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UN CONTRIBUTO ALLA CONOSCENZA DELL'ERPETOFAUNA DELLA SARDEGNA: LA PRIMA CHECKLIST DEGLI ANFIBI E RETTILI DELLA LAGUNA DI SANTA GILLA

Abstract - Francesco Mascia - Building herpetological knowledge about Sardinia: a first checklist of the amphibians and reptiles of Santa Gilla Lagoon.

A five-year field research carried out between January 2008 and January 2013 resulted in the compilation of the first checklist of the herpetofauna of the Santa Gilla lagoon, a protected area sited in southern Sardinia, Italy. By using the Visual Encounter Survey (VES) approach, we systematically collected presence records for 18 species, of which 4 anurans (Amphibia, Anura) and 14 reptiles (Reptilia). Our observations were reinforced and enriched by an accurate consultation of the extant bibliography. In an attempt to perform a semi-quantitative analysis joining dispersion and recurrence data about the species observed, we assigned a Commonness Score to every species observed during the study years for each sampling station in the study area. Among the observed species, *Caretta caretta* (Testudines, Chelonidae), *Emys orbicularis* (Testudines, Emydae) and *Hemorrhois hippocrepis* (Squamata, Colubridae) are the rarest and those of the greatest conservation concern. We recorded only three Sardinian endemics (*Discoglossus sardus*, Anura, Atylidae; *Hyla sarda*, Anura, Hylidae; *Podarcis tiliguerta*, Squamata, Lacertidae), while two alien species *Trachemys scripta* (Testudines, Testudinidae) and *Pelophylax* sp. (Anura, Ranidae), already known for other localities in the island, were observed for the first time at this site. Unfortunately, two species of conservation concern previously recorded in the area (*Testudo graeca* and *T. hermanni*) were never observed during the five-year study, this possibly due to local extinction. We recorded almost 60% of the currently known amphibian and reptilian species of Sardinia and the totality of the anurans, confirming the key role of Santa Gilla lagoon for the conservation of the lowland herpetofauna of Sardinia and, in a broader perspective, of the Mediterranean area, as a whole.

Key words: Amphibia - Reptilia - Santa Gilla - Sardinia - Wetland.

Riassunto - Francesco Mascia - Un contributo alla conoscenza dell'erpetofauna della Sardegna: la prima checklist degli anfibi e rettili della laguna di Santa Gilla.

Una campagna quinquennale di ricerche sul campo realizzate tra il Gennaio 2008 ed il Gennaio 2013 ha consentito la compilazione della prima checklist dell'erpetofauna della laguna di Santa Gilla, un'area protetta situata in Sardegna meridionale, Italia. Utilizzando il metodo di rilevamento VES

(Visual Encounter Survey), sono stati sistematicamente raccolti i dati di presenza per 18 specie, 4 delle quali appartenenti agli anuri (Amphibia, Anura) e 14 ai rettili (Reptilia). I dati di campo sono stati supportati ed arricchiti da un'accurata consultazione della bibliografia disponibile. Al fine di applicare un'analisi semi-quantitativa tenente conto dei dati di diffusione e di ricorrenza delle specie osservate, è stato assegnato un Commonness Score per ciascuna specie osservata durante il periodo di indagine e per ogni sito dell'area di studio. Delle specie osservate, *Caretta caretta* (Testudines, Chelonidae), *Emys orbicularis* (Testudines, Emydae) e *Hemorrhois hippocrepis* (Squamata, Colubridae) sono le più rare e quelle di maggiore interesse conservazionistico. Sono state osservate solo tre entità endemiche (*Discoglossus sardus*, Anura, Atylidae; *Hyla sarda*, Anura, Hylidae; *Podarcis tiliguerta*, Squamata, Lacertidae), mentre due taxa esotici, *Trachemys scripta* (Testudines, Testudinidae) e *Pelophylax* sp. (Anura, Ranidae), già noti per altre località dell'isola, sono osservati per la prima volta nell'area di studio. Due specie di interesse conservazionistico segnalate in passato (*Testudo graeca* e *T. hermanni*) non sono purtroppo state avvistate durante i cinque anni di indagine, e sono forse da ritenersi estinte nell'area di studio. Il compendio di specie osservate rappresenta circa il 60% dell'erpetofauna della Sardegna, a conferma del ruolo-chiave della laguna di Santa Gilla per la conservazione degli anfibi e rettili degli ambienti planiziali in Sardegna e più in generale nell'area Mediterranea.

