

# PRELIMINARY RESULTS OF THE FIRST TRANSPLANTATION OF BROWN BEARS IN THE FRENCH PYRENEES

P.Y. QUENETTE, DIREN-LIFE, RN 117, 31800 Villeneuve de Rivière, France, email: pisyl@compuserve.com

M. ALONSO, Oficina Comarcol DARP, C/ Major 36. 25530 Vielha, Spain

L. CHAYRON, DIREN-LIFE, RN 117, 31800 Villeneuve de Rivière, France

P. CLUZEL, DIREN-LIFE, RN 117, 31800 Villeneuve de Rivière, France

E. DUBARRY, DIREN-LIFE, RN 117, 31800 Villeneuve de Rivière, France

D. DUBREUIL, DIREN-LIFE, RN 117, 31800 Villeneuve de Rivière, France

S. PALAZON, Direccio General del Medi Natural, DARP, Gran Via de les Corts Catalanes, 612-614. Za planta, 08007 Barcelona, Spain, email:ampomcl@correu.gencat.es

M. POMAROL, Direccio General del Medi Natural, DARP, Gran Via de les Corts Catalanes, 612-614. Za planta, 08007 Barcelona, Spain, email:ampomcl@correu.gencat.es

**Abstract:** Within the framework of a European program of brown bear (*Ursus arctos*) restoration, 2 adult female brown bears were captured in May and June of 1996 in Medved Reserve, Slovenia, and translocated to the central Pyrenees, France. The 2 females (Ziva and Mellba) were fitted with radiotransmitters and monitored from release to den entrance. After release from the same site, the bears were highly mobile and were located up to 55 km (Ziva) and 52 km (Mellba) from the release site. Their home ranges encompassed 1,233 km<sup>2</sup> (Ziva) and 796 km<sup>2</sup> (Mellba) during this period. The 2 females used their home range in a multimodal fashion with areas of concentrated utilization. Ziva and Mellba denned on 27 and 23 November 1996 and emerged on 19 and 4 April 1997, respectively. Denning sites were near the release site. These preliminary results suggest that translocation can be an effective technique to restore bear populations or to save small bear populations.

*Ursus* 12:115–120

**Key words:** brown bear, central Pyrenees, home range, radiotelemetry, transplantation, *Ursus arctos*

In 1973, the brown bear was declared a protected species in France and Spain, and the 2 governments signed the Bern Convention for the Conservation of European Wildlife and Natural Habitat in 1979. During this period, 2 unconnected relict populations were identified in the Pyrenees mountains: one in the central Pyrenees and the other in the western Pyrenees (Camarra and Parde 1990, Caussimont and Herrero 1997, Alonso et al. 1993). The first one likely disappeared in the late 1980s, and the western population is presently estimated to contain 5 individuals distributed in France and Spain (Taberlet et al. 1997, J.J. Camarra, Office Nationale de la Chasse, Pau, France, personal communication, 1995).

After preliminary feasibility studies (Parde et al. 1989, Parde 1992, Arquillère 1995), a public information program was begun and a committee of private and public partners created to guide the restoration of brown bear (Spanish and French Ministry of Environment, Association pour le Développement Economique et Touristique and Artus association, Office National de la Chasse, Associations of Hunters, Office National des Forêts). The committee decided in 1993 to release 3 brown bears (2 adult females and 1 adult male) in the French central Pyrenees. If this experimental release succeeded (i.e., adaptation of released bears in a new environment and acceptance by the local population), other bears would be released in the same area. This project was financed by the European Community (L'Instrument Financier de l'Europe project-Restoration of Pyrenean Wildlife) and French and Spanish governments.

The aim of this experiment period was 2-fold. We investigated simultaneously the immediate adaptation of

translocated bears to their new environment and the acceptance of bears by the local human population. To restore brown bears and to determine management measures for this species consistent with human presence, baseline information on spatial behavior, activity patterns, habitat selection, food habits, and denning behavior were needed. In this paper, we present the radiotracking data from 2 translocated adult female brown bears between release and den entrance and data on denning behavior.

