Conservation biology of the European pond turtle *Emys orbicularis* (L.) in Italy

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Abstract

The updated situation and knowledge of the biology, ecology, behaviour and protection of the European pond turtle, *Emys orbicularis* (L.) in Italy is presented and discussed in the light of conservation biological issues.

Key words

Emys orbicularis, distribution, ecology, conservation, Italy.

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Introduction

Populations of *Emys orbicularis* in Italy are distributed mainly in coastal areas and internal plains. Most regions of Italy have been mapped, but in some cases the information is incomplete (Fig. 1, Societas Herpetologica Italica 1996). An uncomplete knowledge of habitat use leads to a biased view on the autecology of a species. This fact must be carefully considered when data on the distribution aid to protect or manage a given species.

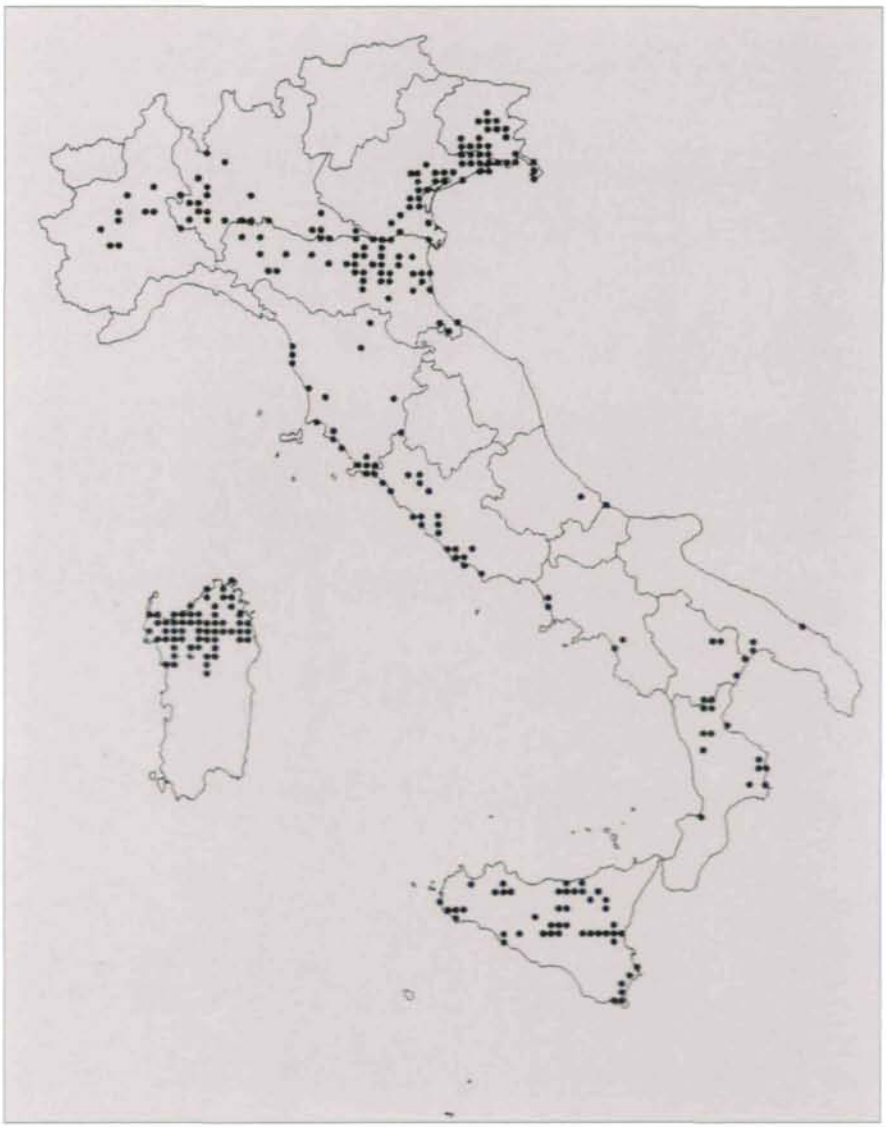

Fig. 1:
The actual distribution of *E. orbicularis* in Italy (Societas Herpetologica Italica 1996).

