

## REFERENCIAS

- Beja, P., Kuzmin, S., Beebe, T., Denoel, M., Schmidt, B., Tar-khnishvili, D., Ananjeva, N.B., Orlov, N.L., Nyström, P., Ogodowczyk, A., Ogielska, M., Bosch, J., Miaud, C., Tejedo, M., Lizana, M. & Martínez Solano, I. 2009. *Epidalea calamita* (errata version published in 2016). *The IUCN Red List of Threatened Species 2009*: e.T54598A86640094. <<https://dx.doi.org/10.2305/IUCN.UK.2009.RLTS.T54598A11160828.en>> [Consulta: 26 marzo 2020].
- Beja, P., Bosch, J., Tejedo, M., Lizana, M., Martínez Solano, I., Salvador, A., García París, M., Recuero Gil, E., Pérez Mellado, V., Díaz-Paniagua, C., Cheylan, M., Márquez, R. & Geniez, P. 2009. *Pelobates cultripes* (errata version published in 2016). *The IUCN Red List of Threatened Species 2009*: e.T58052A86242868. <<https://dx.doi.org/10.2305/IUCN.UK.2009.RLTS.T58052A11722636.en>> [Consulta: 26 marzo 2020].
- Galán, P., Cabana, M. & Ferreira, R. 2010. Estado de conservación de *Pelobates cultripes* en Galicia. *Boletín de la Asociación Herpetológica Española*, 21: 90-99.
- Gómez-Mestre, I. 2014. Sapo corredor – *Epidalea calamita*. In: Salvador, A. & Martínez-Solano, I. (eds.). *Enciclopedia Virtual de los Vertebrados Españoles*. Museo Nacional de Ciencias Naturales, Madrid. España.
- Lizana, M., Márquez, R. & Martín, R. 1994. Reproductive biology of *Pelobates cultripes* (Anura: Pelobatidae) in Central Spain. *Journal of Herpetology*, 28: 19-27.
- Lizana, M. & Barbadillo, L.J. 1997. Legislación, protección y estado de conservación de los anfibios y reptiles españoles. 477-516. In: Pleguezuelos, J.M. (ed.). *Distribución y Biogeografía de los Anfibios y Reptiles en España y Portugal*. Monografías de Herpetología, vol. 3. Asociación Herpetológica Española y Universidad de Granada. Granada. España.
- Recuero, E. 2014. Sapo de espuelas – *Pelobates cultripes* (Cuvier, 1829). In: Salvador, A. & Martínez-Solano, I. (eds.). *Enciclopedia Virtual de los Vertebrados Españoles*. Museo Nacional de Ciencias Naturales, Madrid.
- Reques, R. & Tejedo, M. 2004. *Bufo calamita*. 107-109. In: Pleguezuelos, J.M., Márquez, R. & Lizana, M. (eds.). *Atlas y libro rojo de los anfibios y reptiles de España*. Tercera impresión. Dirección General de la Conservación de la Naturaleza - Asociación Herpetológica Española, Madrid. España.
- SIARE. Servicio de Información de Anfibios y Reptiles de España. 2020. <<https://herpetologica.es/index.php/programas/servidor-de-informacion-de-anfibios-y-reptiles-de-espana>> [Consulta: 26 marzo 2020].
- Tejedo, M. & Reques, R. 2002. *Pelobates cultripes*. 94-96. In: Pleguezuelos, J.M., Márquez, R. & Lizana, M. (eds.). *Atlas y libro rojo de los anfibios y reptiles de España*. Dirección General de la Conservación de la Naturaleza-Asociación Herpetológica Española. Madrid. España.

## Stranding of freshwater turtles at different sea beaches in Catalonia after storm Gloria

Ramón Mascort<sup>1,2</sup>, Enric Badosa<sup>3</sup>, Joan Budó<sup>2</sup>, Xavier Capalleras<sup>2</sup>, Joaquim Soler<sup>4</sup> & Albert Martínez-Silvestre<sup>4</sup>

<sup>1</sup> Cl. La Jonquera, 17. 2. 17600 Figueres. Girona. Spain. C.e.: ramast.33@gmail.com

<sup>2</sup> CRT l'Albera (Centre de reproducció de tortugues de l'Albera). 17780 Garriguella. Girona. Spain.

<sup>3</sup> Cl. Pau Costa, 7. 08350 Arenys de Mar. Barcelona. Spain.

<sup>4</sup> CRARC (Centre de recuperació d'amfibis i rèptils de Catalunya). Av. Maresme, 45. 08783 Masquefa. Barcelona. Spain.

Fecha de aceptación: 17 de junio de 2020.