## STUDY AREA

The Pyrenees Mountains are situated on an east-west axis between France and Spain and extend for 430 km. The study was conducted in the central Pyrenees Mountains (42° 54' N, 0° 36' E), and the release site was near the France–Spain border. Topography is characterized by alternating big massifs and valleys with more or less steep slopes. Elevations range from 500 to 2900 m. Over 40% of the area is forested. Forests are dominated by beech (*Fagus sylvatica*) between 800 and 1600 m, silver fir (*Abies alba*), and mixedwood of beech and fir. Other dominant deciduous tree species include oak (*Quercus robur*, *Q. pubescens*), chesnut (*Castanea sativa*), hazel (*Corylus avellana*), gean (*Prunus avium*), common ash (*Fraxinus excelsior*) between 800 and 1600 m, and common birch (*Betula pubescens*) at higher elevations. Common conifers species are mountain-pine (*Pinus uncinata*), silver pine (*Picea abies*), and Norway pine (*Pinus sylvestris*) in poorly drained areas. Above 1800 m, rhododendron (*Rhododendron ferrugineum*) and heather (*Calluna vulgaris*) dominate with alpine pastures and rocks at the summits. Several ungulate species (*Sus scrofa*, *Cervus elaphus*,

*Rupicapra pyrenaica*, *Capreolus capreolus*) are present in the reintroduction area.

Mean air temperatures were 3.6° C in January and 20° C in July. Mean annual precipitation was 115 cm, with an average of 15.9 snowy days between November and April (Meteorological Station of Fos, Météo France, Haute-Garonne, unpublished data). Snow usually persists from the middle of December to the end of March. During the study period, there were 13 snowy days between the 14 November and 6 January 1997. Then, the weather was particularly mild with no snow and a mean temperature of 12.6° C between February and April (range = 5.9–17.3° C).

The main human activities in this area are timber harvesting and associated road building and cow and sheep-farming. Between June and October, livestock, mainly sheep, are grazed in summer pastures. Various forms of recreational use occur in this area during summer and fall: hunting and fishing, day hikes, backpack trips, and mushroom picking. During winter, Luchon (France) and Baqueira (Spain) are the major tourism centers for skiing.

## METHODS

An experienced bear biologist from Croatia (D. Huber) trapped the bears for this study. He used Aldrich foot snares set at feeding sites baited with corn and cow carcasses. Trapping sites were located in the hunting reserve Medved in Kocevje, Slovenia (45°24'N, 15°0'E). Each snare was connected to an alarm transmitter and checked each half hour during the night to intervene as soon a bear was trapped. Captured bears were immobilized with a mixture of ketamine hydrochloride and xylazine hydrochloride. Immobilizing drugs were initially shot from a gun with additional drugs injected by hand if a bear moved during handling. Dosages were based on estimated weight of the bear. Standard body measurements were recorded, a blood sample was collected and a vestigial premolar was extracted and used to determine the age of the individual by counting cementum annuli. Female bears were fitted with a MOD225 transmitter (150–152 MHz Telonics, Inc., Mesa, Arizona) and marked on both ears with colored ear tags to aid in field identification. The transmitter was equipped with a motion sensor with a 2-minute reset mechanism for monitoring the bear's activity.

Bears were transported in an aluminium cage fixed in an air-conditioned van and immediately moved to the release site. During transport bears were not immobilized. They were given water in the cage but were not fed.

We used Telonics TR-2 and TR-4 receivers and handheld, 2-element directional antennas to radiolocate the bears. We located them from ground by triangulation and

occasionally from the air when they had moved great distances. We used a minimum of 3 bearings to estimate each location. We entered data into Locate II (Pacer 1990), and we estimated locations using Lenth maximum likelihood estimators (Pacer 1990, Nams and Boutin 1991). The Calhome program was used for home range analysis (Kie et al. 1994). Just after release, we monitored each bear at 1 hour intervals for 48 hours. After that, we tried to obtain daily locations until the den entrance. Between 25 December 1996 and 1 March 1997, each bear was located at least weekly, and thereafter daily. A bear was considered denned when it occurred at the same location twice consecutively and was inactive both times. Emergence date was determined by the first daily location indicating a significant movement outside the den.

