Impacts and Management of the Alien Eastern Gray Squirrel in Great Britain and Italy: Lessons for British Columbia

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ABSTRACT

Introduced species are a most serious threat to biodiversity, second only to habitat degradation. The eastern gray squirrel (*Sciurus carolinensis*) is native to eastern North America, but has been introduced to several countries outside its natural range. In Europe, it has been introduced to Britain, Ireland, and Italy, and in all 3 countries it has spread and replaced the native European red squirrel (*S. vulgaris*). There are several possible explanations for the replacement of the European red squirrel by eastern gray squirrels, but the main hypotheses involve exploitation competition between the 2 species, although a disease that is fatal to red squirrels and possibly spread by the gray squirrel also may have contributed. Gray squirrels cause economic damage to forests by removing bark from trees, particularly broadleafed types such as oak and beech, and have the potential to suppress natural forest regeneration. In North America, eastern gray squirrels have been introduced into many areas in the Pacific Northwest, and throughout the southern part of Vancouver Island. They appear to be increasing their range and population densities. This paper outlines the history of eastern gray squirrel introductions to Britain and Italy, the effects on native species, and the management options currently in use and under evaluation. From this knowledge, we predict that gray squirrels on Vancouver Island may have detrimental impacts on the native North American red squirrel (*Tamiasciurus hudsonicus*) and the endangered Garry oak (*Quercus garryana*) ecosystem.

Key words: competition, eastern gray squirrel, Garry oak, Great Britain, introduced species, Italy, *Quercus garryana*, red squirrel, *Sciurus carolinensis*, *Sciurus vulgaris*, *Tamiasciurus hudsonicus*.

Introduced species are one of the most serious threats to biodiversity, second only to habitat degradation (Clout and Lowe 1996, Crooks and Soule 1996, Illueca 1996). On a global scale, almost 20% of all the vertebrates in danger of extinction are threatened in some way by alien species (Berntsen 1996). Introduced species cause dramatic changes to their new ecosystems. They physically alter the habitat, threaten predator-prey relationships, out-compete native species for resources, and act as vectors for disease (Lever 1994).

The eastern gray squirrel (*Sciurus carolinensis*), hereafter called simply the gray squirrel, is just 1 example of a species introduced to areas outside its natural range. Its natural range extends from the Gulf of Mexico, north throughout the eastern United States to southern Manitoba in the west, and to the Canadian Maritimes, southern Quebec, and southern Ontario in the east (Hall and Kelson 1959). It is adapted to hardwoods and is found in oak (*Quercus* spp.), oak–hickory (*Quercus* spp.–*Carya* spp.), and beech–maple (*Fagus* spp.–*Acer* spp.) forests (Gurnell 1987, Koprowski 1994). However, it is highly adaptable and will thrive in urban environments as well as in parks and gardens, and is known to have expanded into mixed-conifer forests. These

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characteristics make the gray squirrel a serious threat to other squirrel species such as the European red squirrel (*S. vulgaris*), the western gray squirrel (*S. griseus*), and possibly the North American red squirrel (*Tamiasciurus hudsonicus*), once introduced into their habitats.

Gray squirrels have been introduced to various locations around the world, including parts of Canada, Europe, South Africa, and Australia (Davis 1950, Corbet 1978, Seebeck 1984, Gurnell 1987). In Europe they were introduced to Britain and Ireland, as well as Italy (Middleton 1930, Shorten 1954, Currado et al. 1987), and have caused serious economic and ecological damage (Gurnell 1996*a*). In Britain, gray squirrels are considered a serious forest pest, damaging timber through their bark-stripping behaviour, and are a threat to European red squirrels, which they have replaced throughout most of England and Wales, and parts of Scotland and Ireland. In Italy, the spread of gray squirrels still is restricted to areas near Turin and Genoa, but they already cause considerable damage to local poplar (*Populus* spp.) plantations, and native red squirrels also are being replaced (Wauters et al. 1997). In Canada, gray squirrels were introduced into Stanley Park in Vancouver and have spread over many parts of the lower mainland of British Columbia. There are now populations in Quesnel, Nelson, Bowen Island, and Squamish, B.C. (E. Gonzales, University of Guelph, 1988, pers. comm.). They have also crossed over the border into the United States (D. Fraser, British Columbia Ministry of Environment, Lands and Parks, 1998, pers. comm.). In Calgary, Alberta, gray squirrels escaped from the municipal zoo and have spread throughout the river valley and parks. On Vancouver Island, gray squirrels also escaped from a captive population (Guiguet 1975) and now pose a possible threat to native red squirrels and the endangered Garry oak (*Quercus garryana*) forests.