Parole chiave: Anfibi - Rettili - Santa Gilla - Sardegna - Zone umide.

Introduction

With a total of 30 species (11 amphibians and 19 reptiles), 12 of which (40%) are Tyrrhenian endemics, Sardinia with the nearby Corsica and smaller islands with which it forms a biogeographical continuum, should be considered part of the most important Mediterranean island complex for the high level of endemicity of its terrestrial herpetofauna (Corti *et al.* 1999; Bassu *et al.*, 2010). In particular, endemisms are more common among urodelians where a species of *Euproctus* and five species of *Speleomantes* are described, but also reptiles are well represented with three species of lizards, *Algyroides fitzingeri* (Wiegmann, 1834), *Archaeolacerta bedriagae* (Camerano, 1885) and *Podarcis tiliguerta* (Gmelin, 1789), shared with Corsica and most of the adjacent smaller Tyrrhenian islands. If we include the island coastal marine environment, three sea turtle species should be added to the list of those recorded for Sardinia, one irregularly breeding, *Caretta caretta* (Linnaeus, 1758), and two accidentally visiting its coastal waters, *Chelonia mydas* (Linnaeus, 1758) and *Dermochelys coriacea* Vandelli, 1761 (Casale *et al.*, 2003; Bassu *et al.*, 2010).

Over the past fifteen years Sardinia met a noteworthy increment in the knowledge of its terrestrial herpetofauna, as a result of research leading to the definition of the biogeographical, phylogenetic and conservation status of a number of critical species (Bassu *et al.*, 2008, 2010; Salvi & Bombi, 2010; Li Vigni *et al.*, 2011; De Pous *et al.*, 2012; Harris *et al.*, 2005; Lanza *et al.*, 2005; Salvi *et al.*, 2010; Bisconti *et al.*, 2011; Pedall *et al.*, 2011; Perez *et al.*, 2011; Chiari *et al.*, 2012; Fritz *et al.*, 2012; Bombi *et al.*, 2011).

Nevertheless, comprehensive multi-year investigations aimed at the description of the herpetological community at single sites of major naturalistic interest in the

island are almost absent (Mulargia *et al.*, 2018). This could bring to erroneous evaluations of their importance for conservation and to the detriment of a proper regional and national management policy.

The aim of the present work is to fill partly this gap by providing an in-depth knowledge contribution to the only sporadically investigated herpetofauna of Santa Gilla lagoon, and to identify the hotspots deserving the maximum protection within this protected area. In effect, no systematic investigations had ever carried out on the herpetofauna of this wetland, and only some isolated records of a few species are known from the scanty extant literature in general (Stock, 2000-2006).

Material and Methods

The research was carried out in an area of 13 km^2 that includes entirely the Santa Gilla lagoon, a brackish wetland located along the southern coast of Sardinia (Italy). This coastal lagoon is connected with the Mediterranean Sea through a narrow permanent canal, and along its northern shore two major water courses (the rivers Cixerri and Mannu) flow into it, supplying this coastal wetland with freshwater.

Inside the area, the Site of Community Importance (SCI, code: ITB040023) and Special Protection Area (SPA, ITB040003) "Laguna di Santa Gilla, Stagni di Cagliari e Saline di Macchiareddu" are recognized. These protected areas extend to 4,000 ha (40 km^2), of which about half are occupied by the coastal lagoon, by the pond of Capoterra and by the saltworks. Part of the same surface is appointed special conservation status by listing it as a Wetland of International Importance according to the Ramsar Convention on Wetlands (code: 3IT018), mainly for its ornithological importance as a breeding, wintering and stop-over site.

An important part of the site is occupied by small temporary or permanent water pans with lentic water ranging from oligohaline to hyperaline and crossed by several water courses either natural, strongly altered or artificial, most of which flowing out of the lagoon.

The study area is characterized by plant communities strictly related to the presence of water and its salinity: brackish waters are everywhere occupied by halophilous submerged vegetation dominated by species of the Ruppiaceae family, while halophilous and halo-nitrophilous terrestrial communities, terophytes or perennial, are spread along the lagoon and saltworks system. Glycophilous assemblages that include helophytes and aquatic – also submerged – macrophytes, are present along the rivers and minor water pans sited around the main basins. Phanerophytic formations are very rare and confined to the main waterways (genera *Populus*, *Salix*, *Tamarix*). Psammophilous vegetation is relegated along the narrow sandy barrier that separates the lagoon from the sea, while anthropogenic, nitrophilous communities

are widespread in the area (De Martis *et al.* 1983; Marchioni , 1988; De Martis *et al.*, 1992; Mossa & Fogu, 1996).

