



HYSTRIX
the Italian Journal of Mammalogy

Volume 29 (Supplement) • 2018



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Impact Factor (2016) 1.479

HYSTRIX the Italian Journal of Mammalogy is an Open Access Journal published twice per year (one volume, consisting of two issues) by Associazione Teriologica Italiana. Printed copies of the journal are sent free of charge to members of the Association who have paid the yearly subscription fee of 30 €. Single issues can be purchased by members at 35 €. All payments must be made to Associazione Teriologica Italiana onlus by bank transfer on c/c n. 001034838399, Bancoposta - Poste Italiane, Italy, banking coordinates IBAN: IT39P0760103200001034838399.

The Italian Teriological Association is available to promote exchanges with journals published by other scientific associations, museums, universities, etc. For information please contact the ATIt secretariat.

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Information about this journal can be accessed at <http://www.italian-journal-of-mammalogy.it>

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HYSTRIX
the Italian Journal of Mammalogy

Volume 29 (Supplement) • 2018

XI Congresso Italiano di Teriologia

Firenze, 20–22 Giugno 2018

edited by

G. Guidarelli, G. Sozio, D.G. Preatoni

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Publication information: *Hystrix* the Italian Journal of Mammalogy is published as a printed edition (ISSN 0394-1914) twice per year. A single copy of the printed edition is sent to all members of Associazione Teriologica Italiana. The electronic edition (ISSN 1825-5272), in Adobe® Acrobat® format is published “online first” on the Journal web site (<http://italian-journal-of-mammalogy.it>). Articles accepted for publication will be available in electronic format prior to the printed edition, for a prompt access to the latest peer-reviewed research.

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Scuola di Giurisprudenza, Università degli Studi di Firenze,
20-22 Giugno 2018

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edited by
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Citazione consigliata / Recommended citation

Guidarelli G., Sozio G., Preatoni D.G. (Eds.) 2018. XI Congr. It. Teriologia. *Hystrix the Italian Journal of Mammalogy* 29 (Supplement).

Riassunti: Comunicazioni e Poster
Abstracts: Communications and Posters

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XI Congresso Italiano di Teriologia

Restoring the water vole, a rat yet a British cultural icon, decimated by the invasive American mink using a multi-disciplinary approach

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Most conservation challenges play out on vast spatial scales, but resources are limited. It is important to design and refine methods to cost-effectively deliver conservation gains on less trivial scales than is typically done and this requires blending disciplines.

A project seeking to protect the water vole, a large amphibious rodent made popular by a children's tale in the UK, required a new understanding of population and predator-prey ecology and of people. The fine Scottish blend also included a dose of social and computing sciences to facilitate the recovery of an endangered species and put in place a long-term invasive species management program delivered by citizen conservationists and local organisations on an unprecedented large scale.

Water voles experienced a 95% decline since 1950 in the UK due to predation by American mink that escaped from, now closed, fur farms. Water voles have a distinctive metapopulation structure such that progression towards ultimate extinction takes place at the pace of the elevated local populations' extinction rate caused by an invasive predator rather than at the pace of the death of individuals. There are therefore long time lags between a metapopulation being committed to extinction and that outcome materialising. Such extinction debt is widespread. While water voles are exceptional dispersers, mink are even more mobile and impose spatially correlated extinctions. The severity of impact by mink is affected by the availability of alternative prey and has been less rapid, but nonetheless real, in the uplands of Scotland that have acted as a temporary low productivity refuge.

Turning back the tide of invasive mink required working on a spatial scale that vastly exceeded what governments could finance. Instead, a diverse coalition of interested parties coming from backgrounds ranging from shooting, fishing and conservation was assembled and the power of citizen conservationists was unleashed to detect, trap and remove mink. The mink control area grew from 300 to 6000 and eventually a massive 29000 km², one third of Scotland's land mass. Mink volunteers operated mink rafts, floating devices that detect the presence of mink and only set cage traps upon detection. Deploying mink rafts using a "rolling carpet" strategy was effective in removing nearly all breeding mink.

An adaptive process was used to refine management using accumulating knowledge on mink dynamics and their ability to compensate for culling through improved fecundity and dispersal. Ensuring the integrity of the mink detection network called for an intense focus on the determinant of volunteer retention, analysed as a survival process, in the face of low residual mink density. This involved close collaborations with social and computer scientists and experimentation with a Mink-App using Natural Language Generation to provide feedback to volunteers.

The invasive mink project has been ongoing for more than 12 years, despite short-term 3–4 year funding packages. In its latest incarnation, it seeks to harness the enthusiasm of volunteer citizen conservationists who have contributed to a rare conservation good news story to control a bundle of riparian invasive species in addition to mink.

Sistematica, Tassonomia e Filogenesi dei Mammiferi: nuovi approcci e stato delle conoscenze

Sistematica e tassonomia sono strumenti fondamentali per lo studio della biodiversità. Infatti, la corretta delimitazione delle specie, integrata dalla loro storia evolutiva e dalla descrizione dei loro adattamenti, rappresenta un presupposto fondamentale in qualsiasi campo di indagine della diversità biologica. La sessione si propone di presentare studi che tramite diversi approcci (filogenesi, filogeografia, morfologia comparata, morfometria, etc.) possano fornire informazioni utili per una corretta stima della diversità biologica nei mammiferi, attuale e passata, e una migliore comprensione dei processi evolutivi che ne sono all'origine, offrendo anche strumenti per un'interpretazione sistematica, e nomenclaturale, la più possibile oggettiva.

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XI Congresso Italiano di Teriologia

Molecular evolution of Eulipotyphla: unresolved problems of phylogenetic reconstruction

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Introduction

The phylogeny of the order Eulipotyphla appears one of the most challenging tasks in Placentalia phylogeny, which illustrates all main problems of evolutionary reconstructions in mammals. Among four extant families of true insectivores: Solenodontidae, Talpidae, Soricidae and Erinaceidae, the relationship between hedgehogs, moles and shrews remains an unresolved issue. In contrast to morphological hypotheses, molecular data give strong evidence for a sister-group relationship between shrews and hedgehogs to the exclusion of moles. The potential reason for the conflict between these hypotheses is the result of biased base composition of hedgehog and shrews nuDNA compared with moles and other mammals.

Methods

To test the molecular phylogenetic hypothesis of Eulipotyphla we employed genomic data and obtained a multi-locus phylogeny based on 137 nuclear genes for a diverse taxon sample including *Condilura* and *Diplomesodon*. The phylogenetic trees of Erinaceidae, Talpidae and the main taxonomic groups of Soricidae were inferred from sequencing of 6–8 nuclear genes. Based on these nuclear data we estimated the timing of major cladogenetic events in Eulipotyphla.

Results and Discussion

We recovered *Solenodon* as the sister of all other Lipotyphla, while Erinaceidae and Soricidae formed a clade to the exclusion of Talpidae. We also found that unlike *Sorex*, the rate of nucleotide changes in the line of *Diplomesodon* is not too high, and the nucleotide composition of it is not an anomalously GC-rich. Thus, *Diplomesodon* balances the entire branch of shrews on the multigene tree, which earlier was represented only by *Sorex*. Since the hedgehog+shrew situation is preserved, there is no reason to believe that the nucleotide composition and ac-

celeration of *Sorex* relative to other insectivores are responsible for this signal.

Erinaceidae. One of the main problem of phylogenetics of Erinaceidae is the large divergence time between Erinaceinae and Galericinae (about 50 My) and as a consequence, the lack of a close outgroup for each of the subfamilies. The other problem we found was an extremely high rate of nucleotide change in hedgehogs mtDNA compared with gymnures and high variation in base composition and evolutionary rate of nuclear genes in these groups. Our molecular phylogenetic analysis demonstrated long evolution of gymnures and their deep diversification with the earliest split estimated to occur in the Late Eocene. In contrast, crown spiny hedgehogs had undergone a sudden burst of radiation at the end of Miocene–early Pliocene.

Talpidae. A potential source of conflict between molecular and morphological phylogenetic reconstructions of Talpidae — is a great role of parallelisms in the evolution of fossoriality. In contrast with the morphological concept, molecular data provide certain evidence for the independent evolution of extreme fossoriality in highly fossorial talpid tribes, Talpini and Scalopini.

Soricidae. Phylogenetic reconstructions in Soricidae are complicated by contrasting rates of nucleotide change in subfamilies Soricinae and Crocidurinae that makes it difficult to determine the time of their split. Among Soricinae the key determinant of evolutionary success of *Sorex* in a temperate zone is that, in contrast to many other shrew genera, the red-toothed shrews benefited from the Pleistocene cooling. Among Crocidurinae, the genus *Crocidura* is also a successful group, but in the tropics. The recent findings suggest that the cryptic diversity of this genus and delimitation of species boundaries is a complex task especially for the groups of recently radiated Asian species.

XI Congresso Italiano di Teriologia

Mitochondrial DNA analysis of the recently extinct gray wolf (*Canis lupus*) from Sicily

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Introduction The *Canis lupus* became extinct in Sicily in the early decades of the XX century. It represented the only insular population of gray wolf in the Mediterranean area and one of the few historic insular populations in the world, together with the Japanese wolf *C. l. hodophilax* and the Hokkaido wolf *C. l. hattai*, both extinct between the end of XIX and the beginning of XX century. The *C. lupus* in Sicily was persecuted as considered “harmful” and, although there is no unanimity on the last wolf shot, the last official hunting was done in 1924. The aim of this work is to reconstruct the identity and the origin of the Sicilian wolf with paleogenetic techniques through the study of the mitochondrial DNA of the last specimens from Sicily.

Methods We collected teeth, skin or nails from six museum specimens dated “late XIX-early XX century”, representing the last individuals attributed to *C. lupus* lived in Sicily before its extinction. The DNA extraction and amplification of HVR1 of mitochondrial DNA were performed in a laboratory dedicated to ancient DNA, following strict guidelines of this field. The amplification was conducted using several couples of primers to overcome the technical challenges related to the conservation of

ancient DNA.

Results We successfully amplified 99 bp of the HVR1 in four samples and, thanks to the major quantity of endogenous DNA contained in teeth, for two of them we also obtained a longer region of 404 bp. Those two long sequences showed the same haplotype, never described before, that differs one substitution from two wolf haplotypes detected in Bulgaria and Poland, two substitutions from the most diffused Italian wolf haplotype W14 and one substitution from the second Italian rare haplotype W16. One of the two samples amplified only at the short fragment showed a new wolf haplotype, and the other a haplotype common in dogs, confirming our concerns about the morphological attribution of this sample to wolves.

Discussion Our results indicate that the Sicilian wolf was genetically differentiated from the contemporary Apennine wolf. This diversity could probably dated back around 21500–20000 years ago, coinciding with the vanishing of the land-bridge between the Italian peninsula and Sicily. Unfortunately it is noted that an endemic taxon of Sicily, representing a unique population in the world, was definitively lost.

The importance of taxonomic level in biological invasions: the case of invasive chipmunks at global scale

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Introduction The Siberian chipmunk *Eutamias sibiricus* is native to north-eastern Asia, but alien populations have been established in many countries, introduced through the pet trade. This squirrel has been listed as an invasive species of European concern by the EU Regulation n. 1143/2014 imposing restrictions on the keeping, importing, selling, breeding and growing. Moreover, the species is considered to be responsible for the spread of the human Lyme disease. Therefore, a complete knowledge on its current distribution range and an analysis of the new areas of potential invasion are required to design sound management actions. In recent times, both morphological features and genetic sequences have shown that *Eutamias sibiricus* has to be considered as a species complex and that three species should be recognized into this taxon: the Siberian chipmunk *E. sibiricus*, the Korean chipmunk *E. barberi* and the Chinese chipmunk *E. senescens*. The Korean chipmunk has been reported to be the most traded ones, as well as that introduced to Europe (France, Belgium, the Netherlands, Switzerland and Greece) and Japan; genetic data for individuals released to Italy are lacking.

Materials and Methods Despite a morphological analysis may allow researchers to distinguish among chipmunk (sub)species, we conducted an analysis of the mtDNA sequence of the cytochrome-b to infer the native geographic range of chipmunks introduced to Italy. Obtained genetic sequences were then compared with other sequences of the same mitochondrial gene from the whole of the range of this species already present in GeneBank. Two sets of species distribution models were carried out at the global level to assess whether differences occurred between outputs resulted by analyses with the “old species” (N=625 occurrences) and with only the Korean taxon (N=255 occurrences). Generalized linear models to analyse the effects of (1) habitat suitability for *E. sibiricus* complex, (2) habitat suitability for *E. barberi*, (3) number of founder individuals, (4) year from first introduction, (5) absence of native European red

squirrels *Sciurus vulgaris* at the time of introduction, (6) latitude, (7) presence of food provided by humans and (8) distance from human settlements on the total population abundance in each introduction area.

Results Genetic analyses on hair of alien chipmunks and phylogenetic reconstructions revealed a multiple origin of alien chipmunks in Italy, with individuals from Siberia (Rome) and from Korea (Rome and northeastern Italy). Our models showed that most of the northern hemisphere supports the establishment of *E. sibiricus* complex, but suitable area increased when considering only *E. (s.) barberi* (especially in Europe, where it is already established). Generalized linear models showed that food supply provided by humans resulted to be an important factor promoting the growth of alien populations of chipmunks, whereas the presence of the native red squirrel at the time of introduction may limit it.

Discussion Genetic analyses revealed a multiple introduction of chipmunks to Italy, with Korean chipmunks (i.e. those also present in central Europe) showing the highest invasive power and chipmunks from Siberian (nominal subspecies) detected in Rome. The ongoing species splitting, if confirmed and accepted by the scientific community, may require a revision of the European Regulation 1143/2014, as it currently bans the trade of Siberian chipmunk only, with no explicit consequences on Korean and Chinese taxa. In Italy, two chipmunk species may be present, a finding which should be taken into account in assessing the national “black list” of concerning invasive species. Accordingly, having a robust and well-supported taxonomical knowledge on the target species may help researchers to identify areas invasion risk. Food provisioning by humans represents may promote Korean chipmunk invasion, particularly in urban and suburban areas. An early-warning and rapid response system concerning the removal of free-ranging individuals and the detection of new invaded areas should be thus rapidly activated.

A complete view of chromosomal and mtDNA relationships among areas of chromosomal polymorphism in the House Mouse, *Mus domesticus*

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Introduction The house mouse *Mus domesticus* started the colonization of the Mediterranean basin from Middle East around 10000 ya and settled in the western Mediterranean area during the bronze age (c.a. 3000 ya). Here the house mouse undergone to an extraordinary chromosomal diversification. The standard and most common karyotype composed of 40 telocentric chromosomes radiated in more of fifty chromosomal races whereas the Robertsonian (Rb) fusions reduced diploid number as far as to $2n=22$. The possible independent origin of the same Rb in different areas (i.e., not common origin) and instances of "reticulate" evolution undermined the chance to obtain a comprehensive phylogenetic reconstruction among Rb races.

We present a preliminary overview of the chromosomal relationships among all the known "Rb areas" (geographic area where different chromosomal races are present, surrounded by standard karyotypes), using an index based on the sharing of Rbs. This index, obtained by a pairwise comparisons between the Rb areas, were correlated both with the geographic distances and the genetic differentiation estimated by a molecular marker (mtDNA Control region). The results allowed to infer hypothesis about the common vs. independent origin of shared Rbs between Rb areas.

Methods Fourteen Rb areas were identified and the identity of the different Rbs was extracted from literature. A Rb Sharing Index (RSI) has been calculated for each pair of Rb areas and a

Geographic Network map was produced. This index has been plotted against a simple fixation index (F_{st}) of genetic differentiation and against the geographic distance. The F_{st} was calculated on the mtDNA control region dataset (728 bp) including 53 original mice from Sicily and 582 sequences downloaded from GenBank.

Results No evidence of correlation exists between RSI and F_{st} values. Furthermore, the RSI resulted not correlated to the geographic distance, since there is a widespread sharing of metacentric even from most distant Rb areas. The Geographic Network map highlighted that Rb areas with the largest number of connections are, in general, limited to areas located in the central Mediterranean area. The F_{st} values are all high (ranging 0.10 to 0.94) and positively correlated to geographic distance, evidencing isolation by distance.

Discussion This analysis shows that pairs of Rb areas sharing an high number of chromosomes are not more genetically similar than those with less chromosome sharing. This suggests that the shared metacentrics may have an independent origin. This is an quite unexpected result because, the independent occurrence of the same combination of Rbs in different areas, even if geographically distant, it is statistically very unlikely. Finally, the high number of connections observed in the Geographic Network among close localities indicated that a chromosomal exchange may occur, as expected, at a smaller geographic scale.

How much hybrid should a hybrid be? Empirical evaluation of proportions of membership to define reliable assignment thresholds

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Introduction Anthropogenic hybridization is increasingly studied as serious conservation threat for the genetic integrity of local populations although the detection of hybrids or backcrosses is often far from trivial. We developed an effective workflow to detect different levels of genetic introgression, by using empirical and simulated data from two hybridizing taxa, the wolf (*Canis lupus*) and the European wildcat (*Felis silvestris*), which can successfully mate with their domestic counterparts.

Methods By applying strict criteria and by using a sample of individuals already typed at genomic data (170000 SNPs), we selected reference wild and domestic populations to simulate 100 genotypes for each of the following classes: wild and domestic parentals, F1 and F2 hybrids, and eight classes of backcrosses with wild and domestic pure parental individuals. Real and simulated genotypes were analysed with different sets of microsatellites (10–30 for the wildcat and 12–39 for the wolf) by the Bayesian admixture procedures implemented in the R package `ParallelStructure` to assign individuals to the two parental populations and assess the average and individual proportions of membership (Q_i and q_i). Efficiency, accuracy and performance were computed to choose the appropriate q -thresholds to identify hybrid individuals.

Results Using 30/39 microsatellites, all reference and simulated parental genotypes of both the studied taxa were fully assigned to their respective clusters at $K=2$. First and second generation hybrids showed intermediate Q_i and q_i values, whereas

backcrosses showed variable Q_i and individual q_i values and became fully overlapping with parental populations from the fifth backcross class. The best q -threshold, splitting wild pure individuals from the first hybrid generations obtained at 30/39 microsatellites, was $q_i=0.995$ for the wolf and $q_i=0.990$ for the wildcat, whereas the best q -threshold distinguishing first generations of admixed individuals from more ancient backcrosses was $q_i=0.955$ for the wolf and $q_i=0.800$ for the wildcat. The selected thresholds for the wolf were able to detect 100% of the first two hybrid generations and 71% of the second backcross individuals, whereas 84.5% of more ancient backcrosses resulted misclassified (hybridization undetected). Similarly, the selected thresholds for the wildcat detected 100%, 98% and 31% of the first three generation hybrids, respectively; whereas 89.6% of more ancient backcrosses were misclassified.

Discussion Our study showed that admixture detection in wild species should be carefully performed using appropriate reference populations, adequate statistical computations and species-specific assignment thresholds. In particular, q -thresholds should not be arbitrarily set but selected on the basis of the number of loci utilized and through the analysis of both empirical and simulated multilocus genotype datasets. Our calculations clearly showed that, even using a large number of polymorphic markers, an accurate diagnosis of hybridization can be afforded only for a handful of generations.

Increasing fluctuating asymmetry in the isolated and highly endangered Marsican brown bear (*Ursus arctos marsicanus*)

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002

Introduction Deviations from the bilateral symmetry can be observed in some Vertebrate species as an adaptive response to specific functional demands, as the directional asymmetry of dolphin skulls. However, random fluctuations from perfect symmetry, i.e. fluctuating asymmetry, can be driven by factors not linked to the ecology or evolutionary history of the species. Specifically, fluctuating asymmetry (FA) has been hypothesized to occur when genetic and/or environmental factors produce an alteration of the developmental processes. It is the case of small and isolated populations with high level of inbreeding, where the emergence of recessive alleles can produce higher level of fluctuating asymmetry with respect to larger populations. We aimed at investigating if FA can be detected in the critically endangered, small and isolated population of the Marsican brown bear, *Ursus arctos marsicanus*, surviving in the Italian Central Apennines. The observed heterozygosity at microsatellite loci of the Marsican brown bear did not recognize a severe inbreeding. However, last genomic analyses posed the attention on the presence of mutations that in human are considered deleterious.

Methods We analyzed 74 skulls belonging to brown bear populations of different size and degree of isolation: the smallest and most isolated Apennine (n=32), the medium sized Scandinavian (n=31), and the large Russian (n=12) population. Skulls were analyzed by means of 3D geometric morphometrics from

3D digital surface images reconstructed from either computer tomography (CT) or photogrammetry. Three replicates of 39 3D landmarks were recorded on each skull using Meshlab. After a generalized Procrustes analysis, the aligned configurations were analysed for deviation from bilateral symmetry in terms of FA compared among the three populations, using a Procrustes ANOVA in MorphoJ.

Results Results showed that FA was a significant component of all populations analysed. However, the Apennine brown bear showed double levels of FA ($F_{\text{ind} \times \text{side}}: 7.49; p < 0.0001$) with respect to both the Scandinavian ($F_{\text{ind} \times \text{side}}: 3.01; p < 0.0001$) and the Russian ($F_{\text{ind} \times \text{side}}: 4.17; p < 0.0001$) samples.

Discussion Our results show that the cranial distinctiveness of the small and highly endangered Apennine brown bear is coupled with a high FA level. This would suggest that the Marsican brown bear is undergoing an alteration of developmental patterns likely due to inbreeding or to the fast genetic drift experienced during the last century. This result shows that FA could represent a valuable tool to assess the ontogenetic alterations in isolated and/or endangered species by the analyse of historical series (i.e. museum specimens) giving also a contribute to a better understanding of the role developmental process modification in the evolution of small populations.

Interazioni ecologiche nei Mammiferi: popolazioni, specie, comunità

In ogni specie, singoli individui possono mostrare comportamenti diversi nell'affrontare il loro ambiente intrinseco ed estrinseco. Tradizionalmente, le teorie evolutive hanno ipotizzato che il comportamento sia centrato su un singolo optimum adattativo, o su due o più strategie di stabilità evolutiva coesistenti. Tuttavia, negli ultimi due decenni, i ricercatori hanno scoperto che ciascun individuo può essere vincolato e comportarsi in maniera subottimale a seconda della sua "personalità", le cui variazioni potrebbero avere importanti implicazioni nella comprensione di processi individuali e a livello di popolazione o gruppi. Inoltre, quasi ogni aspetto del comportamento di un animale è associato all'esposizione a un certo carico parassitario, e le interazioni ospite-parassita possono avere effetti importanti sulla dinamica della popolazione ospitante. Per aumentare la nostra conoscenza di questa "interfaccia" tra ecologia comportamentale, parassitismo e dinamica di popolazione nei mammiferi, questa sessione del Congresso ATIt accoglie con piacere tutti i contributi relativi a comportamento, interazioni ospite-parassita e dinamiche demografiche. In particolare, sarà data la priorità agli studi sulla variazione nel comportamento fra gli individui della stessa specie e sulle loro conseguenze sulle varie componenti della fitness: (i) effetti del comportamento/personalità sulle interazioni ospite-parassita (ii) effetti dei parassiti sulla *fitness* dell'ospite e sulla dinamica della popolazione e (iii) ruolo delle variazioni comportamentali individuali a livello di gruppo (sociale) o di popolazione.

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XI Congresso Italiano di Teriologia

The loss and gain of small mammal ecosystem engineers: cause and consequence

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Invited lecture

The loss of biodiversity remains among the greatest challenges faced by humanity. High extinction rates not only necessarily result in the loss of biodiversity but also lead to the loss of functional relationships among community members. Ecosystem engineers, species that significantly modify or create habitats upon which other species depend, enhance biodiversity due to enhanced connections with other members and processes within the ecosystem. Small mammals have frequently been suggested to be ecosystem engineers despite their small size and often inconspicuous nature. Small mammal biomass and density are often considerable, which supports the plausibility of function as ecosystem engineers. In my research group we have studied the ecology of two potential ecosystem engineers, black-tailed prairie dogs (*Cynomys ludovicianus*) and North American red squirrels (*Tamiasciurus fremonti*) and detailed the cause of loss of these species and the consequences of re-establishment and persistence. Prairie dogs form large colonies with complex burrows systems and well-manicured short open grasslands. Biodiversity is known to increase on these colonies. The loss of

prairie dogs leads to a decline in biodiversity and changes in vegetation structure. We have studied the response of grassland ecosystems to the reintroduction of black-tailed prairie dogs and demonstrated that short term responses in vegetation structure occur quickly with only modest changes in biodiversity. A time lag in response is likely following reintroductions. Red squirrels are central place foragers that create large larderhoards of conifer cones that provide structure, concentrate food resources and create unique microclimates. We have documented increased biodiversity at these sites in addition to elevated densities of some dependent and associated species. However, climate change predictions suggest that the storage efficacy of middens will continue to decline, especially in peripheral locations, under most warming scenarios. Empirical data on the loss and restoration of ecosystem engineers are surprisingly uncommon despite the often cited importance of these species. Given current trends in habitat and species loss, understanding the impacts of restoration efforts are likely to be critical.

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Environment vs climate in the relationship tick and mammalian hosts in Swedish forestM. GRILLINI¹, P. KJELLANDER², M. CHRISTENSSON², A. D. GRASSO¹, D. SCARAVELLI³¹Università degli studi di Parma, Parco Area delle Scienze 11/a, 43124 Parma, Italy²Grimsö Wildlife Research Station, Grimsö 152, 73091 Riddarhyttan, Sweden³Dipartimento di Scienze Mediche Veterinarie, Università di Bologna, via Tolara di Sopra 50, 40064 Ozzano dell'Emilia (BO), Italy. e-mail: dino.scaravelli@unibo.it

009

Introduction Ticks are obligate hematophagous parasites of vertebrates. They are closely linked to the temperature, the kind of environment and the host community and the different tick stages have different host preferences. During the immature stage they typically feed on small mammals and birds and during the adult stages they prefer large mammals. In the last few years, due to climate change, the ticks have increased in numbers and in dispersal and it's important gain knowledge about the dynamic of them in different life stages and the role of wildlife in the dispersal of the ticks. Here are investigated year variation in ticks' abundance, how this variation corresponds to temperature, habitat, previous winter conditions and host density in Sweden.

Methods The data over five year of tick collection in two areas (Grimsö in the boreal zone, Bogesund in the hemiboreal zone) in south central Sweden to analyze what regulates the dynamic in tick numbers. We investigated the relative tick abundance by flagging and the tick infestation on small mammals (*Apodemus flavicollis*, *Apodemus sylvaticus*, *Micromys minutus*, *Myodes glareolus*, *Microtus agrestis*, *Sorex araneus*, *Sorex minutus*, *Neomys fodiens*, *Myopus schisticolor*) captured by traps in the same area at the same time.

Results From 2013 to 2015 20570 ticks of different develop-

mental stages were collected by flagging and 4506 ticks from 1417 small mammals. Our results show the different habitats as significant and a ticks preference for forest with a dense vegetation coverage. The ticks trend shows higher values during the summer and lower during the autumn, when higher presence in summer is strongly influenced by previous milder winters. Despite this, the results show that there is no relationship between the meteorological conditions and the activity of the ticks in some stages of their cycle suggesting that the climatic trend is not very significant. Analyzing the data concerning the sampling through the capture of small mammals have confirmed that they are the main hosts for larvae and nymphs and the abundance of ticks is mainly determined by the number of available hosts, in particular by voles (*Myodes glareolus*, *Microtus agrestis*) and shrews (*Sorex araneus*, *Sorex minutus*, *Neomys fodiens*).

Discussion Landscapes variables can be significant indicators for the presence of ticks. Concerning temperature the activity of ticks in this study was statistically independent but, however, the climate has an impact on ticks, especially regarding the mild winters that favor the survival of ticks and therefore the presence of more adults in the following spring/summer.

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The role of personality in interspecific competition: first insight on tree squirrels

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004

Introduction Individual differences in personality are measured using behaviours that are defined as personality traits, such as reaction to potential risks (willingness to take risks, called boldness), reaction to novel situations (such as exploration tendency), aggressiveness and sociability. Interspecific competition for limited resources, as food or nest sites, can exert selective pressures on all aspects of an animal's phenotype, including its behaviour. The absence or occurrence of competitors belonging to another species, presenting a change in the environmental state, might induce changes in the behaviour of the target species and behaviours less adapted in a single-species situation might become more adaptive when co-occurring with the competing species.

Methods In this study we used the well-known study system of interspecific competition between the introduced invasive Eastern grey squirrel (*Sciurus carolinensis*) and the native Eurasian red squirrel (*Sciurus vulgaris*). The earlier phases of colonization by the alien species and the years of co-occurrence of the two species allowed us to test the predictions of the hypothesis that interspecific competition influences the adaptiveness and hence the relative occurrence of different personality traits in the target species. We studied red squirrels by capture-mark-recapture and arena tests (Open Field (OF) test and the Mirror Image Stimulation (MIS) test) in three control sites (red-only, no competing species: 167 OF and MIS tests) and three experimental sites (red-grey, with grey squirrels as competitor: 185 OF and MIS tests). To reduce the measured behavioural variables defined in

ethograms to a smaller number of synthetic personality traits, we used an expert-based approach that returns personality-trait values for an individual and facilitate comparisons over studies and/or with new datasets. We also investigated whether the scores of these traits had a significant repeatability, which is necessary to validate the methods used to determine personality. **Results** OF returned reliable and repeatable estimates of the personality traits activity and shyness, but not of exploration, while MIS returned repeatable estimates of sociability and avoidance. While there was no significant effect of the presence of grey squirrels on the expression of activity or shyness in OF tests, patterns were more interesting for the scores of sociability and avoidance as measured by MIS. Females expressed a higher sociability than males and behaviours related to sociability were more expressed in red-grey than in red-only situation.

Discussion The results obtained in this study suggest that more sociable animals are better adapted to persist the increasing pressure from extra (interspecific) competitors. Understanding the processes underlying competition between ecologically similar species is important, since the outcome of such competition has implications for character displacement and community structuring. This study shows how individual level variation can be important in determining the outcomes of interspecific resource contests and gives us an insight into the role of behavioural variation in determining interspecific interactions in natural systems.

***Echinococcus multilocularis* and other cestodes in red fox populations of north-east Italy**

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Introduction In Europe, the red fox (*Vulpes vulpes*) is the main definitive host of *Echinococcus multilocularis*, the agent of alveolar echinococcosis, an important parasitic zoonosis. In north-east Italy, a focus of *E. multilocularis* was reported in 2002 in the province of Bolzano, later confirmed in a survey performed in 2012–2013 reporting a prevalence of 0.8% (4/473). The aim of this study was to monitor the prevalence and distribution of cestodes, in order to identify areas at higher risk of *E. multilocularis* spread.

Materials and Methods From 2014–2017, 836 red foxes were collected from the provinces of Belluno, Treviso, Verona, Bolzano, Trento, Trieste, Gorizia, Udine and Pordenone. Fecal samples were frozen at -80°C for at least 48 h and tested for cestode eggs using a filtration/sieving technique. To identify the species of cestodes a PCR using primers targeting mitochondrial genes and sequencing were performed.

