Short Note

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Evidence for naturalization of the American mink (*Neovison vison*) in Friuli Venezia Giulia, NE Italy

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Abstract: The American mink (*Neovison vison*) was introduced to Italy for the fur farming industry during the 1950s. The first feral mink were observed in the 1980s in the northern regions of Veneto, Friuli Venezia Giulia and Emilia Romagna. In this work, we investigated the distribution of mink in Friuli Venezia Giulia, more than 10 years after the last extensive release of farmed animals which happened in this region in 2003. Results indicate that American mink has naturalized in the region and populations are still localized along some tributaries of the upper Tagliamento catchment.

Keywords: distribution survey; floating rafts; *Neovison vison*; Tagliamento catchment.

The introduction and spread of non-native species has become a global ecological and conservation issue, as invasive organisms are increasingly altering terrestrial and aquatic communities worldwide (Bax et al. 2003, Pyšek et al. 2010). New sites of establishment of alien species should be quickly identified in order to accelerate and facilitate management actions (Genovesi 2005).

The American mink (*Neovison vison* Schreber, 1777) is native to North America and is now established as an invasive species in South America, Europe and Asia (Dunstone 1993). The species was introduced to Europe in the early decades of the 20th century to supply the fur farming industry (Bonesi and Palazon 2007). American mink is a generalist predator with an opportunistic feeding strategy. Several studies have demonstrated that through predation it can have serious impacts on native species, in particular on crayfish (Fisher et al. 2009), ground-nesting birds (Craik 1997), rodents (Wodroffe et al. 1990) and can compete for space and resources with native Mustelids of similar size, such as the European mink (*Mustela lutreola*) (Maran and Henttonen 1995). In view of these negative ecological impacts, several European countries have initiated survey and monitoring programs and as a result, American mink distribution is known for some of them (e.g. Brzeziński and Marzec 2003, Harrington et al. 2010, Melero et al. 2010, Rodrigues et al. 2015).

The species was introduced to Italy during the 1950s (Bonesi and Palazon 2007). The first feral mink were observed in the 1980s in the northern regions of Veneto, Friuli Venezia Giulia and Emilia Romagna (Lapini et al. 1996, Ferretto et al. 2008). Evidence of the presence of the species was subsequently reported for central and southern regions of Lazio and Sardinia (Angelici et al. 2000, Andreotti et al. 2001, Lapini 2003). Nonetheless, up to now little is known about the distribution and the ecological impacts of American mink in Italy.

According to Lapini (1991), the region of Friuli Venezia Giulia in the NE of Italy hosted four large mink farms, two located in the northern pre-alpine area (Villa Santina and Socchieve), and two in the south-western plain (San Vito al Tagliamento and Fiume Veneto) (Figure 1). Four substantial releases of farmed mink occurred during the 1980s and the 2000s due to the activities of the Animal Liberation Front, with a total of approximately 5000 mink being released. After the releases of the 1980s, Lapini (1991) collected data on the localities where individuals were observed or where road-kills were found and mapped them on a UTM 10×10 km grid base. Since then, no study has been carried out to assess the status of the species and to reveal if it had naturalized in Friuli Venezia Giulia. The aim of this study was to fill in this gap and to assess the status and the distribution of American mink in Friuli Venezia Giulia. This region is of particular concern because it hosts some ecologically

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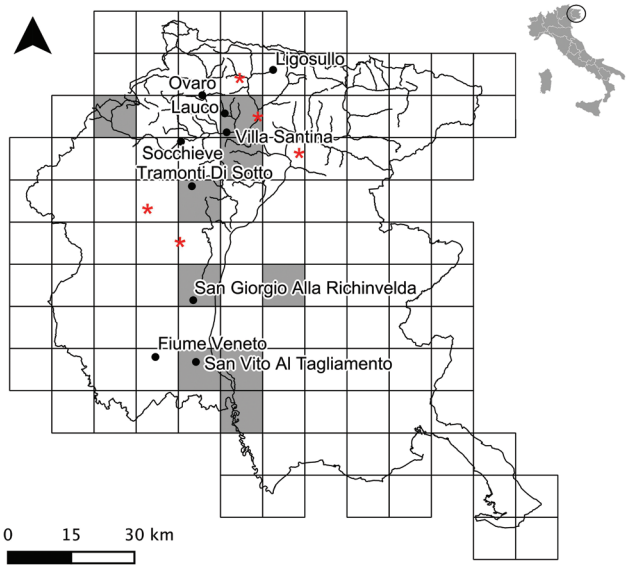