Santa Gilla lagoon suffers the effects of a secular coexistence with human activities which led to deep modifications of the territory and heavy alterations of ecosystems. Especially during the last 50 years, water pollution (mainly due to industrial and urban effluents) and urban expansion represent the main threats to the conservation of the site (Cottiglia, 1995; Deiana & Paracchini, 1996; Frontalini *et al.*, 2009). An increase of semi-natural and artificial (mainly agricultural) habitats to the detriment of the natural areas was recently reported for the protected area (Mascia & Nucci, 2009).

We carried out the research from January 2008 until January 2013 in order to collect information on the herpetofaunal composition and preliminary data on the distribution of each species. Field investigations were carried out using the Visual Encounter Surveys (VES) approach (Crump & Scott, 1994; Matthew et al., 2013). A total 10 sample stations were surveyed (Tab. 1, Fig. 1), with an average of 11 field surveys/year/station (range: 10-13), equally distributed along all months of the year. Field data were integrated by those obtained through a careful consultation of

Site code	Site (Municipality, Province, locality)	Altitude (m a.s.l.)	Coordinates
1	Assèmini (CA), loc. ex cave F. Laterizi	0-2	39°17'09.24"N 08°59'23.76"E
2	Assèmini (CA), loc. foci di Riu Cixerri e Riu Mannu	0-2	39°15'41.72"N 09°00'40.17"E
3	Assèmini (CA), loc. Piscina Diegu	0-3	39°15'00.16"N 09°00'26.76"E
4	Assèmini (CA), loc. Santadi	0-4	39°12'16.09"N 09°00'39.74"E
5	Assèmini (CA), loc. Porto S. Pietro	0-1	39°13'46.53"N 09°01'40.28"E
6	Cagliari (CA), loc. Donna Laura	0-2	39°14'50.37"N 09°04'49.05"E
7	Capoterra (CA), foce del Riu S.ta Lucia e Tanca Nissa	0-8	39°09'54.56"N 09°00'38.02"E
8	Elmas (CA), loc. Correinas/Sa mura	0-2	39°16'05.73"N 09°01'13.83"E
9	Elmas (CA), loc. foce del Riu Sestu and Santa Caterina	0-4	39°15'39.84"N 09°03'02.23"E
10	Uta (CA), loc. Sa tuerra	0-1	39°15'53.96"N 08°59'29.07"E

Tab. I - List of investigated sites.