We estimated home ranges by the minimum convex polygon method (Mohr 1947) and by the adaptive kernel method (Worton 1989). We used the kernel method because by inspecting scatter plots of data, it was not clear what type of parametric model would be appropriate. Furthermore, this method gives information on the distribution of an animal's position in its home range. The bandwidth (called smoothing parameter in Worton 1989) was set at 80% of the estimated optimum to have a better fit (i.e., a lower least-squares cross-validation; Silverman 1986, Kie et al. 1994). To analyze the dynamics of spatial behavior, we estimated a minimum convex polygon for each successive 2-week period for each bear. The home range since release was then calculated as the union of the polygons of the successive 2-week periods. We analyzed movements using the straight line distances between successive daily locations. We used nonparametric tests (Kruskal-Wallis test, Mann-Whitney test) for this quantitative variable.

## RESULTS

### Monitoring

The 2 bears were captured early in the morning (between 0400–0600 h) in Medved Reserve, Slovenia, and moved to the central Pyrenees, France (Fig. 1). Ziva was a 7-year-old 104-kg female, and Mellba, a 5-year-old 98-kg female. The bears were released at the same site, Ziva at 25 hr 50 min after capture on 19 May 1996, and Mellba 27 hr 37 min on 6 June 1996.

We located Ziva and Mellba 149 and 110 times, respectively from date of release to den entrance, averaging 1 location/1.3 days (Ziva) and 1 location/1.5 days (Mellba). Three of Ziva's locations and 6 of Mellba's were from the air.

After release, Ziva stayed 6 days in the vicinity of the release site using an area of approximately 3.3 km<sup>2</sup> and

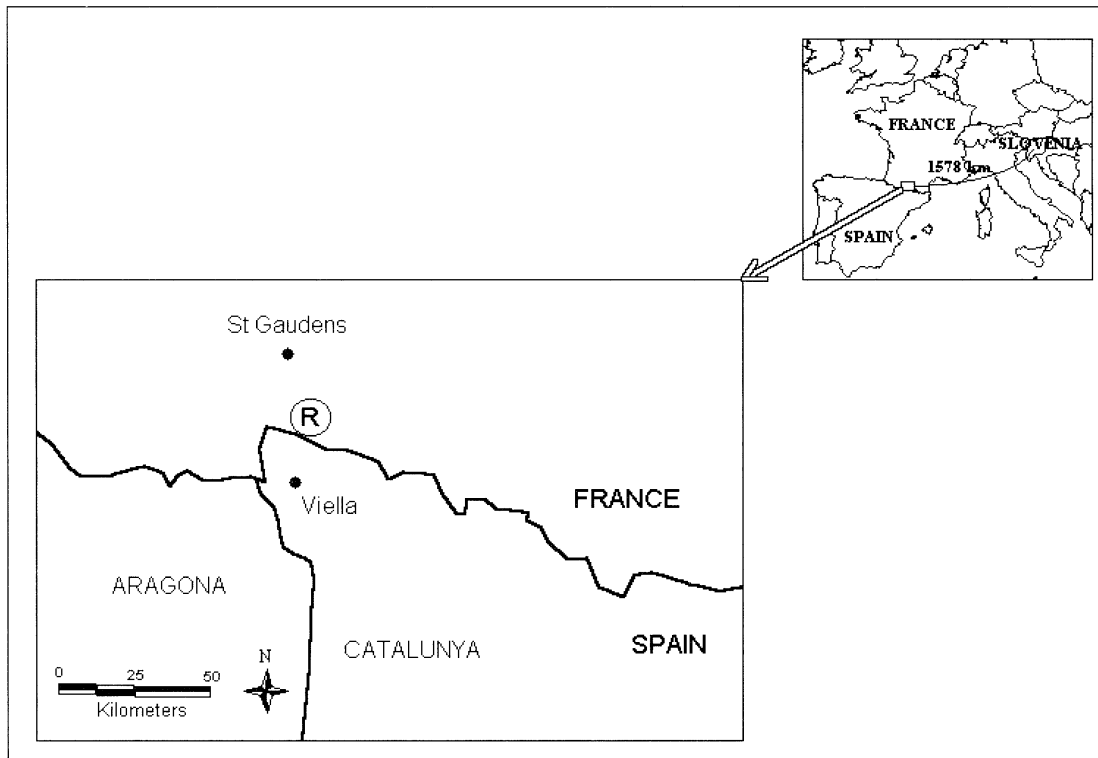


Fig. 1. Capture site in Medved Reserve, Slovenia, and release site in central Pyrenees, France, for 2 female brown bears translocated in 1996.