This paper will outline the history of gray squirrel introductions to Britain and Italy, and describe in detail the effects on native species and forestry operations. Second, it will review the management options currently in use and under evaluation. We then will consider the gray squirrel introduction on Vancouver Island and examine the possible lessons that can be learned from the European experience.

BACKGROUND

Brief History of Eastern Gray Squirrel Introductions to Britain and Italy

The first recorded introduction of eastern gray squirrels (thought to be *S. carolinensis leucotus*) to Britain took place in 1876 in Cheshire, and at least 33 different introductions and translocations had been made by 1930 (Middleton 1930). These occurred from Loch Long in Scotland (1892) to Sandling in Kent (1910), and included an introduction of gray squirrels to Castle Forbes in Ireland (1913). It is thought that, at first, gray squirrels did not spread far from the major points of introduction, but between 1930 and 1945 they dramatically extended their range (Gurnell 1987). Since then gray squirrels have successfully spread to colonize much of England, Wales, and the Scottish lowlands (Gurnell and Pepper 1993), replacing the European red squirrel (Gurnell 1994). Red squirrels are now extinct in southern England, except for some offshore islands such as the Isle of Wight. A few isolated populations can still be found in central England and parts of Wales. The remaining strongholds of the red squirrel are in northern England and Scotland. However, their range is declining even in those areas and careful management of selected conservation areas is required to retain them in northern England in the future (Gurnell and Lurz 1997, Lurz et al. 1998).

In Italy, 4 gray squirrels were introduced in 1946 into the park at Stupinigi, southwest of Turin, and 5 squirrels were released near Genoa in 1966. Surveys have indicated that by 1997, gray squirrels had colonized an area of more than 350 km^2 in northern Italy and that they are replacing the native European red squirrel (Wauters et al. 1997), as is the case in Britain (Gurnell and Pepper 1993) and Ireland (Reilly 1997).

Ecological Replacement of European Red Squirrels by Eastern Gray Squirrels

Understanding the reasons for the replacement of European red squirrels by gray squirrels is vital if effective management strategies are to be formed for the conservation of European red squirrels. Unfortunately, the exact mechanisms of the replacements of red by gray squirrels still are not fully understood. Several hypotheses have been formulated, including interference with red squirrel mating behaviour, direct aggression, competition, and disease (Gurnell 1987, Skelcher 1997). However, the observed replacement of red by gray squirrels indicates that competition based on habitat and food exploitation is the most likely explanation. The presence of large-seeded broadleafed trees, particularly oak, has been suggested as a key factor giving gray squirrels an advantage (Kenward and Holm 1993, Gurnell 1996*b*). Food competition may affect breeding success of red squirrels (Skelcher 1997), and there are indications that it also significantly reduces juvenile red squirrel recruitment (L. Wauters, University of Varese, pers. comm.). The main reasons for this appear to result from adaptations to the different types of habitats within which the 2 species evolved.

European red squirrels are conifer-specialists and probably evolved in boreal forests (Gurnell 1987, Gurnell and Anderson 1996). They are smaller, lighter, and more agile than gray squirrels. This enables them to move easily on the thin branches of coniferous trees and reach food on slender branches (Kenward and Tonkin 1986). In the absence of other squirrel species in continental Europe, red squirrels have colonized all available woodland habitats, including

deciduous woodlands, parks, and gardens. Gray squirrels evolved in eastern North America and are principally adapted to hardwood forests (Gurnell 1987). They are heavier and more terrestrial than red squirrels (Gurnell 1987, Kenward and Holm 1993). There also is evidence that gray squirrels are able to digest acorns more efficiently than European red squirrels (Kenward and Holm 1993). In contrast to European red squirrels, the unrestricted exploitation of this abundant food resource enables them to reach higher densities in hardwood habitats. It has been suggested that gray squirrels colonizing an area will establish themselves in these favourable habitats first and these nuclei will eventually link up to establish gray squirrels over a wider area (Gurnell 1996*b*, Skelcher 1997). Access to oak also has been proposed as a key factor in gray squirrels replacing red squirrels in predominantly conifer forests (Kenward et al. 1998, although see Gurnell 1996*b*). It is believed that red squirrels might find a refuge from gray squirrels only in large conifer forests such as Thetford Forest and Kielder Forest in England (Gurnell and Pepper 1993, Lurz et al. 1995).

