GNHS Report

The Ecology of Water Vole (*Arvicola amphibius*) in Grassland Habitats in the City of Glasgow

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Introduction

Water voles (*Arvicola amphibius*) are considered to be one of Britain's fastest declining mammal species and national surveys conducted by the Vincent Wildlife Trust show that since 1990 there has been an overall UK decline of 88% (Strachan, 2004). Its range is limited to riparian margins along water courses and reed beds and they are considered to have strict habitat preferences.

Historically water voles have been declining since the early 1900's due to changes in land-use and habitat fragmentation with the move towards intensive agriculture and urbanisation resulting in the loss and degradation of vast areas of riparian habitat (Rushton *et al.* 2000; Strachan & Moorhouse, 2006). The accidental introduction of the American mink (*Neovison vison*) from fur farms in the 1950's compounded this decline and resulted in a considerable acceleration in the rate of loss of water vole populations (Woodroffe *et al*. 1990; Barreto *et al*. 1998; Strachan & Jefferies. 1993; Carter & Bright, 2003). As such, the water vole is classed as a UK Biodiversity Action Plan priority species and receives legal protection under Schedule Five of the Wildlife and Countryside Act 1981 and the Nature Conservation (Scotland) Act 2004 which makes it an offence to intentionally or recklessly disturb, damage or destroy water vole burrows or any structure they may use for shelter (Strachan, 2004).

Project Background

In 2008 the Natural Environment Officers of Glasgow City Council were made aware of water vole populations in the city's East End by the accidental trapping of an animal by the Pest Control Department in traps intended for dealing with a rat infestation. What was highly unusual was that the location – a garden in a housing estate in the Garthamlock area with no known nearby water course or suitable riparian habitat. Further investigation revealed sites with what appeared to be abundant water vole field signs in grassland patches in derelict areas (see Fig 1.1), road verges and public parks. This behaviour is largely unrecorded and poorly understood in British populations although grassland populations, termed fossorial because of their more mole-like existence, are common in other parts of their range across Europe (Meylan, 1977).

The East End is known to support riparian water vole populations in wetlands areas such as Hogganfield Park and Seven Lochs Wetland Park (Glasgow Natural History Society, unpublished) but the origin of these grassland populations is largely speculative at this stage. It is possible that the East End water voles are a relic of populations once found along the Monkland Canal and have persisted in the area since the Canal was filled in during the 1950's to create space for the M8 motorway (Scottish Canals, 2015).

Fig 1.1: Grassland habitat: Strone Road site viewed from Skerryvore Road (site 31.2)

Aims

The aim of this study is to investigate the distribution and ecology of grassland water vole populations in order to address the current lack of knowledge. Regeneration of the East End is a high priority for the Scottish Government and GCC because of the higher than national average social deprivation levels in the area (Scottish Government, 2012). To overcome financial constraints GCC have leased council-owned land, including many derelict sites, to housing developers under the agreement that a proportion of the new properties built will be social housing. However, the East End water voles have taken up residence on numerous sites ear-marked for development which has led to the urgent need to investigate the ecology of these unusual populations. Standard mitigation guidelines focus on displacement techniques of maintaining unfavourable conditions (e.g. preventing water vole expansion into a new area by keeping grass mown short) and translocation in more pressing instances (Strachan, 2004). These guidelines are all based on the riparian water vole which may render aspects of this mitigation inappropriate for the East End populations inhabiting grasslands.

This information will be essential for the local authority, Scottish Natural Heritage, local developers and ecologists and will go toward informing best management practice, surveying techniques, protected species licensing and mitigation guidelines.

Study Area

The Seven Lochs Area (see Fig 1.2) was selected as the study area for establishing the distribution of the water vole across the east of Glasgow. This area is situated 3km east from Glasgow city centre and is demarcated by three trunk roads, the M8, M80 and M73. It is predominately an urban habitat, which contains within it a mosaic of habitat types.

