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Home ranges of European mink *Mustela lutreola* in southwestern Europe

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We radiotracked 7 European mink *Mustela lutreola* Linnaeus, 1761 (5 males and 2 females), to determine their distribution, size and temporal changes of their home range in an area of southwestern Europe, where American mink *M. vison* was not established. Size of home ranges varied from 11 to 17 km along watercourses in males and were 0.6 and 3.6 km in females. Home ranges of males were larger than those found in previous studies. Most females captured (either radiotracked or not) were found within the home range of males. Males occupied adjoining river sections with minimal range overlap, suggesting an intrasexually exclusive spacing pattern for males. Each month males used new river stretches, mainly along tributaries; meanwhile they showed a steady use of their stem river section. Resting sites were mainly beneath dense brambles of *Rubus* patches located in the river bank.

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Introduction

The endemic European mink *Mustela lutreola* Linnaeus, 1761 is the smallest species of the semi-aquatic carnivore guild in Europe. Its populations have decreased for last centuries. Although no single factor could be identified as responsible for the decline (Maran and Henttonen 1995, Sidorovich *et al*. 1995), recent studies suggest that the introduced American mink *Mustela vison* may be displacing the endemic species from some areas (Maran *et al*. 1998, Sidorovich *et al*. 1999). Currently, the European mink can be found in two major areas: one in the east with the larger populations in Russia and another in the southwestern European countries near the Bay of Biscay. Both populations are separated by more than 2000 km (Youngman 1982).

It has been suggested that the size of home range in male solitary carnivores, during the mating season, is mainly determined by the distribution of females;

whereas, size of home range of females is determined by the availability of food (Erlinge and Sandell 1986, Genovesi *et al*. 1997, Schmidt *et al*. 1997). In addition, males of these species exhibit larger home ranges than females; with male ranges encompassing those of females (Lockie 1966, Dunstone 1993, Kruuk 1995, Ferreras *et al*. 1997, Genovesi *et al*. 1997). Finally, Sandell (1989) suggested that if males are territorial, their home range size does not change through seasons.

Surveys based on footprints and track data found that home ranges of European mink were about 2.4 km in length (Danilov and Tumanov 1976 cit. in Youngman 1982, Sidorovich *et al*. 1995). Only one radiotracking study on home range size of the species is published. Palazón and Ruíz-Olmo (1998) found that home range of *M. lutreola* was slightly larger than 6 km. However, since they could only survey a small number of individuals for more than a week, home ranges were probably underestimated. The size of home range of other semi-aquatic carnivores of Europe is 20–40 km in the Eurasian river otter *Lutra lutra* (Green *et al*. 1984, Kruuk 1995) and 1–6 km in the American mink (Gerell 1970, Birks and Linn 1982).

Little is known of habitat requirements and spatial patterns of European mink. This knowledge would permit determination of the carrying capacity of similar areas for the species, and offer the framework for studies on its habitat use. In our study, we describe the seasonal home range pattern of a population of European mink inhabiting an area of southwestern Europe where American mink are not established. Our aims were to determine the home range size of European mink, to assess the changes of home range through seasons and to establish their spatial arrangement.

Study area

This study was conducted in the Urdaibai Biosphere Reserve (UBR, 43°29'N, 2°40'W), Basque Country, southwestern Europe (Fig. 1). It is a hilly 230-km^2 area that encompasses the catchment of the Oka River. Elevational range is 0–900 m, and climate is typically oceanic. Mean temperatures are 6 and 18°C (January and July, respectively) and average annual rainfall is 1400 mm. Major landscape units are: forest (54%), mainly plantations of exotic species (Monterey pine *Pinus radiata* and eucalyptus *Eucalyptus globulus*) and holm oak *Quercus ilex*, woodlands, meadows and cultivated fields (29%), estuarine mudflats and saltmarshes (5%), and urban areas (5%) (Arrieta *et al*. 1993, Aldai and Ormaetxea 1998). The human population of ca 44 000 is mainly clustered in the towns of Gernika and Bermeo, both having a population of 18 000. The Oka River and tributaries show low pollution levels, except near the main towns where levels of nutrients and heavy metals are high (Rodríguez and Cid 1995).

