Habitat selection by female otters with small cubs in freshwater habitats in northeast Spain

Jordi Ruiz-Olmo[1], Antoni Batet[1], Juan Jiménez[2] & Diego Martínez[1]

[1] Direcció general del Medi Natural, Dr. Roux 80, 08017, Barcelona, Spain, e-mail: ajruiol@gencat.net
[2] Dirección general para el Desarrollo Sostenible (CMA), Arquitecto Alfaro 39, 46011-Valencia, Spain

Abstract: Otters (*Lutra lutra*) are found in aquatic environments. This study, however, found differences in the use and importance of patches at different moments of the otter life cycle. We studied five natal dens and 38 rearing sectors of small otter cubs in Mediterranean freshwater habitats of southwestern Europe. The results show a strong relationship between the presence of such rearing sectors and the availability of food and the presence of complex dens. Females with small cubs selected the deepest and widest stretches, with more ponds and calm waters, a greater abundance of food and a greater availability of potential and used dens. Some of the rearing sectors were used for generations. Our results highlight the importance of certain stretches for the breeding of the otter. Conservation of these areas should be a basic tool in the management of species such as the otter.

Keywords: otter, *Lutra lutra*, cubs, breeding, habitat, conservation.

Introduction

The otter (*Lutra lutra*) disappeared from much of its European range during the 20th century (Mason & Macdonald 1986, Macdonald & Mason 1994). Habitat destruction was mentioned as a cause of this and, it became recognised that the otter was sensitive to habitat changes and provided an indicator of habitat quality (Jenkins 1980, Mason & Macdonald 1986, Lunnon & Reynolds 1991, Prauser & Röchert 1991). A general point of view emerged that the species needs natural riverbanks, well-developed and structured vegetation, and unpolluted water. However, otters living in marine environments in northern Europe, or in semiarid or Mediterranean environments of Spain or northern Africa, permanently stay in places where vegetation or water is very scarce or non-existent, in reservoirs or man-made irrigation channels, in urban areas, and even close to industrial complexes (Mason & Macdonald 1986, Kruuk 1995, Strachan & Jefferies 1996, Kruuk et al. 1998, Ruiz-Olmo & Delibes 1998, Kranz & Toman 2000). So, otters can be found living in any type of aquatic environment, whether marine or freshwater, natural, man-made or altered, especially when population saturation occurs.

However, several studies have shown that some places are only used by otters to move between stretches of river and other patches are used more intensively (Kruuk 1995, Ruiz-Olmo et al., in press). To a certain degree, otters show habitat preferences, for example with respect to food abundance, potential resting sites or safe conditions (Kruuk et al. 1990, Kruuk 1995, Ruiz-Olmo 1995a, López-Martín et al. 1997, Kruuk et al. 1998, Ruiz-Olmo 2001b, Madsen & Prang 2001, Ruiz-Olmo et al., in press), but some of these preferences do not totally coincide with certain habitat features traditionally thought to influence otter movements and preferences, such as vegetation cover or disturbance (see also Durbin 1998). Furthermore, not all places where indirect otter signs are found are equally important. Fretwell (1972) discusses habitat quality, defined in terms of the fitness that a habitat confers on its occupants, and this can vary according to species, sex, age, and time.

Today, an approach based merely on the *habitat* of the otter (considered as a *distribution* concept), can contribute very little to further know-

ledge of this issue, just as the idea of legally protecting or managing every where that otter tracks or spraints are found hardly appears to be practical. More focused conservation techniques could focus on the specific needs that this carnivore species has at certain times in its biological cycle, especially during breeding, feeding, and resting (Reichman & Smith 1990, Durbin 1996, Oli et al. 1997, Fernández & Palomares 2000). In case of breeding and rearing new-born cubs, such needs can be a limiting factor for a population because this is a time of high energy requirements (Gittleman & Oftedal 1987, Oftedal & Gittleman 1989), especially in a species such as the otter, that has a considerably higher metabolism than would be expected for its body mass (Iversen 1972, McNaab 1989).

As with other solitary mustelids (Powell 1979), the female otter takes sole care for rearing the young (Macdonald & Mason 1986, Kruuk 1995). The selection of a suitable habitat that ensures a minimum mortality of cubs and mothers until dispersal (10-16 months old in the case of the otter; Mason & Macdonald 1986, Watt 1993, Kruuk 1995), is an important factor, as is the case with other carnivores (Laurenson 1994, Laurenson 1995).

This approach should help us in providing a more detailed understanding of the real habitat needs of the species. This study tries to determine whether a selection of habitat occurs in the reproductive period by characterisation of: 1. the places where cubs are born and spend the first few weeks of their life, and 2. the places where they spend the first few months of their life, after emerging from the natal dens.

