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Non-native common snapping turtle *Chelydra serpentina* (Linnaeus, 1758) in Western Europe: a focus on Central Italy showing evidence of a hot spot of introduction

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Abstract. The common snapping turtle, *Chelydra serpentina* (Linnaeus, 1758), is a robust aquatic turtle native to southeast North America. However, it has also been introduced to other countries through the exotic pet trade, where it has gained popularity due to its distinctive appearance and impressive size. Over the past decade, a considerable number of individuals, abandoned by their owners, have been recorded and captured in Western Europe. Here, we report the first comprehensive summary of records at continental scale, showing that France and Italy represent the countries with the highest number of sightings. In France, exhibition, exchange, or sale events of exotic animals (until 2022 legal; now illegal) have been located near large cities, although records of *C. serpentina* were significantly higher outside the core of urban areas. We also recorded a significant increase in total number of records at European scale when comparing the periods of 2010–2015 and 2016–2020. Finally, we focused the current study on a peculiar spatial pattern at local scale (Central Italy) near an important site of exhibition and sale events of exotic animals, suggesting the presence of a hot spot of introduction. Popular events may represent critical colonization hubs from where these freshwater turtles can disperse into the surroundings.

Keywords. Alien species, biological invasion, colonization hub, illegal trade.

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The common snapping turtle, *Chelydra serpentina* (Linnaeus, 1758) is one of the largest freshwater turtles living today [1]. The characteristic carapace, brownish or greenish, usually reaches a length of

40 cm and consists of three rows of flattened and serrated scales in the back; turtles can have a weight of up to 12 kg [2].

Chelydra serpentina is native to North America, occurring from the Rocky Mountains to the entire east coast of the United States, from Nova Scotia and the Great Lakes to the north, up to the Mississippi River and Texas [2]. The species primarily feeds on crustaceans, fish, amphibians, small birds, mammals, and aquatic plants and can inhabit rivers, ponds, reservoirs, canals, and wetlands [3][4]. In the wild, individuals of *C. serpentina* have an estimated lifespan of up to 30 years, while in captivity they can live for up to 47 years [5–6]. Once they reach larger sizes, snapping turtles have relatively few natural predators, despite some mortality risks due to cars while they are moving to search optimal conditions [5] [7–8].

Besides its Nearctic native range, the species has been introduced into many countries in Central and South America (e.g., Mexico, Honduras, Costa Rica, Panama, Ecuador), Europe (e.g., England, Sweden, Germany, Netherlands, France, Italy, Spain) and Asia (e.g., Japan, China, Malaysia) [9–12]. In fact, in the international pet-trade [2][5][9], *C. serpentina* is a popular species due to its characteristics and the important dimensions reached as an adult [13]. However, because of their beak and strength of the bite, in addition to the fast attack abilities, adults of this species can inflict severe injuries on people who improperly handle them [14–15]. Therefore, these snapping turtles are frequently bought by private individuals and then, although infrequently, abandoned [16].

In this study, for the first time, we provide a review of records of this non-native species for Western Europe using different sources (direct and indirect data: web-social, grey literature and original observations), obtaining a coarse-grained list of sites and a time distribution of records within the 2010–2023-time range. We also carry out a survey on the most important exhibition, exchange, or sale events of exotic animals in two countries (France and Italy), showing the highest number of records of *C. serpentina*. We compare frequencies of occurrence at different sites and time intervals (strictly urban vs. outside the core of urban areas; five-year periods).

Moreover, we conduct an in-depth analysis in a specific region of Central Italy (Latium; the ninth largest region of Italy, 17207 km^2) where, recently, we obtained a large amount of fine-grained data at local scale, showing a peculiar clustered spatial pattern of records.

The local reports of *C. serpentina* in Central Italy are derived from original observations, web reports and bibliography sources, confirmed by official reports, all archived in the databases of the Office of Biodiversity of the Forestry Police ('Carabinieri Forestali') and the Observatory for Biodiversity of Lazio (Department of Biology; University of Rome 2 'Tor Vergata'). Finally, we discuss the causes of our findings, and suggest suitable measures for the management of the recovered specimens.