Results We tested 836 red foxes and 76 (9.1%) were positive for cestode eggs. Among these, sequencing identified 12 samples positive for *E. multilocularis* (12/836; 1.4%) from animals of Bolzano province (12/357; 3.4%). The other cestode species were *Taenia polyacantha* (3.5%), *Taenia crassiceps* (3.2%),

Mesocestoides lineatus (0.5%), *Mesocestoides* spp. (0.12%), *Taenia* spp. (0.12%) and *Hymenolepis* spp. (0.12%). The overall cestode prevalence was higher in Bolzano (48/357; 13.4%) and Trento (13/105; 12.4%) provinces, followed by provinces of Veneto region (11/116; 9.4%). The cestode prevalence in Friuli Venezia Giulia region (4/259; 1.5%) was significantly lower than the other areas ($p < 0.01$).

Conclusions These results confirm that the focus of *E. multilocularis* in Bolzano province is still active, with prevalence significantly higher respect the previous study ($p < 0.05$). All the cestode species identified recognize small rodents as intermediate hosts. Notwithstanding, the variability observed in prevalence among areas may suggest differences in feeding/hunting behavior of red foxes and/or different competence and distribution of rodent intermediate host species. More studies could be conducted on intermediate hosts, including muskrats and arvicolid, which are considered potentially good sentinels to investigate the prevalence of *E. multilocularis* in small and specific foci.

This work was funded by the Italian Ministry of Health (project code: RC IZSVE 18/2016)

Biological invasions: personality, parasite infections and their influence on host reproductive success/investmentF. SANTICCHIA¹, C. ROMEO², N. FERRARI², G. GRILLI², E. MATTHYSEN³, A. MARTINOLI¹, L.A. WAUTERS^{1,3}¹Unità di Analisi e Gestione delle Risorse Ambientali, *Guido Tosi Research Group*, Dipartimento di Scienze Teoriche e Applicate, Università degli Studi dell'Insubria, Via J.-H. Dunant 3, 21100 Varese, Italy. e-mail: f.santicchia@uninsubria.it²Department of Veterinary Medicine, Università degli Studi di Milano, Milan, Italy³Department of Biology, Evolutionary Ecology Group, University of Antwerp, Wilrijk, Belgium

005

Introduction Invasive alien species (IAS) are identified as a worldwide threat to biodiversity through different ecological processes, such as interspecific competition, predation, transmission of infectious diseases. Biological invasion success and impact can be determined, positively and negatively, by parasitic infections known to have an important, but often unclear, role over a range of biological scales. Recent studies showed how parasites and animal behaviour are inextricably linked; indeed, risk-taking behaviour, exploration tendency, activity and sociality are all traits that may affect hosts' exposure to parasites by altering contact rates among individuals and/or increasing chances of encountering infective stages in the environment. Furthermore, it has been frequently suggested that personality may play a role in natural invasions with successful invaders being characterised as bolder, more aggressive or more prone to dispersal. Moreover, some studies documented how invasive propensity and, consequently, successful invasion are favoured in (host) species that preferentially allocate resources to growth and reproductive effort over costly immune defence mechanisms against pathogens. On the other hand, the increase in parasite infection is likely to reduce resources that could be used for maintaining homeostasis, body condition, survival and/or reproduction.

We investigated if variation in personality traits of invasive Eastern grey squirrels (*Sciurus carolinensis*) introduced to Italy could affect abundance, infection status and/or intensity of infection of the dominant gastrointestinal nematode (*Strongyloides robustus*) and its potential influence on host reproductive success/investment.

Methods We determined individual personality through indirect indices (trappability and trap-diversity), calculated using

capture-mark-recapture data of invasive grey squirrel, and direct measurements obtained from arena tests. *S. robustus* abundance (n. worms/host), infection status (presence/absence) and intensity of infection (n. worms/infected host) were determined by post-mortem examination of the gastro-intestine from grey squirrel carcasses. Female reproductive success was measured by uterine scars count and male reproductive investment was determined using testes mass as a proxy variable.

Results Indirect indices and direct measurements of personality produced consistent measures of the personality trait activity-exploration. Furthermore, bolder-explorative grey squirrels were more heavily infected by *Strongyloides robustus* (abundance) than shy ones. However, we also found that host personality mainly influences the probability of acquiring *S. robustus*, whereas it has no effect on parasite intensity in already infected hosts. Female grey squirrels annual fecundity was affected only by body mass. Conversely, male testes mass was positively related to body mass but negatively to parasite infection (*S. robustus* abundance and intensity).

Discussion Overall, this study showed that body mass is a prominent factor that drives reproductive output of the invasive grey squirrel, in both sexes. In particular, reaching a good body mass allows female grey squirrels to enter in oestrus and guarantees support throughout pregnancy and lactation of the young. However, male reproductive investment can be influenced by parasites maybe through a more pronounced immune response in more heavily infected individuals, resulting in less energy available to invest in reproduction. Finally, the body mass – parasite load interactions can be mediated by differences in host personality.

Not all impacts are the same: from individual to ecosystems, the environmental impact classification for alien taxa

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The Environmental Impact Classification for Alien Taxa (EICAT), is a standardized system for classifying alien taxa on the basis of the best available evidence of their most severe documented impacts. The EICAT scheme classifies alien taxa as of Minimal Concern (MC), Minor (MN), Moderate (MO), Major (MR) and Massive (MV), depending on the level of the impact, from no effects on native species, to fitness of individuals reduced, changes to populations, or community changes, which are reversible or irreversible. Impacts are classified through 12 mechanisms, including competition, predation, hybridization, transmission of diseases and herbivory.

We applied the EICAT scheme to assess the impacts of ungulate species with alien populations worldwide. A review of all available sources of information, including grey literature and online resources, was undertaken to collect evidences of impact.

A total of 50 species of alien ungulates were identified as introduced: 27 species were data deficient (i.e. inadequate information to classify the taxon), while for 23 species it was possible to perform the assessment. A total of 684 sources were assessed, 396 of them providing evidence of impact. Alien ungulates impact native species mainly for their herbivory (57% of the articles assessed), changing the chemical, physical, and/or structural characteristics of a native biotope (20%), for hybridisation (8%) or competition (7%). Irreversible impacts on communities were assessed only for *Cervus nippon* and *Bison bison* (4% of the species) that could hybridise with native species. Seven spe-

cies (14%) were classified as having a MR impact causing local populations extinction, leading to changes in the ecosystems considered still reversible. The remaining 14 assessed species had a MO impact on the population dynamics of native species. The majority of the studies referred to three species: *Sus scrofa* (15% of the sources), *C. nippon* (14%) and *Odocoileus virginianus* (10%). Most of the classification were associated with a low confidence score, indicating that for some reason (e.g. the study was performed at a restricted spatial scale), the assessor was not confident about the assigned impact magnitude.

The results of this study enlighten how EICAT can be useful to classify alien species according to their proven impacts, a fundamental process for IAS prioritization. This is a necessary step for the development of effective management strategies, such as the European Regulation 1143/2014. Furthermore, it could be used to identify knowledge gaps in the mechanism of impact and in the level of biological organisation affected by IAS. For ungulates one of the emerging issue was the difficulty in assessing the actual impact of browsing, as in most cases it was not possible to disentangle the impact of invasive and native ungulates living in the same environment. Many articles focused on competition, but provided no evidence of impact useful for an EICAT assessment, as the investigation was limited to a diet overlap. For most of the IAS, even introduced for a long time, there is still a lack of evidence on their possible impacts.

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Birth, growth and survival of Italian roe deer fawns in a Mediterranean population. Episode II

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Introduction The roe deer of Mediterranean habitats in the central and southern parts of Italy has been recognised as a distinct subspecies, *Capreolus capreolus italicus*. A population of this endangered subspecies has been monitored in the Preserve of Castelporziano, near Rome, since 1988. An abrupt population decline was observed since 2000 (from 12.5 ± 2.2 SE in 1995 to 2.8 ± 1.1 SE roe deer/km² in 2003–2007), due also to a relevant inter-specific competition with Fallow deer, which may severely threaten the sustainability of this population. Only after 2010, the population has shown to recover although very slowly (4.6 ± 1.3 SE in 2014). We observed an apparent low and variable female-to-fawn ratios during annual field surveys (2010–2017: 0.58 ± 0.14 SE). Since population growth rates of roe deer are sensitive to changes in fawn recruitment rates, we conducted a study of fawn survival rates and related biology to try to understand mechanism underling the slow recovery of this population.

Methods Between 2013 and 20017, 103 fawns belonging to 84 litters had been marked with ear tags and expandable radiocollars and sex, weight, umbilical appearance and behaviour at capture and handling, marking date, GPS coordinates, habitat type and vegetation height were recorded. We examined timing and synchrony of births and investigated the effect of cohort, sex, age of capture, body mass, spring rainfall, birth period, roe deer, hares and foxes densities, on survival of 77 radiotagged fawns over the

first 4 months of life. We modelled survival using the programs MARK and R.

Results The average date of fawning and the dispersion of births did not differ among years, contrary to what previously reported. Births were synchronized in all years: 80% of births took place in <15 days. Fawns exhibited a fast body development with a mean birth weight of 1.27 kg and a mean postnatal growth rate of 0.11 kg/day. There is a tendency to weight compensation, i.e. when birth weight is low, daily increase is high, and vice versa. Birth weights and postnatal growth rates did not differ among years or between sexes or birth periods (before, during and after the peak of births).

Survival probability of fawns was low: 50% of fawns died within the first 19–20 days, after which the survival rate decreases less steeply and stabilizes. The survival rate does not differ between years, between sexes and between the sexes within the different years but differs between fawns born in different periods.

Discussion The Spring-Summer survival rate, although low, is comparable to those reported in other studies and the low female-to-fawn ratios observed during annual field surveys may be due to additional losses in the juvenile classes during autumn-winter period. More data and a longer monitoring period are required to improve our knowledge on the factors affecting population dynamics in this area.

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Structure and population dynamics of roe deer (*Capreolus capreolus*) in dry crop plain of Northwestern Italy

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Introduction Roe deer experienced an important distribution increase throughout its entire range, mainly due to a better management, environmental improvements and its high growth rate. In Italy an increase higher than 200% has been recorded between the eighties and the early years of 2000. Currently the species is colonizing several cultivated areas of the Po Plain, particularly the dry crop plain between the river and the Apennines. Here roe deer can find a high food availability represented by crops, but on the other hand it can suffer the lack of shelter due to the low environmental suitability.

Methods From March 2016 to June 2017 we carried out a survey of two population of roe deer, located in two protected areas (Z.R.C. Trebbia, 34.88 km²; Z.R.C. Nure, 36.09 km²) of the foothills region of the province of Piacenza (Northwestern Italy), to assess the main demographic parameters as population density, structure and reproductive success. Both these areas are mainly cultivated with rotational crops (56.7%), include a water course with riparian and pebbly shore bushy vegetation (21.5%) and present a lot of urban areas (15%). We carried out monthly spotlight counts to estimate population density by Distance Sampling and we collected direct observations throughout transects across the study areas by car in the first three hours after and before the dusk to study the population structure. Then we performed Population Viability Analysis (PVA) with software Vortex 10 to study the viability of the population with and without

harvest for the next 30 years.

Results The best detectability function was the Hazard Rate without adjustment (AIC=723.88; ESW=151.17; $\chi^2=0.36$; df=1; $p=0.55$). Density were 9.36 deer per km² (SE=0.47; CV%=5.03; 95%CI=8.4–10.3) in Nure study area and 10.01 deer per km² (SE=0.50; CV%=5.03; 95%CI=9.1–11.1) in Nure study area without significant differences between study areas. Sex ratio (females/males) was significantly biased toward females in both study areas, particularly for adults (Trebbia: 2.14, $\chi^2=17.00$, df=1, $p<0.0001$; Nure: 1.76, $\chi^2=30.41$, df=1, $p<0.0001$). Considering both the two areas the population was represented in 59% by adults (39% females, 20% males), 22% by sub-adults (13% females, 9% males) and 19% by juveniles (11% females, 8% males) without significative differences between the two study areas. The productivity rate (Juv/Ad_{female}) was 0.65 in Nure study area and 0.48 in Trebbia study area. The PVA showed high viability of the population in absence of harvest, while from a harvest percentage of 15% the population strongly decrease compromising its survival.

Discussion The monitored population seem at low density if compared to those of the Apennines hilly region from which they originated; the productivity is also lower than that reported in European studies. Despite the high food availability, the lack of shelter site can reduce both densities and reproductive success.

Life on the edge: small mammals and ecotonal habitats

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Introduction Forest edges usually exhibit differences in microclimate, species composition and vegetation structure compared to the within-forest habitat. Hence, a habitat edge can be considered a spatial discontinuity that affects a species' behavioural, physiological or demographic performance. Rodents play an important role in the regulation of many processes supporting natural ecosystems, but, because of their restricted vagility, they may be more susceptible to the edge effect, in particular if a species is not a habitat generalist. In this study we explored possible effects of the forest edge on small mammals populations in terms of species richness and distribution, survival, foraging behaviour and individual personality.

Methods Granivorous small mammals were studied from June 2016 to April 2017 in two areas of Pineta di Appiano Gentile e Tradate Regional Park (Lombardy, Italy) along 3 transects 90 meters long that ran parallel along an edge forest-meadow: the first transect was at the edge while the second and third were at 50 m and 100 m, respectively. Six capture sessions were carried out using 30 Sherman traps/area (10 traps/transect) and captured individuals were identified and were subsequently sexed, aged, weighed and permanently marked with passive integrated transponder tags. Capture-mark-recapture data were used to analyse species richness, dispersion, survival and to measure two indirect indices of personality: trappability (boldness) and trap diversity (exploration). Moreover, each month for 24 h a foraging experiment was carried out along each transect using trays filled with 2 l of sand and 30 g of sunflower seeds to calculate the

Giving Up Density (GUD). In each area a vegetation study was carried out.

Results We detected two taxa in both areas and all transects: individuals belonging to the genus *Apodemus* and *Myodes glareolus*. We found a neutral effect of the edge on species richness, survival and on individual's personality (activity/exploration tendency). Bank voles occurred more along the edge while *Apodemus* sp. was evenly distributed over all transects. Seed-eating rodents took more seeds from trays along the edge in both areas and one area had a higher GUD than the other. A possible explanation is the slightly different forest composition of the two areas. The season was a sensitive factor in determining taxa abundance and foraging behaviour, but it did not affect animals in different ways at increasing distance from the forest edge.

Discussion We found positive or neutral responses to the edge (even within the same species/taxon) depending on the factor under consideration (e.g., species richness and dispersion, foraging behaviour). Many studies have tried to extract general conclusions on the presence or not of an edge effect on animal populations. Our study supports evidence that edge effects are species-specific and that microhabitat structure inside the forest is likely to affect the magnitude and possibly direction of edge effects. Our results also suggest that populations should be studied with a multiple test approach to investigate different eco-ethological responses to the edge when trying to reveal the functioning of ecotonal systems.

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Conservazione e Gestione dei Mammiferi *evidence based*

La gestione e conservazione della fauna prevede spesso interventi diretti sulle popolazioni animali e sugli ambienti dove queste vivono. L'uomo manipola le popolazioni e gli ambienti per raggiungere obiettivi quali la conservazione delle specie, il prelievo sostenibile su popolazioni soggette alla caccia o il controllo intensivo di specie invasive. La pianificazione di tali interventi e, più in generale, l'implementazione di politiche di conservazione, dovrebbero essere basate su decisioni prese avendo a disposizione dati scientifici robusti che indichino quali interventi funzionano e quali in passato non hanno funzionato. Questo richiede la pianificazione di studi rigorosi dal punto di vista metodologico che 'misurino quantitativamente' gli effetti, positivi o negativi, degli interventi gestionali, la diffusione dei risultati ottenuti presso il mondo scientifico e presso gli attori della conservazione e che le buone pratiche, qui intese come supportate da evidenze scientifiche, siano poi realmente adottate. Obiettivo della sessione è quello di presentare lavori che abbiano misurato in maniera rigorosa e quantitativa gli effetti di interventi di gestione e conservazione delle popolazioni di mammiferi o che offrano robusti elementi conoscitivi a supporto dell'introduzione e adozione di nuove pratiche gestionali.

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XI Congresso Italiano di Teriologia

An evidence-based approach to mammal conservation

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Invited lecture

Evidence-based medicine is one of the triumphs of recent decades and has indisputably saved innumerable lives and resulted in more cost effective practice. However, is this the right approach for other areas of policy, such as conservation biology, education or crime reduction?

Three key problems are firstly that it is difficult to run randomised controlled experiments for many ecological problems, that there is insufficient funding for reviewing the literature and that local conditions means that experiments elsewhere may not really apply to your site. I will describe the strengths and limitations of the current approaches and suggest that we review entire subject areas at a time — a process we call Subject-wide evidence

synthesis. I will explain how this has been used in the creation of the website www.conservationevidence.com, which has reviews of over 1700 interventions and describe how this could be expanded to all areas of public policy.

We have applied this approach to reviewing the interventions relating to bats and, just recently, to mammals. I will discuss the lessons learnt from these two reviews including the nature and extent of the gaps in the literature. We are also reviewing the interventions relating to all mammals (including redoing the bats).

We are very happy to work with collaborators on this or other areas that need reviewing.

Hidden hurdles in wildlife management: unravelling the impact of poaching on ungulate mortality

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018

Introduction Wildlife management may be hampered by cryptic impacts of human activities that bear negative consequences on the dynamics of animal populations. Poaching is a prominent source of such “hidden hurdles”, as its impacts on wildlife are not outwardly obvious. The consequences of illegal killing may vary widely: poaching, for example, can undo the effects of management protocols, possibly jeopardizing the sustainable use of resources. Unravelling the impacts of illegal killing is thus a crucial step for the development of sustainable management strategies. We aimed to provide robust estimates of the direct impact of poaching on age- and sex-specific mortality probabilities in a population of red deer *Cervus elaphus* subjected to culling, and to evaluate whether poaching-related mortality contrasts with management plans.

Methods Between 2008 and 2017, we marked 141 red deer within the Stelvio National Park (central Italian Alps) and collected data on resightings and mortality causes (poaching vs. other). We assessed the direct impact of poaching on age- and sex-specific mortality using a multievent modelling framework taking into account uncertainty over mortality causes. As we had no a priori hypotheses on the impacts of illegal killing on our study population, we contrasted three alternative hypotheses in either sex: mortalities due to poaching and to other causes 1) vary interactively across age classes; 2) vary additively across

age classes; 3) remain constant across age classes (poaching) and show age-dependent variations (other).

Results Survival probabilities followed a typical age-dependent pattern with negative, non-linear trends in both sexes. Males and females showed similar, age-dependent patterns for the “other” causes of mortality (which mainly included starvation and car accidents). Conversely, in females the absolute probability of mortality by poaching showed fairly consistent values (ca. 3–5%) across all age classes, whereas for males it changed with age and it was particularly high in males older than 8 years (26%). The impact of poaching relative to other causes of death was greatest in adult individuals of either sex (over 50% and 20% for males and females, respectively).

Discussion Multievent models unraveled a strong bias in sex-specific mortality due to poaching, possibly attributable to trophy killing in adult males and “bushmeat-like” killing for private or commercial gain in young males and in females. Poaching impact on deer mortality accounted for large part of the mortality events, and it contrasted with the planned management protocol, which was mainly targeted on females. Illegal killing may thus bear severe, yet undocumented consequences on the dynamics of the study population, and the adoption of appropriate strategies should be considered to mitigate poaching impacts and avoid overexploitation.

A conservation evidence approach to assess the efficacy of control methods for invasive alien mammals

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031

Evidence-based conservation is the application of scientific evidence in conservation and management actions. This requires the analysis of the literature produced on the topic of interest and its synthesis according to standardized procedures to highlight what works. We applied a conservation evidence approach to assess the efficacy of control techniques for invasive alien species (IAS). This is particularly useful for the species included in the list of the species of Union concern attached to the EU Regulation 1143/2014 on IAS as management actions are mandatory for Member states. Our aim was to retrieve published data on the efficacy of the used control techniques on the mammal species included in the list.

Forty-five peer reviewed journals on conservation biology, biological invasions and wildlife management were systematically searched issue by issue for papers that directly test control interventions and report the results. Moreover, Google Scholar and Web of Science were used to retrieve further scientific articles and grey literature (e.g. project reports, articles in national journals). Selected articles and reports were then scrutinized to assess whether they reported evidences of the efficacy of the used control method. Contemporary, a list of possible interventions (i.e. techniques used for control/eradication) was drafted for each species. Here, we present the results for coypu *Myocastor coy-*

pus and squirrels (*Callosciurus erythraeus*, *Sciurus carolinensis*, *Sciurus niger*, *Tamias sibiricus*).

Twenty out of 34 retrieved articles for coypu and 13 out of 30 articles for squirrels reported results on the efficacy of control activities in the field or in the laboratory. Lethal methods are the most used and proved to be efficacious in eradicating or reducing populations of these species, specifically live cage traps (particularly on floating rafts for coypu) and shooting for all, and the use of warfarin for grey squirrels. For squirrels, three studies tested the efficacy of immunocontraception with interesting results, even if further tests are needed to better assess its selectivity. For coypu, no article dealt with non-lethal methods. Other articles evaluated the use of lures, biological control and bounty scheme.

Despite the control activities on coypu and squirrels have been started several years ago, few studies reported data on their use and even fewer showed their efficacy. This can be due to several reasons: non-collection of data during management activities, non-publication of these data, the time required to carry out these studies, the lack of before- and after-study data or the lack of good performance indicator showing the effect of control activities. Our results thus clearly indicate the need of more studies to assess the efficacy of IAS management activities.

Living close to humans: behavioral responses of wolves to anthropogenic features in Central Italy

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030

Introduction Human-modified environments currently represent the playground for main conservation challenges. In this perspective, a first step to understand the process of human-wildlife coexistence would be to characterize wildlife-habitat relationships as a function of interrelating environmental and anthropogenic factors. Our study aims to assess seasonal, circadian, and habitat-mediated effects on spatial responses of wolves (*Canis lupus*) to anthropogenic features, while considering their behavioural state and pack affiliation. We focused on the wolf population of the Abruzzo, Lazio and Molise National Park (PN-ALM, Central Italy), shaped by a long history of coexistence with humans.

Methods Using data collected from 10 GPS-collared wolves in 5 packs (2008–2010), we defined two behavioural states of wolves (moving and non-moving), further tallied by season (summer, fall, and winter) and social status (i.e., pack member vs. floater). We used Step and Resource Selection Functions to assess wolf habitat selection along moving trajectories and within non-moving locations, respectively. We used Generalized Linear Mixed Models based on conditional logistic regression, in which we included wolf ID as a random factor, and we considered topographic, environmental and anthropogenic (distance from main roads and settlements, distance from secondary roads) covariates, accounting for an interaction with the circadian period (i.e., day vs. night). Main roads (31.5 km/100 km²) connected the most populated human settlements, whereas secondary roads (67.4 km/100 km²) mainly connected smaller settlements or logging areas.

Results Resident wolves showed a strong avoidance of all types

of anthropogenic features in summer, and this response was observed both along moving trajectories and in non-moving locations. The tendency was opposite during winter and fall, when resident wolves tended to travel closer to anthropogenic features. We also observed a circadian effect in wolf responses to roads and settlement in winter, non-moving locations, as they were avoided during daylight hours and selected at night. Overall, floaters behaved similarly to resident pack members, as main roads and settlements were selected during fall and winter nights, and secondary roads were selected in winter.

Discussion Wolf responses to anthropogenic features in the PNALM mainly varied according to a seasonal effect, with summer representing the period during which wolves showed the strongest avoidance of roads and settlements, likely because of increased levels of human activities such as tourism and livestock. As opposed to summer, human interference in the PNALM is lower during fall and winter, and wolves may attempt to use roads to ease travel or increase the encounter rates with prey. The behavioural plasticity that allows wolves to live in proximity to humans is a key factor to their persistence in human-modified landscapes, many of which have higher densities of roads and humans than in the PNALM. However, this plasticity should not mask the fact that road networks may lead to increased human-caused mortality of wolves. Considering that a consistent percentage of wolf mortality during the study period was due to poaching and vehicle collisions, the relationship between the roads and wolves should be considered when planning their management and long-term conservation in the central Apennines.

Should I eat or should I go? Patterns of use of supplemental feeding by roe deer in an alpine environment

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Introduction Winter supplemental feeding is a widespread management practice across Europe and North America, however few studies have quantitatively analyzed the utilization pattern of feeding sites. In species with intense and continuous metabolic needs such as roe deer (*Capreolus capreolus*), feeding sites represent concentrated resources that are likely exploited when the conditions are more limiting for the species. Indeed, this small ungulate has minimal physiological and morphological adaptations to cope with harsh winter conditions. Here we evaluated the daily and seasonal patterns of supplemental feeding stations use in an alpine population of roe deer, and the biotic (intra-specific competition, human disturbance) and abiotic (temperature, alternative resources availability) determinants that drive these patterns.

Methods We performed the study in a moderately-mountainous area (600–1000 m a.s.l.) of 45 km² in Val di Cembra (TN), Eastern Trentino. The area is characterized by an ongoing management project of intense, all-year-round supplemental feeding. We used camera traps to monitor the attendance of five feeding stations by six roe deer, marked with individual-specific ear tags to allow visual recognition. Between January and May 2017 we collected 63852 pictures. We generated a database of individual presence and behavior by coding individual pictures in the Aardwolf software. We modelled patterns of use of supplemental feeding by roe deer by means of Generalized Additive Mixed Models (GAMMs), which allowed us to take into account non-linear temporal patterns of resource use.

Results Roe deer daily use of feeding stations followed a

bimodal pattern, with two peaks associated to crepuscular hours. Feeding station use was negatively affected by temperature and positively by the actual presence of food at the stations. The seasonal use of feeding stations significantly decreased towards the spring, due to a combination of availability of alternative natural resources and increase of average temperature. The seasonal pattern was more evident when the feeding stations were provided with forage, with a significant avoidance during weekends. Lastly, we found that the time spent at the feeding sites increased in presence of conspecifics, especially when these were feeding.

Discussion The opportunistic use of feeding stations by roe deer confirms the high ecological plasticity of this ungulate. Roe deer rapidly responded to spatio-temporal dynamics in resource availability, as well as to environmental changes and human disturbance. To our knowledge, this work represents one of the first empirical studies assessing the use of feeding stations by roe deer in continuum. Indeed, the implementation of high-resolution camera traps for monitoring the use of punctual sites such as feeding stations overcomes the limitation of GPS telemetry, for which the temporal resolution is limited by battery constraints. Also, camera traps allow detection of other individuals, and therefore the assessment of intra and/or inter-specific relationships occurring at feeding stations. Our results can inform wildlife managers and ecologists in relation to the potential negative impacts of supplemental feeding on animal welfare and fitness, especially in terms of disease transmission and competition-mediated stress.

Are we effective? An overall assessment of the management strategy applied to remove grey squirrels (*Sciurus carolinensis* Gmelin, 1788) from Umbria

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026

Introduction The eradication of Invasive Alien Species (IAS) can produce significant effects on biodiversity, but a critical evaluation of actions undertaken to remove IAS is needed to identify best management practices. Here, we consider the case of the Eastern grey squirrel (*Sciurus carolinensis* Gmelin, 1788) introduction in Perugia, Umbria, analysing data collected within the LIFE U-SAVEREDS Project. The project aimed at the rapid eradication of the alien species, pursued through the direct removal of animals and according to a well-defined strategy, outlined by an ad hoc Decision Support System. To assess its effectiveness, we quantified changes in the alien species density and in the presence of the native Eurasian red squirrel (*Sciurus vulgaris* Linnaeus, 1758).

Methods In 2015, a first Distance Sampling (DS) survey was implemented, recording sightings of grey and red squirrels from point transects. From 2016, grey squirrels were removed from the Project area through live capture and subsequent euthanasia, following the directions of the DSS. The capture rate was monitored through time and, in 2017, the DS survey was repeated. Data were used to develop Density Surface Models (DSMs). For 2015 and 2017 and for both species, the resulting maps were finally compared to detect local changes in density and

distribution. A Rapid Eradication Assessment (REA) protocol was also tentatively applied in the core area of the grey squirrel distribution.

Results The density of the alien species was significantly reduced by control activities and the capture rate showed a decreasing, although oscillating trend. The grey squirrel DSMs also highlighted that the success of control activities was affected by the accessibility of the areas. In the core area of the grey squirrel distribution, where most of the suitable areas for grey squirrel were accessible to the Project staff, the positive results were confirmed by the REA, which estimated a high probability of eradication. In spite of this, the spatial distribution of sightings and the DSM for the red squirrel suggested that the management strategy was positively affecting its presence in the Perugia area.

Discussion The grey squirrel captures in the Perugia area are still ongoing and the oscillating trend of the capture rate is similar to the one observed in other squirrel eradication programs, which were finally successful. Overall, according to our results, the strategy adopted to manage the alien species seems effective, although complete eradication will probably be delayed because of issues related to the limited access to private lands.

Natal dispersal in wild boar and the nearest neighbour effect

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024

Introduction Despite their relevance for explaining the invasion success of wild boar (*Sus scrofa*) and for predicting the diffusion of transmissible diseases the mechanisms of dispersal have never been studied thoroughly in this species. We analyzed the movements performed by wild boar during the first 18 months of life, using a sample of 784 ear-tagged piglets captured and recaptured between 1995 and 2014 in a protected and fenced Mediterranean oak forest. This long time series of observations allowed us to encompass a large range of climatic, environmental and population-related conditions.

Methods We quantified the occurrence of dispersal and tested a number of hypotheses about the mechanisms triggering it. The dispersal rate was assessed at individual and local scale, using a logistic regression, and at study area scale, using a time-series analyses. Sex, standardized weight, sex ratio of the group captured, presence of sarcoptic mange, habitat quality, acorn production, climatic indexes and local and mean annual densities were used as covariates. The temporal structure of the dispersal rate was assessed via autocorrelation analysis. We computed the dispersal distance kernel and estimated the mean dispersal distance and the fraction of dispersal events occurred above a given distance.

Results The presence of fences does not affect the results that appear comparable to that seen in open study areas. As shown

by other Authors, most wild boar are philopatric and only a small fraction perform a true natal dispersal. Dispersal propensity was (i) male-biased (23.1%±3.0 males and 12.5%±2.3 females disperse) (ii) anticorrelated with piglet's body mass (iii) inversely density dependent (iv) not explained by local mate competition, inbreeding avoidance or local environmental conditions. Dispersal displacements are larger in males than females (on average of 3 km vs 2 km) and the presence of boundaries prevented only 3% of the longest dispersal distances (2% of movements longer than 20 km and 1% longer than 30 km). Dispersal rates showed wide irregular yearly fluctuations correlated to large autumn densities and outbreaks of sarcoptic mange. Lastly, dispersal was not for free: wild boar risk to be shot while dispersing more than philopatric animals and females were found to be more vulnerable than males.