Figure 1: Location of mink farms in Friuli Venezia Giulia (NE Italy) indicated by black dots and labeled on the map. Red asterisks represent records of mink collected in years 2003 and 2004, after the liberation of 2000 of mink from the farm of Villa Santina. The UTM squares where the species was recorded by Lapini (1991) are highlighted in gray. The catchment of the River Tagliamento is also shown in the map.

important areas of international value for the wintering and the stop-off of birds and waterfowls under the Ramsar Convention of Wetlands (Grado and Marano lagoons). Furthermore, in Friuli Venezia Giulia American mink could also impact on a regional project of reintroduction of an autochthonous freshwater crayfish (*Austropotamobius pallipes*).

To update American mink distribution in Friuli Venezia Giulia, we first collected all available information regarding the location of mink farms. Through interviews with the Italian Association of Mink Breeders (AIAV *hereafter*), five additional records of mink farms were collected, three of which were situated across the northern pre-alpine area, in some municipalities along the upper reaches of the catchment of the River Tagliamento (Figure 1). All mink farms closed down after a substantial release of American mink, which happened in 2003 in Villa Santina (AIAV 2013, personal communication). On this occasion 2000 mink were released, with only a few 100 being recaptured. Subsequently, we interviewed experts, rangers and fishermen to obtain further information about the locations where feral mink were observed, road killed or photographed. Several records of mink presence were obtained (Table 1), the most recent and promising ones being located in the upper reaches of the Tagliamento catchment, along the River Degano and some tributaries, along the River But and around Lake Cavazzo. Given these findings, a systematic survey was carried out along these two rivers and their main tributaries and along the main course of the Tagliamento from the source to the confluence with the River Fella, to assess the presence of mink. The survey extended along approximately 200 km of river banks and included the banks of Lake Cavazzo and some nearby small marshes with an area <1 km^2 (Vuarbis Marsh and Das Fontanas Marsh) (Figure 2). It was conducted from the end of July 2013 until mid-October 2013 and was based on the use of floating rafts as footprint tracking devices (Reynolds et al. 2004). This method proved to be highly effective in revealing the distribution of this species in other regions of Italy (Bartolommei et al. 2013), as well as in other countries (e.g. Rodrigues et al. 2015). We deployed one mink raft per 2 km section of river: this distance was based on the average home range of the American mink in freshwater habitats in England (Dunstone 1993). Rafts were positioned among the marginal vegetation typically favored as a hunting habitat for mink, anchored to trees or shrubs. Those sections of rivers which were not easily accessible (e.g. river sources), or which were characterized by gravel river bed, with no riparian vegetation to anchor rafts, were not surveyed (e.g. lower and upper sections of the River Degano). Several other rafts, with irregular interspacing distance, were positioned along other rivers belonging to the upper Tagliamento catchment (Rivers Fella, Aupa, Pontebbana, Saisera, Lumiei), where there have been no records for mink presence (Figure 2). Once set, rafts were checked once per week and were activated for a maximum of 1 month. As soon as an American mink track was found on a given raft, it was removed. Given that polecats are known to also enter rafts and mink and polecat tracks are very similar in shape and size, we used Harrington's classification algorithm to identify the tracks (Harrington et al. 2008).

A total of 1295 trap-nights were performed and rafts were disabled in 10% of the trap-nights by torrential flow of rivers during the heavy rains of October. Cases of human damage/theft of floating rafts were also recorded (n=5), with a loss of 3% of trap-nights. The presence of mink was recorded at seven sites: five along the River Degano, one along the River But and one at the confluence between the Rivers But and Chiarsò (Figure 2). In the 86% of rafts which were found positive for mink tracks, the presence of this species was detected very quickly and results were collected within 1 week of the rafts being set. Besides mink, tracks of another Mustelid species were found on rafts: it was the case of the stone marten (*Martes foina*), which visited two different rafts set on the River Degano and on the main course of the upper Tagliamento in two different occasions.