Key words: Flash flood, *Mauremys leprosa*, *Trachemys scripta*, *Emys orbicularis*, Invasive species.

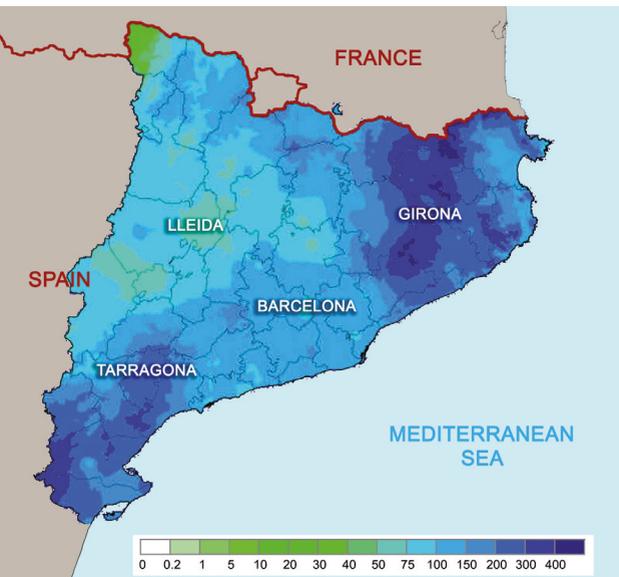
**RESUMEN:** La tormenta Gloria afectó intensamente el litoral mediterráneo de la península ibérica del 19 al 26 de enero de 2020, con un importante temporal marítimo y muy abundantes lluvias que en algunos puntos rozaron los 500 mm. El caudal de los principales ríos de Cataluña aumentó extraordinariamente y arrastró centenares de tortugas acuáticas hacia el mar, mientras que el temporal marítimo diseminó los animales por las playas próximas a esos ríos. En días posteriores se encontraron más de 200 tortugas de cinco especies a lo largo de la costa y en algunos casos alejadas algunas decenas de kilómetros de la desembocadura del río correspondiente. En el presente estudio se constata la capacidad de supervivencia y la potencial capacidad colonizadora del galápagos leproso, ya sea a través de una misma cuenca

fluvial o transportados por las olas de un temporal. También se destaca la necesidad de proteger adecuadamente el hábitat de las especies de tortugas autóctonas y limitar la expansión de las especies exóticas e invasoras.

Storm Gloria arose on 17<sup>th</sup> January 2020 in the North Atlantic Ocean. On 18<sup>th</sup> and 19<sup>th</sup> it moved quickly, reached the Iberian Peninsula and took position over the island of Ibiza. On 20<sup>th</sup> it settled on the sea off the southeast coast of the Iberian Peninsula and then, an intense storm started over the Mediterranean area with strong and humid winds which came from the nearby sea bringing large amounts of rain. The sea storm and heavy rains continued on 21<sup>st</sup> and 22<sup>nd</sup>. From 23<sup>rd</sup> its effects focused on the southeast region and continued active on 24<sup>th</sup> and 25<sup>th</sup>. On 26<sup>th</sup> January it finally moved away towards Italy (AEMet; Amores *et al.*, 2020).

Gloria intensely affected the territory of Catalonia between 19<sup>th</sup> and 23<sup>rd</sup> January. The northeast extreme (province of Girona) was the area where it rained the most, with precipitation ranging from 350 to 500 mm. It also rained heavily in the southern extreme (south and center of the Tarragona province), with precipitation ranging from 250 to 320 mm. There were also significant rains in the descent direction in the province of Barcelona (100-230 mm), east of the province of Tarragona (180-200 mm) and lesser amounts in the inner province of Lleida (60-110 mm) (AEMet; Figure 1). The shoreline was also severely damaged by the power of the waves which were up to 14.77 meters in height and coming from the east (Amores *et al.*, 2020). Rivers experienced a rapid increase in their volume and many of them overflowed and caused flooding (Table 1). These huge rivers' outflow also caused a big number of freshwater turtles to be first dragged by the rivers current and later tossed by the waves on the landing sea beaches.

The Western Mediterranean pond turtle (Verissimo *et al.*, 2016), Mediterranean pond turtle, Spanish terrapin or Mediterranean stripe-necked terrapin (Bertolero & Busack, 2017) (*Mauremys leprosa*) and the Pond slider (*Trachemys scripta*) are the most frequent species in Catalonia's wetlands. *Mauremys leprosa* (Stripe-necked turtle hereafter), is a freshwater turtle species that can grow more than 200 mm in straight carapace length, it has an Ibero-Magrebi distribution, and it is widely distributed in the Iberian Peninsula (Díaz- Paniagua *et al.*, 2015; Bertolero & Busack, 2017). In Catalonia it has recently undergone a considerable increase in population size (Franch *et al.*, 2015). This can be attributed to four main



**Figure 1:** Rainfall map of Catalonia during Storm Gloria (19<sup>th</sup> to 23<sup>rd</sup> January 2020). Data from Servei Meteorològic de Catalunya (<http://meteo.cat>).