Methods

Study area

Data were obtained from several river basins situated in northeast Spain: Middle Cinca (between the Grado and Ballobar), Ésera, Isábena, Noguera Ribagorçana, Noguera Pallaresa, Upper Segre (upstream from the town of La Seu d'Urgell), Bergantes, Matarranya, Algars, Muga, Fluvià and small rivers and channels on the Alt Empordà plain. Their characteristics and the human geography are described in Folch et al. (1986), Terrades et al. (1989), and Ruiz-Olmo et al. (2001a, 2001b, 2002). In accordance with previous studies (Delibes 1990, Ruiz-Olmo & Delibes 1998, Ruiz-Olmo 2001), the stretches of river where the presence of otters is known to be stable, albeit for only part of the year, were selected. Thus, only those watercourses and water bodies within 1,279 1x1 km grid-squares (UTM grid) were considered.

In the Ebro Basin below 800 m, the dominant species in the otter's diet is barbel (mainly *Barbus graellsi*, but also *Barbus haasi*), French nase (*Chondrostoma miegii*) and, in more recent times, the American crayfish (*Procambarus clarkii*) (Ruiz-Olmo & Palazón 1997, Ruiz-Olmo 1998). At altitudes above 800 m, the main food of otters consists of brown trout (*Salmo trutta*) and, in springtime, amphibians (*Bufo bufo, Rana perezi* and *Rana temporaria*). At the local level, otters feed on other important prey-items such as the viperine snake (*Natrix maura*) and other Cyprinids. In the Fluvià and Muga river basins, the main species are American crayfish, fish (a minimum of eight species), amphibians, and water snakes (J. Ruiz-Olmo, A. Batet, J. Jiménez & D. Martínez, unpublished data).

Detection of cubs and dens

The field work was mainly focused on litters with small cubs of two to six months old in rearing sectors. This is the period between when the cubs begin to come out of the den (Mason & Macdonald 1986, Kruuk 1995, Durbin 1996) and the age when, on reaching 90% of their total length (TL) it becomes difficult to distinguish them from the mother (Ruiz-Olmo et al. 2002). In this period cubs are easily distinguished, are more vulnerable, have lesser locomotive and swimming abilities, and don't capture prey on their own (Kruuk 1995). Their dependence on their mother is high, and therefore the quality of habitat is very important.

During direct observations TL of the cubs was used (in 10 cm intervals) in relation to that of the mother. For live captured animals or carcasses, TL and weight were obtained to an accuracy of ±0.5 cm and ±10 g, and compared with 90% of minimum TL and weight of reproductive Iberian females (Ruiz-Olmo et al. 2002). Finally, clearly defined footprints or tracks of small cubs encountered were measured (total length of the front and rear paws including the claw), according to the obtained functions (Ruiz-Olmo et al. 2002).

A *natal den* was considered as a den used by a female to give birth to her young and in which the cubs remain during the first one or two weeks of life without going outside, although the female may transfer them from one place to another. A *breeding sector* refers to a stretch of river where a natal den has been detected, whereas a *rearing sector* was a sector were 2-6 months-old cubs were detected. For comparisons, a 500 m length stretch with the middle point placed either in the den or at the point where cubs were detected, was used.

In order to study the generational use of such type of sectors, data were compiled between 1984 to 2001. However, for the statistical comparisons, we used only rearing sectors occupied by small cubs from 1998 to 2001.

We used direct observation during visual censuses and vigils (Ruiz-Olmo 1995b and 1998, Ruiz-Olmo et al. 2001a, Ruiz-Olmo et al. 2002, Ruiz-Olmo et al., in press), the collection of carcasses of dead cubs or alive cubs found (with precise information on the capture site), cubs captured for radio-tracking studies, the footprints of cubs (Erlinge 1967, Erlinge 1968, Macdonald & Mason 1988, Sidorovich 1991, Dülfer & Roche 1998, Ruiz-Olmo et al. 2002), and the natal dens detected.

Natal dens are difficult to find in freshwater ecosystems without radio-tracking because there is often no external evidence of their presence (Moorhouse 1988, Durbin 1996), although Kruuk (1995) has shown in marine environments that smooth earth is found around the entrance opening, and often it has dried mud on the grass outside with telltale footprints. Natal dens found by radio-tracking were recorded, as were dens with mud and grass remains, together with telltale signs of the presence of small cubs (Kruuk 1995). In one case the repair of an electricity power station, caused the water level to drop, leaving the den exposed. Other methods included the intensive monitoring of foot-prints at the entrance of dens where rearing occurs on a regular basis. The detection of dozens of foot-prints of one particular individual entering or exiting a den, followed by dozens of foot-prints of small cubs several weeks later (eight or more), together with dozens or hundreds of spraints, was considered to be a natal den.

Breeding habitat selection

The values of 71 attributes (table 1) were determined in the rearing sectors. Also, a stratified sample of 100 stretches of 500 m long was randomly selected according to the length of the watercourse and riverbanks in each river basin (3 on the Middle Cinca, 10 on the Ésera, 6 on the Isábena, 10 on the Noguera Ribagorçana, 18 on the Noguera Pallaresa, 9 on the Upper Segre, 5 on the Bergantes, 11 on the Matarranya, 6 on the Algars and 20 in the Muga-Fluvià-Empordà plain complex); two were in areas totally and temporally destroyed during human works and were not surveyed. The accessible part of the slope was prospected in both type of stretches.