then began moving greater distances. Mellba left the release site the first day and immediately exhibited great mobility. The 2 females moved one week after release in an east-southeast direction before turning back toward the release site. Ziva moved up to 55 km from the release site, Mellba up to 52 km (Fig. 2). During this period of long-range movements, both bears used the same basins at different times, but they never met. Daily movements were calculated by 2-week intervals and we compared distributions (Table 1). Distance between successive locations was lowest for Ziva during 1–15 July, 16–31 July, and 16–31 August, and highest during 16–31 October (Kruskal-Wallis test:  $H = 22.302$ , 12 df,  $P = 0.034$ ; Table 1). Average daily movements of Mellba were lowest during 17–31 July and highest during 16–30 September, though none of the eleven 2-week means were significantly different (Kruskal-Wallis test:  $H = 15.856$ , 10 df,  $P = 0.104$ ). During the period of monitoring, daily movements of Mellba were greater than those of Ziva (Table 1, Mann-Whitney test,  $z = -3.214$ ,  $P = 0.0013$ ).

The home range of each bear increased rapidly during the first weeks of monitoring and then stabilized (Fig. 3). The area including all locations between release and den entrance was 1,233 km<sup>2</sup> for Ziva and 796 km<sup>2</sup> for Mellba. Four weeks after release, Mellba and Ziva had used 93.0% and 52.8%, respectively, of the total area they used during the study period. From September to the beginning of

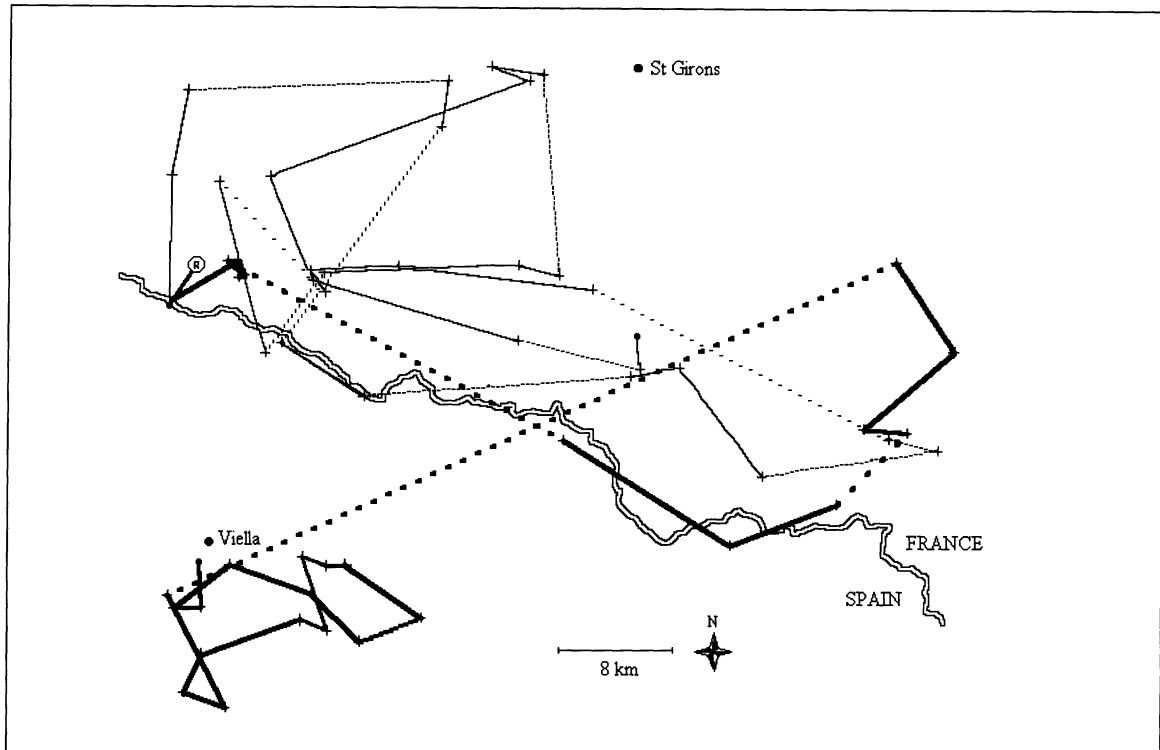
November, Ziva exhibited a second phase of mobility during which she moved over 37.9% of her total home range (Fig. 3). Data analysis with the kernel method indicated a non-convex distribution of Ziva and Mellba positions and the presence of two areas used preferentially by the bears (Fig. 4). The 2 home ranges did not overlap.