Discussion Dispersal rates in wild boar are low, differ among years and are shaped by heterogeneities in density than in habitat quality per se. Piglets move up to settle in high-density areas so dispersal distances are thus determined by the spatial distribution of suitable (more from a social rather than environmental point of view) settling areas. Our study can bring useful information about mechanisms driving dispersal in wild boar, which can be used by managers and researchers to better infer population dynamics and space-use strategies of this species.

Looking for evidence: research gaps and lazy citations in alien species impact

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013

The Environmental Impact Classification for Alien Taxa (EICAT) is a scheme which identifies a set of 12 mechanisms of impact and it considers a sequential series of 5 impact scenarios describing increasing levels of biological organization affected by alien taxa (5 magnitudes: Minimal Concern, Minor, Moderate, Major and Massive). For each species assessed, an exhaustive literature research is performed, and each primary report found is evaluated and associated with a confidence score that provide the level of uncertainty associated with the assessment. Reports that did not provide information suitable for EICAT assessment are listed separately as “not relevant” (NR). We applied the EICAT scheme to introduced ungulates. The exhaustive literature assessment provided the opportunity to identify research gaps and highlight the necessity to improve experimental methodologies to assess impacts.

We collected and assessed 684 reports, 396 of them were used in the assessment, while the other 288 were considered NR. The majority of the assessed reports (54%) had a “low” confidence score, due to a limited temporal or spatial scale over which impacts were described or due to a small sample size. Most of NR reports described extrapolated or potential impact. However, we noticed that many of these inferred impacts were then reported in other articles as evidence for impacts.

We performed a meta-analysis to assess whether the impact described in a given report was cited with the correct magnitude. We randomly selected 50 references equally distributed among the 5 impact magnitudes and the NR list. For each one, we

performed a search on “Web of Science” and “Scopus” to obtain the number of articles citing them. We then selected the most cited papers (mean=66 citing articles; min–max=24–101) for each category of impact and collected all the articles citing them (N=311). For each one, we assessed the appropriateness of the assertion citing the primary source and classified them as “accurate” (i.e. “unambiguous support of the assertion”), “no support” (i.e. cited article did not in any way substantiate the assertion or the results attributed to it) or “ambiguous”. We also recorded if the reported impact corresponded to the EICAT classification for the cited article. Finally, we classified an assertion as “lazy” when the cited source did not observe directly the impact, but reported a secondary article.

A total of 57 citations (18%) were classified as “no support” or “ambiguous”. 27% of the citations (85 articles) were on alien ungulates impact, and in 37 cases (44%) the impact was overestimated; in 37% of cases (N=27) the quotation was a “lazy citation”. Interestingly, all these citations referred to articles with lower impact classifications in EICAT.

Citation errors have been widely described in medical research, but only a few articles have reported this problem in ecology or conservation research. Mis-citations are often related to an omission of the authors to refer to the primary source and may lead to a misinterpretation of the scientific facts. Here we show that this led to overrated impacts of alien species in many cases, with potential major consequences for management practices.

XI Congresso Italiano di Teriologia

Scale-dependent effectiveness of management in reducing deer impact on woodlandN. FATTORINI¹, P. WATSON²¹Department of Life Sciences, University of Siena, Via P.A. Mattioli 4, 53100 Siena, Italy. e-mail: niccolo.fattorini@gmail.com²The Deer Initiative, Brynkinalt Business Centre, Chirk, Wrexham LL14 5NS, United Kingdom

019

Introduction Since the early 2000s, a substantial impact on woodland flora has been recorded from deer in parts of Eastern England (UK), due primarily to high-density by dense populations of introduced fallow deer *Dama dama* (FD), muntjac *Muntiacus reevesi* (MD) and native roe deer *Capreolus capreolus* (RD). Biodiversity in most woodlands has been recorded as in an unfavourable condition, because of excessive impact of deer suppressing plant regeneration. In response, cull pressure has been increased and repeated survey has shown that deer impact on woodland has been decreasing over the last decade. Yet, it remains unclear whether reported changes in impact reflect cull effort and, if any, at which spatial level. Our aims are to assess: (i) whether deer impact on woodland is related to cull effort; (ii) whether the extent of management effectiveness changes with spatial scale.

Methods Data were collected by The Deer Initiative and Forestry Commission (England), in 132 woodland sites in the East of England (UK), for 7 years (2009–2015). Deer impact on woodland was estimated using a standardised index (Cooke-Tabor Index assessed by combination of 5 separate indicators of deer presence and impact). Number of deer of each species culled in each site/hunting season was recorded. We grouped sites in increasingly wider clusters by their reciprocal distance through a

cluster analysis. We arbitrarily established 5 spatial levels based on clustering to evaluate the effectiveness of management across different spatial scales. Using generalised linear mixed models we modelled the overall impact score at each spatial level in relation to deer culled during previous years.

Results For all the species/spatial scales (with the exception of FD at the smallest spatial scale considered), deer management was found to be significantly effective in reducing impact on woodland. However, the strength of the inverse relationship between the number of deer culled overall and the level of impact recorded was scale/species-specific. The most effective culling in reducing deer impact on woodland was achieved at the smallest scale for the relative sedentary MD and RD, whereas at a wider scale for FD. Thus the appropriate scale for management may vary amongst species.

Discussion To our knowledge, this is the first study comparing the efficacy of management across spatial levels. It seems likely, that culling of FD was not effective to reduce deer impact on woodland at the local scale because of greater mobility of this species (e.g. larger home ranges). The spatial scale of ecological processes should be taken into account to plan management, as its effectiveness may vary with the level considered: a scale-dependent, species-specific approach is strongly recommended.

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May media reports and social media switch public perception of large carnivores?V. NANNI¹, G. BOMBIERI², M.D.M. DELGADO², J.M. FEDRIANI², E. CAPRIO⁴, S. SCHIAPARELLI¹, V. PENTERIANI⁵¹DiSTAV, Dipartimento di Scienze della Terra, dell'Ambiente e della Vita, University of Genoa, Corso Europa 26, I-16132 Genoa, Italy. e-mail: veronicananni7@gmail.com²Research Unit of Biodiversity (UMIB, UO-CSIC-PA), Oviedo University, Campus Mieres, Mieres, Spain³Centre for Applied Ecology "Prof. Baeta Neves"/InBIO, Institute of Agronomy, University of Lisbon, Tapada da Ajuda, Lisboa, Portugal⁴Dipartimento di Biologia Animale e dell'Uomo, Via Accademia Albertina 13, I-10123 Torino, Italy⁵Pyrenean Institute of Ecology (IPE), C.S.I.C., Avda. Montañana 1005, 50059 Zaragoza, Spain. e-mail: penteriani@ipe.csic.es

016

Introduction Human acceptance over the presence of predators is crucial for their conservation and is highly ruled by people's perception of the risk they can involve. Even if predator attacks on humans are rare, they arouse a disproportionate media attention. The way the media covers predator attacks and the resonance that these reports have on the ample network of the social media, might affect the perception of risk. Thus, before providing insights into potential strategies to improve the human coexistence with these species, it is necessary to understand how media presents attacks and how public perception might change accordingly.

Methods A total of 1584 media reports of predator attacks on humans were collected on the web and classified as negative (score=1) or neutral (score=0) based on the following criterion: we considered negative reports those instilling in readers a feeling of fear about predators (e.g. through the use of explicitly violent or aggressive contents in title, subtitle or images) and neutrals those describing the facts objectively. We have analysed how these records spread on social media considering the number of "shares" indicated on the web page of each report (n=392). By fitting a negative binomial GLMM, we assessed whether the number of shares varied over the score acquired by the reports, among the species considered (n=13) and the newspaper type

(i.e. local, national or worldwide). We also tested the effect of the presence or absence of images, but being this variable correlated with the score we didn't take them into account in the same model.

Results Nearly half (41.5%) of the media reports collected contained at least one negative element and these reports are those that have significantly more shares on social platforms than neutral media reports. When images are present, the news are more widely shared. Furthermore, species have an important weight on conditioning the number of shares, whereas there are no substantial differences between local, national or worldwide newspaper type.

Discussion Nowadays, internet and social media are emerging as a weighty news referring source, where people learn and construct their world perception, which thus became a major driver in shaping the public opinion. For this reason, a bias in coverage of predator attacks may generate fear and lower public support towards predator conservation, rather than providing insights into the causes of these events and possible solutions. Therefore, constant engagement of carnivore experts with the media and their scientific prompt presence on social media, are crucial in order to provide correct information about carnivores, which is essential for effective conservation.

Teeth and jaws as ecological indicators: the case of roe deerA.M. DE MARINIS¹, R. Chirichella², E. BOTTERO², M. APOLLONIO²¹ISPRA, via Ca' Fornacetta 9, I-40064 Ozzano dell'Emilia (BO), Italy²Department of Veterinary Medicine, University of Sassari, via Vienna 2, I-07100 Sassari, Italy. e-mail: rchirichella@uniss.it

Introduction Increasing evidence suggests that conditions in early life have important consequences for body size and fitness in mammals. As regards herbivores, teeth play a central role in the long-term performance of individuals. In general, eruption times are related to jawbone growth: delayed teeth change is due to a slow body development. Here we described the jaw growth rate and the eruption timing of mandibular teeth in roe deer (*Capreolus capreolus*) in the Northern Apennines (Central Italy) in order to evaluate suitable indicators to monitor the current and future conditions of a population.

Methods We measured the length of anterior and posterior part of the mandible and recorded the eruption stages of incisiviform (I₂, I₃, C) and molar (M₃) teeth in 2161 fawns (1176 females and 985 males) shot in their first winter of life over three hunting seasons (2013–2015).

General Linear Models in an Information-Theoretic approach based on AIC were fitted to examine variation in the jaw lengths and eruption times of front teeth and M₃. We considered environmental and climatic conditions experienced by mothers during gestation and directly by fawns in their first months of life as predictors. These conditions are described by i) environmental variables (elevation, slope, forest productivity); ii) climatic variables (temperature, rainfall, snow cover); and iii) population parameters (local density). Julian date and dressed body weight were added as independent variables in order to remove the effect of the different shooting date and to control the direct effect of the predictors on juveniles' body conditions.

Results Environmental and climatic conditions experienced by

mothers better explained the size of the anterior part of the jaw while the posterior one represented conditions experienced by offspring. The percentage of juveniles exhibiting permanent teeth depends on cohort in particular in relation to population density and body mass. We found a strong positive correlation between environmental (food availability) and climatic (winter temperature and spring rainfall) conditions experienced by mother and eruption timing. The temperature experienced by fawns during their first summer and autumn also affected eruption timing. A greater number of predictors shaped the eruption timing of M₃ (i.e., a costly and long-lasting process) in comparison to incisiviform teeth. Males and females showed a different growth and eruption pattern.

Discussion Mandible growing and/or teeth eruption timing are more suitable indicators than body development to monitor the global conditions of a population as these processes are less influenced than body mass by nutritional deficiencies. Determining teeth eruption stages does not require specific tool and/or skill, which should help standardizing data collection, limiting sampling variance, and reducing monitoring costs. Incisiviform teeth and M₃ can be indicators of ecological changes, because these teeth show a large temporal variation in their development. The use of incisiviform teeth and/or M₃ depends on both the hunting period and the monitoring objectives. Collecting yearly data could give important information about population trends and could contribute to determine limit values below which the condition of the population should be considered critical.

First evidences on raccoon control program in LombardyM. PANZERI¹, A. COSTA¹, G. POGLIANI¹, F. BISI¹, M.V. MAZZAMUTO¹, G. DE FILIPPIS², D.G. PREATONI¹, L.A. WAUTERS¹, A. MARTINOLI¹¹Unità di Analisi e Gestione delle Risorse Ambientali, *Guido Tosi Research Group*, Dipartimento di Scienze Teoriche e Applicate, Università degli Studi dell'Insubria, Via J.-H. Dunant 3, 21100 Varese, Italy. e-mail: mattia.panzeri@uninsubria.it²Parco Regionale Adda Nord, Via Benigno Calvi 3, 20056 Trezzo sull'Adda (MI), Italy

Introduction Biological invasions are a threat to biodiversity and human health, and cause important economic losses at a global scale. Originally a North and Central American species, the Northern raccoon (*Procyon lotor*) has been introduced in Europe during the last century and has become a predator and competitor of native species. Moreover, raccoons host several transmissible pathogens becoming a threat to wild and domestic animals and humans. In Italy, the presence of *P. lotor* was limited to a single population in Lombardy, whose first reports date back to 2003; however, some new reproductive nuclei have been recently found in Tuscany. In this context, as part of the “LIFE GESTIRE 2020” project, a removal program is underway to eradicate the Northern raccoon population in Lombardy.

Methods Using a multidisciplinary approach, we identified the area involved in the raccoon invasion using 88 camera traps randomly distributed, starting from the sightings reported for the species in Adda Nord Regional Park. Once identified, the raccoon presence area was divided in 14 trapping sites, where removal activities started in September 2016 and are still in progress. Raccoons were trapped using ground-placed live traps and immediately euthanized by CO₂ excess. The carcasses were subsequently subjected to parasitological analysis. The camera trap campaign was carried out also during the trapping activities and will continue after their end both in the trapping area and the surrounding territories to confirm the eradication of the species.

Results A total of 54 raccoons (23 males, 31 females; sex ratio

M:F 0.74) were removed so far, from an area of 116 ha, from September 2016 to March 2018. Maximum likelihood estimation of population size from catch-effort data based on removal sampling estimated a maximum population size of 122 raccoons, with a catch-per-unit effort of 0.018. Given that 54 raccoons were removed in 2697 trapping occasions, it can be estimated that the population might be eradicated in 3882 trapping occasions (closed population hypothesis). These results, also considering the decreasing trend in catches since the beginning of control activities, confirm the efficacy of the removal program so far. Data analysis on camera trapping showed a detection value of 0.142 (SE 0.039). However, the raccoons were detected only inside the trapping area, with an occupancy value of 0.137 (SE 0.053). As described in the existing literature, also here raccoons are active exclusively at night, from 9 p.m. to 4 a.m.

Discussion The results achieved so far and the trapping effort spent, indicate the presence of a low-density raccoon population in the study area. For this reason, the intensification of captures and monitoring activities is necessary for the desirable total eradication of the raccoon population from the study area. Currently, we have not seen significant differences in catches by season, but this could be due to the low number of repetitions. In this context, the continuation of the activities will also be important to characterize comparative studies between the different periods of the year.

Workshop Aree Protette, Parchi Faunistici e Musei: luoghi di incontro tra ricerca, divulgazione e ricreazione

Aree protette, parchi faunistici e musei svolgono un importante ruolo per la conservazione e per la ricerca nel campo dei mammiferi. Allo stesso tempo sono anche luoghi dove è possibile realizzare attività divulgative e ricreative, sfruttando il contatto diretto tra pubblico e mammiferi per trasmettere concetti scientifici, promuovere comportamenti virtuosi e abbattere pregiudizi e superstizioni sugli animali. Le molteplici finalità, talvolta si fondono, come nel caso dei progetti di citizen science, che attraverso il coinvolgimento del pubblico mirano a definire lo stato di conservazione delle specie a migliorarne la gestione, o nell'osservazione dei mammiferi in natura, una delle forme di ricreazione che si sta sviluppando, sia per iniziativa privata sia in seno a progetti di conservazione, in grado di portare benefici sociali ed economici alle comunità locali, ma i cui effetti sull'ecologia dei mammiferi non sono stati ancora completamente indagati. I contributi scientifici attesi in questa sessione dovranno far emergere il ruolo indispensabile di aree protette, parchi faunistici e musei per lo studio, la conservazione e la divulgazione dei mammiferi. Saranno accolti esempi di ricerche effettuate a partire da collezioni museali; iniziative di networking tra aree protette, parchi faunistici e musei finalizzate allo studio e alla conservazione dei mammiferi; studi condotti sulla base di dati raccolti attraverso iniziative di *citizen science*; esempi di studi sulle ricadute economiche e sociali delle attività ricreative inerenti i mammiferi; studi sugli effetti ecologici ed etologici provocati dall'osservazione organizzata e ripetuta dei mammiferi.

Il *Workshop* sarà anche l'occasione per presentare un nuovo volume della collana dell'ATI dedicata alla divulgazione di diversi aspetti della gestione, comunicazione e conservazione dei Mammiferi. Il nuovo volume in preparazione è dedicato alle regole di comportamento da tenere in diverse situazioni in cui si entra a contatto con i Mammiferi.

Coordinatori

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XI Congresso Italiano di Teriologia

The great challenge: exploring potentialities of Natural History Museums, wildlife parks and protected areas in a changing world

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Invited lecture

Protected areas, wildlife parks and Natural History Museums (NHMs) play a fundamental role for the study, conservation and dissemination of scientific knowledge. At the same time, they are also places where it is possible to carry out activities to engage people in field studies, to promote virtuous behavior and break down prejudices and superstitions. That virtually applies to any form of life, including of course Mammals, which are often seen as iconic species.

During recent decades, many NHMs have undertaken a profound transformation of the solutions developed to deliver their core functions and the ways in which they interact with both visitors and local communities. Alongside their traditional roles of conserving and providing access to specimen collections, NHMs are increasingly looking to actively engage members of the public in projects that seek to build understanding of the natural world and generating scientific awareness. Protected areas and wildlife parks have also expanded and diversified their public-facing work to encompass the development of new educational approaches and tools that seek to engage broad sectors of society with natural sciences. The driving forces behind these initiatives originate from global and national concerns, such as loss of ecosystems, need for sustainable development, decline in outdoor learning,

need for everyone to play a part, crisis in taxonomy, need for greater public awareness and engagement.

A new way of doing science with the participation of the public underwent a great expansion in recent decades, the so-called "citizen science": a worldwide, fast growing movement that promotes activities at the interface between science and society. The talk will highlight some examples of this recent "revolution", which is at the same time deeply rooted in the core functions of Parks and Museums and oriented to re-define the role they are expecting to play in a quickly changing society. NHMs, in particular, are delivering a wide range of field-based and online citizen science projects. Among others: the support to the development of amateur-expert naturalists, hosting taxon-specific biological recording schemes, the development of species monitoring projects, museum-led BioBlitzes and digital technology-mediated citizen science projects.

Protected areas, wildlife parks and Natural History Museums can play a multiplicity of functions to support a change of lifestyle in the general public, to inspire a new generation of naturalists and, finally, to gain a much greater understanding of the state of the natural environment for research and policy purposes.

The added value of Protected Areas networking for Natura 2000 monitoring: a case study from Lazio

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Introduction According to Directive 92/43/CEE “Habitat”, monitoring the conservation status of species of community interest is mandatory for all member states. The Italian law entrusted this task to administrative regions and autonomous provinces. In 2007, through a government act, the Lazio Region set up a “Regional Monitoring Network” which was the basis of collecting data on species of Annex II and IV of Habitat Directive. Among mammals, three networks have been established until now: *Ursus arctos marsicanus* (2008), Chiroptera (2014), *Musccardinus avellanarius* (2015).

Methods To achieve a full evaluation of species conservation status, data collection should be carried out in the whole range of each species, i.e. in the regional or provincial range when considering the administrative task of regions and autonomous provinces respectively.

Key issues of Lazio networks were: i) coordinated teamworking, ii) standardized data collection.

Coordinated teamworking involved technical staff from protected areas and the Regional Department of Environment. For each target species, one or two central coordinators were designated; local monitoring groups were established, composed by one or two team leaders and some surveyors; team leaders coordinated field activities in strict cooperation with central coordinators; surveyors collected field data. Teams and central coordinators were recurrently trained in the field to refresh knowledge. On the whole, mammal networks included 4 central coordinators, 35 team leaders and about 100 surveyors.

Standardized data collection was based on species-specific, standardized protocols, which were a-priori designed to satisfy

the requirements of European reporting guidelines. For each species, protocols were applied at regional scale; sites of data collection were chosen in an opportunistic way according to the ecology and the local distribution of the species.

Results Coordinated networking increased the quality of collected data, which for the first time were homogeneous and reliable at regional scale, covered the whole regional species range and were consistent with species ecology.

Thanks to the high quality of data, distribution and habitat suitability models were created. In addition, geographic dynamic databases were created and published in the Open Data Lazio geoportal.

Finally, the use of human resources was highly optimized.

Discussion Collected data will be the quantitative basis of an adaptive management approach for biodiversity conservation at regional scale, in particular for priority setting, landscape planning, local and regional regulations (laws, acts, conservation measures and so on). They are consistent with the requirements of reporting under article 17 of Habitat Directive.

As regards human resources, coordinated networking gave value to personal skills, increased productivity and strengthened the link between peripheral branches and central offices.

However, weakness points should still be overcome, for instance many other species of Annex II, IV and V should be monitored, the sites must be surveyed forever, so technical staff and funds should be guaranteed. In addition, the regional networking is not enough to meet the needs of conservation status monitoring at the biogeographic scale: a sampling design and a systematic approach at biogeographic scale are still lacking.

Eritrean ungulates in Italian museums as benchmark for taxonomy and conservation planning

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Introduction The Eritrean colony was established in 1890 but Italian presence in Assab goes back to 1869. In that year a first scientific mission was carried out by Orazio Antinori, Odoardo Beccari, Carlo Piaggia and Arturo Issel, in the area then known as Bogos country (Keren Region) and collections went to the Genoa Natural History Museum. Although Eritrea is biogeographically part of the “Horn of Africa” (Pichi-Sermolli, 1957), it lies at the meeting point of three clearly distinct biomes; the Sudanian savannah (Western lowlands), the Ethiopian highlands and the Danakil desert (Eastern lowlands). Political instability following the Second World War have prevented the beginning of a new phase of research on the mammals of Eritrea while the independence war from Ethiopia does not allowed the maintenance and further development of the embryonic protection system developed in colonial times, with negative consequences for the status of the large mammal fauna.

Methods Through published and unpublished data, an inventory of all Eritrean Ungulate (Artiodactyla, Perissodactyla) specimens is underway. So far we collected data from 5 Italian museums: Milan, Genoa, Florence, Venice (De Reale collection) and Parma (Bottego collection). Probably several other museums may possess some but nevertheless potentially important specimens and we will continue to collect data.

Results We recovered data on 19 taxa. One further species, *Potamochoerus porcus*, was represented by only one specimen in Milan, destroyed in 1944. So far we have evidence of at least

221 specimens currently housed in the five museums. The most represented taxon is *Nanger sommeringi* with 50 vouchers; the lesser one *Capra nubiana* with only one. No *Diceros bicornis* was found confirming the species was already extinct before Italian occupation.

Discussion Mammal vouchers in Italian museums are of valuable importance for future taxonomic, conservation and genetic researches. The Genoa Natural History Museum holds the holotype and the only other known specimen of *Gazella dorcas beccarii* de Beaux, 1931 from the upper Barka area. Genera for which further taxonomic research is recommended includes *Oreotragus*, *Ourebia*, *Sylvicapra*, *Gazella*, *Tragelaphus*. An obvious priority for further research and conservation planning is the endemic *Gazella dorcas beccarii*. The Eritrean population of Somali wild ass *Equus africanus somaliensis* deserves maximum attention for its international relevance, while nothing is known about the distinct and highly threatened Nubian wild ass *Equus africanus africanus*, once found in the north of the country. The Tora hartebeest *Alcelaphus tora*, is feared to have become extinct but a survey in the Western lowlands of Eritrea is barely needed. Other locally extinct species includes Giraffe *Giraffa camelopardalis*, Nile buffalo *Syncerus brachycercus*, and the Beisa oryx *Oryx beisa*, but the list is possibly longer. A collaboration between some Italian institutions and zoologists, and the Eritrea wildlife authority is planned to increase knowledge and protection of Eritrea national biodiversity.

Bears behaviour towards humans: the outcome of 384 encounters interviews collected by Adamello Brenta Nature Park

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Introduction The management and conservation of large carnivores is challenging because of the hostility they often encounter in socio-political contexts. Particularly serious plights concern species, such as brown bears (*Ursus arctos*), that after centuries of persecution and decline, have experienced recent recovery in Europe, increasing human-bear conflicts at the edges of bears range expansion. We designed this study to evaluate the outcome of human-bear encounters in a reintroduced population in Central Alps (Italy) where three cases of attack with physical contact are documented. In such context a better understanding of bears behaviours and their driving causes could help to direct communication tools/subjects and reduce negative experiences.

Methods Through the use of structured interviews, we collected data about the reactions of the brown bears at different sighting distances, with human (n=526, in 384 of which the bear has noticed the human presence). We recorded, mapped, and analysed data in order to describe bears' ethology in relation to i) human behaviour; ii) bear age/sex class (i.e., female with cubs versus other age/sex classes); iii) dog presence; iv) daylight conditions; v) land use; vi) season/year; and vii) sighting distance. We used generalized additive mixed models (GAMM, Poisson family, subject ID = the tracking number of each interviewee) to identify the major drivers of bears behaviour, implemented in `gamm4` package in R and fitted using maximum likelihood. In addition, changes in attitude of people towards this species was

evaluated during the study period (1999–2017).

Results The main reaction of the bear (51.1%) is to move away from the sighting (21.4% quickly and 29.7% slowly).

However, in 40.6% of the overall sample the bear remains in place. There is also a limited number of cases (7.5%) in which bears approach humans and in 0.8% of cases there is an active reaction (intimidation and bluff charge).

The mean tolerance distance (i.e., the threshold distance above which the bear didn't enter into a relationship with the man was about 50 meters but varied considerably (10–100 m) due to both environmental and intrinsic factors. The shyness of the bear for human decreased 1) when females with cubs were involved, especially after hibernation period, 2) according to dog presence, and 3) in open areas. The distance between man and bear influenced its behaviour.

In 20.5% of sightings humans changed attitude towards bears.

Discussion Bears are mostly shy of humans, but in some rare occasions they can be harmful. To maintain this shyness and avoid close confrontations between man and bear is a very important task, especially in growing bear population and in dense human areas where the possibility of encounters exists. This study gives scientific insights towards a very important feature of bears ethology and can contribute to promote virtuous human behaviours based on scientific information, therefore useful for reducing man-bear conflicts.

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Nuovi approcci all ricerca teriologica

La possibilità di raccogliere informazioni attendibili su individui, popolazioni e specie è un fattore critico per la ricerca scientifica sui Mammiferi e per l'applicazione di efficaci strategie di gestione e conservazione. La teriologia è tradizionalmente tra i settori più attivi nella sperimentazione di nuove tecniche e approcci metodologici alla ricerca sul campo e alle collezioni museali. La sessione mira a presentare e discutere tecniche innovative e di indagine applicate ai Mammiferi a livello di individui, popolazioni e comunità. Saranno accettati i contributi che comprendono approcci a una o più fasi del processo, dalla raccolta di dati alla loro analisi e interpretazione (es. modelli di occupancy, genetica non invasiva, DNA ambientale, metagenomica, landscape genetics, modelli di nicchia, distribuzione e connettività, metodi comparativi, tassonomia integrativa, ecomorfologia). Saranno particolarmente benvenuti i contributi che combinano diversi approcci e ne discutono vantaggi e svantaggi.

Coordinatrici

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XI Congresso Italiano di Teriologia

Integrating genomic and ecological approaches to investigate bat responses to global environmental changes

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Invited lecture

Understanding how biodiversity responds to global environmental change can help us predict and prepare for the effects of future conservation threats. Climate change will produce a range of new selection pressures due to rising temperatures and increased frequency of droughts and extreme events, forcing many species to move in search of suitable conditions or adapt. Whether organisms can respond to these threats depends on their sensitivity to change, their ability to adapt or adjust to new environmental conditions, their ability to move away, and the rate and magnitude of change. My research combines genomic tools with ecological research, geographic data and modelling approaches to understand and predict the responses of bats to climate change, and how these responses are confounded by the effects of land use changes. Bats are important ecosystem components, providers of ecosystem services and potential indicators of the state of the

environment and other biodiversity. Bats may be particularly vulnerable to the effects of climate change due to low reproductive output, ecological specialisation, high trophic position and high rates of evaporative water loss.

I address bat responses to global environmental changes from four perspectives. First, I use phylogeography to look at the past, and how bats responded to climatic changes during and after the last glacial period. Second, I use the landscape genetics approach to determine how the landscape affects current patterns of movement and future range shift potential. Third, using genomic data, I identify adaptations to current climatic conditions and their effects on future survival prospects. Finally, I will show how these different approaches can be combined together to identify populations under threat from future climate change based on exposure, sensitivity, range shift potential and adaptive potential.

XI Congresso Italiano di Teriologia

Promises and pitfalls of mammalian ecomorphology

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Invited lecture

Ecomorphology is a relatively novel field of investigation whose aim is to explore the complex relationship between organism morphology and ecological adaptations. Although it has been intensively applied to mammals, we lack a comprehensive methodological framework to better interpret the phenotype-ecology association at different evolutionary scales (macro, above species level, and micro, within species level). If on one side mammalian phenotypic variation is expected to be tightly linked to ecological adaptations due to a number of physiological constraints (e.g., homeothermy), on the other developmental pathways and evolutionary history might impose structural limitations on phenotypic variation. Approaches such as geometric morphometrics, comparative methods and spatial analyses provide promising results to explore mammalian ecomorphology, but the multivariate nature of the data generated by these techniques requires caution. For instance, investigations focused on mammalian skull detect

a strong taxonomic differentiation at macroevolutionary scale in shape. Vector rotation of the multidimensional data support in some cases morphological convergence due to ecological adaptations even if this applies only to a relatively small proportion of the quantifiable variance. Ecological data are equally oversimplified in categories that appears to be nested within taxonomic variation. With these caveats in mind, I demonstrate that ecomorphological adaptations can be detected at different evolutionary scales if phylogenetic covariance matrices or spatial geographical variation are accounted for. So far, the majority of mammalian groups are showing a strong degree of ecomorphological conservatism within clades with few exceptions interpreted as fast radiation events. At intraspecific scale, temporal and geographical isolation might equally influence ecomorphological distinctiveness.

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Multi-grain habitat selection by Apennine brown bears in their core distribution

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The current range of the small and highly imperiled population of Apennine brown bears (*Ursus arctos marsicanus*) is limited to roughly 5000 km² in the central Apennines of Italy, with most of reproduction taking place in the core range restricted to the Abruzzo Lazio and Molise National Park (PNALM) and adjacent areas. Although several habitat suitability models have been produced at the landscape scale to inform proactive conservation of this bear population, no formal analysis has been conducted to unveil habitat selection by bears at a higher degree of ecological resolution, comprising seasonal and circadian effects in habitat decisions made by bears. In this work, we adopt a Multi-grain Resource Selection Function (MRSF) approach to investigate habitat selection by Apennine brown bears in their core distribution. Based on relocations collected 19 adult, GPS-collared bears (11 females, 8 males) in the PNALM from 2006 to 2010, and up-to-date GIS layers of relevant ecological, topographic, and anthropogenic predictors, we used generalized mixed models (R package lme4) within a sample-size corrected Akaike Information Criterion (AICc; R package MuMIn) framework to assess: (i) multi-grain habitat selection patterns within individual home ranges, and (ii) seasonal and circadian effects on habitat decisions

made by bears.

