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Winter habitat preferences of feral American mink *Mustela vison* in Biscay, Northern Iberian Peninsula

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We studied correlates of habitat use of riparian feral American mink *Mustela vison* Schreber, 1777 during winter in Biscay (Northern Iberian Peninsula). We live-trapped and radio-tagged 10 American mink (5 males and 5 females) and successfully radiotracked 7 of them (3 males and 4 females). During resting periods both sexes selected areas with dense scrub and near to deep waters. Both sexes used underground dens as well as resting sites located above the ground, but during cold days females rested in buildings much more often than males. Active females used areas of dense scrub, and males used large scrub patches. The results are interpreted in the light of mink hunting techniques and perceived predation risk: on larger scales, mink select areas primarily by food abundance, while on very small scales they use scrub and similar structures providing safe areas to hunt, forage and rest. The strong preference for banks with dense scrub provides options for management of the species.

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Introduction

The American mink *Mustela vison* Schreber, 1777 is a carnivore mustelid whose natural range spreads over part of North America. However, introductions for fur purposes and escapes from fur farms have lead to the establishment of feral populations in many areas (Macdonald and Harrington 2003). These feral populations are claimed to be causing some problems in many areas, such as competition with native carnivores and predation upon certain endangered small mammal species and breeding bird colonies (Ferreras and Macdonald 1999, Previtali *et al*. 1998, Macdonald *et al*. 2002). Accordingly, eradication and management schedules have been developed. Eradication is usually carried out by live-trapping, thus avoiding killing non--target species. Trapping is performed from late summer to early spring, so as to not interfere with the breeding of other riparian species such as the highly endangered European mink *Mustela lutreola* and because trapping success is usually higher during winter (Zabala *et al*. 2001).

Research on the habitat requirements of protected species is a main concern for ecologists. However, the term habitat has been widely used with very different meanings (Garshelis 2000). In this work we refer to habitat as the collection of resources and conditions that an animal needs to occupy an area (Garshelis 2000). Therefore, the definition of habitat is species-specific. Habitat preferences are defined as the intense use of some areas, characteristics and/or structures according to availability. Indeed, animals do not use their home ranges in a homogeneous way. Rather they use some areas intensively while some others are seldom visited (Powell 2000, Yamaguchi *et al*. 2003), which reflects patterns of habitat preferences. Although concepts such as habitat or niche are widely used as species' characteristic, they are actually characteristics of individuals and much of their variation is due to individual specialization (Bolnick *et al*. 2003). Research on small carnivores has tackled the problem of individual variation of habitat features by analysing sexes separately and comparing features that are relevant to each sex. Animals have different requirements at different ages or according to their status (Palomares *et al*. 2000), and the same animal may use different resources according to its activity patterns (eg, resting vs active). The active periods are mainly devoted to foraging, and hence habitat use during the active period of small carnivores is mainly related to food availability (Lodé 1994, Yamaguchi *et al*. 2003). During the resting period, habitat use of small carnivores is usually correlated with safe and sheltered places (Zalewski 1997a, Zabala *et al*. 2003). However, factors such as predation risk (Lima and Dill 1990) and time of year (related to mating/breeding behaviour, Zabala *et al*. 2001), are also likely to influence habitat use.

Little is known about the habitat use of the American mink in many areas where it has been introduced, and most projects hitherto conducted on riparian mink are out of date (Gerell 1970, Birks and Linn 1982) or have been carried out using medium to large spatial scales for the analyses (Yamaguchi *et al*. 2003). Johnson (1980) presented habitat selection as a complex process taking place on different scales, from landscape dynamics to home-range areas. In this work we aimed to gain insight into habitat use and preferences on high-resolution spatial scales of American mink during winter, accounting for differences between sexes and patterns of activity.

