Institution: University of Aberdeen

Unit of Assessment: 5 - Biological Sciences

Title of case study: Eradication of an invasive alien predator through empowering community conservation stakeholders

1. Summary of the impact

The eradication of alien invasive species is a conservation priority, but is rarely attempted in mainland areas given the logistical and economic challenges of species control over large areas. Any effective control programme must be underpinned by robust scientific understanding of the population ecology of the target species to ensure control is appropriately focussed and directed, and that efforts are not swamped by compensatory dispersal from neighbouring regions.

A University of Aberdeen study of water vole population ecology recognised sharp declines in numbers and identified the invasive, predatory American mink as a primary driver of population extinction. The world's largest mainland species eradication programme was then put in place by Aberdeen, involving many hundreds of volunteers. It has successfully removed breeding mink from over 10,000 km^2 of Scotland and secured the future of an iconic symbol of natural heritage. This conservation success story is now used as a template for the management of invasive mink in other eradication initiatives in Scotland and internationally.

The research thereby impacted the conservation of natural resources and policy and planning of management.

2. Underpinning research

A most insidious threat to the long term persistence of native biodiversity is the spread of invasive alien species. Mitigating the effects of alien species through active control or eradication has long been considered an absolute priority in management and conservation, but has rarely been attempted except on small islands. This reflects both a perception that large scale eradication initiatives are prohibitively expensive and logistically difficult, plus a poor understanding of the underlying ecology and population biology of the focal species to design and execute an effective eradication programme.

Research led by Professor Xavier Lambin, at the University of Aberdeen, on the population demography and dynamics of water voles (*Arvicola terrestris*) catalogued the decline of populations in Scotland, and identified that a primary driver of decline was predation by invasive American mink (*Neovison vison*) that had originally escaped or been released from fur farms since the 1950's [1]. This underpinning research led Lambin to conceive, initiate and lead a mink eradication programme in the Cairngorms National Park (CNP) funded through a grant from the Tubney Charitable Trust [i] augmented with support from Scottish Natural Heritage [ii], the CNP Authority and three river Trusts (rivers Dee, Spey and Bogie-Isla-Deveron). These funds were matched by "partnership" grants from the UK Natural Environment Research Council (NERC) to cement collaboration between University, public and private sector partners [iii-iv]. Overall investment in the first 3 years of the initiative was £555,741 plus £289,000 of in-kind contributions, in addition to an untold amount of volunteers' time.

The overarching goal of the project was to achieve sustainable, multiple catchment-wide removal of mink, hence creating suitable conditions for the recovery of the focal native species, all achieved through empowering local communities to take ownership of, and effectively manage, their biodiversity resources. The key strategy of the programme was mobilising, training and coordinating a workforce of volunteers, including wildlife conservation professionals, local residents, land managers, gamekeepers and fisheries officers, to deploy and monitor a network of mink "rafts" - floating platforms with a footprint recording plate of moist clay under a wooden tunnel that can act as a monitoring device for the presence of mink and also subsequently as a targeted

trapping site. Each raft was in essence adopted by different volunteers who were encouraged to become "citizen conservationists", acting as guardians of a specific stretch of waterway to detect and act upon mink presence. A "rolling carpet" strategy of mink raft deployment was utilised, moving downstream from the headwaters of the five main river catchments that flow from the CNP but retaining the network of rafts behind the expanding control front to ensure detection and removal of any immigrant mink [2].

The project was underpinned by an innovative "adaptive management" approach, whereby the strategy for effective eradication evolved in response to the growing body of understanding of mink ecology and population biology that was obtained during the early stages of the eradication effort to focus strategy and optimise the project's conservation benefit, sustainability and cost effectiveness. This included an understanding of how rabbits influence the interactions between mink and voles [3], the use of molecular genetic approaches to characterise mink spread and identify dispersal hot spots where focussed control effort could ensure maximum eradication return [4,5], and the drivers of volunteer involvement and retention [6].