Within a GIS environment (ArcGIS v.10.2), for each predictor we ran a map-algebra focal function using a circular moving window whose radius was incrementally increased (from 47 to 1531 m), according to scale optimization procedures that allowed us to identify the most parsimonious grain size for each variable. Our findings reveal differences in habitat selection by bears between seasons. As expected, anthropogenic features showed the most seasonal differences, with bears selecting higher distance from primary roads during summer compared to other seasons. Moreover, bears selected for areas of higher forest and shrubland cover, higher terrain roughness, and higher distance from secondary roads in all seasons. We also confirmed a circadian effect on habitat decisions made by bears, with bears avoiding anthropogenic features and preferring vegetative and orographic coverage mostly during the day. Findings from our habitat selection models complement previous suitability models at the landscape scale and are critical to inform habitat management in the bear core distribution in the light of expected natural and human-induced habitat changes.

XI Congresso Italiano di Teriologia

Seasonal movement corridors for brown bears in CroatiaD. DE ANGELIS¹, G. GUŽVICA², D. HUBER³, J. KUSAK³, M. PANZACCHI⁴, S. RELJIĆ³, L. ŠVER⁵, B. VAN MOORTER⁴, P. CIUCCI¹¹University of Rome "La Sapienza", Dept. of Biology and Biotechnology "Charles Darwin", Viale dell'Università 32, 00185 Roma, Italy. e-mail: daniele.deangelis@uniroma1.it²Oikon Ltd. - Institute of Applied Ecology, Trg senjskih uskoka 1-2, HR-10020 Zagreb, Croatia³Faculty of Veterinary Medicine, University of Zagreb, Heinzelova 55, 10000 Zagreb, Croatia⁴Norwegian Inst. for Nature Research, PO Box 5685 Sluppen, NO-7485 Trondheim, Norway⁵Laboratory for Biology and Microbial Genetics, Department of Biochemical Engineering, Faculty of Food Technology and Biotechnology, University of Zagreb, Pierottijeva 6, HR-10000 Zagreb, Croatia

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Introduction Habitat loss and fragmentation are among the major causes of species extinction and are often associated with critical reduction in landscape connectivity. Lack of connectivity can severely hamper species ability to undertake long-distance movements (e.g. migration, dispersal), impeding both gene flow and access to critical habitat. In patchy environments, bears might need to travel long distances to reach areas characterised by resource abundance and meet seasonal energetic requirements. In some European brown bear populations, the need for increasing pre-wintering food intake (i.e. hyperphagia) can lead to individual migration-like movement patterns, with animals completing long-distance round trips to resource-rich areas from their summer ranges. Recently developed tools allow researchers to study landscape connectivity using individual-based movement data, disentangling animal responses to both environmental and anthropogenic features that may act as barriers to animal movement.

Methods In this study, we used Global Positioning System (GPS) relocations collected from Dinaric brown bears in Croatia (from 2005 to 2017, 21 bear-year-seasons) to project suitable corridors connecting summer and fall habitat. To this aim, we used Resource Selection Functions (RSFs) based on bear reloca-

tions representing stationary behaviour (i.e. feeding or resting) to model suitable habitat patches in summer and fall separately. Second, we used Step Selection Functions (SSFs) based on animal trajectories representing active travelling by bears to predict the degree of landscape friction to bear movement. Finally, we used Randomised Shortest Path (RSP) algorithms to project potential bear corridors at the landscape scale. Compared to traditional algorithms, which assume either random (e.g. current models) or optimal (least cost path) animal movements, the RSP method allows for more ecological realism.

Results Our results show substantial differences between habitats selected by bears during the two seasons, possibly reflecting main dietary shifts between the seasons. According to our findings, bears can successfully travel across sub-optimal patches to reach suitable habitat in the fall, although the presence of anthropogenic structures such as highways, main paved roads, railways, and cultivated fields strongly decreased the probability of bear traveling.

Discussion Ours is a promising approach to integrate more classical habitat selection studies and cutting-edge movement algorithms to predict animal connectivity across human-modified landscapes.

Indirect effects of spring-summer temperature on fecundity in a capital breeder: The cooler the better?

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Introduction Female reproduction is a central component of population dynamics, and it can be influenced by individual, social and environmental factors. While previous studies have often assumed direct effects of predictors on reproductive parameters, growing evidence suggests more complex relationships among potential drivers of reproduction. This, in turn calls for the adoption of suitable statistical tools to depict potential cause-effect relationships. Using mountain-dwelling red deer *Cervus elaphus* as a model species, we investigated causal chains of explanations for the variation in female reproduction, accounting for direct and indirect effects of individual, social and environmental drivers.

Methods We analysed the variation in fecundity, measured as the probability of being pregnant, in 215 adult hinds culled within the Stelvio National Park (central Italian Alps) between 2011 and 2016, with respect to age, body mass, kidney fat, jaw length, lactation status, population size, spring-summer temperature and precipitation. To investigate the causal links between female fecundity and individual, social or environmental variables, we adopted a two-step approach: first, we used random forest and logistic regression to select a subset of predictors that best explained fecundity variation; then, we used path analysis to test for alternative hypotheses of direct / indirect effects among selected predictors and depict plausible causal relationships.

Results The variable selection procedures consistently supported the role of age and kidney fat index (KFI) on deer fecundity within our study population, whereas the effect of spring-summer temperature emerged only when temperature was fitted in interaction with KFI. Age had a strong, non-linear negative effect on fecundity probability, while KFI had positive effect. The negative interaction between KFI and spring-summer temperature was considered as a step toward specifying the potential underlying mediation process: path analysis confirmed that higher spring-summer temperature may have negative, indirect effects on fecundity, mediated by decreasing values of body condition.

Discussion Our study highlights the importance of considering the use of appropriate tools to depict more complex relationships between individual, social and environmental variables to explain variation in demographic traits. While parametric and non-parametric methods of model selection accounted for the variables that best explain fecundity variation, path analysis went beyond the simplistic regression approach, allowing to test for biologically plausible relationships among drivers. Our approach allowed to elucidate potential cause-effect relationships between climate and reproduction, emphasising how individual variables and environmental changes may interact to shape life history traits.

Severe range contraction in the globally endangered Pyrenean desman revealed by stream geostatistical modeling and non-invasive genetic sampling

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Detecting species declines and range reductions is key for conservation, as it helps minimizing species extinction risk. Yet, limited historical data and difficulties in identifying rare and cryptic species in the field often prevent such task. The Pyrenean desman *Galemys pyrenaicus* is a globally threatened, elusive species endemic to South-western Europe, and one of the less-studied of all European mammals. In Portugal, twenty years ago the species occurred relatively homogeneously in the central and northern parts of the country. Subsequent, sporadic observations, however, suggested marked decrease in the species occupancy. To assess trends in desman distribution, we revisited 74 sites within two watersheds in NE Portugal surveyed two decades ago by the national authority for Nature Conservation (ICNF), validating all samples collected in the field genetically. Here, we report on a case of range contraction into headwaters of the Pyrenean desman, from surveys carried out in 1993–96 and 2014–15. Novel geostatistical logistic mixed-effects models conceived to deal with spatial autocorrelation in dendritic ecological networks (e.g. streams) were used to relate the probabilities of desman occurrence and extinction to environmental variables, while controlling for linear (Euclidean) and hydrologic spatial dependencies. In 1993–96, desmans were detected at 85.1%

of sites, their presence being positively related to stream order and slope. In 2014–15, desmans were detected only at 31.1% of sites, their presence being positively related to slope steepness and negatively to stream order and maximum temperature of the warmest month. The extinction rate across periods was 63.5%, and the extinction probability increased with stream order and declined with slope steepness. Stream geostatistical models highlighted clear spatial patterns and marked autocorrelation in desman predicted distribution and extinction. Namely, the species was widespread in 1993–96, but largely disappeared thereafter from the main rivers and the largest tributaries, persisting mostly in headwater streams in more mountainous areas. Such severe and precipitous decline, and similar findings in Spain and France, suggest that upgrading the conservation status of the Pyrenean desman is urgently needed. This study also highlights the importance of headwater streams for desman conservation, and, more generally, for biodiversity conservation in modified river systems, favoring the permanence of remnant, fragmented populations. Further research is required to better comprehend Pyrenean desman’s population ecology, dynamics and flexibility, as well as to identify threats and conservation strategies for this ecologically and phylogenetically unique species.

Introduction and invasion risk of exotic mammals under global changeD. BIANCOLINI¹, D. BAISERO¹, C. BELLARD², M. PACIFICI¹, T. BLACKBURN², C. RONDININI¹¹Global Mammal Assessment Program, Department of Biology and Biotechnologies, Sapienza Università di Roma, Rome, Italy. e-mail:

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Introduction During the Anthropocene, biodiversity has experienced a serious crisis. Its anthropogenic drivers, including habitat change, climate change and invasive species, are not independent of each other. Introduced species can cause severe impacts on biodiversity through competition, predation, disease spreading, habitat and ecosystem alteration. These phenomena are exacerbated by global change, whose disturbance on native communities can be easily exploited by an exotic species, often more able to survive in modified environments. Once the alien species is established, implementing strategies for eradication and control is very difficult and expensive, especially for charismatic and pet species such as mammals. Robust methods to predict alien species introduction or invasion are therefore necessary.

Methods We predicted the 2050 introduction and invasion risk of 209 mammal species established outside their native range. We used the InSiGHTS model, which projects species ranges through bioclimatic envelopes and habitat suitability models (HSMs) within range limits under three scenarios of global change: Representative Concentration Pathway (RCP) 2.6 – Shared Socioeconomic Pathway (SSP) 1; RCP 6.0 – SSP 3; and RCP 8.5 – SSP 5. The bioclimatic envelopes were developed using biomod2 with specific settings for alien species, mediated bioclimatic spatial layers from 10 Coupled Model Intercomparison Project Phase 5 (CMIP5) global circulation models and alien species distributions from recent databases. The HSMs

were based on the Land-Use Harmonization dataset (LUH2). We estimated 1. the Extent of Suitable Habitat (ESH) inside the exotic range of each species, plus the area reachable from the 2015 exotic range through natural dispersal by 2050, i.e. the area at risk of invasion; 2. the global ESH of the species outside the 2015 range (natural + exotic), i.e. the area at risk of introduction.

Results Both mammal introduction and invasion risk were positively correlated with climate change mitigation, with higher risk under RCP 2.6 – SSP 1 than in the other scenarios, and decreasing risk under RCP 8.5 – SSP 5, particularly at higher latitudes. The ESH of alien mammals inside the exotic range was generally negatively affected by climate and land-use change, despite their expansion through natural dispersal. Hotspots of invasion risk were located in the Americas, Oceania and Europe and included most biodiversity hotspots.

Discussion Our predictions provide two different kinds of information valuable to management. Introduction risk can inform bio-security policies to prevent the human assisted dispersal of alien species. Invasion risk can assist early-warning, control and eradication measures. Notably, that the “best” scenario for global change (RCP 2.6 – SSP1) is also the worst for alien mammals invasion and introduction risk. It is therefore crucial to plan and implement global mitigation strategies in synergy with invasive species control to ensure biodiversity survival in any possible future.

An application of horizon scanning and prioritization methods to support prevention, and early detection and rapid response measures to alien mammals in Italy

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Introduction Global, European and national policies highlight prioritization of invasive alien species as an essential component of the efforts to address biological invasions, crucial to enhance prevention of not yet established invasive species, facilitate rapid response and focus management on the most harmful species. In order to apply these principles, several researches have shown the importance of a structured expert based approach for identifying priority species based on available information and coupled with consensus building methods. We present the application of this methods to develop a prevention strategy for alien mammals in Italy, and discuss the efficacy and reliability of the approach used.

Methods The prioritisation of alien species for Italy is based on a consensus-building method, adapting to the national context approaches used in other regions for collaboratively identifying priority invasive alien species through series of workshops. The process involves several phases: identification of five groups of species (marine, terrestrial and freshwater plants, vertebrates, terrestrial invertebrates, freshwater invertebrates); workshop with experts within the five groups to agree on a common methodological approach; preparation phase to develop baseline lists of species for all groups; production of a comprehensive list of invasive aliens species and definition of priorities. A semi-quantitative method was used, separating the analyses for two groups of species: aliens species already established in Italy, and alien species not yet introduced in the country but likely to arrive. Several criteria were considered, such as: probability of arrival, establishment, spread, impact, effectiveness and practicality of management, cost, undesired impacts, acceptability, likelihood

of re-invasion. Species distribution models based on climatic variables were used as a first coarse screening tool to evaluate the possibility of a species to establish free-ranging populations in Italy. Scores are elicited using expert judgement, supported by available evidence, and consensus-building methods. For mammals the study involved the ATIt, which selected members with specific expertise on alien species to coordinate the activity. Consensus-building across expert groups will permit to compile and rank the entire list of potential and established invasive alien species.

Results Information were compiled for all alien mammals established in Italy; furthermore, pet-shop websites were searched for mammals traded in the country and all main international resources were searched to identify potential future invader mammals, and to collect basic information for compiling the databases. In a second meeting the preliminary results of the exercises were presented and discussed.

Discussion The approach used for the Italian context is more structured and extended than in previous cases. Several workshops have been carried out over 12 months of work, and others are planned to complete the prioritisation exercise. All alien mammals established in Italy, and all potential future invaders are being considered, taking into account available information. The preliminary analyses show that the approach could provide an essential basis to decision makers to design effective prevention and response measures to invasions, and specifically to enforce the provisions of the recent European and national legislations on this issue.

Social sciences in invasion biology: an alien among aliensJ. CERRI¹, S. BERTOLINO², E. MORI³, R. ZOZZOLI⁴¹Istituto di Management, Scuola Superiore Sant'Anna, Piazza Martiri della Libertà 33, 56127 Pisa, Italy. e-mail: j.cerri@santannapisa.it²Dipartimento di Scienze della Vita e Biologia dei Sistemi, Università di Torino, Via Accademia Albertina 13, 10123 Torino, Italy³Dipartimento di Biologia Evolutiva, Università degli Studi di Siena, Via Banchi di Sotto 55, 53100 Siena, Italy⁴Dipartimento di Scienze Chimiche, della Vita e della Sostenibilità Ambientale, Parco Area delle Scienze 11/A, 43124 Parma, Italy

Introduction Applied social sciences are an heterogeneous toolbox of methods to collect socio-economic data, and of conceptual frameworks to better understand human behavior and social phenomena. Therefore, they could inform managers and guide conservation policymaking, by evaluating the effectiveness of conservation programs for mammals and by discussing these programs from a different viewpoint, innovating conservation paradigms. Arguably, the most common integration of social sciences in mammal conservation is the use of structured questionnaires, to collect self-reported behavioral and attitudinal data from stakeholders. However, other approaches could be very fruitful and informative for conservationists, complementing the use of conventional questionnaires. In this presentation we will show how conventional questionnaires, qualitative methods, and vignettes, could be useful to better manage invasive mammal species in Italy, by considering 3 case studies.

Methods Quantitative questionnaires based on the Theory of Reasoned Action were developed to assess visitors' attitudes, norms and emotions, about the presence of Siberian chipmunks (*Tamias sibiricus*) at urban green areas in Central and Northern Italy. A Likert scale was developed to assess attitudes, based on appropriate scoring combining valence and expectancy values, and latent variable analysis was adopted in order to assess construct validity. In another case study, factorial surveys describing management scenarios, were implemented to explore hunters' preferences for invasive Eastern cottontail (*Sylvilagus floridanus*) in Tuscany. Each scenario described a program with specific characteristics, whose levels were varied in a random way: hunters indicated whether they would have participated into the various scenarios. In a third case study, qualitative interviews

and factorial surveys were combined, to explore whether social norms governed grey squirrel (*Sciurus carolinensis*) feeding by tourists in Torino.

Results In the first case study, attitudes and beliefs about squirrel presence in urban green areas differed between different groups of visitors (e.g. residents, versus tourists). Moreover, regression techniques show how attitudes and norms are influenced by the socio-demographic attributes of respondents. In the second case study, vignettes demonstrate that hunters would be more prone to control invasive cottontails if they were allowed to shoot them, rather than to trap them and that being informed about the ecological impact of the target species stimulate their commitment. In the last case study, qualitative interviews revealed that a wide range of beliefs drive visitors to feed squirrels in Torino. Moreover factorial surveys explored whether these beliefs were conditional on social preferences, indicating which type of collective behavior squirrel feeding could be.

Discussion Our findings show that surveys, qualitative interviews and factorial surveys, are valuable tool to improve mammal conservation. Notably, qualitative interviews provide rich, unstructured data, that could assist and complement survey design, and factorial surveys could play an important role in decision-making about mammal conservation. Interviews revealed normative beliefs, reference networks and expectations about others' behavior and intentions; moreover, they enabled researchers to collect and structured previously unexpected information about the drivers of squirrel feeding. Factorial surveys, on the other hand, assessed whether the decision of feeding squirrels was conditional on visitors' empirical and normative expectations about their reference network.

Occupancy modelling and power analysis to detect trends in threatened species. An example with the otter (*Lutra lutra*) in Italy

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Introduction Accurate assessment of population trends is essential for the conservation of threatened species. The guidelines for reporting under article 17 of European Habitats Directive 2013–2108 consider trends decisive elements for the assessment of conservation status of species listed in the annexes to the Habitats Directive. However, detecting changes in population abundance may be prohibitively expensive. The proportion of sites occupied (occupancy) can be appropriately considered an alternative cost-effective state variable. Occupancy modeling and power analysis can help to ensure meaningful trends are detected under imperfect detection. Here we investigate the power of occupancy monitoring protocols for an Italian endangered carnivore, the Eurasian otter *Lutra lutra*. Population abundance and occupancy rate are expected to decline from the centre to the edges of a species' range. A similar pattern would be expected for detection probability. Accordingly, we identified optimal survey efforts required to detect declines in occupancy in a central area and in a peripheral area of the otter distribution range in Italy.

Methods We conducted scat surveys for otters (presence/non detection) in two study areas located in the centre and in the southern edge of the distribution range. Surveys were identically designed and included 59 and 38 sampling sites and 4–6 spatial replicates per site. We used single-season occupancy models to estimate occupancy and detection probability parameters in each area. Parameter estimates were then used as true values to generate 500 simulated datasets for a given sampling scenario. We considered sampling scenarios with 30 and 50% decline

in occupancy between two points in time and different allocations of sampling effort. Dynamic occupancy models were used to generate and analyze simulated datasets. We assessed the statistical power to detect 30 and 50% declines for each study area. Power was computed as the proportion of simulations in which a significant difference in occupancy was detected. We used a Bayesian hierarchical model specification, with parameter estimation accomplished via Monte Carlo Markov Chain.

Results Detection probability of otters was higher in the central area than in the peripheral area. As expected, detecting a decline in occupancy at the range edge required a larger sampling effort. In particular, a considerable replication effort per site (>5 spatial replicates) was required to achieve adequate statistical power. In the central area a survey protocol with minimum replication (3 spatial replicates) would be sufficient to achieve acceptable power to detect a 50% decline. A 30% decline can be powerfully detected by a small increase in the number of survey sites or spatial replicates.

Discussion Occupancy modelling and prospective power analysis can be extremely useful tools to design cost-effective monitoring programs and identify populations trends. We provided an example with the Eurasian otter in Italy. Our case study illustrates the need to account for geographic variation in optimal sampling effort when designing large scale occupancy monitoring. We advocate a wide use of such valuable tools in national monitoring programs of species of conservation concern, such as the surveillance under article 11 of the European Habitats Directive.

Capitalizing Citizen Science data to develop species distribution models: an example with iNaturalist and Italian terrestrial mammals

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Data from well-designed sampling provide the strongest evidence of causation in biodiversity studies, but the cost and availability of experts needed to collect sufficient quantities of ecological data do not scale readily across broad spatial or temporal extents. Recently, Citizen Science projects have emerged as an efficient way to gather such data by engaging a large number of volunteers and compiling their ecological observations but these data are often highly heterogeneous. Specifically, Citizen Science data are often highly variable in space and time due to the opportunistic approach for data collection, which poses several challenges to its analysis and interpretation (e.g. unknown sampling effort) and thus we need accurate procedure to provide robust estimate of species distribution from this data.

Using data collected within the Citizen Science project “Mammiferi d’Italia” on the online open-platform iNaturalist (<https://www.inaturalist.org/projects/mammiferi-d-italia>), encompassing a total of 7785 observations of 105 species collected by over 688 volunteers throughout Italy, we showed how citizen science data can be “capitalized” to provide robust estimate of species distribution.

Specifically, for each species, we modeled the distribution using its occurrence locations (presences) vs. 10000 pseudo-absences randomly selected among all the observations (i.e. not only terrestrial mammals) collected by those volunteers that sampled

the target species and related them with a total of 26 uncorrelated predictor variables (variance inflation factor, $VIF < 3$) encompassing topographic, land cover, forest structure, climatic and anthropogenic factors. Moreover, we weighted the resulting presence/pseudo-absence locations by the total number of resulting occurrences (i.e. not only mammals) in a given unit (10 km^2), as a proxy for sampling effort. Thus, we calculated the weighted ensemble prediction (wEP; weighted by true skill statistic, TSS, values) of 12 species distribution models (SDMs) to estimate species occurrence and assessed model performance using 10-fold cross-validations.

Our SDMs showed higher predictive accuracy compared to those developed with random pseudo-absences and without accounting for sampling effort. The selection of pseudo-absences as well as the need to account for sampling effort in SDMs are crucial to provide reliable estimates of species occurrence and thus our approach could be helpful to reduce bias estimates due to unequal sampling effort. Further improvement of our approach would include site-specific detection probabilities and account for spatial autocorrelation. We suggest the development of a similar approach to ours for national and international atlas projects to provide accurate estimates of species occurrence in non-sampled or under-sampled areas.



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Assessing the first reproduction of the wolf (*Canis lupus italicus*) in the coastal area of Rome in the last century

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P314

Introduction Since 2013, the Italian wolf (*Canis lupus italicus*) recolonized the Oasi LIPU Castel di Guido and the surrounding natural areas of the Riserva Naturale Statale del Litorale Romano, in proximity to the western outskirts of Rome (Italy).

From 2013 to date, we have monitored the study area, reconstructing the history of the wolf recolonization, until the formation, in 2017, of the first breeding pack in the Municipality of Rome.

Methods Three integrated monitoring techniques were adopted: opportunistic camera trapping, non-invasive genetic sampling and wolf howling. Sampling locations were identified and monitored to collect biological samples (i.e. scats), and camera traps were strategically positioned. The biological samples were sent for analyses to the Istituto Zooprofilattico Sperimentale di Lazio e Toscana (IZSLT), which revealed the species, sex and genotype of the sampled individuals.

The genetic analyses and the camera trapping were also used to detect and identify possible wolf-dog hybrids in the study area. The wolf howling survey was used to locate the home sites.

Results From June 2013 to May 2017, two male wolves (WM1 and WM2) and one female wolf (WF1) were recorded by camera traps and later genotyped, in different periods. The three wolves were assigned to the cluster of the Italian wolf population (i.e. *Canis lupus italicus*), following genetic analyses by the IZSLT.

In February 2016, we verified a breeding pair formation between WM2 and WF1, which camera traps recorded together 48 times, before July 2017.

In early summer 2017, areas potentially suitable for reproduction (i.e. home sites) were identified, considering some environmental and anthropic variables, such as water presence, vegetation cover and a low rate of human activity. In July, the first images of the pups in the rendez vous sites were recorded. Between July and September, footage of 5 pups was recorded 20 different times.

Discussion The wolf reproduction is particularly relevant in a peri-urban context. The critical role of the coastal areas of Rome, as a recolonization area, should be closely monitored in the near future. This area is rich in woods, refuge sites and wild prey, but it is also heavily populated by people. This territory may thus represent a possible “sink”, with highly suitable environmental variables, but also with a high mortality risk, caused by anthropogenic factors.

The coexistence between wolves and human activity is possible, as shown in various contexts. While the presence and expansion of the species would need to be carefully monitored, it would also be necessary to inform and communicate with the local communities, to aim for long-term human-wolf coexistence.

Addressing the issue of stray and roaming dogs for wolf conservation and for limiting depredations on livestock in the provinces of Grosseto and Siena

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P308

Introduction Stray and roaming dogs, can be a major risk factor for:

- the environment, because they can hybridize with wolf and harm various wild species;
- local economy, because they can predate on livestock;
- public safety, because they can cause car accidents or be aggressive toward humans and pets.

For these reasons in April 2014, the Tuscany Region approved and funded a three-years (2015–2017) Operating Plan, managed by the Public Sanitary Agency of South East Tuscany.

Methods The Operating Plan consisted in different actions linked to each other:

1. Searching and containing stray and roaming dogs in woodland, rural and suburban environments, using mostly automated cages baited with food, in order to complement what is already done by the local Municipalities.
2. Free sterilization service for dogs in a rural setting, thanks to an agreement with the Provincial Chambers of Veterinarians.
3. Free registration of dogs in rural setting, in collaboration with the Chambers of Veterinarians.
4. Control activities on the proper registration of hunting dogs, jointly with the Environmental Police (Carabinieri Forestali and Polizia Provinciale).
5. Implementation of an information campaign through public meetings, local newspapers and local television broadcasts, to promote the proper management of dogs in rural areas and encourage the adoption of dogs from kennels, in collaboration with Animal Right and Environmental

NGO.

Results

1. 108 dogs have been captured (only 10 had a microchip): 89 in rural areas, 9 in woodlands and 10 in suburban areas. The majority of these dogs belonged to breeds commonly used to defend livestock from predators.
2. 288 dogs (209 females and 79 males) were sterilized, most of which were livestock guarding dogs.
3. 1172 dogs living in rural areas have been registered.
4. The proper registration of 1043 hunting dogs was controlled: only 3% of them didn't have microchip.
5. 6 television broadcasts were recorded; 11 pages in local newspapers were purchased; 6 meetings with Animal Rights NGOs were organized; 8 meetings with Veterinarians were completed; 1 informative point and 2 public meetings were organized in national event promoted by Legambiente NGO.

Discussion The large number of captures of dog breeds used for livestock protection, is a symptom that a substantial part of roaming dogs in Southern Tuscany is possibly due to an inappropriate managing of dogs by farmers.

Free sterilization service for dogs helped the farmers to properly manage their livestock guarding dogs.

Promoting and controlling the proper registration of dogs contributed to make the owners more responsible to their dogs.

The results were more obvious in Grosseto province and played a part in the reduction of stray and roaming dogs sighting reports and in the decrease of 30% in livestock depredation events between 2015 and 2017.

An extensive and articulated project on the European brown hare (*Lepus europaeus*) in the Lombard plain to study ecology, spatial dynamics, health aspects and provide management responses: first year of work

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P312

Introduction European brown hare has undergone a decline in density over the last few years throughout Northern Italy, largely due to habitat alteration in plain ecosystems. The traditional management model proved to be inadequate to ensure the conservation and consolidation of hare populations in the long term. The quadrennial project, promoted and financed by Federcaccia Lombardia and Brescia A.T.C., arises from the need to increase and update knowledge on the state of conservation of the brown hare in the area of interest, and through planned monitoring actions, to collect data on use of space, environmental preferences, population dynamics, demographic parameters, limiting factors, in order to establish effective conservation and management strategies.

Materials and Methods The study area includes the provinces of Pavia, Lodi, Cremona, Mantova and Brescia. The extension and the territorial and managerial complexity of the project area have imposed the involvement of many actors with different roles: Lombardia Region (faunistic office and veterinary services), Regional Territorial Units, Experimental Zooprophyllactic Institute of Lombardia and Emilia-Romagna (I.Z.S.L.E.R.), Provincial Police, Federcaccia provincial sections, A.T.C., voluntary guards. I.S.P.R.A. provides scientific supervision. Field work also involves collaborators, students, and simple volunteers.

The sample territorial units are restocking and capture free-hunting areas (Z.R.C.). Processing environmental, faunistic and management variables by cluster analysis, 16 representative zones were selected. Between December 2017 and January 2018, a total of 167 hares were released in the selected areas, equipped with VHF adjustable necklace transmitters. The released hares came from local capture, from outdoor enclosures, and from

foreign capture sites. Radio-tracking monitoring will last one year. Blood samples taken before releasing of animals, as well as carcasses of hares and other lagomorphs found in the investigated areas are conferred to I.Z.S.L.E.R. for diagnostic analysis. The demographic dynamics of the hare populations in the sample areas is evaluated through spotlight counts along standard transects in spring and autumn. Seasonally, for each sample zone, habitat cover types and agricultural land use are mapped.

Preliminary results After the first three months post-release monitoring, the survival rate of tracked hares was 77.8% in the whole study area, with a considerable variability among provincial territorial units. Cox regression analysis revealed significant differences in the mortality rates between the groups of hares of different origins: 78.4% of the animals found dead comes from non-local sources, the most frequent causes of death identified in predation and car investment.

Discussion Analysis of the data relating to the first post-release period already highlights problems related to some management practices, primarily restocking programmes using allochthonous individuals. Information on the use of space and on habitat preferences, combined with sanitary data on dead and hunted animals, will allow us to draw a complete picture of the demographic, health and management condition of the hare in the Lombardy plain, and to obtain practical indications useful to land managers. The project, considering extension of the study area and size of the sample, appears as a unique opportunity in the national context, and represents a virtuous example of how hunting associations can promote scientific research through a fruitful cooperation with private sector and public administrations.

The theriological databank of the Italian Mammal Society

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P305

Introduction The Italian Mammal Society (ATIt – Associazione Teriologica Italiana; www.mammiferi.org) is currently promoting the development of an Italian teriological databank aimed at filling an important gap in Italian mammological research (hereby proposed by the authors to be named DaTI – Databank Teriologico Italiano). The key objective is to create a single reference source for all Italian mammal observations. Unlike similar initiatives, DaTI strives to only include observation points within Italy, to develop a focused, reference product that will facilitate the identification and resolution of data gaps, and to build information to evaluate temporal and spatial trends of species. DaTI will be used to contribute to the reporting of European regulations (mainly Habitat Directive CE/43/92 and alien invasive species regulation 1143/2014), to the compilation of a full and updated checklist for Italian mammals, and to produce the first Atlas of Italian Mammals. Here, we will illustrate the DaTI infrastructure, its medium and long-term objectives, as well as benefits for participants.

Methods DaTI is being built following the Darwin Core standard, a reference standard for the distribution of biological data aimed at facilitating the discovery, retrieval, and integration of information from diverse sources. ATIt has identified five key data fields necessary for members to contribute to the databank (i.e. scientific name, observation year, geographical coordin-

ates in decimal degrees or a reference toponym, observer, rights holder), with an additional eleven desired Darwin Core fields. All other Darwin Core fields remain compatible with DaTI, and in order to ensure there is no data loss, all fields that do not fit in the Darwin Core standard will be included as a JSON object string that can be extracted when desired.

Results We compiled a preliminary version of DaTI collecting data from various online sources, mainly related to Citizen Science initiatives. This preliminary version includes 56000 presence point observations on 119 terrestrial mammals. However, 79 species have less than 50 observations each, highlighting the need for a centralised, easily referenced data source collecting data derived from different sources, including museum collections and research projects. These latter represent the most valuable contribution of ATIt members.