Study area

The study was conducted in the Butron river system, Biscay, Northern Spain. This is a small catchment measuring 40 km along its main axis and occupying an area of 174 km^2. Climate is oceanic, with annual rainfall around 1200 mm. Winters are mild, without summer drought; January and July average temperatures are 6°C and 18°C respectively. The study was conducted from November 2004 to March 2005, during the coldest winter in 20 years, with a series of cold weather spells, snowfalls and blizzards separated by periods of mild weather. The study was focused on 20 km of the central part of the river system and its tributaries, where the largest stretch of the stem river is 10 m wide and 1.5 m deep under normal weather conditions, although most stretches are between three and six m wide and between 30 and 50 cm deep. Riverbank vegetation is composed of alder trees *Alnus glutinosa*, willows *Salix alba* and heliophytic vegetation forming dense undergrowth especially where trees are absent. Locally riverbank vegetation has been completely extirpated for grazing. Main land uses are forest plantations in upper and steep areas and grasslands and cattle rearing in the middle flatter ones. The medium and lower parts of the study area were mainly composed of rich lowland areas of water meadows, where cattle rearing has created kilometres of ditches for drainage. The oldest datum of feral American mink in the area dates back to 1993, but the population is suspected to have originated from a local fur farm closed more than 20 years ago (Zuberogoitia and Zabala 2003). Otters *Lutra lutra* are absent from the area and the largest predators are foxes *Vulpes vulpes*, badgers *Meles meles*, dogs *Canis familiaris*, and cats *Felis catus*.

Material and methods

Trapping and radio-tracking

Animals were live-trapped in single-entry cage traps (25 × 25 × 45 cm). Trapping was carried out in streams from November 2004 to January 2005. After immobilisation with 0.8 mg of Zoletil (Virbac, Carros, France) per 100 g of body weight, animals were fitted with radiotransmitters (Biotrack, Dorset, UK). Radio-collars weighed c. 15 g, ie less than 3% of the body weight in all cases. After radio-collaring, mink were returned to the trap and set in concealed areas (bramble patches), where they were observed until they completely recovered and were then released. During handling, mink were kept warm using rags to prevent hypothermia. We captured and fitted 10 individuals with radio collars, and we successfully radio-tracked seven of them. A hand-held 3-element Yagi antenna, and TRX-1000S (Wildlife Materials Inc. Carbondale, USA), Sika Model (Biotrack, Dorset, UK) and RX8910 (Televilt International AB) receivers were deployed on foot. Fixes were obtained by homing-in (White and Garrot 1990) or triangulation at short distances with an accuracy of 1–2 m^2. Accuracy was assessed by locating hidden radio-collars previous to fitting them. When radio-tracking animals, we first determined if they were active or resting by measuring changes in radio-signal intensity, and then we got close to their position by following the radio-signal. Then, we waited in the area and pinpointed the animals by activity signs such as walking or chewing noises, or by sight. On all occasions, mink paid no attention to us and continued with their activities. Variables describing an area of 25 m^2 around locations were measured in the field. Afterwards fixes were plotted on high resolution aerial photographs (0.5 m pixel) and entered into a Geographic Information System (GIS) with an accuracy of 3 m^2. Animals were classified as either active or inactive according to the level of variations in radio-signal strength (Kenward 2001). Tracking periods and data on radio-tracked animals are detailed in Table 1. Mink were radio-tracked twice a week from 16th November 2004 to 7th April 2005. Radio-tracking was carried out at least every second day and every tagged mink was located during that day. At the beginning of the study period we took two fixes per day at different times, but locations tended to be the same or very close, subsequently only one fix per day was considered for analysis in order to avoid bias due to data pseudo-correlation (Aebischer *et al*. 1993). In total, we gathered 267 locations, out of which 188 independent locations met criteria for their use in the analysis. We obtained 108 independent locations for females, and 80 for males (Table 1). Linear home ranges were calculated as metres of waterway used by mink with 100% of the locations (White and Garrot 1990, Dunstone 1993, Yamaguchi *et al*. 2003). With the aid of the GIS we measured the distance between the dens used by each animal by measuring on the aerial photographs the minimum river length separating the dens. We also created with the GIS a set of regularly distributed points in unused areas within home ranges at 300 m intervals along the stream. We described 72 such points for females and 73 for males using the same variables as for radio-tracking locations in order to have data on available but unused sites. Locations and available sites were considered separately for males and females.