For all of Western Europe, we obtained a total of 187 records of *C. serpentina* (2010–2023 period), mainly concentrated in France (n = 127; 68.4%) and, secondarily, in Italy (n=42; 22.5%; Fig. 1; see Supplementary material 1).

The comparison between two five-year periods (2010–2015 vs. 2016–2020) showed a significant difference in the total number of records at the Western European scale ($\chi^2=2.04$, $p=0.018$; Table 1). The events of exhibition, exchange, or sale of exotic animals in France appeared to be mainly located in large cities (e.g., Paris, Marseille, Montpellier, Bordeaux, Toulouse). However, the occurrence of *C. serpentina* in France seemed clustered too far away from these major cities to show a pattern of aggregation. In fact, we obtained a significantly higher number of records outside the core of urban areas (n=73), when compared to urban sites (n=54; $\chi^2=5.685$, $p=0.023$, 1 d.f.). A possible explanation of this contrasting pattern (events in cities vs. records outside the core of urban areas) could be due to a

TABLE 1

Records of non-native common snapping turtle, *Chelydra serpentina*, in Western Europe countries (last row, in italic: the local case, in Central Italy), subdivided for time periods. In the last two columns data have been clustered in five-year periods.

	Time range distribution of records						Five-year periods	
Country	**2001**	**2010–2012**	**2013–2015**	**2016–2018**	**2019–2020**	**>2021**	**2010–2015**	**2016–2020**
Belgium				1	2	1		3
France		17	44	55	5	6	61	60
Germany	1			1	5	1		6
Netherlands				1		3		1
Spain						1		
Italy		9	6	8	11	8	15	19
Western Europe	1	35	56	74	34	28	76	89
Latium (Central Italy)		6	4	1	4	6	10	5

