APPENDIX

OVERVIEW ON PETS WORLD STRAYS, ZOONOSIS AND WILDLIFE IN SARDINIA

Appendix of the Self Evaluation Report 2023

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Overview on pets (dogs and cats) population in Sardinia

Currently 433,100 companion animals are identified by microchip and registered in the "Register of Companion Animals" in Sardinia. The total numbers of registered dogs and cats are 423,689 and 9,381 respectively. Thirty ferrets are registered as well (https://anagrafecanina.vetinfo.it/, last accessed December 2022). The city of Sassari has the highest number of identified dogs, 32,949 (Cagliari has 21,202 and Olbia 16,765). The city with the highest number of registered cats in Sardinia is Cagliari, 995, while Sassari has 777 microchipped cats and Olbia, 746.

Figure 1. Dog and Cat census. Source: "Regional Data Bank of Companion Animals" of the Autonomous Region of Sardinia. [Banca Dati Regionale Animali d'Affezione (vetinfo.it)]

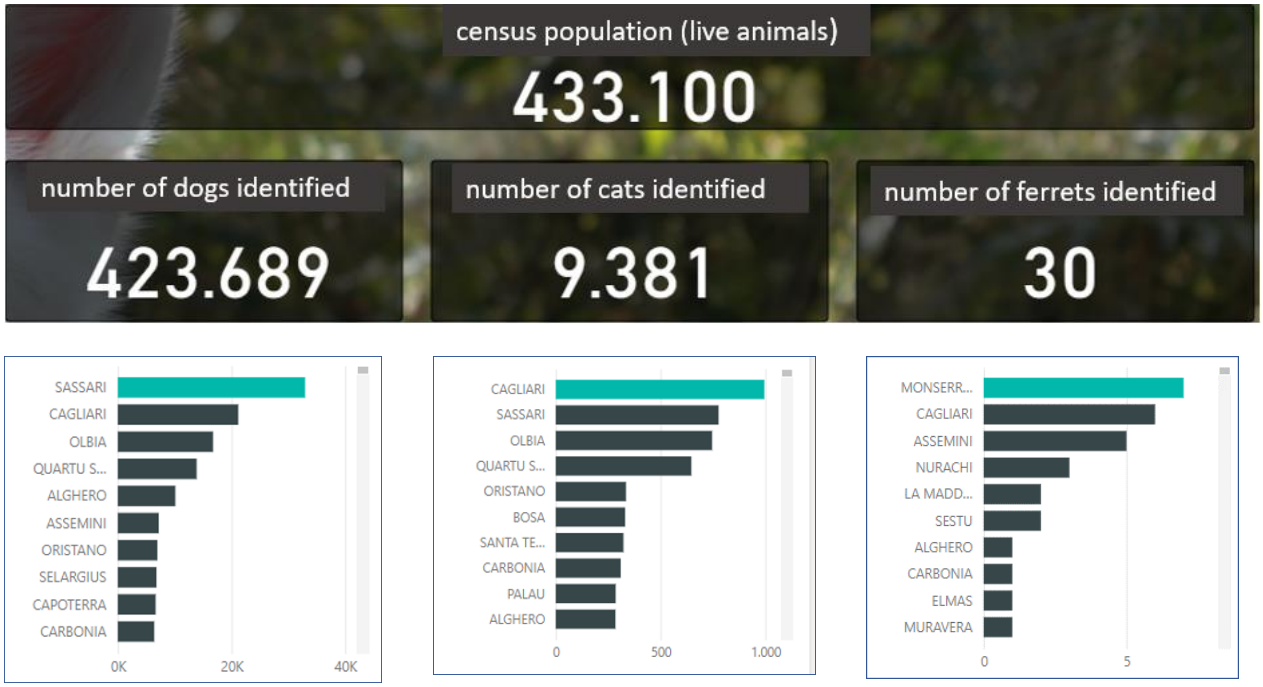

Figure 2. Dog and cat distribution. Source: “Regional Data Bank of Companion Animals” of the Autonomous Region of Sardinia. Banca Dati Regionale Animali d’Affezione (vetinfo.it)

The identification of dogs by means of a microchip was introduced in Sardinia with the regional law of 18 May 1994 n. 21 "Rules for the protection of animals and establishment of the canine registry". Since 2007 the database has been publicly available on the internet. (https://www.sardegnasalute.it/. Last accessed December 2022).

The Register of Companion Animals provides a national database of dogs, cats and ferrets identified by microchip. Data include information about the animal species, breed, gender and ownership. It has been created by the Ministry of Health in collaboration with the regional administrations. The registration of dogs is mandatory, while registration of cats and ferrets is voluntary. The pet rabbit has the opportunity to be registered in a private database dedicated to him created by the AAE-Rabbits onlus (Association of Exotic Animals - Rabbits Section) and called the Register of Rabbits. The Register of Companion Animals of Sardinia is a useful tool to protect animals for counteracting the phenomenon of abandonment, and to plan veterinary public health interventions aimed at preventing animal related diseases.

The interest and passion of Sardinian people for companion animals is expressed in activities linked to ENCI, the National Agency for Italian Cynophile (Ente Nazionale Cinofilia Italiana, www.enci.it). The ENCI agency was founded in 1882 and it federated with the International Cynological Federation based in Belgium, in 1970.

ENCI is the breeding agency for the canine species recognized by the Italian Ministry of Agriculture. ENCI has the task of maintenance of the herd book for each breed, provision of training, technical qualification and cultural updating of judges and experts, while regulating, approving and recognizing sponsors in Italy. The agency organizes, even directly, exhibitions, tests, races and any other cynotechnical event, also for sporting purposes, in order to favor the selection of national purebred dogs.

Today, about 200,000 entries are registered in the National Herdbooks in Italy, and over 2,000 zootechnical events are organized, including about 1,200 work trials and over 400 exhibitions with the annual participation of over 100,000 dogs. ENCI accounts for almost 2,000 breeder members and about 70,000 aggregate members. More than 100 ENCI delegations cover the entire national territory.

In Sardinia there are 144 dog breeders and about 600 aggregate members, 6 main exhibition shows are organized each year (4 international and 2 national), as well as events such as utility and defense, agility, hunting-related trials, gatherings (about 60/70 events each year, in the post-pandemic period) (data provided directly by ENCI officers). Students from the veterinary medicine degree course often participate in the test trials as judge assistants.

Currently ENCI collaborates with seven Regions (including Sardinia) with agreements aimed at "collaboration in the specialization and use of canine units in the field of wildlife hunting and in other areas of social importance". Under those agreements, support actions in the field of fauna management, monitoring and conservation are implemented through the use of specialized and patented canine units. The specialized dog units are employed both in the regulation of hunting activities, in wildlife control, monitoring and management of wild species. Examples of management activities that are carried out with the help of dogs on wild species include the control of the wild boar (*Sus scrofa*) and the recovery of injured ungulates with the help of recovery dogs.

As part of the "Life Under Griffon Wings" project, in order to mitigate the risk of poisoning for the Griffon vulture population, the Department of Veterinary Medicine of the University of Sassari has also created an anti-poison canine unit. The illegal use of poisons to fight terrestrial predators or stray dogs represents one of the most significant threats to vulture populations in Europe (http://www.lifeundergriffonwings.eu/it/index.html).

Sport Horses

Horses are deeply rooted in Sardinian culture, with races and events linked to religious traditions, still alive and present. Horses are also used in leisure and cultural activities, throughout the island (https://www.yumping.it/passeggiate-a-cavallo/sardegna), and, most of all, in sports, since the early 1900s. The horse breed mainly present in Sardinia is Anglo-Arabian, whose breeding stock now counts 139 stallions and 2758 mares (DAD-IS FAO, last accessed in December 2022).

Currently, Sardinia has three racetracks (Chilivani (SS), Sassari (SS) and Villacidro (Ca)) which annually host about 180 flat races in 22 days of competition, always organized on the weekend, with an annual average of 1600 starters (partenti) (http://www.hippoweb.it/prestazioni.php, last accessed on December 2022). Equestrian competitions involve money prizes and also involve evaluation of the horse (Pira et al., 2021).

