Shared Experience of Invasive Grey Squirrel Management Practice

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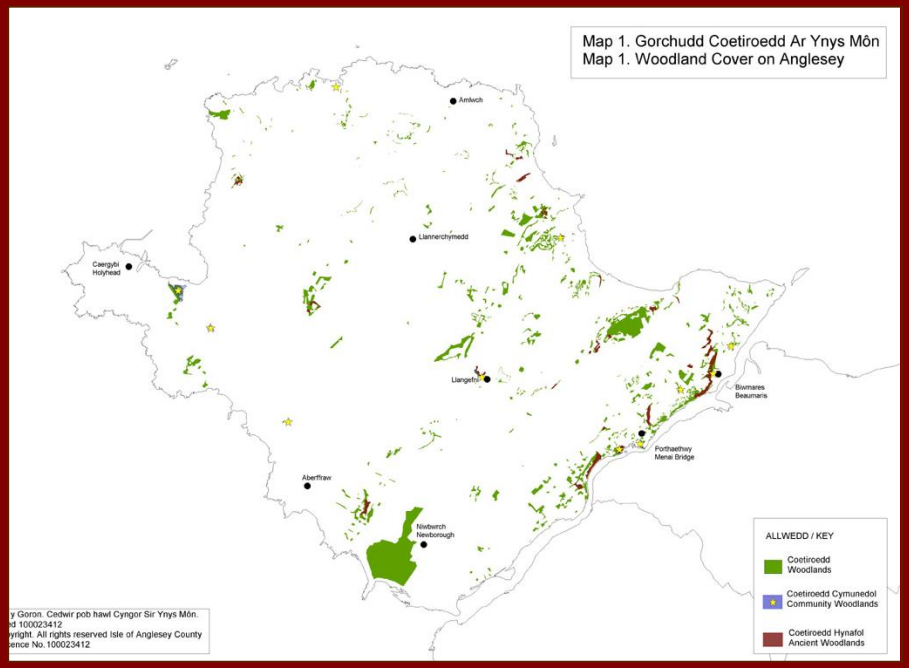
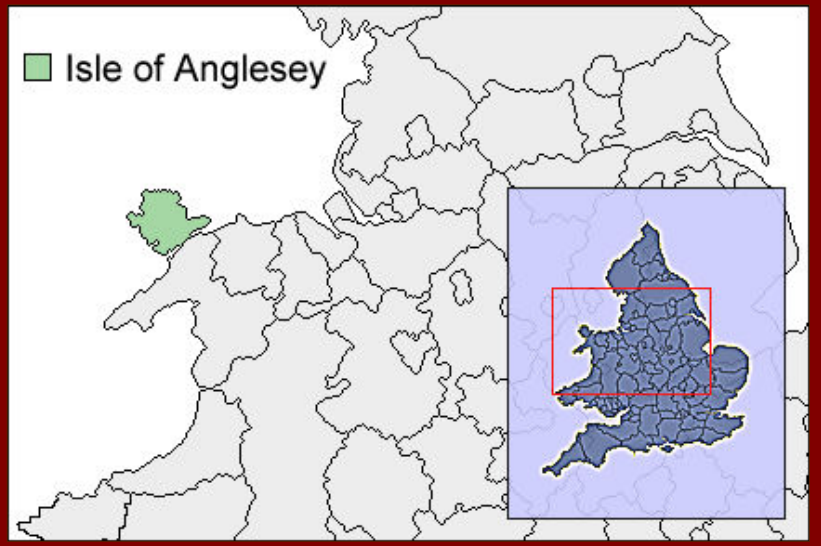
Resource competition and disease mediated ecological replacement

