

## Recalibrating Risk: Implications of squirrelpox virus for successful red squirrel translocations within mainland UK

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**LETTERS AND COMMENTS**

# Recalibrating risk: Implications of squirrelpox virus for successful red squirrel translocations within mainland UK

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Introduced grey squirrels (*Sciurus carolinensis*) cause native red squirrel (*Sciurus vulgaris*) decline via resource competition (Wauters, Gurnell, Martinoli, & Tosi, 2002) and carry squirrelpox virus (SQPV). Infection is sporadically transmitted to red squirrels and spreads within the population—precipitating disease. Sainsbury et al. (2020) assert that UK mainland red squirrel reintroductions cannot be justified in light of international guidance and that translocations will fail because of SQPV. They suggest animal suffering will result because grey squirrel control cannot be sufficient to prevent epidemic disease amongst sympatric red squirrels.

We concur that following international species translocation standards (IUCN, 2013) is fundamentally paramount and animal welfare vitally important. However, standards require translocation proposals to consider all locally prevailing factors (IUCN, 2013), which for red squirrels entails complex assessment beyond binary consideration of squirrelpox viral disease. IUCN (2013) also recommend

calibrating the likelihood and impact of identified risks; crucially including those associated with non-intervention. For example, genetic variation loss occurs in isolated red squirrel populations (O'Meara et al., 2018) and consequently reinforcement translocations have offered the only viable conservation option to prevent extinction, even where grey squirrels threaten (Halliwell & Jenkins, 2019; Ogden, Shuttleworth, McEwing, & Cesarini, 2005). IUCN (2013) recommend removing, but accept sufficiently reducing, identified extinction causes. Water vole (*Arvicola amphibius*) (Rees, 2018) and red kite (*Milvus milvus*) (Evans et al., 1999) UK translocations occurred because planners deemed that, although extinction threats remain (American mink, *Neovison vison* (Telfer, Holt, Donaldson, & Lambin, 2001) and illegal persecution (Madden, Rozhon, & Dwyer, 2019) respectively), such factors are sufficiently reduced locally.

Although widespread red squirrel disease was reported from the early 20th Century (Shorten, 1954), the absence of modern diagnostic testing, and confounding

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symptoms of other infections mean the SQPV contribution is unknown (McInnes, Deane, & Fienga, 2015). SQPV significance emerged after the late 1980s (Gurnell, 1987) with epidemiological testing advances establishing grey squirrels as a SQPV reservoir and demonstrating infection transmission to red squirrels results in disease (Carroll, Russell, Gurnell, Nettleton, & Sainsbury, 2009; Sainsbury, Nettleton, Gilray, & Gurnell, 2000; Tompkins, White, & Boots, 2003).

Squirrelepox disease outbreaks vary in geographical scale and number of confirmed cases (Chantrey et al., 2014; McInnes, Coulter, Dagleish, Deane, et al., 2013; McInnes, Coulter, Dagleish, Fiegna, et al., 2013). For example, McInnes, Coulter, Dagleish, Fiegna, et al. (2013) report only four localized cases recorded across southern Scotland in 2007, while Chantrey et al. (2014) report a “generally stable” Merseyside red squirrel population despite an average of 5.75 SQPV cases annually until a catastrophic 87% population decline associated with 73.50 annual cases. In captive populations, the proportion of animals unaffected also varies (e.g., Carroll et al., 2009; Shuttleworth et al., 2014). Thus, we can reasonably conclude such variation will influence population recovery rates to pre-outbreak levels. Everest et al. (2017) report two confirmed cases within a Welsh metapopulation where surveillance at 200 locations across 720 km<sup>2</sup> (Robinson & Shuttleworth, 2019) detected global index dermatophilosis infection (Holmes, Duff, et al., 2019; Holmes, Everest, Spiro, Wessels, & Shuttleworth, 2019) and demonstrated squirrelepox disease died out without causing local extinctions. Spatial modeling predicted that had infection spread, regional red squirrel extinction would not occur (Jones, White, Lurz, & Shuttleworth, 2017).

