Herpetological Conservation and Biology 13(1):1–9.
Submitted: 3 March 2017; Accepted: 26 November 2017; Published 30 April 2018.

Movement Patterns and Home Range Sizes of Translocated European Pond Turtles (*Emys orbicularis*, Linnaeus, 1758) in Eastern Spain

***Robby M. Drechsler*[1,3]*, Lucía M. Fernández*[2]*, Matthieu Lassalle*[2]*, and Juan S. Monrós*[1]**

[1]Cavanilles Institute of Biodiversity and Evolutionary Biology, University of Valencia, c/ Catedrático José Beltrán Martínez 2, 46980 Paterna, Valencia, Spain
[2]Acció Ecologista – Agró, C/ Portal de Valldigna 15, 46003 Valencia, Spain
[3]Corresponding author, e-mail: robbymar@uv.es

***Abstract*.—Populations of European Pond Turtles (*Emys orbicularis*) suffer from various threats, including habitat loss and fragmentation, and the introduction of invasive species. The aim of this study was an evaluation of the status and population viability of *E. orbicularis* in the Tancat de la Pipa Reserve, located in the Albufera de Valencia Natural Park (Spain). We analyzed activity and habitat use data from 14 introduced individuals. For this purpose, we radio tracked *E. orbicularis* between 2010 and 2015. Our results indicate movement similar to those documented in previous studies, with differences demonstrated between individuals released in different habitat types. We did not detect an effect of translocation on movement distances. We calculated home range areas using MCP and Kernel methods, noting differences according to release site habitat type. We did not detect differences between sexes nor a significant correlation between the extent of the home range and the size of an individual. Our data reveal a clear preference for dense vegetation of different plant species like paspalum grasses (*Paspallum* sp.), Spiny Rush (*Juncus acutus*), and Sea Club-rush (*Bolboschoenus maritimus*) in addition to Common Reed (*Phragmites australis*), and Southern Cattail (*Typha domingensis*) and a water depth of about 15–20 cm. This information will be useful for designing future *E. orbicularis* conservation projects.**

Key Words.—biology; ecology; habitat use; *in situ* conservation; radio tracking; turtles

***Resumen*.—Las poblaciones de galápago europeo (*Emys orbicularis*) se enfrentan a varias amenazas, entre las que se encuentran la pérdida y fragmentación de hábitats y la introducción de especies invasoras. El objetivo de este estudio fue la evaluación del estatus y la viabilidad poblacional de *E. orbicularis* en la reserva natural del Tancat de la Pipa, situada en el Parque Natural de la Albufera de Valencia (España). Para ello se analizaron datos de la actividad y el uso de hábitat de individuos introducidos en el área de estudio, obtenidos mediante el radioseguimiento de 14 *E. orbicularis* entre 2010 y 2015. Los resultados indican un movimiento similar al descrito en estudios previos, con diferencias demostradas entre individuos liberados en diferentes tipos de hábitats. No se observó un efecto de la translocación de los individuos sobre las distancias recorridas. Se calcularon los tamaños de los dominios vitales usando los métodos MCP y Kernel, evidenciando diferencias en relación al tipo de hábitat en donde se soltaron. No se detectaron diferencias entre sexos ni una correlación significativa entre el tamaño del dominio vital y el del individuo. Los resultados muestran una clara preferencia por una vegetación densa de diferentes especies vegetales como hierbas del género *Paspallum*, Junco Espinoso (*Juncus acutus*) o Castañuela (*Bolboschoenus maritimus*), También Carrizo (*Phragmites australis*), y Enea (*Typha domingensis*), además de una profundidad de agua de unos 15-20 cm. Esta información será útil a la hora de diseñar futuros proyectos de conservación de *E. orbicularis*.**

Palabras clave.—biología; conservación *in situ*; ecología; radioseguimiento; tortugas; uso de hábitat

Introduction

Biodiversity is a critical attribute of an ecosystem as it plays a fundamental role in maintaining or enhancing ecosystem function (Naeem et al. 1994). Higher biodiversity has been associated with higher stability and productivity of ecosystems (e.g., Johnson et al. 1996; Hooper et al. 2005; Mazur 2013). Human activity has altered biodiversity of ecosystems in many ways, having an important and often negative effect (Hooper et al. 2005). Thus, conservation of biodiversity is essential to maintaining or increasing ecosystem function. Nevertheless, not all animal classes are treated the same way. Reptiles often suffer from reduced conservation efforts due to a bad image in society caused by a multitude of popular beliefs, most of which are false (e.g., Alves