Disease

Disease associated with a parapoxvirus is a significant cause of mortality in European red squirrels (Scott et al. 1981, Sainsbury and Ward 1996, Sainsbury et al. 1997). The origin of the virus is not known, but it has been put forward that gray squirrels might be the source, because the disease was not known prior to their introduction about 100 years ago (Sainsbury and Gurnell 1995). However, there has only been 1 case of disease associated with a parapox-like virus described in a gray squirrel in Britain (Duff et al. 1996). Interestingly, viruses found in the western gray squirrel in North America contain structures reminiscent of parapoxviruses (Regenery 1975). In 1995, Sainsbury and Gurnell called for a detailed study of the epidemiology of parapoxvirus transmission and infection. Blood samples subsequently taken from populations throughout Britain have revealed that 60% of gray squirrels tested had been exposed to parapoxvirus infection. This indicates a high percentage of endemic infection in gray squirrels of low pathogenicity and suggests that gray squirrels may be regarded as a reservoir host (see Crouch et al. 1995). However, populations of gray squirrels in northwest England, Scotland, Ireland, and Italy showed no antibodies which could represent differences in the distribution of the virus among populations (Sainsbury et al. submitted; L. Wauters, University of Varese, 1998, pers. comm.).

Economic Damage to Forests through Bark-stripping Behaviour

Gray squirrels are not only a threat to the survival of the European red squirrel in Britain and Italy, they are also a serious problem for commercial hardwood timber production. The location of bark damage on a tree varies among tree species and is probably related to the ease of bark removal and bark thickness, and hence to the growth characteristics of different species. Basal damage (within 1 m of the ground) is the most common type of damage in beech (*Fagus sylvatica*). Crown damage frequently occurs in the main canopy of oaks and many conifers, while stem damage usually occurs between the base and canopy in, for example, sycamore (*Acer pseudoplatanus*), beech, birch (*Betula* spp.), larch (*Larix* spp.), and lodgepole pine (*Pinus contorta*). Damage results in wounds that severely degrade timber quality. Crown damage affects the growth and appearance of the tree; severe crown damage kills it. Damage to the base and stem is cumulative occurring over a number of years. Wounds tend to callous over, hiding the damage until the tree is felled. Trees girdled by excessive stem or basal damage will die. Secondary attacks by rotting or staining fungi can occur at the site of wounds (Dagnall et al. 1998). The damage can be serious enough to kill most of the young trees at a particular site (Shorten 1957, Kenward et al. 1992). Damage occurs principally between May and July when the sap is rising. Trees at 10–40 years of age are most vulnerable (Gurnell and Pepper 1988, Kenward 1989), and bark stripping is most likely to occur when juvenile squirrel density is high (Kenward 1983, Kenward and Parish 1986). It may be triggered by agonistic encounters that cause redirected gnawing behaviour (Gurnell in press). In northern Italy, bark stripping of poplars cultivated for pulp and timber is a particular problem. Wounds can girdle the stem so that the top dies and is blown down by the wind (Currado et al. 1987). The spread of the gray squirrel in Italy and across the Alps into central Europe may have serious implications for forest management, as well as the future survival of the red squirrel in Europe, hence there is an urgent need to control its continued range expansion (Gurnell and Lurz 1997).

REVIEW OF MANAGEMENT OPTIONS

Monitoring

A prerequisite to effective management is the determination of the status and trends of squirrel populations. Monitoring is a key task to achieve this objective. Various methods used in Britain include the collection of presence/absence data by methods such as drey (nest) and cone counts, transect walks, public participation surveys, and the use of hair-tubes (Gurnell and Pepper 1994). The latter are plastic tubes containing bait and blocks with sticky tapes on which visiting squirrels will leave hair. These can be identified using a reference collection of red and gray squirrel hairs and by staining a sample with ink (Teerink 1991, Gurnell and Pepper 1994, Dagnall et al. 1995). Hair-tubes also have been used to determine the current spread of gray squirrels in northern Italy (S. Bertolini, University of Turin, 1998, pers. comm.),

and an attempt has been made to use them in estimating red squirrel population densities in commercial conifer plantations (Garson and Lurz 1998). Population estimates derived from live-trapping (capture–mark–recapture) are labour intensive and thus costly, and additionally require licensing in the case of the European red squirrel. Live-trapping is of limited use as a monitoring method, and is mainly used in intensive research projects.