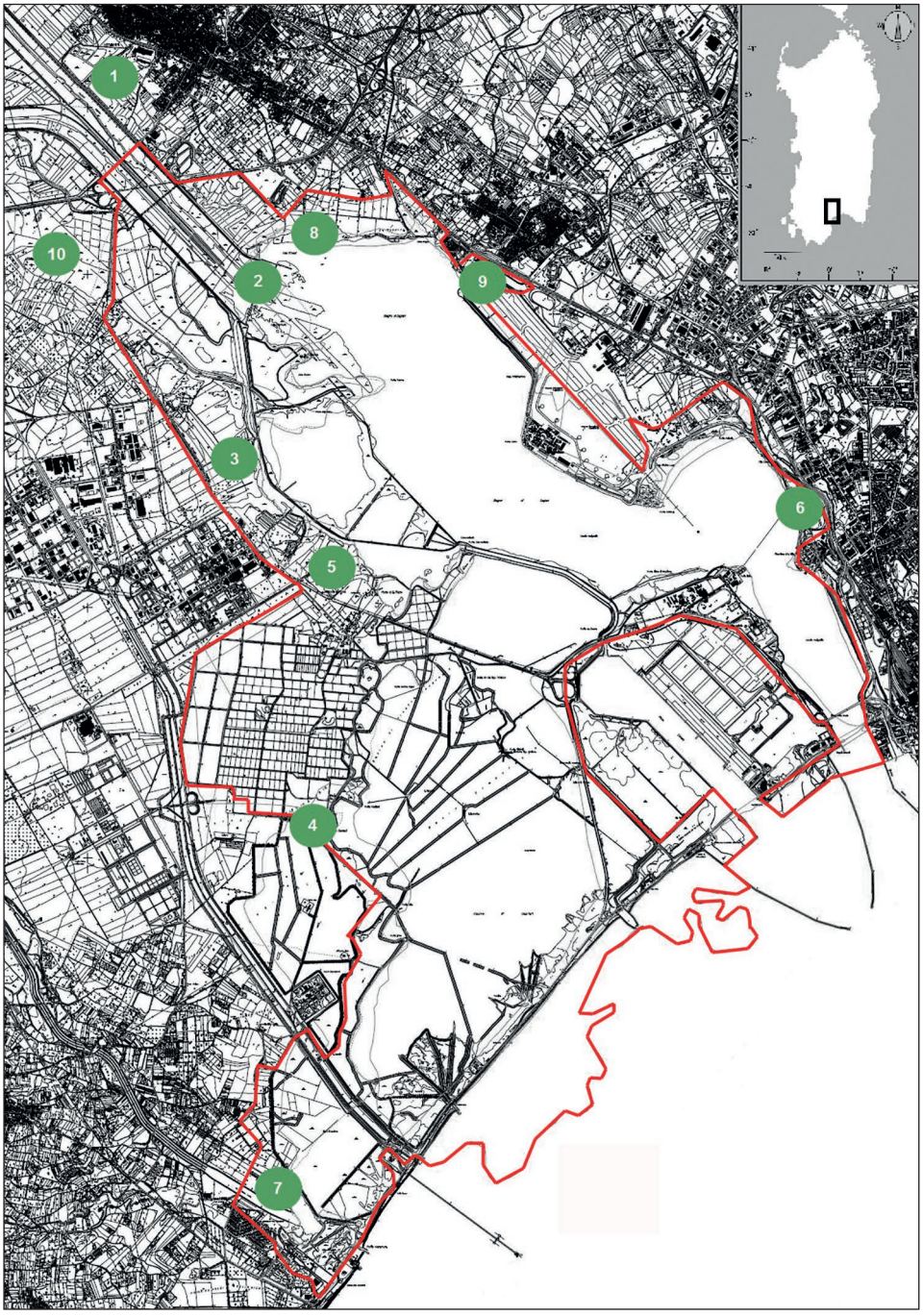

Fig. 1 - Study area and the sample stations surveyed. Red line includes the SCI/SPA area.

the available literature. Species were classified in the field basing on morphological characters, sometimes with the aid of binoculars, mostly at close distance. Breeding of each species was confirmed only when spawns and/or tadpoles (amphibians) or very young individuals (reptiles) were found.

In order to define the frequency of contacts and distribution of each species within the sample area in the study years, we considered three categories of Recurrence (Infrequent, Common, Very Common) and three classes of Dispersion (Localized, Diffused, Ubiquitous) corresponding to just as many discrete groupings. Each class was given a score of 0.5*r, where r is a multiplier from 1 to 3. Recurrence Scores (RS) and Dispersion Scores (DS) so obtained were then crossed and multiplied to get a Commonness Score (CS) which provides a "value" for each species that takes into account its rate of recurrence (number of overall occurrences for the species in the study area) and its dispersion in the study area (number of sampling stations where the species is present). Commonness Scores were then grouped into six classes (Roman numerals I-VI), as follows:

I = infrequent/localized (CS = 2.25)
II = infrequent /diffused, common/localized (CS = 1.5)
III = infrequent /ubiquitous, very common/localized (CS = 0.75)
IV = common/diffused (CS = 1)
V = common/ubiquitous, very common/diffused (CS = 1.5)
VI = very common/ubiquitous (CS = 0.25)

where class I contains the most rarely encountered and less diffused species and class VI the most easily observed and most widespread species (Tab. 2).

Results and Discussion

Our research showed that the herpetofauna of Santa Gilla includes 18 species, among which 4 amphibians (anurans) and 14 reptiles (Table III).

The most represented family is the Colubridae (three species), followed by Emydae, Lacertidae, Scincidae and Testudinidae, each including two species.

The analysis of the chorotypes showed the abundance of Mediterranean *sensu lato* taxa (47%). *Hyla sarda* (De Betta, 1853) (Anura, Hylidae: Sardinia, Corsica and Tuscan Archipelago), *Discoglossus sardus* Tschudi, 1837 (Anura, Alytidae: Sardinia, Corsica and Tuscan Archipelago) and *Podarcis tiliguerta* (Gmelin, 1789) (Squamata, Lacertidae: Sardinia and Corsica) are endemic species, these account only for 25% of the endemic herpetofauna in Sardinia.