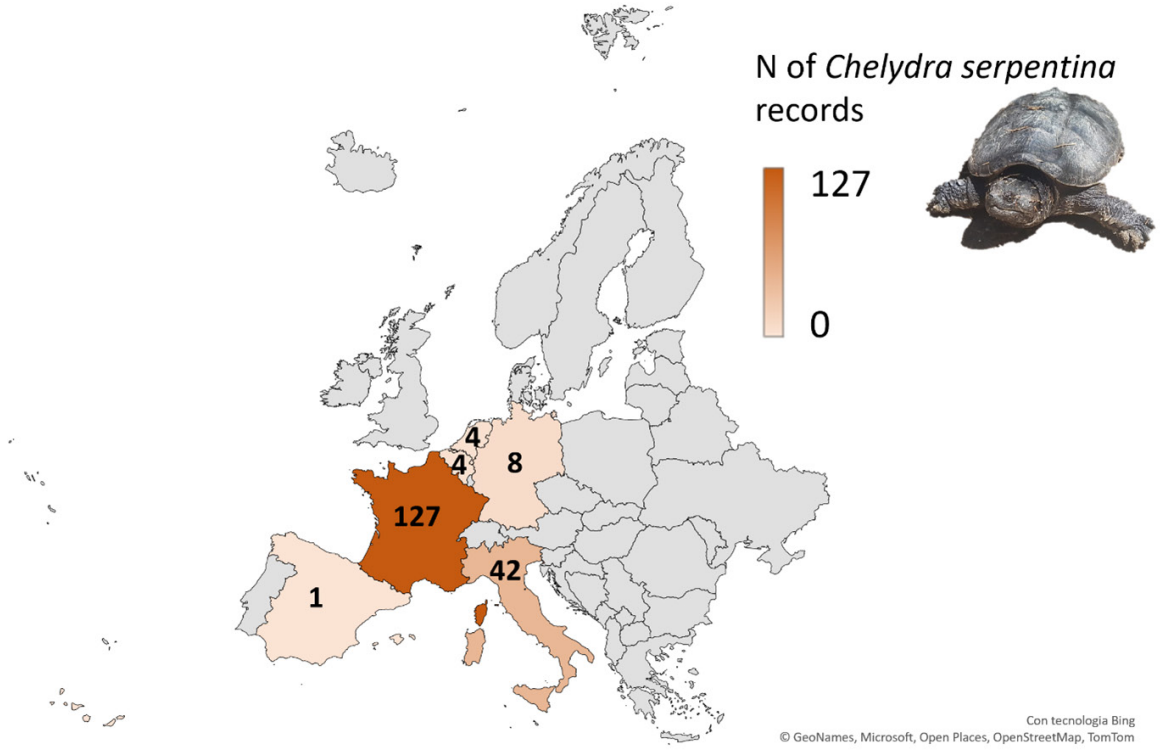

Figure 1 – Number of records of common snapping turtle, *Chelydra serpentina*, in Western Europe, as obtained by web sources and scientific literature (see Supplementary material for details).

non-random release of turtles by people who actively select the ponds they consider more suitable for their pet animals [see, e.g., for *Trachemys scripta*: 17].

At a local scale, in Central Italy, we observed a particularly high number of records in Latium, corresponding to half of the data at national level (n = 21; Table 2; Fig. 2) [18]. The captured individuals (all measuring between 30 and 40 cm, corresponding to adult-sized specimens) have been entrusted by the Forestry Police (CITES Offices) to authorized recovery centres. The turtles' bodies were observed to be often covered in clotted or greenish mud, caused by the proliferation of filamentous algae (see, e.g., [19–20]).

Most records were situated near the Tiber River (frequency = 0.47), followed by roads being distant from water sources (0.26); private pools and wetlands each accounted for the same frequency (0.11), while public parks showed the highest frequency (0.53). Differences among frequencies were significant ($\chi^2 = 76.6$; $p < 0.001$, 4 d.f.). However, when comparing the two five-year periods (2010–2015 vs. 2016–2020), no significant differences were observed in the number of records ($\chi^2 = 3.33$; $p = 0.14$, 1 d.f.; Table 2).

