Asia and Europe (*Sciurus vulgaris*) may have negative effect on the regeneration of many tree species" we'd like to point out that analysing the effect of one animal species without considering the effects of other animals living in the area is not a scientific approach. Red squirrels (*Sciurus vulgaris*) – like red squirrels (*Tamiasciurus hudsonicus*) – definitely prefer coniferous forests where they can be certainly seen as regenerators of at least some trees, like Korean pine (Zong et al. 2009). In addition to that in many cases one animal species can very well balance the effect of animals of other species. Even if Asian/European red squirrels are only "seed predator" for many tree species, in many areas like the UK, Ireland or Italy they live in the same habitats as grey squirrels (*Sciurus carolinensis*) – which as shown by research are unrivalled leaders in seed distribution and forest regeneration (Steele et al. 1996, Smallwood 1998, Goheen & Swihart 2003) – which makes any "seed predation" by red squirrels in the given area balanced by the seed distribution done by grey squirrels. Many other species of mammals and birds may have a similar positive effect on seed distribution but there is a need to conduct more scientific studies.

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