Material and methods

Animals were live-trapped in single entry cage traps (25 × 25 × 45 cm). Three trapping sessions were conducted in streams: 877 trap-nights from February to March 1999, 621 trap-nights in September 1999, and 111 trap-nights in January 2000. Mink were immobilised with 0.8 mg of Zooletil (Virbac, Carros, France) per 100 g of animal weight, and collared with radiotransmitters (Biotrack, Dorset, UK).

Table 1. Survey data, home range size and number of resting sites of European mink.

Mink	Sex	Survey period	Number of days tracked	Locations	Home range (km)		Resting sites (no./km)	
					Total	Stem river	Day time	Night
M1	M	March–May 1999	19	30	11.1	2.5	1.2	0.3
M2	M	February–April 1999	20	39	11.8	6.5	1.3	0.3
M3	M	February–October 1999	56	87	11.2	3.7	2.4	1.4
M5	M	March–August 1999	32	52	16.8	11.2	1.1	0.5
M6	M	September 1999 – February 2000	48	71	12.7	6.5	2.0	1.0
F1	F	March–May 1999	21	27	3.6	0	1.4	0
F3	F	January–March 2000	19	24	0.6	0.3	10.3	0

In February, we trapped 7 mink (5 adult males and 2 adult females). One of the females, noticeably pregnant, was released without a transmitter. Two adult male mink were caught in September, one of them previously captured and surveyed. In January 2000, we captured two adult females. European mink were the only stream-dwelling mustelid captured. Tagged individuals and tracking periods are summarised in Table 1. Two individuals were not considered for analysis: M4, which was found dead during a blizzard 3 days after capture, and female F4, found dead at release site several days later.

A hand-held 3-element Yagi antenna and TRX-1000S radio-receiver (Wildlife Materials Inc. Carbondale, Illinois, USA) were used to monitor movements. Radiotracking was carried out weekly. Full night surveys were performed, lasting from 3–4 hours before dusk to 1–2 hours after dawn and recording a minimum of one location every hour. Additionally, we gathered several daylight radio-locations in a non-systematic basis. Telemetry fixes were achieved by homing-in and located in a map to the nearest 100 m. Animals were classified as either active or inactive according to the level of variations in strength of radio signals (Kenward 1987). Distance measurements were made after transferring the locations into a Geographic Information System (Arcview 3.2. ESRI, California, USA).

As minks are usually associated with streams (Youngman 1982) two-dimensional home range estimators represent an overestimate of movements (White and Garrott 1990). Hence, home range was calculated as meters of waterway used by mink. This home range estimation procedure has no statistical basis, and thus, over the sampling schedule used, the estimate is unlikely to be affected by time-dependent data. However, to avoid inflation of sample size with locations that contributed little or no additional information (White and Garrott 1990), we performed time-independence analysis for consecutive nightime radio fixes using the Schoener's index, as suggested by Swihart and Slade (1985, 1986). The minimum time interval between independent night fixes was 2 h. Therefore, only consecutive fixes separated by more than 2 h were considered. Among successive inactive fixes only one location was picked up for analysis.