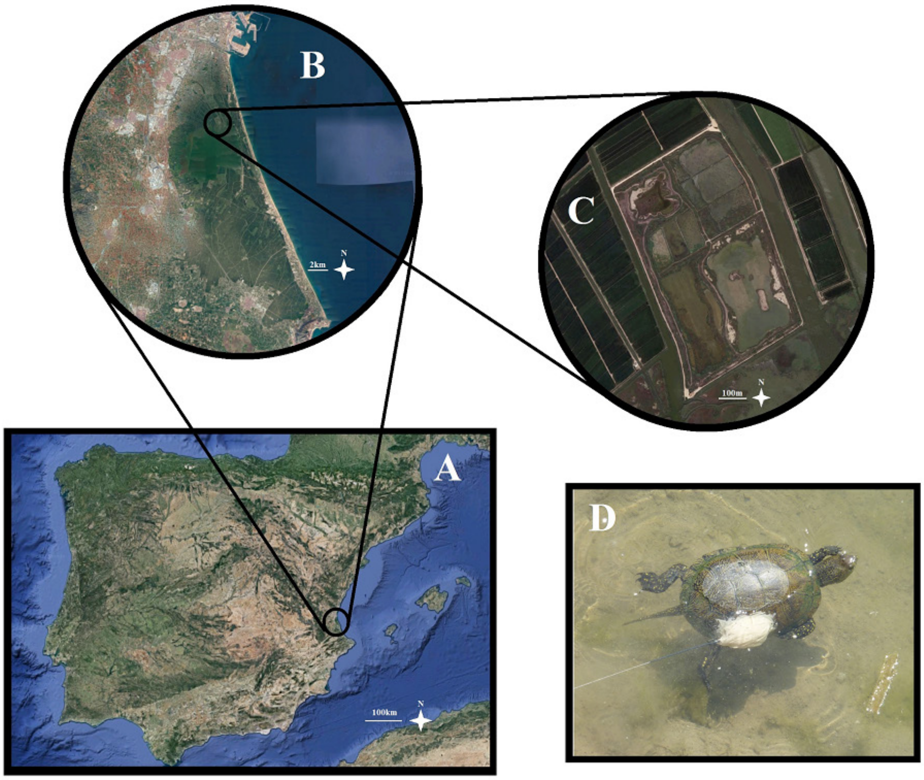

Figure 1. Location of the study area (satellite images from Google Maps): Iberian Peninsula (A), Albufera de Valencia Natural Park (B), and Tancat de la Pipa reserve (C). (D) *Emys orbicularis* at the Tancat de la Pipa Reserve, Spain. (Photographed by Lucía Moreno).

et al. 2012). However, turtles and tortoises are the most accepted reptiles in society and very often are held as pets, given that they are not perceived to be dangerous and are easy to handle in general. This acceptance by the general public leads to a greater conservation effort dedicated to turtles, accruing up to 75% of the financial investments dedicated to reptile conservation (Jiménez and Lacomba 2002).

A high proportion of turtle species require conservation measures due to alteration and exploitation of their habitats. Turtles are a special case among vertebrates that colonize aquatic environments because their semi-aquatic behavior allows us to study and understand the close connection between terrestrial and aquatic environments (Bodie and Semlitsch 2000). The conservation of turtles not only depends on the quality of the aquatic habitat but also on the quality of the terrestrial habitat surrounding it. This makes the conservation of turtles a complicated and expensive undertaking (Turtle Conservation Fund 2002).

Rangewide the European Pond Turtle (*Emys orbicularis*; Fig. 1) is listed as Near Threatened (NT) in the International Union for the Conservation of Nature (IUCN) Red List (IUCN 2017). In Spain, specifically, it is considered Vulnerable (VU) in the Red List of Endangered Species (Keller and Andreu 2002). The same authors indicate that even this category is optimistic, considering the status of most *E. orbicularis* populations in Spain and that it should be elevated to Endangered (EN) (Keller and Andreu 2002). Its populations are mainly threatened by habitat destruction and fragmentation due to an extensive and intensive agriculture, construction of infrastructure, and urbanization (Cordero and Ayres 2004, Vicente Sancho, unpubl. report). The introduction of exotic species also represents a serious problem, especially Red-eared Sliders (*Trachemys scripta elegans*; Pérez-Santigosa et al. 2013). To a lesser extent, poaching for pet trade or consumption also affects Iberian populations negatively. Additionally, populations occupying temporal humid areas suffer from recent severe droughts, especially in areas with unsustainable water extraction for agriculture (Fahd et al. 2009). The Valencian region of Spain is known to be a relatively dry region, with regularly occurring droughts (Estrela et al. 2000; Vicente-Serrano et al. 2004), although dry periods are becoming more common. For example in 2013, the accumulated annual mean precipitation was only 50% of the average value (Agencia Estatal de Meteorología. 2017. Resúmenes Climatológicos. Available from http://www.aemet.es/en/serviciosclimaticos/vigilancia_clima/resumenes?w=0&datos=2 [Accessed 1 June 2017]).

Various international conservation projects have been carried out in Europe where, on a regional scale, numerous researchers are working on the conservation of the species and its habitats and the eradication of invasive species like *T. scripta elegans* (Ayres et al. 2013). *In situ* conservation activities, such as introduction or translocation of individuals can be a valuable tool for projects aimed at reversing negative impacts on wild populations (Griffith et al. 1989). In these cases, it is essential to evaluate the success of each project; however, this leads to high costs. The best way to evaluate success of translocation projects is long-term monitoring of the released individuals (Bertolero et al. 2007). A common method for monitoring and evaluating such projects is the attachment of radio transmitters to animals (e.g., Bremner-Harrison et al. 2004 in mammals; Sanz and Grajal 1998 in birds; or Plummer and Mills 2000 in reptiles). The aim of this study was to evaluate activity patterns and habitat use data of introduced *E. orbicularis*, information useful for designing future conservation projects for this species.

Materials and Methods

The study area is located in the Tancat de la Pipa Reserve, an artificial wetland in the Albufera de Valencia Natural Park (coordinates 39.36374 -0.346283), Spain, which covers an area of about 40 ha. The vegetation is formed mainly by Common Reed (*Phragmites australis*) and Southern Cattail (*Thypha dominguensis*). The study site was surrounded by Bomba Rice (*Oryza sativa*) fields, except at the south, where it was close to the Albufera Lagoon (Fig. 1).