Pelophylax sp. (Anura, Ranidae) and *Trachemys scripta* (Schoepff, 1792) (Testudinata, Emydae) are non-native species of European (continental) and North-American origin, respectively.

		RECURRENCE*		
		Infrequent 1-10 (1.5)	Common 11-50 (1)	Very Common >51 (0.5)
DISPERSION**	Localized 1-3 (1.5)	2.25 (i)	1.5 (ii)	0.75 (iv)
	Diffused 4-7 (1)	1.5 (ii)	1 (iii)	0.5 (v)
	Ubiquitous 8-10 (0.5)	0.75 (iv)	0.5 (v)	0.25 (vi)

* Based on number of overall occurrences for each species (sightings and reference citations).
** Based on number of sample stations where each species is present (sightings and reference citations).

Tab. II - Definition of a Commonness Score assessing the recurrence and dispersion of each species of amphibians and reptiles observed (or recorded in the literature) in the Santa Gilla Lagoon. Each Recurrence and Dispersion class scores (0.5-1.5) and Commonness Score categories (i-vi) are indicated in brackets.

The most common/ubiquitous species are *H. sarda* for amphibians, *Tarentola mauritanica* (Linnaeus, 1758) and *Podarcis siculus* (Rafinesque, 1810) for reptiles (CS VI), while *D. sardus, Emys orbicularis* (Linnaeus, 1758), *T. scripta* and *Hemorrhois hippocrepis* (Linnaeus, 1758), are infrequent/localized, being observed no more than 10 times at 2, 1, 1, 2 sites, respectively (CS I) (Tab. 3). In addition, *Bufo viridis* Laurenti, 1768 and *Podarcis tiliguerta* (Gmelin, 1789) are common, but localized (CS II). For the first it is possible to correlate its rarity with the scarcity of lentic/glycophilous environments, while for the latter we hypothesize a gradual regression due to habitat degradation and possible competition with the more adaptable *P. siculus* (Rafinesque, 1810), as assumed in the past (Borri *et al.*, 1988) and recently proposed by Mangiacotti et al. (2013) for Sardinia.

D. sardus is the only terrestrial native species found at Santa Gilla, but not recorded for the nearby Molentargius-Saline wetlands (Atzeni *et al.*, 2011).

Among the species worth of note we list:

Pelophylax sp.

Phylogenetics of the genus *Pelophylax*, and in particular of Italian and Mediterranean populations belonging to the complex *P.* (*Rana*) *lessonae* is still under investigation and its taxonomy and nomenclature strongly debated (Canestrelli & Nascetti, 2008). Traditionally, at least two different taxa are reported as probably present in Sardinia basing on their calls: *Pelophylax ridibundus* species group (northen Sardinia), and *Pelophylax* kl. *esculentus* (southern Sardinia) (De Pous *et al.*, 2012). More recently, through the combined analysis of mitochondrial and nuclear diagnostic markers, three distinct taxa were detected in the island and assigned to

Suprapsecific classification	Species	Bibliographic records	Present study	Breeding	Distribution	CS	IUCN Assessment	Habitat Directive 92/43 CEE Annex
Amphibia								
Anura - Alytidae	*Discoglossus sardus* Tschudi, 1837	-	x	x	2, 9	i	VU	II
Anura - Bufonidae	*Bufo viridis* Laurenti, 1768	x	x	x	1, 7	ii	LC	IV
Anura - Hylidae	*Hyla sarda* (De Betta, 1853)	x	x	x	1, 2, 3, 4, 5, 6, 7, 9, 10	vi	LC	IV
Anura - Ranidae	*Pelophylax* sp.	-	x	x	1, 2, 7, 10	iii	introduced	introduced
Reptilia								
Testudines - Chelonidae	*Caretta caretta* (Linnaeus, 1758)	x	-	-	-	(i)	EN	II*-IV
Testudines - Emydae	*Emys orbicularis* (Linnaeus, 1758)	x	x	-	2	i	EN	II-IV
Testudines - Emydae	*Trachemys scripta* (Schoepff, 1792)	-	x	-	2	i	introduced	introduced
Testudines - Testudinidae	*Testudo hermanni* Gmelin, 1789	x	-	-	-	(i)	EN	II-IV
Testudines - Testudinidae	*Testudo graeca* Linnaeus, 1758	x	-	-	-	(i)	NT	II-IV