Complete niche overlap

Grey squirrel impacts in the UK



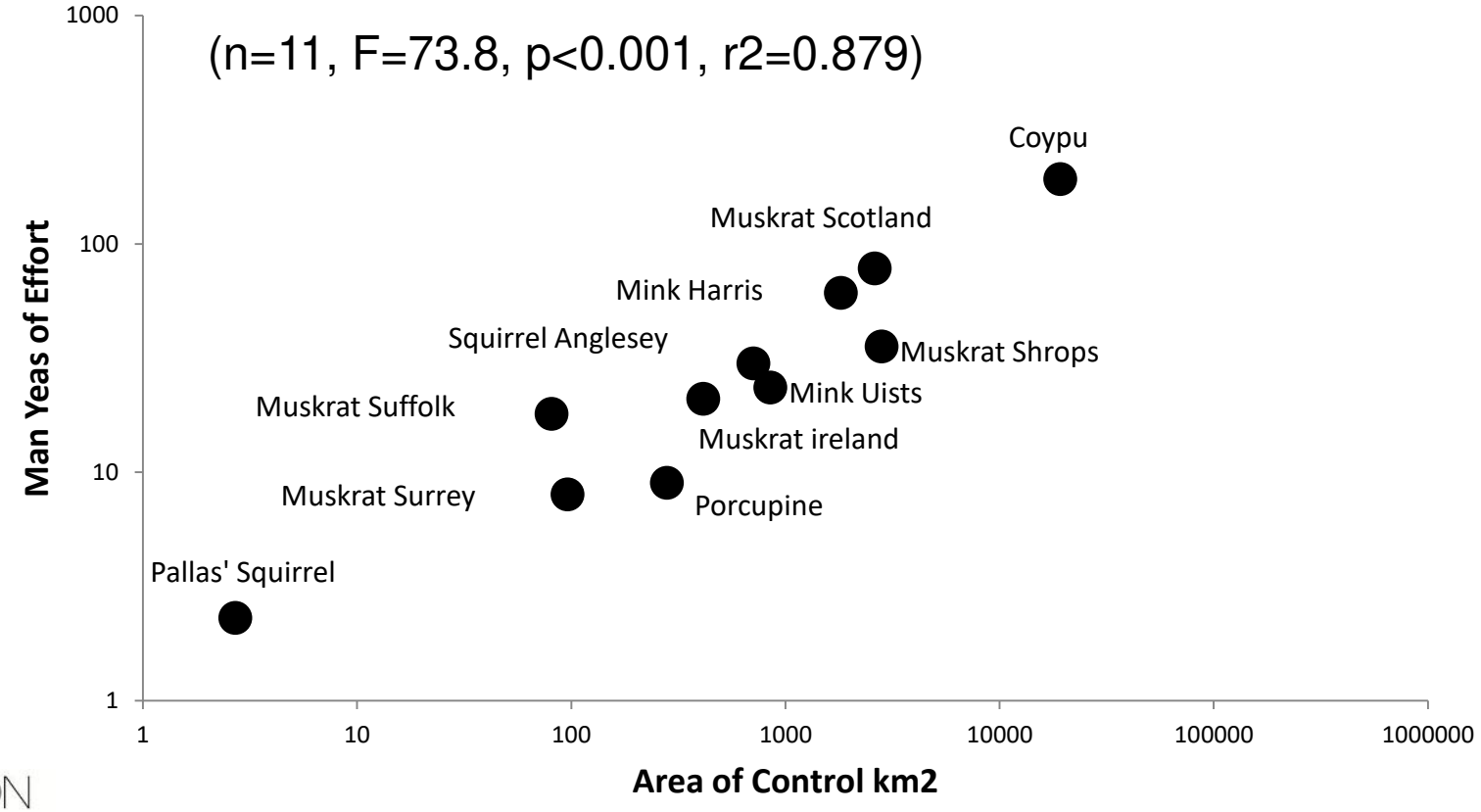


Grey squirrels first arrived on Anglesey in the mid 1960s and by 1998 the Eurasian red squirrel was almost extinct.

