Research Article

ACTA ZOOLOGICA BULGARICA
Acta zool. bulg., Suppl. 10, 2017: 91-104

The European Pond Turtle, *Emys orbicularis* (L., 1758), in the River Ter Basin (North East Iberian Peninsula): 40 Years of Conservation

Ramon Mascort[1,2] & Joan Budó[2]

[1]C. la Jonquera, 17, 2; 17600 Figueres, Girona, Spain; E-mail: rmascortb@eresmas.net
[2]CRT l'Albera; 17780 Garriguella, Girona, Spain; E-mail: crt@tortugues.cat

Abstract: The European Pond Turtle, *Emys orbicularis*, in the area around the River Ter estuary (north east Iberian Peninsula) was first studied during the 1970s. In the following years, the population was seen to be in rapid decline. Therefore, during the mid-1980s, the first adults were captured and later a long-term captive breeding programme started. Since then, several reintroduction programmes (including three EU LIFE projects) have been carried out in the area with turtles hatched and raised at the CRT l'Albera (l'Albera Turtle and Tortoise Captive Breeding Centre), located 40 kilometres directly north of the River Ter estuary area. Conservation and reintroduction efforts are summarised in this paper in order to show the recent changes in the European Pond Turtle populations settled in the River Ter basin. Since 2001, 548 juveniles have been released at twelve different sites. Radio-tracked and trapped turtles have shown good adaptability to their new environment ever since the first releases, and gravid females as well as a few hatchlings have been found. The chosen age at release has also proved to be appropriate, as captive bred juveniles 2–3 years old are already big and fit enough to survive the dangers that threat the hatchlings. Those juveniles are also able to quickly settle in their new habitat without undertaking long migrations due to stress, as is more typical in displaced adults.

Key words: *Emys orbicularis*, River Ter, north east Iberian Peninsula, captive breeding, reintroduction, EU LIFE project

"*Ja fa anys que vaig adonar-me que el desenvolupament econòmic era per a les espècies com un diluvi. No vaig construir cap arca, però si que he protegit tot el que he pogut a espècies autòctones molt amenaçades.*"
"*Years ago I realized that economic development was for animal species like a flood. I did not build an ark, but I've protected as many highly endangered native species as I could.*"

Ramon Ribas, Serra de Daró, 14th March 1983

Introduction

The European Pond Turtle in Catalonia, north east Iberian Peninsula

The European Pond Turtle, *Emys orbicularis* (Linnaeus, 1758), occupies a wide range of habitats from the north east of Germany, Poland and Latvia in the north, to the streams of the Atlas Mountains in Morocco and the low-lying wetlands of Tunisia in the south, and from Portugal in the west to Kazakhstan in the east (Podloucky 1997).

Over the last few decades, the endangered European Pond Turtle has received attention in order to conserve and restore its habitat, protect its populations and study its biology and ecology, especially in Europe (Fritz & Chiari 2013).

The species still survives in a few scattered sites in Catalonia, in the north eastern corner of the Iberian Peninsula. By the third quarter of the twentieth century (1950–1975), water pollution, drainage of wetlands, industrial development and widespread urban growth started to push the turtles out of their habitat. After that period, these facts led to the survival of only four threatened populations that by the 1980s had very low numbers: three with less than 50 animals each (Mascort 1992a, 1998a, 1999a), and the fourth one, consisting of three partially connected subpopulations, only had good densities in a marsh drainage channel and the nearby ditches (S. Ramos, pers. comm.).

Since then, a number of different captive breeding and recovery programmes have been started. The first ones were at the Riudarenes population site during the early 1990s, in the south of the Province of Girona, and at the River Ter estuary in the east of the Province of Girona. Another captive breeding programme started in the River Ebro delta, at the southern tip of the Province of Tarragona during the mid-1990s (Mascort 1992b, 1998a, Bertolero 2000, Ramos et al. 2009, Vilardell et al. 2013).

Some restoration of their habitat has also been carried out at different locations: a) at Sils, also in the south of the Province of Girona and near the village of Riudarenes, during the late 1990s and the early 2000s, b) at Vila-seca Salou, in the centre of the coastal strip of the Province of Tarragona during the early 2000s, and c) at the River Ter estuary in the east of the Province of Girona also during the early 2000s (Vilardell et al. 2013).

Furthermore, two main reintroduction programmes have been recently undertaken starting in 2010s: a) one at the Estany de Banyoles Lake, in the northern section of the Province of Girona (CRT L'Albera 2011) and b) at the Estany de d'Ivars i Vila-sana Lake, in the south of the Province of Lleida (CRARC 2010a, 2010b); both during the early 2010s. In this latter site, up to 2017, 40 turtles have been released and one hatchling has been found this same year (Q. Solé, pers. comm.).

Genetics of the European Pond Turtle in the east of the Province of Girona

In 1999, Uwe Fritz's team drew up an initial map of the Eurasian region with 20 haplotypes from 7 main groups based on the mitochondrial nucleotide sequences of 423 specimens: Asia Minor (lineage I), central Europe and the central Balkans (II), southern Italy (III), around the Adriatic Sea (IV), the north west coast of the Mediterranean (V), the Iberian Peninsula and North Africa (VI), and the Caspian region (VII) (Lenk et al. 1999).

The previously endangered population of the European Pond Turtle found in the River Ter estuary wetlands is unique because, even though it is a coastal settlement in the western Mediterranean (an area mainly occupied by haplotype V animals), it only shows mitochondrial haplotype II, also to be found in west and central France, central Europe and the central Balkan Peninsula. Other populations in the south of the Province of Girona show the same haplotype II, but with a slight intrusion of the above mentioned haplotype V that can be found in animals living in coastal areas in the arc extending from west central Italy to east central Spain. Nevertheless, pond turtles from all the other regions of the Iberian Peninsula show haplotype VI except for the north central Iberian Peninsula (south west of the Pyrenees), where they also carry haplotype II. This indicates that the species crossed that mountain range southwards during the Holocene.

Therefore, pond turtles bearing haplotype II found in the River Ter estuary wetlands arrived there after crossing the Pyrenees, passing across both sides of that mountain range and probably coming from the north of the Alps after leaving the Balkans, where the species might have taken refuge during the last glacial period (Lenk et al. 1999, Mascort et al. 1999, Fritz et al. 2005).

Thus, the River Ter estuary turtles are more closely linked with animals from west and central France, central Europe (Austria, Hungary) and the central Balkans than animals from the River Ebro delta (where a mixture of different haplotypes can be found), the Valencia region (haplotype V) or other locations in the Iberian Peninsula (haplotype VI).

Further studies extended the range of haplotype II to the French region of Aquitaine, south western France (although one out of 14 animals showed an Iberian haplotype VI), and the French region of La Camargue, south eastern France (where the 17 haplotype II animals were mixed with 14 haplotype V turtles) (Lenk et al. 1999, Mascort 1999b, Fritz et al. 2005, Pedall et al. 2011) (Fig. 1).

As the same time as Lenk et al. (1999), a morphological study of 131 turtles from six different locations in the north east of the Iberian Peninsula showed that populations from the River Ter wetlands and from the south of the Province of Girona were morphologically different from the rest of the populations (the coastal area of the centre of the Province of Tarragona, River Ebro delta, the coast of the Province of Castelló and the east of the Province of Huesca). These turtles from those two first mentioned populations from the Province of Girona were classified into what was then understood as the *E.*

orbicularis cf. *orbicularis* group, identified later as the genetic haplotype II group (Mascort et al. 1999).

Further studies on eight polymorphic microsatellite loci to extend the investigation of genetic differentiation in the European Pond Turtle, show affinities of the River Ter estuary wetland turtles with those from the south of the Province of Girona and the coastal area in the centre of the Province of Tarragona and to a lesser extent, with those from Aquitaine and La Camargue. The 15 animals newly sampled from Navarra (north central Spain) showed haplotype II, confirming the intrusion of haplotype II at both extremes south of the Pyrenees (Pedall et al. 2011).

The River Ter area

The River Ter is situated in the north eastern part of Catalonia, south of the eastern end of the Spanish-French border; it has a total length of 208 km and a total basin area of 3,010 km². It is both a Pyrenean and Mediterranean type river and it is retained by three dams that were designed to store water for human consumption and generate hydroelectric power (Consorci Del Ter 2013) (Fig. 2).