**Figura 1:** Distribución de las precipitaciones en Cataluña durante la tormenta Gloria (19 al 23 de enero de 2020). Datos extraídos del Servei Meteorològic de Catalunya (<http://meteo.cat>).

reasons: massive selling as pets for several years, listing as a protected species in Catalonia since 1988, improvement of the water quality of the rivers after the setting of water treatment plants and, finally, the release of sized and captive turtles into the wild as considered an autochthonous species. The other native freshwater turtle, the European pond turtle (*Emys orbicularis*) is scarcer and its populations are more scattered (Mascort & Budó, 2017).

On the other hand, the Pond slider can reach more than 250 mm of straight carapace length, it began to be sold as a pet around 1983, its presence in the wild is common since the mid-nineties, and at the end of that decade it was already free-range breeding (Martínez-Silvestre *et al.*, 2015). In Spain *T. scripta*, *Pseudemys peninsularis* and *Chrysemys picta* are considered as invasive species under the current regulation (RD 630/2013), but not yet many other exotic species found in the wild.

After Storm Gloria's passing, all spotted freshwater turtles were collected by the brigades of clean-up volunteers. Those animals and other turtles found by ramblerers were han-

ded in at three official rescue centers: 1) Torreferrusa Wildlife Recovery Center in Santa Perpetua de la Mogoda (Barcelona), 2) The CRARC (Amphibian and Reptile Recovery Center of Catalonia) in Masquefa (Barcelona), and 3) The CRT l'Albera (l'Albera Turtle and Tortoise Captive Breeding Center) in Garriguella (Girona). Some other animals were entrusted to the "Fundació Emys" in Riudarenes (Girona), whilst the "Canal Vell" Wildlife Centre in Deltebre (Tarragona) did not record any rescued freshwater turtle after the storm.

Nine sections of Catalonia's coastal area were selected, matching the beaches adjoining the mouth of the main rivers in Catalonia. All rescued turtles were assigned to one of these nine sections based on their geographic location after the storm. In these sections there were differences in terms of the numbers of stretches that were surveyed and the time elapsed between the passing of the storm and the access to the beaches: this fact is reflected in the results. For instance, most of the peri-urban area of the river Tordera was promptly and consistently

**Table 1:** Flow volume of rivers in Catalonia before and after Storm Gloria's passing. Data from ACA (Agència Catalana de l'Aigua) and CHE\* (Confederación Hidrográfica del Ebro).

**Tabla 1:** Caudal de los ríos en Cataluña antes y después del paso de la tormenta Gloria. Datos extraídos de ACA (Agència Catalana de l'Aigua) y de CHE\* (Confederación Hidrográfica del Ebro).

River	Station	Distance to the sea (km)	Flow before 20 <sup>th</sup> Jan (in m <sup>3</sup> /s)	Maximum flow (day)	Maximum flow (in m <sup>3</sup> /s)
Muga	Castelló d'Empúries	4	0.7	22 <sup>nd</sup> Jan	385
Fluvià	Espionellà	40	0.4	24 <sup>th</sup> Jan	1469
Ter	Torroella de Montgrí	7	5.6	23 <sup>rd</sup> Jan	633
Tordera	Fogars de la Selva	14	1.4	23 <sup>rd</sup> Jan	376
Besós	Santa Coloma de G.	2	2.9	22 <sup>nd</sup> Jan	503
Llobregat	Sant Joan d'Espí	12	3.8	24 <sup>th</sup> Jan	1330
Foix	Castellet i la Gornal	9	0.1	22 <sup>nd</sup> Jan	30
Gaià	Vilabella	20	0.2	22 <sup>nd</sup> Jan	30
Francolí	Tarragona	1	1.6	23 <sup>rd</sup> Jan	115
Ebre*	Tortosa	45	368	24 <sup>th</sup> Jan	846

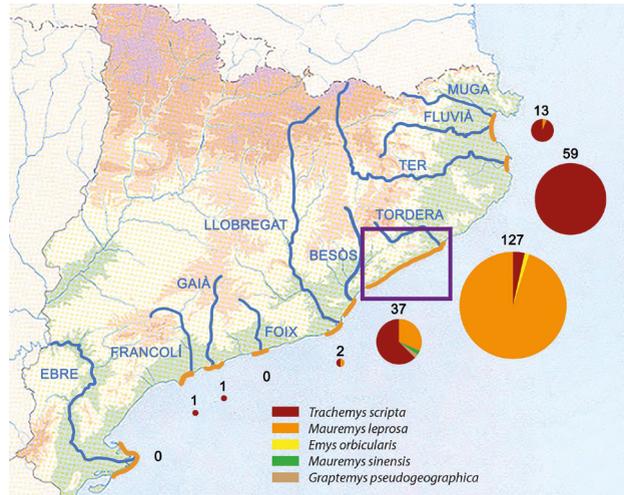
scanned, while at the other end, the remote beaches surrounding the Ebro River delta received less attention.