The presence of horses in Sardinia dates back to the Bronze Age (1500 BC), but during the second half of 1800, rearing and breeding of military horses was encouraged, and later, in 1967 the "Anglo Arabo Sardo" breed was created, by crossbreeding Thoroughbred and Arabian stallions with local mares. In 1993, the first International Anglo-Arabian Horse Conference officially defined the breed standards. All countries, to varying degrees, had to renounce national or local breed definitions. This also happened in Italy where the Anglo Arabo Sardo was renamed as Anglo-Arabian. The Anglo-Arabian horses born and bred in Sardinia have won important races in France and in the Italian peninsula and became also favorably noticed in national breeding awards for their distinction and morphological harmony (Cherchi, 2020).

Following the law of 1st August 2003 n.200 and the relative decree of 5th May 2006, which dictated the guidelines and principles for the organization of the equine registry, from 1st January 2007 all Equidae residing in Italy must be identified and registered in the Equid Registry, managed by A.I.A. (Associazione Italiana Allevatori). Subsequently with the issuing of EC Reg. 504/2008 which defined at European level the legislation for the management of databases of equidae, the A.I.A. continued through the A.A.R.S. (Associazione Allevatori della Regione Sardegna, http://www.allevatorisardegna.it/it, Breeders Association of the Region of Sardinia) to identify the subjects defined as "common" or "income", those registered in the Registry and those registered in the Genealogical Books of its pertinence. The art. 13 of Law 20 November 2017, n. 167 brought innovation to the current discipline of the Equidae registry, establishing that this matter falls within the competence of the Ministry of Health (https://www.salute.gov.it/portale/home.html).

Feral animals, typical of the island: Sardinian White donkey, Grey donkey, Giara and Sarcidano horses

Among the typical mammals of Sardinia, we find the "Cavallino della Giara" horse, the "Sarcidano" horse and the "Asino dell'Asinara" white donkey of Asinara island. The two native horse breeds are classified "at risk" by FAO (http://www.fao.org/dad-is) for their status.

The “Cavallino della Giara” horse is one of the 15 indigenous horse breeds of limited distribution in Italy recognized by the AIA (http://www.aia.it/aia-website/en/about/la-storia), the Italian breeders’ association. It has very small size and it is considered as a miniature horse, males have withers height of 125 -135 cm, and females 115 – 130. The Giara (https://parcodellagiara.it/) plateau extends over 45 km^2 in the center/south Sardinia, at an altitude of 500-600 m above sea level, with steep mountain slopes which prevent migration of the horses and contribute to their isolation. Vegetation is made up of open cork forests interspersed with vast pasture meadows. Characteristic are the "paùlis", temporary ponds which, in spring, are covered with aquatic buttercups, considered priority habitats by the EU. The “Cavallino della Giara” horses are today the only survivors of the numerous herds that have lived in the wild on the island until the late Middle Ages. Since 2002, the Giara horses, that in the past belonged to private owners, have been acquired as public property through funding from the Sardinia Region. The population of the Giara, consisting of about 557 animals (FAO 2018; last updated october 2022; https://www.fao.org/dad-is/data/en/), live in the wild and form family herds; horses suffer the limited extension of the plateau and also the presence of domestic livestock, mainly cattle and goats, which compete for grazing (https://www.sardegnaforeste.it/fauna/cavallino-della-giara).

The Sarcidano horses are concentrated on a single farm in Laconi (in central-western Sardinia), their origin is mostly unknown, but nonofficial records suggest a descent from the ancient Spanish horse, an ancestor of the Andalusian breed (Morelli et al., 2014). The Sarcidano Horse is a rare semi-feral breed recognized by the AIA (http://www.aia.it) as “of limited distribution”, with 159 animals (65 females and 50 males) (DAD-IS FAO, https://www.fao.org/dad-is/en/, last accessed October 2022). Both Giara and Sarcidano horses are bred in semi-feral conditions and recorded in the Anagraphic Register of equine populations (http://www.anagrafeequidi.it).

The Sarcidano horses were purchased in 1996 by the Municipality of Laconi (OR), in order to prevent their extinction. Since then the Forestry Authority, the Municipality, the Institute of Horse Breeding, the Department of Veterinary Medicine of Sassari and the University of Milan have been carrying out studies to understand the origins and characteristics of this particular horse breed. The defense of the breed (declared as such in 2005) is, therefore, of great interest to scholars due to its great historical, cultural, and biological importance. Mitochondrial DNA analysis revealed that the two sardinian horse populations consisted of distinct gene pools having no gene flow between them (Cozzi et al., 2004; Morelli et al., 2014).

During the last five decades, Italian autochthonous donkey populations suffered from a severe reduction in population size, which led to the extinction of several breeds. At present, eight donkey breeds remain in Italy, all classified by FAO as critically endangered or endangered, including the “Asinara”, and “Sardo Grigio” both authochthonous of Sardinia. The Asinara donkey is an autochthonous breed of the island of Asinara (North Sardinia), small in size, with a characteristic white coat with pink skin and light blue eyes attributed to a form of incomplete albinism (https://www.sardegnaagricoltura.it/index.php?xsl=443&s=44929&v=2&c=3679).

For the Asinara white donkey, 431 animals were reported (DAD-IS FAO, https://www.fao.org/dad-is/en/, last accessed October 2022), while the Sardinian gray counts to 3436 gray donkeys in Sardinia, as reported by

FAO, and in situ conservation programs are also reported. In order to preserve the remaining autochthonous donkey breeds, their status was officially recognized by the Italian government, and breeding associations with managed herdbooks have been established for the majority of the breeds. The Sardinian donkey breeds, Asinara and Sardo Grigio, shared some distinctive genetic traits that separated them from the remaining Italian donkeys, according to genetic analysis carried out by Colli et al., (2012). In the municipality of Ortueri (Nu, Central Sardinia) a park has been established for the protection of the Sardinian donkey breed, named Sardinian donkey park Mui Muscas (https://www.comune.ortueri.nu.it/index.php/tzente/turismo/3). It is an oasis of about 55 hectares of forest, it hosts the largest group of purebred donkeys in all of Sardinia. A collaboration with the Department of Veterinary Medicine of Sassari is active, for educational purposes (https://www.comune.ortueri.nu.it/index.php/tzente/articoli/362).

Veterinary clinics in Sardinia

In the socio-economic context of Sardinia, mainly based on dairy sheep breeding, the veterinary doctor has always had great appeal. In Sardinia, a total number of 1484 veterinary doctors are currently registered in the Order of Veterinary Doctors, with 43,6 % in Sassari, 27,8 % Cagliari, 18 % Nuoro and 10 % Oristano (FNOVI, https://www.fnovi.it/). They are divided into the categories of clinical activity, food safety, laboratory activity, and industry; additional categories include bee veterinarians, veterinarians expert in animal behavior, "accredited veterinary doctors" (a new proposal from Fnovi (https://www.fnovi.it/), mainly related to the accreditation of experts in the care of exotic animals, still in an experimental phase), Telenarcosis, farm veterinarians, veterinarians with expertise in traditional Chinese medicine – acupuncture and veterinarians with expertise in the field of feeding, nutrition and clinical dietetics of pets (https://www.fnovi.it/albi-e-iscritti/ricerca-iscritti-per-ambiti-professionali).

According to the Italian Ministry of Finance, veterinary offices have an average annual income of 21,160 euros, based on data relating to the average incomes declared for 2016 (Il valore sociale del Medico Veterinario. Censis 2019, https://www.censis.it/welfare-e-salute).

More data are available for the Veterinary sector in Italy: in 2018 there were 33,302 members of the Order of Veterinary Doctors in Italy, 23.5 % more than in 2008. The percentage of women increased by 53.6 % and in ten years they went from 37.4 % to 46.5 % of total subscribers.

Tab. 1 - Registered veterinary doctors in Italy, by professional field, 2018.