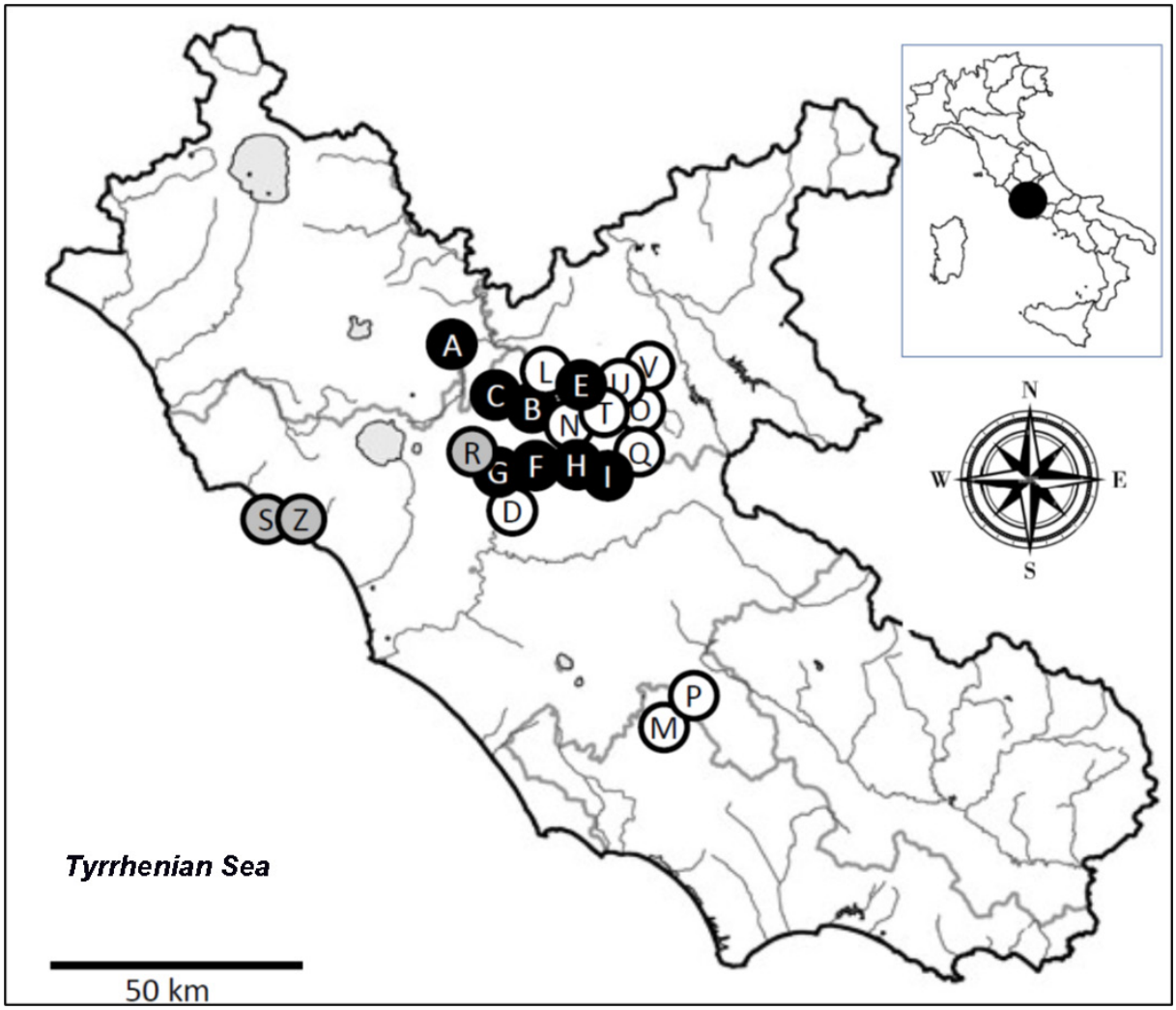

Figure 2 – Map of the focus study area (Latium, Central Italy) and sites (from A to Z) with records of the non-native common snapping turtle, *Chelydra serpentina*. Black circles: records from literature; grey circles: original records; white circles: records from social-web sources.

TABLE 2

Records of non-native common snapping turtle, *Chelydra serpentina*, in Latium region (Central Italy). Record number, location (the administrative provinces are indicated: RI=Rieti; RM=Rome; VT=Viterbo), longitude and latitude (UTM 33 T), date, source of record (B=bibliography, with references; S=web-social; o=original), and eventually notes (from a to l) are reported.

	Site	Longitude	Latitude	Date	Source	Reference or notes
A	Tiber River, Scalo Teverina, Gallese (VT)	290522	4694798	2011	B	[14]
B	Tiber River, Filacciano (RM)	301757	4682538	2011	B	[14]
C	Tiber River, Ponzano Romano (RM)	298677	4683766	2012	B	[14]
D	Fidene (RM), Peter Pan play area	293911	4650378	2012	S	a
E	Tiber River, Poggio Mirteto (RI)	304494	4678669	2012	B	[14]
F	Roads SP15a/SP6c, Castelnuovo di Porto (RM)	298699	4663168	2014	B	[14]
G	Tiber River near Colle Salario (RM)	293418	4650700	2014	B	[14]
H	Tiber River, Monterotondo Scalo (RM)	298780	4659919	June 2014	B	[14]; b
I	Tiber River, Monterotondo Scalo (RM)	298780	4659921	August 2014	B	[14]
L	Tiber River banks near Stimigliano (RI)	298672	4684739	18 Sept. 2012	S	c
M	Provincial road Cori-Cisterna (Latina), Cesaponzolo	324012	4608574	14 June 2016	S	d
N	Via Tiberina, Castelnuovo di Porto (RM)	300358	4662829	20 May 2020	S	f
O	Monterotondo Scalo, Tiber River (RM)	300531	4661336	30 May 2020	S	g
P	Locality of Doganella di Ninfa (LT)	327069	4604236	18 June 2020	S	m
Q	Private pool (Monteverde Nuovo, RM)	287489	4637686	17 May 2022	S	h
R	Le Palme Lake (Castel Giubileo, Rome)	292821	4651646	1 April 2023	O	e
S	Coastal wetland Torre Flavia (RM)	259676	4646140	14-Apr-23	O	i
T	Private garden (Capena, RM)	296757	4668397	18 May 2023	S	n
U	Provincial Road, Capena-Morlupo (RM)	296523	4670226	21 May 2023	S	o
V	Provincial Road Capena-Morlupo (RM)	296466	4670361	2 June 2023	S	o
Z	Coastal wetland Torre Flavia (RM)	259676	4646140	9 August 2023	O	l