After radio-tracking, animals were recaptured as part of an eradication program and four out of five were found to have wounds caused by radio collars. In two cases wounds were severe with fur and skin round the neck worn away, exposing the flesh of the animal. In the other two cases wounds consisted of superficial wearing of parts of the neck skin with small patches of flesh exposed. Yamaguchi and Macdonald (2003) also reported such wounds and suggest monthly recaptures for checking the animals' state and refitting of radio collars, in an attempt to avoid wounds caused by thickening of the neck during the mating period (Yamaguchi and Macdonald 2003).

Variable selection

We selected a set of 11 variables describing habitat features (Table 2). Mink habitat use is known to be correlated with the vegetation, mainly trees and scrub, present along the water edge (Gerell 1970, Dunstone 1993, Yamaguchi *et al*. 2003, Zabala *et al*. 2003). Therefore we considered two vegetation variables describing the degree of tree and scrub cover, which was estimated on a categorical scale from 0 to 5 regardless of the species. Tall rank grass was recorded as scrub. We also measured the size of scrub patches (length × width × height) or estimated them when actual measuring was not possible. In addition we measured the width of the stream at each location point and estimated the mean depth. Finally, we included the land use of the immediate

Table 1. American mink tracking periods, weight (in grams) and home range size (in metres). The number of independent locations is shown. Mink that were not included in the analyses because of scarce data are marked with an asterisk.

Individual	Tracking period	Weight	Home range size	Number of locations	Active	Inactive
MMV1*	16/11/04–13/12/04	1100	2237	5	2	3
MMV2	16/11/04–23/02/05	1300	4085	30	11	19
MMV3*	23/11/04–01/12/04	1250	1017	2	0	2
MMV4	26/11/04–24/01/05	1080	1193	18	4	14
MMV5	13/01/05–07/04/05	1725	15874	25	14	11
FMV1	18/11/04–28/02/05	740	10486	27	6	21
FMV2*	24/11/04–07/12/04	705	332	1	0	1
FMV3	13/01/05–07/04/05	750	2099	29	14	15
FMV4	14/01/05–07/04/05	730	4063	25	14	11
FMV5	15/01/05–07/04/05	750	3051	26	13	13

Table 2. Variables considered during resting and/or activity periods and main analysis in which they were included.

Variable	Activity	Resting	Analysis
Scrub cover	Yes	Yes	LRA
Tree cover	Yes	Yes	LRA
Scrub patch size	Yes	Yes	LRA
Land use	Yes	Yes	χ^2
River width	Yes	Yes	LRA
River depth	Yes	Yes	LRA
Above ground / den	No	Yes	χ^2
Substratum	No	Yes	χ^2
Distance to water	No	Yes	*U*-test
Bank slope	No	Yes	LRA
Scrub species	Yes	Yes	χ^2

area, the distance from the location to the water and the slope of the bank, although these last two variables were only considered in the case of resting animals (Table 2). For the resting site analysis we also included as variables the substratum of the area and the location of the resting site: aboveground or underground (the latter being called dens).

Statistical analyses

To seek key habitat features that could help us separate used from unused locations we performed a Logistic Regression Analysis (LRA), using the Stepwise method and the Wald statistic (Morrison *et al*. 1998). The LRA is a type of multivariate analysis that allows for the inclusion of categorical variables. The Stepwise method is an exploratory tool that allows one to identify the best predictors from the pool of potentially useful parameters. In this approach, variables are entered into the LRA individually and the selection of variables ends when no further increase in the accuracy of the model can be achieved. For the LRA analyses, following the recommendations of Morrison *et al*. (1998), we randomly selected a set of 20 points plus eight more for each variable from the data pool (locations and unused points). In each pool of positives and negatives were equally represented. We performed separate LRAs for males and females as well as for resting and activity locations.