### Denning behavior

For Ziva and Mellba, den entrance was estimated as 27 November and 23 November 1996, respectively, and emergence 19 April and 4 April, respectively (denning period: Mellba, 131 days; Ziva, 142 days). The distance between release and den sites was 2.7 km for Ziva and 6.6 km for Mellba (Fig. 4). Mellba denned in a natural cavern located on a steep northeast slope (43°), at an elevation of 950 m. Vegetation around the den site was dominated by beech and a dense undergrowth of box (*Buxus sempervirens*). Ziva's den was an old gallery used for mineral extraction at the beginning of the 20th century, at an elevation of 1,730 m. The slope was 53 degrees. The den was located at the upper limit of a silver fir forest.

### DISCUSSION

Though there were some differences, the general pattern of spatial behavior of the 2 bears was similar: a short period of intense mobility after release followed by spa-



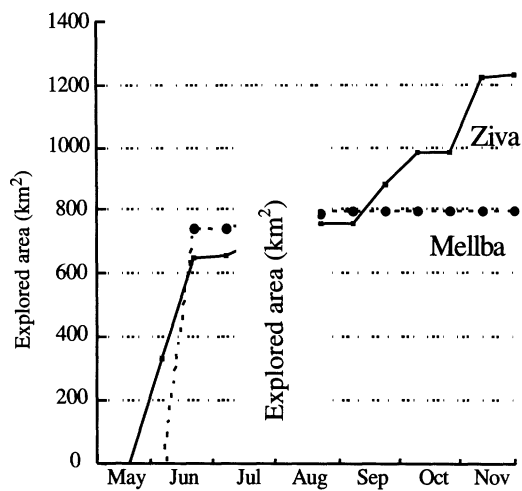
**Fig. 2.** Displacements of Ziva (thick line) and Mellba (thin line) 42 days after release in the central Pyrenees, France, 1996. Successive locations are connected with solid lines, locations with 2 days apart with dense dotted lines, and locations more than 2 days apart with spaced dotted lines. R = Release site.

tial stabilization on a limited area around where they first explored. Indeed, for approximately 4 weeks after release, both bears made long-range movements in all directions, but mainly along the east–west axis. It is interesting to note that 2 weeks after release, Mellba had already explored 93% of the total area she would use before she denned. The bears repeatedly used the same small drainages or valleys; consequently, their ranges increased little

in size (Fig. 3). For Ziva, the second phase of intense exploration (Sep–Oct) led her to her denning site located near the release site. Similar movement patterns have been documented for other introduced bears (Rauer 1997, for European brown bear, Servheen et al. 1995, for grizzly bear), and for other mammal species in a new habitat (*Lepus europaeus*, Pépin and Cargnelutti 1985; *Capreolus capreolus*, Dubray et al. 1990; Gerard et al. 1997; *Lepus*

**Table 1.** Mean distance and range of distance between successive radio locations of 2 translocated female brown bears (Ziva and Mellba) from release until den entry in the central Pyrenees Mountains, France, 1996.