Management for European Red Squirrel Conservation

Conservation management in Britain involves a number of short- and long-term tactics, which have been reviewed by Gurnell and Pepper (1993) and Lurz and Garson (1997). In the short term these include: the removal of gray squirrels (e.g., by trapping) from selected areas to reduce the effects of competition; if appropriate, the reintroduction or translocation of individual red squirrels into a conservation area to establish or boost a red squirrel population (Venning et al. 1997); and selective supplementary feeding of red squirrels. By providing food only to red squirrels in a mixed red and gray squirrel area it may be possible to offset the competitive advantage gray squirrels have in deciduous habitats. The Forest Commission in the United Kingdom has designed a red-only supplementary food hopper that selects for red squirrels on a weight basis (Pepper 1993). Red squirrels can access the food, but the heavier gray squirrel falls through a see-saw floor before reaching the food container. However, the effectiveness of supplementary food still has to be proven. The efficiency of the supplementary food hopper in keeping out gray squirrels is uncertain, and hoppers could provide foci for the spread of disease. Moreover, the benefits of extra food at the population level are unclear. Research has shown that supplementary food can increase the abundance of North American red squirrels (Sullivan 1990, Klenner and Krebs 1991) and of Douglas squirrels (*Tamiasciurus douglasii*; Sullivan and Sullivan 1982). However, in the case of the European red squirrel, both Holm (1987) and Lurz (1995) reported no benefit from supplementary feeding and concluded that supplementary feeding on its own was not a sufficient management option. Similarly, Shuttleworth (1995) concluded that the removal of gray squirrels may be a better option than supplementary feeding of red squirrels alone, as gray squirrel control reduces the overall "squirrel-pressure" on natural foods.

Long-term management options include designing habitats that benefit red squirrels but deter gray squirrels (Gurnell and Pepper 1993, Gurnell 1994, Lurz et al. 1995). This should include felling and restocking programs that maintain forest cover, connectivity, and a continuous seed-food supply. Modelling approaches can assist here to predict the spatial distribution of both squirrel species in relation to gray squirrel spread and habitat composition (Armitage et al. 1997, Rushton et al. 1997).

Damage Control

Damage control in Britain has been reviewed by Gurnell and Pepper (1998), Dagnall et al. (1998) and, more recently, Gurnell (in press). It is not possible to eradicate gray squirrels from Britain, but it is still possible to do so in Italy before their distribution becomes too large. Gray squirrel numbers can be reduced locally and in the short term by targeting control. Since 1973, the most cost-effective method in Britain has been the use of warfarin poison from special hoppers that keep out non-target species (Pepper 1990). This is legally controlled by the Warfarin Order 1973, the Wildlife and Countryside Act 1981, and the Control of Pesticides Regulations 1986. There is no significant secondary poisoning hazard to birds such as the tawny owl (*Strix aluco*) from warfarin in prey animals, but weasels (*Mustela nivalis*) could be at risk if they feed exclusively on contaminated animals (Townsend et al. 1984). It is illegal to use warfarin for gray squirrel control where red squirrels are at risk. The use of poison is not allowed in Italy. Live-trapping is also effective but more labour intensive and costly (Gurnell in press); it may be the only method available if warfarin is banned from use under European law (Annex A of the European Union Plant Protection Directive; H. Pepper, Forestry Commission, pers. comm.).

A more recent approach involves synthetic oral immunocontraception. In this technique, DNA coding for specific sperm or egg antigens involved in fertilization are introduced into the animal via oral vaccination. This causes the body to produce antibodies against the targeted egg or sperm proteins, thereby creating an immunocontraceptive barrier and rendering the host sterile (Moore 1997). The success of immunosterilization techniques in the case of the gray squirrel depends on the identification of suitable reproductive antigens that are species-specific, an effective delivery system, and an understanding of the ecology of the animal (H. Moore, University of Sheffield, 1998, pers. comm.). It could be several years before this form of control becomes available.