It has a narrow basin in relation to its length and rises in the Pyrenees Mountains, with its first stretch running north to south and its second stretch running west to east, finally discharging into the Mediterranean Sea (Fig. 3). The middle and lower stretches of the river, in between farmland, have some meanders, ditches, a few river islands, and a few small and medium sized ponds linked to the main river that are suitable for the turtles, as well as the extensive marshes at its mouth (Fig. 4).

The present data compilation also includes neighbouring areas just south of the river basin where turtles have been collected for captive breeding purposes (Riudarenes; Fig. 2, area 5); and north of the river, where turtles have been released (Parc Natural dels Aiguamolls de l'Empordà (Fig. 2, area 6).

Results

First findings in the 1970s

In 1975, Francesc Peracaula (1931–2011) and Ramon Ribas (born in 1935) first discovered a few adult pond turtles in a short string of shallow ponds around the River Ter estuary area next to crop fields and concealed by French Tamarisk, *Tamarix gallica,* and Blackberry bushes, *Rubus* sp. They documented these encounters in a paper written in February 1982 but only published years later (Ribas & Peracaula 2009).

At that time, the total number of adult pond turtles in the area was estimated at 45 (R. Ribas, pers. comm.). Later transects showed that turtles also inhabited another group of small ponds between crop fields and a few ditches behind the beach (Fig. 2, area 1).

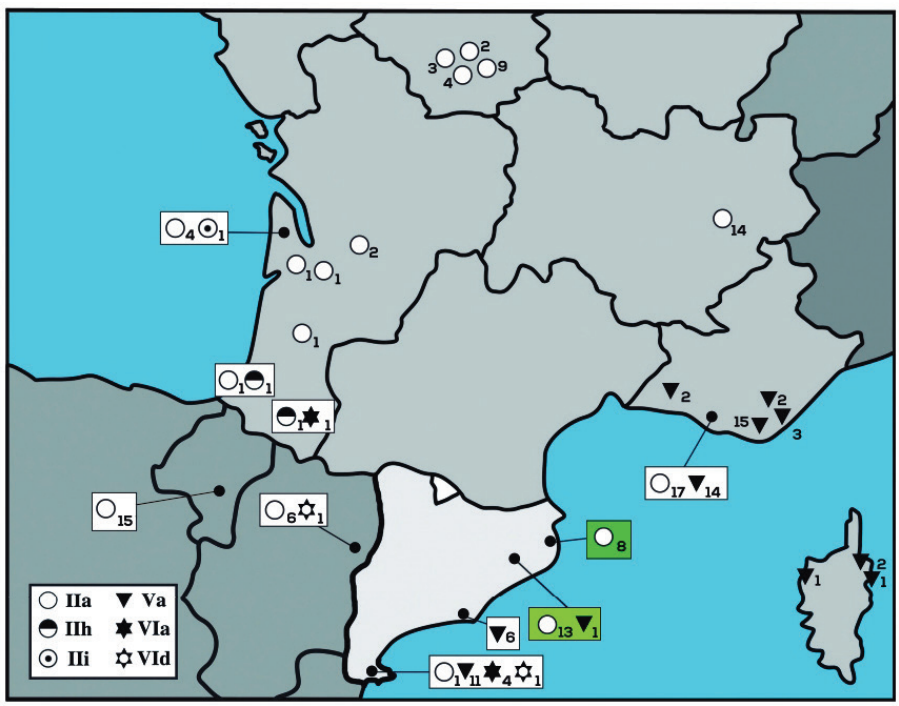

Fig. 1. Distribution of European Pond Turtle (*Emys orbicularis*) mtDNA haplotypes in France and Catalonia, north east Iberian Peninsula (Modified after Fritz et al.2005). Haplotypes are shown in the lower left corner table

Fig. 2. Localities for the European Pond Turtle (*Emys orbicularis*) populations in the River Ter basin and neighbouring areas in the province of Girona, in Catalonia (north east Iberian Peninsula)

Fig. 3. Estuary of the River Ter in a photograph from the 1990s. The river mouth lies in the foreground and the platja de Pals beach and the southern section of the lower river floodplain in the background

Population decline in the 1980s

Ramon Ribas and the late Francesc Peracaula continued studying that turtle population and they noted that the total number of adults had decreased by the early 1980s. At that time, the total number of adult turtles was probably around 30 animals (R. Ribas, pers. comm). Some turtles still thrived there not much later though and proof of this is that in May 1985, 12 animals (6 adults and 6 juveniles) were seen during a single transect in the group of small ponds between crop fields, by that time the most untouched area of the River Ter estuary wetlands.

By the 1980s about half a dozen turtles were collected and kept in captivity at a private enclosure near the river estuary. Furthermore, another about half a dozen adults were captured and kept in

Fig. 4. The lower River Ter floodplain in a photograph from the 1990s. In the background and from left to right, the Canigó mountains (2,784 m), part of the French Pyrenees; the Montgrí massif (303 m) in the middle; and the Alberes range (1,256 m) in the right, where a population of Hermann's Tortoise (*Testudo hermanni*) occurs

a concrete pond near the Muga River estuary, adjoining the Parc Natural dels Aiguamolls de l'Empordà, but no captive breeding was achieved and the animals were finally moved away. Finally, another half a dozen captive turtles were kept at Albons, about 15 km north west of their home area but unfortunately they were stolen (R. Ribas, pers. comm.).

In addition, by the 1980s and the 1990s some isolated animals were periodically being found all along the lower part of the River Ter. These records of the past include observations of the turtles in the lower reaches of the river and even in the area surrounding the city of Girona (R. Ribas, pers. comm.; X. Capalleras, pers. comm. in Mascort 1998a; P. Feliu, pers. comm.) and there are even some recent records from this latter area (Q. Pou, pers. comm.).

Interestingly, on the other hand no European Pond Turtles inhabited the wetlands at the estuary of the Rivers Muga and Fluvià, some 25 kilometres north of the River Ter estuary (Montori et al. 1985), in what is nowadays the Parc Natural dels Aiguamolls de l'Empordà, nor in the area up to the French border: the record by Fèlix & Grabulosa (1980), from la Mugueta, close to the Muga River estuary, was later disclaimed (Fèlix & Grabulosa 1986).

The 1990s: the start of the conservation programme

By 1992, after some unfortunate episodes involving the dumping of chemicals into the ditches that caused some deaths (R. Ribas, pers. comm.), the estimate was that only about 20 animals were left in the area, including adults, juveniles and hatchlings (Mascort 1992a, 1992b).

As a result of this slow but constant decrease in the remaining number of adults, a conservation plan with four different goals was presented to the local authorities: 1) a capture and recapture study plan; 2) close monitoring of the habitat that was subjected at that time to high human pressure; 3) studying the possibility of finding alternative habitats if the area was to be destroyed; and 4) captive breeding as a solution to population decline (Mascort 1992b, 1993).

Before these measures were recommended, the first adult turtle was captured for breeding purposes during 1991 (a full adult female, still currently alive at the CRT l'Albera). Later, in 1992–1994, 12 adult turtles (3 males and 9 females) were captured, almost all of the known wild animals; and 6 of them (1 male and 5 females) were kept in captivity. Unfortunately, the third male captured, a sub-adult turtle, drowned under a basking stone. After that event, which denoted that the viability of the population was then even more doubtful, the release of animals from the nearest population was suggested once the habitat had been restored and protected. During 1993 the first 9 hatchlings were born though, and another 6 were born in the 1994 season in the private authorised enclosure where they were kept (Mascort 1994).

In March 1995, the captive adult turtles were transferred to the CRT l'Albera. One more male and one more female from a private collection were

Fig. 5. Adult male European Pond Turtle (*Emys orbicularis*) with reddish iris, kept at the CRT l'Albera for breeding purposes for more than twenty years

Fig. 6. Adult female European Pond Turtle (*Emys orbicularis*) with yellowish iris, kept at the CRT l'Albera for breeding purposes for more than twenty years

added to the group (then totalling 8 adults: 2 males and 6 females) and they were kept in a pond that was specially built for captive breeding purposes. By 1996 the hatchlings born in 1993 and 1994 were thriving in the above mentioned private enclosure (Mascort 1996).