During the samplings 240 freshwater turtles were located in seven out of the nine sampling locations (Figure 2). The recovered turtles belonged to five different species: the native Stripe-necked turtle (*M. leprosa*) and the European pond turtle (*E. orbicularis*), plus three other introduced species: the Pond slider (*T. scripta*), the Chinese stripe-necked turtle (*Mauremys sinensis*) and the False map turtle (*Graptemys pseudogeographica*) (Table 2).

The number of rescued males and females was similar and the different age groups of both the Stripe-necked turtle and the Pond slider appeared to be well represented, including neonates and old animals. On the other hand, almost no turtles were recorded from the southern half of the study area, although all rivers had a huge increase in their flow. Nevertheless, the Foix, Gaià and Francolí southern rivers' small catchment area received less rain, have dams reducing their flow and only host a reduced number of turtles. In addition, southern beaches received less attention, so the number of turtles found there was probably underestimated.

Furthermore, turtles were rescued from the beaches up to two months after the storm because as ectotherms they are limited by their reduced mobility during the winter season. However, while Stripe-necked turtles appeared alive and only with a few scratches –except for a single dead animal–, many of the Pond sliders were found with eroded carapaces or plastrons, and a few other specimens were found dead several days after Storm Gloria's passing.

Next, we will report the results for each of the sampling locations.



**Figure 2:** Freshwater turtles rescued at the beaches in Catalonia after Storm Gloria's passing.

**Figura 2:** Tortugas acuáticas rescatadas en las playas de Cataluña después del paso de la tormenta Gloria.

**Rivers Muga and Fluvia:** These two rivers merge in the Gulf of Roses and make up a single unit, washed by two rivers. There is a genetically differentiated and well-preserved Stripe-necked turtle population around the middle-upper basin of the River Muga (Palacios *et al.*, 2015). These turtles are outnumbered by the Pond sliders at the wide and slow-flowing end of the river. Moreover, the last section of the River Fluvia flows through a wide and deep riverbed, also with the presence of Pond sliders. On the other hand, there is a good population of the Stripe-necked turtle in a protected area behind the beaches of the Gulf of Roses but, like the Pond slider there, they inhabit channels and ponds that were unaffected by the increase in flow of both rivers. Not all of the beaches were surveyed and some of them were only inspected some days after the Storm (Figure 3). In total, 11 *T. scripta* and two *M. leprosa* were found.

**Table 2:** Freshwater turtles rescued at the beaches in Catalonia after Storm Gloria's passing.  
**Tabla 2:** Tortugas acuáticas rescatadas en las playas de Cataluña después del paso de la tormenta Gloria.

River	<i>Mauremys leprosa</i>	<i>Emys orbicularis</i>	<i>Trachemys scripta</i>	<i>Mauremys sinensis</i>	<i>Graptemys pseudogeographica</i>	TOTAL
Fluvià / Muga	2	0	11	0	0	13
Ter	0	0	59	0	0	59
Tordera	122	1	4	0	0	127
Besòs	15	0	20	1	1	37
Llobregat	1	0	1	0	0	2
Foix	0	0	0	0	0	0
Gaià	0	0	1	0	0	1
Francofí	1	0	0	0	0	1
Ebre	0	0	0	0	0	0
<b>TOTAL</b>	<b>141</b>	<b>1</b>	<b>96</b>	<b>1</b>	<b>1</b>	<b>240</b>

**River Ter:** The final section of the river has slow moving and shallow waters with interspersed small islands and abundant riverbank vegetation. A few hundred Pond sliders live in this section of the river and they thrive in suitable habitat for the species. Some of the rescued turtles were old animals, with males

displaying melanistic features and revealing the existence of a long-term settled population (Figure 4). In addition, since 2005 more than 500 juvenile European pond turtles have been released in the wetlands of the lower basin of the Ter river (Mascort & Budó, 2017). However, none were found on the bea-



**Figure 3:** The beach of Sant Pere Pescador between the mouths of rivers Muga and Fluvià after Storm Gloria's passing, one of the most affected beaches in Catalonia.  
**Figura 3:** La playa de Sant Pere Pescador entre la desembocadura de los ríos Muga y Fluvià después del paso de Gloria, una de las playas más afectadas en Cataluña.



