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Potential risk of American mink to water vole populations in east Glasgow

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Water voles (*Arvicola amphibius*) have undergone a rapid decline in the U.K. over the last few decades, due in part to the high predation pressure from introduced American mink (*Neovison vison*) (hereafter "mink") (Strachan, 2011). The water vole population within the Greater Easterhouse area of Glasgow was recently found to be of national importance, since this area contains some sites with the highest densities of water voles recorded within the U.K. (Stewart *et al.*, 2017, 2019). Although these populations are fossorial in dry grassland, the extensive network of watercourses within the Greater Glasgow area (Fig. 1) and the proximity to the Seven Lochs Wetland Park may make these populations potentially at risk from mink invasion.

Mink are distributed throughout the Greater Glasgow area (64 identified records) with the highest frequency

of reports on the River Kelvin and the Forth and Clyde Canal, based on 1997-2017 records (Glasgow Museum Biological Record Centre, 2018; National Biodiversity Network Atlas, 2018). Interestingly, there seems to be few records of mink within the east of Glasgow (Fig. 1). This could be due to either the unsuitability of habitat for mink establishment or a lack of recording effort within the area. Mink could potentially access the fossorial water vole populations through the Luggie Water. This watercourse is directly connected to the River Kelvin and the Forth and Clyde Canal and linked to the Seven Lochs Wetland Park through the Bothlin Burn, therefore potentially serving as a corridor for mink (Fig. 2). Indeed, there was a recent sighting of mink on Johnston Loch, Gartcosh, in September 2014 (R.A. Stewart, unpublished data), which suggests that they are already present within the area.

Mink generally settle in close proximity to water, as their feeding habits and protection from predators depend on these habitat features (Gerell, 1970; Yamaguchi *et al.*, 2003; Macpherson & Bright, 2010; Ahlers *et al.*, 2016). When settled in their territories, these predators generally forage within 10 - 50 m of streams (Macpherson & Bright, 2010), but they can also forage up to 500 m from a watercourse if suitable foraging opportunities exist (Gerell, 1970; Yamaguchi *et al.*, 2003). Additionally, mink can disperse across great distances overland between catchments, with one study reporting a mean dispersal distance in north east Scotland of 37.1 km (Melero *et al.*, 2017). This highlights their potential ability to colonise grassland where fossorial water vole populations may be found.

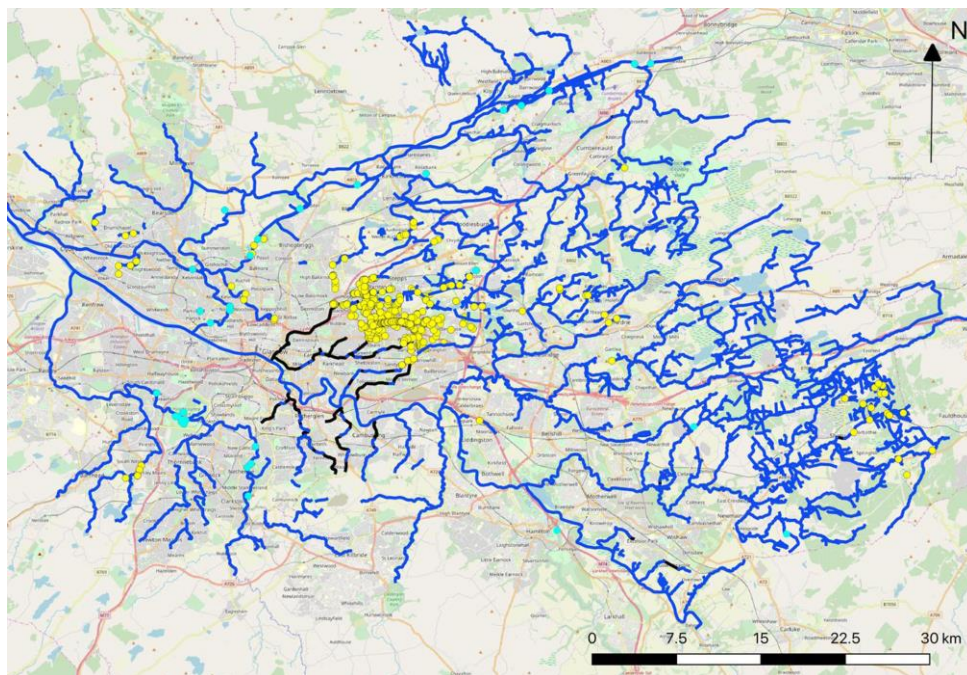


Fig. 1. Map of Greater Glasgow showing above-ground watercourses (blue) and underground watercourses (black). Water vole records 1994-2017 (yellow circles) and American mink records 1997-2017 (light blue circles) are plotted.