Discussion An established reference databank on Italian mammals would allow the implementation of more visionary initiatives, such as for example a long-term plan to compile and publish bi-annual summaries and spatially-explicit assessments on the status of Italian mammals in peer-reviewed literature. ATIt members would benefit from the initiative in multiple ways, including usage conditions that facilitate visibility and citation of data published in traditional peer-reviewed literature, as well as potential co-authorship in the planned bi-annual summary.

Multiple captures as indicator of social tolerance in a guild of terrestrial rodents

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P210

Introduction Information on intra- and inter-specific social tolerance is useful to evaluate the role of social interactions at shaping population dynamics. This is particularly interesting for sympatric species with similar ecological requirements that can be potential competitors. In this light, we investigated multiple captures of *Apodemus flavicollis*, *A. sylvaticus* and *Myodes glareolus* constituting a guild of forest- and ground-dwelling rodents in central Italy.

Methods Small mammals were live-trapped every other month for four years in a deciduous oak forest of the sub-Mediterranean zone, in Tuscany. Traps (Sherman® and L.O.T.) were positioned in fifteen 60×60 m grids (49 traps, 10 m spacing) and were active three nights per grid during each trapping session, for a total of 46305 trap-days. Captured animals were identified at species level, weighed, sexed, aged, individually marked and then released at the place of capture. Reproductive status was defined by visual parameters. Molecular analyses were performed in order to correctly identify the *Apodemus* species and to confirm field sex identification of *M. glareolus*.

Results Multiple captures made up 3% of the 3668 total captures, with a very similar occurrence in all three species. Individuals of the same species were caught together in 85% of multiple captures and, in each species, the number of intra- and

inter-specific multiple captures increased with both population density and amount of caught conspecifics. Heterosexual dyads were not concentrated in a specific season and their occurrence did not differ from that of the homosexual ones. In all three species, sexually active individuals were also involved in homosexual and interspecific multiple captures. Signs of injuries were only recorded in one case, where a female bank vole was found dead and partly eaten by a conspecific female, in accordance with the known aggressiveness among females of this species.

Discussion Our results show that multiple captures of *A. flavicollis*, *A. sylvaticus* and *M. glareolus* were related to population density and captures abundance, rather than to the reproductive behaviour of the species. The occurrence of intra- and inter-specific multiple captures and the absence of injury signs in individuals caught together do not only suggest intraspecific tolerance but also support the hypothesis of weak competitive interactions between the species, which constitute the guild of forest- and ground-dwelling rodents in this sub Mediterranean deciduous oak forest. Considering that multiple capture events can occur during live trapping, we stress the importance of utilising this secondary data to gain useful information on social factors influencing small mammal populations.

Invasive Alien Species in Lombardy Region: when “unity is strength” becomes the best strategy

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P001

Introduction Invasive alien species (IAS) are one of the major threats to biodiversity. In the last decades, the rate of voluntary or accidental introduction of non-native plants and animals into Europe has considerably increased. To reverse this trend, the European Union (EU) has released Regulation No. 1143/2014 concerning measures to prevent and manage the introduction and spread of IAS, which is in force from January 1st, 2015. A list of invasive exotic plant and animal species of Union concern has been published in the EU Official Journal of 14 July 2016, updated on the 2 August 2017 to a total of 49 species for which immediate actions are mandatory. Recently, Italy has issued Legislative Decree 15 December 2017, n. 230 (GU General Series n. 24 of 30/01/2018 with entry into force on 14/02/2018). In the meantime, in the Lombardy region, LIFE14 IPE IT 018 GESTIRE2020 – Nature Integrated Management to 2020 – project was underway. This project, which takes into account all the efforts addressing the optimization of the management strategy of the regional Natura 2000 network areas, also foresees the management of IAS, focusing on defining a unified framework of the priority actions of prevention, dissemination and contrast to the spread of IAS.

Materials As first step, the scientific community actively working on this topic has been involved, creating a IAS working group including four universities, all those that have research groups actively investigating alien organism within the context of wildlife management and conservation, and one private company with direct experience of active IAS management and commu-

nication on these issues. This group collects the expertise of researchers specialised in different taxa. The team created a priority blacklists for the regional territory, collected data from all the stakeholders involved in managing IAS in order to analyse the risk of further dispersion and the possible pathways of introduction. A special focus has been made about the potential sites of introduction, such as airports.

Results The main result has been the creation of a regional strategy for IAS management and control with species-specific protocols for mammals and other taxa. Stakeholders and citizens have been involved in the process through different meetings and level of awareness about IAS has been tested through questionnaires. A specific action deals with the control of invasive squirrels, which was started in 2011 with the LIFE EC-SQUARE project.

Discussion A high number of IAS are present in Lombardy or could be potentially introduced due to their presence in areas bordering the Region. Among these, several are mammals, such as raccoon, grey squirrel, American mink and coypu. Lombardy region will produce an Action plan for IAS management. IAS are a relatively new emergence whose comprehension requires the analysis of complex ecological interactions. To reach success in IAS control, it will be fundamental to continue the involvement of a wide scientific community and to interact frequently with all stakeholders interested in this biological emergence. It is expected that all elements laid out in the Action plan will be become routinely applied.

Re-emerging of canine distemper virus (CDV) in red fox (*Vulpes vulpes*) populations of Friuli-Venezia Giulia

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P208

Introduction Red fox (*Vulpes vulpes*) populations of NE Italy have faced different disease epizootics during the last decade. Canine distemper virus (CDV) is a highly contagious Morbillivirus of the Paramyxoviridae family that affects wild and domestic carnivores. Clinical signs vary according to species but frequently include neurological symptoms and behavior disruption leading to lack of fear to humans and favoring interactions with domestic animals and human enclosures. We focused on the evolution and spread of CDV in foxes during the period 2010–2018, after a major CDV epidemic occurring since 2006 that expanded from eastern to western Alps and subsequently rabies epizootic of 2008–2011.

Methods Fox populations estimates and hunting bags were regularly recorded from a Regional database. Opportunistic collection of 2319 found dead foxes in the frame of rabies surveillance and research projects were considered for the study of CDV along with general passive surveillance data. Viral RNA was extracted from brain samples and a one-step RT PCR was performed. Foxes hunted and culled for rabies vaccination monitoring or for population control purposes were excluded from this study.

Results In the Friuli-Venezia Giulia Region fox abundance decreased from almost 6000 counts in 2010 during rabies outbreak, to 4500 in 2015 and this level was maintained during the last three years. A minor CDV spread was recorded in our Region between

2012 and 2013 (27% and 18% of prevalence, respectively). The virus outwardly almost disappeared in the following years, with a prevalence range of 0–0.7% until 2017, when 6% prevalence of cases clustered in the last months of the year. Since January 2018 a sudden increase of clinical cases was recorded and CDV prevalence reached a peak of 46% (39 cases until February).

Discussion This study evidenced re-emergence and periodicity of CDV epizootics in red foxes populations, in accordance with previous studies in other carnivores such as raccoons (*Procyon lotor*). Interestingly, ahead of foxes abundance reduction, carnivores richness increased during the last decade with the range expansion of golden jackals (*Canis aureus*), raccoon dogs (*Nyctereutes procyonoides*) and recent presence of wolves (*Canis lupus*); all of these species are sensible to CDV infection, thus enhancing conservational issues. Further insights may derive from phylogenetic analysis of current strains and their similarity with previous CDV epidemics. It appears to be crucial a continuous monitoring of foxes populations and to study the impact of the ongoing epizootic in the ecology of red foxes and on the occurrence and dynamics of zoonotic diseases, notably echinococcosis and trichinellosis.

This work was funded by the Italian Ministry of Health (project codes: RC IZSVe 07/08, RC IZSVe 06/09 and current RC IZSVe 18/16).

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Structure and productivity of a population of roe deer (*Capreolus capreolus*) in a highly fragmented hilly environment

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P012

Introduction Population dynamics of large herbivores can be influenced by extrinsic factors, in particular the reproductive performance of roe deer is influenced by several factors such as population density, female phenotypic characteristics, habitat quality and weather conditions. In order to manage the species in the best way possible, in Italy, it is important to know how this influences work, especially considering that most research regarding the roe deer fertility and population dynamics was focused on a population living in northern temperate regions disregarding the effect of the harvest rate (which should be mandatory).

Materials and Methods For this study we have used biometric data from 3 consecutive hunting seasons including: sex, age class, weight and the number of fetuses in each pregnant female. As weather variables we have considered the average of the daily average temperature, the average daily maximum temperature, the average daily minimum temperature and the rainfall; for each of these variables we have calculated the annual and seasonal value. In order to highlight which variables influence the pregnancy rate we have run a binary logistic analysis, while for the number of fetuses we have run a GLM. We have then performed a PVA using both data coming from the population in analysis and from literature, simulating the probability of the population survival with different harvest rates.

Results We collected a total of 409 females in reproductive age, 91.6% of them were pregnant. The best model retained to explain

the occurrence of pregnancy included the body mass of females and spring average temperature; pregnancy was correlated positively with the first and negatively with the second one. The GLM retained a model, including two variables, to explain the number of fetuses: female body mass and female class age. Both of them had significant and positive coefficient. The PVA simulations have highlighted that with no harvesting, the population will grow up to the carrying capacity and that the population can't bear a harvest rate higher than 10%. The harvest rate expected by the ATC was 20%, which will lead to the local extinction of the population in 100% of cases in just 10 years, but the actual harvest rate is 8.35% because of a lack of animals due to the over exploitation of the population in the last years.

Discussion This study revealed that the phenotypic quality was the most important factor in determining the reproductive performance of roe deer females: heavier females have a better reproductive performance than the lighter ones and adult females have a better one than the sub-adult females. This results are conform with the literature. Even if the average number of fetuses of 1.44 and the productivity of 1.08 are an indication of a growing population, the data from the annual winter census have highlighted that the population is rapidly decreasing: from 3477 in 2014 to 1794 in 2017; this is due to the elevated harvest program. In order to correctly manage this population a better planning of the harvest is mandatory.

Which roe is in your backyard? Genetic make-up of two roe deer populations of central Italy

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P313

Introduction In Italy, roe deer (*Capreolus capreolus*) populations declined during the last centuries, reaching a minimum at the beginning of the XX century. Therefore, reintroduction and restocking operations were carried out to restore its original range, by using stocks from northern Italy, central Europe and the Balkans. Such practices led to the contact between diverging gene pools, especially in central Italy where relict populations of native roe deer (classified as *C. c. italicus*) had survived. The resulting introgressive hybridization has raised concerns for the genetic integrity of the Italian endemic form.

We analysed roe deer from the Massa-Carrara and the Arezzo provinces (Tuscany) on a combination of biparental (microsatellites) and uniparental (mtDNA) genetic markers, aiming to disentangle the genetic make-up of these populations and evaluate the possible influence of landscape features on it.

Methods Specimens from the two provinces were analysed on 11 autosomal microsatellites and compared with reference populations from surrounding areas. Fine population structure and the effects of anthropogenic infrastructures on gene flow were investigated with Bayesian cluster analyses and analysis of variance. A portion of the mtDNA control region was also sequenced for a subset of samples and aligned with homologous sequences retrieved from GenBank. Haplotypes belonging to the *italicus* lineage were identified by a diagnostic nucleotide deletion and by phylogenetic analysis.

Results A total of 117 (Massa) and 196 (Arezzo) individuals were successfully genotyped. The two populations were sharply separated by the Bayesian analysis. The Massa population

formed a single panmictic deme, while the Arezzo population was composed by two genetic clusters, one prevailing in the north and the other one in the south of the area, apparently separated by the Arno river and the A1 highway. The AMOVA and ANOVA analyses indicated that this separation was very significant, explaining 5% of the overall genetic variation in the sample and 51% of the cluster assignment in the Bayesian analysis. A total of 32 and 74 individuals were successfully sequenced for the Massa and Arezzo provinces, bearing six and seven different haplotypes, respectively. The proportion of *italicus* haplotypes was very high (75%) for Massa and relatively low (20%) for Arezzo, where only one individual with such a haplotype was detected in the northern area.

Discussion We assessed the genetic composition of two roe deer populations of central Italy. In both areas, our analyses detected a contact between the *italicus* lineage and non-native roe deer. The Arezzo population was sharply structured, showing native roe deer in the southern area (likely spreading from the Siena province) and admixed individuals mainly in the central area, with a sharp genetic discontinuity explained by natural and anthropogenic barriers contrasting gene flow. Conversely, the Massa population was genetically homogeneous, diverging from the neighbouring populations of the Parma and Lucca provinces, and showing a surprisingly high proportion of *italicus* haplotypes. This pattern seems to indicate a possible role of genetic drift favoured by genetic isolation due the barrier-effect of mountains, or an origin from local introduction of native roe deer from southern populations.

Use of camera trap method to verify the distribution area expansion of the European wildcat in the Venetian Prealps

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P311

Introduction The phenomenon of expansion of the European wildcat (*Felis silvestris silvestris*, Schreber, 1777) population in the eastern Italian Alps has been well documented for many decades. The southern Dolomites probably represent the westernmost limit of this population. From the winter of 2015 until the spring of 2016 we performed a pilot study. In the summer of 2016 a study with camera traps began. The objective of the project was to ascertain the presence of a stable wildcat population in the Venetian Prealps using the camera trap method.

Methods From July 2016 to October 2017 a camera trapping project was conducted on the north-western side of the Venetian Prealps (Col Visentin 1763 m a.s.l.). 20 camera traps were used in 20 different stations. The effective working time for every camera station was never less than 120 days. The average elevation of the trapping stations was 1206 ± 161 m a.s.l. The trap stations were distributed in order to obtain an inter-trap-station distance of 1095 ± 410 m. This ensured that at least one camera station was located inside the smallest home range size known for this species. The total influence area was the merged area of all the buffers (radius 1000 m) created for each trap which was slightly more than 26 km². To determine the number of different photographed specimens, we used morphological criteria

to distinguish between free-ranging domestic cat (*Felis silvestris catus*), European wildcat (*F. s. silvestris*) and hybrids between them. Furthermore to distinguish individuals, we analysed phenotypical characteristics, such as coat colour and marking systems, age class and gender as well.

Results The camera traps operated for 3750 trapping days. Fourteen pictures of wildcats were taken. A minimum of six different specimens were identified: one of these surely was a female (it was photographed with two kittens). One domestic cat and, probably, one hybrid were also registered. The rate of capture success for the wildcats was 1 capture/268 trap-days and the annual population density is 0.182 wildcat per 100 ha.

Discussion The results proved the presence of a population of *Felis silvestris silvestris* in the Venetian Prealps also confirmed by two reproduction events (one during the pilot study and the second in 2017). The population density falls within the medium/low range of these species in Europe. This is coherent with the density of a population on the fringe of the distribution area of the species. The camera trap method proved to be a valuable technique for monitoring such as elusive species with low population density.

Can we use camera traps to estimate mammalian species richness and occurrence? First insights from the Mongolian steppe

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P403

Introduction Camera trapping is considered one of the most powerful tools for detecting and monitoring mammal species, and it is becoming a more rapid-growing sampling method to guide specific conservation priorities.

Methods Data on the mammal species occurrence in the South-West Mongolian-Manchurian Grassland Ecoregion are still scarce. To fill this gap of knowledge we conducted a camera trap survey, between July and October 2017, covering an area of approximately 200 km².

Results Of the 25 camera traps originally set, 448 independent detection events (an event is an instance of capture obtained by screening the original images acquired by a set interval of time between subsequent images) were obtained through a survey effort of 1149 camera days. Our data provide new insights on mammal species presence and distribution in the study area. We detected and identified 10 wild mammal species belonging to 3 orders and 7 families. A total of 5 species for the Carnivora order have been recorded, followed by Artiodactyla (3 species) and Lagomorpha (2 species). Most of detection are related to Artiodactyla (236 independent events), followed by Lagomorpha (99 events) and Carnivora (51 events). Therefore, the majority of species detected are locally or globally threatened: the Argali sheep (*Ovis ammon*) the Wapiti deer (*Cervus canadensis*), the Siberian ibex (*Capra sibirica*) belonging to ungulates; the Pallas's cat (*Otocolobus manul*) and the Grey wolf (*Canis lupus*) among carnivores.

We found for the Wapiti deer a naïve occupancy of 0.89 and

175 independent detection events, while for the Argali a naïve occupancy of 0.78 and 55 independent events that confirms a high density of presence for the two species. All carnivore's species were recorded at low densities: the Pallas's cat and the Asian badger (*Meles leucurus*) were recorded in a single event, and the Grey wolf in two events. The Red fox and the Beech marten (*Martes foina*) were the most detected carnivores species (26 and 21 detection events), showing a naïve occupancy of 0.45 and 0.39, respectively.

Discussion In our study, camera trapping has been demonstrated to be a reliable tool to detect meso and large mammals, but it is not efficient to gathered data on small mammals (i.e., animals <1 kg). In fact, Rodents and Eulipotyphla species were not detected, but, conversely we got images within the Lagomorpha, specifically for the Tolai hare (*Lepus tolai*) and the Daurian pika (*Ochotona daaurica*).

The small mountainous areas laying throughout the South-West Mongolian-Manchurian Grassland represents an important refuge for large ungulates populations. Wapiti deer were frequently detected in the dry and tree-less habitats, despite this steppic ecosystem does not represent for them a preferred foraging habitat. Furthermore, the species is spreading its range towards the southern part of our study area.

Although such basic information is precious to established mammal diversity, there are currently a lot of topics that remain poorly understood. Our study will be a starting point for other future researchers on threatened mammals in this fragile ecosystem.

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Faecal glucocorticoid metabolites assessment in *Apodemus flavicollis* and *Apodemus sylvaticus*: validation of a commercially available enzyme immunoassay kit

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P408

Introduction In many fields of vertebrate research physiological parameters are increasingly employed as indices of individual and population health status. The level of glucocorticoids is one of the most investigated parameters due to their important role in the regulation of many physiological functions. Assessment of plasma/serum levels is the conventional method utilized to measure steroid hormones in vertebrates. This method requires animal restraint for blood withdrawal that could be difficult to perform quickly enough to avoid the induction of relevant stress to the animals, especially when applied to wild animals. For this reason, non-invasive steroid hormone determination is currently considered a good alternative to plasma-serum assessment. Faecal sampling is among the most used non-invasive methods for hormone assessment in wild animals even though, in faeces, the native hormone is rarely found due to the high level of metabolism that takes place in the intestinal tract. Based on the diverse array of metabolites present in the faeces, some researchers apply group-specific home-made enzyme immunoassay (EIA) kits rather than commercially available kits to have reliable hormone assessments. However, the latter are easier to be executed and allow higher level of replicability in comparison with the home-made EIA kits. The aim of this study was to analytically and biologically validate a commercially available EIA

kit used for faecal corticosterone metabolite (FCM) assessments on males and females *Apodemus flavicollis* and *A. sylvaticus*, two species often studied to monitor rodent populations response to environmental variations.

Methods Biological validation was performed on live-trapped animals. Faeces excreted in the traps were used to assess “basal” FCM levels, as, due to intestinal transit, these corresponded to the time preceding trapping. Immediately after capture the animals were housed singly in plastic boxes with nesting materials, food and water ad libitum, up to 24 h, in the sites of capture, knowing that this novelty should activate the hypothalamus-pituitary-adrenal axis and the following release of corticosterone.

Results The results showed analytical validity and replicability of the hormone assessments obtained through the chosen EIA kit in male and female faecal samples of both species. Following the captivity period, FCM levels increased in males and females of both species in comparison with their respective basal levels, demonstrating the biological validity of the measurements.

Discussion This study demonstrated the reliability of FCM levels assessments through the chosen commercially available EIA kit. Our results support a more widespread use of this type of assay after a species-specific validation.

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Ultrasound deterrents devices test for Ungulates in Umbria

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P302

Introduction As a result of repeated reports of damage to high-income crops, OFR provided to purchase and install some ultrasound deterrents made by Natech at two farms of the Alto Tevere Umbro. These devices are battery operated, with continuous output within 24 hours and require periodic battery replacement and recharging.

This report presents the indications emerging after the first months of such devices use for the protection of cultivated fields from wild boar and above all roe deer.

Methods These devices were used on crops already in the field, during ripening and harvesting, in areas with a high density of roe deer and wild boar.

In order to verify the frequentation of the crops by the wildlife, interviews to the farmers were carried out and the indicators of presence in the field and in a photo-trapping case were detected. The damage trend was monitored through periodic inspections and calculations also in a test area.

Results The first devices installation was carried out on 29 December 2017 and involved three different plots at the same time, two of which cultivated with “radicchio” (*Cichorium intybus*, 3 Orti 1 e 3 Orti 2) and one with “fave” (*Vicia faba*, Nimbi). The devices have been active: in 3 Orti 2 for a month, ensuring the whole plot harvest without registering any damage caused by roe deer; in 3 Orti 1 at least until March 3, when an intense phase

of bad weather closed the harvest in advance. In the last month an increase in the damage of only 7 plants out of 245 in the area test has been noticed (the plants consumed were lined up along a single roe deer that had crossed the whole plot). The survey of the presence indicators and the interviews to the farm owners led to confirm the disappearance of roe deer and wild boar.

At Nimbi’s a series of early nibblings concentrated in a restricted area has been detected, however almost all the ungulates tracks are found only around the plot.

Discussion Where the maintenance and control of the equipment was daily, there were no interruptions of the protection, ensuring a complete harvest.

At Nimbi’s there have been some interruptions during the batteries replacement, but to evaluate the real damages level it is necessary to wait for the harvest (by the middle of May).

At the moment Natech is producing new generation devices with a solar panel for power supply and passive infrared sensors (PIR) for activation that make them much more versatile and practical in the field.

Their development and diffusion, if supported by economic measures such as “Piano di Sviluppo Rurale” and adequate Ungulates removal plans will allow a new phase of relationship between farmers, hunters and conservationists.

The Wolf in Umbria (Central Italy) and new management perspectives

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P304

Introduction The grey wolf (*Canis lupus*) has reoccupied most of its former ranges in Umbria (Italy), leading to new interactions and encounters with humans and with their activities in the region. Servizio Faunistico of Provincia di Perugia and of Provincia di Terni and the Osservatorio Faunistico Regionale collected, validated and archived critical encounters reported by citizens (e.g. farmers, hunters, shepherds).

Methods From 2008 to 2017, we collected reports of critical encounters between wolves and citizens in anthropic or natural areas, for example nearby towns. We consider as critical encounters, those in which humans and wolves are at close range, "face to face". In addition, we investigated the numerical trend of dead wolves in Umbria and their causes of death, examined by the Istituto Zooprofilattico Sperimentale of Umbria and Marche. We received reports from citizens, Carabinieri Forestali and Prefettura Officers. We also collected reports during our investigation on predation events.

Results We gathered 19 critical events, even though three reports were not taken into consideration due to lack of evidences:

- 15 encounters occurred nearby houses;
- simultaneously with 13 encounters, predation was observed on livestock flocks (9), barnyard animals (3), free-ranging dogs (2) and on wildlife (1);

- in four events, citizens described the encounter as an aggression; in five, a close approach that lasted few seconds was reported;
- in three events dogs scared away the wolf.

We investigated the causes of death of 86 wolves: motor vehicle accident trauma showed the highest rate (50 wolves, 69.4%), followed by poaching (10 wolves, 13.9%), poisoning (10 wolves, 13.9%), aggression by other wolves (one wolf, 1.4%) and infection (one wolf, 1.4%).

Discussion The investigation of the causes of death showed that poaching remained relatively constant during years and that it showed a peak in 2014. Poisoning was detected from 2011 and it showed a rising trend in the following years, until 2016.

Discussing our results, we should take into consideration local factors that affect wolf-management and the relation between humans and wolf: the expansion of wolf population, the absence of a new National Action Plan for the wolf, the lack of control on poaching due to the suppression of local police services (Polizia Provinciale), the chronic absence of public compensation funds for predations on livestock and for preventing further attacks.

Unfortunately, due to these issues, rural human population perceives wolf expansion as a threat and with the aim to protect from it, employs illegal solutions.

Consumption by scavenging species of fallow deer (*Dama dama*) killed but not consumed by the wolf (*Canis lupus*) in a protected area

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P207

Prey consumption is evaluated by camera trapping survey in San Rossore Estate, Tuscany Region (43°43'20" N; 10°18'47" E) where a wolf (*Canis lupus*) male presence is documented since autumn 2016. Its main prey here is fallow deer (*Dama dama*), whose local density is about 46 individuals/100 ha. The only other wild ungulate is wild boar (*Sus scrofa*) with a density of 7.3 individuals/100 ha. Domestic ungulates are represented by cattle and horses, ranging from 30 to 50 individuals each. Since his presence wolf showed a particular prey consumption pattern, characterized by the consumption of inner organs only, like heart, lungs and kidneys. We monitored 7 carcasses of fallow deer killed by wolf with movement-triggered cameras, filming the activity of wolf and others species which act as scavenger. In any of the 7 cases, a second visit of the wolf to carcass of the deer he killed was ever recorded. The consumption of deer carcasses was done by opportunistic species, in particular wild

boar, fox (*Vulpes vulpes*), hooded crow (*Corvus cornix*) and buzzard (*Buteo buteo*). The different species showed a different time of permanence on the carcasses (ANOVA: df=3, F=7.944, $p<0.001$). Moreover, wild boar and red fox have consumed the carcasses in equal measure (Student t-test: $t=0.06$, $p=0.941$), and both species have consumed carcasses more than crow (wild boar vs. crow: $t=65.381$, $p<0.001$; red fox vs. hooded crow: $t=37.764$, $p<0.001$). The crow has consumed carcasses more than buzzard ($t=97.135$, $p<0.001$). The wolf's limited consumption pattern of the carcasses made available a consistent resource for scavengers. This was particularly evident for wild boar that, being an opportunistic species making extensive use of carcasses could have expanded the animal share of his diet. This scenario opens up new research themes that will be explored in an immediate future.

Preliminary data on the distribution, habitat use and diet of the wolf in the Ticino Natural Park (northern Italy)

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P205

Introduction In spring 2017 the return of the Italian wolf (*Canis lupus italicus*) in the Ticino Natural Park after 150 years was confirmed by camera-traps. The Park could play a key role within the wolf distribution dynamic in Italy, representing a natural ecological corridor that can facilitate the movement of individuals from the Apennine to the North, directly in correspondence of the colonization front on the Alps, increasing chances to surge the Italian population genetic diversity. The objective of this research was to provide a preliminary study of the distribution, habitat use and diet of the predator within this ecological corridor.

Methods The Ticino Natural Park is a 220 km² wide protected area in the lowland of north-western Italy. To analyze the wolf distribution within the Park, a kernel analyses on all the collected presence signs (sightings, predations, scats) of the species was performed to obtain a density map which allowed to identify the area of highest species attendance. Here, to investigate the habitat use by the predator, data from presence signs were added to data specifically collected along itineraries. By adopting a presence vs. availability approach, the influence on the probability of wolf presence of several environmental variables was investigated by univariate GLMs and by developing a multivariate GLM with a dredge selection procedure and the development of an average model. Trophic ecology was investigated by an optical microscope analysis of the material contained in 22 wolf scats.

Results The density map revealed that the area of highest attendance corresponds to an area of about 5 km² located in the central part of the Park. Univariate and multivariate analyses of habitat use showed that the wolf in the Park significantly selects areas close to the Ticino River characterized by a high cover of deciduous forest and a high abundance of prey species (*Capreolus capreolus* and *Sus scrofa*). Conversely, the species avoids areas with greater anthropogenic impact such as arable lands. The wolf in the Park mainly feeds on wild ungulates (62% in volume), and particularly on wild boar, followed by domestic ungulates (22%), medium-sized mammals (13%) and plants (0.5%). Consequently, the diet breadth resulted quite low (Levins' index=0.523).

Discussion The wolf in the Ticino Natural Park seems to frequent a circumscribed area, which probably represent the core area of a pair, and to select specific environmental conditions, such as undisturbed woodland areas characterized by high prey availability. The species also showed a trophic ecology typical of a specialized predator, that is usually observed in areas where wolves are establishing stable territories. All these results suggest that the Ticino Natural Park not only play the role of an excellent ecological corridor for the wolf, but it could also be a sufficiently suitable habitat in which to establish a stable territory, which in the future could represent an important source for dispersal.

Variation in the echolocation calls of *Pipistrellus kuhlii* and *P. pipistrellus* from islands of the Tuscan Archipelago National Park

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P011

Introduction We investigated the extent of variation in the echolocation calls of two species of microchiropteran, *Pipistrellus kuhlii* and *P. pipistrellus*, in the islands of the Tuscan Archipelago National Park (Italy). The purpose is to describe the variability of the calls of these two species of bats and to evaluate the differences between single islands.

Methods Between 2015 and 2017 a total of 406 bat calls were recorded: 254 of (*Pipistrellus pipistrellus*) and 152 of (*P. kuhlii*) from four islands: Elba, Pianosa, Montecristo and Capraia.

Bat calls were recorded with SM4BAT FS detectors (Wildlife Acoustic, USA), and analysed using BatSound software. We used only search-phase echolocation calls. The averages of 7 parameters were extracted from all included pulses of each call sequence. The parameters that were used are: SF=start frequency (kHz), EF=end frequency (kHz), Fmax=highest frequency of the pulse (dB), D=duration (ms), IPD=inter pulse distance (ms), BW=band width (kHz), BW/D (kHz/ms).

The statistical analysis was undertaken using a two-fold approach. Firstly, ANOVAs were conducted on all 7 call parameters to compare differences between the four islands. Level of significance was evaluated with Tukey test. Secondly, the

call parameters were subjected to a Linear Discriminant Analysis (LDA). This was to determine the discriminative ability over the different islands. These tests were performed using PAST 3.06.

Results ANOVAs highlighted a significant difference in the 7 call parameters between the four islands in both bat species. In particular, *Pipistrellus pipistrellus* presents the maximum values of the parameters EF, Fmax and BW on the island of Pianosa. Same result for the *Pipistrellus kuhlii* for the EF and Fmax parameters on Montecristo.

The linear discriminant analysis resulted in a 43% misclassification rate. These indicate low power of the discriminant function to separate the five islands. Only for Elba island the discriminative capacity of *P. pipistrellus* is 81%.

Discussion The analysis of the 7 call parameters highlighted a series of significant differences between islands. In particular, there is a particularly marked difference between the island of Elba and the others that were examined. The reasons for this strong variability probably must be sought in the environmental diversity of the various islands and perhaps also in the competitive interaction between different species that on islands so small is particularly accentuated.

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Bats and caves microclimate: three study cases

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P202

Introduction One of the most common generalizations is that cave temperature varies only near entrances while the inner part has constant temperatures, with the temperature closely approximating the local mean annual external temperature. These generalizations are true in some cases but not in all. The internal conditions of a cave are clearly affected by external conditions. As shown by some research, the temperature and humidity inside natural and artificial caves vary much more than assumed, with a significant impact on the fauna of these environments. This poster presents the data relating to the variation in temperature in some cavities (natural and artificial) of three geographical areas that are used by important colonies of bats.

Methods Between 2010 and 2017 a series of sensors (model HOBO Pro V2, Onset, USA) were placed inside various caves that are the object of the present study, and located in three geographically distant areas.