Fish abundance was determined through published information, where available or obtained by electrofishing during a period of known presence of cubs (Ruiz-Olmo 1995a, López-Martín et al. 1998, Ruiz-Olmo et al. 2001a, Ruiz-Olmo et al. 2002, Saavedra 2002). However, in some cases this option was not available, and we have instead used data from table 2 (as for crayfish and amphibians).

A detailed search of the riverbank was made for places that were potentially suitable for dens, or that showed signs of having been used for breeding or rearing cubs. Safety against predators (various wild species and dogs) and environmental exposure (high temperatures in summer,

Table 1. Attributes studied for each 500 m stretch. (*) Attributes included in a stepwise logistic model. Habitat structure was recorded as six categories: 0 represents 0% cover, 1 represents 1-20%, 2 represents 21-40%, 3 represents 41-60%, 4 represents 61-80% and 5 represents 81-100%. Structure diversity was calculated as follows: for the substrate the sum of values of rocks, stones, gravel, sand and earth, and for vegetation, the sum of values of long grass, short grass, rushes, helophytic vegetation, brambles, and each type of riparian forest. Food was calculated as was described in the section on methods; values were corrected by means of a logarithmic transformation (ln). Bankside slope was recorded as four categories: 1 represents <10%, 2 represents 11-25%, 3 represents 26-50% and 4 represents >50%. Accesibility was recorded as four categories, 1 represents <1 min, 2 represents 1-10 min, 3 represents 11-30 min and 4 represents >30 min.

Category of attribute	Attributes
Cub rearing sectors characteristics	Presence / absence
	Altitude (m) (*)
	Bankside slope
Water in stretch	Surface (m^2)
	Maximum speed (m/s) (*)
	Tributaries (number) (*)
	Small streams (number)
	Length of calm waters (m) (*)
	Maximum depth (m) (*)
	Average width (m) (*)
	Presence of waterfalls (*)
Ponds in the river	Number with depth >1 m and >2 m (*)
	Surface in ponds with depth >1 m and >2 m
	Average width in ponds >1 m depth
Food availability(see text)	Fish
	Crayfish
	Total food (fish + crayfish + amphibians) (*)
Den availability	Rocky dens systems (number)
	Number of holts in rocky systems
	Total rocky and other dens systems (number) (*)
	Total holts (number) (*)
Habitat structure; <2 m and <10 m from water	Big rocky blocks and rocky cliffs (*)
	Stones
	Gravel
	Sand
	Earth
	Long grass (>0.1 m in height) (*)
	Short grass (<0.1 m in height)
	Rushes (e.g. *Juncus*)
	Helophytic vegetation (*)
	Brambles (e.g. *Rubus*, *Coriaria*) (*)
	Small/Immature riparian forest
	Height/Mature riparian forest
	Small/Sparce riparian forest
	Height/Sparce riparian forest

Table 1. [Continued]

Category of attribute	Attributes
Structure diversity; <2 m and <10 m from water	Substrate (*) Vegetation
Human structures and landscape <500 m	Irrigation small ditches (*) Urban (villages, towns) Paved roads Paved + unpaved roads Unirrigated crops (*) Fertile plain Irrigated intensive crops Fruit trees Forest (*) Grassland Bush Esclerophyl small forest Accesibility from paved road Accesibility from unpaved road Distance from village (m) Distance from inhabited house (m)

Table 2. Scale used to estimate the abundance of fish, crayfish and amphibians.

Scale of abundance	Electrofishing (g /m^2)	Fish Visual estimation*	Crayfish Visual estimation	Amphibians Visual estimation
0	0	0 seen	0 seen	0 seen
1	0.01 – 1.0	1 seen	1 seen	1 seen
2	1.0 – 13.0	2 to 20 seen	2 to 20 seen	2 to 20 seen
3	13.0 – 20.0	Frequent	Frequent	Frequent
4	20.0 – 48.0	Abundant	Abundant	Abundant
5	> 48.0	High abundance	High abundance	High abundance

* Based on the significant relationship (P<0.05) found in the study area between the visual estimation of fish observed in a 600 m stretch and the average biomass available (Ruiz-Olmo & López-Martín 2000).

low temperatures in winter, fluctuations in the water level) were considered by means of some of the considered attributes (those related to potential dens and vegetation). The entrance had to be large enough to allow an adult to enter (diameter equal to, or larger than 15-20 cm; Reuther 1991, C. Reuther, personal observations) and had to lead to sufficiently deep chambers. According to results of radio-tracking studies in the study area (Ruiz-Olmo 1995a, Jiménez & Palomo 1998, Jiménez & Ruiz-Olmo, in press), potential places for dens (specially for breeding) were limited to rock formations (loose rock, large rocks, rocky ledges), deep tree roots with holes, thick masses of tangled living vegetation carried downstream by floods, and helophytic vegetation systems. In the case of dense vegetation, a search was carried out, with special emphasis being put on frequently used passages.