To derive lessons from squirrelepox viral disease outbreaks, we must consider prevailing local circumstances, especially when infection occurred during translocation. Importantly, historical management approaches should not be calibrated against our contemporary published scientific SQPV research, but instead viewed as a limited historical understanding of how grey squirrels affected red squirrels. This explains why grey squirrel control was limited or absent in ultimately unsuccessful experimental translocations during the 1990s (Lawton, Waters, & Shuttleworth, 2015; Pritchard, 1996).

Sainsbury et al. (2020) cite Carroll et al. (2009) to illustrate that grey squirrel control cannot prevent inter-specific SQPV infection. Importantly, earlier documentation quantifying the effectiveness of control (Gurnell, Sainsbury, & Venning, 1997; Gurnell & Steele, 2002) indicates hundreds of grey squirrels were culled in the immediate area during this translocation; grey squirrels were present at release enclosures even gaining access inside. In summary, Gurnell and Steele (2002) stated, “there is no evidence that grey squirrels were cleared from any

part of the study area for any length of time using the control effort applied.” In contrast, Schuchert, Shuttleworth, McInnes, Everest, and Rushton (2014) report on grey squirrel eradication where SQPV seroprevalence progressively declined from 1999 to 2010 from 52% to 4% amongst residual grey squirrels. However, red squirrel translocations first occurred when grey squirrel population seroprevalence was at 40%, twice the 20% threshold below which McInnes et al. (2015) suggest infection is not an imminent threat. This is the largest Welsh red squirrel population (Shuttleworth et al., 2015) monitored since 1998 (Shuttleworth, 2003) and expanding from 4× to 12× 10×10 km squares between 2005 and 2017 (WSF, 2018) and from 40 to 750+ adults (Halliwell et al., 2015) because grey squirrel incursion is effectively managed (Robinson & Shuttleworth, 2019).

Differences in grey squirrel control effort (Robertson et al., 2016), geographical isolation and evolving rapid responses to incursion (Robinson & Shuttleworth, 2019) contributed to the contrasting failure and success reported by Carroll et al. (2009) and Schuchert et al. (2014) respectively. The successful modern volunteer-based co-ordinated approach to grey control (Shuttleworth et al., 2020), based on decades of learning, sadly came after regional red squirrel population extinctions. This included extinctions from within enviable geographical defensible locations when compared with landscapes where extant remnant populations exist. Mainland populations commonly have grey squirrel sympatry and high landscape connectivity (Gurnell et al., 2006). Sainsbury et al. (2020) allude to successful conservation translocations being only temporary, destined eventually to succumb to SQPV epidemics. However, translocating species often means the original threat remains (e.g., climatic change) but is ameliorated at the new site (see Chauvenet, Ewen, Armstrong, & Petteorelli, 2013; Willis et al., 2009). As grey squirrels currently occupy every county in England, scientifically well-conceived red squirrel translocation into highly defensible geography is a legitimate management tool to explore in synergy with wider national conservation approaches including pine marten (*Martes martes*) restoration (Sheehy, Sutherland, O'Reilly, & Lambin, 2018).

In a rapidly changing world, we must collaborate, learning from past endeavors to facilitate dynamic conservation. A disease risk zero tolerance could result in freezing crucial conservation programs into inaction (Ballou, 1993; Callen et al., 2020; Hayward et al., 2019).

## CONFLICT OF INTEREST

None of the authors have conflict of interest.

## AUTHOR CONTRIBUTIONS

Craig Shuttleworth structured the initial draft manuscript framework. Conor McKinney, Nikki Robinson, and

Stephen Trotter inputted landscape lessons from the successful community-based EU LIFE14 NAT/UK/000467 and National Lottery Heritage Fund mainland grey squirrel control demonstration project. Matt Hayward and Deborah Brady provided advice on IUCN translocations and welfare considerations. Laura Gardner, Andrew Greenwood, Nick Jackson and Kim Wood provided lessons learned from 20 years of red squirrel conservation translocations including associated epidemiological findings. Paul Cross and Simon Valle provided species conservation overview with respect to risk management. Together the authors contributed to the development of the paper.