Fig 1.2: Google Earth satellite image of eastern Glasgow with study boundary (purple line) and 1 x 1km² survey grid squares

In total the area encompasses 30 km² of which approximately 17 km² is urban habitat and takes in the city suburbs of Ruchazie, Garthamlock and Easterhouse at the most southern boundary along the M8 and the towns of Stepps, Gartcosh, Chryston and Moodiesburn to the north and east. The Seven Lochs Wetland Park, an actively managed area of man-made lochs, parkland, Local Nature Reserves (LNRs) and woodland (Seven Lochs, 2014) makes up 9 km² within the study site. The Wetland Park extends beyond the M73 further east to Coatbridge but was excluded from the study

area due to time budget considerations. North of the Wetlands Park lies predominately agricultural land continuing on to Chryston and Moodiesburn and the M80 boundary.

The study area was subdivided by 1km² grid squares using OS 1:25 000 Explorer Map 342 of Glasgow and a stratified sampling approach adopted: 2 sites within each grid square with suitable grassland habitat were identified and surveyed using 100m presence/absence transects based on the identification of water vole field signs. A total of 65 sites were identified; 65 were surveyed in March-April and 62 repeat-surveyed in Sept-Oct 2014. All grassland sites were a minimum of 50m from riparian habitat in order to reduce the likelihood of recording field signs from water voles occupying wetland habitat.

Survey forms were adapted from the standard Water Vole Survey Form set out in the Water Vole Conservation Handbook (Strachan *et al*. 2011) to take into account the variation in field signs for the fossorial ecotype. Along with field sign counts, the site location and altitude was recorded using GPS, a site map hand-drawn and the following environmental variables also recorded: aspect of slope, angle of slope, soil type, soil compaction/water logging/trampling, habitat type, neighbouring land use (recorded at an approximate visual distance of 100m of each site), National Vegetation Community/ dominant grass species, vegetation height, disturbance (e.g digging by domestic dog, *Canis lupis familiaris*), presence of predators (*N. vison, Vulpes vulpes, Rattus norvegicus, Felis catus*).

Each grid square was surveyed twice during 2014, recording both pre-breeding (March-April) and post-breeding (Sept-Oct) field signs to establish temporal persistence of water vole populations at each site. Once field signs were counted a score of presence or absence was allocated to each site. Presence was further subdivided into three categories to give an overall idea of habitat suitability based on habitat usage by the water voles as indicated by field signs (see Table 1.1). This could only be done for post-breeding surveys in Autumn because the breeding season is from late April to August in more northerly populations (Strachan & Moorhouse, 2006).

Abundance of water vole using capture-mark-recapture (CMR)

Six sites were selected for CMR based on advice from Glasgow City Council and results from the pre-breeding surveying effort under the premise that high levels of field signs may represent core colonies and could therefore be important for long-term water vole conservation in the area. Due to considerable difficulties during trapping (trap theft, verbal abuse, etc) trapping was only conducted at two sites: Cranhill Park and Tillycairn Drive. Paired Sherman traps were set on a 100m transect at 10m intervals, baited and provisioned with hay. Traps were checked three times

daily for a trapping period of five days. All individuals trapped were weighed, measured, sexed and marked for CMR using Passive Integrated Transponder (PIT) tags then released.

Presence/absence Score	Field Signs Present	Habitat Suitability
0	No field signs recorded	Habitat unsuitable/never been occupied
1	Old burrows and/or tumuli	Habitat no longer suitable/temporary residence
2	Fresh signs of: burrows, tumuli, lawns/foraging remains, blocked tunnels, droppings	Habitat suitable to sustain water vole population
3	Fresh signs of: latrines, expelled nesting material (in addition to field signs in category 2)	Habitat suitable to sustain a breeding water vole population

Table 1.1: Table of Presence/Absence Score for Water Vole Field Signs

Results

Presence/absence Field Sign Surveys: Water Vole Distribution

The pattern of water vole distribution across the Seven Lochs study area showed a clear division between the local authorities of Glasgow City Council and North Lanarkshire, with no presence recorded within North Lanarkshire (see Fig 1.3). Presence appeared to be concentrated along the M8 corridor and nearby urban sites, although presence was also recorded within 50-150m of large water bodies i.e. Hogganfield Loch, Bishop Loch and Gartloch and 50m of marsh/reed bed.