Statistical analysis

Two types of analysis have been used to compare the attributes:

1. A *PCA* multivariate analysis (based on the correlations matrix) to reduce the number of variables to be analysed. A stepwise logistic regression, in order to establish an equation (using only the main variables selected), so that predictions can be made of the stretches

with the highest probability of use by otters when rearing their cubs. This type of analysis uses data of the dependent variable (presence-absence of a cub rearing sector) to generate the regression for one or more habitat variables. A logit transformation must also be used for it to fit a logistic curve of the data (Collett 1991, Lovett et al. 1997) to establish which parameters affect the use of ponds in marine habitats, and where other aspects of its use can be consulted.

2. A univariant comparison for main attributes in the model, using the Student *t*-test and Mann-Whitney *U*-tests.

Results

Natal dens

Five natal dens were found, with the birth of young being verified in four of these. Rocks served as dens for the majority (three cases), with one in reeds and the other in thick, bank-side vegetation. Four dens were in stretches with continuously flowing water throughout the year, although in one case there were several years when it dried up completely (but not the year of breeding). Three were less than 500 m from a village, and four were less than 100 m from an asphalt-surface road. Average distance to the nearest inhabited house was 225 m ± 112 m (150 to 450 m) and to the nearest village 620 m ± 466 m (150 to 1,450 m). The biggest difference was the distance to the water's edge, which oscillated between 2 m and 249 m (53.4 m ± 109.9 m), although the entrances in three of the cases were less than 5 m from the water.

Rearing sectors

A total of 38 rearing sectors were detected (2 on the Middle Cinca, 3 on the Isábena, 10 on the Noguera Ribagorçana, 7 on the Noguera Pallaresa, 3 on the Upper Segre, 3 on the Bergantes, 2 on the Matarranya, 5 on the Algars, 2 on the Fluvià, and 1 in a water channel on the Alt Empordà plain). The presence of ponds (over 1 m deep) was detected in 97% of the stretches studied; still water, backwaters, irrigation or similar types of dams were also detected in 97% of cases; an average water width of greater than 5 m was found in 92% of all cases and a maximum water depth of more than 1.4 m in 76% of cases. As for den availability, at least one potential den for small cubs was found in 87% of all rearing sectors, with potential dens amongst rocks existing in 66% of the stretches. The one found at the highest altitude was at 1,050 m.

Model

Stepwise logistic regression was applied to 20 of the attributes (marked in table 1), selected after a *PCA* multivariate analysis for reduction of variables. The analysis showed that the presence of small cub rearing sectors was most strongly related to the availability of food in the environment, followed by den complexity (with more entrances) (table 3). Between these two, it was possible to correctly classify the presence of small cub rearing sectors in 79.2% of the stretches. Other variables that entered the model were water current speed and the presence of small irrigation ditches. Analysis of other attributes did not significantly lead to a decrease in the residual deviation. The resulting equation was as follows:

Logit (probability of the presence of small cubs) = -17.962 + 4.874 (food) + 0.350 (den entrances) - 1.545 (water speed) + 2.012 (small irrigation ditches)

The univariant comparative analysis of stretches with rearing sectors (i.e. with small cubs) and random stretches for the variables in the model, again showed the preference of otter females with small cubs for stretches with lower water speed (P=0.042), longer stretches of calm waters (P=0.0005), fewer waterfalls (P=0.035), a greater abundance of food (P<0.0001), more small overgrown irrigation ditches (P=0.019), greater availability of potential dens for cubs (P=0.0001; in the case of rocky stretches P=0.0027) and with more den entrances (P= 0.004).

Table 3. Logistic models using maximum likelihood estimates fitted to the presence-absence of small otter cubs in the different stretches, following the final model (difference in deviance approximates the *Chi*-square distribution with respective degrees of freedom, d.f.).

Variable added	Model deviance	Difference in deviance	df	% correct classification
+ Food	20.128	20.128	1	76.4
+ Den entrances	28.50	8.378	1	79.20
+ Water speed	36.768	8.262	1	83.72
+ Presence of small irrigation ditches	44.043	7.275	1	86.05
Variable	**Regression coefficient**	**se**	**Probability coefficient = 0**	
Food	4.874	1.086	< 0.0001	
Den entrances	0.350	0.121	0.0038	
Water speed	-1.545	0.537	0.0040	
Presence of small irrigation ditches	2.012	0.746	0.0070	

Other attributes that could be related with these precedents include, small cubs rearing sectors were also found more frequently at sectors with tributaries (P=0.034), with more ponds, with deeper (>1 m: P=0.045; >2 m: P=0.0005) and wider ponds (P=0.05), at the deepest stretches (P=0.006), at stretches with less grass (P=0.002), with more helophytic vegetation (P=0.0007), and with a higher abundance of brambles (P=0.003).