Eradication from 710km^2 island to a coastal boundary was completed in 2013

Schuchert et al. 2014 Biological Invasions

Effort for Success



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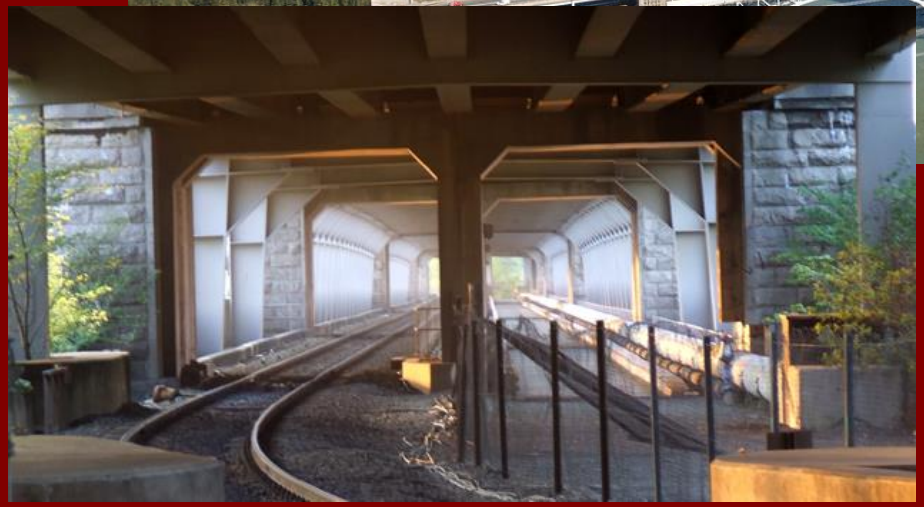
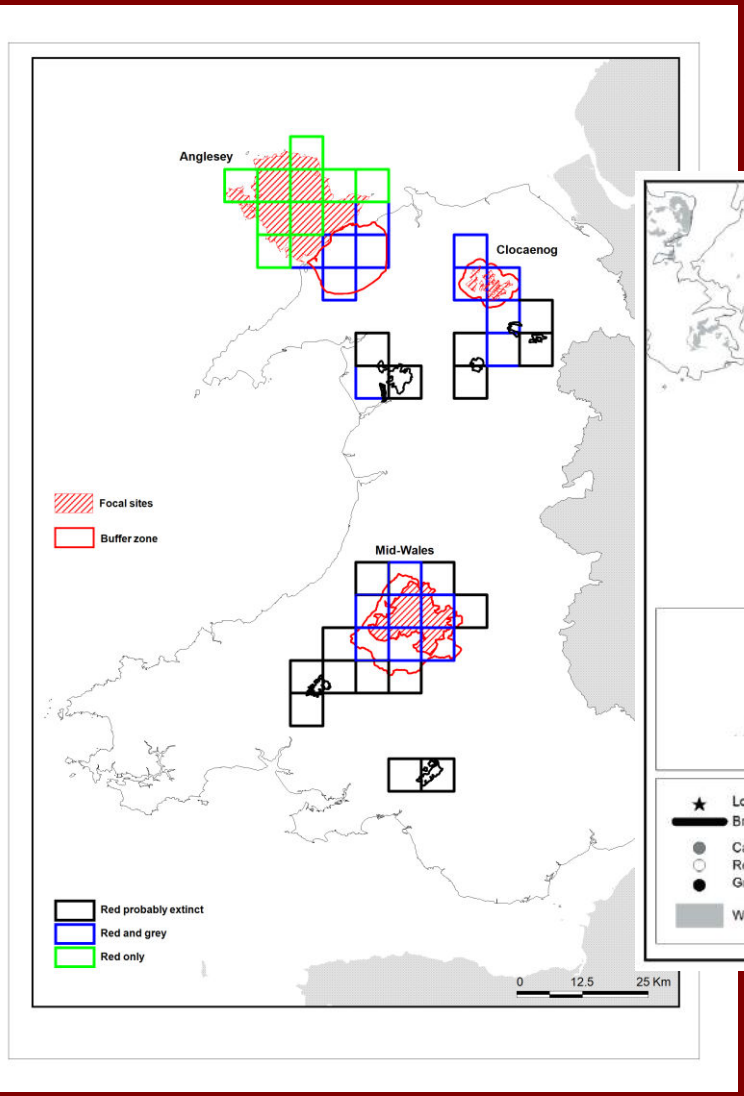
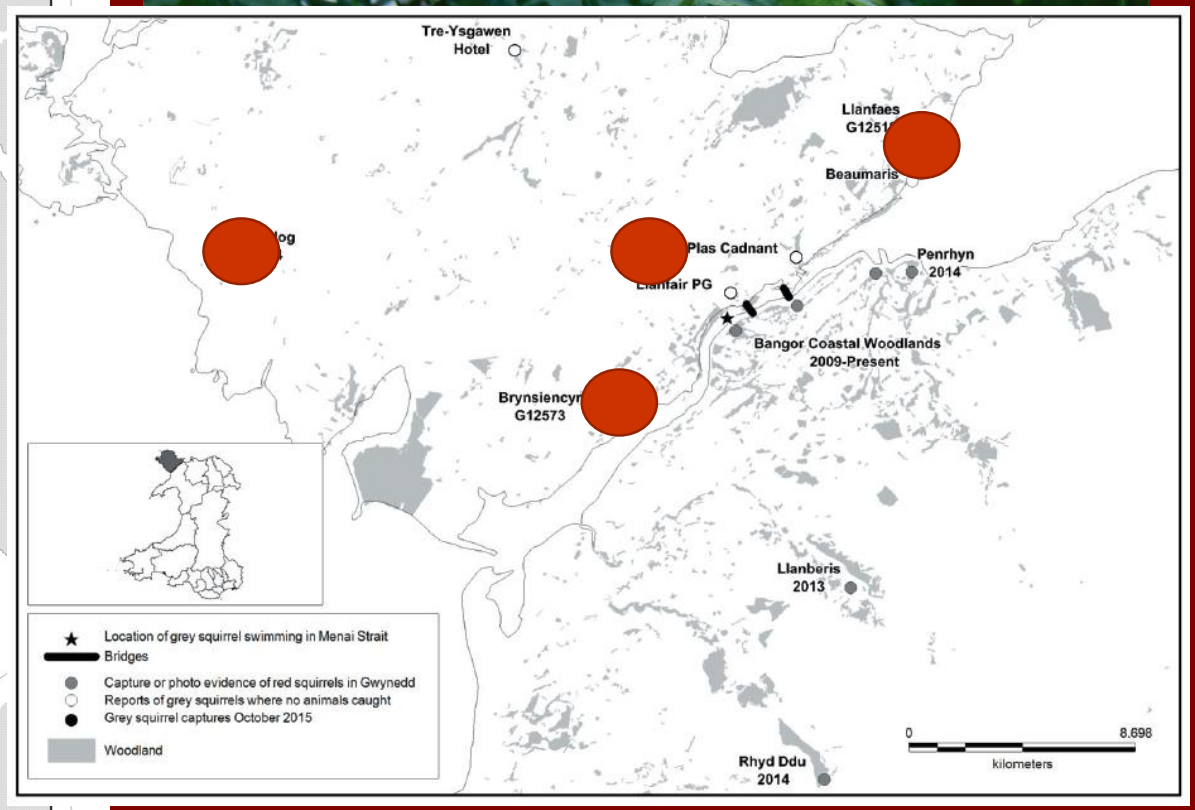
Robertson et al. (2016) *Pest Management Science*