Results

Males occupied adjoining home ranges which covered most of the length of the main rivers in the Urdaibai Biosphere Reserve (Fig. 1). Male home ranges spanned from 11.1 to 16.7 km ($\bar{x}$ = 12.7 km, n = 5). Mink occupied rivers measuring 5–10 m wide to streams less than 1 m in width, and also nearby marshes. Length of stem river, defined as the river of higher order that provides direct access to water-courses of lower order, ranged from 2.5 to 11 km ($\bar{x}$ = 6.0 km, n = 5; Table 1). Inter-individual variation in home range size was not significantly related to the

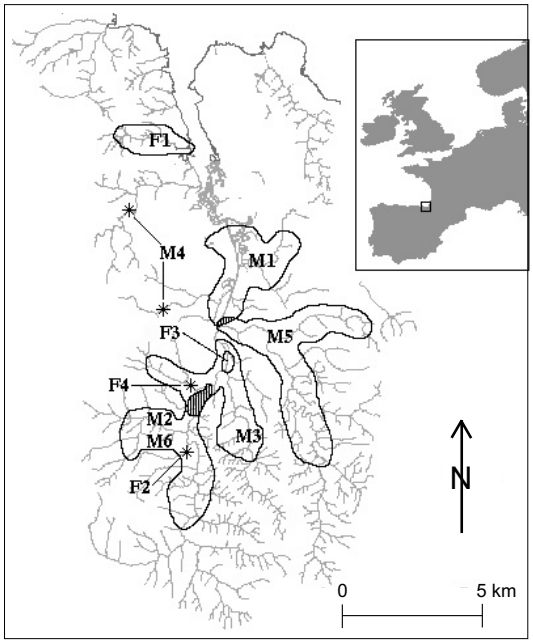

Fig. 1. Spatial distribution of home ranges of European mink in Urdaibai Biosphere Reserve. Streams inhabited by the surveyed minks are encircled and stars show location of non-surveyed minks. Overlapping areas between home ranges of adjoining males are shown by hatching. M2 and M6 occupied the same home range in different periods.

number of locations or to the number of survey days (Spearman Rank test: $r_S = 0.6$, $p = 0.23$ for both).

Mean monthly home range size was 6.0 km (SD = 2.3 km, $n = 24$) and it was significantly different between individuals (Kruskall-Wallis test: $H = 9.5$, df = 4, $p < 0.05$; Fig. 2). No significant correlation was found between the monthly home range size and the number of locations or the number of survey days per month ($r_S < 0.36$, $p > 0.07$ for both).

No encounters were recorded between radiocollared individuals. In 2 out of 20 direct sightings, radiotracked males were accompanied by an untagged mink, although we could not determine its sex or status. Coetaneous males with adjoining home ranges overlapped in 2 cases out of 5, the extent of overlap being 3–10% of their home ranges (Fig. 1).

From September 1999 to January 2000, M6 occupied almost the same length of river as did M2 during February–April 1999. In fact, their overall home ranges overlapped for as much as 84 and 85%, exploiting almost the same main length of stream (Table 1). On the other hand, despite the intensive trapping effort made in September 1999 within the former home range of M2 (near 500 trap-nights), only mink number M6 was captured there (captured 3 times at different sites).

We periodically recorded on the extreme ends of the stem river section. Meanwhile, almost every month males entered river stretches that were not previously used (Fig. 2). From the 3rd month of survey, 93% (range 70–100%, $n = 5$) of the length of these new stretches were along tributaries of the stem river. Overall, the tributaries encompassed 38 ± 24.0% ($n = 27$) of the monthly home ranges and use of some tributaries changed seasonally.

All captured females except F1 were caught within the home range of tracked males (Fig. 1). F1 ranged along 3.6 km of a small stream and nearby marshes, and F2 used only 0.6 km along a stem river.

We found 144 dens, most beneath dense brambles of *Rubus* shrub patches located in river banks ($n = 129$), and reeds (*Phragmites australis* and *Arundo*