Squamata - Gekkonidae	*Hemidactylus turcicus* (Linnaeus, 1758)	x	x	x	1, 3, 4, 6, 7, 8	iii	LC	-
Squamata - Phyllodactylidae	*Tarentola mauritanica* (Linnaeus, 1758)	x	x	x	1, 2, 4, 5, 7, 8, 9, 10	vi	LC	-
Squamata - Lacertidae	*Podarcis siculus* (Rafinesque, 1810)	x	x	x	1, 2, 3, 4, 5, 6, 7 , 8, 9, 10	vi	LC	IV
Squamata - Lacertidae	*Podarcis tiliguerta* (Gmelin, 1789)	x	x	x	2, 7, 9	ii	NT	IV
Squamata - Scincidae	*Chalcides chalcides* (Linnaeus, 1758)	x	x	x	1, 2, 6, 7, 8, 9, 10	iii	LC	-
Squamata - Scincidae	*Chalcides ocellatus* (Forskål, 1775)	x	x	x	1, 2, 6, 7, 8, 9, 10	iii	LC	IV
Squamata - Colubridae	*Hemorrhois hippocrepis* (Linnaeus, 1758)	x	x	-	6, 9	i	NT	IV
Squamata - Colubridae	*Hierophis viridiflavus* (Lacépède, 1789)	x	x	x	1, 2, 3, 4, 6, 7, 8, 9, 10	vi	LC	IV
Squamata - Colubridae	*Natrix maura* (Linnaeus, 1758)	x	x	x	1, 2, 3, 6, 7, 9, 10	v	LC	-

Table III. The herpetofauna of Santa Gilla lagoon. Previous records are compared to the present study and breeding evidence is indicated for each species (x = observed, - = not observed). Distribution within the 10 sample stations (cf. Table I and Fig. 1), Commonness Scores (CS) classes (i-vi; cf. Tab. II, where brackets indicate species not directly observed, but recorded in the literature) and conservation status according to IUNC categories and Habitat Directive 92/43 CEE are also indicated for each species.

P. kurtmuelleri and two cryptic taxa of the "*bedriagae*" group. Among the water frog populations investigated by the authors of this last study, the sampled population closest to the study area (S2 from Uta - CA), was referred to *P.* cf. *bedriagae* "Cilician West" (Bellati *et al.*, 2019). That is why, in the difficulty of clearly assign Santa Gilla lagoon marsh frogs to one or another taxon, we limit to the generic notation.

Marsh Frogs of alien origin belonging to the genus *Pelophylax* were observed more and more frequently in four localities throughout the period of investigation, also in halophilous habitats. In particular, the largest groupings were found along the lower bed of the Cixerri river, and at the mouth of the Santa Lucia stream. In August 2010, the population found at the locality Tuerra, Assèmini-Uta/CA (10) exceeded one hundred individuals. *Pelophylax* frogs were never found before at this site, where at present are common and diffused (CS IV). We assume that these frogs may have colonized the Santa Gilla lagoon using the Cixerri, Mannu and Santa Lucia waterways as ecological corridors, occupying most of the river course and reaching its mouth and other localities in the site. In effect, populations of frogs referred to this genus were reported for two localities of the Cixerri river basin (Li Vigni *et al.*, 2011; De Pous *et al.*, 2012), and other populations were found during this study along Cixerri river near Siliqua (40 m a.s.l., 39°16'55.16"N - 08°50'59.36"E), and Mannu river near Decimomannu (6 m a.s.l., 39°18'56.62"N - 08°56'54.77"E) (personal observation).

For the nearby Molentàrgius-Saline Natural Park non-native frogs were never reported (Atzeni *et al.*, 2011).

Trachemys scripta (Schoepff, 1792).

The presence of Yellow-bellied Slider Turtle is most likely due to deliberate human introduction. An individual was observed in July 2010 at Riu Mannu River, Assèmini (2). *T. scripta elegans* has been reported throughout the island in anthropized sites in the provinces of Olbia, Sassari, Oristano and Cagliari, as well as in natural habitats (Lago di Baratz, Cannigione, Cala Gonone, Sorso, Castelsardo, Tirso and Flumendosa rivers, Molentargius wetlands and S. Pietro island) (Bassu *et al.* 2008; Battisti, 2017). For Parco Naturale Regionale Molentargius-Saline, Quartu S.E./CA its presence has been recently confirmed (Atzeni *et al.*, 2011).