In particular, the caves were Beata Vergine, Infinito, Vernino and Fiume within the Gola della Rossa and Frasassi Regional Park (Ancona); the Poggio alla Guardia cave (Pieve a Nievole, Pistoia) which is an extremely complex old quarry divided into two branches and various floors; the Castell'Azzara cave (Castell'Azzara, Grosseto).

Simultaneously with the microclimatic survey, a series of ob-

servations were made on the chiroptero fauna present in order to evaluate the diversity of species, their abundance and their annual numerical variations. The microclimatic data collected are at least relative to a calendar year, but in some cases the surveys have gone far beyond, covering some years.

Results There is a great microclimate variability of the various hypogea that were examined. The annual temperature variation varies between 0.4 °C (Infinito Cave) and 10 °C (Poggio alla Guardia quarry). In particular, the relatively deep natural caves present small oscillations of the internal temperature, thus determining the possible roost for wintering or reproduction. The greatest microclimatic variability is observed in relatively small caves or in artificial cavities where the variation of temperature determines their continuous use by the various species of bats.

Discussion The collection of microclimatic data of the hypogea used by bats during the various phases of the biological cycle is still particularly limited. Above all, temperature is an important factor in determining the type of use of the hypogea. This type of data makes it possible to better understand the ecological aspects of the caves and the various hypogea, being very useful for possible comparisons and for evaluating the anthropic impact on these delicate environments.

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Be careful crossing the road! Assessing the road-kill risk for Eurasian otter (*Lutra lutra*) in central-southern Italy

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P027

The interaction between wildlife and human activities is constantly growing as anthropic activities and wildlife diffusion increase. One of the artificial elements that mostly influences the relationship between man and wildlife is the road network. In particular, collisions with vehicles represent the main conflict between infrastructures and wildlife, as road mortality is a growing phenomenon the largest single cause of death for many vertebrates, representing a of remarkable dimension. Specifically, the European otter (*Lutra lutra*) is highly vulnerable to road-kills, which represent the predominant cause of deaths recorded in Europe for this species. We aimed at producing a spatially explicit assessment of road kill risk for the European otter in central and southern Italy by means of species distribution modelling (SDM). Specifically, a SDM was calibrated including 56 records of road collisions collected between 2004 and 2016, in combination with seven environmental predictors rasterized at 1 km grid cells: density of highways, state, regional, and local

roads, diversity of land-cover categories, biopermeability index, and elevation. SDM predictive accuracy was evaluated by calculating the area under the receiver operating characteristic curve (AUC) according to two cross-validation methods: random data splitting and block cross-validation. SDM of road risk achieved a good level of predictive accuracy, showing mean AUC values of 0.835 and 0.824, respectively. Elevation, density of state roads and biopermeability were the variables that mostly affected the predicted road-kill risk. Particularly, we found that risk was higher at high elevation values and at intermediate values of state roads density and biopermeability. By contrast, highways, regional and local roads densities did not show any significant effect on road-kill risk. The proposed approach proved able to provide information on where to install cost-effective mitigation measures. These results are valuable as large scale evaluation, requiring further refinements at small scale to optimize site location of risk mitigation measure.

Comparison between acoustic stimulation protocols applied to the monitoring of the golden jackal (*Canis aureus*) in Italy and Romania

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P407

Acoustic stimulation is widely used for monitoring canids distribution (such as wolf, coyote and jackal). This method is based on the induction of the response of the animals through the emission of a pre-recorded howl with a speaker.

We tested the impact of the standard monitoring protocol and that of an over-stimulation protocol in order to analyze differences in jackal's response rates in Italy and Romania. We hypothesized that excessive stimulation can lead to a reduction in animal's response rate.

The Italian study area is located in Friuli-Venezia Giulia on the Karst near Gorizia and consists of 4 calling stations distributed over a surface of about 1700 ha characterized by arid meadows and scrubland. Here the jackal population is steadily since 1996 with a density of 1.1 heads/100 ha. The Romanian study area is located in the private reserve of Ultima Frontiera concession of the Danube Delta Biosphere Reserve to the SKUA Nature group and has a surface of about 1000 ha in which 3 calling stations are distributed. The area is predominantly swampy with some dry lands that are mainly covered by arid grasslands and shrublands. The jackal population has a density of about 1.5 heads/100 ha. In both protocols, every survey session is composed of three consecutive days of stimulation. A maximum of 5 emissions (trials) with a duration of 30 seconds alternating with 3 minutes of listening are emitted. In the standard protocol the stimulation session stops when a jackal or a group of jackals respond while in

the over-stimulation protocol, all the 5 emissions are performed even if the animals respond.

In Italy (IT) the standard protocol allowed to collect 91 responses in 23 days for a total of 286 emissions in 2015, and 93 responses in 25 days for a total of 307 emissions in 2017. In Romania (RO) the standard protocol allowed to collect 72 responses in 9 days for a total of 84 emissions in 2015 while in 2016 the over-stimulation protocol allowed to collect 49 responses in 8 days for 115 emissions. For all protocols, most of the responses were collected between the first and second trials. (I 61.2%, II 19.1%, III 9.3%, IV 9.8%, V 0.54% in IT; I 42.8%, II 9.5%, III 7.1%, IV 11.9%, V 28.5% in RO). The average response rate (the ratio between the number of trials executed and the number of response) for each of the three days, did not show a statistically significant decrement of the response rate both for Italy (I 0.58 std 0.42, II 0.50 std 0.43, III 0.53 std 0.43) and Romania (I 0.45 std 0.39, II 0.52 std 0.37, III 0.47 std 0.35). The over-stimulation protocol allowed to collect the 24.38% more responses than the standard protocol but the 46% of animals did not respond to ulterior stimulation if had already howled. It emerged that the use of a three-day stimulation protocol allows to gather a large number of feedback in a short time without negatively affecting the response rate. The use of over-stimulation, on the other hand, is potentially more impactful, causing a reduction in responses in at least one part of the census population.

Golden jackal (*Canis aureus*) behaviour in livestock predation

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P217

Golden jackal (*Canis aureus*) has a large range expansion in Europe. With the increasing of the jackal population also increase the chance of interaction with human activities. Livestock predation are the main sources of conflict and can lead to a negative perception of the species by the human population.

The study area is located on the Karst near Gorizia in the south-eastern part of Friuli Venezia Giulia. This area is home of a consolidated population of golden jackal since 1996. Today is present with a density of 1.1 heads/100 ha. From the 2013 two sheep livestock was sporadically attacked by jackal. During 2015–2016, was started a collaboration with a local breeder. They have been analyzed 18 carcasses of sheep presumably preyed by the jackal. The flock was composed by 40 Istrian Milk sheep breed and some hybrid with Scottish sheep. The farm has 25 fenced hectares with a semi extensive management without the presence of the shepherd at night. The outer perimeter of the enclosures, consisted of one meter tall metal wire mesh.

After the finding of carcasses they were examined to find signs of bite and to evaluate the amount of consumption. 15 carcasses were monitored with camera traps to study the consumption behaviour of jackals and kleptoparasites. In 11 cases the predation were made by a single jackal. In 7 cases, the predation have probably occurred by more jackals and multiple traces have been found. Predation took place from summer to autumn mainly at night or at dawn (6.25% may, 12.5% July, 12.5% September, 68.75% October).

Predated animals were mainly weak condition subjects such as lambs (less than one year old, in 8 cases), elderly (5 cases) and sick. The jackal behaviour in carcass consumption and predation

is very similar to the wolf approach. In open field it was possible to detect traces of the chase, during the escape the sheep could be attached to the front or rear limbs. Death came after a single bite in the neck area. Bites were often evident in carcasses skin, in particular when the hair were removed, the distance between the two tooth holes were from 3 to 3.5 cm. During the necropsies after the flattening of neck area, the region showed: haemorrhages and lacerations of muscles and big vessels and tracheae were rare lacerated with only signs of compression. In eleven cases, the carcass was moved by the predator from open fields to the bottom of a soil depressions.

The consumption took place mainly at night or at dawn with a constant distribution per hour (18–21: 23%, 21–24: 24%, 24–3: 26% 3–6: 27%). On average, for adult sheep, consumption lasts for 7–10 days, but it is often observed that jackals return to the place of predation at 20 days or more. The average total daily consumption duration is 28 minutes (min 1 min – max 85 min). Factors affecting permanence are related to the disturb and the carcass consumption rate. Feeding behaviour was often alternate with vigilance behaviour (about 42% of the time spent). The consumption began removing the bowels through the abdominal cavity and dislocates it to a few meters from the carcass to avoid the dispersion of faecal material. Feeding begins from the muscular part of the back limbs, then passing to the heart and lungs. In lambs jackal eats also the thin skin, in the adult sheep it proceeds to flay them. The presence of kleptoparasitism by wild boars and foxes makes difficult to estimate the amount of consumption by the predator.

The Barbero Collection, a new acquisition of the Natural History Museum of the University of PisaS. FARINA¹, R. BARBUTI^{1,2}¹Museo di Storia Naturale, Università di Pisa, Via Roma n.79, 56011 Calci, Pisa. e-mail: simone.farina@unipi.it²Dipartimento di Informatica, Università di Pisa, Largo B. Pontecorvo 3, 56127 Pisa

P104

The Natural History Museum of the University of Pisa has recently acquired the Barbero collection, one of the most important private collections of Italy. It consists of 629 animals, 334 of which are mammals (248 complete naturalized specimens and 86 hunting trophies). Most of the mammals were hunted by Giorgio Barbero in the wild mainly in the seventies and eighties of the Twentieth century.

The mammal collection has a very relevant scientific value because Barbero, in his memories, described his travels reporting also the localities where he found the animals. Furthermore, the part of the collection concerning ungulates is so rich and diversified, presenting all the tribes of Bovidae and Cervidae defined by the most recent classification.

The analytical study of the Barbero collection will make a significant contribution to the knowledge of African ungulates, of which, in many cases, little is known.

The main part of the Barbero mammal collection, after a systematic review, has been exhibited in the new “Mammals Gallery” of the Museum that has been inaugurated in February 2018, together with the mammals of the historical collection of the Museum appropriately restored.

The aim of the exhibition is to show the greatness of the biodiversity on the Earth and, at the same time, its fragility. In fact, each specimen exhibited is associated with a tag that contains, in addition to the basic information, the state of conservation of the IUCN red list of threatened species, to raise the awareness of visitors and school groups to the preservation of biodiversity.

The exhibition, which has a significant educational value, is organized according to a systematic criterion and consists of 296 animals belonging to monotremes, marsupials, xenarthrans, pangolins, carnivores, even-toed ungulates and odd-toed ungulates. The rest of the Barbero mammal collection will be exhibited in 2019 with two new galleries, the first completely dedicated to bears and the second characterized by big natural history dioramas representing the biodiversity on the Earth.

This multi-year project connected with the Barbero collection includes not only new exhibitions but also the creation of related didactic and information activities.

Thus, the Natural History Museum of the University of Pisa contributes to underline the fundamental role played by museums in mammal research and divulgation.

Vigilance behaviour in roe deer: the role of group size, season and sex-age class

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P015

Introduction Vigilance behaviour allows gregarious foragers to reduce the risk of predation, while still retaining a sufficient food intake. Previous studies have shown that vigilance can be influenced by various factors, e.g. group size, seasonality, sex and age of individual. Roe deer *Capreolus capreolus* form mixed-sex groups in the cold months. At the end of winter, groups split: adult males defend territories from intrusion of other males throughout spring-summer, up to the mating season (late July-mid August), whereas females isolate to give births (mid April-May), and then are accompanied by fawns. Subadult males and females tend to be solitary before the following cold season. The different trade-offs, faced through seasons and amongst sex-age classes, may determine relevant differences in levels of vigilance behaviour. Here we have investigated the effect of group size, season and sex-age class on vigilance levels, in a seasonally-gregarious herbivore, the European roe deer.

Methods Data were collected in the Maremma Regional Park (April 2006-May 2008), through behavioural observations (focal animal sampling: 15 minute bouts/individual). Three different indicators were assessed: proportion of time spent feeding (PTF), proportion of time spent in vigilance (PTV) and vigilance rate, i.e. n. head lifts/min (VR). Data were analysed in two steps, by using generalised linear mixed models. (i) We assessed differences related to the interaction between group size and sex-

age class, irrespective of the season. (ii) We assessed differences related to group size and season, in adult male and female roe deer.

Results (i) Irrespective of the season, PTF increased with increasing group size, while PTV/VR increased with decreasing group size, in all age/sex classes. Females accompanied by offspring were the most vigilant individuals, whereas fawns were the least alerted ones. (ii) A group size effect was present for all the indicators, in both adult females and males: PTF increased and PTV/VR decreased with increasing group size. Adult females were more vigilant in winter and spring than in summer-autumn. Adult males were more vigilant in winter and, to a lower extent, in summer, than in the other seasons.

Discussion Group size, season and sex-age class were key-predictors of vigilance levels, in roe deer. As group size effect occurred in all seasons/sex-age classes, antipredatory vigilance could have overcome costs of group-living, e.g. intraspecific feeding interference, also in a seasonally-gregarious ungulate. Higher levels of vigilance at the beginning of winter might be related to establishment of dominance hierarchies in newly formed groups. Other seasonal peaks of vigilance may be related to presence of offspring and reproductive costs (e.g. gestation/parturition), for females, and to patrolling/defence of territories, for males.

XI Congresso Italiano di Teriologia

Diffusione di cervi sika (*Cervus nippon*) in Italia, dagli Appennini alle AlpiM. FERRI¹, R. FONTANA², A. LANZI², E. ARMAROLI², C. MUSARÒ³, L. ANDINA⁴, M. ALLEGRI⁵, P.L. ADORNI⁵, F. PELOSO⁶¹Via San Remo 140, Modena. e-mail: ferrimaur@gmail.com²Studio Gec, Arceto (RE)³ATC PR5⁴AFV Lama, PR⁵ATC PR8⁶Centro Servizi ATC MO2

P031

Nel 2011 un cervo maschio simile ad un sika fu fotografato nell'Appennino modenese e la disponibilità del soggetto, abbattuto nel 2012, permise di identificarlo con certezza come *Cervus nippon*, pur senza stabilirne il grado di ibridazione. Nella stessa località, dopo alcuni mesi, fu cacciato un altro maschio con caratteri simili e ciò stimolò la messa a punto di una iniziativa volontaria formativa per i tecnici, i biometri volontari ed i cacciatori degli ATC MO2 e MO3, elaborata sulla base di schede di confronto fra le specie *Cervus elaphus*, *Dama dama* e *Cervus nippon* messe a punto in collaborazione con ISPRA, abbinata alle immagini dei due sika abbattuti. Questa prima sensibilizzazione ha permesso la raccolta locale di immagini, dati e campioni relativi ad altri capi abbattuti aventi una o più caratteristiche sika mentre si sono rivisitate le informazioni sulla origine della popolazione cervina modenese e reggiana, sviluppata da soggetti in dispersione dalle province tosco-emiliane limitrofe ma anche da alcune fughe da allevamenti locali e reintroduzioni ufficiali effettuate con soggetti provenienti da allevamenti nazionali di cervi costituiti negli anni '70 con riproduttori di origine scozzese, notoriamente spesso ibridati. Pur con eccezioni, fu invece frustrante la ricerca, su scala nazionale, di informazioni da enti e da privati sullo stato di eventuali allevamenti e/o detenzioni di cervi sika mentre all'VIII, IX e X Congresso di Teriologia (2012, 2014, 2016) sono stati presentati poster basati su immagini ed informazioni aggiornate, ad esempio anche per il parmense dove, oltre a soggetti manifestamente ibridi di recente abbattimento, risultarono fotografati nel 2004–2005 soggetti sika liberi in apparente

purezza, mentre col poster del 2016 è stato possibile comunicare che, nel frattempo, ad un gruppo di ricerca ceco i due soggetti abbattuti nel modenese (2011, 2012) erano risultati ibridi di Cervo europeo *Cervus elaphus*, di Cervo sika *Cervus nippon* e di Cervo sika di Dybowski *Cervus nippon hortulorum*. Lo stato delle conoscenze è stato ulteriormente aggiornato per il III Congresso sulla fauna problematica (Cesena, 24–26 novembre 2016), favorendo un ulteriore allargamento del numero dei volontari interessati, incrementando così la successiva disponibilità di nuove immagini di cervi con caratteristiche sika più o meno marcate, dall'Abruzzo alle Alpi, oltre che in Emilia dove risultano recentemente confermati anche sika liberi in stato di apparente purezza. In un contesto di indagini ufficiose svolte a titolo pressoché volontario da ben 8 anni, ora si sta sondando anche la possibilità di indagini genetiche sui campioni raccolti, pur mantenendo prioritaria la raccomandazione di adottare a priori la sensibilizzazione su base fenotipica congiuntamente ad un piano di eradicazione, per ogni distretto nazionale di gestione del cervo, come già stabilito dalla Regione Emilia-Romagna. Infine, si ritiene che i parchi faunistici e gli allevamenti di cervidi dovrebbero essere assolutamente ricondotti nell'ambito della rigorosa applicazione delle Leggi 150/1992 e 157/1992 ed evitare che possano ripetersi il rilascio di autorizzazioni a commerciare, allevare e detenere di animali definiti "cervi" *tout court*, senza differenziare specie cervine fra loro ben distinte anche per le conseguenze amministrative, civili e penali innescate dagli abusi.

Pregnant uterus in a female Roe deer *Capreolus capreolus*, Class “0”, hunted in the lower Modenese Apennines

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P413

At the beginning of January 2016, during the control of ungulates selectively hunted, the voluntary biometre and “trained hunter” (in health and hygiene of the game, as per EC Reg. No. 853/2004, Annex III, Section IV, chapter II) in turn at the Biometric Check Point of the ATC MO2 in the “hunting party house” of S. Michele d/M of Sassuolo (MO), noted an incongruity of the appearance of the uterus of a female of Roe deer Class “0”. In fact one of the two thin uterine horns appeared asymmetric due to a small swelling present in its middle part. Noting a resemblance, albeit at very reduced proportions, with the pregnant wombs of adult females arriving at the Biometric Check Point in those days, after a quick telephone veterinary consultation, the “trained hunter”, also in his capacity as “voluntary biometer” has rechecked the animal, its general conditions, the measures, the weight and the teeth reconfirming that it was unequivocally a female “zero” class in excellent state of nutrition and not an adult in strong regression, and this was confirmed by other voluntary biometers present. The uterus was then packaged for the prompt submission to the laboratory of the Modena Section of the Ist. Zooprofilattico di Lombardy and Emilia Romagna which confirmed the apparent

gravid status but decided a histological study at its Milan Section, to exclude pathological events with a similar appearance. Before the histological preparation the uterus was photographed by insuffling it to better highlight the roundish mass, which proved to be unequivocally an embryo. The sharing of the news of such a finding has not caused excessive surprises in the local professional and voluntary technical environment, so much so that the occurrence is not rare and suggesting the opportunity for a future focused study, with the collaboration of “trained hunters” rooms from which during the censuses to the “first green” of 2018, in early March was also reported an episode of courtship and effective copulation between a male and a female roe deer class “0”, in the same area of the subject shot in 2016. These inspection and behavioral notifications suggest not only the opportunity to deepen but confirm once again the importance of a large presence of hunters “trained in hygiene and health” in the management of local hunting venues, as a first passive surveillance garrison and important also for the development of investigations on the biological and behavioral aspects of the species managed for game.

Take it easy: scat detection dog and conservation of Italian hare (*Lepus corsicanus*)

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P029

Introduction The Italian hare *Lepus corsicanus* is endemic to central-southern Italy and Sicily, and its distribution range has been greatly altered by human activities. Although this species is protected in continental Italy, it is morphologically similar to European hare *Lepus europaeus* and the two species could be confused during hunting. To determine the geographical range of Italian hare in the hunting districts of L'Aquila province, we conducted non-invasive genetic sampling using scat detection.

Methods From September to October 2017 we surveyed five areas of Abruzzi Region (ranging from 400 to 3600 ha), located within the species historical distribution. The chosen areas are placed between 450 m and 1800 m a.s.l., principal habitat were: broad-leaved forest, coniferous forest, natural grasslands, transitional woodland-shrub, pastures and agriculture area with natural vegetation. The study areas were adjacent are to three protected areas. Searches for faecal pellet sampling were conducted using a scat detection dog. The dog was a English springer spaniel trained by positive reinforcement for hare scats recognition. Faecal pellets indicated by dog were collected for genetic analysis if they were free from mould and not crushed or broken; scat position, dog paths, temperature and humidity were also recorded. DNA was extracted with QIAamp DNA Stool Mini Kit. The determination of the species for the DNA extracted from the pellets was done through High Resolution Melting Analysis, conducted with the Rotor-Gene Q and the Type-it HRM PCR Kit. We developed a *L. corsicanus* distribution model using MaxEnt,

occurrence data were basing on Italian hare's scat position, following the exclusion of multiple record in the same pixel (250 m grid).

Results In total, 31 transects were made. Overall, the dog travelled 72 km (about 6 hours per day), the driver 28 km. The survey lasted 10 days. The duration of the search phase was 20 hours 20 minutes, the resting time (i.e. the time in which the dog remained stationary because in the resting phase or in the phase of passive alert, was 9 h 31 min. The total effective search time was 10 h 49 min. Dog indicated 120 hare pellets, considering the fresh and old samples. The faecal pellets sampled, as suitable for the DNA extraction analyzes were a total of 51. Out of all samples analysed, the characterization of the species was successfully carried out for 47 of them: 24 were assigned to Italian hare and 23 to Brown hares. For 4 samples it was not possible to carry out the characterization probably due to the bad state of DNA conservation.

Discussion Use of detection dog greatly improved scat collection (short searching time and survey in difficult habitat and substrates) and genetic analysis success (92% characterization rate). In every surveyed area, we assessed the presence of both Italian and European hare. On the basis of our results we proposed the ban of hare hunting in the sympatry areas and the ban of restocking of *L. europaeus* in the suitable area of *L. corsicanus*, as predicted by the species distribution model.

Effect of hunting with hounds on hair cortisol accumulation in European roe deer: a case of study

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P025

Hair glucocorticoid metabolite quantification is a non-invasive tool that provides important information concerning endocrine status, and is a valuable method for studying potential stressors that may affect wildlife under both natural and artificial conditions. Hunting season may represent a stressful event which could lead to an increased adrenocortical activity in wildlife. The aim of this study is to assess the effect of hunting with hounds on hair cortisol accumulation in European roe deer (*Capreolus capreolus*), and to determine the eventual existing difference between genders and age classes. In the year 2016/2017 we measured the cortisol level accumulated in hair of both hunted (n=104) and road killed (n=64) individuals in Friuli Venezia Giulia. Cortisol concentration has been obtained using a radioimmunoassay protocol. A significant difference ($p < 0.05$) in term of cortisol concentration has been found among the two groups: hunted individuals showed lesser cortisol levels (mean±sd=2.47±2.05 pg/mg) compared to road killed ones (mean±sd=3.19±2.78 pg/mg). Considering only hunted individuals, from the application of a Generalized Linear Model we obtained that there is a significant difference in hair cortisol concentration between genders, but only if we consider the interaction among gender itself and hunting month: in September, males showed lesser cortisol levels (mean±sd=1.85±0.79 pg/mg) compared to females (mean±sd=2.94±2.15 pg/mg), while in October the opposite

trend were recorded (males → mean±sd=3.34±3.29 pg/mg; females → mean±sd=2.20±1.10 pg/mg). More, we obtained which there is a difference in term of hair cortisol levels among age classes. From the application of a permutation test, a significant difference among class 0 (mean±sd=3.31±1.91 pg/mg) and class 2 (mean±sd=1.96±0.92 pg/mg) were recorded. The difference in hair cortisol concentrations between hunted and road killed roe deers may be related to ecological condition such as season and/or degree of naturalness of the area, in which each road killed individual has been discovered. Concerning the comparison in hair cortisol concentration between genders and among age classes, as males and females (as well as the considered age classes), react differently to environmental conditions, the difference is probably related to ecological and/or physiological factors. Concluding, this study enabled us to determine that hunted roe deer showed lowest cortisol levels compared to road killed individuals, and that youngest individuals showed higher cortisol levels compared to the oldest ones. However, due to reduced sample size and scarce information concerning the effect of both ecological and physiological factors on adrenocortical activity in European roe deer, we cannot affirm which hunting with hounds has a significant effect. Further detailed studies are, thus, strongly suggested to better understand the effect of hunting, as well as that of the main ecological factors, on adrenocortical activity in wildlife.

Brown bear (*Ursus arctos arctos*) monitoring in the transboundary area of Eastern Italian Alps in 2012–2017

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P405

Introduction Brown bear is a flagship species whose conservation needs international efforts. Today, in Europe brown bears live in 10 fragmented populations due to habitat loss and historical human persecution. A reintroduced brown bear population in Central Italian Alps presently numbers 52–63 individuals. This population risks loss of genetic variability due to very small effective population size ($N_e=18$ individuals) and inbreeding depression, because 20 years after the translocations no gene flow has been recorded with the closest Dinaric population. In order to ensure its persistence a brown bear metapopulation system could sustain dispersal movements and gene flow. In this context the Friuli-Venezia Giulia region could have a key role because is the only area frequented every year by males from both populations.

Methods Aiming to assess the role of this study area, we mon-

itored brown bear presence in 2012–2017, integrating an existing dataset with new observations obtained mainly by noninvasive genetics and telemetry.

Results Results confirmed the exclusive presence of males dispersing from both Slovenia and Central Italian Alps. Individuals showed a great turnover highlighting a high degree of environmental permeability. Genetic variability of Slovenian bears roaming in Friuli is higher than Central Alpine bears.

Discussion The establishment of a reproductive stepping-stone population asks for the presence of females that could be translocated to Friuli and international cooperation for the species' management. Translocations needs to be carefully evaluated taking into account human dimension and other socioeconomic aspects.

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Diet of otter *Lutra lutra* in river basins of the Sila National Park: a first assessment

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P014

Introduction In 2017 a research project was undertaken in the Sila National Park (SNP) to evaluate the conservation status of a recently-established otter (*Lutra lutra*) population and to conduct a first assessment of the local diet of otters. Knowledge of feeding habits of the otter can help protected areas to implement adequate conservation actions for this endangered carnivore. However, investigations on the trophic ecology of otters are still scarce at the southern edge of the Italian distribution range. Here we explore prey and diet composition of otters in three river basins of the SNP, using spraint analysis.

Methods Spraints (faeces) of otters were collected at 25 stream sites in the SNP and neighboring areas in March and June-July 2017. All spraints found were individually stored in paper bags, labelled and left to dry. For the analysis, spraints were washed and sifted through 0.5 mm mesh sieve. Undigested remains were examined under a binocular microscope. Prey were identified from diagnostic hard parts (DHP) using reference keys and personal bone collections. Contribution to diet of different prey types was quantified as relative frequency of occurrence (RFO), i.e. the percentage of occurrences of each prey category in relation to the sum of all prey items. We also counted the minimum number of prey individuals (MNI) consumed based on the number, pairs and side of DHPs. Diet composition was expressed as RFO of general prey categories: fish, amphibians, reptiles, crustaceans, birds and mammals.

Results The remains of 540 food items were identified in 113 spraints collected along streams and rivers of Neto, Savuto and Trionto river basins. We identified 20 different prey taxa in spraints. Fish (64% RFO), main brown trout, and anurans (24% RFO), main brown frogs, were staple prey of otters in the study area. Reptiles (grass snake), aquatic invertebrates, birds and crustaceans (river crab) made a minor contribution to the otter diet (0.9–7% RFO). Diet was more diversified in the lower reaches of rivers and outside the park, where otters prey also upon Cyprinids, eels, spine loaches and crabs. Small numbers of prey individuals were counted in spraints.

Discussion Results suggested that richness and abundance of otter prey are relatively low in watercourses of the SNP and increase in lower course of rivers, outside the protected area. This condition can result from natural and anthropic factors: watercourses occupied by otters in the SNP are high elevation, low order streams and are impounded by hydropower dams and plants. Fish species richness and biomass are naturally low in upper streams and hydroelectric schemes are known to cause ecological stress on ecosystem and river biota to downstream reaches. We believe that increasing food resources in the SNP is critical to improve the conservation status of the local population of otters. Fish restocking with local broodstock and a sustainable hydropower reservoir operation can contribute to achieve this goal.

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Use of space by red deer (*Cervus elaphus*, L. 1758), Cansiglio Forest: ecological and silvicultural assessments in summering and wintering areasC. GALVAN¹, S. OLM¹, M. BOTTAZZO², A. MALTONI¹, S. NICOLOSO³¹DISPAA – Università degli Studi di Firenze²Veneto Agricoltura, Agripolis Padova³D.R.E.Am. Italia, Pistoia. e-mail: nicoloso@dream-italia.it

P209

Introduction The Cansiglio Forest (BL/TV and PN) experienced, in the last years, an increasing number of red deer presence within the protected area reaching a density strongly impacting the whole ecosystem providing a risk to the perpetuation of the forest.

With this study we analyzed the seasonal use of the red deer habitat using geolocation data received from 10 female equipped with GPS-GSM radio-collars. In this way, different summer and winter habitats have been identified and data on the main ecological and forest parameters have been collected.

Methods Satellite data were used for the period between April 2015 and June 2016. Fixes were transmitted every 4 hours up to 6 times a day.

The georeferenced data were joined together in chronological order obtaining 10 polylines; around them, areas of tolerability (buffer) of 200 m were created. The 10 polygons obtained were fused together. The object obtained was superimposed on a 100×100m grid meshes then we started to randomly extract the jerseys within three attendance classes (TOP, MED, NULL). Thus, 120 test areas were analyzed equally divided between winter and summer areas and between attendance classes.

The work was focused on the analysis of χ^2 test, to test the presence of correlation within collected data.

Results On the visual covering values at 10 and 25 meters

from shrub and tree vegetation there was a clear selection for open formations compared to forest, both during the summer and winter seasons.

Beech woods were the least affected by the stable presence of the red deer, probably due to scarcity of undergrowth.

A clear differentiation has emerged between wintering and summering areas, where the main role is played by vegetation component that offers visual coverage and microclimatic regulation. During both summer and winter, the areas that offer a tree cover between 50 and 75% are preferred, where this is present.

Most of the areas frequented during the winter season have a general greater arboreal and shrub cover, therefore also visual.

Discussion This work is part of research aimed to acquiring distributive knowledge of this population of red deer gravitating seasonally between the protected Cansiglio area and external areas where hunting is allowed. In particular, the knowledge of the forest and environmental parameters of the various seasonal habitats allows the managing body to have information on which types of forest favour or not the species and therefore orientate itself on a silviculture attentive also to these aspects. The red deer pressure is also strong throughout the state-owned area and the population dynamics are still vital and therefore it is necessary to constantly monitor the impact on the forestal environment and on all the other faunal components.