## ETHICS STATEMENT

This is a review containing scientific opinion and has not needed to involve an ethical review committee.

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## REFERENCES

- Ballou, J. (1993). Assessing the risks of infectious diseases in captive breeding and reintroduction programs. *Journal of Zoo and Wildlife Medicine*, 24, 327–335.
- Callen, A., Hayward, M. W., Tamessar, C., Upton, R., Broekhuis, F., Davies-Mostert, H., ... Taylor, A. (2020). Envisioning the future with 'Compassionate Conservation': An ominous projection for biodiversity conservation. *Biological Conservation*, 241, 108365.
- Carroll, B., Russell, P., Gurnell, J., Nettleton, P., & Sainsbury, A. W. (2009). Epidemics of squirrelpox virus disease in red squirrels (*Sciurus vulgaris*): Temporal and serological findings. *Epidemiology and Infection*, 137, 257–265.
- Chantrey, J., Dale, T. D., Read, J. M., White, S., Whitfield, F., Jones, D., ... Begon, M. (2014). European red squirrel population dynamics driven by squirrelpox at a gray squirrel invasion interface. *Ecology and Evolution*, 4, 3788–3799.
- Chauvenet, A. L. M., Ewen, J. G., Armstrong, D., & Petteorelli, N. (2013). Saving the hihi under climate change: a case for assisted colonization. *Journal of Applied Ecology*, 50, 1330–1340. <https://doi.org/10.1111/1365-2664.12150>
- Evans, I. M., Summers, R. W., O'Toole, L., Orr-Ewing, D. C., Evans, R., Snell, N., & Smith, J. (1999). Evaluating the success of translocating Red Kites *Milvus milvus* to the UK. *Bird Study*, 46, 129–144.
- Everest, D. J., Floyd, T., Donnachie, B., Irvine, R. M., Holmes, J. P., & Shuttleworth, C. M. (2017). Confirmation of squirrelpox in welsh red squirrels. *Veterinary Record*, 181, 514.1–514.51515. <https://doi.org/10.1136/vr.j5132>
- Gurnell, J. (1987). *The Natural History of Squirrels*. London: Helm.
- Gurnell, J., Rushton, S. P., Lurz, P. W. W., Sainsbury, A. W., Nettleton, P., Shirley M. D. F., ... Geddes, N. (2006). Squirrelpox virus: Landscape scale strategies for managing disease threat. *Biological Conservation*, 131, 287–295.
- Gurnell, J., Sainsbury, A. W., & Venning, T. (1997). *Conserving the red squirrel Sciurus vulgaris in Thetford forest*. English Nature Research Reports 262.
- Gurnell, J., & Steele, J. (2002). *Grey squirrel control for red squirrel conservation: A study in Thetford forest*. Report prepared for English Nature and the Forestry Commission. English Nature Research Report 453.
- Halliwell, E. C., & Jenkins, R. (2019). Grey squirrel management in the upland coniferous forest of Clocaenog. In N. Robinson & C. M. Shuttleworth (Eds.), *Invasive Alien Species Colonisation Prevention: Your Guide to Early Detection and Rapid Response* (pp. 91–100). Newark, England: The Royal Society of Wildlife Trusts.