Testudo hermanni Gmelin, 1789
Testudo graeca Linnaeus, 1758

These two tortoises were repeatedly recorded in the study area in the past (Stock, 2000-2006; Comune di Cagliari - Assessorato Ambiente, 2006). *Testudo hermanni* was successively excluded from the Stagni di Cagliari UTM 10x10 kilometers cell, while for *T. graeca* only historical records are reported (Bassu *et al.*, 2010). The possible presence of both species was recently assumed for the site, although basing only on deficient data (Ministero dell'Ambiente e della Tutela del Territorio

e del Mare, 2013). During our surveys, we observed neither of the two species, but we collected several oral evidence of the presence of wild tortoise by local stakeholders: the failure to find the two tortoises may indicate their extreme rarity within the study area or even their local extinction due to the loss and fragmentation of suitable habitats. We also do not exclude that records of *T. hermanni* might be referred to misidentification of *T. graeca* specimens, and also to the release in the wild of house kept individuals of both species. Also for Molentargius-Saline wetland system the presence of formerly reported Testudinidae was not confirmed (Parco Naturale Regionale Molentargius-Saline, 2008; Atzeni *et al.*, 2011).

Caretta caretta (Linnaeus, 1758)

Although the choice of only terrestrial sample sites don't allowed us to confirm the presence of *Caretta caretta* (Linnaeus, 1758). The accidental occurrence of the species into the SCI / SPA is proven by one recent observation referred to a stranded dead juvenile individual found in December 2006 (Nissardi & Zucca in Comune di Cagliari - Assessorato Ambiente, 2006), and two individuals accidentally caught in a net by a fisherman in 2013, and freed after a short period of rehabilitation (G. Ollano pers. comm.).

Hemorrhois hippocrepis (Linnaeus, 1758)

Horseshoe Whip Snake is clearly an infrequent/localized species (CS I) for Santa Gilla site: an individual was observed in April 2011 at the Roman ruins of Santa Caterina, 3 m a.s.l., Elmas/CA (9), and another one in August 2012, loc. Donna Laura, 1 m a.s.l., Cagliari/CA (6). As indicated by Bombi et al. (2011), "Stagno di Cagliari" represents a crucial refuge for Sardinian *H. hippocrepis*, probably being the only area where this snake can still be observed regularly. From the study area the species was recorded for the first time in 1839 by Gené, from *Masu* (= Elmas) (Gené, 1839; Bruno & Hotz, 1976), and most recent official record dates back to 1993 for "Assemini" (Stock, 2000-2006). During the study period, we could observe Horseshoe Whip Snake at some localities in Cagliari outskirts, often in urban and suburban environments (GPS coordinates are omitted for conservation issues): loc. Cala Mosca, Cagliari/CA, 6 m a.s.l., 22-VI-2011; loc. Colle di Bonaria, Cagliari/CA, 24 m. a.s.l., 10-IX-2009; loc. Palabanda-Orto Botanico, 47 m a.s.l., Cagliari/CA, 12-VI-2009; loc. Sella del Diavolo, Cagliari/CA, 120 m a.s.l., 13-VII-2011; loc. Tuvixeddu, Cagliari/CA, 70 m a.s.l., 02-IX-2008; loc. viale Marconi, Quartu S.E./CA, 6 m a.s.l., 02-VI-2008; loc. San Lussorio, Selàrgius/CA, 8 m a.s.l., 20-V-2009; loc. Cùcuru Angius, Sestu/CA, 45 m a.s.l., 09-IX-2012. Some of these observations refer to roadkills.

Following the recently published Red List of Italian vertebrates (Rondinini *et al.*, 2013), which applies the IUCN criteria of assessment to the Italian fauna,

the herpetofauna of Santa Gilla includes three Endangered (EN), one Vulnerable (VU), three Near Threatened (NT) and nine Least Concern (LC) species (Tab. 3). Moreover, one amphibian and four reptiles are included in the Annex II, while three amphibians and nine reptiles in the Annex IV of Habitat Directive 92/43 CEE (Table III). According to the Italian Red List, the non-native *T. scripta* is assigned to no IUCN category and while *Pelophylax* kl *esculentus* is therein indicated as Least Concern (LC) for the Italian territory, we consider *Pelophylax* sp. not worth being assigned to a IUCN category due to it being not pertinent to the fauna of Sardinia.

Breeding within the study area was confirmed for 11 species (four Amphibians, eight Reptiles), while for the remaining ones only adult individuals were observed.