Between 2010 and 2015, we released 14 *E. orbicularis* (six in June 2010; two in July 2010; four in July 2011, and two in April 2015). Although the exact origin of these individuals was unknown, they did come from the region of the Albufera de Valencia Natural Park in Spain, including south of the Turia River. We housed all individuals at the El Saler Wildlife Center *La Granja*. Turtles we used in this study included wild individuals found by people and individuals held as pets. To identify the turtles, we marked each individual with a code of small notches on the marginals of the carapace (Cagle 1939). We then attached 15 g radio-transmitters (made for this study; Dexilon Automation, Valencia, Spain) to the carapace of each individual with epoxy resin. The transmitters emit 30 pulses per minute and we programmed them to work 12 h a day, with an estimated battery life time of about 24 months. We tracked individuals one or two times a week using an ICOM receiver (model IC-R20, Biotrack, Wareham, UK) and a directional Yagi antenna (Biotrack, Wareham, UK). We recorded the UTM coordinates each time we located a turtle, similar to other studies (Cadi et al. 2004; Meeske and Mühlenberg 2004; Mignet et al. 2014).

We collected data from 11 females and three males, with a total of 365 locations (or tracking events). The weight of turtles at their release ranged from 220 to 492 g (two < 300 g; four 300–400 g; seven > 400 g; we did not record the weight of one individual). We analyzed GPS data using QGIS (2016) v2.12.3 software. This allowed us to obtain information about turtle activity patterns, size of home ranges, and habitat use. Due to defects in some transmitters, seven individuals produced fewer than 10 locations. We did not include these individuals in the estimation of home range size after observing a significant correlation between the number of locations and the size of the home range (Spearman Correlation Test, $\rho = 0.858$, $P < 0.001$). We did not find a significant correlation for turtles with > 10 locations (Spearman Correlation Test, $\rho = 0.627$, $P = 0.097$). We also excluded turtles with fewer than 10 locations from the analysis of habitat use. We made all statistical analysis using R v3.2.3 (R Core Team 2016).

To investigate turtle activity, we estimated mean distance traveled per day. We obtained this mean distance by standardizing the distance between two consecutive locations by the days elapsed between them. We grouped the data in periods of 15 d throughout the year, calculating the mean distance traveled in each period. The representation of these values allowed us to obtain the phenologic variation of the activity. Afterwards, we grouped the data in periods of 10 d elapsed after release, until day 370 (approximately one year). This allowed us to see how the activity of a turtle changed after being released.

Because data were not normally distributed (Shapiro-Wilk $W = 0.909$, $P < 0.001$ for phenologic grouped data and $W = 0.750$, $P < 0.001$ for post-release grouped data), we performed a Kruskal-Wallis test to evaluate differences in movement based on sex, weight classes at release (< 300 g, 300–400 g, > 400 g), and individuals released in different habitats. We distinguished five types of macrohabitats in the study area (Fig. 2): Canal were narrow areas where there was a constant water flow and a dense reed vegetation on the sides; Filter were areas characterized by a dense vegetation of different plant species like paspalum grass, Spiny Rush (*Juncus acutus*), and Sea Club-rush (*Scirpus maritimus*). These areas also had Common Reed and Southern Cattail on the shores and some areas inside this habitat and a water depth of about 15–20 cm; Subaquatic Fountain was a habitat that originated from a 250 m deep sounding and the vegetation along the shore was mainly formed by Southern Cattail; Marsh included two shallow lagoons that recreated the outline of the Albufera Lagoon at its healthy state, with areas of abundant subaquatic