Afterwards, the selection of classes within determinant categorical variables after the LRA was tested using the χ^2-test corrected with Bonferroni's inequality. Electivity was assessed through Jacobs' index (Krebs 1989). For these two tests we computed availability by merging data from unused and used areas. We included every datum of unused areas and one datum of used areas for each 300 m of used patch.

Finally, for the comparison of distance data sets we used the Mann-Whitney *U*-test, and for categorical variables the χ^2-test, with the Yates correction in the case of dichotomy tables (Zar 1999); α value was set at 0.05 in all cases.

Results

Resting sites

Resting sites and dens were located 8 (SD = 15) metres from the water, the mean distance for females being 7 (SD = 15) and 9 (SD = 15) metres for males, the difference being statistically significant (Mann-Whitney *U*-test: z = –2.434, p = 0.015). The overall use of underground dens was low (26.3% of the locations, including dens inside barns and other buildings) (Table 3), and was related to rocky substrates (χ^2_{11} = 44.5, p < 0.001; comparison of the use of dens by males and females in rocky substrates against use of dens in other types of substrate). Females used dens on 29.5% of occasions, compared with 22.6% for males, but this difference was not significant (χ^2_{11} = 2.341, p = 0.126). Females were found resting inside buildings (barns, henhouses, farms, cottages and similar) in 24.6% of the

Table 3. Structures used by mink as resting sites. Resting sites in scrub were on the surface. Others include resting sites between tree roots and rank grass. Different sites indicate the number of different resting sites identified in each type of structure, with the mean number of times used and standard deviation in brackets. Proportion indicates percentage of resting sites found in each type, with percentage of use in brackets.

Resting site type	Males		Females		Overall	
	Different sites	Proportion	Different sites	Proportion	Different sites	Proportion
Scrub thickets	30 (1.6 ± 0.72)	80 (77)	34 (1.2 ± 0.6)	79 (67)	64 (1.3 ± 0.6)	79 (72)
Buildings	1 (1)	3 (2)	5 (3 ± 1.4)	12 (25)	6 (2.7 ± 1.5)	7 (14)
Burrows	4 (1)	10 (8)	1 (1)	2 (2)	5 (1)	6 (4)
Holes in rocky areas	3 (2.3 ± 2.3)	7 (13)	1 (2)	2 (3)	4 (2.2 ± 1.9)	5 (8)
Others	0	0 (0)	2 (1)	5 (3)	2 (1)	3 (2)

cases, while males only rested inside buildings in 1.9% of the cases (χ^2_{11} = 10.075, p = 0.002) (Table 3). There was a correlation between the use of buildings by females and spells of cold weather (blizzards, snow or maximum temperature below or equal to 5°C; χ^2_1 = 17.63; p < 0.001). Mink reused some dens and above ground resting sites, and in some cases returned to them after periods of over a month. On average females used each resting site 1.6 times (SD = 0.9, range 1–4) and males 1.9 times (SD = 1.5, range 1–7), but the difference was not significant (z = –0.484, n_1 = 43, n_2 = 36, p = 0.628) (Table 3). Mean distance between resting sites was 201 m (SD = 622, range 11–2918, n = 39) for females and 271 m (SD = 752, range 9–1948, n = 35) for males, but differences were not significant (z = –0.805, n_1 = 39, n_2 = 33, p = 0.421). Although it is difficult to estimate den availability we measured the percentage of home range covered by dense scrub and the number of buildings included within 25 m of the river. In the case of females 37% (SD = 8.2, range 27–49, n = 4) of home range was covered by dense scrub (categories 4 and 5), and each female included 7 buildings (SD = 8, range 0–19, n = 4) in its home range. Males' home ranges included 42% of dense scrub (SD = 5.2, range 38–48, n = 3) and 5.5 buildings (SD =10, range 1–21, n = 3).

