Global Re-introduction Perspectives: 2016

Case-studies from around the globe

Edited by Pritpal S. Soorae

IUCN/SSC Re-introduction Specialist Group (RSG)

RSG

Environment Agency - ABU DHABI

calgaryzoo

Turner Endangered Species Fund

DENVER ZOO

The designation of geographical entities in this book, and the presentation of the material, do not imply the expression of any opinion whatsoever on the part of IUCN or any of the funding organizations concerning the legal status of any country, territory, or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The views expressed in this publication do not necessarily reflect those of IUCN.

Published by: IUCN/SSC Re-introduction Specialist Group & Environment Agency-ABU DHABI

Copyright: © 2016 International Union for the Conservation of Nature and Natural Resources

Reproduction of this publication for educational or other non-commercial purposes is authorized without prior written permission from the copyright holder provided the source is fully acknowledged.

Reproduction of this publication for resale or other commercial purposes is prohibited without prior written permission of the copyright holder.

Citation: Soorae, P. S. (ed.) (2016). *Global Re-introduction Perspectives: 2016. Case-studies from around the globe*. Gland, Switzerland: IUCN/SSC Re-introduction Specialist Group and Abu Dhabi, UAE: Environment Agency-Abu Dhabi. xiv + 276 pp.

ISBN: **978-2-8317-1761-6**

Cover photo: Clockwise starting from top-left:
i. Bolson's tortoise, USA @ Turner Endangered Species Fund
ii. Wetapunga, New Zealand @ Richard Gibson
iii. Morelos minnow, Mexico @ Topiltzin Contreras-MacBeath
iv. *Silene cambessedesii*, Spain @ Emilio Laguna
v. Tasmanian Devil, Maria Island, Tasmania @Simon DeSalis
vi. Agile frog, Jersey @ States of Jersey Department of the Environment

Cover design & layout by: Pritpal S. Soorae, IUCN/SSC Re-introduction Specialist Group

Produced by: IUCN/SSC Re-introduction Specialist Group & Environment Agency-ABU DHABI

Download at: www.iucnsscrsg.org

Developing red squirrel re-introduction techniques for use during regional grey squirrel eradication programs in Europe

Craig Shuttleworth[1], Robert Kenward[2] & Nick Jackson[3]

[1] - Honorary Research Fellow, School of Environment, Natural Resources and Geography, Bangor University, Bangor, Gwynedd, LL57 2UW, UK craig@redsquirrels.info
[2] - Fellow, Centre for Ecology & Hydrology, Benson Lane, Crowmarsh, Gifford, Wallingford, OX10 8BB, UK reke@ceh.ac.uk
[3] - Director, National Zoological Society of Wales, The Welsh Mountain Zoo, Colwyn Bay, Conwy, LL28 5UY, UK nick@welshmountainzoo.org

Introduction

The red squirrel (*Sciurus vulgaris*) is an arboreal rodent of temperate forests across the Palaearctic. In the UK, Ireland and Italy it faces resource competition and lethal disease infection from the introduced north American eastern grey squirrel (*Sciurus carolinensis*). The red squirrel is of 'Least Concern' on the IUCN Red List, listed under Article III of the Berne Convention and protected under the UK Wildlife & Countryside Act 1981. In 1993, 14 radio-tagged red squirrels were translocated from the wild into a 580 ha pine woodland in Dorset, England to study survival and interactions with non-native grey squirrels. Re-introductions also took place on Anglesey, a 720 km^2 island linked by bridges to the adjacent northern coast of Wales. In 1998, the island contained 40 red squirrels and some 3,000 grey squirrels which were then subject to an eradication program. The Anglesey work was informed by the release in Dorset and another in broadleaved habitat in Conwy, Wales.

Adult red squirrel in Anglesey 2014
© Steve-Ransome

The first Anglesey re-introduction was successful and occurred in the Newborough pine plantation (Shuttleworth *et al.*, 2008). Subsequent releases occurred in broadleaved woodland. We describe how techniques evolved in the light of pathological disease and the presence of grey squirrels at release sites.

Goals

Dorset:

- Goal 1: To learn about release technique suitability, and behavior and survival of red squirrels in the presence of grey squirrels. This was done by experimental releases of radio-tagged red squirrels in pine woodland similar to that holding a dense island population nearby.

Conwy:

- Goal 2: To establish and co-ordinate a UK-wide red squirrel captive-breeding program. This would develop techniques for releasing captive-bred red squirrels to the wild from enclosures within a mixed conifer and broadleaved woodland.
- Goal 3: To educate the public about the natural history of the red squirrel and the threats faced by the species in the UK. Assessing the level of support needed to ensure the long-term viability of a newly-established re-introduced population of red squirrels in terms of control of grey squirrels, provisioning and artificial breeding sites.