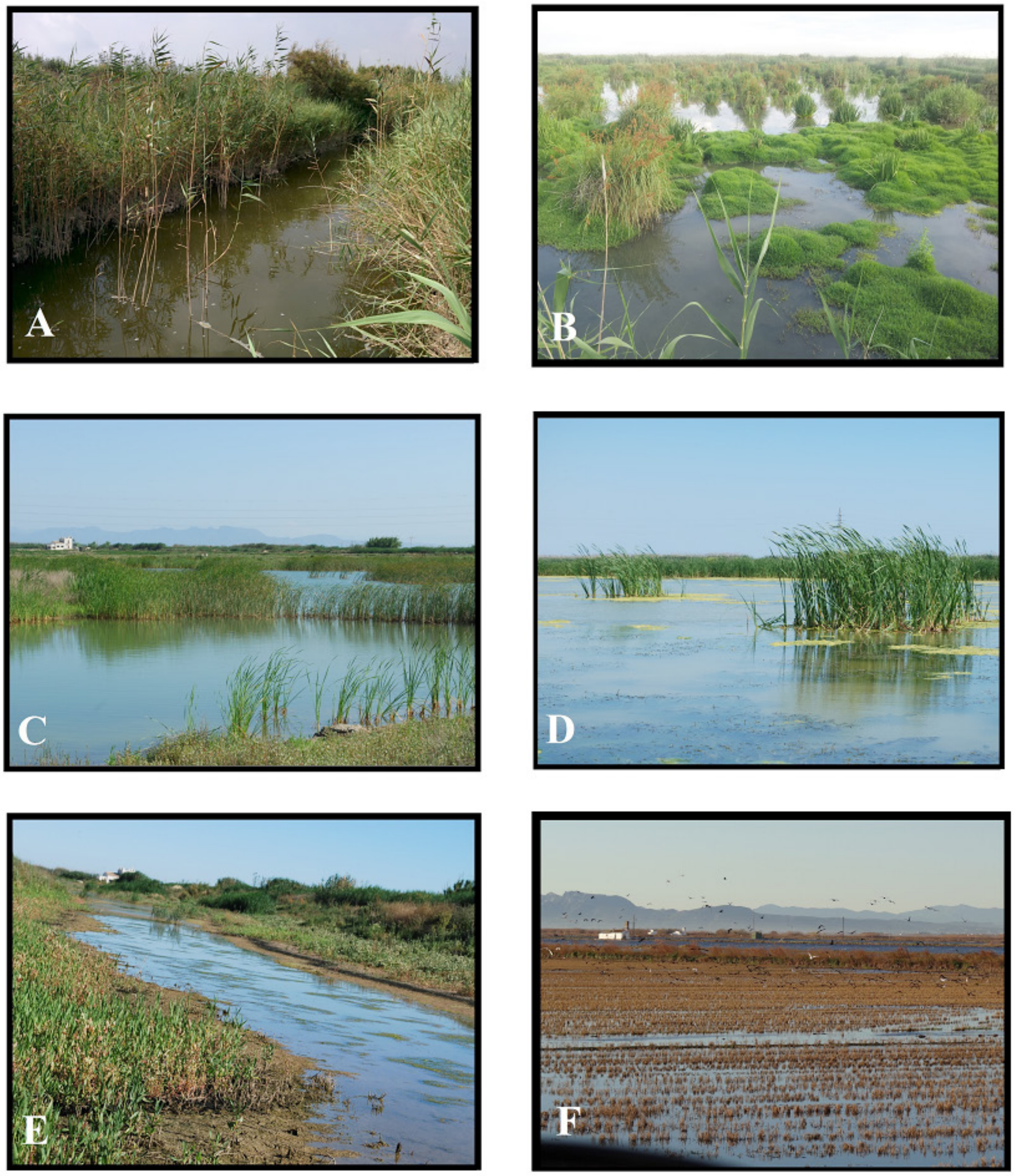

Figure 2. Habitats used by released *Emys orbicularis* at the Tancat de la Pipa Reserve, Spain: (A) Canal (photographed by Matthieu Lassale), (B) Filter, (C) Subaquatic Fountain, (D) Marsh, (E) Swampy Areas (B-E Photographed by Lucía Moreno), and (F) Exterior (Photographed by Matthieu Lassale).

macrophytes and a high plant and animal biodiversity; Swampy Areas where variations of the water level cause temporal inundation; and, Exterior for locations situated outside the limits of the reserve.

For the analysis of home ranges, we calculated the size of the home range of each individual by the Minimum Convex Polygon (MCP; Mohr 1947) method, using 100% of the locations, and by the Kernel method (at 90% for the representative area and at 50% for the core area; Worton 1989). We performed linear regression to determine if there was a relationship between the size of an individual (weight at time of release) and home range size. We also analyzed if there were significant differences in home range size between sexes or individuals released in different habitats. We then associated each location with the type of habitat and calculated the percentage of locations each individual turtle had in each habitat type. After transforming the data to meet parametric assumptions, we used ANOVA to test for differences in macrohabitat use. In addition, we performed a *post hoc* Tukey test to elucidate proportional habitat use. Because percentages do not

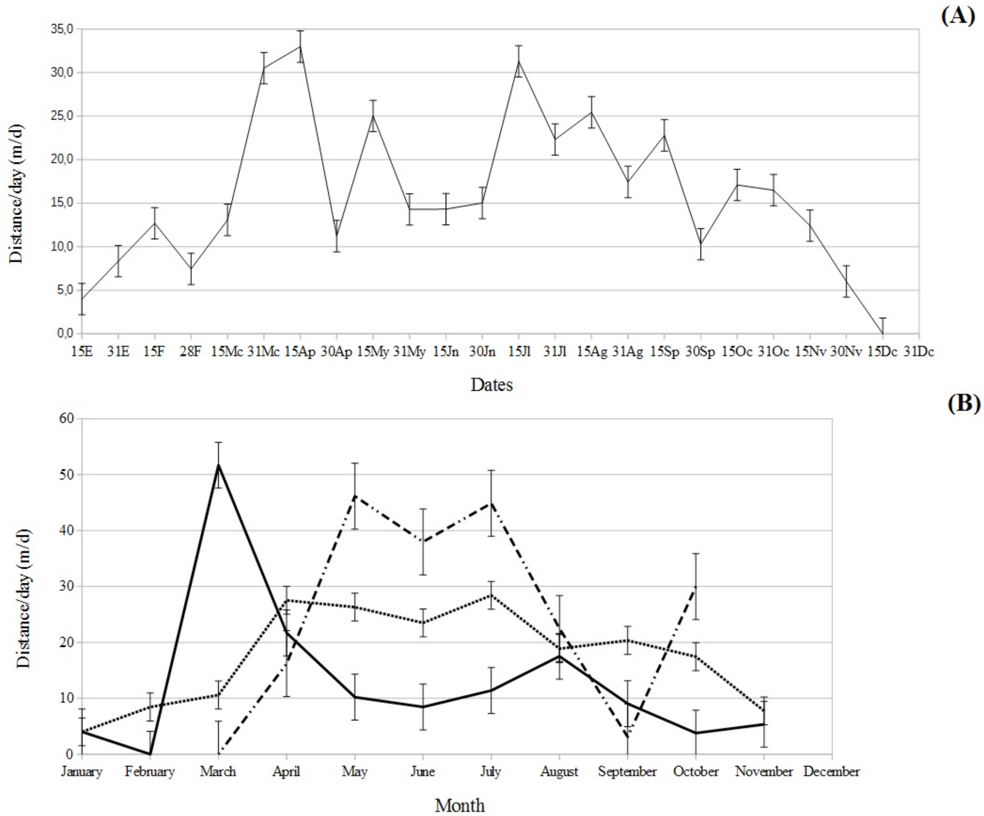

Figure 3. (A) Representation of the mean and standard error of the movements per day every 15 d of *Emys orbicularis* at the Tancat de la Pipa Reserve, Spain. (B) Representation of the mean and standard error of the movements per day every month, separating the individuals by the habitat they were released in: Filter (continuous line), Subaquatic Fountain (regularly dashed line) and Swampy Areas (irregularly dashed line).