The LRA for female resting sites produced a four-step model, extracting the variables tree cover, river width, river depth and scrub cover (Table 4). The LRA for males produced another four-step model with the variables scrub cover, scrub size, tree cover and river depth. The differences between unused and used sites were statistically significant for every variable but for river depth (Table 5). The selection of categories within categorical variables for males and females is shown in Table 6. Both sexes selected areas with dense scrub and rejected areas with low scrub cover. The main type of scrub used by mink in our study area was dense bramble (*Rubus sp.*) thickets. However, mink also used patches of rank grass, dense shrub underground of hazels *Corylus avellana* or reeds *Phragmites australis*, and other species that form dense vegetation structures at ground level (*Rosa* sp., *Smilax aspera*, *Lonicera* sp.). The use of areas with no scrub by females (Table 6) is a consequence of their use of buildings. Both sexes showed positive selection for areas of low tree cover while rejecting areas of high tree cover.

Active locations

The LRA for female mink produced a two-step model with the variables Scrub Cover and Tree Cover (Table 7). Females used preferentially areas of dense scrub and scarce tree cover, avoiding areas with scarce scrub and/or high density of trees (Table 6). Males, in turn, selected largest scrub patches, as deduced by the single-step model produced by the LRA that highlighted Scrub Patch Size as the only important variable (Table 7).

Table 4. Results of the Logistic Regression Analysis for resting sites of females.

Step	Included variables	Beta	Wald	df	p	r	Correctly classifies (%)
1	Tree cover		28.8	5	0.001	0.360	74.0
2	Tree cover		24.4	5	0.001	0.416	73.3
	River width	–0.223	6.9	1	0.001		
3	Tree cover		21.3	5	0.001	0.531	78.6
	River width	–0.709	16.8	1	0.001		
	River depth	0.039	10.7	1	0.001		
4	Scrub cover		4.6	5	0.033	0.560	83.2
	Tree cover		20.9	5	0.001		
	River width	–0.723	15.6	1	0.001		
	River depth	0.041	10.5	1	0.002		

Table 5. Results of the Logistic Regression Analysis for resting sites of males.

Step	Included variables	Beta	Wald	df	*p*	*r*	Correctly classifies (%)
1	Scrub cover		24.9	5	0.001	0.332	70.7
2	Scrub cover		11.1	5	0.001	0.402	72.4
	Scrub patch size	0.001	3.8	1	0.051		
3	Scrub cover		7.6	5	0.006	0.466	75.6
	Tree cover	–0.485	7.3	1	0.007		
	Scrub patch size	0.000	5.7	1	0.017		
4	Scrub cover		6.7	5	0.010	0.494	76.4
	Tree cover		7.6	5	0.006		
	Scrub patch size	0.001	5.4	1	0.020		
	River depth	0.014	3.7	1	0.056		

Habitat use and land use

Mink locations were unevenly distributed with regard to land use in the area (Table 6). Selection of land use was the same during activity and inactivity for each sex but differed between sexes. Both sexes used areas situated in large scrub patches, normally where agriculture has recently been abandoned, running along steep areas, or where riverbank management policies protecting a 5 m wide band along the shores have been implemented. Females avoided forested areas and used open areas (meadows, orchards and similar) according to their availability. Males avoided open areas but used forested areas according to their availability.

Table 6. Assessment of selection over different categories and correlations between mink locations and land use in the area. Numerical values indicate the Jacobs' index of electivity, values that reached statistical significance trough Bonferroni's inequality are quoted *. Variables Scrub cover and Tree cover were not produced by the Logistic Regression Analysis for active males, so they are marked as not selected.

Variable	Category	Females		Males	
		Resting sites	Active	Resting sites	Active
Scrub cover	5	0.46*	0.81*	0.70*	not selected
	4	–0.27	0.00	–0.04	not selected
	3	–0.04	0.22	0.25	not selected
	2	0.63	0.00	–0.69*	not selected
	1	–0.88*	–0.53*	–0.60*	not selected
	0	–0.19	–0.82*	–0.85*	not selected
Tree cover	5	–0.83*	–0.68*	0.36	not selected
	4	–0.91*	–0.88	–0.45	not selected
	3	–0.34	–0.08	–0.89*	not selected
	2	–0.28	0.49	–0.16	not selected
	1	0.26	–0.07	0.38	not selected
	0	0.74*	0.64*	0.38*	not selected
Land use	Scrub/Abandoned	0.64*	0.71*	0.88*	0.83*
	Meadows/Orchards	0.05	0.08	–0.78*	–0.64*
	Forest	–0.77*	–0.69*	–0.21	–0.36

Table 7. Results of the Logistic Regression Analysis for the activity periods of females and males.