There was no evidence that attributes connected with the substrate of the riverbed, vegetation diversity or human structures correlated with the presence or absence of rearing sectors.

Generational use of the rearing sectors and conservation

Of the 21 rearing sectors monitored for reuse over years (in six cases the rearing sector remained active up to 18 years later), 15 (71%) turned out to be used regularly by females with small cubs which confirms that a large number of dens and rearing sectors are used over different generations. In some dens monitored by our team, it has been verified that otters breed in the same location every year, except after heavy drought, catastrophic flooding or food shortages. The causes for the non-reuse of rearing sectors in one or more years include particularly catastrophic flooding (up to 73% of the sectors were affected in some years), drought (27%), highway construction work (5%), and the changes in the levels of reservoirs (5%). 39% of the rearing sectors studied (n=38) were affected either totally or partially by construction works or similar human activities at some point during the period covered.

Discussion

Natal dens

Data of this type is very scarce in the literature (Harris 1968, Taylor & Kruuk 1990, Moorhouse 1998). The otters studied here gave birth to their young and reared them during the first few weeks in places that were not necessarily away from human activity. In our study area, the otter is respected and is not hunted (Ruiz-Olmo 2001) and this may be a possible contributory factor. It might be adduced that certain otters could be forced to breed near to human beings at times of population saturation, however, some of these natal dens, were first found during years when the otter population was at a lower level and far from saturation.

Otters can use various types of places to give birth and rear their young during the first few weeks of their life (Harris 1968, Moorhouse 1988, Taylor & Kruuk 1990, Durbin 1996). Nev-

ertheless, the most frequently used type of structure in freshwaters in northeast Spain were rock systems, and quite often these were the only type of structure available (Ruiz-Olmo 1995a, Jiménez & Palomo 1998, Ruiz-Olmo 2001). The fact that one of the females followed by radiotracking gave birth 249 m from the river, leads us to believe that appropiate dens are scarce. However, rock systems that the Iberian otter can use do frequently occur near to the water, as we found on three separate occasions. Taylor & Kruuk (1990) found a natal den in reeds less than 2 m from a small watercourse (less than 1 m wide) in northeast Scotland. In the same area, Durbin (1996) found a natal den 150 m from the main river but next to (3.5 m) a small tributary 0.7 m wide. On the Shetland Islands, Kruuk (1995) found natal dens far from the sea (between 100 m and over 1 km), although they were very close to their own supply of fresh water. The Mediterranean rivers that we have studied and where rearing sectors have been found, often carry much less water and are not so wide as in northern Europe, and the abundance and density of these rivers and small tributaries are also much lower than in northern Europe.

The higher abundance of potential wild predator species of the otter in the Iberian Peninsula (wolf (*Canis lupus*), Iberian lynx (*Lynx pardinus*), golden eagle (*Aquila chrysaetos*), Iberian imperial eagle (*Aquila adalberti*), eagle owl (*Bubo bubo*), etc.), could also partially explain why natal dens area far away from watercourses could be less advantageous.

Rearing sectors and dens

Female otters selected stretches to rear small cubs with high food availability, suitable dens with abundant exits, deeper and calm water, and good accessibility for the cubs (small irrigation ditches, backwaters). If the otter is a food-limited species (Kruuk 1995, Kruuk & Carss 1996), then its breeding success and cubs' survival depend on the abundance of food (Kruuk et al. 1987, Kruuk et al. 1991, Elmeros & Madsen 1999, Ruiz-Olmo et al. 2001a, Ruiz-Olmo et al. 2001b) and choice of sectors with plenty of suitable preyshould be expected. The presence of sufficient food near where the cubs are kept, represents an important energy saving strategy as this reduces female movements (as was found by Saavedra 2003, Jiménez 2005), reduces the vulnerability of the cubs and the mother and thereby contributes to maintaining or increasing the breeding success rate.

The presence of safe dens for the cubs was also an important habitat selection factor. Such places can be very abundant in certain areas, although our results show that this is not the case in others, with 55% of the randomly selected stretches lacking any kind of structure that would be appropriate for the presence of such dens. In reference to resting sites (where the otter is less selective and uses many different ones in its home range; Ruiz-Olmo et al. 1995, Jiménez & Palomo 1998), Beja (1996) found a low frequency of use of different dens in southwestern Portugal, and pointed out that this could be a limited resource in some areas. Dens used by otters in marine environments in Northern Europe are limited by the geology of the terrain, with limitations being imposed by certain types of soil (Kruuk et al. 1989, Kruuk 1995, Yoxon 2000).