have a normal distribution, we transformed percentages using the Arcsine Transformation (Zar 1999), applying the following formula, p' being the transformed value and p the original value (expressed as proportion from 0 to 1)

$$p' = \frac{\arcsin\left(\sqrt{p}\right) * 180}{\pi}$$

Results

Analysis of movements.—In winter (December to the end of February), movement of turtles was relatively low, between 0 and 10 m/d, corresponding with their period of torpor. Movement peaked in spring with turtles moving 31.8 ± 34.0 m/d (range 0.0–132.6 m/d) between March and April. During the first month of summer (June), movement decreased to an average of 14.6 ± 19.29 m/d (range 0.0–83.9 m/d), until a second peak spiked in July, then movement progressively decreased in fall until hibernation (Fig. 2A). We did not observe differences in movement between sexes (H = 0.789, P = 0.374) nor between weight classes (H = 0.480, P = 0.787) but between individuals released in different habitats (H = 7.353, P = 0.025). The analysis of the movement among individuals released in different habitats showed that the peak of movement of three individuals released in Filter habitat was in March, while in summer they were quite inactive, with a small peak in August (Fig. 2B). The four individuals we released in Subaquatic Fountain moved less than in other habitats, but they were active longer, from March to October, with greatest distances moved at the end of spring and the beginning of summer (Fig. 2B).

Considering days elapsed after release, we observed a clear decrease in movement distances at the first 150 d, with values of about 300 m/d dropping to values approximating 5 m/d. Activity maintains this level until day 250 and then returns to the initial values. If we draw a tendency line for the first year after release, it has a slope near to 0 (Fig. 4). If we consider that the majority of individuals were released in summer, the variations in activity adjust very well to known movement patterns for the species. We did not observe differences in

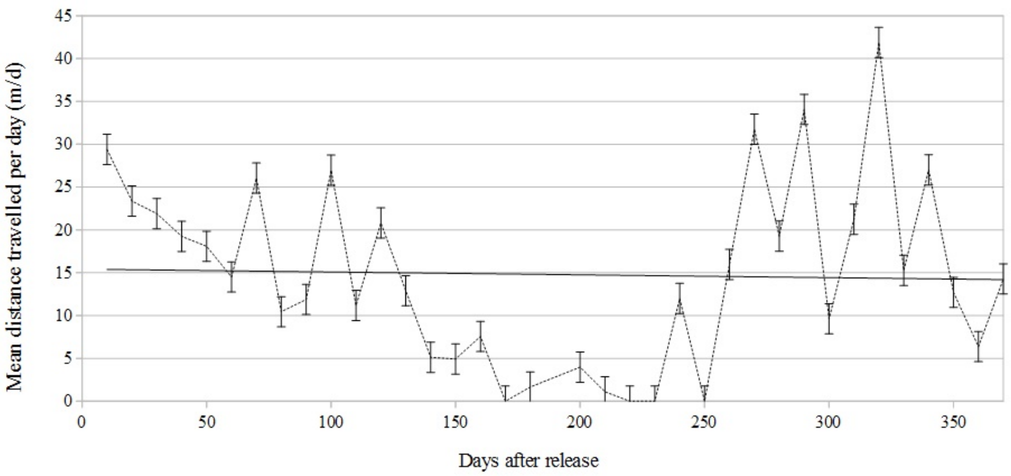

Figure 4. Representation of the mean and standard error of the movements per day every 10 d of *Emys orbicularis* at the Tancat de la Pipa Reserve, Spain, after release.

movements post-release based on sex (H = 3.693, P = 0.055), weight classes (H = 0.776, P = 0.679), but there was a significant difference in movement for individuals released in different habitat types (H = 12.24, P = 0.002).

Home ranges and habitat use.—Home ranges were quite variable. We observed significant differences in the extension of the core areas (Kernel 50) between individuals released in different habitats, with the turtles released in Filter habitat having the smallest values and the ones released in Swampy Areas exhibiting the highest values (Table 1). This pattern was also observed considering the representative area of the home range (Kernel 90) and the home range obtained by the MCP method, although in these cases the differences were not significant (Table 1). We did not detect differences between sexes in either case (Table 2), nor a significant correlation between the extension of the home range and the size of an individual, considering its weight at release ($F_{4,8}$ = 0.175, P = 0.908). The percentages of locations we recorded in each habitat type varied considerably: 7.7 ± 11.9% for Canal; 54.0 ± 36.2% for Filter; 16.3 ± 24.6% for Marsh; 13.7 ± 26.8% for Subaquatic Fountain; 7.4 ± 9.7% for Swampy Areas, and 0.9 ± 2.6% for Exterior. We found significant differences in habitat use based on these percentages ($F_{5,72}$ = 8.821, P < 0.001). The percentages of locations we recorded were significantly higher in Filter habitat than in all other habitats (Tukey HSD, P < 0.001). The percentages of locations did not differ significantly between any other pair-wise comparisons (Tukey HSD, P > 0.05).