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Bats and urbanisation: on the road to coexistenceF. GILI¹, S.E. NEWSON², D.E. CHAMBERLAIN¹, J.A. BORDER²¹Dipartimento di Scienze della Vita e Biologia dei Sistemi, Università di Torino, Via Accademia Albertina 13, 10123 Turin, Italy. e-mail: fabrizio.gili@edu.unito.it²British Trust for Ornithology, The Nunnery, Thetford, IP24 2PU, UK

P410

Urbanisation can be described as the most ecologically damaging change in land use, posing significant threats to global biodiversity. Most bat species are threatened by urbanisation, due to the lack of vegetation, scarcity of prey, artificial lighting, noise and generic disturbance in urban areas. However, buildings can also offer important roosting sites to bats, and some species have adapted to forage near street lamps. To date, our understanding of what influences bat species in urban habitats is still very limited, and further studies are needed focusing on the effects of urbanisation on bats, in order to apply the necessary preventive measures to make the coexistence between bats and humans possible. In this study, data from a citizen science project were used to quantify the importance of fine-scale habitat configuration and composition for bats, focusing on urban areas and their surroundings. Specifically, relationships between bat distribution and activity in built-up areas in Norfolk (UK) were analysed in relation to fine-scale remote sensing data representing the impervious surface (i.e. buildings and roads), waterbodies (drains, lakes and rivers) and tree-cover density. Furthermore, hypothetical future scenarios were considered, assuming an increase in impervious surface, woodland surface, or number of impervious patches, and the effects of these changes on bat species were quantified.

Over a million bat recordings from four years of monitoring (2013–2016) were used in this study. The complex interspecific variability in habitat selection by different bat species was highlighted. Lakes and discontinuous woodland were the most

preferred habitats. Urban areas were the least selected habitat, confirming urbanisation as the most ecologically damaging land use type. However, the way in which urbanisation affected bat populations greatly depended on the species considered. Species of the genus *Myotis*, barbastelle and brown long-eared bat were the most impacted, whereas species of the genera *Nyctalus* and *Pipistrellus*, as well as serotine, were less impacted. Potential evidence of *Nathusius*' pipistrelle migratory behaviour was detected. Bats were shown to be more capable of exploiting rural areas than large urban centres, probably due to lower disturbance, lower levels of artificial lighting, a greater amount of old buildings and greater proximity to foraging sites. Management plans aimed at improving the suitability of built up areas for bats would therefore have a much more positive effect if performed in small urban centres, suburbs and villages. The ecological land-use complementation approach, which involves the allocation of different types of urban green patches in close proximity to each other, seems the most sensible solution to encourage the exploitation of large urban areas by bats. Connections among these strategic green areas in cities, rural areas and natural habitats should be improved. New buildings should be located in already existing urban areas, with no creation of new urban patches, in order to avoid disturbance in potential commuting or foraging sites. Expansion of discontinuous woodland surface should be encouraged, while the preservation of unmanaged areas within large plantations, as well as the use of bat boxes, would support the exploitation of continuous woodland by bats.

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Monitoring extent of occurrences as a way to understand elusive species' population dynamic: an update to the otter status in ItalyS. GIOVACCHINI¹, M. DI MARZIO², M. MARRESE³, A. LOY¹¹Dipartimento di Bioscienze e Territorio, Università degli Studi del Molise, Contrada Fonte Lappone, 86090 Pesche (IS). e-mail: simone.giovacchini@yahoo.com²Raggruppamento Carabinieri Biodiversità, Reparto Biodiversità Pescara, viale Riviera 299, 65100 Pescara³Centro Studi Naturalistici ONLUS, via Vittime Civili 64, 71121 Foggia

P201

To be able to detect the population dynamics of elusive species with large home ranges we can monitor either their Areas of Occupancy (AOO) or their extent of occurrence (EOO), as range contractions or expansions often reflect population trends. This is true especially for the Eurasian otter (*Lutra lutra*), whose populations are spatially arranged among fluvial systems, which are connected by the watershed environmental matrix. As otter presence is easily detected through indirect signs, otter survey are efficient in the discovery of new areas of presence or local extinctions, and to relate survey site characteristics with presence/absence of the species. We surveyed river catchments at the most northern boundary of the distribution and within the gap area between the two residual Italian populations in southern Italy joining a project promoted by the Cilento Vallo di Diano e Alburni National Park. Following the standard procedures recommended by the IUCN Otter Specialist Group, up to four sites were surveyed for each 10×10 km UTM grid cell of the study area, searching for otter signs (faeces, anal jellies, foot-

prints) along ten rivers (Volturno, Candelaro, Sinello, Osento, Feltrino, Moro, Arielli, Foro, Alento and Pescara). We found otter signs along all rivers of the gap area: those flowing westward (Volturno and its main tributary Calore) were fully occupied by the species, while in the eastern catchment of Candelaro just few signs were detected. Along the northern boundary, we only found four positive sites in the Foro catchment, and none along the Sinello, Osento, Moro, Feltrino, Arielli, Alento and Pescara. Results revealed that the small northern subpopulation is no more isolated from the core southern area of occurrence, and that the expansion northward is still ongoing, likely reaching the wide Pescara catchment in the near future. Also, the Volturno river basin likely reached its carrying capacity, thus further northward expansions is expected from this river toward the neighbouring Garigliano river, still avoided of otters. On the eastern portion of the gap area the expansion process is less marked, and further investigation are needed to identify the factors that could speed up the process.

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A new framework for photo-trapping data managementG. LA PORTA¹, F. VERCILLO², G. LOMBARDI³, L. CONVITO³, U. SERGIACOMI³¹Dept. of Chemistry, Biology and e Biotechnology, University of Perugia, Italy. gianandrea.laporta@unipg.it²WildUmbria Association, Perugia, Italy³Osservatorio Faunistico Regionale, Regione Umbria, Perugia, Italy

P406

Introduction Wildlife conservation is a major concern for many public administrations that require simple methodologies and cheap instruments for carrying out routine monitoring activities. In the last years, photo-traps have represented one of the best proficient and inexpensive methods to monitor wildlife populations. By using these devices, observations can be made by day and night, and wildlife managers can achieve information on the area of distribution of species and some indications on their abundances as well. However, managers frequently under-exploit the amount of information collected by cameras because cataloging and organization of digital material, and related data extraction are highly demanding.

The basic aim of the study was to develop a framework for a systematic organization of photo-trapping images for operators involved in wildlife management. In particular, the specific targets are: i) to reduce the time required to managers to archive the essential information collected by cameras; ii) to provide a set of standard procedures for the elaboration of photo-trapping data, and iii) to investigate the patterns and the habits of wildlife species.

Methods As a primary method for data elaborations we chose the R computational environment because it is open source, cross platform, and widely used in ecological research. In R, every step of data processing is stored as a script, making it possible

to reproduce the analysis for many co-workers. We designed a series of functions starting from the exif metadata reading to the species pattern elaboration.

Results The designed script is constituted by a series of functions that analyse an organized structure of folders and sub-folders properly arranged by the operator after the downloading process of pictures from the camera. In fact, in order to work properly, the script requires pictures of the same species to be in the same folder. In combination with the exif tools, the script archive the information collected by each shot in a data frame of the photo-trapping session, differencing day and night records. The elaboration procedure require less than one second to process each picture and a glimpse on the distribution of the shots over time is provided.

Discussion Currently, photo-trapping represents one of the best methods to monitor wildlife populations, but photo collection organization and, subsequently, acquisition and recording of the exif data could represent a bottleneck that creates delays and higher elaboration costs. The developed package may help operators to manage their photo collections in a functional way and provides a simple tool to standardize their routine analyses. At the present time the framework is limited to the elaboration of photo files, but it is under study the possibility to extend the project to video files as well.

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Conditions determining PCR success in otter landscape geneticsF.A. LIOCE^{1,2}, M. VALLISNERI¹, G.A. DE GROOT², D. SCARAVELLI³¹Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Bologna, Via Selmi 3, 40126, Bologna, Italy²Wageningen Environmental Research (WENR), P.O. Box 47, 6700 AA Wageningen, The Netherlands³Dipartimento di Scienze Mediche Veterinarie, Università di Bologna, via Tolara di Sopra 50, 40064 Ozzano dell'Emilia (BO), Italy. e-mail: dino.scaravelli@unibo.it

P028

Non-invasive sampling for genetic analysis using DNA from feces is a useful technique to monitor animal populations. But despite being a very promising tool, it still has some limitations and can give some problems such as low success rates of genotyped samples, contamination concerns and high microsatellite genotyping error rates. To optimize success, it is important to follow specific steps, including a stringent sample selection in the field, proper storage conditions, and choice of the optimal DNA extraction method for the study species. Furthermore, the PCR success rate could potentially be influenced by factors prior to collection, such as temperature and the diet of the species, as well as by sample storage time. Here, we investigated the effect of temperature at time of collection, average maximum temperature one week prior to collection and storage time on the amplification success rate of microsatellite DNA extracted from fecal samples of the Eurasian otter (*Lutra lutra*) in the Netherlands. To do this, we considered two cases: firstly, we performed a logistic regression to assess whether temperature at time of collection and/or storage time could be used to predict the genotyping success rate for one microsatellite locus, that is used as a primary selection tool for sample quality. Secondly, we considered PCR success rate as the number of successfully scored loci out of the total

13 loci used in the landscape genetic study of Dutch otters and assessed the effect of temperature at time of collection, average maximum temperatures one week prior to collection and storage time. Results showed that when considering one locus only, the amplification success rate was not influenced by temperature. However, when considering all the loci temperature at time of collection and temperature one week prior positively influenced the PCR success rate, meaning that as the temperature raised, the success rate increased. This result was contrasting most of the literature, indeed, as it would be expected, high temperatures should cause a more rapid degradation of DNA caused by higher activity of hydrolytic enzymes in feces. Probably there were outside factors (e.g. the otters' diet) that we did not control and that were confounded with temperature requiring the need for further investigation. Storage time had no effect on DNA amplification success rate in any of our tests. Our results suggest that DNA amplification success rate is influenced by many factors. Before starting a non-invasive study, it is fundamental to take into account several factors and to study to what extent each factor influences the amplification success in order to maximize the DNA amplification success rate and to reduce genotyping error rates.

Diet of the otter (*Lutra lutra*) in NE Italy: a preliminary study using traditional and NGS approaches

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P030

Eurasian otter (*Lutra lutra*) has recently returned to colonize the river network of the Region Friuli Venezia Giulia in the area of Tarvisio, along the catchment "Slizza-Gailitz". The aim of this study was to analyse the composition of the diet of otters in this newly colonized area. The traditional approach to get information on diet of predators, is based on the identification of prey remains found in their scats with the help of a microscope. This analysis, however often leads to problems as, for example, the lack of prey identification at genus/species level. To overcome these problems, an additional NGS approach has been recently widely applied, the DNA-barcoding which has proven to be valuable in several diet studies on different species of animals, although it may also lead to biases related to quantification of number of prey found in scats.

In this study, we analysed otter diet in the area of Tarvisio, by integrating these two approaches. Furthermore, we investigated the existence of a trophic selection of otters on different size classes of fish, comparing data gathered on their diet with data on the availability of fishes of different size classes along the Slizza-Gailitz catchment.

From June 2016 to February 2017, 102 spraints were collected. All spraints have been analysed with a microscope. A subsample of 50 spraints was analysed also with DNA-barcoding method, based on the hypervariable V9 region of the 18S rRNA.

Traditional analysis revealed that otters eat mainly fish, followed by amphibians, both annually and seasonally. A little presence of crayfish was also recorded from spring to autumn. Fish eaten by otters belonged to two taxa: Salmonids and European bullhead (*Cottus gobio*), with the first preyed more frequently. Results indicated also a selection on Salmonids of small size (75–100 mm). DNA-barcoding analysis confirmed the results obtained with the traditional analysis in terms of composition of the diet of otters. Moreover, through DNA-barcoding it was possible to obtain information on the Salmonid species preyed: some of the sequences obtained, were in fact attributable to the brown trout (*Salmo trutta*).

Results obtained reflect trends described in other diet studies in Europe, with fish being the most preyed taxon by otters. The size of preyed Salmonids does not overlap with the size-range of angling interest, thus preventing the possibility of arising conflicts with anglers. DNA barcoding approach proved to be more informative at species-level identification than traditional approach, but the lack of reference sequences in GenBank database for many potential prey species present in the study area, prevented us to identify the other taxa found in spraints at more informative levels. In conclusion, DNA-barcoding has proved promising also for Eurasian otter diet studies but, to improve our results, further investigation is needed.

Study about deer spatial behavior (*Cervus elaphus*, Linnaeus 1758) using GIS techniques and the use of spatial data with GPS-GSM collars in the State-owned Forest of Cansiglio (BL)

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P310

Introduction The research focused on the study of deer spatial behavior, considering a sample of 10 female specimens, in the State-owned Forest of Cansiglio through the use of GPS-GSM collars. In this area, the monitoring of the deer has been active for many years, with the final purpose of outlining the areas most frequented by these individuals and to minimize the interactions between the species and the anthropic activities, but also the negative effects that have been found on the biocenosis.

Methods The trial was carried out from 11/04/2015 to 31/12/2016. During the test 18636 localizations were recorded, in order to analyze the preferences of the animals concerning different types of soil and landcover, divided by season and time slot. The whole study area has been divided into two zones, the summer and the winter, based on the locations. Subsequently, the data were differentiated according to the time slot, thus being able to observe not only the seasonal behavior, but also the daily one. Thanks to the help of the CORINE Land Cover 2000 database, it was possible to correlate the fixed animal positions at a given time to the different land use of the study area.

Results In this way, it was possible to define the density of animal locations recorded in each single zone divided by season and time band. Since each registered point is associated with geographic coordinates, it is possible to trace the path of the animals, highlighting the places of greatest frequency. By means of the GPS plus X and QGIS software is possible to study what the animal prefers and what it avoids, thus going to define what the individual is driven to look for. Thanks to the use of various programs, it has been possible to diversify the summer and winter ranges, also highlighting the soil preferences in the various seasons and time slots.

Discussion The results show that the animals exploit intensely only some circumscribed zones of the study area, while other sites are little or not at all attended. The land use varies a lot according to the season and the time slot considered. Future developments could concern a reclamation of the unpopulated areas present in the study area, in order to increase the pasture areas in these zones, reducing grazing problems in farm areas.

Only differentiated surveys allow to find the major ecological factors limiting ungulates presence

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P404

In the context of management of protected areas, Ungulates play often an important role, firstly because they are in many situations keystone species, shaping therefore the structure and composition of vegetation and habitats. Ungulates, on the other hand, may be important per se, if they belong to species or populations of conservation interest.

Sardinia holds nowadays the main existing population of the Corsican Red Deer (*Cervus elaphus corsicanus*). A proper management of its habitat is essential for the conservation of this endemic subspecies. We conducted a multidisciplinary study in the most important Corsican Red Deer area, the Monte Arcosu Forest (30350 ha), protected as a Site of Community Interest (SCI). The study involved all wild Ungulates, namely the Red Deer, Fallow Deer and Wild Boar.

A part of the study concerns the identification of ecological factors shaping presence and distribution of Ungulates in the SCI area throughout their annual cycle. To obtain these information, we conducted a series of surveys, involving pellet group counts (in spring and autumn), thermal infrared census (in spring and autumn) and, for the Red Deer only, the census of rutting males. All these surveys were conducted in the entire SCI area.

The collected data were enough for statistical analyses for Red Deer and Wild Boar, instead for the Fallow Deer (it was less numerous in the area) we have only few data. We have mod-

elled the presence and abundance of the Ungulates obtaining five (four for Wild Boar) models per species, all built considering as independent factors a series of vegetational, morphological as well as anthropic features of the area. Presence-only data (rutting males, thermal infrared detections) were modelled with a maximum entropy approach (MaxEnt), quantitative data (pellet counts) were modelled with a GLM approach (with a zero-inflation correction). All models were built with subsets of the original data, leaving the remaining for their validation.

Within each species the obtained models differ to a certain extent, also when they involve the same season. This result is not totally surprising, because each of the selected census methods is able to identify different aspects of the habitat use made by the species. As an example, in spring Red Deer do prefer Mediterranean maquis as stated by pellet counts, but it avoid coltures and tend to approach urbanized areas, as stated by thermal IR model. Similar situations concern the generality of our models. Only with the chosen approach we were able therefore to identify some important factors (either natural and anthropogenic) shaping the Ungulates distribution in the SCI area, allowing to more properly drive the management of the most important habitat and anthropic features to obtain a reliable conservation policy of the area.

EC-SQUARE project: overview on activities, outcomes and lessons learntM.V. MAZZAMUTO¹, F. SANTICCHIA¹, A. BALDUZZI², S. BERTOLINO³, A. MARSAN², A. MARTINOLI¹, M. PANZERI¹, D.G. PREATONI¹, L.A. WAUTERS¹¹Unità di Analisi e Gestione delle Risorse Ambientali, *Guido Tosi Research Group*, Dipartimento di Scienze Teoriche e Applicate, Università degli Studi dell'Insubria, Via J.-H. Dunant 3, 21100 Varese, Italy. e-mail: maria.mazzamuto@uninsubria.it²Department of Earth Environment and Life Sciences, University of Genova, Genova, Italy³Department of Life Sciences and Systems Biology, University of Turin, Torino, Italy

P007

Introduction The EC-SQUARE project was carried out in N. Italy between 2010 and 2015 with the aim of the conservation and protection of the Eurasian red squirrel (*Sciurus vulgaris*) through the removal and control of invasive alien squirrels: the Eastern grey squirrel (*Sciurus carolinensis*) and the Pallas's squirrel (*Callosciurus erythraeus*). The project, realized with the contribution of the LIFE financial instrument of the EC (LIFE09 NAT/IT/095), was carried out in Lombardy, Piedmont and Liguria in partnership with their regional governments, three Universities and Istituto Oikos, an Italian organisation that operates to safeguard biodiversity.

Methods The project used an integrated approach that included: monitoring and control of the invasive squirrel populations through live trapping followed by CO₂ euthanasia; habitat improvement that led to the creation of guidelines for forest management actions favourable to the red squirrel and for the increasing of the presence and observability of the red squirrel in urban parks; communication strategies to inform and improve public opinion and information campaign in schools.

Results The complete eradication of the alien species was not accomplished in Piedmont and Lombardy. Therefore, in Genoa Nervi Urban Park in Liguria, flexible management resulted in the first case in Italy where more than 450 grey squirrels were successfully removed by neutering. Local eradications of invasive squirrels in some sites resulted in natural recolonization by native red squirrels. The communication campaign resulted in the production of a web site (131000 visitors; www.rossoscoiattolo.eu/documenti), brochures, posters, videos and the information

campaign in schools involved more than 4000 students. Initially, EC-SQUARE received strong opposition from (local) public opinion and animal right associations. Consequently, the project staff was constantly active in providing correct information to the public and to administrative and legal authorities, and this led over time to an increase in news illustrating the project in a positive light.

Discussion Although EC-SQUARE achieved some early encouraging results, the eradication of the grey squirrel and Pallas's squirrel is far from complete. The areas interested by the invasion were wide and scattered and funding was insufficient to cover necessary manpower (trappers) costs. Trapping was expensive and human demanding and new technical solutions are currently under study to be applied in the future (e.g. shooting, automatic kill-traps, safe use of rodenticides in areas of exclusive IAS presence). Moreover, the areas with invasive squirrels were mostly woods or parks in an urban matrix and often private land owners refused access to their estates, that became a refuge and source site for the IAS.

After-LIFE activities are ongoing in order to ensure the effectiveness of the results already achieved and to improve the conservation tools and status of the native red squirrel. For the near future, to increase the efficiency of the interventions, it will be necessary to make the activities become routine and to intensify the intervention efforts involving a greater number of operators.

Evaluation of factors affecting genotyping success in brown bear (*Ursus arctos arctos*) feces

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P409

Introduction The success in extraction rate of fecal DNA in brown bear may be problematic owing to the low efficacy of conservation and collection methods. In Italy, the mean genotyping success of samples collected between 2003 and 2016 was very low (17% is referred to the Italian Alps). We therefore tested new preservation methods and new sampling techniques to evaluate the possibility of increasing the success of DNA extraction rate.

Methods In 2017, 20 feces of different individuals belonging to the Brenta population (Trentino, Italy) were collected within 48 hours from deposition. For each sampled scat, 4 portions were preserved in 4 different compounds: 96% ethanol, silica gel, DETs buffer and ATL buffer (a tissue lysis buffer used in nucleic acids purification, supplied by QIAGEN – DNeasy® Blood & Tissue Kit). The samples were sent to the Unit for Conservation Genetics laboratory of ISPRA on the same day of collection. DNA was extracted from each scat (sub)sample after being stored for 3–4 days at -80°C , to nullify the occurrence of *Echinococcus* sp. The collection, shipment and DNA extraction was repeated for the same scat with the same protocol, after 1 and 2 weeks; during this time scats were kept outside, in an accessible forest area.

To evaluate individual genotyping success, we used a mixed modeling approach fitting the sample ID as a random intercept to account for repeated measures, assuming a binomial structure for the response variable.

Results Preliminary results showed a significantly higher probability of individual identification in fresh feces (mean value 0.77) than in 1 week and 2 week-old feces (mean value <0.07), and there was a tendency (albeit not statistically significant) for higher conservation efficiency of DETs buffers in fresh feces, compared to other preservation methods (0.92, 95%CI: 0.43, 0.99). The random term was highly significant and explained about 66% of model variance.

Discussion The relevance of the random term (sample ID) suggest that further analyses are needed to assess whether the addition of more sample-based variables, such as diet and environmental conditions, might help to explain more variance in the model. However, our preliminary findings provide useful indications as how to maximize the success of fecal DNA extraction in brown bear, and more generally in wildlife, by selecting the most appropriate sampling and preservation protocol.

Evaluation of a genetic scat survey methodology to study micromammals presence: The study case of water shrews in Trentino province

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P411

In this study, we have combined the use of scat collecting technique with genetic analyses to update the available data of two species of water shrews in Trentino province, Northern Italy: the Eurasian water shrew (*Neomys fodiens*) and Miller's water shrew (*Neomys anomalus milleri*), whose distribution is poorly known. The second aim of this study was to test both field and laboratory methodologies.

We performed our survey in 3 biotopes were the presence of these species have been previously reported. Besides, we extended the survey to two more biotopes along the Brenta river basin. We applied two different collecting techniques to test which one provides the most successful scat sampling results: by baited tubes and random transects; we also tested the best preservation method for DNA samples with silica-gel and 70% ethanol. On the other hand, we tested two DNA extraction protocols, DNA Blood & Tissue and QIAamp DNA Stool; finally, we tested the results of a restriction enzyme protocol to identify the species by validating it with a standard sequencing protocol.

Out of 94 scat samples, 24 were positive (25.5%). Of these, 19 belonged to *Neomys* sp. and 5 to other mammals. Our results

proof and update the available data of water shrews' presence in Pizè, Inghiaie and Palude di Roncegno biotopes. Furthermore, for the first time we assessed the presence of *Neomys* sp. in Fontanazzo and Resenzuola biotopes.

These results shows that these species are distributed along all the Brenta river basin. The most effective collecting technique has been by random transects, and silica-gel gave us the best preservation results. DNA Blood & Tissue protocol allowed us to extract a higher quantity of DNA compared to QIAamp DNA Stool. Finally, only for one sample we confirmed the enzyme restriction identification method with the sequencing results.

This is the first trial to apply a non-invasive technique aimed at detecting water shrews' presence carried out in Trentino province. These findings have produced a wealth of baseline information for future surveys. But still we have to continue improving the method in order to obtain higher positive results. The aim of this initial survey is to develop an appropriate non-invasive field methods to collect samples that combined with genetic analyses can be adopted for monitoring such elusive and tiny mammals.

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Porcupines facing the Alps: first records of *Hystrix cristata* in Trentino (northeastern Italy)E. MORI¹, A. BRUGNOLI^{2,3}, P. PEDRINI²¹Dipartimento di Scienze della Vita, Università degli Studi di Siena, Via P.A. Mattioli 4, 53100 Siena, Italy. e-mail: moriemiliano@tiscali.it²MUSE - Museo delle Scienze di Trento, Corso del Lavoro e della Scienza 3, 38123 Trento, Italy³Associazione Cacciatori Trentini, via Guardini 41, 38122 Trento, Italy

P018

Introduction The crested porcupine *Hystrix cristata* is the largest rodent currently present in Italy. Until the 1970s, the crested porcupine only occurred in Central to Southern Italy, mostly along the Tyrrhenian coast. After being legally protected and potentially because of the ongoing climatic change, this species has shown a marked range expansion in Italy during the last 40 years, reaching areas where historically absent.

Materials and Methods We collected and summarized all the occurrences of the crested porcupine in Trentino, which is the last Italian region reached by the crested porcupine during its natural range expansion. Occurrences were obtained by checking on open-access citizen-science platforms (iNaturalist.org; www.naturaesocialmapping.it), as well as through camera-trapping.

Results We collected five records of the crested porcupine, all of them located in the southern part of Trentino. The first one dates back to 2011, with one individual observed in the surroundings of Saccone (municipality of Brentonico), at the foothills of Monte Baldo. Three other records are relevant to camera-trapped individuals in Valsugana in 2016 and 2017. A subadult porcupine

was photographed in Pradellano (municipality of Pieve Tesino) in December 2016. In May 2017, two more individuals were reported for Grigno (2nd May 2017) and Samone (9th May 2017). To conclude, some quills were collected in Val di Sella - Malga in October 2017. All these records were collected between 690 and 850 metres above sea level.

Discussion Currently, knowledge on the population status of the crested porcupine in Trentino is still scanty, as only 5 records are available. All of them are confirmed by direct photos. We rule out that quills were used for fishing, as no stream was present in the surroundings of the record site. Although no data are yet available on reproduction of this rodent in Trentino, records of *H. cristata* from this region are all related to young or subadult individuals, most likely in dispersal from the population established in Veneto. Genetics confirmed that the haplotype of the individual from Saccone was also common in the population of porcupine from Verona. As to the other individuals, they may have reached the Valsugana (Trentino) through the Brenta river valley from the near population of Vicenza.

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Long term and large scale management of an Apennine red deer (*Cervus elaphus*) population: results, critical points and perspectivesS. NICOLOSO¹, S. MATTIOLI², A. GAGGIOLI¹, P. SEMENZATO¹, L. ORLANDI¹¹D.R.E.Am. Italia. e-mail: nicoloso@dream-italia.it²Unità Ricerca Ecologia Comportamentale, Università di Siena

P024

The management of red deer encounters difficulties almost everywhere in Europe. This is particularly true for Italy, where a specific hunting tradition does not exist. In 1954 the first selective hunting was carried out in the eastern Alps and the reference management model for decades was very similar to that developed for roe deer. Given their different ecological requirements, red deer and roe deer need a totally different management approach. The large home ranges and daily and seasonal movements of red deer call for vast and well coordinated management units centred on the whole population.

In 1994 we began to monitor the Northern Apennine red deer population, including the provinces of Bologna, Pistoia, Prato, and Florence, by reconstructing its distribution range and perform the first censuses. In 1998 we proposed an innovative management system by planning a unique mega-district encompassing the whole population and constituted of 11 macro-districts in two Regions. The mega-district is governed by means of a five-year management plan and by annual operational programs. Every year, the roaring activity of adult stags is simultaneously monitored across the whole territory, giving an order of magnitude of the population size (now estimated at around 3500 heads in 1613 km²). More accurate census techniques have been adopted in sample areas to evaluate seasonal variation in density. Since 2000 a unique shooting plan is submitted annually, concentrating the culling effort where the damage to

agriculture is highest. During the first 17 hunting seasons, 8438 heads were culled (72.8% of the planned harvest). The overall management approach can be defined as adaptive, capable of being re-modulated according to the needs of the moment.

The initial objective of stabilising the population and then slightly decreasing it and lowering the degree of damage has been reached. Culling activity has not changed the natural demographic structure and the quality of animals in terms of body weight and fertility has been preserved over years. The long duration of this management experience has also permitted the detection of weak points and the identification of significant difficulties in planning. For example fixing precise density targets per zone and classifying the territory as suitable or unsuitable clashes with the high fluidity of daily and seasonal movements of the species. Two assignment systems of shooting permits were tested, the individual and the collective ones, with different long-term consequences on the population structure.

This innovative large-scale unit approach proved to be suited to a conservation-oriented management of the red deer population. Moreover, the large amount of data we collected in these years (biometry, fertility, parasitology etc.) permitted to improve knowledge on population and perform adaptive management actions. It is not insignificant that in the last few years, researchers from Scandinavia have also proposed larger and more coordinated management units.

Evaluation of foraging pressure sustainability of a red deer population (*Cervus elaphus corsicanus*) on habitats in a protected area of Sardinia (Italy)

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P306

Deer migrate between different areas due to seasonal and spatial variation in food availability and predation risk. In small protected areas it is possible that habitat types are not sufficient to cope with deer needs over the seasons, cause moving out of the areas. However, external hunting and poaching activity may inhibit these movements, forcing the animals to remain inside. This causes an increase in density and in foraging pressure, with negative consequences on habitats and populations conservation. The aim of this work was to assess the sustainability of feeding pressure of a red deer population on habitat types in a small protected area.

We monitored a red deer population in the protected area Monte Arcosu Forest SCI (Sardinia, Italy), 30.350 ha, from 2012 to 2014. We estimated the annual density through thermal imagery and pellet-based distance sampling methods. Then, we evaluated the seasonal variation of each habitat types productivity in the same area, and the seasonal variation of sex- and age-specific biomass intake by red deer, assuming a constant annual density during the year.

Biomass intake was estimated using the specific average weight for each age-class, multiplied by fresh biomass harvest per kg, and by an index considering the variations of energetic requirements related to physiological cycles of animals (e.g. mating, and lactating periods). The monthly variation in productivity was estimated in different cover types, and for each of them,

we evaluated the productivity of fruits, herbaceous, deciduous, and evergreen plants. We converted all of them to fodder unit to contrast the estimates. Finally, we evaluated if and when the harvested biomass was not sustainable, exceeding the productivity of habitats. To evaluate the sustainability of harvest, we used the removable biomass threshold (>20%) beyond which the habitats are considered impoverished.

For the analysis, we evaluated a constant foraging pressure of 14 deer/100 ha. We observed that seasonal variation in biomass intake by red deer peaked in summer. Also, we found differences in the temporal patterns and productivity levels reached on the habitat types. The comparison between biomass available provided by the different habitats and the requirements by animals showed a strongly negative balance during Winter when the estimated of biomass intake had exceeded the removable biomass threshold. In contrast, we observed a sustainable situation from Spring to Autumn.

This work highlighted how the protected area may not support the feeding pressure of red deer in some periods of the year when emigration and immigration processes are interrupted. The anthropogenic disturbance, which forces animals to remain into the protected area, does maintain not sustain foraging pressure. Therefore, a correct conservation of habitats and populations should guarantee movement between protected and external areas.

Analysis of spatial use by monitored red deer (*Cervus elaphus*) in the Cansiglio ForestS. OLMI¹, C. GALVAN¹, M. BOTTAZZO², G. ARGENTI¹, S. NICOLOSO³¹DISPAA - Università degli Studi di Firenze²Veneto Agricoltura, Agripolis Padova³D.R.E.Am. Italia, Pistoia. e-mail: nicoloso@dream-italia.it

P002

Introduction This work deals with monitoring the red deer population (*Cervus elaphus*) resting in the Cansiglio Forest. The area has been studied for many years due to a significant presence of red deer, with consequences both on the forest renewal and on the grassland available for livestock. Before this study, the hypotheses about the seasonal migrations never found objective confirmations, for limited size of that area with respect to the known red deer ranges. The objective of the present work is to analyze the effective land usage in the different seasons.