Notes: (a): https://www.newsby.it/cronaca/trovata-una-tartaruga-azzannatrice-sulle-rive-del-tevere/;
(b): Large female, observed in attempt of nesting;
(c): https://roma.corriere.it/roma/notizie/cronaca/12_settembre_18/tartaruga-azzannatrice-sequestrata-2111866603276.shtml;
(d): about 7 kg in weight;
(e): recorded in a pond for sport fishing on Tiber riverside. Adult fished with fishing line at bottom. Individual photographed and filmed. Tony Scaringi (pers. obs.), Daniele Marini (determinavit). Database Societas Herpetologica Italica, Latium Section;
(f): specimen about 30 cm long;
(g): https://www.romatoday.it/cronaca/tartaruga-azzannatrice-tevere.html;
(h): Monteverde Nuovo (Rome), in a private fountain of a condominium courtyard where it occurs together with the goldfish; https://www.fanpage.it/roma/stava-per-mordere-mia-figlia-catturata-tartaruga-azzannatrice-in-un-condominio-romano/;
(i): carapace length: 30 cm long; tail: 28 cm; head: 10 cm; total length 68 cm;
(l): carapace length: 27 cm; 2 years old, healthy specimen;
(m) Observation of F. Cervoni and G. Ungolo: https://www.inaturalist.org/observations/130245774;
(n) https://tiburno.tv/2023/05/17/capena-catturata-in-un-tereno-una-tartaruga-azzannatrice/;
(o) https://www.kodami.it/tartaruga-azzannatrice-trovata-a-morlupo-lesperta-il-suo-morso-possibile-veicolo-di-infezioni/.

Despite the prohibition on the sale and possession of *C. serpentina* in Italy, occasional records were still reported over the last decade [21–22]. The most accredited hypothesis of these findings is that turtles are illegally bought abroad and then abandoned as they are difficult to manage. In fact, the size of individuals in captivity increases rapidly in the early years of life (e.g., [23]). As a result, the critical size at which their bite can pose a potential danger can be attained as early as three years after a careless purchase. Furthermore, in the past three years, the media have extensively focused on non-native fauna and the regulations governing the trade of this species. In Italy, *C. serpentina* is included among the species considered dangerous for health and public safety [24]. Italian law has prohibited its trade and detention: violators are subject to arrest for up to three months and a sanction of up to 100 000 Euros [24–25]. This has likely prompted illegal owners of *C. serpentina* to opt for the quickest route to avoid any legal issues, which is abandoning the turtles in the nearest water body.

In our case study, interestingly, most *C. serpentina* observations were clustered north of Rome (Table 2; Fig. 2). In this regard, it is not plausible that all the 'careless' owners would release their illegal snapping turtles in the stretch of river between Ponzano Romano and the large dam on the Tiber River at Castel Giubileo, located on the outskirts of Rome. A possible explanation for the high number of clustered records in the centre of this area could be the organization of a big annual event that has gained significant popularity and recognition over the past three decades: the International Exotic Animal Fair in Fiano Romano, one of the most important exhibition, exchange and sale events of exotic animals in Italy (Supplementary material 3). It is worth noting that instances of 'escaped' reptiles have previously occurred in the surroundings of this fair. For example, in 2015, five individuals of *Pantherophis guttatus* (Linnaeus, 1766) were documented in this area [26]. Regarding *Chelydra serpentina*, it is plausible to hypothesize that a specific group of animals from this species were abandoned by people who, upon the commencement of the event, became aware of the illegal nature of owning and trading them under the current Italian laws.