The research on mink and water vole ecology and interaction has involved three independent Marie Curie Fellows (Molero, Luque-Larena and Aars) four postdoctoral researchers (Oliver, Bryce, Aars and Webster) and PhD student (Fraser), at the University of Aberdeen, all led by Lambin. The eradication effort within the CNP employed four mink control officers (Davies, Grey, Urquhart and Taylor) to oversee, coordinate and monitor stakeholder effort.

The success of the CNP mink eradication initiative was such that it increased in scale and scope to cover an area of Scotland of over 10,000 km^2, making it the largest mainland invasive species eradication effort worldwide. Its successor, the on-going Scottish Mink Initiative 2010-13, is autonomously managed by a partnership led by the Rivers and Fisheries Trust of Scotland with oversight from Lambin and targets an area of 30,000 km^2 for mink eradication.

3. References to the research

Primary publications

[1] Aars J, **Lambin X**, Denny R & Griffin A. (2001) Water vole in the Scottish uplands: distribution patterns of disturbed and pristine populations ahead and behind the American mink invasion front. *Animal Conservation* 4, 187-194. *Paper that describes the catastrophic impact of mink on water vole populations through surveys over a 2 year period in the Scottish uplands* – 31 citations

[2] Bryce R, Oliver MK, Davies L, Gray H, Urquhart J & **Lambin X.** (2011) Turning back the tide of American mink invasion at an unprecedented scale through community participation and adaptive management. *Biological Conservation* 144, 575–583. *Paper that describes the strategy utilised and indicators of success of the Cairngorms National Park mink eradication programme.*

[3] Oliver M, Luque-Larena JJ & **Lambin X.** (2009) Do rabbits eat voles? Apparent competition, habitat heterogeneity and large-scale coexistence under mink predation. *Ecology Letters* 12, 1201-1209. *Paper that describes how the persistence of water voles (native prey) is determined by the spatial distribution of rabbits (invasive prey) through the mobility of a shared invasive American mink predator.*

[4] Zalewski A, Piertney SB, Zalewska H & **Lambin X.** (2009) Landscape barriers reduce gene flow in an invasive carnivore: geographical and local genetic structure of American mink in Scotland. *Molecular Ecology* 18, 1601-1615. *Population genetics analysis that describes genetic differentiation among mink populations to infer barriers to dispersal across Scotland that influence the spread and rate of invasion* – 18 citations

[5] Fraser EJ, Macdonald DW, Oliver MK, Piertney SB & **Lambin X.** (2013) Using population genetic structure of an invasive mammal to target control efforts – an example of the American mink in Scotland. *Biological Conservation* 167, 35-42. *High resolution landscape genetics*

analysis of mink population structure to identify hotspots of mink dispersal and targets areas where control efforts could be maximised.

[6] Beirne C & **Lambin** X. (2013) Understanding the determinants of volunteer retention through capture-recapture analysis: answering social science questions using a wildlife ecology toolkit. *Conservation Letters* - DOI: 10.1111/conl.12023. *Paper that exploits mark-recapture analysis to provide novel insight into understanding the determinants of volunteer retention rates in conservation programmes, and how involvement is affected by management practice.*

Relevant Grant Funding:
[i] PI – X. Lambin: *Cairngorms water vole conservation project*. Tubney Charitable Trust (2006-2009) £250k
[ii] PI - X. Lambin: *Cairngorms water vole conservation project*. Scottish Natural Heritage (2006-2008) £ 128k
[iii] PI – X. Lambin: *Overcoming the compensatory response of an invasive predator*. NERC (2007-2010) £160k
[iv] PI – X. Lambin: *Dispersal and depensation in low density culled mink population*. NERC (2012) £50k

4. Details of the impact

Lambin's research has directly underpinned the World's largest mainland species eradication programme. The CNP eradication initiative involved the deployment of over 500 mink rafts by over 180 volunteers that has led to the removal of over 700 mink and the effective eradication of all breeding mink from a 10,570 km^2. Within the CNP eradication zone, many populations of water vole that had gone extinct have been recolonized, and the remnant populations are beginning to show signs of population recovery and expansion [a]. As such, this project is recognised as "…*having a positive impact on the conservation and management of biodiversity in Scotland"* [b] through safeguarding populations of one of the most iconic species of conservation concern and UK biodiversity, the water vole, as well as salmonids, ground nesting birds and other key riparian species.