Anglesey:

- Goal 4: To evolve re-introduction techniques to successfully re-introduce red squirrels to broadleaved woodlands, a habitat type where grey squirrels have a significant competitive advantage over their congener. This action would increase species distribution to an extent that would facilitate public participation in conservation, and increase community involvement in the latter stages of ongoing grey squirrel eradication.
- Goal 5: To restore a genetically rich and self sustaining red squirrel population within Anglesey bringing associated economic dividends through environmental tourism.

Success Indicators

Dorset:

- Indicator 1: The gathering of reproductive, survival and ranging behavior data from at least 10 released red squirrels for comparison with archive data from a natural population in similar Scots pine habitat nearby.

Conwy:

- Indicator 2: The establishment of a captive red squirrel breeding population in enclosures that would produce sufficient healthy and genetically diverse animals for release to the wild.
- Indicator 3: Establishment of a re-introduced red squirrel population with successful breeding in the wild; the resulting written protocols enabling re-introductions at other sites and raised public awareness of red squirrel conservation.

Anglesey:

- Indicator 4: The establishment and expansion of red squirrel populations in broadleaved woodland habitats especially within community parkland and wooded gardens.
- Indicator 5: Developing re-introduction techniques and management protocols for squirrelpox virus and adenovirus. These would reduce mortality rates and thus help facilitate an increase in the genetic variation within the wild red

Semi-natural broadleaved woodland on Anglesey

squirrel population following translocation. In 1998 the population had been monomorphic for Mitochondrial DNA.

Project Summary

Feasibility: Studies of competition between red and grey squirrels in the UK focussed upon feeding ecology during the 1980s. Such research preceded experimental re-introduction studies in the presence of grey squirrels, which started with Bertram & Moltu (1986). However, no released population persisted for longer than 18 months. The use of radio-tags on released red squirrels, on wild animals in a similar habitat nearby, and on 32 grey squirrels in the release area, enabled a later experiment on the Purbeck peninsula (Dorset) (Kenward & Hodder, 1998, as included here) to produce detailed data on inter-specific interactions and competition (and through much later repeated autopsy, on disease too). Subsequent trials in broadleaved woodland in Conwy (Shuttleworth *et al.*, 2014, also included here) were further key studies that particularly underpinned the final two projects on Anglesey that we report. A precursor to the Anglesey projects was a systematic grey squirrel eradication program initiated on the island in 1998 to facilitate natural recovery of the small remnant red squirrel population in a 244 ha forest (Shuttleworth, 2003). However, woodland fragmentation and geographical isolation of the initial red squirrel population precluded rapid re-colonization of wider landscapes. Project managers were aware of the public popularity of red squirrels (88% of UK adults would like to see red squirrels back in local parks and gardens) and that increased presence of this charismatic animal could be used as major driver in eradication of grey squirrels (Schuchert *et al.*, 2014).

In the first Anglesey translocation project, the successful re-introduction of red squirrels into 689 ha coastal pine plantation greatly benefitted from techniques evolved in the Dorset and Conwy releases. However, despite contingency planning, pathological adenovirus infection and difficulties in maintaining habitat free from grey squirrels were key lessons in a study which centered upon the release of young born to adults permanently housed within woodland enclosures following methods trialed in Conwy (Shuttleworth *et al.*, 2008). The remaining ~2,000 ha of island woodland habitat was predominantly broadleaved, and therefore was recognized as both a preferred grey squirrel habitat and also representative within the range of habitats naturally occupied by red squirrels in the absence of greys. Parkland and private garden woodland habitats offered the opportunity to bring red squirrels back into recreational locations and so

seamlessly create a learning and participation interface between local people and red squirrel conservation. The second Anglesey translocation project was into broadleaved habitat and is described below.

Implementation and monitoring: In the winter of 2006 - 2007 we initiated the first re-introduction of red squirrels into broadleaved woodland in the South East of Anglesey where grey squirrels were close to eradication. Captive-born red squirrels were housed in two separate 1.5 m x 3 m forest enclosures either as pairs or singularly. Animals were released after 4 - 12 weeks captivity into woodland containing supplemental food and nest boxes of a design identical to those within the enclosures. Red squirrels continued to have access to the enclosures for 3 months. Enclosures were thoroughly cleaned with Virkon S anti-viral disinfectant before other captive red squirrels were housed there. A total of 6 animals were released from 22nd January 2007 to 18th July 2008. Two other animals died whilst captive, one was confirmed as being infected by adenovirus. Within 3 years red squirrels had spread up to 4 km from the release site and populations established in local gardens where people began to put out supplemental foods. Local people joined a project Facebook group where they could post pictures and talk about the red squirrels. This dynamic platform also encouraged reporting of grey squirrel sightings.