Of the 65 sites surveyed in Spring, water vole presence was recorded on 21 sites. Sixty-two sites were repeat-surveyed in Autumn with water vole presence being recorded on 19 sites.

Distance From Water

Distance of sites from suitable riparian water vole habitat (e.g. pond, river, marsh, reedbed) was measured as a direct overland distance using Google Earth and found to be significant for water vole presence (Spring: df 3, N=65 χ^2=13.166 p=0.004; Autumn: df 3, N=62 χ^2=13.565 p=0.004). Within 100m of riparian habitat, presence was recorded in 9 out of 27 sites in Spring and 7 out of 24 sites in Autumn. For sites over 500m from riparian habitat, presence was recorded in 9 out of 15 sites for both Spring and Autumn (see Fig 1.4a and 1.4b). Presence was least frequently recorded at distances of 100-500m from riparian habitat.

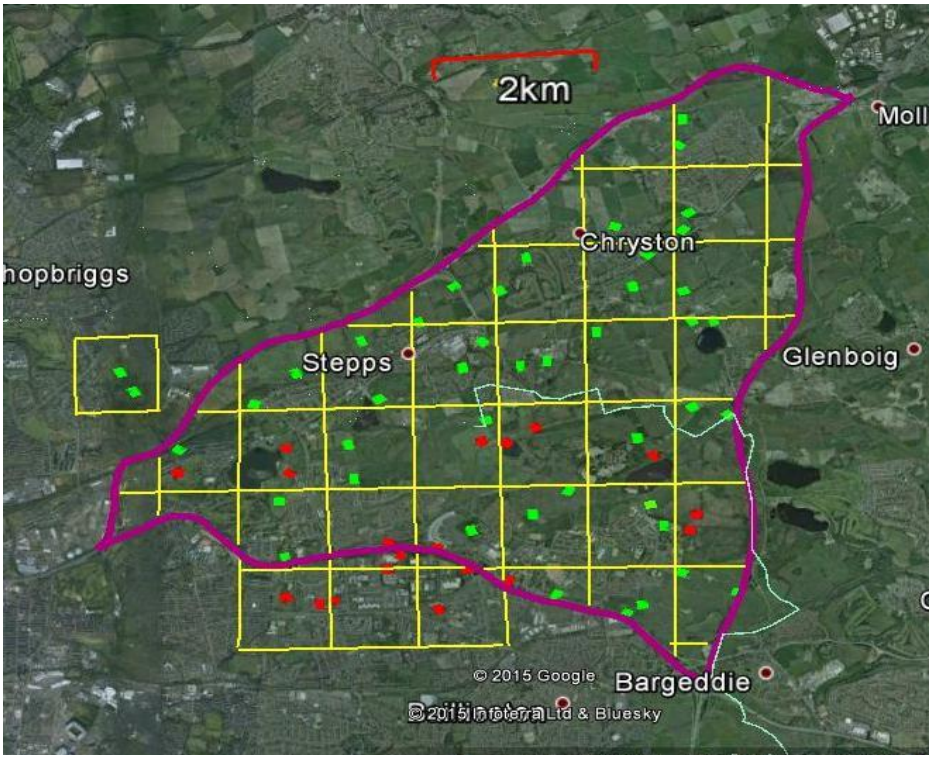

Fig 1.3: Google satellite image showing Autumn distribution of water vole presence (red) or absence (green) across study area