Table 1. Means and standard deviations of home range size in hectares, calculated using the 100% MCP method and the kernel method (at 90% and 50%), for individuals grouped by the habitat in which they were released. The results from ANOVA are degrees of freedom and sample sizes (df/n), F statistics and significance levels (P).

	Filter	Subaquatic Fountain	Swampy Areas	df|n	F	P
MCP 100	5.80 ± 5.07	13.36 ± 8.10	24.95 ± 0.00	2|8	2.927	0.144
Kernel 90	6.12 ± 5.05	24.15 ± 15.50	50.12 ± 0.00	2|8	5.021	0.064
Kernel 50	1.53 ± 1.17	6.61 ± 4.26	15.21 ± 0.00	2|8	6.369	< 0.05

Discussion

Movements of turtles in our study were similar to those obtained in previous reintroduction studies (Cadi et al. 2004; Mignet et al. 2014). In a study in France (Cadi and Miquet 2004), peak of turtle movement began in May, two months later than at our site. This may be due to the difference in latitude, given that in lower latitudes favorable temperatures for the initiation of activity are reached earlier. We observed decreased activity in

Table 2. Means and standard deviations of home range size in hectares, calculated using the 100% MCP method and the kernel method (at 90% and 50%), for individuals grouped by sex. The results from ANOVA are degrees of freedom and sample sizes (df/n), F statistics and significance levels (P).

	Males	Females	df|n	F	P
MCP 100	10.46 ± 1.56	12.48 ± 10.3	1|8	0.068	0.802
Kernel 90	15.52 ± 5.07	22.33 ± 21.1	1|8	0.185	0.682
Kernel 50	3.48 ± 0.91	6.55 ± 6.13	1|8	0.450	0.527

June, despite that fact that most of the individuals in our study were females. Typical movement patterns in *E. orbicularis* are that males travel large distances from April to May to search for females for mating and females move the most from May to June for egg laying (Duguy and Baron 1998; Schneeweiss et al. 1998; Cadi and Miquet 2004; Cadi et al. 2004; Mignet et al. 2014). The difference we saw might be because our study area is surrounded by rice fields and the lagoon (at the south), and that these exterior environments are not favorable for egg laying, so females are forced to lay eggs inside the study area. This is supported by the presence of juveniles in the study area after the hatching period (pers. obs.), given that juveniles do not tend to make large movements.

It is also interesting that we found differences in movements among individuals released in different habitat types, although interpretation of this is difficult because the individuals were changing habitats while moving around the study area. However, individuals released in Filter generally presented lower activity levels compared to individuals released in the other habitat types. In addition, the data regarding the habitat use indicate a clear preference for Filter. This may suggest that this type of habitat is the most favorable. We also have to consider that the majority of individuals were released in June and July, where the differences between movement phenologies were most significant. This could indicate that the type of habitat a turtle is released in affects the initial movement pattern, and we indeed detected differences in movement distances post-release among individuals released in different habitat types.

Our post-release activity matches phenology previously described for reintroduced individuals of the species (Mignet et al. 2014). We did not observe a decrease in movement after a year, contrary to what Mignet et al. (2014) observed with their study population. Their individuals also had smaller home ranges than newly released turtles. This reduction in activity could be the conclusion of an initial phase of exploration just after the release and with the establishment of a new territory near the releasing site. We did not detect such a decrease, which could be interpreted as our study area offered a selection of habitats that were adequate so that the individuals rapidly settled down near the release site.

Home range sizes between sexes did not show significant differences. Neither Cadi et al. (2004) nor Mignet et al. (2014) observed significant differences between sexes. Values of home range sizes obtained for each sex (10.46 ha for males and 7.30 ha for females using 100% MCP) were similar to the values obtained in other studies (7.74 ± 3.63 ha for males and 12.51 ± 8.38 ha for females, using 95% MCP in Cadi et al. 2004). We also did not detect a correlation between the size of an individual and the size of its home range, although this correlation has been found in another study of turtles in Spain (Pérez-Santigosa et al. 2013). Correlations of animal size and home range size have also been found in other ectothermic organisms: lizards (Perry and Garland 2002) and tortoises (Drechsler et al. 2016). Our small sample size may have contributed to the lack of correlation, but also a recent study (Slavenko et al. 2016) concluded that in turtles, energy requirements are not a reliable predictor for home range size and that there must be other, much more reliable factors, such as the cost of locomotion in each habitat, considered.

Regarding habitat use, we recorded that Filter was the most used habitat, probably indicating that this type of habitat is the most favorable. This agrees with the comparisons of home range sizes between individuals released in different habitats: individuals released in Filter also had smaller home ranges, meaning that they remained near the release site. In previous studies, habitats similar to this have been described as appropriate for the winter torpor of *E. orbicularis* (Segurado and Araújo 2004; Thienpont et al. 2004).

In conclusion we think that the Tancat de la Pipa Reserve is a favorable area for releasing individuals of *E. orbicularis*. It also represents an important wildlife refuge given the exploitation of the Albufera area for rice cultivation and fishing. We also note that until now, we have not found any *Trachemys scripta elegans*, or other invasive turtles, increasing the population stability. We have also found successful reproduction by *E. orbicularis* inside the study area. The isolated nature of the site means that it would be difficult for invasive species from other areas to find this area, but it also means that immigration by native turtles will be difficult. We suggest creating ecological corridors to enhance the dispersion of turtles, combined with intensive monitoring in such corridors to avoid an influx of invasive species. A more economical approach may be to establish a stable native population inside the reserve, which can be used as a source of individuals for introduction or population reinforcement projects.