Step	Included variables	Beta	Wald	df	p	R	Correctly classifies (%)
			Female				
1	Scrub cover		25.4	5	0.001	0.400	76.3%
2	Scrub cover		20.6	5	0.001	0.456	81.4%
	Tree cover		9.5	5	0.002		
			Males				
1	Scrub patch size	0.001	6.40	1	0.011	0.279	75.4%

Discussion

Resting sites were restricted to the immediate surroundings of the river. Although mink occasionally rested up to 100 m from water, locations beyond 40 m only accounted for 2% of the total and 90% of locations were restricted to a strip of 10 m from the water level, normally in upper parts of the river bank or close to it. Our results are similar to those reported in other works (Dunstone 1993, Yamaguchi *et al*. 2003).

Resting sites were mainly located above ground and the use of dens seemed to be opportunistic, mink using artificial holes mostly in manmade structures. Both sexes had similar preferences for resting site use. Both avoided resting in open areas, and selected spots with dense scrub cover and deep water. Resting site use by small carnivores has been explained through the influence of three habitat features: shelter against predators, thermal insulation and proximity to preferred feeding patches (Weber 1989, Dunstone 1993, Brainerd *et al*. 1995, Lindstrom *et al*. 1995, Genovesi and Boitani 1997, Zalewski 1997a, 1997b, Zabala *et al*. 2003, Birks *et al*. 2005). Although thermal insulation is not likely to play an important role throughout the year due to the mild temperatures of the study area, it is likely to have encouraged the use of buildings by females. The high surface-to-volume ratio in mustelids is associated with high energetic costs for thermoregulation (Harlow 1994), and this is specially true for smaller females.

Other studies on habitat use by the American and European mink have also reported strong correlations with scrub (Yamaguchi *et al*. 2003, Zabala *et al*. 2003, Zabala and Zuberogoitia 2003). The intense use of bramble probably reflects its huge availability rather than selection of bramble over other bush species, because thickets of species other than bramble were scarce. Studies of habitat use assume that the variables included in analyses are correlated or surrogates to variables or clues that animals use in their decision-making process (Battin 2004). Our results, together with others, suggest that the key for American mink resting site selection might be reflected in the preference for three-dimensionally complex structures near the ground that provide narrow passages as well as overhead cover keeping mink out of sight. In areas where little scrub is available, mink may use reed beds, tree roots or other sheltered areas (Gerell 1970, Dunstone 1993, Stevens *et al*. 1997). In addition, scrub may also offer some slight thermal insulation compared to other resting sites (Powell 1993, Birks *et al*. 2005).

Both sexes also used resting sites in areas with deep water, although this was secondary to scrub cover. Mink use water as a means of escape by diving when attacked by predators (Dunstone 1993). Resting near deep water suggests that mink use areas with several escape routes in case they are detected. The fact that mink reused some sites after long periods of time suggests that they use some resting sites in an opportunistic way while others are well-known and regularly used. The latter could also be a consequence of proximity to preferred feeding areas (Dunstone 1993). Two neighboring males used the same resting site beneath a huge bramble patch, although they were never found together. In addition, when one of the males was poached, the other took over most of its territory and used the same areas and some of the preferred resting sites of the former territory owner. This suggests that for the selection of resting sites and habitat use mink use clues recognizable by different individuals.

Between-sex differences in the use of forested and open areas for resting are difficult to explain. In any case mink almost always used dense scrub patches, but females rarely used patches in forested areas whilst males did not use those in open areas. Possible explanations are different prey or microhabitat preferences (Lodé 2003), and sexual segregation in habitat use derived from intolerance to conspecifics (Lodé 1996).