For the European pond turtle in Italy, several studies have been conducted since the beginning of the nineties, and until recently, this species was relatively unknown from a scientific point of view (LANZA 1983).

In this last decade, a "Big Bang" of interest in Italian populations of *E. orbicularis* enabled to build up a consistent data set. Information on biometry (ZUFFI & GARIBOLDI 1995a, b), systematics (FRITZ & OBST 1995; FRITZ 1998), population structure (KELLER et al. 1998; KELLER 1999), space usage (LEBBORONI & CHELAZZI 1991), reproductive biology (ZUFFI & ODETTI 1998; ZUFFI et al. 1999; KELLER 1999), and thermal ecology (DI TRANI & ZUFFI 1997), have become available. However, only a few studies have focused on the conservation biology of *E. orbicularis* in Italy (GARIBOLDI & ZUFFI 1994; LEBBORONI & CHELAZZI 1998; CHELAZZI, LEBBORONI, TRIPEPI, UTZERI & ZUFFI 1999).

On the basis of colouration, markings, body size and shape of *E. orbicularis* specimens throughout the distribution range, several morphological subspecies have been recognized, some of which have also been confirmed by a genetical approach (LENK et al. 1998; FRITZ & OBST 1995; ODETTI, MANCINO, BATISTONI & ZUFFI 1999; ZUFFI et al. unpubl.). Prior to this, subspecies have not been considered. It is consequently of great importance to conduct any future studies with taking the subspecies' identity into account.

Conservation biology is a relatively young working field. Projects should incorporate all known aspects of the target species, and it should be structured as an open, changeable and integrable framework.

This contribution is based on recent work on *E. orbicularis* in Italy, with a particular emphasis on interdisciplinary approaches (e.g. ecology, ethology and genetics). The aim is to present results from Italian populations and to stimulate an interdisciplinary discussion on the biology of *E. orbicularis* in southern European countries. The following aspects are considered as basic for conservation biological aspects of the European pond turtle:

i) distribution patterns and population status,
ii) habitat use,
iii) reproductive behaviour,
iv) reproductive biology and
v) nest predation.

Materials and methods

I considered data from unpublished thesis of my research team (Di Trani 1989; Odetti 1997; Fabbri 1999; Rovina 1999), and recently published work (Lebboroni & Chelazzi 1991; Mazzotti 1995; Zuffi & Gariboldi 1995a, 1995b; Rovero & Chelazzi 1996; Di Trani & Zuffi 1997; Lebboroni & Chelazzi 1998; Zuffi & Odetti 1998; Zuffi, Odetti & Meozzi 1999). Generally, each captured specimen was measured and weighed, and marked with individual plastic tags on the carapace (Fig. 2) and permanent notches on the marginal scutes. The reproductive status of adult females was determined with inguinal palpation and the count of oviductal eggs with radiographs. Clutch size was determined by counting eggs from intact nests.

Variables were generally tested under normality and statistical analyses were performed with parametric or non-parametric methods. For further details, it is suggested to follow the original paper.

Results

Distribution patterns and population status

The subspecies *E. o. galloitalica* is found along the Ligurian and the Thyrrhenian coasts southwards to the Gulf of Policastro and is also present in Sardinia and Corsica. *Emys o. cf. hellenica* occurs in southern Italy, while the taxonomy of populations from the Padane plain is still uncertain (Fritz & Obst 1995; Lenk, Joger, Fritz, Heidrich & Wink 1998). The European pond turtle is mainly distributed along the coasts and areas at low elevation and occurs sporadically in several areas in northwestern Italy (Societas Herpetologica Italica 1996). Most of the largest Italian populations are found in nature parks, biological reserves, and protected areas (Lebboroni & Chelazzi 1991; Gariboldi & Zuffi 1994; Zuffi & Gariboldi 1995; Ravagli 1996; Rovero & Chelazzi 1996; Utzeri et al. 1996; Zuffi et al. 1999). None of these populations seems to be at risk of extinction, but this conclusion might be caused by a lack of knowledge. Habitat