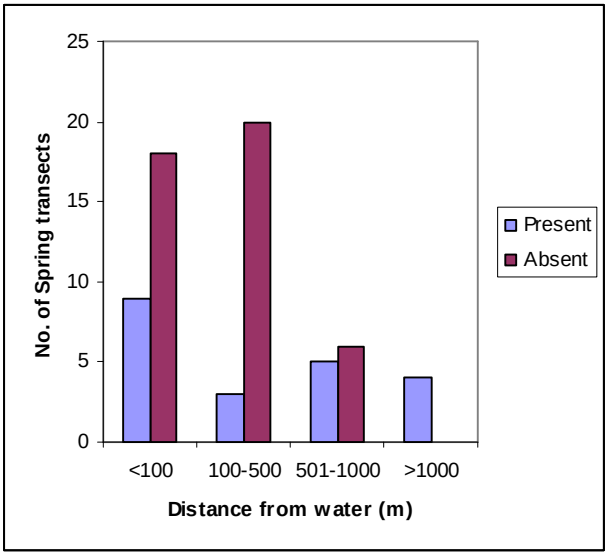

Fig 1.4a: Water vole Spring presence/absence by distance from water

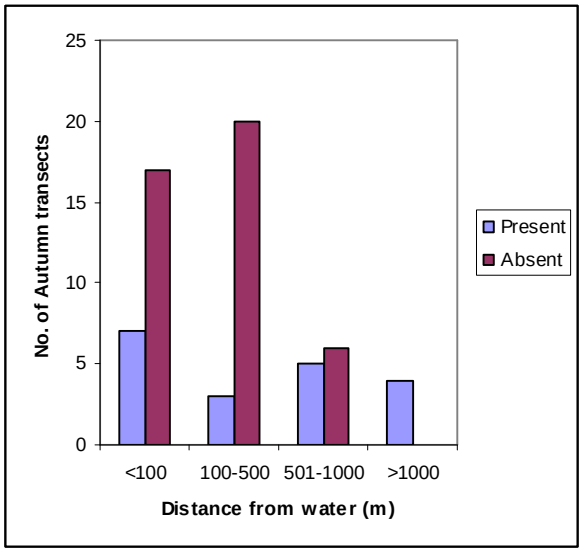

Fig 1.4b: Water vole Autumn presence/absence by distance from water

Principle Component Analysis: Sites by Presence/Absence

The effect of environmental variables on water vole distribution was analysed using Principle Component Analysis (Program CAP 3.0). Water vole habitat preference was inferred from the level of habitat use; subdivided into peripheral, feeding and breeding use based on field signs recorded from Autumn surveys.

Chi Square Test

Overall, water vole presence was independent of the environmental variables expect for profile (p=0.005) and aspect (p=0.015) which were the only explanatory variables for Spring and Autumn presence. Predator signs were an explanatory variable for Spring presence (p=0.004) but not Autumn (p=0.176). Predator signs were significant for a number of environmental variables: habitat type (p=0.002), vegetation type (p=0.002), aspect (p=0.011) and disturbance (p=0.002) in both Spring and Autumn surveys.

Analysis of Similarities (ANOISM)

Similarity of environmental variables between presence or absence groups was non-significant (ANOISM, Pairwise test, No. of randomizations= 1000, p= 0.081). However, when presence was subdivided by level of water vole habitat use (absent, peripheral use, feeding, breeding) then the similarity of environmental variables was significant between sites with breeding compared to absence (ANOISM, Pairwise test, No. of permutations= 1000 p= 0.029).

Trapping

A total of 48 individuals were captured at the two trapping sites. Forty-four out of the 48 were identified as adults. There was an unequal sex ratio with 29 females and 15 males (df 1, N= 44 χ^2 = 3.84 p= 0.05 using Yates correction). Only 4 juveniles were trapped, 2 males and 2 females, all of which were at Tillycairn.

Discussion

The findings of this study show that 43% of sites occupied by water voles in Spring and 38% of sites in Autumn were within 50-100m of suitable riparian habitat. Sites at > 500m accounted for the greatest proportion of sites with water voles present (43% of Spring sites and 47% of Autumn sites) and they were temporally persistent for presence in the 2014 surveys.