- Halliwell, E. C., Shuttleworth, C. M., Wilberforce, E. M., Denman, H., Lloyd, I., & Cartmel, S. (2015). Striving for success: an evaluation of local action to conserve red squirrels (*Sciurus vulgaris*) in Wales. In C. M. Shuttleworth, P. W. W. Lurz, & M. W. Hayward (Eds.), *Red Squirrels: Ecology, Conservation & Management in Europe* (pp. 175–192). Woodbridge, Suffolk, England: European Squirrel Initiative.
- Hayward, M. W., Callen, A., Allen, B. L., Ballard, G., Broekhuis, F., Bugir, C., ... Wüster, W. (2019). Should the compassionate tail wag the conservation dog? *Conservation Biology*, 33, 760–768. <https://doi.org/10.1111/cobi.13366>
- Holmes, J. P., Duff, J. P., Barlow, A., Everest, D., Man, C., Smith, F., & Twomey, F. (2019). 20 years of national wildlife disease surveillance. *Veterinary Record*, 184, 520–521.
- Holmes, P., Everest, D. J., Spiro, S., Wessels, M., & Shuttleworth, C. M. (2019). First report of dermatophilosis in wild European red squirrels (*Sciurus vulgaris*). *Veterinary Record Case Reports*, 7(3), e000838. <https://doi.org/10.1136/vetreccr-2019-000838>
- IUCN/SSC. (2013). *Guidelines for reintroductions and other conservation translocations. Version 1.0*. Gland, Switzerland: IUCN Species Survival Commission.
- Jones, H., White, A., Lurz, P. W. W., & Shuttleworth, C. M. (2017). Mathematical models for invasive species management: Grey squirrel control on Anglesey. *Ecological Modelling*, 10, 276–284.
- Lawton, C., Waters, C., & Shuttleworth, C. M. (2015). Reintroductions and translocations of red squirrels within Europe. In C. M. Shuttleworth, P. W. W. Lurz, & M. W. Hayward (Eds.), *Red squirrels: Ecology, conservation & management in Europe* (pp. 193–210). Suffolk, England: ESI.
- Madden, K. K., Rozhon, G. C., & Dwyer, J. F. (2019). Conservation letter: Raptor persecution. *Journal of Raptor Research*, 53, 230–233. <https://doi.org/10.3356/JRR-18-37>
- McInnes, C. J., Coulter, L., Dagleish, M. P., Deane, D., Gilray, J., Percival, A., ... Sainsbury, A. W. (2013). Squirrelpox in Ireland. *Animal Conservation*, 16, 51–59.
- McInnes, C. J., Coulter, L., Dagleish, M. P., Fiegna, C., Gilray, J., Willoughby, K., ... MacMaster, A.-M. (2013). First cases of squirrelpox in red squirrels (*Sciurus vulgaris*) in Scotland. *Veterinary Record Case Reports*, 1(1), e528rep. <https://doi.org/10.1136/vetreccr.164.17.528rep>
- McInnes, C. J., Deane, D., & Fienga, C. (2015). Squirrelpox virus: Origins and the potential for its control. In C. M. Shuttleworth,