EASTERN GRAY SQUIRRELS IN BRITISH COLUMBIA

History of Eastern Gray Squirrel

Introduction to Vancouver Island

The eastern gray squirrel introduction on Vancouver Island originated at Metchosin in 1966 (Guiguet 1975), when 2 females and 1 male imported from Ontario escaped from a game farm. At first the population remained fairly concentrated near the site of the release, but over the past 15 years the species has increased its range dramatically. Gray squirrels have now spread throughout the southern portion of Vancouver Island, including northward through Goldstream Provincial Park and beyond. In recent years, the range of the animals also has expanded through Esquimalt to beyond

Sooke, and along the Saanich Peninsula almost to the ferry terminal at Swartz Bay. As the population density around Victoria has increased, more and more pest controllers have been called upon to trap the animals. In some cases the captured animals are re-released farther north on the island, thus exacerbating the situation. Gray squirrels can now also be found on the north end of the Malahat at Bamberton, Duncan, and Nanaimo (D. Fraser, British Columbia Ministry of Environment, Lands and Parks, 1998, pers. comm.). The continued release of gray squirrels and the favourable habitat over large parts of Vancouver Island make a continued and rapid expansion of the gray squirrel population appear unavoidable.

Displacement of North American Red Squirrels

The North American red squirrel evolved in the conifer forests of North America (Obbard 1987, Gurnell and Anderson 1996) and, like the European red squirrel, it is a conifer-specialist. North American and European red squirrels fill a similar ecological niche on their respective continents, and, therefore, one might expect that they will be impacted by the invasion of gray squirrels in a similar fashion; that is, displacement would occur in hardwood and mixed woodlands and in urban environments.

Since North American red squirrels are largely territorial and dependent on defending middens, they can be more aggressive than eastern gray squirrels and there have been reports of red squirrels chasing off gray squirrels. Although this may be true on an individual basis, gray squirrels can reach higher densities in mixed and deciduous habitats, and red squirrels may become outnumbered and eventually replaced. Additionally, in deciduous forests (the habitat type in which they are most likely to suffer from the presence of gray squirrels), red squirrels cease to defend territories and adopt a social organization based on overlapping home ranges (Gurnell 1987). Both the gray squirrel and the European red squirrel live in overlapping home ranges and, as we have seen in the United Kingdom and Italy, this system clearly allows displacement of red squirrels by gray squirrels (Gurnell 1987). In fact, a displacement of red by gray squirrels on Vancouver Island has already happened in habitats other than conifer woods in and around Victoria (D. Fraser, British Columbia Ministry of Environment, Lands and Parks, 1998, pers. comm.).

The British situation has shown that disease may play a role in the displacement of red squirrels by gray squirrels. Not only may gray squirrels aid the spread of a disease already existing in a native population, they also may introduce a new disease to which native populations have not evolved immunity.

Impacts on the Garry Oak Ecosystem

As discussed above, gray squirrels are hardwood-specialists and are likely to do best in hardwood and mixed woodland types on Vancouver Island. The endangered Garry oak ecosystems are, therefore, prime candidates for habitats where gray squirrels may replace North American red squirrels and reach higher densities than those of the red squirrel populations they have replaced.

In British Columbia, the Garry oak ecosystem is restricted mainly to the southeast coast of Vancouver Island and the southern Gulf Islands. Urban development and the encroachment of another alien species, Scotch broom (*Cytisus scoparius*), have been important causes of ecosystem loss in the past (Erickson 1993). The Garry oak ecosystem has been placed on the provincial Red List in view of its threatened status within the province, and it has become one of the rarest habitat types in Canada. The Garry oak is the only oak native to British Columbia. On Vancouver Island, Garry oak ecosystems have existed without the presence of the hardwood-specialist gray squirrel. There are several possible repercussions of the establishment of gray squirrel populations in Garry oak stands:

Prevention of natural regeneration

High densities of gray squirrels in hardwood forests could prevent natural regeneration (e.g., Shaw 1968, Gill et al. 1995). Even though gray squirrels scatterhoard seeds during autumn and are sometimes cited as agents for seed dispersal (e.g., Mellanby 1968), they cut out the radicle of acorns from the white oak group (which includes Garry oak) soon after they fall to the ground, thus preventing their germination (Fox 1982, Pigott et al. 1991). “Notched” acorns have been observed in Garry oak ecosystems on Vancouver Island (M. Fuchs, Foxtree Ecological Consulting, 1997, pers. comm.). Further evidence comes from England, where gray squirrels have been known to completely destroy germinating acorns (Pigott et al. 1991). In many urban parks and gardens in the United Kingdom (where there is no squirrel control) young trees seldom reach 30 years old (Gill et al. 1995). Thus, it seems likely that gray squirrels will affect recruitment of younger oak trees. In fact, diminished oak regeneration already has been observed in some Vancouver Island stands (K. Stewart, Garry Oak Meadow Preservation Society, 1997, pers. comm.). It is not clear at this time whether gray squirrels are the cause of this trend or a contributing factor.