Eradication to a boundary



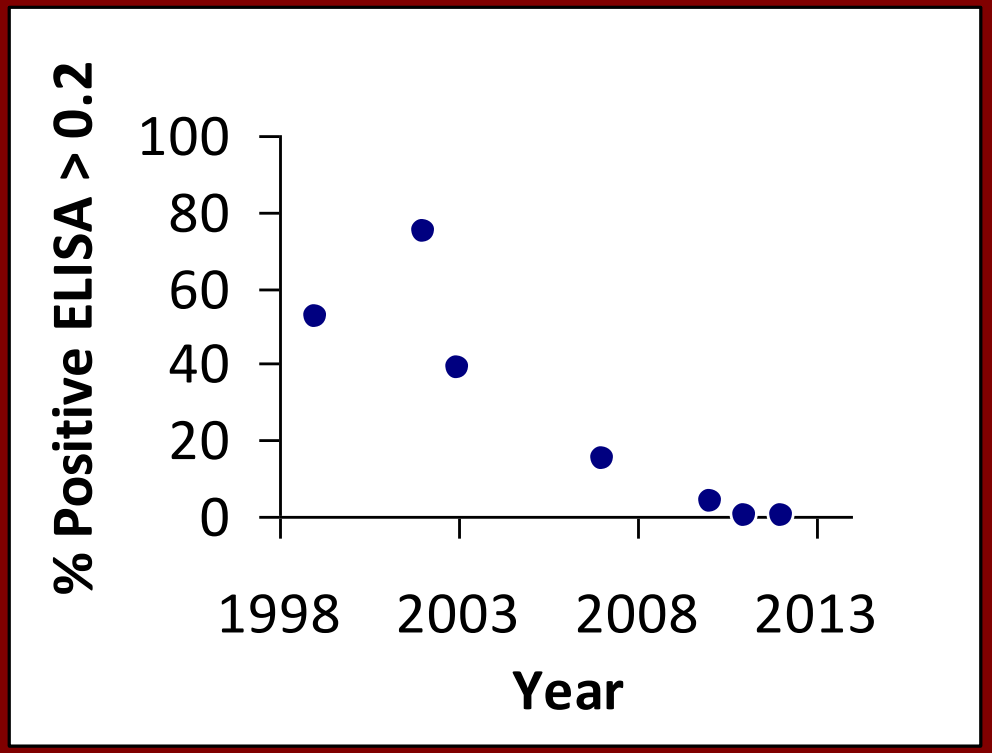
Island Refuge?