**Figure 4:** Plastron of two adult females and one old male Pond slider rescued from one of the beaches close to the mouth of river Ter.  
**Figura 4:** Plastrón de dos hembras adultas y un macho viejo de tortuga de Florida rescatados en una de las playas próximas a la desembocadura del río Ter.

ches after the storm. Furthermore, 15 days after Gloria's passing, four adult Pond sliders were found dead on the beach north of the river. The southern half of the beaches in this unit were not routinely surveyed. In total, 59 *T. scripta* were found.

**River Tordera:** The Tordera is a river with surface waters and an intermittent course on a sandy substrate where there is an abundant population of Stripe-necked turtles. The long beaches to the south of the river mouth and their straight-line northeast-southwest orientation eased the stranding of turtles along the Maresme county shore during the storm, which mainly struck in an east-west direction (Figure 5). In Malgrat de Mar and at a short distance from the mouth of the river (0 – 4.0 km), 41 turtles were rescued, accounting for the 32% of the total in this unit. Further south, the breakwater at the port of Arenys de Mar (19.0 km) acted as a sediment trap, intercepting 23 turtles: 18% of the total (Figure 6). Also in Arenys de Mar, four Pond sliders and a two-year-old European pond turtle were found, with the latter showing the morpho-

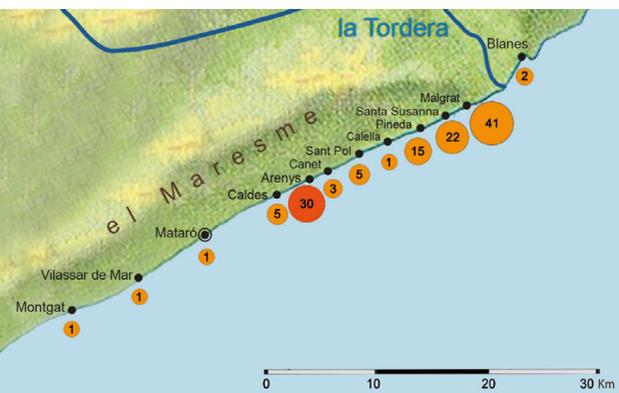


**Figure 6:** Adult Stripe-necked turtle while moving on Arenys de Mar beach.

**Figura 6:** Galápago leproso adulto desplazándose en la playa de Arenys de Mar.

logical traits of the populations from the core of the river basin, located approximately 25 km upstream from the sea (Figure 7). Further south, on Caldes d'Estrach (22.2 km), five more Stripe-necked turtles were collected while three other specimens were rescued even further south, in Mataró (30.2 km), Vilassar de Mar (35.3 km) and Montgat (44.7 km), possibly also coming from the river Tordera. In addition, three Stripe-necked turtle hatchlings were rescued on the Maresme beaches but died shortly afterwards, from an unknown cause. This unit was the most surveyed area. In total, 121 *M. leprosa*, four *T. scripta* and one *E. orbicularis* were found.

**River Besòs:** The River Besòs is an example of a river-course recovery after several decades of abuse in the form of communal and industrial discharges. Water treatment plants and a strict control of illegal emissions turned it into a river with clean waters and it had already a controlled ecological flow before the turn of the Century. Nevertheless, the vicinity of its final section to three large urban areas (Bar-



**Figure 5:** Freshwater turtles rescued at the Maresme county beaches after Storm Gloria's passing.

**Figura 5:** Tortugas acuáticas rescatadas en la comarca del Maresme después del paso de la tormenta Gloria.



**Figure 7:** Two-year-old European pond turtle rescued at Arenys de Mar beach.

**Figura 7:** Galápago europeo de dos años de edad rescatado en la playa de Arenys de Mar.

celona, Santa Coloma de Gramanet and Sant Adrià del Besòs) entails the constant appearance of released native and invasive turtles' species. In total, 20 *T. scripta*, 15 *M. leprosa*, one *M. sinensis*, and one *G. pseudogeographica* were found.

**River Llobregat:** The area around the mouth of the river Llobregat is a protected area of wetlands with a strong anthropic impact where industrial zones, the port and the airport of Barcelona meet. In these wetlands there is a population of Stripe-necked turtles that compete for the same space with Pond sliders (Franch *et al.*, 2007). In 2004, more than three kilometers of the final stretch of the river were diverted, although large amounts of funding have been invested for recovering and maintaining its ecological resources. Moreover, the areas which are most frequented by turtles are the channels and protected lagoons adjoining the river delta and, although the Storm caused a huge increase in the river flow, only two turtles were found at the nearby beaches. In total, one *M. leprosa* and one *T. scripta* were found.