The localities with the major species richness are found at the mouth of the four main rivers of the site: Foci del Riu Mannu e Riu Cixerri (2), Foce del Riu Santa Lucia e Tanca di Nissa (site code 7), Ex cave Laterizi (1) and Foce del Riu Sestu e Santa Caterina (9), with 12, 11, 10 and 10 species observed, respectively. The poorest locality in terms of species richness is Porto San Pietro (5) with only one amphibian and two reptile species observed in five years (Fig. 2).

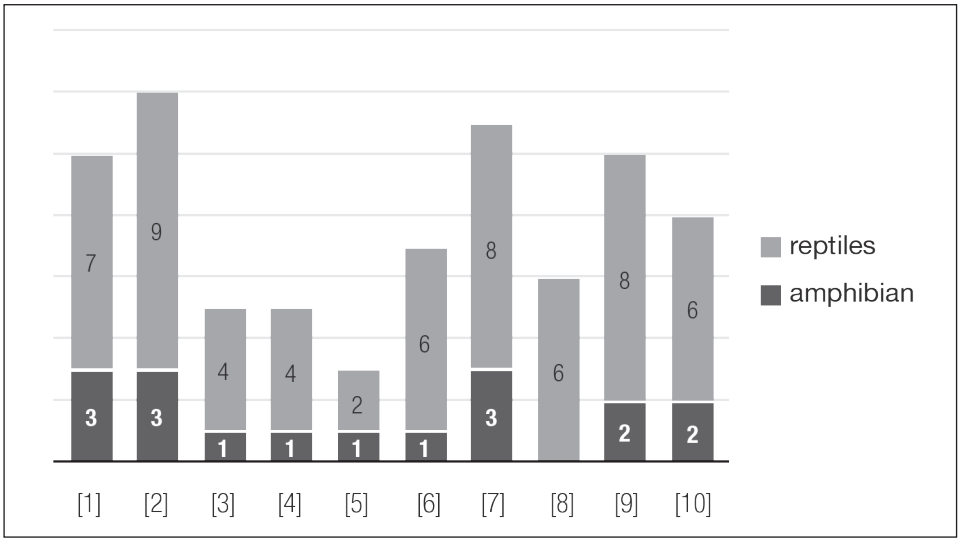

Fig. 2 - Species richness of each sample station.

Conclusions

Our survey highlights the key ecological importance of the study area as an important habitat for amphibians and reptiles. The number of species recorded for the site represents almost 60% of the currently known herpetofauna of the island and includes the totality of Sardinian anurans with the exception of the Common toad *Bufo bufo*, recently reported as a new non-native species for Sardinia (Cossu *et al.*, 2018; De Pous *et al.*, 2012).

These data suggest the key role of the Santa Gilla SCI/SPA for the conservation of coastal and lowland herpetofauna of the island. This leads to consider this area, together with the Molentargius-Saline protected area, the most important wetland system of southern Sardinia. Furthermore, our observations corroborate its inclusion in the map of Important Faunal Areas (IFAs) of Italy (Stock, 2008).

The analysis of the faunal composition of each investigated site, also indicate the high ecological value of river habitats, as well as that of the minor freshwater wetlands around the lagoon, which support populations of species of the greatest conservation concern (e.g. *D. sardus*, *E. orbicularis*, *H. hippocrepis*) and represent the main breeding sites for amphibians. Moreover, xeric emerged areas localized close to wetlands could host relict populations of *Testudo* species, and also of *H. hippocrepis*. In this regard, it was shown that the Santa Gilla site is the only protected area expected to maintain suitable conditions for this last species under future climate change (Bombi *et al.*, 2011). Some of these sites suffer from continuous degradation and reduction due to the expansion of agricultural activities and urbanized areas, and the lack of any legal protection, being not included in the SCI / SPA area. Therefore, for most of these sites, and in particular Santa Caterina (site code: 9 - Elmas), northern sectors of Correinas/Sa mura (8 - Assemini/Elmas) and Tuerra (10 - Assemini/Uta), the integration within the SCI area in the immediate future is highly recommended.

However, intense changes in land use, even on a short time scale, will involve all the investigated sites at the expense of the integrity of habitats and wildlife of the entire protected area (Mascia & Nucci, 2009).

Finally, the management of non-native *Pelophylax* sp. and *T. scripta* -as well as of the Red swamp crayfish *Procambarus clarckii* more and more frequently observed in the study area- should be promoted in order to prevent and/or contain their uncontrolled expansion and the possible related impacts on the native aquatic fauna.

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