Both sexes had similar preferences during the active and inactive periods. Again the key variable was scrub, dense patches being preferred by females and large ones by males. In addition females used scrub more often than expected according to availability in open areas and less in forested areas (Tables 6, 7). If we assume that activity is mainly devoted to food finding and catching, the habitat preferences during the activity periods are very similar to resting site preferences, bearing out the statement that resting sites are located near preferred food patches (Weber 1989, Dunstone 1993, Yamaguchi *et al*. 2003). Indeed, a male who remained for several consecutive locations in the same resting site was found to be intensively feeding in a nearby henhouse (100 m) where it killed more than 20 hens before being poached. Studies on habitat use by mink, and small mammals in general, have focused on food availability as estimated by prey abundance (Gerell 1970, Dunstone 1993, Bonesi *et al*. 2000, Lodé 2000, Yamaguchi *et al*. 2003). However, fish move along the rivers thus making their availability variable; small mammals might be abundant in both dense scrub areas as well as open ones (Escala *et al*. 1997); the presence of crayfish and amphibians is independent of scrub (Marnell 1998) and hens, probably the most energetically rewarding prey at the study area, are kept in henhouses or else free ranging in fields adjacent to farms, together with some domestic rabbits and other poultry. Therefore, we can hardly suggest that the main force driving habitat use at the studied scale in our study area is food abundance. In the same way, Gerell (1970) also noted that mink used densely vegetated riverbanks, and not adjoining fields despite the high availability of potential prey. We suggest two not mutually exclusive explanations for the observed preferences in the study area. Firstly, mink do not chase prey but stalk and/or enter burrows (Dunstone 1993). Mink move easily beneath scrub thickets, where they probably find prey and hunt more efficiently. In this way, the use of areas with dense vegetation cover at ground level will be related to prey availability, but not necessarily to prey abundance. On the other hand, carnivores are subject to inter-specific predation by larger carnivores, and intraguild predation can account for more than half the casualties reported (Palomares and Caro 1999). Otters, foxes, dogs, humans and probably cats and large raptors and owls kill mink (Zuberogoitia *et al*. 2001, Bonesi and Macdonald 2004). The importance of behavioural decisions made taking into account predation risk has been widely studied in small mammals, birds and other prey groups (Lima and Dill 1990). Perceived predation risk may affect many, if not all, aspects of animal ecology, and it certainly influences time budgets, patch selection and food selection (Lima and Dill 1990, Buskirk and Powell 1994, Barreto and Macdonald 1999). In addition, there is growing evidence that animals are able to assess and behaviourally influence the probability of being preyed upon (Lima and Dill 1990). Most studies of habitat use and preferences of mink have pointed out the utilization of areas with vegetal cover and strong avoidance of open areas (Gerell 1970, Dunstone 1993, Stevens *et al*. 1997, Previtali *et al*. 1998, Bravo and Bueno 1999, Yamaguchi *et al*. 2003). In some cases, dense shrub entanglements or bramble thickets can prevent access to mink by other predators, while other structures such as reeds or rank grass can be entered by dogs, foxes and similar predators. They keep mink concealed and allow them to escape if harassed. In addition, all the vegetation types reported in the literature keep mink out of sight from avian predators. In general, our results suggest that within areas and patches with an abundance of food used by mink and small carnivores (Bonesi *et al*. 2000, Lodé 2000, Yamaguchi *et al*. 2003), mink use a small range of structures allowing for efficient foraging and ranging. Lack or eradication of such structures could render areas of abundant food useless to mink.

The dependence of American mink on dense bank vegetation provides opportunities for habitat management in eradication and control programs. Scrub control on riverbanks would drastically lessen habitat suitability for the American mink and enhance its vulnerability, while creating a mosaic of small or medium-sized patches at regular intervals would fit the requirements of other species such as the bank vole (Macdonald and Rushton 2003). However, such management decisions must be cautiously considered and tested prior to implementation because they could interfere with other riverbank species with similar requirements such as the endangered European mink (Zabala *et al*. 2003, Zabala and Zuberogoita 2003).

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