Fig. 2:
Each captured specimen was marked with plastic tags on the carapace and with permanent notches on the marginal scutes.

changes caused by human activities, also in protected areas, is a relatively recent phenomenon. The negative consequences for *E. orbicularis* remain to be shown. Some relictual and small populations in the central and western parts of the Po plain (northern Italy) are believed to be endangered (GARIBOLDI & ZUFFI 1994). The low number of reported hatchlings and juveniles in some of these areas could be due to a lack of data, and in some areas it is very difficult to find nests, even if juveniles are abundant. Younger age-classes are often underestimated, in comparison with the older classes, both due to lower detectability and different habitat use (see below).

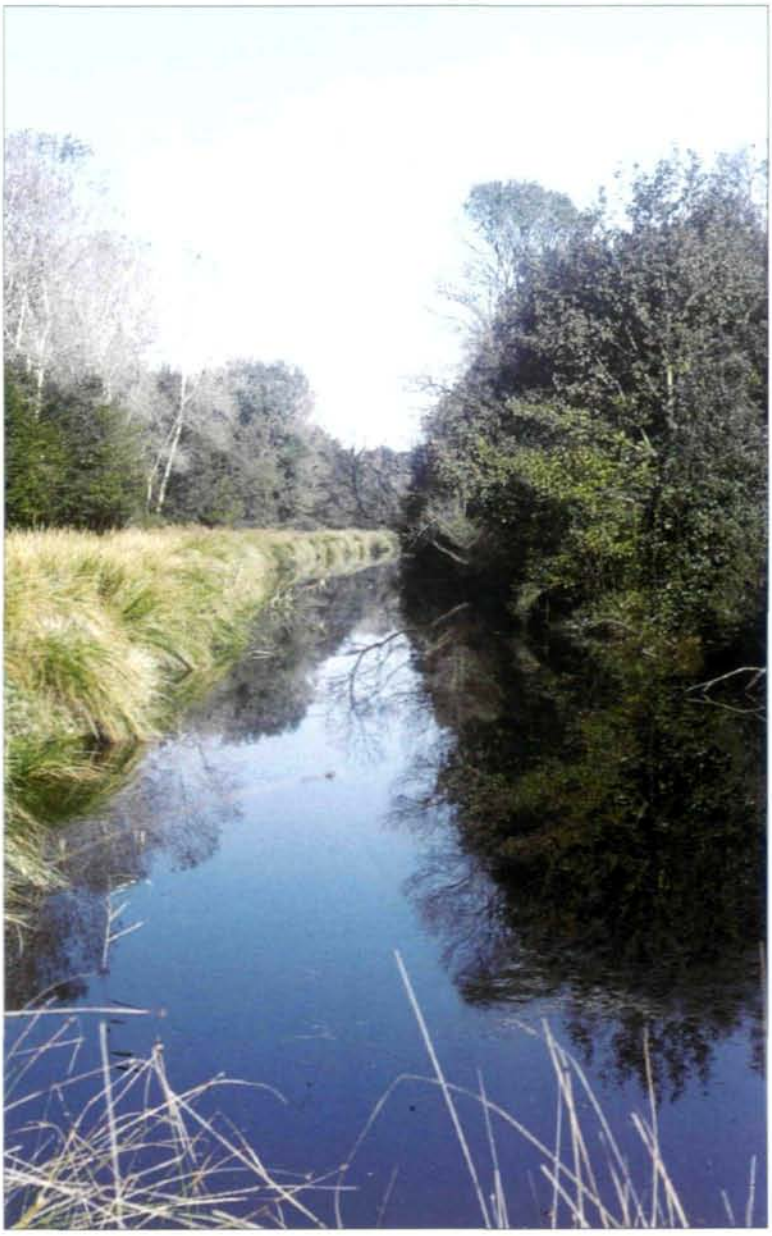

Fig. 3:
The "canal" habitat is characterised by artificial drainage canals and open or marginal areas (Bosco Mesola).