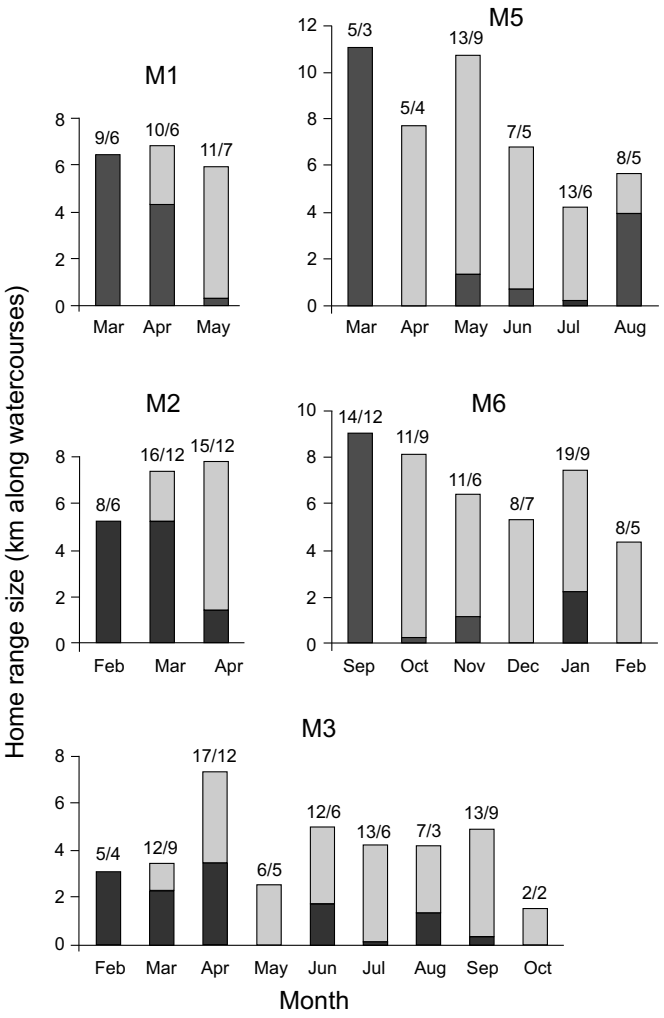

Fig. 2. Monthly size of home range (in kilometers along watercourses) of five male European mink. The dark sections represent the length of the stretches used by first time and the light sections represent the length of the stretches that were reused. Numbers above bars are number of radiolocations and number of days surveyed.

donax) in the marsh (n = 13). In most cases we could not determine if they were in burrows or on simple couches, but the signal strength suggested that animals were always on the soil surface. However, female F1 often used a burrow in a reed patch during the breeding season. Male M6 was twice found during the daytime beside an underground waste collector tube opening into the bank and 5–6 m from it, resided under the pavement of an occupied dwelling. All night resting sites were used once, and daytime den use averaged 1.3 (SD = 1.0, n = 99) for males.

Discussion

The home range size of male and female European mink differed greatly in the Urdaibai Biosphere Reserve: males used home ranges from 11 to 17 km, whereas values for females were between 0.6 and 3.6 km. In their study of home range of European mink in the southwestern area, Palazón and Ruíz-Olmo (1998) measured movements of 6–8 km for males and 4.5 km for females. However, their tracking periods did not last beyond 2 months for any individual and the values for males are well within the range of sizes we calculated for a single month. This suggests that the size of their long-term male home ranges would be similar to ours. The two females surveyed in our study and the one tracked in the work of Palazón and Ruíz-Olmo (1998) does not allow further comparison.

Although home ranges of some males overlapped, the length of overlap was small and in general, males used separate river sections. This result agrees with Sidorovich's (2000) in the eastern range, since he did not observe simultaneous presence of individuals of the same sex in the same place. Sandell (1989) considered less than 10% overlap as a strong indicator of exclusivity of home ranges. Only 2 males were tracked within the same range (M2 and M6). But in that case, they were surveyed at different periods and despite the large trapping effort they were not captured at the same time. Thus, we believe M6 replaced M2 after the latter disappeared. The distribution of sexes at the UBR suggests that the range of females are encompassed by that of males, although our data do not allow to determine the number of females included within the male range. The maintenance of exclusive male home ranges may be the best spatial tactic when numbers of females are high and evenly distributed, so that males can monopolise some females and mate (Sandell 1989). Males at the UBR stayed rather steadily along their stretch of stem river also during the nonbreeding season. Steadiness in exclusive ranges all the year long has been also observed in stone marten *Martes foina* (Genovesi *et al*. 1997).