During 1997, several documents were prepared in order to obtain more legal protection for the area while the 8 adult turtles kept at the CRT l'Albera were doing well and the 15 hatchlings born in 1993 and 1994 were already sub-adults (Mascort 1998b).

By 1999, the first 25 juveniles born at the CRT l'Albera during the period 1995–1999 were thriving and the total number of captive bred animals reached 40 (Mascort 1999c).

In 2001, the last two adult turtles, coming from another private collection, met the captive breeding group at the CRT l'Albera, then totalling 10 animals: 2 males and 8 females. A further male was added to the group when captured during 2010 in the Ter Vell area, a coastal wetland behind the beach which is the final stretch of an old arm of the river and about 2,500 m north of its estuary (Fig. 2, area 3).

Therefore, since then there are a total of 11 captive adult pond turtles from the Baix Ter area at the CRT l'Albera, that is: 3 males and 8 females (Figs. 5 & 6) (CRT L'Albera 2016).

Furthermore, during the 1990s, 26 young turtles privately bred from ancestors coming from two distant geographical regions (the coastal area in the centre of the Province of Tarragona and the island of Minorca), were released into the Cortalet area (near the Park headquarters and visitors centre), in the Parc Natural dels Aiguamolls de l'Empordà. Three more juveniles from the Baix Ter area were also released there in August 1993 (CRT L'Albera 2017).

The 21st century: new projects and the development of captive breeding protocols

In the year 2000, an agreement was signed with different authorities to restore a pond inside the perimeter of the Torroella de Montgrí - l'Estartit sewage treatment plant (Fig. 2, area 2) and to establish a new breeding colony there and about 3 kilometres from the place of origin of the last wild animals. The project was conceived to hold 40 adult turtles, first released as juveniles, as well as adults of 7 species of amphibians, and included an observatory set up for environmental education (Fortià 2001). In the year 2000 the total captive bred turtles numbered 60 (CRT L'Albera & Mascort 2000).

During the first decade of the new century, the captive breeding programme continued at the CRT l'Albera with an increasing number of hatchlings produced every year, reaching by the end of that decade almost 40 hatchlings per season (CRT L'Albera 2003, 2004, 2005, 2006a, 2007a, 2007b, 2008a, 2009a).

Furthermore, a breeding protocol was drafted in 2007, which established the adults' and hatchlings' diet, which for the latter includes live mosquito larvae for the first month, progressively changing to frozen red mosquito larvae and squashed pellets, then dehydrated shrimps and small pieces of chicken liver and fish. This latter diet is kept up for their second year until just before their release. By that time, the sub-adults' diet consists of pellets once daily, fish once a week and chicken liver once a month.

Nests are left outdoors on the same spot where the female lays the clutch, hatchlings are kept indoors for the first year in glass aquariums (with water depths starting at 3 cm and increasing with

growth up to 10 cm) and the one-year old juveniles are then kept outdoors in 2 m² shallow ponds. (CRT L'Albera 2006b, 2007c; 2007d, 2014b).

Moreover, the captive breeding programme ran during the first half of the 2010s bring off more than 60 hatchlings each season (CRT L'Albera 2010a, 2012, 2013, 2014a, 2015a).

Furthermore, in May 2001, 20 captive bred turtles at the CRT l'Albera (74 to 109 mm straight carapace length, SCL) were released at the Cortalet area of the Parc Natural dels Aiguamolls de l'Empordà (CRT L'Albera 2017). A male turtle released at that time with SCL = 77 mm, in 2014 measured 145 mm SCL thirteen years later. However, some active management is required there, as the release of animals of alien origin has taken place. The past reintroduction protocols designed for the area (Mascort 1999a, CRT L'Albera 2009a) must thus be updated.

The first EU LIFE Project: LIFE Emys Ter (2005–2008)

The first EU LIFE Project aimed at the capture, breeding and release of European Pond Turtles was carried out in the Baix Ter area around the river estuary. It was called LIFE Emys Ter 2005–2008: "Amphibian and aquatic reptiles' habitat recovery in the Baix Ter wetlands" (LIFE 04 NAT/ES/000059). It included the removal of non-native species, the restoration and creation of new ponds for the European Pond Turtle and for some amphibian species. This project was developed after the completion of the previous project; LIFE Emys Ter 1999–2004: "Restoration and arrangement of ponds and coastal systems in the Baix Ter" (LIFE 99 NAT/E/006386) that implemented its main objectives of restoring coastal ponds, the creation of new perennial ones and conservation of dunes and marshland vegetation (Gesti et al. 2005, Quintana et al. 2005).

When trapping for *Trachemys scripta* specimens took place, there were no captures of *E. orbicularis* or *Mauremys leprosa* (Feo et al. 2006), although half a dozen European Pond Turtles were released during the 1980s and about the same number of Mediterranean turtles in June 1995 in the Ter Vell area.

Moreover, different public acts were performed and the first transfer of private land was undertaken in order to protect and improve the habitat, which included the restoration of riparian forest, the creation of several trails and the removal of alien animal and plant species (Barriocanal et al. 2005, López-Flores & De Quintana 2006; López-Flores et al. 2006).

On the other hand, in April 2005, eight captive-bred juveniles (50 to 82 mm SCL), were released at the Estany de Boada private reserve (Fig. 2, area 4), a private restored shallow lake, about 5 km south west of the primal population (CRT L'Albera 2005, 2008b). During the same year, turtles were seen basking a few times, although during the following years 2006 and 2007, none were observed (CRT L'Albera 2008a).

During August 2006 a few ponds were created and others restored, and some trees, especially Ash, *Fraxinus angustifolia* and French Tamarisk, *Tamarix gallica* were planted on the wetlands of the River Ter estuary. That same year, leaflets, public talks and road signs came into being (López-Flores & De Quintana 2007).

Also in 2006, the pond inside the perimeter of the Torroella de Montgrí sewage treatment plant was finally restored, including an observatory for up to 30 people, and in October 2006, 20 animals (86 to 122 mm SCL) were released there (CRT L'Albera 2006b, 2007a, López-Flores & De Quintana 2007). During 2007, these turtles were trapped, inspected and surveyed with variable results, as some of them did not grow as expected (CRT L'Albera 2007d).

In April 2007, 16 animals (69 to 86 mm SCL) were first released and radio-tracked in their original habitat at the restored ponds on the wetlands of the River Ter estuary (CRT L'Albera 2008a). For their first wild season, turtles moved a lot and did well (except for two that died in May and September), with a mean maximum movement of 150 m. Three juveniles moved between 200 and 250 m and one was found 746 m from the release point in between the Pals rice fields, south of the release site (Franch & Feo 2007).

During April 2008, nine wild turtles (two males and seven females) were captured from the well-preserved population at Riudarenes, the nearest available and about 50 km south-west of the Baix Ter population, in order to improve the genetic viability of the released animals (CRT L'Albera 2009a). The genetic imprint (haplotype II) of each of the new captive turtles was checked. Male adults there only reach about 140 mm and females only about 150 mm (Ramos et al. 2009). High intraspecific competition exists there in a small optimal habitat. In contrast, animals from the River Ter estuary area reach a bigger size and are known to attain 170 mm SCL for full-grown females, although this is far less than the 219 mm SCL that can be attained by female European Pond Turtles from the east of European Russia (Khabibullin 2004), or the more than 220 mm SCL claimed for turtles from the Ukraine-Poland border (Szczerbak 1998).

Also in April 2008, 16 turtles (67 to 90 mm

SCL) were released for the second time at the River Ter estuary ponds, and this time only one juvenile died during their first year as wild animals. Most of them remained in the newly created shallow ponds (Franch & Feo 2009, Feo & De Quintana 2009).

In July 2008, 10 more animals (61 to 75 mm SCL) were released at the Estany de Boada (CRT L'Albera 2008b). That same month a turtle released there in 2005 was captured and was found to have wide growth rings (R. Fortià, pers. comm.).

In September 2008, 20 more turtles (83 to 123 mm SCL) were released at the Torroella de Montgrí sewage treatment plant, thereby completing the 40 turtles initially planned to be released there (CRT L'Albera 2008a).