Supposed competition between *Emys orbicularis* and the various subspecies of *Trachemys scripta* actively or accidentaly introduced into natural and artificial ponds and wetlands in Italy has yet to be demonstrated (LUISELLI, CAPULA, CAPIZZI, FILIPPI, TRUJILLO JESUS & ANIBALDI 1997).

The effective protection of wild populations by habitat protection and the limitation of animal trade is afforded by the Bern Convention (1979) and Washington Convention (1980), the latter better known as CITES. Other effective measures are found in the local legislation of Natural or Regional Parks and Reserves, which have included the European pond turtle among protected species or which protect all living organisms in the reserve.

Habitat use

Populations of *E. orbicularis* in Italy are mainly found in two different kinds of habitat, the former being represented by "pond" systems, consisting of one or more natural, shallow water bodies, generally in forest areas (Monte Rufeno, Pollino, Castel Porziano), and the latter being the "canal" habitat (Bosco Mesola (Fig. 3), Uccellina, Tombolo) (LEBBORONI & CHELAZZI 1998), which is characterised by artificial drainage canals, generally in open or marginal areas. During a long-term study in the "Monte Rufeno" Natural Reserve (northern Latium, central Italy), LEBBORONI & CHELAZZI (1998) found that the population of *E. orbicularis* is sub-divided into different groups, each of which tied to a distinct pond system, with no consistent exchange of turtles from one system to another. Each of the pond systems includes a permanent primary pond where most adult turtles spend the entire year, and a number of satellite ponds of different types (temporary primary ponds, permanent secondary ponds, and temporary secondary ponds). In the Tombolo area (S. Rossore Fig. 4., Camp Darby) there are both habitat types. Canals are permanently flooded and overland movements are rare. Canals are inhabited by the same individuals over the whole year.

Reproductive behaviour

Overland movements for nesting differ among populations depending on the location of suitable nesting areas. In canal systems (Bosco Mesola, Tombolo, Uccellina) nests are generally dug in open sunny areas, with low density vegetation, 2 to 20 m from the river's bank (ODETTI 1997; ROVINA 1999; ZUFFI & GARIBOLDI unpubl.). Females usually lay 3-9 eggs (mode 6) in nests of about 6-8 cm in diameter and 5-10 cm deep (e.g., DI TRANI 1989: n=78; ROVINA 1999: n=209; ZUFFI & GARIBOLDI unpubl. data: n=75). In forest areas a large fraction of females may migrate up to 1000 m from their pond systems for nesting (ROVERO & CHELAZZI 1996), which generally occurs in the first hours of night. Then females return to their home ponds, after a period varying from 36 hours to one week, depending on weather conditions and/or distance of the nesting sites. The start of the nesting migration is related to the increase of average air temperature (MARANGIO 1999). Suitable nesting areas are bushy, sunny clearings with marly-limestone soil, situated on slopes or at the base of small landslides. All females inhabiting the same pond system were recorded to lay eggs within the same nesting area year after year. During nesting migration females spend daytime in permanent secondary ponds (Fig. 5), where they pump water for softening the soil during digging into the accessory urinary bladder. At sunset they start searching for a specific nest site, generally under a shrub (*Juniperus communis*), in grass, or next to a stone, preferably on a gentle slope with an east to southwest exposure. Sometimes females dig several holes before laying. In the Pisa population 50% of total nests (n=209 nests) were within 6 m from the water's edge, and 90% within 20 m. Frequency of nests was significantly higher in North to South canals with respect to those oriented East to West (152 vs 57 nests, $X^2 = 144.17$, 1 df, $P < 0.001$; ROVINA 1999). Vegetation probably limits direct exposure of nests to the sun. In most cases there is a strong correlation between nest locations and their relative distance from surrounding vegetation.