The 38% of the monthly home range of males corresponded to tributaries and some of them showed a seasonal use pattern. This space use pattern suggests a seasonal exploitation of the smaller streams accessible from a single main river section. Intensive use of areas that changed temporally has also been observed in *Mustela putorius* (Weber 1989a, Lodé 1993). Lodé (1996) argued that this space-use pattern was related to the changing distribution of preferred food resources, both in time and space. On the other hand, the extent and timing of these excursions are rather different to the large and seasonal ones showed by transient, dispersing or juvenile individuals of other carnivore species (Woollard and Harris 1990, Lodé 1993, Kruuk 1995). Our data suggest that male European mink have exclusive home ranges, exploiting the same stretch of main stream throughout the year and periodically entering different streams accessible from there.

In contrast to other semi-aquatic carnivores, the European mink rarely used burrows or tree root cavities in the UBR (Birks and Linn 1982, Melquist and Hornocker 1983, Stevens *et al*. 1997, Palazón and Ruíz-Olmo 1998). Although carnivores commonly used bramble patches as shelter, the almost exclusive use of it by European mink is striking. Mild temperatures occurred at the study area throughout the year. This may promote the use of these patches as insulation due to their relatively low thermoregulation costs (Weber 1989b). In addition, burrowing may be energetically more demanding than simple couches, especially if many burrows have to be created in the home range. The use of brambles by this species at the UBR probably reflects a compromise between safety and extensive exploitation of home ranges.

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References

Aldai P. and Ormaetxea O. 1998. [Urdaibai Biosphere Reserve: historical guidebook to human environment and landscape]. Basque Government, Gasteiz: 1–163. [In Basque]

Arrieta I., González-Pérez E. and Landa J. 1993. [Guidelines for the use and management of the Urdaibai Biosphere Reserve]. Basque Government, Gasteiz: 1–213. [In Basque]

Birks J. D. S. and Linn I. J. 1982. Studies of home range of the feral mink. Symposia of the Zoological Society of London 49: 231–257.

Dunstone N. 1993. The mink. T & AD Poyser, London: 1–232.

Erlinge S. and Sandell M. 1986. Seasonal changes in the social organization of male stoats, *Mustela erminea*: an effect of shifts between two decisive resources. Oikos 47: 57–62.

Ferreras P., Beltrán J. F., Aldama J. J. and M. D. 1997. Spatial organization and land tenure system of the endangered Iberian lynx (*Lynx pardinus*). Journal of Zoology, London 243: 163–189.

Genovesi P., Sinibaldi I. and Boitani L. 1997. Spacing patterns and territoriality of the stone marten. Canadian Journal of Zoology 75: 1966–1971.

Gerell R. 1970. Home ranges and movements of the mink *Mustela vison* Schreber in southern Sweden. Oikos 21: 160–173.

Green J., Green R. and Jefferies D. J. 1984. A radio-tracking survey of otters *Lutra lutra* on a Perthshire river system. Lutra 27: 86–145.

Kenward R. 1987. Wildlife radio tagging. Equipment, field techniques and data analysis. Academic Press, London: 1–222.

Kruuk H. 1995. Wild otters. Predation and populations. Oxford Univesity Press, Oxford: 1–290.

Lockie J. D. 1966. Territory in small carnivores. Symposia of the Zoological Society of London 18: 143–165.

Lodé T. 1993. Stratégies d'utilisation de l'espace chez le putois Européen *Mustela putorius* L. dans l'ouest de la France. Revue d'Ecologie (Terre Vie) 48: 305–322.

Maran T. and Henttonen H. 1995. Why is the European mink (*Mustela lutreola*) disappearing? A review of the process and hypotheses. Annales Zoologici Fennici 34: 47–54.