Professional field		Number	Percentage	Difference % 2013-2018
Public sector		5.288	15,9	-2,1
	University	425	1,3	0,3
	Local Health Services	4.303	12,9	-2,1
	Administrations	560	1,7	-0,3
Private Sector		26.654	80,0	1,0
	Freelance	26.070	78,3	1,3
	private employee	461	1,4	0,4
	Breeders associations	123	0,4	-0,6
Retired		309	0,9	-0,1
Not available		1.051	3,2	1,2
Total		33.302	100,0	-

Source: "Il valore sociale del Medico Veterinario" Censis 2019 (https://www.censis.it/welfare-e-salute)

In Italy, veterinarians guarantee the quality and safety of foods of animal origin to protect consumers who are increasingly attentive to the genuineness and traceability of what they eat. Domestic consumption of food products of animal origin amounted to 65 billion euros in 2017: 43 % of the total food expenditure of Italian families. Furthermore, veterinary doctors certify the quality of Italian products of animal origin and authorize exports to the world, to oversee the supply chain of "made in Italy" food. Italian exports of food products of animal origin amounted to 7.8 billion euros in 2017- +44.0 % in quantity and +57.4 % in value in the last ten years.

The veterinary doctors employed in the public health sector are directly involved in the environment protection, through the control of river and marine waters, sources of environmental pollution, and the protection of animal species in danger of extinction, as well as Bee veterinarians, experts in beekeeping and honeybee medicine. Veterinary doctors support the new paradigm called 'One Health', i.e. one health and one medicine for the entire community: man, animal and environment together, according to a systemic and multidisciplinary logic.

In addition, veterinarians provide medical treatment to farm animals, companion animals, exotic and wild animals, depending on their specialization . According to a 2019 survey from CENSIS (Centro Studi Investimenti Sociali, Center for Social Investment Studies, https://www.censis.it/) and FNOVI (Federazione Nazionale Ordini Veterinari Italiani, National Federation of Italian Veterinary Orders), Italians are among the top nationalities in Europe to own a pet. Pets are present in 52% of Italian homes. With 53.1 pets for every 100 inhabitants, Italy ranks second in Europe (Hungary being the first, 54.2 pets per 100 people) followed by France (49.1), Germany (45.4), Spain (37.7) and the United Kingdom (34.6). In Italy there are a total of 32 million pets: 12.9 million birds, 7.5 million cats, 7 million dogs, 1.8 million small mammals (hamsters and rabbits), 1.6 million fish and 1.3 million reptiles.

In 2017, Italian families spent 5 billion euros for the care and well-being of their pets (+12.9% in the last three years),: an average of 371.4 euros per year for each family with animals intended for food, collars, leashes, cages, litter boxes, grooming and veterinary care.Moreover, 141 million euros were dedicated to the purchase of pets (€10.5 per household with animals)and 3,934 million euros were spent on the purchase of pet products, while expenditure for veterinary services and other services for pets amounted to 941 million euros (Censis processing on Istat, Assalco – IRI data). During the COVID19 epidemic, there was an increase in general spending, which also affected the Pet food category. Pet owners made massive purchases that exceed the animals' physiological nutritional needs. According to ASSALCO (https://www.assalco.it/), the positive trend of the Italian pet food market continues, as in 2020 grew both in terms of value (+4.2% compared to 2019) and in volumes (+2%), with an overall turnover well over the 2 billion euros.

The veterinary sector also invested in technological innovation and offered specialized services. The Italian veterinary structure for the care of pets is a growing sector. For four out of ten veterinarians, professional activity has increased in the last two years, a growth that precedes the 2020 pandemic. The number of structures and the number of specialist treatments has increased. From 7,100 in the latest Research & Consulting survey

for Anmvi (https://www.anmvi.it/) (year 2018), the Italian veterinary facilities rose to 9,400 in 2021 (source: Seat/Italiaonline). The degree of complexity of treatment has also grown (83% of Italian structures provide specialist consultancy, 63.8% advanced surgery). The specialization reflects the scientific and technological growth of veterinary medicine and the increasing demand for veterinary care beyond the threshold of basic medicine. Outpatient clinics continue to be the dominant type of facility. Compared to the propensity to invest, the sector appears less static than the latest Research & Consulting survey for Anmvi (year 2018) but remains deeply traditional in its organizational and legal configuration. The majority of Italian veterinary structures are simple (outpatient clinics/studies) and when they are not run by a single owner, they prefer the formula of the professional association rather than the corporate one. The new forms of business in terms of professional aggregation are struggling to take off, as are the new STP (companies between professionals).

Stray dogs

In Italy, several laws are aimed at protecting animal welfare and health, in compliance with European regulations. The framework law of 14 August 1991, n. 281, states the general principle that "the State promotes and regulates the protection of companion animals, condemns the acts of cruelty against them, the mistreatment and their abandonment in order to favor the correct coexistence between man and animal and to protect public health and the environment". Pets are recognized the right to life and security, while the killing of those without owners, found wandering, has been prohibited. Prevention of stray dogs is necessary, to prevent health issues, related to zoonoses such as rabies, echinococcosis, leptospirosis and leishmaniasis, implications in public safety like assaults, bites, accidents, animal welfare, mistreatment, poisoning and killing.

The current regulations offer different tools to reduce stray dogs which include the Register of Companion Animals, sterilizations, adoptions, training and information for citizens. The Italian Regions are entrusted with the task of implementing national regulations, through their own provisions, while specific tasks and responsibilities have been assigned to the various Institutions and Control Authorities, as well as to the owners of the animals. The data about straying and protection of companion animals' welfare by the Sardinia Region are reported in the table below.

Table 1. Stray dogs in Sardinia, data as of December 31, 2020

Number of sanitary kennels	number of shelter kennels	mixed structures	entrances to sanitary kennels	entrances to shelter kennels	dogs returned to the owner	dogs given up for adoption	Number of dogs in sanitary	Number of dogs in shelter	sterilization of dogs	Sterilization of cats

							kennels	kennels		
5	39	78	2926	8978	181	0	9159	0	711	577

Source: Relazione Annuale del Piano di Controllo Nazionale Pluriennale (PCNP) 2020/2022 extracted and translated from Table 2 (following)

Table 2. Stray dogs in Italian Regions, data as of December 31, 2020

Dati sul randagismo al 31 dicembre 2020

Regioni	Numero canili sanitari	Numero canili rifugio	Strutture miste	Gattili	Ingressi nei canili sanitari	Ingressi nei canili rifugio	Cani restituiti al proprietario	Cani dati in adozione	Numero cani nei canili	Numero cani nei canili rifugio	Sterilizzazioni cani	Sterilizzazioni gatti
Abruzzo	5	11	6		3.369	1.114	258	3.073	116	3.123	1.701	1.684
Basilicata	0	1	29	1	2.117	1.934	50	1.145	98	6.775	1.070	133
Bolzano	1	2	0		100	100	50	87	3	40	np	0
Calabria	13	19	0		1.651	1.473	63	1.662	477	8.361	np	0
Campania	0	0	101		8.672	3.656	875	7.322	1.088	8.285	6.087	6.896
Emilia Romagna	0	0	60		5.859	0	3.252	2.879	3.875	0	307	6.504
Friuli Venezia Giulia	6	9	0		1.213	163	755	459	49	412	np	np
Lazio	25	50	0		8.240	5.085	1.406	6.050	827	7.763	5.011	7.323
Liguria	1	15	0		338	993	118	535	10	959	np	884
Lombardia	28	66	0		6.039	2.166	3.864	2.868	196	1.962	381	8.462
Marche	20	32	0		1.556	934	679	1.208	33	1.959	404	3.779
Molise	0	0	10		579	0	183	339	1.139	0	459	257
Piemonte	16	14	8		5.578	3.065	3.296	3.383	151	2.855	np	410
Puglia	48	102	25		5.925	7.324	600	7.866	2.426	16.132	4.586	5.211
Sardegna	5	39	78		2.926	8.978	181	0	9.159	0	711	577
Sicilia	8	21	25		4.956	0	855	1.759	7.949	0	11.938	6.306
Toscana	0	0	82		4.489	1.327	2.829	1.636	370	3.119	np	4.577
Trento	3	3	0		244	63	81	71	0	59	np	545
Umbria	6	23	0		1.095	359	384	816	191	2.461	735	2.647
Valle d'Aosta	1	1	0		161	39	122	56	7	80	2	485
Veneto	9	22	0		3.264	1.524	1.591	2.171	302	1.529	1.141	10.562
Totale	**195**	**430**	**424**	**1**	**68.371**	**40.297**	**21.492**	**45.385**	**28.466**	**65.874**	**34.533**	**67.242**

N.B. I dati riferiti alle strutture presenti sul territorio, evidenziati in rosso, non sono aggiornati

Source: Relazione Annuale del Piano di Controllo Nazionale Pluriennale (PCNP) 2020/2022

In the province of Sassari there are 4 municipal kennels, two of which are sanitary, which can host a total of about 750 dogs. Thanks to projects and collaboration agreements, the Department of Veterinary Medicine of Sassari has been offering its competence to the Municipal kennel of the city of Sassari since 2009.