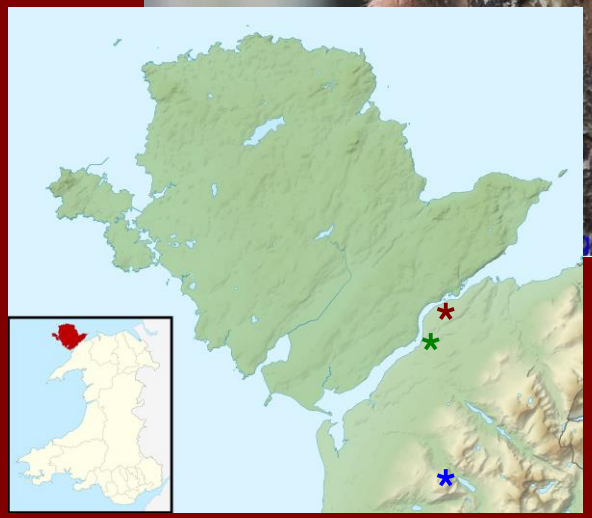
Halliwell et al. 2015 In Shuttleworth, Lurz & Hayward (eds)
Shuttleworth et al. 2016 In Shuttleworth, Lurz & Gurnell (eds)

SQPV (Pox) ELISA results within a culled grey population (1998-2012)



Schuchert et al. 2014 Biological Invasions

Mainland Gwynedd



Interactions & opportunities for viral spread

LIFE14 NAT/UK/000467

‘Sciuriosity’ - Evolving IAS grey squirrel management techniques in the UK

Potential role of ectoparasites in squirrel pox epidiomiology

Modelling SQPV disease epidemiology

The individual-based model used previously to interrogate SQPV disease at a landscape scale in different UK regions (Norfolk, Rushton et al. 2000; Cumbria, Rushton et al. 2006) was adapted to investigate disease spread at the individual woodland scale with shorter time-steps (within year) to spatially articulate seasonal processes. These modifications also allowed us to develop a model incorporating SQPV carriage by nest-site inhabiting ectoparasites (e.g. fleas) as potential disease vectors. Data collected in this study regarding flea loads on individuals and in nest boxes were used to re-parameterize the extended model along with others from the extant literature. We used Cochwillan Wood

We modelled scenarios with and without ectoparasite vectored transmission in grey only, mixed and red only populations.

Cowan et al. 2016 In Shuttleworth, Lurz & Gurnell (eds)

- 73% of grey squirrels had ectoparasites.
- 69% (43-89%) of greys were sero-positive for squirrel pox.
- Models predicted the virus cannot be maintained in grey squirrels, in the absence of ectoparasite vectored transmission.
- Opportunities for an innovative means of disease prevention by insecticide application.