During May 2009 and once the EU LIFE Emys Ter 2005–2008 Project was completed, 10 more animals (68 to 87 mm SCL) were released in the Estany de Boada private reserve.

Again during May 2009, 15 more turtles (64 to 72 mm SCL) were released in the River Ter estuary area (CRT L'Albera 2009c).

Moreover, during June 2010, 10 more turtles (72 to 81 mm SCL) were released into the Estany de Boada Lake.

Again in June 2010, 20 more turtles (66 to 82 mm SCL) were released in the River Ter estuary area (CRT L'Albera 2010a).

In September 2011, 10 more animals (76 to 93 mm SCL) were released at the Estany de Boada Lake and a young female turtle (SCL = 154 mm) rescued from a nearby urban area was released at the Torroella de Montgrí sewage treatment plant (CRT L'Albera 2012).

In April 2013, 10 more juveniles (74 to 91 mm SCL) were freed in the Estany de Boada Lake with attached transmitters. Most of them stayed around a small area for the first days but since May they started moving around and beyond the main lagoon. One carcass of a juvenile predated by an Eurasian Otter, *Lutra lutra*, was found there (CRT L'Albera 2014a, 2014b).

In April 2016, four more juvenile turtles (78 to 95 mm SCL) were released in the River Ter estuary area.

In September 2016, 23 more juveniles (73 to 85 mm SCL) were freed at the Ter Vell lagoons section of the Baix Ter area (CRT L'Albera 2016).

Moreover, in October 2017, other 23 turtles (75 to 103 mm SCL) have been released into the Ter Vell lagoons (CRT L'Albera 2017).

By the end of the 2017 season and since the first juveniles were released in 2005, a total of 216 European pond turtles have been freed in the Baix Ter wetlands: 58 in the Estany de Boada private reserve, 41 at the Torroella de Montgrí sewage treatment plant, 71 into the restored Mas Pinell ponds near the River Ter estuary, and 46 in the Ter Vell lagoons area (CRT L'Albera 2008a, 2009c, 2010a, 2012, 2013, 2016, 2017) (Fig. 7).

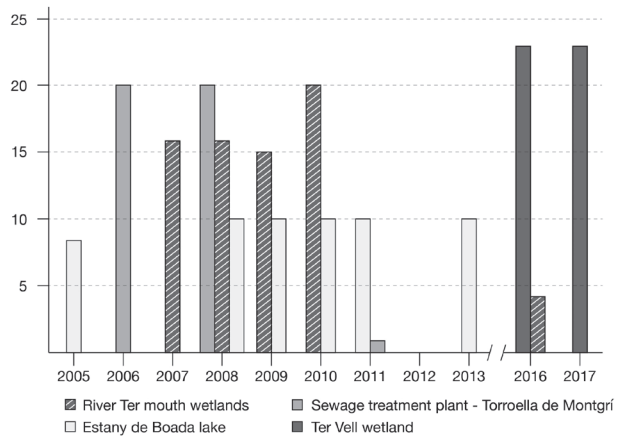

Fig. 7. Number of turtles released at each of the sites at the "Baix Ter" area

At the restored Mas Pinell ponds at the River Ter estuary area, the first hatchling was spotted in September 2011, another one was found in March 2013, a third one was uncovered in April 2014 and two more where sighted in September 2017 (X. D. Quintana, S. Ramos, pers. comm.). Moreover, one other hatchling was found at the Estany de Boada Lake in April 2014 (R. Fortià, pers. comm.). These results show that some of the juveniles released in the Baix Ter area have grown with a remarkable rate and matured enough to breed successfully in a healthy environment (Fig. 8).

The second EU LIFE Project: Project Estany (2010–2013)

In 2010, a second EU LIFE Project was started at the Estany de Banyoles Lake protected area which included the lake and some unique adjacent plots (Fig. 2, area 7). The lake (measuring approximately 2,500 × 500 m) and the surrounding area is one of the most important lake and wetland ecosystems in the Mediterranean region of the Iberian Peninsula. The main aim of this project was a large-scale intervention to combat, slow and reverse the decline in species and habitats by controlling invasive species of plants, fish and turtles and strengthening populations of native species such as *E. orbicularis*, *M. leprosa*, *Barbus meridionalis* and *Unio elongatus*. Its title was: "Improving the habitat and species of Banyoles Natura 2000: a demonstrative project (2010–2013)" (LIFE 08 NAT/E/000078). This main aim was

Fig. 8. A European Pond turtle (*Emys* orbicularis) hatchling found in March 2017 in the Mas Pinell area of the Baix Ter wetlands (Santi Ramos)

complemented by other goals such as the implementation of actions to effectively combat the spread of invasive alien species and the recovery through captive breeding or restocking of the populations of the four above mentioned native species (Campos et al. 2011). Other actions included the purchase of land and the restoration of alluvial habitats (Consorci De L'Estany 2008a, 2008b). The presence of the European Pond Turtle in the area goes back to the Holocene (Massip 1993, Fèlix et al. 2006), but there are only a few recent scattered records: one animal was observed and another captured prior to 1993 (Massip 1993); and a few large and isolated animals were seen later without proof of breeding (Consorci De L'Estany 2008a).

This second EU LIFE Project was developed after the completion of a previous project: the EU LIFE "Restoration of the water environment of Porqueres and Banyoles 2003–2007" (LIFE 03 NAT/E/000067), the main objectives of which were to improve and conserve aquatic habitats, build new small lakes, eliminate exotic flora species and recover the shore vegetation (Ajuntament De Banyoles 2003, Campos et al. 2007). Within the project, a captive bred turtles release programme was devised (CRT L'Albera 2010b, 2011).

Moreover, during the three-year period, 584 non-native turtles from seven different species were captured and removed, mainly from the 21 basking traps set around the lake area: 501 *Trachemys scripta elegans*, 54 *T. s. scripta*, 9 hybrids of the two above mentioned subspecies, 1 *Trachemys emolli*, 8 *Graptemys presudogeographica*, 7 *Pseudemys concinna*, 1 *Pseudemys nelsoni* and 1 *Chrysemys picta* (Feo et al. 2014). In addition, two European Pond Turtles were removed as genetic analysis established that they were escaped pets. Eighteen Mediterranean pond turtles, *M. leprosa*, were also captured, marked and then released (Vilardell 2013, Feo et al. 2014).

In April 2011, the first release of captive-bred European Pond Turtles at the Estany de Banyoles Lake site was undertaken at the Llacunes de Can Morgat area, where a group of three shallow ponds were created in 2006, each roughly measuring 150 × 100 m. This section of the Estany de Banyoles Lake is located about 300 m west from the main lake. A total of 50 animals (63 to 96 mm SCL) were released there (17 males and 33 females), 13 of which were equipped with transmitters, although the turtles were mainly recaptured in basking traps. During their first year the young turtles mainly stayed within the perimeter of the release pond, most of them grew between one and two centimetres and almost half of them doubled in mass, facts that showed that some of the turtles quickly adjusted to the new habitat (Vilardell et al. 2011).

In April 2012, 25 juveniles (71 to 108 mm SCL; 9 males and 16 females), were released in the Llacuna dels Amaradors area, a shallow swampy area at the northern tip of the Estany de Banyoles Lake, and some 500 m from the Llacunes de Can Morgat. These animals only grew up to a centimetre in SCL and only gained between 5% and 20% of body mass during the 2012 season, which showed that the habitat in the Amaradors area was not as good as that at Llacunes de Can Morgat (Vilardell et al. 2012), probably due to the existence of alien

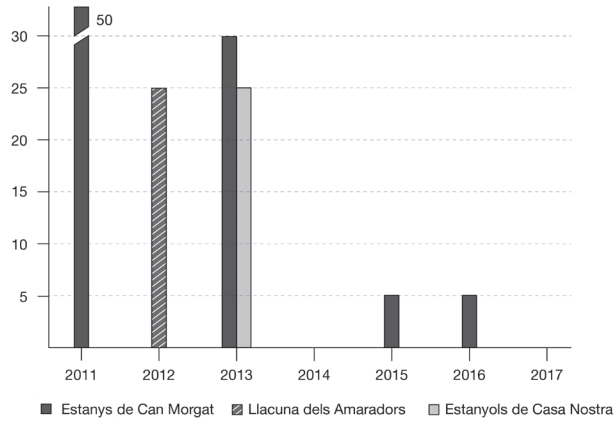

Fig. 9. Number of turtles released at each of the sites at the "Estany de Banyoles" area

fish which can disturb or compete for prey with the young turtles (C. Feo, pers. comm.).