**River Foix:** The River Foix is a short seasonal Mediterranean river, while the Foix reservoir, located 6.5 km from its mouth, retains most of the river's flowing water. A big population of Stripe-necked turtles lives in this artificial lake although other non-native species such as *T. scripta*, *G. pseudogeographica* or *Pseudemys floridana* have been found. Stripe-necked turtles also inhabit a few ponds upstream that hold water all year-round and a small wetland near the mouth of the river where also a few Pond sliders have been reported (Martínez-Silvestre *et al.*, 2013). We should mention that no active searching was organized and, thus, no turtles were collected.

**River Gaià:** The River Gaià is also a seasonal river with only two stretches with permanent water: the Catllar reservoir, 11.0 km from its mouth, and a section of brackish waters before reaching the sea. Some native and other introduced turtles live in these two areas. Living in the stagnant wet-zone near the sea, there are a few Stripe-necked turtles, two other introduced turtle species specimens (*Chrysemys picta* and *Pseudemys concinna*) and egg-laying and hatchlings of the Pond slider have been documented (Martínez-Silvestre *et al.*, 2011). The beach sections near the river mouth were not systematically surveyed. Only one *T. scripta* was found.

**River Francolí:** Like the abovementioned Foix and Gaià, the River Francolí has an intermittent water regime, which does not flow during the dry summer season. Striped-necked turtles are present in the main river-course and nearby wetlands, although in low numbers. Also a few Pond sliders have been documented from the same area (Ortiz, 2014). The river discharges into the port of Tarragona and only one Stripe-necked turtle

was incidentally recorded to the south of the city, while no beach inspection was undertaken. Only one *M. leprosa* was found.

**River Ebre:** In the river-delta wetlands there is a European pond turtle population inhabiting lagoons and channels that is being reinforced with captive bred animals. Likewise, there is a population of the Stripe-necked turtle upstream. Furthermore, the lower course of the river with its wide, deep channel and flushing current does not appear suitable for turtles. Although the storm severely hit the shore of the river-delta (Amores *et al.*, 2020), the river's flow was not excessively affected by Gloria due to an uneven rainfall pattern during the episode, with only localized heavy rains in some areas of its extensive basin. Since no intensive search was done, no turtles were collected.

Storm Gloria highlighted the important hydrologic consequences of storms in the western Mediterranean area, which are recently being magnified by climate change. After the storm, uprooted turtles first traversed undetermined distances, while being swept along by rivers' current and then, they travelled another variable distance, while being shifted by the waves towards the landing location, which in cases was several tens of kilometers away from river mouths.

The displacement of freshwater turtles caused by the power of rivers can lead to new settlements in areas where species have been depleted. In the present case, the appearance of more than one hundred Stripe-necked turtles along the Maresme county coastline reached 22.2 km distance from the river Tordera mouth for five turtles at Caldes d'Estrach and possibly a journey with a maximum of 44.7 km for one turtle that was found at Montgat. This

fact emphasizes the survival capability of Stripe-necked turtles in the open sea and their potential to arrive to distant landing sites. In this sense, and in the case of the eastern related species, the Balkan terrapin (*Mauremys rivulata*) (Zhou *et al.*, 2015), Vamberger *et al.* (2014) found great genetic similarity between populations that were kept apart by different geographic barriers and they ascertained that the only possible explanation for this pattern is gene flow across the sea. In contrast, Veríssimo *et al.* (2016) found great diversity in the genetic structure of the Stripe-necked turtle from north-west Africa (Morocco) and concluded that the isolation caused by the east-west mountain barriers determined the appearance of subspecies. They also noted that the species may have reached the Iberian Peninsula during the Chibanian or Middle Pleistocene (770 – 126 kyr) and again –and recurrently– in the Tarranian or Upper Pleistocene (126 – 11,7 kyr), crossing from north Africa and bypassing the currently 14.4 km-long strait of Gibraltar barrier, consequently using their colonizing capacity across the sea. As for the Stripe-necked turtle, Velo-Antón *et al.* (2015) also noted a double colonization of the Iberian Peninsula by the European pond turtle coming from North Africa, comprising of a first arrival during the Pleistocene followed by a second and more recent arrival.