Population density 5-10x compared with native red squirrel

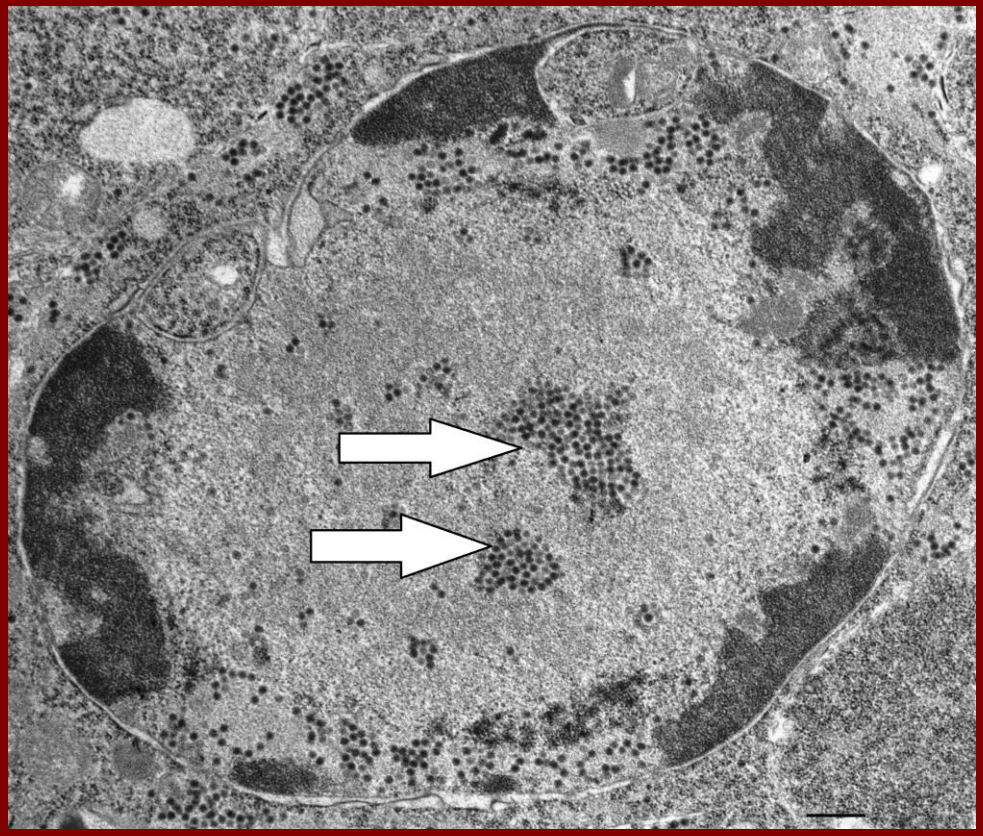
Reovirus 3	80%	Cross-infection to other species including man is possible
Reovirus	63%	*As above*
Sendai virus	53%	Common in wild rodents. Mild human infection may occur.
LCMV*	20%	Potential source of human infection
Adenovirus	1-56%	Potential infection source for wild rodents
Bovine TB	0.4%	Spill-over host, limited risk of disease transmission.

* Lymphocytic Choriomeningitis Virus

Vet. Record 150: 543-546. The Vet. Journal 173 (2007) 287–301.
Mammal Review 44 (2014) 225–233, Journal of Wildlife Diseases 50: 409–411.

Grey squirrels may introduce novel infections and parasites

They may alter epidiomiology of existing infections amongst native animals



Micrograph of adenovirus particles (arrowed) detected in an ultra-thin section of enterocytes from a red squirrel large intestine.

Intestinal Adenovirus 2007 paper triggered a focus on Anglesey red squirrels

Enteric adenovirus infection in a red squirrel (*Sciurus vulgaris*)

SIR, – There is increasing evidence that squirrel pox disease is the principal cause of the rapid decline of the red squirrel (*Sciurus vulgaris*) in England (Rushton and others 2006). However, relatively little is known about other infectious

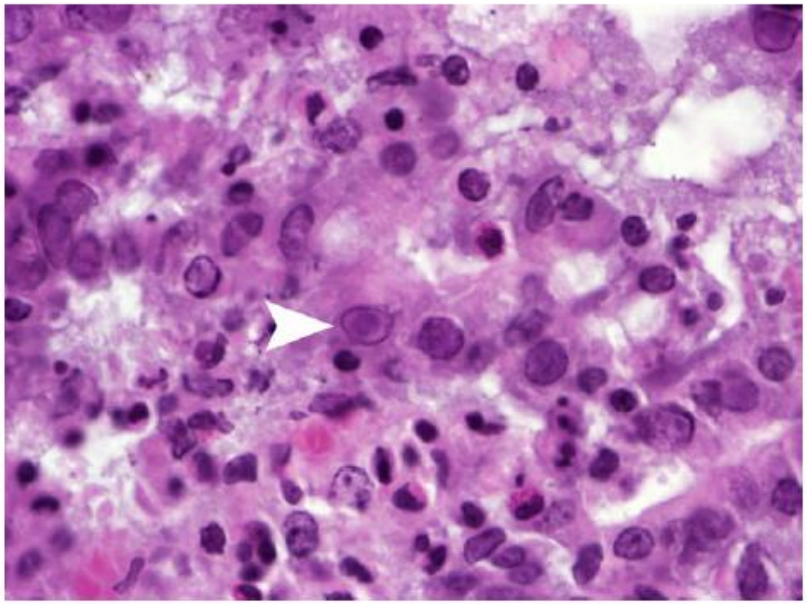


Fig. 1. Haematoxylin and eosin histology image of a section of red squirrel *Sciurus vulgaris* small intestine, showing intra-nuclear virus inclusion bodies (arrowed) and extensive damage to the villi, findings consistent with adenovirus infection. ×600 magnification.