Date (Mellba is different)	Ziva			Mellba		
	Locations	$\bar{x}$ (km)	Range (km)	Locations	$\bar{x}$ (km)	Range (km)
19 May–1 Jun	9	1.63	0.41–13.18			
2–15 Jun (6–18 Jun)	8	4.49	0.00–8.29	8	6.73	3.024–9.021
16–30 Jun 19–2 Jun	13	3.53	0.56–7.11	7	5.95	1.639–13.190
1–15 Jul (3–16 Jul)	13	1.43	0.08–6.67	10	7.22	1.931–18.552
16–31 Jul (17–31 Jul)	13	2.59	0.35–8.66	10	1.95	0.022–8.409
1–15 Aug	13	3.36	0.41–8.63	7	6.21	1.055–14.631
16–31 Aug	14	2.85	0.38–5.78	5	8.25	0.895–18.523
1–15 Sep	10	4.62	0.22–11.0	6	6.97	4.166–13.136
16–30 Sep	9	3.55	0.35–6.53	5	8.33	0.212–15.090
1–15 Oct	4	5.36	1.06–9.46	11	7.19	0.190–15.985
16–31 Oct	9	6.98	0.88–11.60	8	7.81	0.118–16.940
1–15 Nov (1–23 Nov)	12	1.87	0.29–5.11	12	3.81	0.000–17.389
16–27 Nov	6	2.35	0.17–6.98			
19 May–27 Nov (6 Jun–23 Nov)	133	3.47	0.00–13.18	89	6.10	0.00–18.552



**Fig. 3.** Successive areas explored by 2 translocated female brown bears from release until den entry in the central Pyrenees, France, 1996.

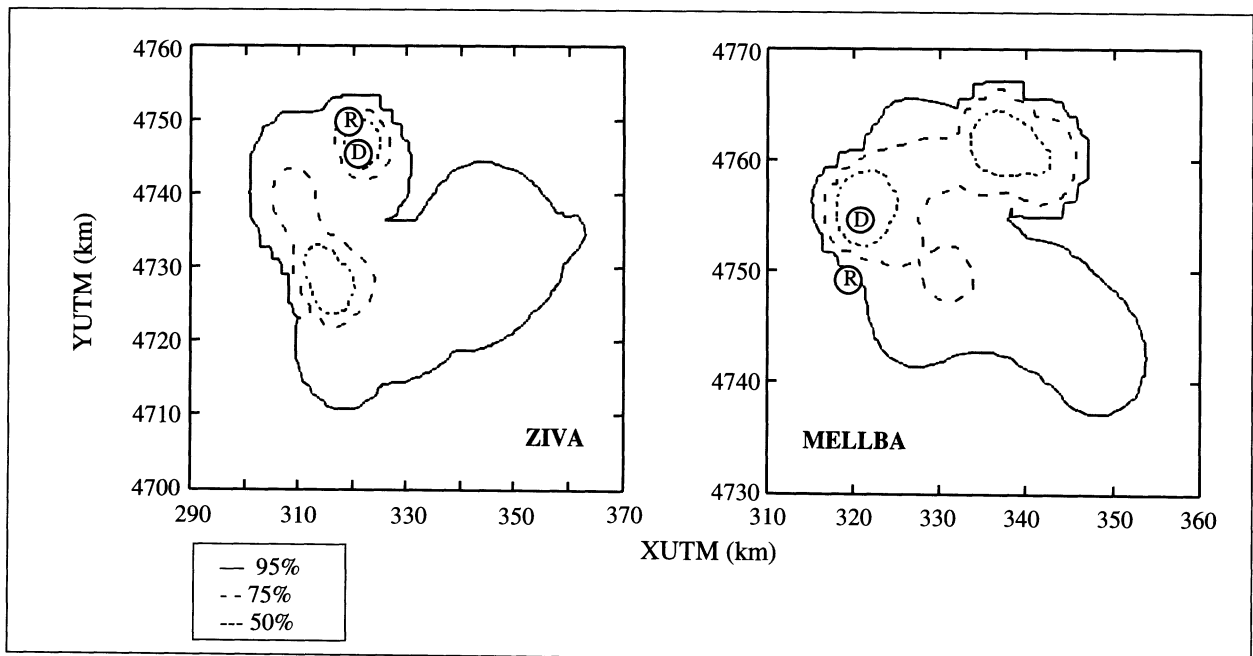
*americanus*, J. Ferron, Université du Québec à Rimouski, Rimouski, Canada, personal communication, 1994). It is likely that such phenomenon (i.e. rapid extension and then stabilization of the home range in a limited area of the total explored area) could be explained by a simple recurrent mechanism: an animal tends to use an area it has already visited. Mathematical modelling of such an algorithm should allow testing of this assumption.