Furthermore, the massive displacement of freshwater turtles due to the strength of Storm Gloria suggests that in Catalonia those animals sometimes inhabit anthropogenic or degraded habitats to the detriment of the normal development of their life cycle. In this direction, Chelazzi *et al.* (2007), Alarcos *et al.* (2008) and Serrano *et al.* (2019) in northern Greece, western Spain and southern Portugal respectively, highlighted the importance of terrestrial habi-

tats for the three officially recognized native European freshwater turtles (Speybroeck *et al.*, 2020) and this remark includes areas for seasonal movements, reproductive purposes, egg-laying or hibernation. Therefore, it is important to conceive the habitat of freshwater turtles as a wide and diverse space and this concept must be implemented when creating protected areas, planning habitat conservation or designing restoration projects. It is also necessary to continue with the eradication programs that are conceived for invasive turtles in Catalonia which have given excellent results in the Lake of Banyoles or in some areas of the protected wetlands of the northern counties of l'Alt and Baix Empordà, where hundreds of alien turtles have been removed and where they have been almost eradicated.

**ACKNOWLEDGEMENTS:** To Agrupament Flos i Calcat from Arenys de Mar, P. Allain from Canet de Mar, Associació Arenys pel món from Arenys de Mar, A. Bertolero (river Ebro delta), A. Cufí (CRT l'Albera), O. Curto and O. Ferran from Arenys de Mar, E. Filella (Societat Catalana d'Herpetologia), E. Garcia (Agència Catalana de l'Aigua), H. Hernández (Associació la Sinia), J. Mayné (Centre de Fauna de Torreferrusa), B. Minobis (Centre de Fauna dels Aiguamolls de l'Empordà), D. Perpiñán (Nature Picture Library), S. Poch (Ajuntament de Malgrat de Mar), E. de Roa (Ajuntament del Prat de Llobregat), F. Santaefèmia (Espais Naturals del Delta del Llobregat), J. Serra (Associació Nàutica Llevantina), P. Sunyer (Fundació Emys), A. Tarragó (Servei de Fauna i Flora de la Generalitat de Catalunya), B. Weitzmann (Parc Natural del Montgrí, Illes Medes i Baix Ter), A. Xarles (Digital Esteve). Also special thanks to E. Gracià for the revision of the text, M. Copley for the proofreading and A. Gosà for editing the final version.

## REFERENCES

- AEMET. Borrasca Gloria. <[http://www.aemet.es/es/conocermas/borrascas/2019-2020/estudios\\_e\\_impactos/gloria](http://www.aemet.es/es/conocermas/borrascas/2019-2020/estudios_e_impactos/gloria)>. [Accessed: 01 March 2020].
- Alarcos, G., Ortiz-Santaliestra, E., Fernández-Beneitez, M.J., Lizana, M. & Madrigal-González, J. 2008. Preliminary data on the structure of freshwater turtle populations (*Emys orbicularis* and *Mauremys leprosa*) in a stream in the Natural Park of Los Arribes del Duero (Zamora, Spain). *Revista Española de Herpetología*, 22: 33-43.
- Amores, A., Marcos, M., Carrió, D.S. & Gómez-Pujol, L. 2020. Coastal Impacts of Storm Gloria (January 2020) over the Northwestern Mediterranean. *Natural Hazards and Earth Systems Science*, 20: 1955-1968.
- Bertolero, A. & Busack, S.D. 2017. *Mauremys leprosa* (Schoeffer in Schweigger 1812) - Mediterranean Pond Turtle, Spanish Terrapin, Mediterranean Stripe-necked Terrapin. In: Rhodin, A.G.J., Iverson, J.B., van Dijk, P.P., Buhlmann, K.A., Pritchard, P.C.H., & Mittermeier, R.A. (eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC-TFTSG. *Chelonian Research Monographs*, 5(10):102.1-19. doi: 10.3854/crm.5.102.leprosa.v1.2017; <<https://iucn-tftsg.org/cbftt/>> [Accessed: 01 April 2020].
- Chelazzi, G., Naziridis, T., Benvenuti, S., Ugolini, A. & Crivelli, A.J. 2007. Use of river-wetland habitats in a declining population of the terrapin (*Mauremys rivulata*) along the Strymon River, northern Greece. *Journal of Zoology*, 27: 154-161.
- Díaz-Paniagua, C., Andreu, A.C. & Keller, C. 2015. Galápago leproso - *Mauremys leprosa*. In: Salvador, A. & Marco, A. (eds.). *Enciclopedia Virtual de los Vertebrados Españoles*. Museo Nacional de Ciencias Naturales, Madrid. <<http://www.vertebradosibericos.org/>> (versión 27-10-2015). [Accessed: 01 April 2020].
- Franch, M., Llorente, G.A. & Montori, A. 2007. Primeros datos sobre la biología de *Trachemys scripta elegans* en sin-topía con *Mauremys leprosa* en el delta del Llobregat (NE ibérico). 85-101. In: Grupo Especialista en Invasiones Biológicas (ed.). 2º Congreso Nacional sobre Especies Exóticas Invasoras. Grupo Especialista en Invasiones Biológicas, Serie Técnica 3. León.
- Franch, M., Montori, A., Sillero, N. & Llorente, G.A. 2015. Temporal analysis of *Mauremys leprosa* (Testudines, Geoemydidae) distribution in northeastern Iberia: unusual increase in the distribution of a native species. *Hydrobiologia*, 757: 129-142. doi:10.1007/s10750-015-2247-8.
- Martínez-Silvestre, A., Soler, J. & Hernández, H. 2011. Nuevos datos sobre la presencia de *Trachemys scripta* en aguas salobres del río Gaià. *Boletín de la Asociación Herpetológica Española*, 22: 151-153.
- Martínez-Silvestre, A., Soler, J. & Cano, L. 2013. La població de tortugues del Foix: balanç de deu anys de gestió. *Mono-grafies del Foix*, III: 15-16.
- Martínez-Silvestre, A., Hidalgo-Vila, J., Pérez-Santigosa, N. & Díaz-Paniagua, C. 2015. Galápago de Florida - *Trachemys scripta*. In: Salvador, A. & Marco, A. (eds.). *Enciclopedia Virtual de los Vertebrados Españoles*. Museo Nacional de Ciencias Naturales, Madrid. <<http://www.vertebradosibericos.org/>> (versión 12-11-2015) [Accessed: 15 April 2020].