Duff et al. 2007 Vet Record

PCR Adenovirus tests

- Mice (A. sylvaticus) 8-20%
- Grey squirrels 54-60%
- Wild red squirrel trauma deaths 30%
- UK captive red mortality (n=188) 71%
- TEM to date only found particles in red squirrel intestines and pathology so far absent in greys.

Everest et al. Mammalian Biology (submitted)

Everest et al. 2014 Mammal Review

Fig. 4. Location of adenovirus positive free-living wild (●) and captive (□) red squirrel *Sciurus vulgaris* cases from Great Britain, as analysed by PCR and TEM.

Adenovirus distribution in Great Britain

Letters

WILDLIFE

Adenovirus infection in red squirrels in areas free from grey squirrels

ADENOVIRUS infection of red squirrels (*Sciurus vulgaris*) was first identified in 1997 in free-living animals that had died following translocation and which showed signs of enteritis and splenitis at postmortem examination (Sainsbury and others 2001). Cases continue to be reported in both free-living animals (Duff and others 2007)

wild red squirrels had be
24 (8 per cent) mice trapp
enclosures housing capti
north Wales also tested p

To determine wheth
adenovirus is present in
squirrel populations wh
are absent, we re-examin
intestinal contents previ
be negative for viral part
alongside intestinal cont
samples recently collect
living in geographical ar
squirrels. Samples from
– 12; Isle of Wight – sev
Island – one) were exam

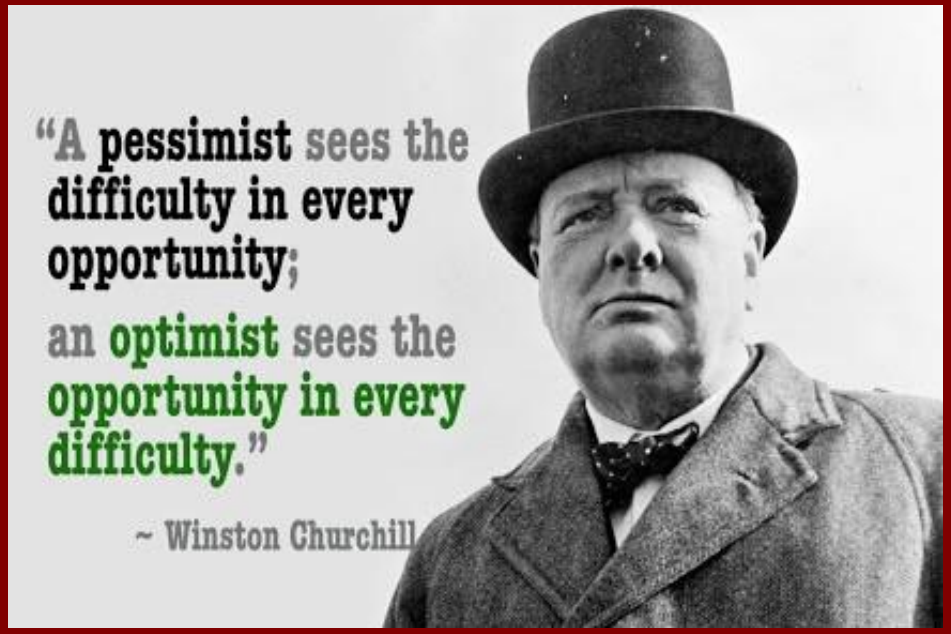
Grey Squirrel infections in BC

- A paucity of data on infections and epidiomiology.
- Need to establish provisional baseline data.
- Understand population history and translocation rates – does moving animals risk moving viral infections?
- Recalibrate impact on native sciurids to include viral infections

BC Grey squirrel screening

Infection	Harvested material	Tests
Squirrelpox	Lip & blood	PCR & ELISA
Adenovirus	Spleen & gut	PCR & TEM
LCMV	Liver	PCR
Hanta	Kidney	PCR
Other RNA	Kidney/ Liver	PCR

2017 Fellowship & Travel Award



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