Maran T., Macdonald D. W., Kruuk H., Sidorovich V. and Rozhnov V. V. 1998. The continuing decline of the European mink *Mustela lutreola*: evidence for the intraguild agression hypothesis. [In: Behaviour and ecology of riparian mammals. N. Dunstone and M. L. Gorman, eds]. Cambridge University Press, Cambridge: 297–320.

Melquist W. E. and Hornocker M. G. 1983. Ecology of river otters in west-central Idaho. Wildlife Monographs 83: 1–60.

Palazón S. and Ruíz-Olmo J. 1998. A preliminary study of behaviour of the European mink (*Mustela lutreola*), by means of radio-tracking. [In: Behaviour and ecology of riparian mammals. N. Dunstone and M. L. Gorman, eds]. Cambridge University Press, Cambridge: 93–105.

Rodríguez P. and Cid A. 1995. Ecotoxicidad de los efluentes industriales en la comarca de Urdaibai y prespectivas en el control de los vertidos. [In: Reserva de la Biosfera de Urdaibai: Investigación básica y aplicada. E. Angulo and I. Quincoces, eds]. Eusko Jaurlaritza, Gasteiz: 245–255.

Sandell M. 1989. The mating tactics and spacing patterns of solitary carnivores. [In: Carnivore behavior, ecology and evolution. J. L. Gittleman, ed]. Cornell University Press, Ithaca, New York: 164–182.

Schmidt K., Jędrzejewski W. and Okarma H. 1997. Spatial organization and social relations in the Eurasian lynx population in Białowieża Primeval Forest, Poland. Acta Theriologica 42: 289–312.

Sidorovich V. 2000. The on-going decline of riparian mustelids (European mink, *Mustela lutreola,* polecat, *Mustela putorius*, and stoat, *Mustela erminea*) in eastern Europe: a review of the results to date and an hypothesis. [In: Mustelids in a modern world. Management and conservation aspects of small carnivore:human interactions. H. I. Griffiths, ed]. Backhuys Publishers, Leiden: 295–319.

Sidorovich V., Kruuk H. and Macdonald D. W. 1999. Body size, and interaction between European and American mink (*Mustela lutreola* and *M. vison*) in Eastern Europe. Journal of Zoology, London 248: 521–527.

Sidorovich V. E., Savchenko V. V. and Bundy V. 1995. Some data about the European mink *Mustela lutreola* distribution in the Lovat River Basin in Russia and Belarus: Current status and retrospective analysis. Small Carnivore Conservation 12: 14–18.

Stevens R. T., Ashwood T. L. and Sleeman J. M. 1997. Fall-early winter home ranges, movements, and den use of male mink, *Mustela vison* in Eastern Tenessee. Canadian Field-Naturalist 111: 312–314.

Swihart R. K. and Slade N. A. 1985. Testing for independence of observations in animal movements. Ecology 66: 1176–1184.

Swihart R. K. and Slade N. A. 1986. The importance of statistical power when testing for independence in animal movements. Ecology 67: 255–258.

Weber D. 1989a. Foraging in polecats (*Mustela putorius* L.) of Switzerland: The case of a specialist anuran predator. Zeitschrift für Säugetierkunde 54: 377–392.

Weber D. 1989b. The ecological significance of resting sites and the seasonal habitat change in polecats (*Mustela putorius*). Journal of Zoology, London 217: 629–638.

White G. C. and Garrott R. A. 1990. Analysis of wildlife radio-tracking data. Academic Press, London: 1–383.

Woollard T. and Harris S. 1990. A behavioural comparison of dispersing and non-dispersing foxes (*Vulpes vulpes*) and a evaluation of some dispersal hypotheses. Journal of Animal Ecology 59: 709–722.

Youngman P. M. 1982. Distribution and systematics of the European mink *Mustela lutreola* Linnaeus, 1761. Acta Zoologica Fennica 166: 1–48.

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