Table 1: Year, municipalities, name of the river/lake where individuals of American mink were observed, trapped or photographed in Friuli Venezia Giulia from 2003 onwards, obtained by searching through interviews with experts, rangers and fishermen.

Year	Municipalities	River	Source	Data
2003	Tolmezzo – Avons	Tagliamento	Ponton 2003	Picture: one specimen
2003	Arba	Colvera	Lapini 2003	One male road killed
2003	Venzone	Venzonassa	Mainardis intw	Various specimens: accidental kills
2004	Frisanco – Colvere	Colvera	Lapini intw	One female: accidental kill
2003–2011	Sutrio – Fish Farm	But	Farmer intw	Pictures: various specimens
2006	Rigolato – Gracco	Degano	Lapini intw	Scats and footprints
2010	Forni Avoltri – Pierabech	Degano	Utmar intw	Obs: female with two cubs
2013	Forni Avoltri – Pierabech	Rio Fleons	Paradisi intw	Obs: one specimen
2013	Forni Avoltri – Pierabech	Degano	Giorgini intw	Video: two swimming specimens
2013	Forni Avoltri – Pierabech	Degano	Pacolin intw	Picture: one specimen
2010	Somplago	Lake Cavazzo	Cimenti intw	Obs: one specimen
2013	Alesso – Villa Turchini	Lake Cavazzo	Stefanutti intw	Obs: one specimen

Obs, Observation; intw, interview.

Figure 2: Results of mink survey in the upper Tagliamento catchment. Rivers surveyed for mink presence are reported with a continuous line. Circles represent the positions of the rafts along the investigated rivers. Dark circles represent rafts which resulted positive for mink tracks and white circles represent rafts where mink tracks were not recorded. UTM squares where the species was detected are highlighted in grey.

Results of this survey suggest that, since the beginning of the 1990s American mink has colonized the most northern sections of the upper Tagliamento catchment and nuclei of individuals are distributed along two of its main tributaries, the River Degano and the River But. Given that no mink farm is currently present in the region and therefore no escapes or releases could have happened after 2003, data from this study provide evidence that the species has naturalized in the region Friuli Venezia Giulia.

Similar surveys should be carried out throughout Italy, where records of the species exist. This could help to produce an accurate and updated distribution map for American mink in the country and to design an effective management strategy of the species on a national level. Given the confined distribution of mink in the upper Tagliamento catchment and its potentially serious impact on autochthonous fauna, a priority management action in the area should be the realization of an eradication program before the species undergoes further expansion. Moreover, the southern low plain and the lagoons, which were not covered in this study, should be the subject of an extensive mink survey, starting from those areas where the farms where present in the past (Figure 1). Even if occasional recent observations of mink are not available

for this area, it hosts suitable habitat for the species, given the high abundance of water courses, lagoon areas and waterfowl species which have been shown to form a significant portion of mink diet (Bartoszewicz and Zalewski 2003). The last notable releases of farmed mink in the southern low plain happened more than 20 years ago, an interval of time during which mink could have dangerously expanded (Iordan et al. 2012).

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References

Andreotti, A., A. Baccetti, M. Perfetti, M. Besa, P. Genovesi and V. Guberti. 2001. Mammiferi ed Uccelli esotici in Italia: analisi del fenomeno, impatto sulla biodiversità e linee guida gestionali. Quad. Cons. Natura, 2. Min. Ambiente-Ist. Naz. Fauna Selvatica, pp. 194.

Angelici, F.M., L. Luiselli and L. Rugiero. 2000. First note of dietary habits of American mink *Mustela vison* in Italy. Mammalia 2: 253–257.

Bartolommei, P., L. Bonesi, I. Guj, A. Monaco and A. Mortelliti. 2013. First report on the distribution of the American mink *Neovison vison* (Mammalia: Mustelidae) in central Italy. Ital. J. Zool. 80: 455–461.

Bartoszewicz, M. and A. Zalewski. 2003. American mink, *Mustela vison* diet and predation on waterfowl in the Slonsk Riserve, western Poland. Folia Zoologica 52: 225–238.

Bax, N., A. Williamson, M. Aguero, E. Gonzalez and W. Geeves. 2003. Marine invasive alien species: a threat to global biodiversity. Mar. Policy 27: 313–323.