The municipal kennel of Sassari is both a sanitary and a shelter kennel, including an ambulatory, equipped surgery room and 3 hospitalization rooms and hosts an average of 250 dogs. The kennel is accessible from the Department of Veterinary Medicine, being only 10 km far. The Medical Director of the kennel, prof.ssa Maria Luisa Pinna Parpaglia, is also the Medical Director of the VTH (Veterinary Teaching Hospital). The Department offers its service to perform all the routine veterinary activities, such as diagnosis and prophylaxis of infectious and parasitic diseases, diagnosis and therapy of the common and non-complicated medical pathologies, spying/neutering of the hosted dogs and application of animal welfare rules. To perform other

kinds of surgeries or in case of critical and emergency cases the dogs are transported to the VTH for better assistance. The Department also follows all the dogs with behavioral problems that need specific rehabilitation in order to facilitate their adoption. Many students of the Degree Course in Veterinary Medicine attend the kennel during their practical teaching activities and Clinical Rounds.

In this context, an agreement between the Sardinia ATS (https://www.atssardegna.it/) (Institute of Health) and the University of Sassari, Department of Veterinary Medicine, for the sterilization of stray dogs and cats is now active, while agreements for sterilizations have been active until 2021 with the ASLs of Sassari and Oristano. New agreements are currently being made for 2023 with different ASLs to continue sterilization activity with Sassari, Oristano, Olbia and Nuoro.

Agreements with the ASL of Sassari (https://www.asl1sassari.it/) for first assistance to dogs without owners (dogs up to 2021 and cats up to 2022) have been active in the past. In addition, agreements with the Municipalities of Sassari, Stintino, Sorso, and the Union of Municipalities of Coros for second assistance to dogs without owner and with the Municipality of Sassari for I and II assistance to cats without owner have been made over the years, as well. Animals, without owners, who are ill or are victims of accidents or poisoning, are emergency rescued, stabilized (I assistance) and subjected to appropriate therapies until they recover (II assistance).

The veterinarian of the public health service has the task of supervising and controlling the health status of kennels, catteries and shelters, he is required to carry out the identification and registration of the dogs in the canine registry and check the microchip presence. The vet has to set up sterilizations of stray dogs and cats from feline colonies. In addition, he collaborates with the Municipalities for the promotion of initiatives aimed at creating the correct human-animal relationship and organizes, in agreement with the Municipalities, training courses for the dog owners. The veterinarian of the public health service activates, following episodes of biting or aggression, a path aimed at ascertaining the psychophysical conditions of the animal and proper management by the owner. He maintains and updates the register of "dogs responsible for biting or aggression" on a regular basis. He also sends the carcasses of domestic or wild animals and any other sample useful for laboratory analysis, received by veterinarians or private citizens for the purpose of confirming suspected poisoning to the Experimental Zooprophylactic Institute (IZS) competent for the territory.

Till date, sixty-one voluntary associations for the protection of animals are recognized in Sardinia (data from the Sardinian health system, https://www.sardegnasalute.it/index.html). Among these, the L.I.D.A. (Italian League of Animal Rights, http://www.lida.it/), testifies that: "Since 1987 (the year in which L.I.D.A. was founded in Sassari), we have given absolute priority to sterilizations. We were helped by Prof. Pau, head of the University clinic of obstetrics (now Department of Veterinary Medicine), who accepted our female dogs, collected from the streets with our own means. In those years, around 200 bitches were sterilized and at least 250 dogs were placed for adoption (https://www.lidasassari.it/)".

Zoonoses

Maintaining the complex relationship between human health, animal populations and the environmental contexts is the goal of veterinary public health (Sanità Pubblica Veterinaria, SPV) and veterinary medicine which contribute most to human health and well-being. It covers multiple aspects of the human/animal relationship, such as animal health and welfare, veterinary drug development and management, veterinary intervention during disasters, veterinary urban hygiene and wildlife health management. Therefore, the SPV is a determining component of the unitary vision of the concept of One Health, a modern conception of the relationship between human, animal and environmental health. Zoonoses, or diseases transmissible from animals to humans, are one of the most consolidated areas of the SPV. Over 70% of emerging human diseases have a zoonotic origin. They range from "historical" diseases such as rabies and salmonellosis, to diseases that have emerged in recent decades (Ebola, Coronavirus, SARS, HIV/AIDS, deriving from the monkey immunodeficiency virus, hepatitis E, prion diseases). The interdisciplinary approach of One Health is crucial for the study and management of zoonoses.

In Sardinia, as in all regions of Italy, Zooprophylactic Institutes (IZ) were created, aimed at prevention of animal diseases and zoonoses at a territorial level. A Regional Veterinary Epidemiologic Observatory (https://www.izs-sardegna.it/CdSE-OEVR.cfm) (O.E.V.R.) has been set up within the IZS of Sardinia, aimed at evaluation, planning and veterinary epidemiological surveillance on the regional territory. It is constantly involved in the epidemiological-statistical processing of data from the Zooprophylactic Institute. Among other functions and activities, the O.E.V.R. provides the technical-scientific support to the Department of Health, necessary for addressing and planning interventions for the governance of veterinary activities; collects and processes data relating to animal health, food hygiene, livestock farming and productions, also in collaboration with other centers; collaborates with the Prevention service of the Department of Health, for the creation of the Regional Veterinary Epidemiological Bulletin, intended as an Information System of animal diseases persisting in the region.

These activities are necessary because several zoonoses persist in Sardinia, each managed with a control and eradication plan (https://www.izs-sardegna.it/index.cfm).

Among the parasitic zoonosis that cats and dogs can transmit to humans are: *Echinococcus granulosus*, one of the main zoonosis present in Sardinia; *Giardia duodenalis*; *Cryptosporidium spp*; *Toxoplasma gondii*; *Toxocara canis*; *Toxocara cati*; *Ancylostoma caninum* and *Strongyloides stercolaris*.

- Cystic Echinococcosis or Hydatidosis is a parasitic zoonosis caused by the larval form of the tapeworm *Echinococcus granulosus*. The disease is mostly endemic in rural areas where sheep farming is practiced, such as Central Asia and China, South America and Mediterranean countries where human incidence rates for Cystic Echinococcosis can reach values above 50 per 100,000 people / year. In the Sardinia Island, from 2001 to 2010, an average annual rate of 6.5 patients per 100,000 inhabitants was recorded, compared to a national average of 2.4 cases per 100,000 inhabitants, with the highest peaks in the province of Nuoro, where the average annual rate was 12.2 patients / 100,000 inhabitants. The

average direct cost for a CE case in Sardinia was estimated at Euros (€) 5,970.92 for an average annual expenditure about € 746,316.66. Total disability-adjusted life years (DALYs) were estimated to be 505.40. Despite the efforts made in the field of prevention and control, WHO includes echinococcosis among the 17 neglected tropical diseases (NTDs). The presence of extensive sheep farms, the consistent presence of stray or shepherd dogs, unsupervised home slaughter and improper disposal of carcasses are the predominant factors for the persistence of CE in the endemic regions where dogs are in close contact with livestock. The WHO / FAO Committee of Experts in Veterinary Public Health (SPV) recognized zoonoses and trauma caused by animals as occupational hazards in 1975. In 2012, a joint FAO / WHO expert group ranked *E. granulosus* among the top eight foodborne parasites in order of global public health importance. Currently, the Ministerial Decree of 27 April 2004, updated by the Ministerial Decree of 11 December 2009 and by the Ministerial Decree of 10 June 2014, lists many occupational zoonoses in the farming sector including Cystic Echinococcosis (in List I "diseases whose working origin is highly likely "- Group 3).