When field signs were subdivided by the level of water vole habitat use, eight of the nine sites within 100m of riparian habitat showed feeding behaviour. At the intermediate distance of 100-500m, historical presence was recorded at two sites on both survey occasions. A total of 9 sites supported breeding colonies, seven of which were >500m from riparian habitat, the exceptions being Hogganfield Park grassland which was adjacent to reed beds (<100m) and the Fort Green Wall (336m from Auchinlea pond which was negative for water vole presence).

Distance from riparian habitat was significant for both Principle Component Analysis and Chi-square Test and points towards two distinct populations of water voles in the East End: one using

grasslands in close proximity to riparian habitat and one inhabiting grasslands in complete isolation of water. The findings of this study provide strong evidence for the East End populations displaying similar behaviour to fossorial populations found in Europe.

Grassland habitat appeared to be highly important for water vole populations in the area with 89% of all breeding colonies recorded 500-1182m distant to suitable riparian habitat. These breeding colonies were all associated with a 3km length of the M8 corridor and adjacent grassland patches and their distance from water was a key explanatory variable in Principle Component Analysis.

Grassland water vole distribution was associated with urban habitats all subjected to moderate to high levels of disturbance: parks and gardens, road verges and derelict sites.

Presence of predators was also an explanatory variable for water vole occurrence. The main predators of East End populations were fox and the domestic cat. Predator signs were least likely to be recorded in moderate to highly disturbed sites indicating grassland water vole populations may experience lower levels of predation.

The occurrence of water voles was strongly associated with certain grass species, particularly *Holcus lanatus* and *H. mollis* which were the dominant grasses on 43% of all occupied sites and 67% of breeding sites. Both grasses provide dense cover and are a nutritious food source.

Capture-mark-recapture at the two sites, Cranhill Park and Tillycairn Drive, allowed the estimation of population size by population modelling in Program MARK. Population densities were estimated to be between 40-156 water voles per hectare indicating grasslands are high quality habitat for water voles. Cranhill Park had the highest population density estimate and Tillycairn, the lower.

Conclusions

Establishing the distribution and habitat variables of water vole populations across the East End was the first step towards pro-active conservation management of this species yet there are still questions regarding their origin, genetic diversity, population dynamics, behaviour and life history traits. Population densities alone indicate the East End water voles are of national significance being at the highest densities ever recorded in the UK to the best of our knowledge.

Even with the current lack of genetic research on these populations, there is a strong argument for their consideration as an Evolutionary Significant Unit (ESU) on the basis of their population and ecological distinctiveness (Crandall ***et al.*** 2000). It is highly likely that gene flow between breeding colonies is restricted due to isolation distances and the urban habitat matrix and these

populations may show genetic variation from other Scottish populations. However, this does not necessarily mean that East End populations will be affected by inbreeding as the period of time these populations have been isolated for remains unknown. Genetic diversity can be maintained within metapopulations of water voles (Stewart *et al.* 1998).

The grasslands of the East End of Glasgow are a far cry from the pristine image of wetland habitat we associate with water voles; yet populations here occur at the highest density ever recorded in the UK. Even with the slowing of the decline in Britain reported by Strachan (2004), the East End populations represent a glimmer of hope for water voles: not only are these populations immune to mink predation given their distance from water courses, grassland habitat is commonplace, easier and cheaper to create and capable of supporting much higher numbers compared to riparian habitat. The city of Glasgow alone hosts over 90 parks and green spaces. Whether the occurrence of fossorial behaviour is unique to Glasgow populations of water vole is a question still to be addressed yet grassland populations here appear to be bucking the trend of decline. It is possible that the limitations of standard surveying techniques has resulted in other grassland populations being missed throughout the UK.

Grasslands should be considered a refuge habitat for water voles, similar to reed beds but with the huge benefit of being a product of urbanisation rather than one under threat from it. While a longer-term study is required to further understand metapopulation dynamics and life history of the East End water voles, the occurrence of these populations does highlight the need for a re-think on what is suitable habitat for water voles. Grasslands could be a critical management tool for the conservation of this protected species.

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