Bonesi, L. and S. Palazon. 2007. The American mink in Europe: Status, impacts, and control. Biol. Cons. 134: 470–483.

Brzeziński, M. and M. Marzec. 2003. The origin, dispersal and distribution of the American mink *Mustela vison* in Poland. Acta Theriol. 48: 505–514.

Craik, C. 1997. Long-term effects of North American mink *Mustela vison* on seabirds in western Scotland. Bird Study 44: 303–309.

Dunstone, N. 1993. The mink. T & AD Poyser Ltd., London, UK.

Ferretto, M., L. Bonesi and L. Guidolin. 2008. Primi dati di distribuzione del Visone americano (*Neovison vison*) nella provincia di Vicenza. Natura Vicentina 12: 219–232.

Fisher, D., P. Pavluvcik, F. Sedlacek and M. Salek. 2009. Predation of the alien American mink *Mustela vison* on native crayfish in middle-sized streams in central and western Bohemia. Folia Zool. 58: 45–56.

Genovesi, P. 2005. Eradications of invasive alien species in Europe: a review. Biol. Invasions 7: 127–133.

Harrington, L., A. Harrington and D.W. Macdonald. 2008. Distinguishing tracks of mink *Mustela vison* and polecat M. putorius. Eur. J. Wildl. Res. 54: 367–371.

Harrington, L., A. Harrington, J. Hughes, D. Stirling and D.W. Macdonald. 2010. The accuracy of scat identification in distribution surveys: American mink, *Neovison vison*, in the northern highlands of Scotland. Eur. J. Wildl. Res. 56: 377–384.

Iordan, F., S.P. Rushton, D.W. Macdonald and L. Bonesi. 2012. Predicting the spread of feral populations of the American mink in Italy: Is it too late for eradication? Biol. Invasions 14: 1895–1908.

Lapini, L. 1991. Il visone americano in Friuli Venezia Giulia. Fauna 2: 44–49.

Lapini, L. 2003. *Mustela vison* (Schreber, 1777), In: (L. Boitani, S. Lovari, A. Vigna Taglianti, eds.) Fauna d'Italia. Mammalia III. Carnivora-Artiodactyla., Calderini publ., Bologna, pp. 152–157.

Lapini, L., A. Dall'Asta, L. Dublo, M. Spoto and E. Vernier. 1996. Materiali per una teriofauna dell'Italia nord-orientale (Mammalia, Friuli-Venezia Giulia). Gortania-Atti del Museo Friulano di Storia Naturale 17: 149–248.

Maran, T. and H. Henttonen. 1995. Why is the European Mink (*Mustela lutreola*) disappearing? A review of the process and hypotheses. Annal. Zool. Fennici 32: 54–74.

Melero, Y., S. Palazón, L. Bonesi and J. Gosàlbez. 2010. Relative abundance of culled and not culled American mink populations in northeast Spain and their potential distribution: are culling campaigns effective? Biol. Invasions 12: 3877–3885.

Pyšek, P., S. Bacher, M. Chytrý, V. Jarošík, J. Wild, L. Celesti-Grapow, N. Gassó, M. Kenis, P.W. Lambdon, W. Nentwig, J. Pergl, A. Roques, J. Sádlo, W. Solarz, M. Vilà and P.E. Hulme. 2010. Contrasting patterns in the invasions of European terrestrial and freshwater habitats by alien plants, insects and vertebrates. Glob. Ecol. Biogeo. 19: 317–331.

Reynolds, J.C., M.J. Short and R.J. Leigh. 2004. Development of population control strategies for mink Mustela vison, using floating rafts as monitors and trap sites. Biol. Conserv. 120: 533–543.

Rodrigues, D., L. Simões, J. Mullins, S. Lampa, R. Mendes, C. Fernandes, R. Rebelo and M. Santos-Reis. 2015. Tracking the expansion of the American mink (*Neovison vison*) range in NW Portugal. Biol. Invasions 17: 13–22.

Wodroffe, G.L., J.H. Lawton and W.L. Davidson. 1990. The impact of feral mink *Mustela vison* on water voles *Arvicola terrestris* in the North Yorkshire Moors National Park. Biol. Cons. 51: 49–62.