- P. W. W. Lurz, & M. W. Hayward (Eds.), *Reds Squirrels: Ecology, Conservation & Management in Europe* (pp. 251–264). Suffolk, England: ESI.
- O'Meara, D., McDevitt, A., O'Neill, D., Harrington, A., Turner, P., Carr, W., ... O'Reilly, C. (2018). Retracing the history and planning the future of the red squirrel (*Sciurus vulgaris*) in Ireland using non-invasive genetics. *Mammal Research*, 63, 173–184. <https://doi.org/10.1007/s13364-018-0353-5>
- Ogden, R., Shuttleworth, C. M., McEwing, R., & Cesarini, S. (2005). Genetic management of the red squirrel, *Sciurus vulgaris*: A practical approach to regional conservation. *Conservation Genetics*, 6, 511–525.
- Pritchard, S. (1996). *The investigation of methods to establish and subsequently manage a population of red squirrels in an isolated commercially managed, conifer plantation in south east Scotland*. Scottish Natural Heritage Report.
- Rees, A. (2018). Water vole reintroduction on the Gwent Levels, Wales, UK. In P. S. Soorae (Ed.), *Global Reintroduction Perspectives: 2018. Case Studies from around the Globe* (pp. 230–232). Abu Dhabi, UAE: IUCN/SSC Reintroduction Specialist Group, Gland, Switzerland and Environment Agency xiv + 286 pp.
- Robertson, P. A., Adriaens, T., Lambin, X., Mill, A., Roy, S., Shuttleworth, C. M., & Sutton-Croft, M. (2016). The large-scale removal of mammalian invasive alien species in northern Europe. *Pest Management Science*, 73, 273–279. <https://doi.org/10.1002/ps.4224>
- Robinson, N., & Shuttleworth, C. M. (2019). *Invasive Alien Species Colonisation Prevention: Your Guide to Early Detection and Rapid Response*. Newark, England: The Royal Society of Wildlife Trusts.
- Sainsbury, A. W., Chantrey, J., Ewen, J. G., Gurnell, J., Hudson, P., ... Tomkins, D. M. (2020). Implications of squirrelpox virus for successful red squirrel translocations within mainland UK. *Conservation Science and Practice*, 2. <https://doi.org/10.1111/csp2.200>
- Sainsbury, A. W., Nettleton, P., Gilray, J., & Gurnell, J. (2000). Grey squirrels have high seroprevalence to a parapoxvirus associated with deaths in red squirrels. *Animal Conservation*, 3, 229–233.
- Schuchert, P., Shuttleworth, C. M., McInnes, C. J., Everest, D. J., & Rushton, S. P. (2014). Landscape scale impacts of culling upon a European grey squirrel population: Can trapping reduce population size and decrease the threat of squirrelpox virus infection for the native red squirrel? *Biological Invasions*, 16, 2381–2391.
- Sheehy, E., Sutherland, C., O'Reilly, C., & Lambin, X. (2018). The enemy of my enemy is my friend: native pine marten recovery reverses the decline of the red squirrel by suppressing grey squirrel populations. *Proceedings of Royal Society B*, 20172603. <https://doi.org/10.1098/rspb.2017.2603>
- Shorten, M. (1954). *Squirrels*. London: Collins.
- Shuttleworth, C. M. (2003). A tough nut to crack: Red squirrel conservation in Wales. *Biologist*, 50, 231–235.
- Shuttleworth, C. M., Everest, J. D., McInnes, C. J., Greenwood, A., Jackson, N. L., Rushton, S., & Kenward, R. E. (2014). Inter-specific viral infections: Can the management of captive red squirrel collections help inform scientific research? *Hystrix, Italian Journal of Mammalogy*, 25(1), 18–24. <https://doi.org/10.4404/hystrix-25.1-10126>
- Shuttleworth, C. M., Robinson, N., Halliwell, E. C., Clews-Roberts, R., Peek, H., Podgornik, G., ... Larsen, K. W. (2020). Evolving grey squirrel management techniques in Europe. *Management of Biological Invasions*, 11(4), 747–761.
- Shuttleworth, C. M., Schuchert, P., Everest, D. J., McInnes, C. J., Rushton, S. P., Jackson, N. L., & Kenward, R. E. (2015). Developing integrated and applied red squirrel conservation programmes: What lessons can Europe learn from a regional grey squirrel eradication programme in North Wales? In C. M. Shuttleworth, P. W. W. Lurz, & M. W. Hayward (Eds.), *Red squirrels: Ecology, conservation & management in Europe* (pp. 233–250). Beccles, England: European Squirrel Initiative.
- Telfer, S., Holt, A., Donaldson, R., & Lambin, X. (2001). Metapopulation processes and persistence in remnant water vole populations. *Oikos*, 95, 31–42.
- Tompkins, D. M., White, A. R., & Boots, M. (2003). Ecological replacement of native red squirrels by invasive greys driven by disease. *Ecology Letters*, 6, 189–196.
- Wauters, L. A., Gurnell, J., Martinoli, A., & Tosi, G. (2002). Inter-specific competition between native Eurasian red squirrels and alien grey squirrels: does resource partitioning occur? *Behavioural Ecology and Sociobiology*, 52, 332–341.
- Willis, S. G., Hill, J. K., Thomas, C. D., Roy, D. B., Fox, R., Blakeley, D. S., & Huntley, B. (2009). Assisted colonization in a changing climate: A test-study using two U.K. butterflies. *Conservation Letters*, 2, 45–51.
- WSF (2018). *Red Squirrel Conservation Plan for Wales Review of Progress and Update 2018*. Natural Resources Wales Report 29 pp. Retrieved from <https://cdn.naturalresources.wales/media/691092/eng-red-squirrel-conservation-plan-for-wales.pdf>

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