Retrospective investigations have now revealed that adenovirus can be carried asymptomatically by red squirrels, grey squirrels and woodmice (Everest *et al.*, 2012, 2013), findings which only reinforce the need to design methodologies that reduce intra and inter-specific infection risks. Subsequent broadleaved habitat re-introductions on Anglesey therefore involved trapping and removal of woodmice from red squirrel enclosures and feeding stations. Red squirrels are also subjected to fecal screening to detect pathological cases of adenovirus infection but determining asymptomatic infections remains challenging as blood and fecal samples are suboptimal material to test (Everest *et al.*, 2012).

Integrated landscape management of squirrels Re-introductions of captive-bred animals into broadleaved habitats have been instrumental in the Anglesey red squirrel population increasing from 80 - 90 adults in 2002, to around 700 today making it the largest and most genetically diverse in Wales. There are now over 150 supplemental feeding stations in woodlands and gardens being managed by volunteers and community-based network is the basis of a framework of wider public monitoring of red squirrels. Annually we would now anticipate receiving 20 - 40 red squirrel carcasses collected from roads, gardens or woodlands by members of the public. This facilitates gross post mortem and histological population surveillance to be undertaken at a scale which would otherwise be beyond the scope of the project. Members of the community now act as ambassadors raising public awareness of red squirrel conservation and the impacts of non-native species. In 2009 the first red squirrels were found having dispersed across the sea channel to the mainland and establishing a population in parkland within the City of Bangor.

When the first Anglesey red squirrel re-introductions were undertaken the eradication of grey squirrels was well progressed but island-wide incomplete. Despite our best efforts grey squirrels were occasionally found sympatric with red squirrels and yet we did not record squirrelpox outbreaks. We now know that as the grey squirrel abundance decreased the prevalence of squirrelpox in remaining animals declined and the virus became extinct before grey eradication was complete (Schuchert *et al.*, 2014).

Major difficulties faced

DORSET:

- All squirrels survived translocation and 6 days of soft release, however 3 died in the next week, only 3 survived 3 months, and none for 4 months. Squirrels from Corsican pine (*Pinus nigra*) habitat dispersed from release within cone-rich Scots pine (*Pinus sylvestris*) woodland to the best Corsican pine stands, and 7 of 11 were eaten by foxes while dispersing. Behavior of three long-term survivors indicated competitive pressure from grey squirrels and the last surviving animal was infected with squirrelpox virus (SQPV).

CONWY:

- The development of a productive captive-breeding population in the Conwy project proved difficult. Protocols for successful births and rearing, including enclosure design, took several years to develop, as did the national network of breeding institutions who would make a long-term commitment to red squirrel captive management on sound genetic and demographic principles. Some private collections, although very successful at breeding squirrels, would not, or could not, conform to the basic principles of population management such as individual specimen identification, record keeping, and providing data to the studbook keeper/coordinator.
- Although the initial stages of the trial Conwy release project in the 1990s went well and a released female reared two litters of young in the wild, SQPV was a major factor in local extinction. At the planning stage, disease had been one of a number of risk factors considered, but as little was known about the impact of SQPV at that time, managers focused on reducing the competitive pressure from grey squirrels by controlling numbers rather than eradication to prevent transmission of pathogenic viral infection to the red squirrels. Tests for SQPV were not available at the start of the project, but as they became available and as released squirrels died, it was clear that eradication of grey squirrels would be essential for any future red squirrel releases.

ANGLESEY:

- Broadleaved woodlands are a habitat which gives grey squirrels a much greater competitive advantage over red squirrels than conifer plantations, and thus on Anglesey proved to require much more intensive levels of grey squirrel control. A series of strategic local re-introductions created opportunities for local communities to see foraging animals and so become involved in their conservation. However, grey squirrels were not eradicated from Anglesey before red squirrels were released locally, and this caused objections from some conservation agencies to our phased re-introduction strategy.
- There were no data available upon the impact of culling upon rates of

squirrelpox infection in residual grey squirrel populations, or on adenovirus epidemiology in red squirrels generally. Although the culling associated fall in SQPV infection benefitted re-introduction outcomes, lack of fore-knowledge hindered planning and lack of information on adenovirus epidemiology made efficient infection management difficult.

Children building squirrel feeding boxes

Major lessons learned

DORSET:

- For translocation of wild squirrels, release habitat should be as similar as possible to the habitat of origin. Radio-tagging was essential for indicating the advisability of removing grey squirrels, and possible predators from areas where red squirrels will be released.