Home ranges and daily movements of these transplanted

brown bears are similar to those reported for other translocated European brown bears (Rauer 1997) or grizzly bears (Servheen et al. 1995), but are much larger than those of resident brown bears in their usual habitat (Roth 1983, Clevenger et al. 1990, Huber and Roth 1995). Our quantitative data on spatial behavior tend to show the importance of initial movements for the settlement of translocated bears. They also allow us to identify areas and the specific sites (i.e. denning site, corridor, core area) where management measures compatible with human activity must be applied in the central Pyrenees (Berduccou and Hetier 1995).

The chronology of denning behavior and denning sites are consistent with the observations made in Slovenia and Croatia (Huber and Roth 1997). To our great surprise, Mellba emerged in April with 3 cubs. As we supposed there were no bears in the central Pyrenees, she must have bred before capture during the May–June breeding season (D. Huber, University of Zagreb, Zagreb, Croatia, personnel communication, 1996). The 3 cubs were observed 8 times in July in the Spanish portion of her home range. The production of cubs indicated that this bear was not too stressed by the transplantation and found sufficient food to complete her pregnancy.

These first preliminary results suggest that the transplanted bears have adapted well to their new environment and that the technique of transplantation described in this paper may be a good tool to restore bear populations or to save small bear populations. Nevertheless, the long-term



**Fig. 4.** Adaptive kernel density estimates of the utilization distribution (point percentage contour) of Ziva (95%, 1,596 km<sup>2</sup>; 70%, 283 km<sup>2</sup>; 50%, 94 km<sup>2</sup>) and Mellba (95%, 707 km<sup>2</sup>; 70%, 252.31 km<sup>2</sup>; 50%, 77 km<sup>2</sup>), from the release site (R) to den site (D) in the central Pyrenees, France, 1996. Axes are in units of universal transverse mercator (UTM).

success of such operations requires acceptance by local residents. We must also solve or minimize conflicts (with hunters and the timber harvest, but especially with farmers over damage to livestock, which occurred during this study) that led in the past to excessive human-caused mortality and to the extirpation of this species from the central Pyrenees.

## ACKNOWLEDGMENTS

This study represents the collective effort of many people. The authors thank D. Huber (Zagreb University) and his team who carried out the bear captures. We thank the members of the Brown Bear Network and the Catalan Keepers of the Val d'Aran and Pallars Subira for their field assistance, and pilots R. Cazaux and P. Vergnes and pilots of Agricultural Department for their availability. We acknowledge also N. Greslier and P. Pauwels (Direction Régionale de l'Environnement Midi-Pyrénées) and M. Pomarol (Generalitat de Catalunya) for their administrative assistance. A special thanks to the citizens of the communes (represented by ADET association) for accepting the reintroduction of the bears. This project was financed by the European Community-LIFE program.