During 2013, 25 more juveniles (60 to 104 mm SCL; 10 males and 15 females), were released at the Casa Nostra ponds, at the southern tip of the Banyoles Lake, an area of ditches and small shallow ponds surrounded by farmland and near urban areas (Vilardell 2013). The turtles did well there their first season, although they moved a lot and scattered across the area (C. Feo, pers. comm.).

In July 2013, 30 more juvenile European Pond Turtles (68 to 88 mm SCL) were released in the Llacunes de Can Morgat area (CRT L'Albera 2015a), the site where two years before 50 turtles were freed. By the end of 2013, the turtles there were thriving (C. Feo, pers. comm.).

Moreover, in May 2015, five more juveniles (77 to 86 mm SCL) were released into the Llacunes de Can Morgat area (CRT L'Albera 2015b) and in May 2016, five more turtles (77 to 89 mm SCL) were released in that area (CRT L'Albera 2016).

Furthermore, probably a few more turtles will be released in the following years in the area of the Estany de Banyoles Lake. The exact site locations will depend on the progress of the recently reintroduced populations (Feo et al. 2013), which is being closely monitored.

In summary, by the end of the 2017 season, a total of 140 European Pond Turtles have been released into the Estany de Banyoles Lake area: 90 into the Basses de Can Morgat ponds, 25 in the Llacuna dels Amaradors area, and 25 more in the Casa Nostra ponds area (CRT L'Albera 2017) (Fig. 9).

In June 2015, four years after the first release at the Estany de Banyoles Lake, two gravid young females were found there and in June 2017, a 135 mm SCL female released in May 2015 with 80 mm SCL has been found (C. Feo, pers. comm.), showing that the reintroduction programme had reached one of its main goals. Moreover, intensive radio-tracking, monitoring, and continuous captures using basking traps during the three-year project showed good adaptation to the new habitat by the majority of the young turtles, but also led to the discovery that six animals had died: one turtle was predated by an Eurasian Otter, one was killed on a road, two died due to a trap's design failure, and two more by unknown causes (Vilardell et al. 2011).

On the other hand, in April 2013, 10 juveniles with attached transmitters were released in the Estanys del Tec lagoons area (73 to 86 mm SCL) in the northern section of the Parc Natural dels Aiguamolls de l'Empordà, near the estuary of the ancient lake of Castelló d'Empúries (CRT L'Albera 2014a, 2017). The juvenile turtles left the area soon and they have not been recaptured nor detected in the subsequent years but they are probably inhabiting the extensive nearby well vegetated ditches.

Furthermore, in July 2013, one more young male (107 mm SCL) was released in the Cortalet area of the Parc Natural dels Aiguamolls de l'Empordà, and another young male (129 mm) was released there in 2015 (CRT L'Albera 2017) (Fig. 10).

The third EU LIFE Project: LIFE Potamo Fauna (2014–2017)

By 2014, a third EU LIFE Project begun, focusing on the middle basin of the River Ter: LIFE Potamo Fauna or "Conservation of river fauna of European interest in the Natura 2000 network in the basins of the rivers Ter, Fluvià and Muga" (LIFE 12 NAT/ES/001091). The project's main aim is the recovery and long-term conservation of several endangered species of river fauna of European interest such as the Naiad (*Unio elongatus*), White-clawed Crayfish (*Austropotamobius pallipes*), the European Pond Turtle (*E. orbicularis*), the Mediterranean Turtle (*M. leprosa*) as well as different species of amphibians. The project also includes actions to combat invasive alien species settled in the basins of the Rivers Ter and Muga. For this purpose, the project plans to establish up to 40 basking traps for capturing alien turtle species.

The project focuses on the recovery of Mediterranean temporary ponds as a special habitat for the European Pond Turtle, the Mediterranean Turtle, and five native amphibians and includes the creation of 24 small ponds with different sizes and depths near the main river course (Puigvert 2014a, 2014b), in the same location as a previous EU LIFE Project was focussed, the LIFE Riparia-Ter 2010–2013 or "Recovery of riparian habitats of the River

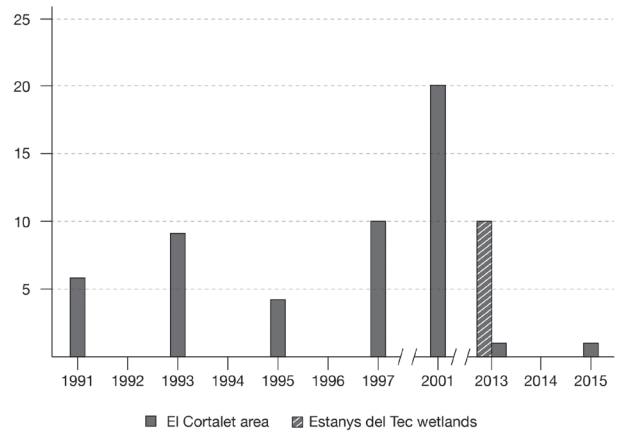

Fig. 10. Number of turtles released at the "Parc Natural dels Aiguamolls de l'Empordà" area

Ter" (LIFE 08 NAT/ES/000072) that restored 75 ha of river forest habitats and removed invasive alien tree and plant species (Consorci Del Ter 2014).

During 2015 70 juvenile European Pond Turtles (72 to 124 mm SCL) were released into some of the newly created ponds and into other previously existing ones along the River Ter upstream from Girona city, while 17 of them had radio trackers fitted (Budó et al. 2014, Feo et al. 2015, CRT L'Albera 2017).

In April 2015, 30 turtles (76 to 96 mm SCL) were released around Bescanó (Fig. 2, area 9) some 10 km upstream from Girona city. The turtles were released in groups of ten animals in three different ponds. During the first year, in the pond with optimal basking spots, turtles did well with a good growth rate; in another half-shaded pond they remained there with little growth, and in the third one (with almost no access to basking areas) some of the turtles left the pond, travelling towards the main river (C. Feo, pers. comm.).

Moreover, in May 2015, 15 animals (78 to 92 mm SCL) were released at the Santa Eugènia ponds (Fig. 2, area 10) an area of orchards on the outskirts of Girona city. These turtles remained in the two main ponds and thrive well (C. Feo, pers. comm.).

Again in May 2015, 25 more young turtles (74 to 89 mm SCL) were freed on a river island near Anglès (Fig. 2, area 8) some 15 km upstream from Girona city, but no information has been gathered yet about those turtles (CRT L'Albera 2015a).

During May 2016, 50 more juvenile turtles have been released in ponds beside the main course of the River Ter, roughly halfway between Girona city and the river's estuary: 30 animals (72 to 88 mm SCL) near Flaçà (Fig. 2, area 11), and 20 more turtles (71 to 120 mm SCL) near Colomers (Fig. 2, area 12), the last downstream releasing site before reaching the river estuary (CRT L'Albera 2016). These turtles have shown a good adaptation to their new habitat during their first year (C. Feo, pers. comm.).

During May 2017, the last year of the LIFE Potamo Fauna Project, 40 more animals were released: 15 juveniles upstream from Girona city (near Bescanó) and 25 more downstream from Girona city (13 at Flaçà and 12 at Colomers).

By the end of the 2017 season, a total of 160 European Pond turtles have been released in the Ter river middle reaches during the 4-year project. Listed downstream: 25 in Anglès, 45 in Bescanó, 15 at Santa Eugènia gardens, 43 in Flaçà and 32 in Colomers (CRT L'Albera 2017) (Fig. 11).

Since the European Pond Turtle release programme started in 2014 at the River Ter middle reaches, no breeding has been disclosed, but at most of the sites turtles are thriving. Interestingly, juveniles have grown at a good rate at the Santa Eugènia urban area. There the only incident observed was that of a turtle chewed by a dog in 2015 (C. Feo, pers. comm.).