Alternatively, the numerous recent records of specimens along this stretch of the Tiber River and surrounding town could suggest that some individuals of *C. serpentina* were born from a female abandoned in the area, like the one observed exhibiting reproductive behaviour [14]. However, there is currently no targeted monitoring, and no evidence of reproduction in Italy has been found so far. No hatchlings have been discovered in the wild, so this finding can only suggest, rather than prove, the presence of reproduction [27].

It would be necessary to conduct more frequent and extensive monitoring in this specific area. Additionally, distributing a questionnaire to angling groups that regularly visit the Tiber River would enable timely reporting of the presence of specimens.

Furthermore, it is essential to prioritize the verification of captive individuals currently residing in wildlife centres authorized by the Italian Ministry of the Environment. In fact, there is a need that the technicians and operators monitoring the protected areas of Latium, as well as the Forestry Policy ('Carabinieri - Biodiversity – CITES'), have an overall knowledge of the animals housed in these centres. Finally, it is mandatory to establish clear and well-defined procedures for promptly collecting and delivering animals to specialized centres. These procedures should be effectively communicated to the public, ensuring that any recovered animals can be immediately handed over to the competent authorities.

The issue of non-native species, such as *C. serpentina*, is undoubtedly of fundamental importance and requires attention. On a continental scale, our data showed an uneven distribution among countries (with France and Italy being overrepresented), while on a local scale, we observed a peculiar spatial pattern of records, clustered in the surrounding of a site where events are held where these animals are probably sold, even illegally. Moreover, the higher number of local records could maybe be due to releases from

sellers when encountering controls. Therefore, we suggest a more regular monitoring of this possible hot spot of introduction with defined, rapid protocols for the capture and transfer of animals seized by the authorities to specialized centres.

Regulation of *C. serpentina* in Western Europe is very heterogeneous between countries. In some countries where the trade of exotics is more widespread, an obligation to mark all individuals individually and to register purchases in a national database is or has already been made. Therefore, in a few years from now, it should become difficult for any abandonments not to be followed by sanctioning processes, including criminal ones in some countries, if the species involved are non-native. In Italy, trade fair events are not controlled: that is, sellers do not declare in advance what they will present and sell. More checks on sellers are needed to prevent abandonment of exotic species including *C. serpentina* as it is already mandatory in several countries, including France [28].

Further research is also needed to verify if this local pattern with a 'hub' of introduction is recurrent in other European countries by analysing data at finer scales (i.e., at local level). A first screening for France of only large events showed how these events are limited exclusively to large cities (Supplementary material 2), while the distribution of *C. serpentina* appears to be significantly more frequent outside the core of urban areas. In contrast to France, in Italy, such events were held only occasionally in large cities (e.g., Naples, Bologna), while all others were organized in small urban towns (Rovigo, Pordenone, Mantua, Busto Arsizio; Supplementary material 3). However, these first data are only explorative and further research remains necessary. For example, it could be interesting to investigate whether analogous aggregations of records like those we detected in Latium are observed around other towns. This is urgent: in France, there is already evidence of naturalization of females that have reproduced in nature [29]. Recent models indicate potentially suitable areas outside the native ranges for *C. serpentina* under future climate scenarios, highlighting the need for additional data collection to monitor the status as non-native species, to identify reproduction in the wild, and to detect early invasions [27].

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Supplementary files

Supplementary material 1

Records of common snapping turtle (*Chelidra serpentina*) available for Western Europe. Scale (continental vs. local), country, site, date, type of records and sources are also provided. https://doi.org/10.26496/bjz.2024.180.266

Supplementary material 2

Exhibitions, exchanges, or sale events of exotic animals in 2023 in France. Names and locations are provided; see also the text for details. https://doi.org/10.26496/bjz.2024.180.267

Supplementary material 3

Exhibitions, exchanges, or sale events of exotic animals in 2023 in Italy. Names and locations are provided; see also the text for details. https://doi.org/10.26496/bjz.2024.180.268