Finally, the availability of water and the form in which it occurs played an important role in our study area. Ponds and small irrigation ditches were favoured as these offered protected spaces where Small cubs can safely learn to swim during the first weeks after leaving the den (Kruuk 1995) with less danger of being carried away by the current or drowned. Kruuk (1995) found similar results in Scotland and the Shetland Islands, where females used areas with calmer water whereas males frequently used more exposed places with a faster current. Selection of deep and wide ponds is (most likely also) related to the greater availability of the fish that otters prey on and where most of the available fish biomass is concentrated (Ruiz-Olmo 2001, Ruiz-Olmo et al. 2001a, Ruiz-Olmo et al. 2001b). This indicates that the selection of ponds is due to the availability of food rather than to the otter's need for water.

Fresh water habitat in the study area typically favoured by otter females to rear cubs. *Photograph: Jordi Ruiz-Olmo*.

Small irrigation ditches (less than 1 m wide) could also be a reserve of water and food during times of drought, small dams can block the streams, but the water often remains for more weeks or months in such ditches.

The occurrence of good breeding and rearing sectors may be limited, and the repeated use of some dens, by successive generations of otters, appears to support this observation. Similar patterns of repeated use has also been noted in dens in marine environments in Northern Europe (Kruuk 1995).

Conclusions

According to our results, female otters show definite preferences in selecting sites in which to rear their small cubs. Preferred variables related to the availability of food and water, current speed, water depth, and availability of den complexes. Distance from to human activity did not play any role in this selection, neither (with the exception of the presence of helophytic vegetation (positive relation) and grass (negative relation)) did vegetation cover or plant diversity in the vicinity of the water.

Our results show that good breeding and rearing sectors also undergo human pressure (works, forest fires, gravel extraction, roads, reservoirs) and drastic changes due to natural agents (catastrophic flooding, heavy snowfall, etc.). This means that special attention needs to be paid if the otter population is to be conserved and correctly managed. Actions needed involve the mapping of rearing sectors, monitoring and protecting such areas and, if necessary, their regeneration.

References

Beja, P.R. 1996. Temporal and spatial patterns of rest-site use by four female otters *Lutra lutra* along the south-west coast of Portugal. Journal of Zoology (London) 239: 741-753.

Collett, D. 1991. Modelling binary data. Chapman and Hall, London, UK.

Durbin, L.S. 1996. Some changes in the habitat use of a free-ranging female otter *Lutra lutra* during breeding. Journal of Zoology (London) 240: 761-810.

Durbin, L.S. 1998. Habitat selection by five otters *Lutra lutra* in rivers of northern Scotland. Journal of Zoology (London) 245: 85-92.

Elmeros, M. & A.B. Madsen 1999. On the reproduction biology of otters (*Lutra lutra*) from Denmark. Zeitschrift für Säugetierkunde 64: 193-200.

Erlinge, S. 1967. Home range of the otter *Lutra lutra* L. in southern Sweden. Oikos 18: 186-209.

Fernández, N. & N. Palomares 2000. The selection of breeding dens by the endangered Iberian lynx (*Lynx pardinus*): implications for its conservation. Biological Conservation 94: 51-61.

Folch, R. 1986. Vegetació. In: R. Folch (ed.). Història Natural dels Països Catalans: 7. Enciclopedia Catalana, Barcelona, Spain.

Fretwell, S.D. 1972. Populations in a seasonal environment. Princeton University Press, Princeton, USA.

Gittleman, J.L. & O.T. Oftedal 1987. Comparative growth and lactation energetics in carnivores. Symposia of the Zoological Society of London 57: 41-77.

Harris, C.J. 1968. Otters. A study of the recent Lutrinae. Weidenfeld and Nicolson, London.

Iversen, J.A. 1972. Basal energy metabolism of mustelids. Journal of Complex Physiology 81: 341-344.

Jenkins, D. 1980. Ecology of otters in northern Scotland. I. Otter (*Lutra lutra*) breeding and dispersion in mid-Deeside, Aberdeenshire in 1974-79. Journal of Animal Ecology 49: 713-735.

Jiménez, J. 2005. Ecología de la nutria (*Lutra lutra* L.) en ambientes mediterráneos fluctuantes: respuesta a la variación de los recursos. University of Valencia, Valencia, Spain.

Jiménez, J. & J.J. Palomo 1998. Utilización de refugios por la nutria en el río Bergantes (Cuenca del Ebro). Galemys 10: 167-173.

Jiménez, J. & J. Ruiz-Olmo, in press. Assessing linear home ranges and movements in the Eurasiatic otter (*Lutra lutra)*, influence of sex, age and methods: a case study in the Mediterranean rivers. Journal of Wildlife Management.

Kranz, A. & A. Toman 2000. Otters recovering in man-made habitats in Central Europe. In: H.I. Griffiths (ed.). Mustelids in a modern world – Management and conservation aspects in small carnivore: Human interactions: 163-183. Backhuys Publishers, Leiden, The Netherlands.

Kruuk, H. 1995. Wild Otters. Predation and Populations. Oxford University Press, Oxford, UK.

Kruuk, H. & D.N. Carss 1996. Costs and benefits of fishing by a semi-aquatic carnivore, the otter *Lutra lutra*. In: S.P.R. Greenstreet & M.L. Taske (eds.). Aquatic predators and their prey: 67-73. Fishing News Books, Oxford, UK.