- *Giardia duodenalis* is a protozoan that causes parasitic diarrhea in the world. Giardiasis has been included in the "Neglected Disease Initiative" project of the World Health Organization (WHO) since 2004, due to its prevalence and incidence in the poorest areas of the world. Transmission occurs via fecal-oral pathway, most frequently through the ingestion of contaminated food and water, classifying as "Foodborne disease" and "Waterborne disease" as well. *Giardia duodenalis* includes eight (A-H) genetic group or assemblages. The assemblages A and B are subdivided into subgroups, and they are the only ones recognized as causing infection both in mammals and humans, showing a zoonotic potential that cannot be underestimated.
- *Cryptosporidium* spp. is a group of protozoan parasites which infect fish, amphibians, reptiles, birds and mammals. Cryptosporidiosis is a frequent cause of diarrhea in humans, especially in susceptible subjects like children and immunocompromised individuals. It is primarily transmitted through water but other mechanisms of transmission are ingestion with contaminated food, fecal contact and direct contact with infected people. The infection has been reported in more than 90 countries and on five continents.
- *Toxoplasma gondii* is one of the most widespread parasites in the world, both in warm-blooded animals and humans. All warm-blooded animals can be the intermediate hosts, including farm and wild animals, as well as humans, while the definitive hosts are represented by the felids, especially the cat. The cat, through the feces, releases up to 100 million oocysts which do not sporulate until about 15 days in the external environment, eventually undergoing sporulation and becoming infectious within 1-5 days. Toxoplasmosis is one of the most important foodborne parasitic zoonoses, occupying the fourth place in the global ranking of food-borne parasites drawn up by the Food and Agriculture Organization of the United Nations (FAO) and the WHO. Although the infection can have a benign outcome, the diagnosis in pregnant women is crucial for the consequent risks on the fetus.

- *Toxocara canis* and *Toxocara cati* are ascarides mainly responsible for human toxocariosis. The final hosts are the dogs and cats respectively, while the other animals, upon which dogs and cats usually prey, like rodents, are the paratenic hosts. Human, in this case, represents an accidental host. Toxocariosis in humans occurs predominantly with asymptomatic or subclinical symptoms, but symptomatic infestations can generate visceral larva migrant (VLM) syndromes, ocular larva migrans (OLM) or neurotoxocariosis
- *Ancylostoma caninum* is categorized as "hookworm" completing its lifecycle with dogs as the definitive hosts. This parasite also infects humans which are the accidental hosts because they do not play any role in the completion of the biological cycle. In humans, the infectious larvae (L3), penetrate through the skin causing cutaneous larva migrans (CLM) also called "creeping eruption" which cause intense itching with serpiginous linear skin lesions having erythematous-papulo-vesicular appearance, which can grow a few millimeters per day. If left untreated, the parasitic forms move aimlessly within the skin for one to two months leading to secondary infections. In rare cases, the larvae migrate into the intestine causing eosinophilic enteritis with abdominal pain, anorexia, diarrhea and nausea.
- *Strongyloides stercoralis* is a zoonotic parasite, widespread throughout the world, which infests dogs, cats and primates including humans. *Strongyloides stercoralis* is one of the soil transmitted helminths (STHs) and is listed among the NTDs. Strongyloidiasis in humans includes a number of nonspecific but common gastrointestinal symptoms such as diarrhea, abdominal pain and urticaria. However, most infestations, including chronic ones, remain asymptomatic. Asymptomatic infestations can be dangerous in the case of immunosuppressive treatments, especially with corticosteroids, because they can lead to disseminated infestation.

Other zoonosis occurring in Sardinia are:

- Bovine Tuberculosis (TB) is a bacterial disease supported by *Mycobacterium bovis*. Although cattle are the main hosts, other domestic and wild animal species are susceptible to the infection, such as sheep, goats, equines, pigs, dogs, cats, wild boars, deer, and antelopes. Bovine tuberculosis is characterized by the appearance of nodular lesions of the granulomatous type in the host, known as "tubercles" located in several body districts (lymph nodes, lungs, intestines, liver, spleen, pleura, and peritoneum). Bovines are the main source of infection for humans. The zoonotic transmission can occur either directly, through close contact with infected animals (aerosols), or indirectly through the consumption of contaminated products (unpasteurized raw milk, fresh or short-aged dairy products, and undercooked meat). Although many actions are carried out to control the infection in cattle herds, the complete elimination of the disease is complicated by persistent infection of wild animals. In Sardinia, the first case of a wild boar infected with *Mycobacterium bovis* was reported in 2006 in the Goceano area. In the same area, during an outbreak of bovine tuberculosis in 2007-2008 over 700 cattle were culled with a cost of over 400,000 euros. It appears clear that this disease has a considerable importance in the regional economy and also the social aspects must be considered (https://www.regione.sardegna.it/j/v/25?s=291638&v=2&c=1250&t=1)

- Brucellosis is a bacterial disease caused by different bacteria of the family *Brucella*, which tend to have a host specificity. However, most *Brucella* species can infect other animal species as well. Brucellosis in cattle (*B. abortus*) in sheep and goats (*B. melitensis*) and in swine (*B. suis*) are diseases listed in the World Organization for Animal Health (WOAH) Terrestrial Animal Health Code. Adult males may develop orchitis, while pregnant females show placentitis and necrotic and haemorrhagic cotyledonitis, causing abortion in the last trimester of pregnancy, and possibly leading to hypofertility. Most infected animals remain carriers and eliminators throughout their lives. In addition to the detrimental economic impact on livestock production, brucellosis represent a serious threat for human health (https://www.regione.sardegna.it/j/v/25?s=291638&v=2&c=1250&t=1). Brucellosis transmission to humans can occur both directly, through close contact with infected animals immediately after delivery or abortion (handling infected animals and aborted fetuses or placentae), and indirectly, through the consumption of raw milk and fresh or short seasoned dairy products. In pregnant women brucellosis can also cause abortion.
- Bovine Spongiform Encephalopathy, BSE, is a disease of the group of Transmissible Spongiform Encephalopathies (TSE), or prion diseases. BSE is a fatal disease of the nervous system of cattle that is caused by the accumulation of an abnormal protein called 'prion' (PrP). Causing the progressive degeneration of the central nervous system, the outcome is always fatal. Two forms can be distinguished: the classical BSE occurs in cattle after ingesting prion contaminated feed, while the atypical BSE is believed to occur spontaneously in all cattle populations. BSE is considered zoonotic due to its assumed link with the emergence of the variant Creutzfeldt-Jakob disease in humans; the transmission can occur by the consumption of contaminated bovine products (brain, marrow). To date, the incidence of both forms is negligible and estimated to approach zero cases per million cattle.
- Salmonella infections are a major cause of foodborne illness in humans, both sporadic and epidemic, and the second most common zoonotic disease after campylobacteriosis in the EU. Salmonella is commonly found in the intestines of healthy birds and mammals. Humans usually get infected by the manipulation or the consumption of contaminated products. Salmonella is most frequently found in eggs and raw meat from pigs, turkeys and chickens (https://www.anmvioggi.it/images/PIANO_NAZIONALE_DI_CONTROLLO_SALMONELLOSI_AVICOLI_2022-2024.pdf). In humans, salmonellosis causes fever, diarrhea, and abdominal cramps, the infection can be life-threatening if it reaches the bloodstream. EFSA has estimated that the overall economic burden of human salmonellosis could be as high as €3 billion a year.
- Leptospirosis is a disease transmitted by bacteria of the genus *Leptospira*. Leptospirae can infect both domestic and wild animals, including humans. Leptospirae are maintained in nature through chronic kidney infection of carrier animals, such as rats, dogs, cattle, horses, sheep, goats, and pigs. These animals can release leptospirae in their urine for years. Dogs and rats are probably the most frequent source of human infections. The transmission occurs through contact of skin abrasions and exposed mucosa (conjunctival, nasal, oral), with infected urine or contaminated water. Common leptospirosis

symptoms are fever, headache and sore throat, but fragile individuals can develop icterus and meningitis.