Bark-stripping damage to trees

Research in Britain has shown that young oak trees (10–40 years old) are among the species most frequently bark-stripped. With all the other pressure on the endangered Garry oak ecosystem, this additional threat could prove to have severe consequences on the perpetuation of this habitat. Damage to oaks often occurs in the crown, and detailed surveys are required to see whether damage is occurring where gray squirrels have colonized Garry oak forests.

Predation

There is an ever-growing awareness of the fact that squirrels often prey on other animal species as well as plants (e.g., O'Donaghue 1994). Nesting birds and their offspring are particularly vulnerable (Sullivan 1991). Although the native red squirrel will exhibit predatory behaviour, higher gray squirrel densities in Garry oak ecosystems likely will result in higher predation rates on other species using the same habitat. As the Garry oak community on Vancouver Island has not developed in the presence of the gray squirrel, the ecological impact may be severe.

Competition with native species

Besides competing with and replacing the native red squirrel, competition from gray squirrels may affect the numbers and distribution of other acorn-eating species.

Potential Consequences of the Gray Squirrel Introduction on Vancouver Island

To summarize, we predict that the impacts and the future of gray squirrels on Vancouver Island are as follows:

- Eastern gray squirrel populations will expand further, with the speed of increase varying from year to year, depending on factors like weather, food supply, disease, and translocation by humans.
- The initial expansion will be mainly into deciduous and mixed woodland and urban environments.
- Gray squirrels will replace North American red squirrels in the above habitats. The southeastern part of Vancouver Island contains a reasonable proportion of forests with non-conifer species and urban areas in which this displacement is likely to occur. This predicted shift from red squirrels to gray squirrels already has been observed in some areas of Vancouver Island.
- Gray squirrel populations will reach higher population densities in these habitats than North American red squirrels populations.
- The Garry oak ecosystem will suffer especially from the invasion of gray squirrels as it is already under threat from other pressures and gray squirrels can reach particularly high densities in this type of habitat. Gray squirrels may affect the ecosystem through prevention of regeneration, bark stripping damage, predation, replacing native red squirrels, and food competition with other native seed-eaters.
- Potentially higher densities of gray squirrels compared to North American red squirrels may result in an increase of squirrels raiding bird feeders, bird nests, and fruit crops in urban areas and gardens.

FUTURE RESEARCH AND MANAGEMENT

We wish to add a cautionary note here, as the gray squirrel introductions to Europe and Vancouver Island cannot be directly compared because of differences in habitats and climate. Further, the European and North American red squirrels are different genera. However, we believe that there are enough similarities to be concerned about the impacts on Vancouver Island's native flora and fauna. This warrants further research into the Vancouver Island introduction.

What needs to be done? There are several lines of research that should be carried out. For example, the changing distribution of gray and red squirrels on Vancouver Island needs to be mapped, and the future distribution of gray squirrels predicted using modelling methods. Exclosure studies can be used to study the effects of gray squirrels on native fauna and flora, including natural regeneration in Garry oak stands. Tree damage surveys also need to be carried out and experimental field studies on red-gray interactions conducted, together with studies on the possible impact of disease. Research should be undertaken in a timely fashion while the gray squirrel expansion is not complete and "controls" still are available. Perhaps equally important is to raise public awareness of the problem through various educational programs. This is particularly so if local authorities recommend in the future some level of gray squirrel control or other intervention management techniques (see Gurnell 1996*a*).

Probably the most important lesson to learn from the U.K. experience is to investigate the potential problems as soon as possible after the introductions, and to explore potential management options. It is fortunate that gray squirrels have been present on Vancouver Island for only 30 years, and much of the island has yet to be colonized. However, some impacts have been already observed and there may be others that have so far gone unnoticed. The potential threat from gray squirrels on Vancouver Island should receive due attention as soon as possible.

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