Kruuk, H., D.N. Carss, J.W.H. Conroy & M.J. Gaywood 1998. Habitat use and conservation of otters (*Lutra lutra*) in Britain. In: N. Dunstone & M. Gorman (eds.). Behaviour and ecology of riparian mammals: 119-134. Cambridge University Press, Cambridge, UK.

Kruuk, H., J.W.H. Conroy & A. Moorhouse 1987. Seasonal reproduction, mortality and food of otters (*Lutra lutra* L.) in Shetland. Symposia of the Zoological Society of London 58: 263-278.

Kruuk, H., J.W.H. Conroy & A. Moorhouse 1991. Recruitment to a population of otters (*Lutra lutra*) in Shetland, in relation to fish abundance. Journal of Applied Ecology 28: 95-101.

Kruuk, H., A. Moorhouse, J.W.H. Conroy, L. Durbin, & S. Frears 1989. An estimate of numbers and habitat preferences of otters *Lutra lutra* in Shetland, UK. Biological Conservation 49: 241-254.

Kruuk, H., D. Wansink & A. Moorhouse 1990. Feeding patches and diving succes of otters, *Lutra lutra*, in Shetland. Oikos 57: 68-72.

Laurenson, M.K. 1994. High juvenile mortality in cheetahs (*Acinonyx jubatus*) and its consequences for maternal care. Journal of Zoology (London) 234: 387-408.

Laurenson, M.K. 1995. Cub growth and maternal care in cheetahs. Behavioural Ecology 6: 405-409.

López-Martín, J.M., J. Jiménez & J. Ruiz-Olmo 1998. Caracterización y uso del hábitat de la Nutria *Lutra lutra* (Linné, 1758) en un río de carácter mediterráneo. Galemys 10: 175-190.

Lovett, L., H. Kruuk & X. Lambin 1997. Factors influencing use of freshwater ponds by otters, *Lutra lutra*, in a marine environment. Journal of Zoology (London) 243: 825-831.

Lunnon, R.M. & J.D. Reynolds 1991. Distribution of the otter *Lutra lutra* in Ireland, and its value as an indicator of habitat quality. In: D.W. Jeffrey & B. Maddsen (eds.). Bioindicators and Environmental Management: 435-443, Oxford, UK.

Macdonald, S.M. & C.F. Mason 1987. Seasonal marking in an otter population. Acta Theriologica 32: 449-462.

Macdonald, S.M. & C.F. Mason 1994. Status and conservation needs of the otter (*Lutra lutra*) in the