- Vector-borne diseases are caused by several bacterial, viral, and protozoan species transmitted by arthropods (mainly ticks and mosquitoes), and many of them can cause zoonotic infections. Among them, human cases of West Nile fever are reported every year in Italy and in Sardinia. The West Nile fever is a zoonotic disease caused by a flavivirus transmitted by *Culex* mosquitoes from birds (usually asymptomatic) to mammals. Horses and humans develop flu-like symptoms, but some animals can also develop skin rash and neurological symptoms. *Anaplasma* bacteria are tick-borne pathogens that infect several animal species, including humans (involved as accidental "dead-end" hosts), among them, *A. phagocitophylum* causes the tickborne fever of ruminants, the granulocytic anaplasmosis of horses and dogs, and the granulocytic anaplasmosis in humans. Mediterranean spotted fever is an acute febrile, zoonotic disease caused by the bacterium *Rickettsia conorii* and transmitted by the dog tick *Rhipicephalus sanguineus*. This disease is endemic in Sardinia and represents an important public health problem. Vectors represent a link between human communities, domestic animals, and wildlife, and control plans necessarily must take into account a One Health approach.

The EU has defined a Zoonoses control program (Reg.CE 2160/2003) which provides for the progressive decrease of the prevalence of the main zoonotic agents in animals, in particular specific control programs are envisaged for breeding chickens, laying hens and meat chickens in farms with a number of heads > 250. In order to optimize sampling sensitivity, both fecal material (on top of shoes or pools of fresh feces) and environmental material (dust samples from different points of each production unit) are taken according to the quantity and the specific number for each control plan. National control plans are based on biosecurity measures, vaccination and self-control plans. The prophylaxis measures implemented by the farmers are verified by the Official Veterinarians of the ASL through checks on the farms.

In addition, zoonoses transmitted through milk are mainly of bacterial nature due to systemic (i.e. brucellosis) or local infections. Some strains of *Staphylococcus aureus* produce an enterotoxin responsible for food poisoning, even *Bacillus cereus*, which causes sporadic cases of mastitis, may be responsible for food poisoning. *Listeria monocytogenes* and *Streptococcus equi subsp. zooepidemicus* (only in goats) can cause infections in humans (Pisoni et al., 2009). Moreover, unpasteurized sheep milk can transmit other zoonotic agents, such as *Brucella sp*. and *Nocardia farcinica* (Winter et al., 2004; Las Heras et al., 2002; Maldonado et al., 2004). Finally, *Coxiella burnetii*, responsible for Q fever, can be eliminated through milk (Angelakis et al., 2010).

Zoonoses related to food consumption

Trichinellosis is a zoonosis caused by nematode roundworms belonging to the genus Trichinella. This worldwide parasite is present in both carnivorous and omnivorous wild animals (mammals, birds and reptiles) and pigs, horses and other domestic animals. Humans acquire the infestation through the consumption of raw or undercooked infested meat. This disease, precisely because of the importance it covers for public health and

the economy influencing the trade of animals and their products, is included in the O.I.E (World Organization for Animal Health) list of the most important animal diseases. The search for trichinae is regulated, at the Community level, by the EC Regulation 2075 of 2005, which provides for the systematic sampling in slaughterhouses or game treatment establishments, as part of the post-mortem examination, of samples of Equidae, wild boar and other farmed or wild animal species at risk of Trichinella contamination.

Exotic Animals

According to the Italian Syndicate of Public Medicine Veterinarians (Sindacato Italiano Veterinari Medicina Pubblica, SIVeMP, https://sivemp.it/), there are an estimated 500 million exotic animals in Europe and an average of 3 million are imported into Italy each year. As previously reported, in Italy there are a total of 32 million pets: 12.9 million birds, 7.5 million cats, 7 million dogs, 1.8 million small mammals (hamsters and rabbits), 1.6 million fish and1.3 million reptiles, as the market has grown in recent years, including the illegal ones (CENSIS, Centro Studi Social Investments, Center for Social Investment Studies).

Currently, it is not possible to provide a reliable number of exotic animals in Sardinia, as there is no official exotic animals registry.

In Sardinia, exotic animal lovers share information about their animals on the main social media platforms, from which a large buying and selling activity can be deduced. As far as birds are concerned, there are currently eight ornithological associations in Sardinia, all affiliated to the Italian Orniculturists Federation (FOI https://www.foi.it/sardegna). The number of breeders in Sardinia is estimated at around 100, and various national and regional competitions and exhibitions are organized annually. The sector has been significantly penalized by the pandemic, with exhibition bans in some cities still in place.

No specialization school for exotic animals exists in Italy, therefore, veterinarians who deal with exotics undergo a personal post-graduate training path, which can include experience in clinics that treat exotics. Masters and training courses dedicated to obtain the title of “accredited veterinarian” are still in an experimental phase (https://www.trentagiorni.it/files/1362496565-07.pdf).

The SIVAE (Italian Veterinary Society for Exotic Animals), is a company that was established in Cremona, in April 1999, by a group of veterinary surgeons who had already formed together the Study Group of Exotic Animal Medicine and Surgery, and worked within the SCIVAC (Italian Cultural Society of Pet Veterinarians) for over 11 years. The main purpose of SIVAE is the study and post-university updating of medicine and surgery of exotic animals and new pets, such as rabbits, ferrets and Mediterranean tortoises, for the veterinary doctors (but also for undergraduates) through the organization of meetings, congresses, seminars, study days, and the publication of a quarterly magazine, "Exotic files" (https://www.sivae.it/).

Exotic animals produce a huge turnover but there are risks that should not be underestimated, including zoonoses and resistant bacteria. It represents a rapidly growing market that Italy is trying to regulate more strictly, as it affects aspects related to animal welfare, public health and nature conservation.

The entry into force of European Regulation 2016/429 dates back to 21 April 2021. Legislative decrees issued on 5 August 2022 (however leaving a year for the issuing of the implementing decrees) will bring about a historic change in public and private veterinary healthcare. The legislative decree 5 August 2022 n. 135 dictates provisions on trade, importation, conservation of wild and exotic animals and training for animal operators and professionals, also with the purpose of prevention and control of animal diseases that are transmissible to animals or humans and the reduction of the risk of outbreaks of zoonoses. It also introduces penal provisions aimed at punishing the illegal trade in protected species. In particular, the topic of registering pets is addressed, expanding it to other species besides dogs and cats. It also provides for the list of permitted or prohibited animal species and regulates the sector for the first time in an organic way, in agreement with the Ministry of the Environment.

Notwithstanding the new law on the import and trade of exotic animals, the Ministry of Health published the list of species that can be taken from their natural environment, with a Decree published on 11 October 2022. In the list, published as an attachment to the decree, we find six species, all linked to the aquarium world. There are in fact five species of fish and a nudibranch, a marine mollusk with very showy colors. Here is the complete list: *Proterorhinus semilunaris*, *Acanthurus chirurgus*, *Acanthurus coeruleus*, *Pomacanthus maculosus*, and the mollusk *Chromodoris quadricolor*, also known as pajama nudibranch. All the other exotic animals can no longer be snatched from their habitat and imported into Italy.