Acknowledgments.—We would like to thank all the volunteers from the Projecte Emys project of Acció Ecologista Agró for their help with the fieldwork. The present work has been partly financed by the CGL2016-78260-P project of the Spanish Ministry of Economy and Competitivity; the Social Work of the Mediterranean Savings Bank; the Júcar River Hidrographic Confederation and Dexilon. The corresponding author Robby Drechsler is supportet by a Val I+D predoctoral grant (ACIF/2016/331) of the Ministry of Education, Investigation, Culture and Sport of the Regional Government of Valencia.

Literature Cited

Alves, R.R.N., K.S. Vieira, G.G. Santana, W.L.S. Vieira, W.O. Almeida, W.M.S. Souto, P.F.G.P. Montenegro, and J.C.B. Pezzuti. 2012. A review on human attitudes towards reptiles in Brazil. Environmental Monitoring and Assessment 184:6877–6901.

Ayres, C., A. Alvarez, E. Ayllon, A. Bertolero, X. Buenetxea, A. Cordero-Rivera, A. Curco-Masip, J. Duarte, M.A. Farfan, M. Ferrandez, et al. 2013. Conservation projects for *Emys orbicularis* in Spain. Herpetology Notes 6:157–164.

Bertolero, A., D. Oro, and A. Besnard. 2007. Assessing the efficacy of reintroduction programs by modelling adult survival: the example of Hermann's Tortoise. Animal Conservation 10:360–368.

Bodie, J.R., and R. Semlitsch. 2000. Spatial and temporal use of foodplain habitats by lentic and lotic species of aquatic turtles. Oecologia 122:138–146.

Bremner-Harrison, S., P.A. Prodohl and R.W. Elwood. 2004. Behavioural trait assessment as a release criterion: boldness predicts early death in a reintroduction programme of captive-bred Swift Fox (*Vulpes velox*). Animal Conservation 7:313–320.

Cadi, A., and A. Miquet. 2004. A reintroduction programme for the European Pond Turtle (*Emys orbicularis*) in Lake Bourget (Savoie, France): first results after two years. Biologia (Bratislava) 59/ Suppl. 14:155–159.

Cadi, A., M. Nemoz, S. Thienpont and P. Joly. 2004. Home range, movements, and habitat use of the European Pond Turtle (*Emys orbicularis*) in the Rhône-Alpes region, France. Biologia 59:89–94.

Cadi, A., M. Nemoz, S. Thienpont and P. Joly. 2008. Annual home range and movement in freshwater turtles: management of the endangered European Pond Turtle (*Emys orbicularis*). Revista Española de Herpetología 22:71–86.

Cagle, F. R. 1939. A system of marking turtles for future identification. Copeia 1939:170–173.

Cordero Rivera, A., and C. Ayres Fernandez. 2004. A management plan for the European Pond Turtle (*Emys orbicularis*) populations of the river Louro Basin (NW Spain). Biologia 59/Suppl. 14:161–171.

Drechsler, R., M. Vilalta and J. Monrós. 2016. Analysis of movement patterns and macrohabitat use in Hermann's Tortoises (*Testudo hermanni hermanni*, Gmelin 1789) reintroduced in a coastal area dominated by pinewood in eastern Spain. Amphibia-Reptilia 37:359–371.

Duguy, R. and J.P. Baron. 1998. La cistude d'Europe, *Emys orbicularis*, dans le marais de Brouage (Char.-Mar.): cycle d'activité, thermorégulation, déplacements, reproduction et croissance. Annales de la Société des Sciences Naturelles de la Charente-Maritime 8:781–803.

Estrela, M. J., Peñarrocha, D., and M. Millán. 2000. Multi-annual drought episodes in the Mediterranean (Valencia region) from 1950–1996. A spatio-temporal analysis. International Journal of Climatology 20:1599–1618.

Fahd, S., B. El Marnisi, M. Mediani, and U. Fritz. 2009. Zur Verbreitung und zum Bedrohungsstatus der Europäischen Sumpfschildkröte (*Emys orbicularis*) in Marokko. Elaphe 17:30–33.

Griffith, B., J.M. Scott, J.W. Carpenter and C. Reed. 1989. Translocation as a species conservation tool: status and strategy. Science 245:477–480.

Hooper, D.U., F.S. Chapin III, J.J. Ewel, A. Hector, P. Inchausti, S. Lavorel, J.H. Lawton, D.M. Lodge, M. Loreau, S. Naeem, et al. 2005. Effects of biodiversity on ecosystem functioning: a consensus of current knowledge. Ecological Monographs 75:3–35.

Jiménez, J., and J.I. Lacomba. 2002. La conservación de la herpetofauna valenciana. Revista Española de Herpetología 2002:111–117.

Johnson, K.H., K.A. Vogt, H.J. Clark, O.J. Schmitz, and D. J. Vogt. 1996. Biodiversity and the productivity and stability of ecosystems. Trends in Ecology & Evolution 11:372–377.

Keller, C. and A.C. Andreu. 2002. *Emys orbicularis*. Pp. 137–142 *In* Atlas y Libro Rojo de Anfibios y Reptiles de España. 2ª Impresión. Pleguezuelos, J.M., R. Márquez, and M.R. Lizana (Eds.). Dirección General de Conservación de la Naturaleza-Asociación Herpetológica Española, Madrid, Spain.

Mazur, L. 2013. Cultivar la resiliencia en un mundo en peligro. En Worldwatch Institute, The State of the World 2013: Is Sustainability Still Possible? W.W. Norton, New York, New York, USA. (Spanish version with the title ¿Es aún posible lograr la Sostenibilidad? edited in Barcelona by Icaria).