CONWY:

- Successful management of captive red squirrel collections needs to be underpinned by research, perseverance, allocation of resources and the long-term commitment of a holding institution.
- Future attempts to re-introduce red squirrels to habitats with invasive grey squirrels not only have to address the issue of the grey squirrel competitive advantage, but also the infectious disease threat they pose.

ANGLESEY:

- Building on disease findings from Purbeck and Conwy, the development of measures to reduce pathogenic viral infection in both captive and released red squirrels was essential. Reducing adenovirus infection risk was achieved by shortening the captivity phase, using a low founder group size (6 - 8 animals) and introducing proactive fecal viral screening of animals within breeding institutions before transport to release sites. Long-term (5 - 10 years duration) post mortem monitoring of red squirrel mortality cases was also central to disease management. The study also demonstrated that culling of grey squirrels needs to have reduced their SQPV infection levels prior to red squirrel release.
- Releases into habitats which included wooded public parks and private gardens enabled people to see red squirrels regularly. This galvanized community support for regional grey squirrel eradication and was essential for securing the resources necessary for island wide eradication. However, the dispersal of red squirrels from Anglesey, across the Menai Straits into mainland Gwynedd was faster than anticipated. Although this increased the

geographical distribution of red squirrels it presents the challenge of managing potential disease risks from mainland grey squirrels. Contingency and management protocols to deal with this were consequently being produced reactively and without funding in place.

Success of project

Purbeck Peninsula (Dorset):

Highly Successful	Successful	Partially Successful	**Failure**
			√

Broadleaved woodland (Conwy):

Highly Successful	Successful	**Partially Successful**	Failure
		√	

Newborough pine forest (Anglesey):

Highly Successful	**Successful**	Partially Successful	Failure
	√		

Broadleaved sites (Anglesey):

Highly Successful	Successful	Partially Successful	Failure
√			

Reason(s) for success/failure:

DORSET:

- Release of wild-born translocated squirrels into habitat not exactly matching their original appeared to promote dispersal, during which predation was a problem; range sizes and trap response of settled survivors indicated possible competition effects from grey squirrels and the longest surviving animal became infected with SQPV.

CONWY:

- Successful long-term maintenance of a captive-breeding population at Conwy depended upon a long-term commitment to the program and the availability of animals from other co-operating breeders. The ability to adapt and redesign holding facilities and husbandry practice in the light of experience has also been important.
- The trial re-introduction in the late 1990s was a partial success in that protocols for on-site breeding and release were developed and later used on Anglesey, but the aim to establish a re-introduced population at the Conwy site failed due to infectious disease from grey squirrels.

ANGLESEY:

- During the progressive eradication of grey squirrels the rates of asymptomatic SQPV infection within residual populations declined dramatically. This decreased the risk of inter-specific infection, whilst in parallel soft-release protocols also evolved to minimize risk of pathogenic adenovirus infection.
- The series of releases progressively increased the geographical distribution of red squirrels, enhancing opportunities for local people to see animals and participate in their conservation by providing supplemental foods in gardens and woodlands. This reinforced political support for red squirrel conservation and was fundamental in obtaining the financial resources required to eradicate invasive grey squirrels. Anglesey now contains the largest (700 adults) and most genetically diverse red squirrel population in Wales. In 2009, red squirrel dispersed across the narrow sea channel and re-colonized the mainland county of Gwynedd.

References

Bertram B.C.R. & Moltu D-P (1986) Re-introducing Red Squirrels into Regent's Park. Mammal Review 16: 81-88.

Everest D.J., Shuttleworth, C.M., Grierson, S.S., Duff, J.P., Jackson, N., Litherland, P., Kenward, R.E. & Stidworthy, M.F. (2012) Systematic assessment of the impact of adenovirus infection on a captive re-introduction project for red squirrels (*Sciurus vulgaris*). Veterinary Record 171: 176.

Kenward, R.E. & Hodder, K.H. (1998) Red squirrels (*Sciurus vulgaris*) released in conifer woodland: the effects of source habitat, predation and interactions with grey squirrels (*Sciurus carolinensis*). Journal of Zoology 244: 23-32.

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 squirrel pox virus infection for the native red squirrel? Biological Invasions DOI: 10.1007/s10530-014-0671-8

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 DOI: 10.4404/hystrix-25.1-10126

Shuttleworth, C.M., Kenward, R.E. & Jackson, N.L. (2008) Re-introduction of the red squirrel into Newborough forest on the island of Anglesey. **In:** Soorae, P.S. (ed.) Global re-introduction perspectives: re-introduction case studies from around the globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, UAE, pp 163-166.

INTERNATIONAL UNION
FOR CONSERVATION OF NATURE

WORLD HEADQUARTERS
Rue Mauverney 28
1196 Gland, Switzerland
Tel +41 22 999 0000
Fax +41 22 999 0002
www.iucn.org