Incubation lasts between 80 and 90 days, and the hatching coincides with the autumnal flooding of the temporary secondary ponds (Fig. 6). Hatchlings probably spend their first year in other habitats than the adult population. In the Monte Rufeno population, hatchlings (average carapace length 24 mm, weight 3.7 g, n=18) inhabit small temporary ponds of 1-5 m^2, 5 to 40 cm in depth. In a few cases hatchlings were recorded to overwinter in their nest and emerged in the following spring, as observed also in Tuscanian populations (ZUFFI 1995 unpubl. data; ODETTI 1997, unpublished thesis, University of Pisa).

Fig. 4:
Each of the pond systems includes a permanent primary pond where most adult turtles spend their entire year (San Rossore).

Fig. 5:
During nesting migration females spend daytime in permanent secondary ponds, where they pump water into the accessory urinary bladder (*E. o. galloitalica*).

Reproductive biology

The reproductive patterns of Italian populations are summarized in Tab. 1. In *E. orbicularis* the frequency of egg production varies with latitude, with the northernmost populations generally laying larger clutches (MITRUS & ZEMANEK 1998; KELLER 1999), and the southernmost laying a small clutch (ZUFFI & ODETTI, 1998). In the Italian populations, reproductive females ranged from 69.2 to 100% of the total adult female sample (ZUFFI & ODETTI 1998; ROVINA 1999; LEBBORONI et al. unpubl. data). For the first time in the European pond turtle, a double egg laying was recorded in at least two Tyrrhenian populations (Tuscany: ZUFFI & ODETTI 1998; Latium: SERRA, 1998), but we cannot determine the frequency of such occurrences (ODETTI 1997, ZUFFI & ODETTI 1998, ROVINA 1999). The estimated presence of oviductal eggs (ZUFFI & ODETTI 1998) is about 39 ± 6 days (n=15) and the time between two consecutive periods with detectable oviductal eggs is about 9-11 days. Although clutch frequency is the most important parameter for studies on turtle reproductive biology (GIBBONS et al. 1982), the occurrence of double egg deposition is probably subject to underestimation. However, estimation based on the Tuscanian population, indicated that from 2.3 to 70.8% of the reproductive females may lay eggs twice a year (ODETTI 1997, ZUFFI & ODETTI 1998; ROVINA 1999).

Fig. 6:
A hatching juvenile of San Rossore: hatching is coinciding with the autumnal flooding.

Table 1 - Reproductive parameters of *E. orbicularis* in Italy. CL = mean carapace length of reproductive females; SD = standard deviation; n.r.=not recorded. Reproductive frequency = mean percentage of reproductive females nesting yearly. CS = mean clutch size (from CHELAZZI et al., 1999)