Discussion

Since the first European Pond Turtles were captured, more than 500 juvenile turtles have been raised at the CRT l'Albera with continuous improvements in methodology, achieving an almost 100% hatchling success after implementing different protocols.

Those more than 500 animals have already been released at twelve locations, and in the future more turtles will be released. The age (mainly after their second or third year) and size (70–90 mm SCL) of the turtles chosen for release, have proven to be suitable, also appropriate in north–western Italy (Canessa et al. 2016). At this age, the turtles are big enough to withstand different threats in their habitat wearing their already ossified carapace, such as predation by birds (White Stork, *Ciconia ciconia*; Grey Heron, *Ardea cinerea*), or mammals (Wild Boar, *Sus scrofa*, Domestic Dog, *Canis familiaris,* Red Fox, *Vulpes vulpes*, Eurasian Otter, *L. lutra*, or the introduced American Mink, *Neovison vison*), although they are not yet completely free of risks, as results have shown.

High survival rates, fidelity to certain areas as well as early habitat exploration after release have been recorded in successful reintroduction programmes in north western Italy and eastern and south western France (Canessa et al. 2016, Cadí & Miquet 2004; Mignet et al. 2014), as is the case at most of the sites in the River Ter basin. Moreover, the turtles are doing well at most of the sites. As two examples, one female released in 2005 in the Estany

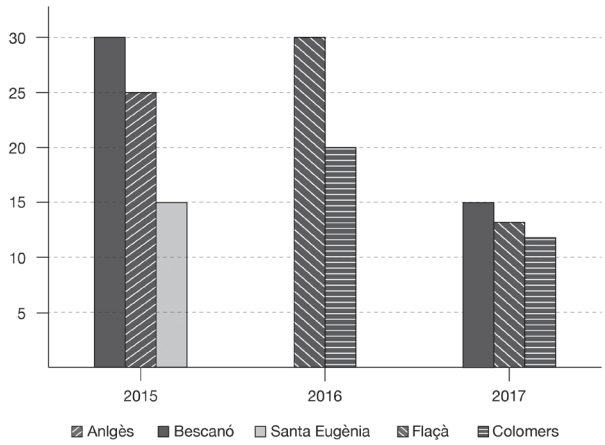

Fig. 11. Number of turtles released at each of the sites at the "River Ter middle reaches" area

de Boada area was caught three years later in 2008 with wide growth rings; and in 2017 another female released in 2015 in the Estany de Banyoles area has grown from 80 mm to 135 mm SCL, showing a quick adaption to the new habitat.

Furthermore, up to date, six wild-born hatchlings have been spotted since the first one located in September 2011: five at the Mas Pinell area of the river Ter estuary and a sixth one at the Estany de Boada lagoon. Adding to this, two gravid females were captured in June 2015 in the Estany de Banyoles Lake. All these facts show full acclimatization of the captive bred turtles to their new environment. Even the animals released in an urban area in the Santa Eugènia ponds on the outskirts of Girona city have shown good survival rates up to now and they are expected to stay there growing at a good rate and healthy, as other emydids have done in similar urban areas (Budischak et al. 2006).

No mortality due to predators has been observed except for two cases at two sites due to the Eurasian Otter. Another two animals were found killed by cars. As the released turtles are still young, more road kills are to be expected in the future as females can travel long distances to dig their nests (Rovero & Chelazzi 1996, Schneeweiss & Steinhauer 1998). The long distances travelled by gravid females highlight the importance of establishing a protected buffer area around the ponds where the turtles live. Such a bordering area has proven to be extremely important for their survival (Ficetola et al. 2004).

Other problems that could arise can be assigned to intraspecific competition in reduced habitats (Boussekey 1988), such as at the small ponds at Bescanó or the Casa Nostra ponds in the Estany de Banyoles area, resulting in dispersal and disappearance in cases of extremely reduce habitats.

Finally, the haplotype of every non-marked European Pond Turtle trapped in the wild is checked at the CRT l'Albera as this is the best way to allocate animals of unknown origin to their source areas (Velo-Antón et al. 2011). A special delivery protocol is applied in order to send animals of haplotype VI to GREFA-Madrid, and animals of haplotype V to CRARC-Estany d'Ivars Vila-sana or to the River Ebro delta breeding station.

Acknowledgements: The senior author is grateful to Ramon Ribas and the late Francesc Peracaula for the disclosure of the existence of the turtles at the River Ter estuary wetlands, which provided a source of interest and enjoyment. Many thanks to Carles Feo, project secretary of LIFE Emys Ter 2005–2008, technician for LIFE Estany de Banyoles 2010–2013 and technician for LIFE Potamo Fauna 2014–2017; Ramon Fortià (Paisatges); Mónica Martinoy (Servei de control de mosquits del Baix Ter); Quim Pou, technical specialist for LIFE Estany de Banyoles 2010–2013 and technical coordinator for LIFE Potamo Fauna 2014–2017; Xavier De Quintana, project director for LIFE Emys Ter 2005–2008; Santi Ramos (Parc Natural del Montgrí, les Illes Medes i el Baix Ter); and Aïda Tarragó (Servei de Biodiversitat i Protecció dels Animals; Generalitat de Catalunya) for their comments on the manuscript. Finally, many thanks to Xavier Capalleras, Enric Capalleras and Andreu Cufí (CRT l'Albera), to Jordi Perez and Ignasi Rodriguez who helped with the maps and figures, and also to the three reviewers for their valuable comments.

References

Barriocanal C., Boix D., Brucet S., Franch M., Ramos S., Budó J., Mascort R., Capalleras X., Díaz A., Pujol J., Roig O., Feo C., Gascón S., Sala J. & De Quintana X. D. 2005. Projecte LIFE per a la recuperació de les poblacions de la Tortuga d'estany (*Emys orbicularis*) al Baix Ter. (poster). Abstracts 4th International Symposium on *Emys orbicularis*, Valencia: 12.

Bertolero A. 2000. Suivi de la population de Cistude *Emys orbicularis* dans le Delta de l'Ebre (NE Espagne). Chelonii 2: 63–68.

Boussekey M. 1988. Recherche experimental d'établissement d'une hiérarchie au sein d'un groupe captive de Cistudes d'Europe *Emys orbicularis*. Bulletin de la Société Herpétologique de France 46: 1–9.

Budischak S. A., Hester J. M., Price S. J. & Dorcas M. E. 2006. Natural history of *Terrapene carolina* (box turtles) in an urbanized landscape. Southeastern Naturalist 5 (2): 191–204.

Cadí A. & Miquet A. 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.

Canessa S., Genta P., Jesu R., Lamagni L., Oneto F., Salvidio S. & Ottonello D. 2016. Challenges of monitoring reintroduction outcomes: insights from the conservation breeding program of an endangered turtle in Italy. Biological Conservation 204: 128–133.

Fèlix J. & Grabulosa I. 1980. Herpetofauna de l'Alt Empordà (II). Revista de Girona 91: 99–103.

Fèlix J. & Grabulosa I. 1986. Els amfibis i els rèptils. En: Els Aiguamolls de l'Alt Empordà. Revista de Girona 110: 32–34.

Fèlix J., Budó J., Capalleras X. & Mascort R. 2006. The fossil register of the genera *Testudo*, *Emys*, and *Mauremys* of the Quaternary in Catalonia. Chelonii 4: 47–52.

Ficetola G. F., Padoa-Schioppa E., Monti A., Massa R., de Bernardi F. & Bottoni L. 2004. The importance of aquatic and terrestrial habitat for the European Pond Turtle (*Emys orbicularis*): implications for conservation planning and management. Canadian Journal of Zoology 82: 1704–1712.

Fritz U. & Chiari Y. 2013. Conservation actions for European Pond Turtles – a summary of current efforts in distinct European countries. Herpetology Notes 6: 105–164.

Fritz U., Cadi A., Cheylan M., Coïc C., Détaint M., Olivier A., Rosecchi E., Guicking D., Lenk P., Joger U. & Wink M. 2005. Distribution of mtDNA haplotypes (cyt *b*) of *Emys orbicularis* in France and implications for postglacial recolonization. Amphibia-Reptilia 26: 231–238.