## LITERATURE CITED

- ALONSO, M., A. PANDO, AND L.X. TOLDRA. 1993. El oso pardo en Cataluña. Pages 24–31 in J. Naves and G. Pallomero, editors. El oso pardo en España. Colección Técnica, Icona, Madrid, España. (In Spanish.)
- ARQUILLIÈRE, A. 1995. Expertise sanitaire en Slovénie préalable à la réintroduction de l'ours brun dans les Pyrénées centrales. Direction Régionale de l'Environnement Midi-Pyrénées, Toulouse, France. (In French.)
- BERDUCOU, C., AND N. HETIER. 1995. Pour la restauration de l'ours en France: les nouvelles règles de gestion dans les forêts domaniales. Pages 522–531 in F. Bourlière, V. Barre, J.J. Camerra, V. Herrenschmidt, F. Moutou, C. Servheen, S. Stuart, and M.C. Saint Girons, scientific committee. Proceedings on the management and restoration of small and relictual bear populations, French Museum of Natural History, Grenoble, and Ministry of Environment, Paris, France. (In French.)
- CAMARRA, J.J., AND J.M. PARDE. 1990. The brown bear in France, status and management in 1985. *Aquila Ser Zoologica* 27:93–96.
- CAUSSIMONT, G., AND J. HERRERO. 1997. The brown bear in the Spanish Pyrenees: present status and recommendations for protection. *International Conference on Bear Research and Management* 9(2):2–12.
- CLEVENGER, A.P., F.J. PURROY, AND M.R. PELTON. 1990. Movement and activity patterns of a European brown bear in the Cantabrian Mountains, Spain. *International Conference on Bear Research and Management* 8:205–211.
- DUBRAY, D., J.C. GAUDIN, J.M. BOUTIN, E. BIDEAU, AND J.F. GERARD. 1990. Suivis radiotéléométriques de deux introductions de chevreuils en zone méditerranéenne française: premier bilan après trois mois d'étude. *Bulletin mensuel de l'Office Nationale de la Chasse* 143:23–28. (In French.)
- GERARD, J.F., E. BIDEAU, M. ANGIBAULT, F. MECHKOURT, AND M.L. MAUBLANC. 1997. Settlement dynamics of an introduced roe deer population on a Mediterranean peninsula: importance of spatial attachment and social interactions. *Revue d'Ecologie (Terre Vie)* 52:123–132.
- HUBER, D., AND H.U. ROTH. 1997. Denning of brown bears in Croatia. *International Conference on Bear Research and Management* 9(2):79–83.
- , AND ———. 1995. Movements of European brown bears in Croatia. *Acta Theriologica* 38:151–159.
- KIE, J.G., J.A. BALDWIN, AND C.J. EVANS. 1994. Calhome home range analysis program, Data Preparation Utilities Electronic User's Manual. U.S. Forest Service, Fresno, California, USA.
- MOHR, C.O. 1947. Table of equivalent populations of North American mammals. *American Midland Naturalist* 37:223–249.
- NAMS, V.O., AND S. BOUTIN. 1991. What is wrong with error polygons? *Journal of Wildlife Management* 55:172–176.
- PACER. 1990. Locate II User's Guide. Pacer, Truro, Nova Scotia, Canada.
- PARDE, J.M. 1992. Renforcement de la population d'ours bruns des Pyrénées centrales. Association Artus et Ministère de l'Environnement, Toulouse, France. (In French)
- , S. JOYEUX, AND T. CAZEDEBAT. 1989. Etude de la faisabilité du renforcement des populations d'ours bruns des Pyrénées centrales et orientales. Potentialités biologiques. Association Aremip et Ministère de l'Environnement, Direction de la Nature et des Paysages, Paris, France. (In French.)
- PÉPIN, D., AND B. CARGNELUTTI. 1985. Dispersion et cantonnement de lièvres de repeuplement (*Lepus europaeus*). *Biology of Behavior* 10:353–365. (In French)
- RAUER, G. 1997. First experiences with the release of 2 female brown bears in the Alps of eastern Austria. *International Conference on Bear Research and Management* 9(2):91–95.
- ROTH, H.U. 1983. Home ranges and movement patterns of European brown bears as revealed by radiotracking. *Acta Zoologica Fennica* 174:143–144.
- SERVHEEN, C., W.F. KASWORM, AND J.T. TIMOTHY. 1995. Transplanting grizzly bears *Ursus arctos horribilis* as a management tool—Results from the Cabinet Mountains, Montana, USA. *Biological Conservation* 1:261–268.
- SILVERMAN, B.W. 1986. Density estimation for statistics and data analysis. Chapman and Hall, London, U.K.
- TABERLET, P., J.J. CAMARRA, S. GRIFFIN, E. UHRÈS, O. HANOTTE, L.P. WAITS, C. DUBOIS-PAGANON, T. BURKE, AND J. BOUVET. 1997. Noninvasive genetic tracking of the endangered Pyrenean brown bear population. *Molecular Ecology* 6:869–876.
- WORTON, B.J. 1989. Kernel methods for estimating the utilization distribution in home-range studies. *Ecology* 70:164–168.