Localities	Bosco Mesola	Tombilo	Uccellina	M.Rufeno	C.Porziano	Pollino
CL (SD) Cm	13.63 (1.14) N=50	13.17 (0.97) N=115	12.52 (0.88) N=41	12.12 (0.76) N=18	13.43 (1.23) N=34	n.r.
Reproductive frequency	n.r.	20-58.3%	n.r.	80-85%	32.5%	n.r.
CS (SD)	n.r.	5.08 (0.30) N=15	5.91 (0.23) N=18	3.70 (0.82) N=10	n.r.	n.r.
Clutch frequency	1	1-2	1-2	1	1-2	1
Egg deposition	May-July	May-July	May-July	June	n.r.	n.r.
Nest predation	85 %	75 %	75 %	80 %	n.r.	n.r
Activity	March-October	February-November	March-October	March-October	March-October	mid March-mid October
Latitude	44.55	43.40	42.40	42.45	41.40	39.19
Alt. (m a.s.l.)	9	7	10	550	10	1000
Mediterranean basin	EAST	WEST	WEST	WEST	WEST	EAST
Subspecies	*orbicularis*	*galloitalica*	*galloitalica*	*galloitalica*	*galloitalica*	*hellenica*
Source	ZUFFI & GARIBOLDI, unpubl.	ZUFFI & ODETTI, 1998; ZUFFI et al., 1999	DI TRANI 1989; DI TRANI & ZUFFI, 1997; ZUFFI, unpubl. data	ROVERO & CHELAZZI 1996; LEBBORONI & CHELAZZI, 1998	UTZERI et al., unpubl. data	TRIPERI et al., unpubl. data

Nest predation

A marked predation of nests, with estimated values of about 75% was recorded at almost all of the sites (DI TRANI 1989, n = 89 nests; ZUFFI et al. 1999, n = 33 nests; ROVINA 1999). Possible nest predators, among mammals, are the badger (*Meles meles*), the wild boar (*Sus scrofa*), the red fox (*Vulpes vulpes*), the common rat (*Rattus rattus*), the wood mouse (*Apodemus sylvaticus*), and the northern water vole (*Microtus terrestris*), and, among birds, the jay (*Garrulus glandarius*). Damage occurs by large mammals, for example wild boar and fallow deer, which walk on the soft ground around temporary or permanent ponds. Also humans, for example military personnel or guardians of protected areas, may occasionally break freshly dug nests or kill hatchlings around wet areas. In the Migliarino, S. Rossore, Massaciuccoli natural park (Northern Tuscany), a damage to canal borders by farm tractors passing too close to nesting areas during reproductive season (pers. observ.) or when cutting reeds during winter or early spring has been noted.

In all studied sites, protection of nests by means of wire-net cages and fences proved very effective in raising nest survival to 95-100% (n = 20; ODETTI 1997), with respect to natural predators.

Discussion

The basic data set so far is not surprisingly linked to a common situation: scientific activities are carried out in natural areas adjacent to university and museums. In Italy this seems to be the case for *E. orbicularis*, and the lack of research (Societas Herpetologica Italica 1996) is due to the absence of experts.

The inventory, study and awareness of available natural resources leads to a better understanding of all biological variables, necessary for the management and conservation of species. In the USA, after decades of long-term studies across a wide range of interests, it is now possible to better understand the phenotypic plasticity of wild populations of some species of terrapins and land tortoises (among others ELGAR & HEAPHY 1989; IVERSON et al 1993; ROWE 1994).

Further studies on *E. orbicularis* are needed for the understanding of

1) latitudinal and altitudinal trends in reproductive patterns;
2) the influence of habitat features on reproductive success;
3) determine the reproductive parameters responsible for long-term population dynamics;
4) human pressure.

Finally I suggest that a conservation biology and management plan for *E. orbicularis* should cover:

a) the understanding of the taxonomic status by means of morphological and molecular methods;
b) the identification of the habitats required by different age-classes all around the year;
c) consideration of migration routes and movement patterns of reproductive and post reproductive females;
d) protection of nests against predation and the limitation of human activities in, or close to, nesting areas;
e) the limitation or interruption of introduction projects in non-protected environments;
f) the ecosystem reconstruction and (sub)species reintroduction in areas previously inhabited by *E. orbicularis*;
g) quantitative and/or qualitative projects regarding introduction, reintroduction, population reinforcement or population management into protected areas, in order to verify the suitability of the proposed methods.

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Zusammenfassung

Die gegenwärtige Situation und der Kenntnisstand von Biologie, Ökologie und Verhalten der Europäischen Sumpfschildkröte in Italien wird unter dem Aspekt des Artenschutzes beschrieben und diskutiert.

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