Khabibullin V. 2004. Distribution of *Emys orbicularis* in the South Urals, Russia. Biologia, Bratislava 59 (Suppl. 14): 27–32.

Lenk P., Fritz U., Joger U. & Wink M. 1999) Mitochondrial phylogeography of the European Pond Turtle, *Emys orbicularis* (Linnaeus 1758). Molecular Ecology 8: 1911–1922.

Mascort R. 1992a. Estudio preliminar de una población de galápago europeo, *Emys orbicularis*. (poster). Libro de Resúmenes del II Congreso Luso-Español y IV Congreso Español de Herpetología, Granada: 91.

Mascort R. 1998a. Distribution and status of the European Pond Turtle, *Emys orbicularis*, in Catalonia. Mertensiella 10: 177–186.

Mascort R. 1999b. Situación actual del galápago europeo en la península ibérica. Quercus 161: 18–23.

Mascort R., Bertolero A. & Arribas O. 1999. Morphology, geographic variation and taxonomy of *Emys orbicularis* L. 1758, in the northeast of the Iberian Peninsula. Revista Española de Herpetología 13: 7–16.

Massip I. & Gibert J. M. 1993. Tortuga d'estany – *Emys orbicularis*. pp. 134-138. In: Els amfibis i els rèptils. In: Massip I. & Gibert J. M. (Ed.): Els amfibis i els rèptils. Banyoles fauna comarcal. Banyoles: pp. 134–138.

Mignet F., Gendre T., Reudet D., Malgoire F., Cheylan M. & Besnard A. 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 (1): 72–80.

Montori A., Bea A. & Pascual X. 1985. Característiques generals de l'herpetofauna dels Aiguamolls de l'Empordà. Butlletí de la Societat Catalana d'Ictiologia i Herpetologia 10: 39–43.

Pedall I., Fritz U., Stuckas H., Valdeón A. & Wink M. 2011. Gene flow across secondary contact zones of the *Emys orbicularis* complex in the Western Mediterranean and evidence for extinction and re-introduction of pond turtles on Corsica and Sardinia (Testudines: Emydidae). Journal of Zoological Systematics and Evolutionary Research 49 (1): 44–57.

Podloucky R. 1997. *Emys orbicularis* (Linnaeus 1758). In: Cabela A. et al. (Eds.): Atlas of amphibians and reptiles in Europe. Paris: SEH and MNHN, pp. 170–171.

Ramos S., Franch M., Llorente G. A. & Montori A. 2009. Morphometry and biological cycle of a European Pond Turtle (*Emys orbicularis*) population from north-eastern Spain. Revista Española de Herpetología 23: 117–128.

Ribas R. & Peracaula F. 2009. La tortuga d'estany, l'*Emys orbicularis*. Avanç 17 - Revista de Serra de Daró i Sant Iscle: 32–33.

Robero F. & Chelazzi G. 1996. Nesting migrations in a population of the European Pond Turtle, *Emys orbicularis* (L.) (Chelonia: Emydidae) from central Italy. Ethology Ecology and Evolution 1996(3): 297–304.

Schneeweiss N. & Steinhauter C. 1998. Habitat use and migration of a remnant population of the European Pond Turtle, *Emys o. orbicularis* (Linnaeus 1758), depending on landscape structures in Brandenburg, Germany. Mertensiella 10: 235–243.

Szczerbak N. 1998. The European Pond Turtle in Ukraine. Mertensiella 10: 259–266.

Velo-Antón G., Wink M., Schneeweiss N. & Fritz U. 2011. Native or not? Tracing the origin of wild-caught and captive freshwater turtles in a threatened and widely distributed species (*Emys orbicularis).* Conservation Genetics 12: 583–588.

Vilardell A., Soler J., Bertolero A. & Ramos S. 2013. Galápago europeo: proyectos en seis poblaciones de Cataluña. Quercus 333: 50–58.

Official and technical reports

Ajuntament De Banyoles 2003. Restauración de los ambientes acuáticos de Porqueres y de Banyoles. LIFE Naturaleza. (Proyecto nº LIFE 03 NAT/E/000067). 108 p.

Budó J., Capalleras E., Capalleras X. & Vilardell A. 2014. Protocol de reproducció, reforçaments i seguiments de tortugues aqüàtiques autòctones - Protocol de reproducció en captivitat de *Emys orbicularis*. (Projecte LIFE 12 NAT/ES/001091). Amics de la Tortuga de l'Albera. 32 p.

Campos M., Nevado D. & Camós I. 2007. Restauración de los ambientes acuáticos de Porqueres i Banyoles. (Proyecto nº LIFE 03 NAT/E/000067). Informe de actividad final. Consorci de l'Estany. 137 p.

Campos M., Feo C. & Pou Q. 2011. Protocol per a la captura i descast poblacional de tortugues exòtiques. (Projecte LIFE 08 NAT/E/000078). Consorci de l'Estany. 47 p.

Consorci De L'estany 2008a. Life + Nature and Biodiversity. Technical Application forms Part B - Technical summary and overall context of the project. (Project number LIFE 08 NAT/E/000078). 38 p.

Consorci De L'estany 2008b. Life + Nature and Biodiversity. Technical application forms Part C - Detailed technical description of the proposed actions. (Project number LIFE 08 NAT/E/000078). 49 pp.

Consorci Del Ter 2013. Recuperació d'hàbitats ripàris del riu Ter (Riparia – Ter) (LIFE08 NAT/E/000072) Informe Layman. 12 p.

Consorci Del Ter 2014. Recovery of the riparian habitats on the river Ter (LIFE Riparia-Ter). (Project number LIFE 08 NAT/E/000072). Final report. 106 p.

CRARC 2010a. Projecte d'introducció de la Tortuga d'estany (*Emys orbicularis*) a l'estany d'Ivars i Vila-Sana. 54 p.

CRARC 2010b. Memòria 2010. Projecte d'introducció de la Tortuga d'estany (*Emys orbicularis*) a l'estany d'Ivars i Vila-Sana. 19 p.

CRT L'Albera 2003. Informe referent a l'any 2002. 3 p.

CRT L'Albera 2004. Informe referent a l'any 2003. 3 p.

CRT L'Albera 2005. Informe referent a l'any 2004. 3 p.

CRT L'Albera 2006a. Informe referent a l'any 2005. 3 p.

CRT L'Albera 2006b. Cria en captivitat de la tortuga d'estany (*Emys orbicularis orbicularis*) al Centre de Reproducció de Tortugues de l'Albera. (Projecte LIFE 03 NAT/E/000067). Informe 2006. 29 p.

CRT L'Albera 2007a. Informe referent a l'any 2006. 5 p.

CRT L'Albera 2007b. Informe referent a l'any 2007. 6 p.

CRT L'Albera 2007c. Protocol de cria de la tortuga d'estany, *Emys orbicularis*. (Projecte LIFE03 NAT/E/000067). 10 p.

CRT L'Albera 2007d. Resultados de cría del galápago europeo (*Emys orbicularis*) en el Centre de Reproducció de Tortugues de l'Albera. Año 2007. (Projecte LIFE 03 NAT/E/000067). 4 p.

CRT L'Albera 2008a. Informe referent a l'any 2008. 8 p.

CRT L'Albera 2008b. Alliberament de tortuga d'estany (*Emys o. orbicularis*) a l'estany de Boada, al Baix Empordà. 2 p.

CRT L'Albera 2009a. Projecte de recuperació de la tortuga d'estany (*Emys orbicularis*) al P. N. dels Aiguamolls de l'Empordà. 8 p.

CRT L'Albera 2009b. Captura de 10 Tortugues d'estany (*Emys orbicularis*), a la comarca de La Selva. Establiment d'un nou nucli reproductor al Centre de Reproducció de Tortugues de l'Albera. 1 p.

CRT L'Albera 2009c. Informe referent a l'any 2009. 9 p.

CRT L'Albera 2010a. Informe referent a l'any 2010. 8 p.

CRT L'Albera 2010b. Protocol de cria de *Emys orbicularis*. (Projecte LIFE 08 NAT/E/000078). 11 p.

CRT L'Albera 2011. Projecte per la preservació i restauració dels habitats i espècies d'interès especial a l'estany de Banyoles. (Projecte LIFE 08 NAT/E/000078). 9 p.