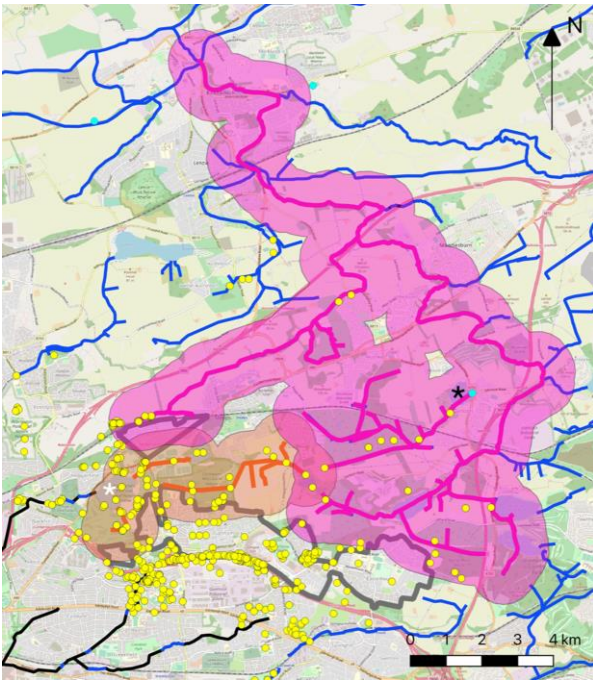


Fig. 2. Map of the east of Glasgow showing the records of American mink (light blue circles) and water voles (yellow circles). The 500 m zone surrounding the mink corridor (purple) represents the current potential distribution of mink. The 500 m zone (orange) represents the future potential distribution of mink around Hogganfield Loch and its tributaries (shown as orange lines). An urban land cover (buildings, parking lots, roads, maintained lawns and railroads) of over 80% is found within the thick grey margin in the bottom. Above-ground watercourses (blue) and underground watercourses (black). White asterisk: Hogganfield Loch; black asterisk: Johnston Loch.

In the light of the above, we attempted to identify the potential risk to fossorial water vole populations from current and future mink establishment in riparian habitats in the Greater Easterhouse area. This was undertaken by identifying fixed distance zones 50 m and 500 m around the putative mink corridor (Luggie Water and Bothlin Burn) using an open source geographic information system (QGIS Version 2.18) (Fig. 2) and

plotting the number of water vole records (Glasgow Museum Biological Record Centre, 2018) within these zones obtained through a mix of opportunistic and systematic records of East Glasgow surveys (Table 1). This study assumed that the overlap between the potential mink distribution and the water voles could negatively affect water vole populations, as previously seen in linear riparian populations (Strachan, 2011). For the purposes of this study we use "record" to represent sites occupied by water voles. This analysis identified 27 water vole records that currently potentially face low risk from mink (between 50 and 500 m from a watercourse) and 11 records potentially facing high risk (between 0 and 50 m from a watercourse), representing respectively 4.3% and 1.8% of the total number of identified records (627) in the Greater Easterhouse area. Notably, if mink were to reach Hogganfield Loch (Table 1) and its associated tributaries, the number of records potentially at risk would increase considerably with low risk from mink increasing to 11.6% and high risk to 6.9% of records. Fortunately, the built environment in Glasgow may reduce the risk of mink predation, as areas with more than 80% urban land cover have been found elsewhere to act as a barrier to mink dispersal (Ahlers *et al.*, 2016). However, given the history of establishment of mink within the U.K., mink have a high capability of dispersal and are likely to be more tolerant of human landscapes than was found in this recent study.

As water voles are protected under Schedule 5 (Section 9) of the Wildlife and Countryside Act 1981 (Strachan *et al.*, 2011), it is important to conserve populations. Hogganfield Loch is currently a relocation site for water voles affected by urban developments and therefore it is crucial to determine whether or not mink are found within this area. We would recommend the implementation of a monitoring scheme using rafts to detect mink occupancy in this particular site (Reynolds *et al.*, 2004), and would encourage local communities and naturalists throughout Glasgow to report sightings of mink for the benefit of this nationally important water vole population.

	Current potential risk		Future potential risk	
	Low	High	Low	High
Number of records	27	11	46	32
Percentage of records	4.3	1.8	7.3	5.1

Table 1. Current number of water vole records (representing occupied sites in the Greater Easterhouse Area, Glasgow) that are potentially at risk and future records (in the same sense) that could potentially be at risk from American mink predation if mink reached Hogganfield Loch and its associated tributaries. High risk corresponds to records found within 50 m and low risk to records found within 500 m of a watercourse. The total number of water vole records and mink records was 627 and 64 respectively.

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