The eradication protocol put in place by the CNP initiative has now been adopted as the "standard operating procedure" for effective mink eradication both nationally and internationally. Equivalent eradication initiatives in place or planned in Europe recognise Lambin's research as "…*instrumental for defining procedures and protocols*" and "…*have impacted on management policies and practices put in place*" [c]. The CNP initiative underpins a follow-on mink eradication programme in Scotland covering a 30,000 km^2 area north of a line running from Montrose to Ullapool, which involves over 500 volunteers and (to Sept 2013) the removal of over 1700 mink. This project is coordinated and run autonomously by a cooperative involving Rivers and Fisheries Trusts of Scotland (RAFTS), Scottish Wildlife Trust (SWT), Scottish Natural Heritage (SNH), Cairngorms National Park Authority, University of Aberdeen and many river authorities with an economic interest in keeping northern Scotland mink free [d].

As such, Lambin's initial research and subsequent eradication project has influenced environmental policy and delivered changes in management practice. In recognition, the Scottish Government Minister for the Environment & Climate Change presented Lambin with a certificate for special contribution to species conservation and management in Scotland, notably through the SNH Species Action Framework programme [b].

Lambin's work on invasive species eradication in the CNP has had broader conservation and management impact beyond mink. According to Scottish Natural Heritage "*Lambin has been instrumental in changing the way we undertake directed conservation action across large geographic regions, and has empowered local communities to take ownership of, and steward, their natural capita*l". Moreover, Lambin's work is "*…turning back the tide of pessimism and establishing that low level actions can have significant positive outcomes for our native wildlife*" [b].

This is echoed by the Cairngorms National Park Authority, who highlight "*stakeholder groups now feel empowered to take ownership of the conservation of their local biodiversity and* (have a) *perception that their efforts can have positive effects*."[a]

Indeed, as a consequence of the CNP eradication initiative the stakeholder groups involved in the project have taken the decision to expand mink control activities into lowland agricultural landscapes, and represent a trained and motivated workforce keen to take on board other conservation issues. The project has thus secured a legacy for conservation beyond mink and water voles. This is exemplified by the statement "*Lambin's project gave the Cairngorms National Park Authority the confidence to initiate a program aimed at conserving the critically endangered Scottish Wildcat*" [a].

More broadly the project has had impacts for improved public understanding of conservation issues [e], as directly quantified by a subsequent social science study [f].

The impact of the research as defined by REF includes: Impacts on the Environment by affecting the management and conservation of natural resources, informing and influencing environmental policy and planning decisions, and affecting the management of an environmental hazard; and Impacts on Society through improving public understanding and engagement/involvement in research and adoption of new processes involved in conservation.

5. Sources to corroborate the impact

[a] Testimonial from Head of Land Management and Conservation for the Cairngorms National Park Authority confirming the recovery of water vole populations as a consequence of mink eradication efforts and the impact of Lambin's work beyond mink and water voles.

[b] Testimonial from Director of Policy and Advice, Scottish Natural Heritage highlighting how Lambin's research through the CNP mink eradication initiative has directly contributed to the conservation of natural resources in Scotland and influenced policy and procedure for conservation and management.

[c] Testimonial from the Leader of the Ecophysiology and Behavioral Ecology Research Unit, Mammal Research Institute, Polish Academy of Sciences, indicating how on-going and planned mink eradication initiatives in Poland and elsewhere in eastern Europe are using the approaches and procedures defined by Lambin for the CNP eradication project.

[d] Testimonial from Project Development Manager for Rivers and Fisheries Trusts Scotland - RAFTS highlighting how the success of Lambin's CNP eradication initiative has underpinned broader eradication initiatives for invasive species.

[e] http://abdn.ac.uk/lambin-group/mediacoverage.html - provides a series of radio and TV broadcasts and associated press articles that exemplify how the Aberdeen-led research and mink eradication initiative has been used to increase the public understanding of science.

[f] Evely AC, Fazey I, Reed MS & Pinard M. (2010). High levels of participation in conservation projects enhance learning. *Conservation Letters*. DOI:10.1111/j.1755-263X.2010.00152.x