CRT L'Albera 2012. Memòria d'actuacions 2011. 6 p.

CRT L'Albera 2013. Memòria d'actuacions del 2012. 7 p.

CRT L'Albera 2014a. Memòria d'actuacions del 2013. 9 p.

CRT L'Albera 2014b. Alliberament i radioseguiment de 10 exemplars de tortuga d'estany, *Emys orbicularis*, a l'estany de Boada. Parc Natural del Montgrí, illes Medes i Baix Ter. 31 p.

CRT L'Albera 2015a. Memòria d'actuacions del 2014. 8 p.

CRT L'Albera 2015b. Informe d'actuacions del CRT de l'Abera. Any 2015. 8 p.

CRT L'Albera 2016. Informe d'actuacions del CRT de l'Albera. Any 2016. 9 p.

CRT L'Albera 2017. Alliberaments de tortuga d'estany (*Emys o. orbicularis*) per part del CRT de l'Albera al P.N. del Montgrí, Baix Ter i Illes Medes; P.N. dels Aiguamolls de l'Empordà; E.I.N de l'estany de Banyoles; i riu Ter; amb exemplars juvenils d'haplotip II nascuts al CRT. 1 p.

CRT L'Albera & Mascort R. 2000. La població de Tortuga d'estany, *Emys orbicularis* al Baix Empordà. Informe any 2000. 4 p.

Feo C., Boix D. & Ramos S. 2006. Estudi i seguiment de quelonis. Informe del segon any - desembre 2006. (Projecte LIFE 04 NAT/ES/000059). Institut d'Ecologia Aplicada, Universitat de Girona i Fundació Emys. 36 p.

Feo C. & De Quintana X. 2009. Recuperación del hábitat de anfibios y *Emys orbicularis* en el Baix ter. Informe final de actividades 2005 - 2008 (Proyecto nº LIFE 04 NAT/ES/000059). Informe final. 97 p.

Feo C., Pou Q. & Campos M. 2013. Conservation and Continuity after-LIFE plan. Consorci de l'Estany. (Project nº LIFE 04 NAT/ES/000059). 24 p.

Feo C., Campos M. & Pou Q. 2014. Seguiment de les captures de tortugues exòtiques invasores. Resultats de l'aplicació del protocol per a la captura i descast poblacional de tortugues exòtiques. (Projecte LIFE 12 NAT/ES/001091). Consorci de l'Estany. 52 p.

Feo C., Budó J., Capalleras E., Capalleras X. & Vilardell A. 2015. Protocol de reproducció, reforçaments i seguiments de tortugues aquàtiques autòctones - Protocol de reforçament poblacional de *Emys orbicularis*. (Projecte LIFE NAT/ES/001091). Consorci de l'Estany i Amics de la Tortuga de l'Albera. 24 p.

Fortià R. 2001. Projecte d'adequació de l'antiga activitat extractiva de la depuradora de Torroella de Montgrí - l'Estartit com a habitat per a la tortuga d'estany (*Emys* orbicularis). Paisatges. 15 p.

Franch M. & Feo C. 2007. Radioseguiment dels exemplars alliberats de *Emys orbicularis*. Informe desembre 2007. (LIFE 04 NAT/ES/000059). Institut d'Ecologia Aquàtica, Universitat de Girona i Fundació Emys. 16 p.

Franch M. & Feo C. 2009. Reintroducció i radioseguiment dels exemplars alliberats de *Emys orbicularis*. Informe final 2005-2008. (LIFE 04 NAT/ES/000059). Institut d'Ecologia Aquàtica - Dept. Ciències Ambientals, Universitat de Girona. 28 p.

Gesti J., Badosa A. & De Quintana X. 2005. Pla de gestió dels espais naturals del Ter vell i la Pletera (Torroella de Montgrí - l'Estartit, Baix Empordà) en el marc del Projecte LIFE-Natura: restauració i ordenació de les llacunes i dels sistemes costaners del Baix ter. (LIFE 04 NAT/ES/000059). Institut d'Ecologia Aquàtica – Dept. Ciències Ambientals, Universitat de Girona. 103 p.

López-Flores, R. & De Quintana X. 2006. Recuperació de l'hàbitat d'amfibis i d'*Emys orbicularis* en el Baix Ter. Informe d'activitat. (LIFE 04 NAT/ES/000059). Institut d'Ecologia Aquàtica, Universitat de Girona. 21 pp.

López-Flores R., Gesti J. & De Quintana X. 2006. Creación de lagunas en Mas Pinell para la posterior reintroducción de *Emys orbicularis*. (Polígono Life 2- Mas Pinell). (LIFE 04 NAT/ES/000059). Memoria Valorada. Institut d'Ecologia Aquàtica i Departament de Ciències Ambientals, Universitat de Girona. 8 p.

López-Flores R. & De Quintana X. 2007. Recuperació de l'hàbitat d'amfibis i d'*Emys orbicularis* en el Baix Ter. Informe de intermedio. (LIFE 04 NAT/ES/000059). Institut d'Ecologia Aquàtica, Universitat de Girona. 69 p.

Mascort R. 1992b. Projecte d'estudi d'una població de tortuga d'estany, *Emys orbicularis* al Baix Empordà. Informe 1992. 4 p.

Mascort R. 1993. Sol·licitud d'autorització per l'estudi d'una població de tortuga d'estany (*Emys orbicularis*) al Baix Empordà. 2 p.

Mascort R. 1994. La població de Tortuga d'estany, *Emys orbicularis* al Baix Empordà. Informe 1993/1994. 3 p.

Mascort R. 1996. La població de Tortuga d'estany, *Emys orbicularis*, al Baix Empordà. Informe 1995/1996. 3 p.

Mascort R. 1998b. La població de Tortuga d'estany, *Emys orbicularis*, al Baix Empordà. Informe 1997. 3 p.

Mascort R. 1999a. La tortuga d'estany, *Emys orbicularis* a l'Empordà: passat, present i projectes de recuperació. 4 p.

Mascort R. 1999c. La població de tortuga d'estany, *Emys orbicularis*, al Baix Empordà. Informe 1998/1999. 4 p.

Puigvert T. 2014a. Redacció de projectes executius per a la recuperació de microaiguamolls al riu Ter. Recuperació de microaiguamolls al Baix Ter com a habitat per a herpetofauna fluvial. Projecte Executiu Tram A. (LIFE 12 NAT/ES/001091). Consorci del Ter. 175 p.

Puigvert T. 2014b. Redacció de projectes executius per a la recuperació de microaiguamolls al riu Ter. Recuperació de microaiguamolls al Baix Ter com a habitat per a herpetofauna fluvial. Projecte Executiu Tram B. (LIFE 12 NAT/ES/001091). Consorci del Ter. 152 p.

Quintana X., Gesti J. & Badosa A. 2005. Restauración y ordenación de las lagunas y de los sistemas costeros del bajo Ter. Proyecto LIFE Naturaleza BA - 3200/1999/00 6386. Informe final de actividad. (Projecte LIFE 04 NAT/ES/000059). Ayuntamiento de Torroella de Montgrí, Universidad de Girona y Servicio de Control de Mosquitos de la bahía de Roses y el Bajo Ter. 68 p.

Vilardell A., Capalleras X. & Budó J. 2011. Seguiment de la Tortuga d'estany. Informe anual de cria, recria, i alliberament d'exemplars juvenils de tortuga d'estany (*Emys orbicularis orbicularis*) a les llacunes de Can Morgat. (Projecte LIFE 08 NAT/E/000078). Centre de Reproducció de tortugues de l'Albera. 36 p.

Vilardell A., Capalleras X. & Budó J. 2012. Seguiment de la Tortuga d'estany. Seguiment del reforç poblacional de tortuga d'estany a la llacuna dels Amaradors. (Projecte LIFE 08 NAT/E/000078). Amics de la Tortuga de l'Albera. 39 p.

Vilardell A. 2013. Seguiment de la tortuga d'estany. Seguiment dels reforços poblacionals de Tortuga d'estany del 2011, 2012, i 2013. (Projecte LIFE 08 NAT/E/000078). Amics de la Tortuga de l'Albera. 75 p.

Accepted: 21.11.2017