Western Palearctic. Council of Europe, Strasbourg, France.
McNaab, B.K. 1989. Basal rate metabolism, body size, and food habits in the order Carnivora. In: J.L. Gittleman (ed.). Carnivore behaviour, ecology, and evolution: 335- 354. Chapman and Hall, London, UK.
Madsen, A.B. & A. Prang 2001. Habitat factors and the presence or absence of otters *Lutra lutra* in Denmark. Acta Theriologica 46: 171-179.
Mason, C.F. & S.M. Macdonald 1986. Otters. Ecology and conservation. Cambridge University Press, Cambridge, UK.
Moorhouse, A. 1988. Distribution of holts and their utilisation by the European otter (*Lutra lutra* L.) in a marine environment. MSc thesis. University of Aberdeen, Aberdeen, UK.
Oftedal, O.T. & J.L. Gittleman 1989. Patterns of energy output during reproduction in carnivores. In: J.L. Gittleman (ed.). Carnivore behaviour, ecology, and evolution: 355-368. Chapman and Hall, New York, USA.
Oli, M.K., H.A. Jacobson & B.D. Leopold 1997. Denning ecology of black bears in the White River National Refuge, Arkansas. Journal of Wildlife Management 61: 700-706.
Powell, R.A. 1979. Mustelid spacing patterns: variations on a theme by *Mustela*. Zeitschrift für Tierpsychology 50: 53-165.
Prauser, N. & R. Röchert 1991. Habitat destruction and otters – Suggestions towards a more sophisticated approach. In: C. Reuther & R. Röchert (eds.). Proceedings V. International Otter Colloquium Hankensbüttel 1989. Habitat 6: 201-208.
Reichman, O.J. & S.C. Smith 1990. Burrows and burrowing behaviour by mammals. Current Mammalogy 2: 197-244.
Reuther, C. 1991. Otters in captivity – A review with special reference to *Lutra lutra*. In: C. Reuther & R. Röchert (eds.). Proceedings V. International Otter Colloquium Hankensbüttel 1989. Habitat 6: 269-308.
Ruiz-Olmo, J. 1995a. Estudio bionómico sobre la nutria (*Lutra lutra* L., 1758) en aguas continentales de la Península Ibérica. PhD Thesis. University of Barcelona, Barcelona, Spain.
Ruiz-Olmo, J. 1995b. Visual Census of Eurasian Otters (*Lutra lutra*): A new method. In: C. Reuther & D. Rowe-Rowe (eds.). Proceedings, VI. International Otter Colloquium Pietermartizburg 1993. Habitat 11: 125-130.
Ruiz-Olmo, J. 1998. Influence of altitude on the distribution, abundance and ecology of the otter (*Lutra lutra*). In: N. Dunstone & M. Gorman. (eds.). Behaviour and ecology of riparian mammals: 159-176. Cambridge University Press, Cambridge, UK.
Ruiz-Olmo, J. 2001. Pla de Conservació de la Llúdriga a Catalunya: Biologia i conservació. Generalitat de Catalunya, Departament de Medi Ambient. Documents dels Quaderns del Medi Ambient 6: 1-87.
Ruiz-Olmo, J. & M. Delibes 1998. La Nutria en España ante el horizonte del año 2000. Sociedad Española para la Conservación y el Estudio de los Mamíferos, Málaga, Spain.
Ruiz-Olmo, J. & S. Palazón 1997. The diet of the European otter (*Lutra lutra* L.) in Mediterranean freshwaters habitats. Journal of Wildlife Research 2: 171-181.
Ruiz-Olmo, J. & J.M. López-Martín 2000. La nutria en la cuenca del río Matarraña. Quercus 167: 12-41.
Ruiz-Olmo, J., J.M. López-Martín & S. Palazón 2001a. The influence of fish abundance on the otter (*Lutra lutra*) populations in Iberian Mediterranean habitats. Journal of Zoology (London) 254: 325-336.
Ruiz-Olmo, J., J. Jiménez, S. Palazón & J.M. López-Martín 2001b. Ecologie et conservation de la loutre (*Lutra lutra*) et du vison d'Europe (*Mustela lutreola*) aux milieux Mediterranèes. In: G. Chapron & F. Moutou (eds.). L'Etude et la Conservation des Carnivores: 104-112. Société Française pour l'Étude et la Protection des Mammifères, Paris, France.
Ruiz-Olmo, J., J.M. Olmo-Vidal, F. Mañas & A. Batet 2002. Influence of seasonality of resources on the Eurasian otter (*Lutra lutra* L.) breeding patterns in Mediterranean habitats. Canadian Journal of Zoology 80: 2178-2189.
Ruiz-Olmo, J., A. Margalida & A. Batet, in press. Use of small rich patches by Eurasian otter (*Lutra lutra*) females and cubs during the predispersal period. Journal of Zoology (London).
Saavedra, D. 2002. Reintroduction of the Eurasian otter (*Lutra lutra*) in Muga and Fluvià basins (North-East Spain): viability, development, monitoring and trends of the new population. PhD thesis. University of Girona, Girona, Spain.
Sidorovich, V.E. 1991. Structure, reproductive status and dynamics of the otter population in Byelorussia. Acta Theriologica 36: 153-161.
Strachan, R. & D.J. Jefferies 1996. The otter survey of England 1991-1994. The Vincent Wildlife Trust, London, UK.
Taylor, P.S. & H. Kruuk 1990. A record of an otter (*Lutra lutra*) natal den. Journal of Zoology (London) 222: 689-692.

Terrades, J. 1989. In: R. Folch (ed.). Sistemes naturals. Història Natural dels Països Catalans 14. Enciclopèdia Catalana, Barcelona, Spain.
Watt, J.P. 1993. Ontogeny of hunting behaviour of otters (*Lutra lutra* L.) in a marine environment. Symposia of the Zoological Society of London 65: 87-104.
Yoxon, P. 2000. Geology and otters. IUCN Otter Specialist Group Bulletin 17: 86-88.

Samenvatting

Habitatselectie door vrouwelijke otters met jongen in zoetwater-habitats in noordoost-Spanje

Otters kunnen worden gevonden in aquatische omgevingen. Er konden verschillen worden vastgesteld tussen sectoren op verschillende momenten van de levenscyclus zowel in gebruik als belangrijkheid. Wij hebben vijf nestholten bestudeerd en 38 sectoren in Mediterrane zoetwaterhabitats in zuidwest-Europa waarin jonge otters opgroeiden. Stapsgewijze logistische regressie toonde een sterke relatie aan tussen de aanwezigheid van bepaalde sectoren en de aanwezigheid van voedsel en de aanwezigheid van complexe nestholten. De vrouwtjes met jongen selecteerden de diepste en breedste stukken, met meer vijvers en rustig water, een grotere rijkdom aan voedsel en een grotere beschikbaarheid van potentiële en gebruikte holten. Sommige van de sectoren waar de jonge otters opgroeiden, werden generaties lang gebruikt. Onze resultaten onderstrepen het belang van bepaalde sectoren voor de voortplanting van de otter. Het behoud van deze gebieden zou het basale instrument moeten zijn in het beheer van de soort.

Received: 5 July 2004
Accepted: 4 January 2005