Wildlife in Sardinia

Natura 2000 (https://www.mite.gov.it/pagina/rete-natura-2000) is the main instrument of the European Union policy for the conservation of biodiversity. It is an ecological network spread throughout the territory of the Union, established pursuant to the "Habitats" Directive 92/43/EEC to ensure the long-term maintenance of natural habitats and threatened or rare species of flora and fauna. The Natura 2000 network is made up of Sites of Community Importance (SIC), identified by the Member States in accordance with the provisions of the Habitats Directive, and Special Protection Areas (SPAs) established pursuant to Directive 2009/147/EC "Birds" about the conservation of wild birds. The Natura 2000 network in Sardinia is currently made up of a total of 128 sites, of which 31 Special Protection Zones (ZPS, type "A" sites), 89 Special Areas of Conservation (ZSC, type "B" sites), 8 Sites of Community Interest (SCI) are awaiting the Ministerial Decrees approving the measures of conservation.

The C.A.R.F.S. (Centro Allevamento e Recupero Fauna Selvatica, Wildlife Rearing and Recovery Center) were set up in Bonassai and Monastir by the Forestas agency (https://www.sardegnaforeste.it/content/sede-carfs-bonassai; https://www.sardegnaforeste.it/struttura-territoriale/carfs-di-monastir) for the recovery of injured wild fauna. Bonassai is in the north of Sardinia, the hospitalized animals here belong mainly to the Sardinian avifauna. The Clinic is equipped with an examination room, a surgical room, a radiological room and a laboratory where necropsies and parasitological examinations are carried out. The Center is equipped

with structures for the hospitalization of injured animals with shelter boxes dedicated to each species. More than sixty different species of wild animals are registered each year, with an annual average of five hundred hospitalizations. Research programs of the main pathologies of the Sardinian fauna are carried out at the Recovery Clinic in collaboration with the university structures. The Monastir C.A.R.F.S. center is in southern Sardinia, it deals with the recovery and care of wildlife, with its own veterinarians. The health activity includes the care and hospitalization of wild animals that come mainly from areas in the province of Cagliari and part of the province of Nuoro. The center is equipped with shelter facilities, some of which include wetlands for aquatic animals. A large part of the health care activity consists of surgical and medical therapy and the subsequent gradual recovery. Wild animals are subjected to serological tests in statistically significant numbers for the purpose of monitoring the main diseases affecting wild animals. The Center is a point of reference and offers field operations in restocking and reintroduction projects for endangered species, such as the Sardinian deer, the Griffon vulture, Bonelli's eagle.

An agreement of both C.A.R.F.S. centers with the Department of Veterinary Medicine of Sassari has been active for many years. Here the students of the Degree Course in Veterinary Medicine carry out the clinical rounds and collaborative activities for their degree thesis.

The origin of Sardinian fauna and the evolution of its composition are closely linked to the geological and environmental phenomena that have affected the island from the Tertiary era until present, and to the direct and indirect consequences of human activities. The favorable environment of Sardinia allowed the diffusion of numerous plant and animal endemisms of extraordinary naturalistic value. The typical flora of Sardinia consists of mostly evergreen plants, particularly resistant to drought, while animals show the typical traits of the islands, such as smaller size, or distinctive traits due to the long isolation.

A total of nine amphibian species live in Sardinia, a small number, but relevant because five of them, the Euprotto and the four species of the genus *Speleomantes*, constitute "total" populations, so called because they are present only in Sardinia. These species are threatened, and for this reason they have been protected since 1983. They are included in the Red Book of amphibians, set up by the International Union for Conservation of Nature and Natural Resources (IUCN) as species deserving protection.

Among reptiles, three species of Lacertids are endemic to Sardinia and Corsica: the tiliguerta lizard (*Podarcis tiliguerta*), the Bedriaga lizard (*Archeolacerta bedriaghae*) and the dwarf algyroid (*Algyroides fitzingeri*). These last two species can be considered real paleoendemisms. Two sea turtles, the common terrapin (*Caretta caretta*) and the leatherback turtle (*Dermochelys coriacea*) visit the coastal waters of Sardinia, the first still lays its eggs on some isolated beaches. The nesting sites are manned and protected by the Regional Network and by the Forestry Corps which circumscribes the area with physical barriers.

The occurrence of wild birds reproducing and nesting in the island of Sardinia is dynamic, as it depends on environmental variations and the season. Migratory birds are characterized by the use, during the annual cycle, of different geographical areas and environments often located at enormous distances from each other, they represent a natural resource whose conservation and management require monitoring activities carried out on

a large geographical and regulatory scale, shared internationally. Sardinia is at the center of the migration routes between Africa and Europe. Migratory birds are monitored in order to regulate the wildlife hunting activity and to monitor their well-being and state of health, as they might be vectors of zoonoses. Among the protected species, the plover (*Charadrius alexandrinus*), the white stork (*Ciconia ciconia*), the great spotted woodpecker (*Dendrocopos major*) and the pink flamingo (*Phoenicopterus roseus*) nest in Sardinia. The pink flamingo is the symbol species of the Molentargius Regional Park (https://www.parcomolentargius.it/index.php), where they are continuously monitored, to avoid dangers, in particular by packs of stray dogs. Some wild birds have been recently reintroduced in Sardinia with projects that are part of the Life and Life plus programs.

The Life Under Griffon Wings project (http://www.lifeundergriffonwings.eu/it/index.html), funded by the Life Programme of the European Union, was set up and conducted by the University of Sassari together with Forestas Agency, the Forestry and Environmental Surveillance Corps and the Municipality of Bosa. The project aimed at the conservation of the Griffon Vulture in Sardinia, it lasted five years, with the main actions being: creation of farm feeding stations, repopulation action (restocking), operations of the first Anti-Poison Dog Unit set up on the island. A second currently active project, "LIFE Safe for Vultures" (https://www.lifesafeforvultures.eu/), has been funded by the European Program for Environment and Climate action (LIFE 2014-2020) and is aimed at bringing the Griffon back to all of Sardinia.

The project "AQUILA a-LIFE" (https://www.aquila-a-life.org/index.php/es/) funded by the European Union aimed at increasing the presence of the Bonelli's eagle in the western Mediterranean and reversing its regressive population trend to help restore the ecosystems where it once lived. Since 2018, the European project for the reintroduction of Bonelli's eagle in Sardinia has completed the release into the wild more than 120 specimens in Spain and Italy (Sardinia). To obtain this result, the coordinated effort of different institutions was necessary: ISPRA, Grefafauna, Forestas Regional Agency and Forestry Corps, E-distribuzione.

Wild mammals of Sardinia include 40 species, with as many as 19 belonging to the order of Chiroptera. There are four Insectivores, with three Soricids measuring 4.5 mm (the smallest mammals in Sardinia) and two Lagomorphs, the common hare and the wild rabbit, both subjected to intense hunting pressure and poaching. Four species of carnivores occur in Sardinia, belonging to the families: Mustelidae (*Mustela nivalis boccamela*, *Martes martes*), Canidae (*Vulpes vulpes ichnusae*), and Felidae (*Felis silvestris lybica*).

The two species of Mustelidae include weasel and marten. The weasel "*Mustela nivalis boccamela*" is a subspecies of the "*Mustela nivalis*" mainly present in the western Mediterranean region, thanks to its remarkable ecological plasticity, it is evenly distributed throughout the island, from coastal to mountainous areas. The weasel is common and often considered harmful because it occasionally enters chicken coops and rabbit hutches, causing real massacres. Together with hedgehog and fox, it is among the mammals most commonly hit by cars. Actually, given its great ecological value, it can be considered a successful species. Protection is achieved under the Berne Convention (law 503/1981, annex III).

The marten (*Martes martes*) is very similar to the weasel but larger in size (head - body length 39-51cm, weight 1-1.2 kg) and has a characteristic very elongated yellow-orange pectoral spot. Typical inhabitant and predator of the woods, in the absence of competitors, its ecological niche is wider including cultivated areas and scrubland. It is a predator of small and medium-sized vertebrates, it also feeds on insects (Coleoptera and Orthoptera) and on wild fruits and berries (blackberries, figs, carobs, pears, grapes, etc.). Some common threats are the reduction and anthropization of habitats, and fires. Degree of protection: Bern Convention (law 503/1981, annex III); Regional Law 29 July 1998, n° 23.