- Mascort, R. & Budó, J. 2017. The European Pond Turtle, *Emys orbicularis* (L. 1758), in the River Ter Basin (North Eastern Iberian Peninsula): 40 years of Conservation. Proceedings of the 5<sup>th</sup> International Symposium on *Emys orbicularis*. Kiten, Bulgaria, August 2015. *Acta Zoologica Bulgarica, supplementum*, 10: 91-104.
- Ortiz J. (ed.). 2014. *La vida al riu Francolí. Els humans i els sistemes aquàtics*. Publicacions Universitat Rovira i Virgili.
- Palacios, C., Urrutia, C., Knapp, N., Franch, M., Bertolero, A., Simon, G., Du Preez, L. & Verneau, O. 2015. Demographic structure and the genetic diversity of *Mauremys leprosa* in its northern range reveal new populations and a mixed origin. *Salamandra*, 51(3): 221–230.
- Serrano, F., Pita, R., Mota-Ferreira, M., Beja, P. & Segurado, P. 2019. Landscape connectivity affects individual survival in unstable patch networks: The case of a freshwater turtle inhabiting temporary ponds. *Freshwater biology*, 2019;00: 1-12. <<https://doi.org/10.1111/fwb.13449>>.
- Speybroeck, J., Beukema, W., Dufresnes, C., Fritz, U., Jablonski, D., Lymberakis, P., Martínez-Solano, I., Razzetti, E., Vamberger, M., Vences, M., Vörös, J. & Crochet, P.A. 2020. Species list of the European herpetofauna - 2020 update by the Taxonomic Committee of the Societas Europaea Herpetologica. *Amphibia-Reptilia*. doi: 10.1163/15685381-bja10010.
- Vamberger, M., Stuckas, H., Ayaz, D., Lymberakis, P., Siroky, P. & Fritz, U. 2014. Massive transoceanic gene flow in a freshwater turtle (Testudines: Geoemydidae: *Mauremys rivulata*). *Zoologica Scripta*, 43: 313–322.
- Velo-Antón, G., Pereira, P., Fahd, S., Teixeira, J. & Fritz, U. 2015. Out of Africa: did *Emys orbicularis occidentalis* cross the Strait of Gibraltar twice? *Amphibia-Reptilia*, 36: 133–140.
- Verissimo, J., Znari, M., Stuckas, H., Fritz, U., Pereira, P., Teixeira, J., Arculeo, M., Marrone, F., Sacco, F., Naimi, M., Kehlmaier, C. & Velo-Antón, G. 2016. Pleistocene diversification in Morocco and recent demographic expansion in the Mediterranean pond turtle *Mauremys leprosa*. *Biological Journal of the Linnean Society*, 119 (4): 943-959. <<https://doi.org/10.1111/bij.12849>>.
- Zhou, H., Jiang, Y., Nie, L., Yin, H., Li, H., Dong, X., Zhao, F., Zhang, H., Pu, Y., Huang, Z., Song, J. & Sun, E. 2015. The historical speciation of *Mauremys sensu lato*: Ancestral area reconstruction and interspecific gene flow level assessment provide new insights. *PLOS ONE*, 10(12): e0144711. doi:10.1371/journal.pone.0144711.