Meeske, A.C.M., and M. Mühlenberg. 2004. Space use strategies by a northern population of the European Pond Turtle, *Emys orbicularis*. Biologia 59:95–101.

Mignet, F., T. Gendre, D. Reudet, F. Malgoire, M. Cheylan, and A. Besnard. 2014. Short-term evaluation of the success of a reintroduction program of the European Pond Turtle: the contribution of space-use modeling. Chelonian Conservation and Biology 13:72–80.

Mohr, C. 1947. Table of equivalent populations of North American small mammals. American Midland 37:223–249.

Naeem, S., L.J. Thompson, S.P. Lawler, J.H. Lawton, and R.M. Woodfin. 1994. Declining biodiversity can alter the performance of ecosystems. Nature 368:734–737.

Pérez-Santigosa, N., J. Hidalgo-Vila, and C. Díaz-Paniagua. 2013. Comparing activity patterns and aquatic home range areas among exotic and native turtles in southern Spain. Chelonian Conservation and Biology 12:313–319.

Perry, G., and T. Garland, Jr. 2002. Lizard home ranges revisited: effects of sex, body size, diet, habitat, and phylogeny. Ecology 83:1870–1885.

Plummer, M.V., and N.E. Mills. 2000. Spatial ecology and survivorship of resident and translocated Hognose Snakes (*Heterodon platirhinos*). Journal of Herpetology 2000:565–575.

QGIS Development Team. 2016. QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.

R Core Team. 2016. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. www.R-project.org.

Sanz, V., and A. Grajal. 1998. Successful reintroduction of raised Yellow Shouldered Amazon Parrots on Margarita Island, Venezuela. Conservation Biology 12:430–441.

Segurado, P., and A.P.R. Araújo. 2004. Coexistence of *Emys orbicularis* and *Mauremys leprosa* in Portugal at two spatial scales: is there evidence of spatial segregation. Biologia 59:61–72.

Schneeweiss, N., B. Andreas, and N. Jendretzke. 1998. Reproductive ecology data of the European Pond Turtle (*Emys orbicularis*) in Brandenburg, northeast Germany. Mertensiella 10:227–234.

Slavenko, A., Y. Itescu, F. Ihlow, and S. Meiri. 2016. Home is where the shell is: predicting turtle home range sizes. Journal of Animal Ecology 85:106–114.

Thienpont, S., A. Cadi, R. Quesada, and M. Cheylan. 2004. Overwintering habits of the European Pond Turtle (*Emys orbicularis*) in the Isere department (France). Biologia-Section Zoology 59:143–147.

Tortoise & Freshwater Turtle Specialist Group. 1996. *Emys orbicularis*. (errata version published in 2016) The International Union for the Conservation of Nature Red List of Threatened Species. http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T7717A12844431.en.

Turtle Conservation Fund. 2002. A Global Action Plan for Conservation of Tortoises and Freshwater Turtles. Strategy and Funding Prospectus 2002–2007. Conservation International and Chelonian Research Foundation, Washington, D.C., USA. 30 p.

Vicente-Serrano, S.M., J.C. González-Hidalgo, M. de Luis, and J. Raventós. 2004. Drought patterns in the Mediterranean area: the Valencia region (eastern Spain). Climate Research 26:5–15.

Worton, B.J. 1989. Kernel methods for estimating the utilization distribution in home-range studies. Ecology 70:164–168.

Zar, J.H. 1999. Biostatistical Analysis. 4th Edition. Prentice Hall, Upper Saddle River, New Jersey, USA.

Robby M. Drechsler studied biology at the University of the Balearic Islands, Spain. Afterwards, he acquired his Master's degree in Biodiversity, Conservation and Evolution at the University of Valencia, Spain. He is now initiating his scientific career writing his Ph.D. dissertation studying the ecology of reptiles in the Albufera de Valencia Natural Park. (Photographed by Robby Drechsler)

Lucía M. Fernández studied biology at the University of Valencia (Spain) and obtained her Master's degree in Biodiversity, Conservation and Evolution also from the University of Valencia. Currently, she is working at the Tancat de la Pipa Natural Reserve in the Albufera de Valencia Natural Park. (Photographed by Lucía Fernández).

Matthieu Lassalle acquired his Master's degree in Nature Conservation after studying ecology in several universities in France, the UK, and Spain. He has been working for 11 y studying, monitoring, and manageming wetlands of the Valencia region. He started working with the NGO Acció Ecologista-Agró in 2009 as a Technician for the integral management of the natural reserve Tancat de la Pipa in the Albufera de Valencia Natural Park. Matthieu is still in charge of different tasks such as management of artificial wetlands, natural aquatic habitats, fauna and flora surveys, and environmental education, awareness, and training programs. (Photographed by Matthieu Lassalle).

Juan S. Monrós is an Associate Professor of Ecology at the University of Valencia (Spain) and Director of the *Cavanilles* Institute of Biodiversity and Evolutionary Biology. He received a B.A. and Ph.D. in Biology from the University of Valencia studying ecological aspects from the Montpellier Snake (*Malpolon monspessulanus*) in the Eastern Iberian peninsula. Currently, his studies are about population ecology of terrestrial vertebrates, mainly birds, focused on the conservation of small populations. Juan also works on the ecology of other vertebrates like mammals (bats), amphibians living in temporal ponds, and reptiles in the Albufera de Valencia Natural Park. (Photographed by Juan S. Monrós).