The fox (*Vulpes vulpes ichnusae*) is the only canid present today in the Mediterranean islands. The endemic subspecies *ichnusae*, which differentiated following geographical isolation, lives in Sardinia. This "Sardinian" subspecies of the European red fox is smaller: its triangular head, pointed snout, large ears and eyes, elongated and slender trunk are characteristic. The Sardinian fox is a non-threatened species at a regional, national and European level, and it is also a huntable species, according to regional law LR23/98. It is one of the few carnivores with a high number of animals, so much so that in some situations it needs population control. It is generally improperly considered as "harmful" and, therefore, persecuted and killed with special hunting trips.

Ungulates are the largest mammals on the island, which host four species: wild boar, mouflon, Sardinian deer and fallow deer.

The Sardinian wild boar (*Sus scrofa meridionalis*) is distributed in Sardinia and Corsica; the origin of the wild boar in Sardinia is traced back to the rewilding of populations raised for meat during the Neolithic age. It is present on almost all the territory, from the coastal areas to the inland mountain areas (https://www.sardegnaforeste.it/fauna/cinghiale). It is omnivorous but its diet may vary according to the seasonal availability of food. The Sardinian wild boar prefers the Mediterranean scrub and woods, but sometimes it enters cultivated fields. Compared to the nominal species, the Sardinian wild boar is smaller, has a total length of 100 - 120 cm and reaches a maximum weight of 70 - 80 kg in adult males. The coat of the adults has a blackish brown or grayish brown color, the young have the characteristic streaks. The Sardinian wild boar is not endangered, in recent years it has undergone a notable expansion; adults have no natural enemies except man, through hunting, poaching and the free grazing of domestic pigs, which results in uncontrolled genetic pollution and reciprocal transmission of epizootic diseases (swine fever, foot and mouth, etc.). It is a huntable species (L.R. 23/98).

Mouflon (*Ovis orientalis musimon*) is one of the most representative animals of the island, at least for the mountains (https://www.sardegnaforeste.it/). It is a skilled jumper, great climber and fast runner (about 60 km/h). The mouflon occurs nowadays in many populations scattered across Europe and in other countries outside Europe as well (Apollonio et al. 2010). All populations have their roots in the two islands of Sardinia and Corsica, where the mouflon was introduced in the beginning of Neolithic (6000 B.C., Vigne 1992). Mouflon populations in Sardinia and Corsica have been listed in the Annexes II and IV of the Habitat Directive 92/43/CEE (Brivio et al., 2022). The mouflon is included in the "vulnerable species" category of the IUCN

Red List of 2000, and the regional law 23/1998 regarding the protection of fauna and regulation of hunting places it among the "particularly protected" species.

The Sardinian mouflon population has undergone a dangerous decline over the years during the 20th century, which lasted until the 1970s, when it was estimated that there were a total of about 300 individuals. Subsequently, there was a progressive increase in the number of specimens (1,000 heads estimated in 1980). The current mouflon colonies present in Sardinia are disjointed and are mainly found in Ogliastra, Monte Tonneri, Gennargentu, Supramonte, Monte Albo and, more recently, in Capo Figari, Asinara and the Limbara Mountains. Mouflon has a compact and robust appearance, with muscular trunk and limbs, large eyes and short ears, particularly suitable for rough and rocky environments. The height at the withers varies from 65 to 75 cm. The horns, generally present only in the male, are permanent. The mouflon lives in the most impervious and rugged areas of the island, with very high slopes and rockiness, from sea level to mountain environments. It feeds mainly on shrubs and trees of the Mediterranean shrub and on grasses in general. From a trophic point of view, the mouflon is very adaptable, and does not seem to have particular preferences but chooses the most abundant plant species. Furthermore, the mouflon exploits the vegetable parts that the cervids do not exploit, making food competition almost absent. Mouflons are protected under the Berne Convention, Annex III; DIR. EEC 43/92 Annex B, D; Law 157/92, Regional Law 23/98.

The Sardinian-Corsican deer is the largest wild mammal present in Sardinia, it is the endemic Sardinian-Corsican subspecies of the European deer (*Cervus elaphus* Linnaeus, 1758), with scientific name *Cervus elaphus corsicanus* (Pitra et al., 2004). At present, approximately 4270 animals occur in Sardinia, but the subspecies is classified as “endangered” by the IUCN (IUCN, 2004) (Pitra et al., 2004). The Sardinian deer survived naturally only in a few mountain areas: one of this is the Sette Fratelli Mountain (Casula et al., 2013). This subspecies is slightly smaller and more slender than continental red deer. Its antlers differ from the European subspecies by weight, shape and by the number of tines, which is limited to 4–5, against the ordinary 8–10 tines of an adult deer in Central-Europe (Caboni et al., 2006). Due to the strong anthropic pressure, the subspecies has risked extinction. In the 1960s, the population was estimated at between 80 and 100 specimens divided into 3 sub-areas (Sulcis, Arburese, Sarrabus) without interruption between them. The census records of the years 1973-75 estimated a minimum overall consistency of 193-200 specimens in the whole island, while it was extinct in Corsica. Since the 1980s, thanks to various protection projects, there has been a significant increase in the populations that have survived in the wild and through reintroduction projects carried out by the Forestry Authority for the establishment of new populations, also in Corsica. The 2014 census, conducted, like the previous ones, with the "roaring technique", by listening to the typical vocalizations that male deers emit during the mating period, has established an estimated consistency in the territories managed by Ente Foreste at 4270 heads, with an increase in the presence of this ungulate in all the recently introduced populations and a relative stability of those of Sulcis, Sarrabus and Arburese.

The fallow deer (*Dama dama*) is the most widespread cervid in the world and one of the most common animals in Europe (Chapman and Chapman, 1980). It is a western Palaearctic species which originates from Western Asia and has been introduced to the majority of Europe. The fallow deer is a highly farmed species with

fragmented free-ranging populations. However, as an alien species, they can have deleterious effects as well, including negative effects on vegetation or competition with native cervids. The fallow deer, whose adults have the characteristic flattened stage, is an extremely adaptable species that survives well in many environments, preferably mainly broad-leaved woods with clearings or open clearings, avoiding mountainous areas and high altitudes. Compared to the deer, the fallow deer is much less elusive and wary (especially the young and females) and can be observed more easily even during the day. Until the 1950s, this splendid ungulate was present in many parts of the island with good stocks; it became extinct in the late 1960s due to excessive hunting pressure and poaching. Since the second half of the 1970s, the former State Forestry Company has made reintroduction interventions starting from nucleuses from Tuscany and Calabria. It is currently present in various repopulation enclosures and with some free, substantial and vital populations, such as those of the Porto Conte Forest (Alghero-SS) and Assai (Neoneli-OR) and on the Limbara mountain. Some nucleuses of limited consistency, having escaped from the fences, live freely near the same fences.

The appearance is typical of cervids, even if the deer appears slightly shorter and stockier and has a proportionately shorter neck. The fallow deer has an overall elegant appearance and carriage although the legs are proportionately shorter than those of the red deer. It has a total length of 150-170 cm and a height at the withers of 70-95 cm, the weight varies from 50 to 110 kg in adult males. The head is elongated and ends in a bare muzzle, the ears are large, the eyes are oval and expressive. The coat is reddish-brown in summer with white markings on the back and sides, in winter it is noticeably darker and without white markings. The knob in the fallow deer remains in the adult while in the deer it is only present in the fawns. Frequent in Sardinia is the melanic coat, a characteristic linked to insularity. It is a species of great ecological plasticity and has adapted to different environments like coastal areas with artificial pine forests, agricultural areas and wooded or partially wooded pastures, hilly areas with Mediterranean scrub and forest formations. It resists drought well but suffers, unlike the mouflon, from excessive slopes and high rockiness. As an intermediate grazer, it also feeds on the Mediterranean shrubs. As regards conservation status, the fallow deer is rare at regional level, not threatened at Italian and European level. Factors of threat are mainly poaching and straying. It is protected by the Bern Convention (law 503/1981, annex III); Regional Law 23/98.

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