Methods The study is based on 9252 animal localization (fix) from GPS-GSM collars placed on ten deer females. The fixes were every 4 hours (6 daily) between April 2015 and June 2016. Successively, a square mesh-grid of 100 m side has been created containing all fixes and trajectories of every animal has been obtained by connecting the fixes in chronological order. Buffers of 200 m side have been created along trajectories, and they have been fused in a single object containing all fixes and the whole study area, using previously created mesh-grid. Random extraction was performed on mesh-grid in order to obtain 121 sample areas according to different seasons (summer, winter) and to animal frequentation (no frequentation, averagely frequented and highly frequented). Samples concerned circular areas of 10 m radius centered on pertinent mesh. Investigated parameters involved topographical variables, vegetation covering, visual covering degree, the pastoral value and the incidence of environ-

mental and vegetation parameters.

Results Statistical analysis allowed to determine the meaningfulness of some selected variables and the relevance of some parameters for understanding the animal choice concerning the frequented areas. The deeper analysis has been that related to the grass/shrub covering, the importance of the pastoral value and the visibility of a plywood cutout of the red deer female. Parameters like elevation, the shrub and grass covering, the presence of palatable species appear to be significant for habitat selection. The possibility of visual covering and refuge, instead, does not seem to be a priority in the area choice.

Discussion This study can be a useful instrument to assess the possibility of improving the management of red deer in the Cansiglio area, aimed to reduce the excessive density that affects trees and understory renewal, both essential for biodiversity maintenance. Another interesting aspect it's about the "protection" of the area: although the food availability here is definitely lower than in the Friulian side, the larger part of the red deer come back to the protected area after snowmelt, concentrating in a limited forest area, also as a consequence of exclusion of some paddocks for livestock grazing. Increasing the number of monitored animals and enchaining field survey, could bring to the development a new strategy of red deer management in the Cansiglio, aimed at protection of forest and biodiversity.

Use the distance sampling applied to the pellet group count to estimate density of Sardinian ungulatesL. ORLANDI¹, P. SEMENZATO¹, A. GAGGIOLI¹, F. MARTINI¹, A. COIS²¹DREAm Italia soc. coop. Via Garibaldi 3, I-52015 Pratovecchio, AR, Italy. e-mail: orlandi@dream-italia.it²Wildlife Protection and Hunting Office, Metropolitan City of Cagliari, Italy

P307

The distance sampling applied to the pellet group count to estimate the densities of ungulates has been widely used in temperate forest environment. The applicability of this method and the accuracy of the estimates obtained are strongly influenced by climatic and environmental characteristics, therefore this study represents an experimentation of its applicability in the Mediterranean environment. This method has been applied to the population of Sardinian Red deer (*Cervus elaphus corsicanus*) and Wild boar (*Sus scrofa meridionalis*) in the Monte Arcosu Forest SCI (30.353 ha) Sardinia (Italy).

It was necessary to estimate the decay and defecation rates for both species, so from June 2012 to May 2013 the decay time of fresh pellets has been estimated in 25 sample stations placed in representative way of the 11 identified environmental typologies. The autumn average decay rate of the Red deer resulted 121.6 (SD 9.0) and 71.11 (SD 1.7) in spring; respectively for the Wild boar 66.27 (SD 7.45) and 65.58 (SD 1.58). The defecation rate was inferred by the bibliography because there were no enclosures in which it could be experimentally deduced: for the Red deer a value of 23.4 group/deer/day (SE 6.5) was used and a value of 23 for the Wild boar. In order to minimize the sources of error caused by the recognition of the pellets, the detectors were trained to discriminate Red deer from the other deer pellets in the area (Fallow deer).

The pellet count was carried out for 4 sessions (Autumn 2012, Spring 2013, Autumn 2013 and Spring 2014) respectively on a total number of 166, 122, 108 and 108 transects (total 504) with a length between 200 and 300 m. Since it's a retrospective method, the estimated densities refer to the number of months prior to sampling, which corresponds to the average decay time. The Red deer average annual density results 10–11 (95% CI) and respectively for each season: 13.93±4.69; 11.3±3.3; 10.9±3.5; 7.9±1.5. There are no significant differences between annual or seasonal densities. The Wild boar average annual density results 2.6–7.8 (95% CI) and respectively for each season: 4.9±0.9; 5.0±0.6; 4.0±0.9; 5.8±0.9.

The method applied in the Mediterranean environment allowed to obtain estimates of density for both species, but with a low level of precision (up to 30% CV in some samples) due to some findings raised. The more problematic was the lack of visibility within the Mediterranean maquis which involved a low number of observations outside the transect line and influenced the accuracy of the final estimates. Instead the climatic and environmental homogeneity of the study area, in comparison to Apennine or Alpine environments determined a smaller seasonal variability of the decay rate favoring therefore a good precision in the density estimation.

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Food for all: when and how does supplemental feeding drive roe deer space use patterns?F. OSSI¹, J. BRIGHT ROSS², W. PETERS³, F. CAGNACCI¹¹Department of Biodiversity and Molecular Ecology, Research and Innovation Centre, Fondazione Edmund Mach, 38010 San Michele all'Adige, TN, Italy.
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P021

Introduction The provisioning of supplementary food in winter is a common management practice for ungulates across Europe and North America. Although the presence of feeding stations presumably affects individual distribution and space use patterns, few studies have examined what determines the degree to which ungulates use these concentrated food resources, and its consequences on space use patterns. By being unable to store fat reserves, and limited by further morphological adaptations for coping with winter severity, roe deer (*Capreolus capreolus*) living in harsh winter environments represent an excellent ecological model for evaluating the impact of this human-induced resource alteration on individual space use patterns. Accordingly, we present a set of analyses to address this topic. First, we examined whether roe deer habitat selection is locally influenced by supplemental feeding sites. Then, we assessed the determinants of feeding stations use by roe deer, and its consequence on space use patterns, through a multi-population analysis at the European level. Finally, we evaluated the impact of deploying these artificial sites on the predicted habitat suitability of an alpine roe deer population.

Methods Within the framework of Resource Selection Functions, we empirically assessed third-order habitat selection in winter in an alpine GPS-collared roe deer population, with a specific focus on selection for supplemental feeding sites. We then scaled up our analysis by evaluating the effect of several biotic and abiotic determinants on roe deer supplemental feeding usage across nine populations spanning a wide latitudinal and altitudinal gradient. Finally, we used the data from contemporary

(2012–2015) and historical (1997–2002) datasets of roe deer relocations to examine whether the deployment of supplemental feeding stations in an historically feeding-free alpine area has influenced the predicted spatial distribution of this ungulate.

Results Our empirical sampling found that roe deer selected strongly for sites in proximity to supplemental feeding stations in the alpine study area. The large scale comparative analysis showed that roe deer used feeding station sites opportunistically, especially when weather conditions were harshest, no competitor species were present, and the sites were supplied with food. We also found that the intense use of these resources led to a shrinkage of individual home ranges. Accordingly, our predictive models showed that roe deer winter habitat suitability was influenced by a combination of snow cover abundance and supplemental feeding stations availability.

Discussion Our results emphasize the role of supplemental feeding sites in roe deer movement ecology. These concentrated resources can heavily alter winter space use patterns, especially when conditions are harsh and individual metabolic needs are high. We highlight the need to carefully consider the presence of these sites when analyzing movement patterns of ungulates, as well as those of other non-target species that can feed at the stations. We also invoke research on the pros and cons of such practice, including the measurement of individual fitness (e.g. phenotypic quality, fawns number), overwinter survival, population density, competition-driven stress and disease dynamic transmission risk.

Distribution and habitat selection of the Eurasian red squirrel near Perugia, Umbria: collecting and analyzing data to inform conservation and management

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P303

Introduction The Eurasian red squirrel (*Sciurus vulgaris* Linnaeus, 1758) is known to locally disappear because of the competition with the Eastern grey squirrel (*Sciurus carolinensis* Gmelin, 1788), that has been introduced into Europe from North America. In Italy, the alien species is reported in several regions, including Umbria, where it was probably introduced near Perugia just before 2000. Here, the sightings of the native species seemed to be decreasing following the grey squirrel introduction, but no quantitative data were available on its abundance and distribution.

Methods Within the framework of the LIFE U-SAVEREDS Project, funded by the European Commission to protect the red squirrel and to prevent the loss of biodiversity in the Apennines, we thus performed point transect surveys in the city of Perugia and neighboring areas, adopting a distance sampling approach. Data were collected in 2015, at the beginning of the Project, and then in 2017, after the implementation of a management plan aimed at the eradication of the alien species. Density Surface Models (DSMs) were then fitted to investigate the species-habitat relationships and to derive distribution maps. The latter allowed to visualize local densities and to verify the suitability of specific sites within the study area with respect to the implementation of reintroduction or restocking activities.

Results 25 and 50 red squirrels were observed in 2015 and 2017, respectively. In 2017, the native species was detected on 40.8 km². Sightings were recorded in areas where the red squirrel did not occur in 2015 and that were previously occupied only by the alien species. Accordingly, taking into account the results of the Generalized Additive Model used to fit the DSMs, the spatial distribution of the red squirrel seemed affected by the vegetation type, namely by the type of woodland (e.g. broadleaved woods vs. coniferous woods), but the presence and density of grey squirrels also played a role in determining the local densities of the native species.

Discussion According to our results, the red squirrel seems to be expanding its range in the Perugia area, following the partial removal of grey squirrels, but a significant change in the density of the native species is probably yet to come. The critical analysis of the local densities and of the 2017 distribution map indicates that the sites previously identified for reintroduction/restocking activities already host red squirrels. Although reinforcing the native squirrel population in these sites could represent a viable option, translocations should be implemented with caution also to avoid impacts on the source site, identified on the outskirts of the study area.

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OpenMICE: An Accessible Georeferenced Database on Small MammalsC. PANICCIA¹, M. DI FEBBRARO¹, L. DELUCCHI², R. OLIVETO¹, M. Marchetti M.³, A. LOY A.¹¹Environmetrix Lab, Dipartimento di Bioscienze e Territorio, Università degli Studi del Molise, Contrada Fonte Lappone, I86090 Pesche, Italy. e-mail:

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P047

Introduction The use of database technologies as a tool for implementing data for quantitative ecological studies and biodiversity conservation planning has recently attracted the attention of the biological community. Despite the fact that the number of biodiversity datasets is quickly rising, data on small mammals are still scarce, mainly because of these animals' high elusiveness and to the taxonomic identification problems they raise. Fortunately, owl pellets can be a powerful cost-effective and efficient method to sample small mammal communities across broad spatial and temporal scales. Based on this, we implemented the first standardized and accessible georeferenced database of small mammal occurrences, abundances and functional traits in south-central Italy.

Our specific goals were: (1) making data usually restricted to specialized research groups available to a large audience; (2) summarizing information about small mammal inventories derived by owl pellets, focusing on the richness, abundance and functional traits of these species; (3) filling gaps of knowledge on small mammals and consequently guide future sampling and conservation efforts.

Methods Small mammal occurrences derived from owl pellets were obtained from different sources, including original field surveys, publications, grey literature, existing databases and museum collections. We first performed a data-gathering and then georeferenced available sites from five owl species occurring in Italy (i.e. *Asio otus*, *Athene noctua*, *Bubo bubo*, *Tyto alba*, *Strix aluco*). Additionally, for each small mammal species, we

recorded abundance at each site and 18 functional traits with an exhaustive literature review.

We stored data into a relational database, i.e. a set of tables related each other: OpenMICE was designed by normalization rules to minimize redundancy and dependency and to isolate data. This means that design changes (e.g. modifications of a field) can be made in just one table and then be automatically propagated throughout the database.

Results OpenMICE includes 42 new unpublished and 148 published sites for small mammals covering more than 10000 km² in south-central Italy. It includes around 2000 occurrence records and 52650 sampling units on 23 small mammal species (13 Rodentia and 10 Eulipotyphla), covering a 45-year time span (1972–2017). Most of the data collected is on Rodentia (n= 41401, 79.05%), followed by Eulipotyphla (n=10971, 20.95%).

Discussion OpenMICE represents the first attempt to obtain an inventory of small mammal communities including occurrences, abundances, and functional traits, which we hope will help in gaining a better understanding of ecological processes in an anthropized world.

The applications of our community-based spatial relational database are manifold: individual-based models considering functional traits as well as community-based models as potential indicators of global change (i.e. climate, land use) will be explored. Finally, given the long-term support for data storage, new information data can be added and the database can be expanded to include other geographical contexts.

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Composition and complexity of wolves chorus: a multicomponent acoustic behaviour

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P103

The wolf (*Canis lupus*) is a gregarious species, whose vocal interactions plays a central role in its social behaviour.

Long-distance vocal communication between wolf packs are mostly mediated by chorus howling, a series of vocalizations emitted by a pack, in which one wolf begins howling, followed by other members, thus forming the chorus. Chorus howlings are complex, multicomponent signals that include several elements; indeed, choruses begin with simply-structured howls, but also other type of calls frequently occurred in the choral responses. Although howls, the main component, have been highly studied, poor attention has been drawn upon the other vocalizations of the chorus.

In this study, we investigate the structure of the chorus by analysing and quantifying the different components. We combine spectrographic examinations and unsupervised, automated classification techniques in order to examine systematically the qualitative and quantitative acoustic variations in the chorus of free-ranging wolves, with the aim of identifying the different types of call that compose the chorus.

Our results showed that choruses of wolves are rich, complex structures, with several other types of call, different from those

howls. We have identified six types of calls in the wolves chorus, defined by different combinations of fundamental frequency, duration and by the presence or the absence of nonlinear phenomena (deterministic chaos). Wolf choruses are typically composed by at least other three different types of calls: the bark, i.e. relatively long calls characterized by low frequencies and the presence of harsh components; the whimper, characterized by a harmonic structure and a very short duration; and the growl, a call with a noisy structure, low frequencies but relative long duration. Finally, other identified calls are: whine, squeak and yelp.

Whereas some components could be useful in order to transmit information, as the howls, others could be used in the context of attention-altering signal, as found in coyote barks or these calls could be related to social interactions between members of the pack, reinforcing relationships and maintaining hierarchies. Although further studies are necessary to understand the function and ontogenesis of these different calls, our classification of the structure highlight the complexity and multicomponent nature of the chorus, providing a basis for further researches on wolves and other canids vocal behaviour.

Passive acoustic detection of wolvesD. PASSILONGO¹, S.M. SUTER², M. GIORDANO², S. NIETLISPACH³, M. APOLLONIO¹¹Department of Science for Nature and Environmental Resources, University of Sassari, Sassari, Italy. e-mail: danipassi@gmail.com²Institute of Natural Resource Sciences, Zurich University of Applied Sciences, Wädenswil, Switzerland³Nature Reserve and Wildlife Park Goldau, Goldau, Switzerland

P013

Wolves (*Canis lupus*) survey is a difficult and often expensive task due to high mobility, pack dynamic, shyness and nocturnal activity of this species.

Wolves communicate acoustically through howling, within pack and with packs of the neighbourhood. A wolf howl is a low-frequency vocalization that can be transmitted over long distances and thus it can be used for monitoring.

Elicited howling survey is a current method to monitor wolves in different areas all over the world, however, elicited howling may be invasive to residential wolf packs and could create possible negative reactions from the human population.

The aim of this study is to investigate the potential of a non-invasive wolf survey by detecting spontaneous howls with automatic recorders, without broadcast of acoustic stimuli.

We conducted passive acoustic monitoring between August 24th and September 22nd (30 nights) using 6 SM3 Songmeters (Wildlife Acoustics, Inc, USA) to record wolf howls.

We found that it is possible to detect wolves by recording spontaneous howling events. We recorded a total of 18 spontaneous howls (15 single howls, 3 choral howls), with a daily rate of 0.6 howls. We successfully recorded at least one howl in 33% of the considered nights.

Automated broadcasting/recording systems could be useful to reduce labour costs and night work associated with acoustic surveys. Although further studies are needed to investigate the differences between domestic dog and wolf howls, dog localizations are generally well known (houses, farms, kennels), and misinterpretation of results could be avoided with this information.

The use of passive field recorders and the development of optimized field designs for recording as well as enhanced data analysis may provide a powerful non-invasive tool for future wolf monitoring and thus help to establish sustainable management plans for this species and other canids with similar vocal behaviour.

The Brown Bear remains (*Ursus arctos*) from the Late Pleistocene of Crypta degli Avi (Bernezzo, Cuneo), the oldest record of the Western AlpsM. PAVIA¹, E. ARMANDO², C. TARICCO^{3,4}, S. RUBINETTI^{3,4}, L. FERRERO⁵¹Dipartimento di Scienze della Terra, Università di Torino²Gruppo Speleologico Piemontese³Dipartimento di Fisica, Università di Torino⁴Osservatorio Astrofisico di Torino (OATo, INAF)⁵Soprintendenza Archeologia, belle arti e paesaggio per le province di Alessandria, Asti e Cuneo

P101

Introduction During the first months of 2014, the Speleological Club of Cuneo, in particular the Bernezzo Section, found some "bear" bones in a new cave close to the city of Bernezzo named Crypta degli Avi. The bones were exposed during the opening of new passages within the cave. Almost immediately, the Bernezzo Municipality contacted the Earth Science Department of the Torino University for the study and enhancement of the bone remains. We collected the exposed bones and, during two further inspections, we excavated the residual sediments and collected some more bones, which were brought to the Earth Science Department for their cleaning, restoration and study. Thanks to the interest of the Bernezzo Municipality, we could set a scientific and didactic project with a great impact to the general public and to the Bernezzo scholars.

Methods The Crypta degli Avi is a small cavity, mostly vertical, of tectonic origin. The sediments, and the bones therein, infilled the cave after gravitational and alluvial events. The bones were imbedded in a red-clay sediment with no structures and also scattered in different points of the cave.

During the various inspections, more than twenty bones were found. As the cave shows any calcitic structure suitable for dating, we tried, in collaboration with the ETH Lab (Zurich,

Switzerland), a carbon-14 dating on the bear bones, the most representative taxon, using 20 grams of bone material.

Results After the taxonomic analysis, the bones found in the Crypta degli Avi have been referred to 3 taxa: the Brown Bear (*Ursus arctos*), Wild boar (*Sus scrofa*) and a big-size bovid (*Bos* vel *Bison*). The Brown bear is the most representative taxon with at least 15 remains. The presence of two axes clearly indicates two individuals, also confirmed by the analysis of the dental remains, which revealed that the mandible probably belong to a female while the skull is probably of a male. The dating successfully revealed an age interval between 41599 and 43910 years BP, in the last phases of the Late Pleistocene, being the Bernezzo Brown Bear the oldest record of the species in the Italian Western Alps.

Discussion The study of the Pleistocene Bear remains from Crypta degli Avi is a great example of scientific and popular enhancement of paleontological remains, which has to be a pilot for future similar projects, also for other kinds of remains. In details, this project revealed how great the interest on few fossil remains could be if adequately transmitted to the different type of general public.

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The felid remains (*Panthera* sp.) from the Late Pleistocene of Arma del Grai (Garessio, Cuneo)

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P004

Introduction The Arma del Grai cave is opened in the Mesozoic-Eocene limestone in the Tanaro valley, between Garessio and Ormea (Cuneo). The cave shows a quite articulated sub-flat development, with a secondary narrow ramus, opened at the end of the main room, in which a partial skeleton of a mid-sized felid has been found in 1971.

The fragmented skeleton consists in some cranial parts with almost the entire dentition, the two pelvis and some tarsal bones. The mandible was found almost completely crushed and encrusted with calcite and was collected embedded in the sediment.

These remains were preliminary described by Novelli in 1971 in a paper where he described the position of the various remains and their conservation status, without giving any indication about the taxonomic attribution.

Thanks to a collaboration with the Municipality of Garessio, in particular with the Cultural Centre of the town, the remains were moved to the Earth Science Department for their study and enhancement.

The project is started at the beginning of March, so we could present here only the methodology and the expected results.

Methods The remains will be cleaned and restored where ne-

cessary, as they were stored in a chaotic repository for more than 30 years and very few of them only recently exposed to the public, but without any restoration.

After the cleaning, the bones will be analyzed from a taxonomic point of view, comparing them to the various *Panthera* species, also with attention to the various extinct Pleistocene forms.

We also perform a preliminary analysis trying to understand if the fossil remains from Arma del Gari are suitable for the carbon-14 dating thanks to the collaboration with the ETH Lab (Zurich, Switzerland). In fact, will be of crucial importance have the dates of the deposition of those remains, to give them a better meaning.

Results We expect to be able to refer the bone remains to a taxon at species level, as the dental remains are quite well preserved. In addition, we also hope to be able to date the remains, in order to place those remains among the other Felid remains of Northern Italy. It is worth telling here that any Felid is extremely rare in North-Western Italy, with only scattered remains of *Panthera pardus* in two sites in the Cuneo County.

The results of the analysis will be presented to the Garessio general and scholar public and disseminate to the scientific community as soon as we will arrive to the final results.

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Maternal condition and offspring sex-ratio in a red deer (*Cervus elaphus*) population in central Apennine, Italy

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P206

The Trivers-Willard hypothesis (TWH) predicts the ability of mothers to adjust offspring sex-ratio in relation to their dominance and body condition. The probability to produce sons is higher when mothers are dominant and in good condition. The objective of the present work was to study the relation between maternal condition and sex-ratio of fetuses in a wild population of red deer (*Cervus elaphus*) in the central Apennines to test the predictions of the TWH.

We used biometric data collected on adult red deer females killed during the winter hunting seasons, from 2000 to 2016, in Province of Pistoia (District Central ACATER – Area of the deer of the Central Tuscan-Emilia-Romagna Apennine). Assuming that maternal weight and kidney-fat are positively correlated with maternal condition, we performed Generalized Linear Mixed-Effects Models to analyze the probability of producing a son in relation to eviscerated weight (all internal organs removed) and

kidney-fat index (KFI – mass of kidney with / mass of kidney without fat), considering also their seasonal variation. In order to use the most appropriate dataset to assess mother condition effects on offspring sex ratio, we analyzed the increment of weight-for-age and the probability of being pregnant related to weight and age.

Our explorative analysis showed that by age 3 females they reach about 90% of asymptotic mass, and by 2 age have about 80% of probability of being pregnant, dependently on exceeding weight critical threshold. The results confirmed the predictions of TWH. The probability of producing a son increased with the increase of weight and, with greater effect, of KFI index.

Moreover, this study highlighted the great importance of collecting long-term accurate biometric data, during the hunting activity, to increase our understanding of the ecology and dynamics of the wild ungulate populations.

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Monitoring and management of a grey squirrel (*Sciurus carolinensis* Gmelin, 1788) population: effectiveness of the removal strategy implemented in Umbria

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P301

Introduction Just before 2000 Eastern grey squirrels (*Sciurus carolinensis* Gmelin, 1788) were introduced in Umbria, near the city of Perugia. They began to slowly spread from the release site and started to compete with the native Eurasian red squirrel (*Sciurus vulgaris* Linnaeus, 1758). The LIFE U-SAVEREDS Project was thus funded by the European Commission to protect the red squirrel and to prevent the loss of biodiversity in the Apennines. To achieve these goals, management activities aimed at the eradication of the alien species were launched in 2016.

Methods Within the framework of the LIFE U-SAVEREDS management plan, grey squirrels were removed from Perugia and surrounding areas through live capture and subsequent euthanasia. Captures were carried out in an area of 27.8 km² and, at the same time, monitoring activities were implemented to verify the effectiveness of the management plan. In particular, the local densities of the grey squirrel were estimated through the adoption of a distance sampling approach, gathering data from over 750 point transects. Data collected in 2017, after the start of the removal activities, were compared to those recorded at the beginning of the Project, in 2015. In the core area of the grey squirrel distribution, where the capture rate dropped rapidly to

zero because of the intense control activities, we also estimated the probability that local eradication was successful by applying a Rapid Eradication Assessment (REA) protocol.

Results 184 and 64 grey squirrels were observed in 2015 and 2017, respectively. The results of the conventional distance sampling analyses suggested that management activities were effective in reducing the density of the grey squirrel in the Perugia area. Indeed, over 900 animals were removed, and the density estimate dropped from about 4 individuals per hectare, in 2015, to about 0.3 individuals per hectare, in 2017. Also, the overall capture rate showed a clearly decreasing trend. In the core area of the grey squirrel distribution, the eradication probability was around 90%.

Discussion The management activities implemented through the LIFE U-SAVEREDS Project seem effective in reducing the density of the alien species in the Project area, but at present grey squirrels are still captured within the city of Perugia as well as in surrounding areas. As a consequence, for the Project to fulfill its objectives, it is necessary to continue the removal activities at least till the end of 2018, if not further.

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Use and habitat selection of roe deer (*Capreolus capreolus*) in a dry crop plain of north-western Italy

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P022

Roe deer is the most widespread European ungulate, with an estimated population of 9.5–10 millions of individuals covering a 7.2 millions km² range. A 200% increase has been reported in Italy from the half of eighties to early 2000, due to both reintroductions for hunting purposes and positive change in land quality.

Currently the species is colonizing several cultivated areas of the Po Plain, particularly the dry crop plain between the Po River and the Apennines. In these sub optimal areas roe deer can find a high food availability represented by crops (cereals, alfalfa, soybean, hay field), although it can suffer shelter lack such as woodland and scrubland.

The aim of the study was to analyse habitat selection of a roe deer population in two protected areas located in an intensive agriculture landscape in Piacenza province (ZRC Val Trebbia and ZRC Val Nure), far from the species ecological optimum.

From March 2016 to June 2017 day and night transect censuses have been carried out. Comparisons between habitat use and availability have been carried out to show species preferences for some habitat instead of others. χ^2 test has been used to compare observed to expected frequencies. Bonferroni fiducial intervals have been calculated when χ^2 showed a significant difference.

For habitat selection analysis Resource Selection Probability Functions (RSPF) have been formulated to compare habitat feature and landscape metrics around roe deer presence spots to that of likewise random spots situated in each study area. Comparis-

ons have been carried out through Mann-Whitney test. To obtain RSPF binary logistic regression analysis has been used.

365 observations have been reported during dawn or sunset census whereas a total of 393 observations have been recorded during night spotlight census. Habitat selection analysis showed a significant selection of wooded areas, whereas cultivated lands has been avoided or used proportionally with their availability. Urban area didn't show an important avoidance, probably because in protected areas animals are less stressed by human presence.

Home range analysis revealed that both during day and night wooded areas had a negative worth, while cultivated lands, roads, rows and uncultivated were selected. Selection of uncultivated lands doesn't surprise because they are the most like ecotone, which represents roe deer favourite habitat. However, in Val Trebbia ZRC, uncultivated lands hadn't been selected, maybe because of a better river bank vegetation quality than the Nure ZRC. About landscape metrics, mean shape index and total length and total edge showed a significant positive value.

Roe deer therefore seems to have been able to adapt to this sub optimal habitat, using cultivated lands to feed and fragmented woods, rows and uncultivated lands to refuge. Knowing how habitat selection is influenced by landscape structure is essential to predict species ecological responses, to avoid future problems due to his expansion in a such anthropic area.

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Activity patterns of semiaquatic carnivores living in Mediterranean climates: do higher temperatures affect species current behavior?L. QUAGLIETTA^{1,2,3}, A. MIRA², L. BOITANI¹¹Dipartimento di Biologia "Charles Darwin", Università "La Sapienza" di Roma, Viale dell'Università 32, 00185 Roma, Ital. e-mail:

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P026

Traditionally, research assessing climate change effects on wild-life focuses on forecasting how increasing temperatures will change species distributions. Far more rare, instead, is research focused on understanding the effects of higher temperatures on current animal behavior, and the limited available research focuses mostly on small species and is performed in (semi)captivity conditions. Field research assessing the effects of climate and other extrinsic factors on current animal behavior, e.g. daily rhythms, in hot environments (e.g., Mediterranean regions) remains thus rather overlooked, particularly in medium-to-large mammals, including semiaquatic species. This knowledge gap limits the comprehension of how these animals might react to widely-anticipated global environmental changes. One of the topics assessed by LQ's PhD project on the ecology of the Eurasian otter (*Lutra lutra*) performed in Southern Portugal was the behavioral plasticity of Mediterranean otters in coping with harsh climatic conditions. Here, we report on the effects of extrinsic

— focusing on seasonality and air temperature — and intrinsic factors on the current behavior (i.e., daily activity rhythms) of a Mediterranean population of radio-tracked otters. Otter activity, assessed using multiple components cosinor population models, was markedly nocturnal, being affected by seasonality and air temperature. In particular, otters lowered their daylight activity and increased their nighttime activity during the dry season, being generally less active under higher air temperatures. Other extrinsic factors affecting otters' daily rhythms were moon phase, habitat type and wind, while differences in activity patterns owing to intrinsic factors were mostly associated to males' ranging behavior and females' reproductive status. This study provided detailed, population-mean data on *Lutra lutra* daily rhythms, showing that Eurasian otters are well adapted to the dry and wet season-cycle typical of Mediterranean climates, while highlighting potential vulnerability of otters to increasing air temperatures.

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IMIData: a new Database of Iberian Mammal Interactions

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P402

Species interactions are key elements in the shaping of ecosystems and in most ecological processes. Thus, the study of species interactions within and across taxonomic groups allows better comprehension of several relevant ecological patterns, including species' trophic interactions, evolutionary adaptations, ecological and functional roles, and community ecology and evolution. Despite the large availability of traditional dietary studies, quantitative knowledge on the factors affecting geographic and environmental variation in species dietary preferences at global scales remains limited. We assembled a comprehensive species-specific dataset including 430 references from the literature reporting data on species interaction occurrences — for now, mainly trophic — involving mammals from the Iberian Peninsula, termed "IMID" (Iberian Mammals Interactions Database). Data on the diet of mammals or of any species consuming mammals were compiled from the literature, with occurrences georeferenced, checked for errors, standardized and assigned to the taxonomical level using the Global Names Resolver platform (<http://resolver.globalnames.org/>) and the GBIF Taxonomic Backbone. Here, we describe the procedure used to collect and extract data from the literature, and georeference and insert them in a customized data input format, match species names to reference sources, associate species to their taxonomic classification, and check, annotate and correct errors, as well as present preliminary outputs. So far, the IMID database con-

sists of 21221 interaction occurrence records, referring to the 1915–2016 period, concerning the diet of 91 species of predators, belonging to the classes Mammalia (68.2%), Aves (29.9%), Actinopterygii (1%), Insecta (0.5%), and Reptilia (0.4%), and encloses 1573 consumed species belonging to 7 phyla (Anellida, Arthropoda, Ascomycota, Basidiomycota, Bryophyta, Chordata, Mollusca, Nematoda, Tracheophyta), including 442 genera of plants. We built this dataset to facilitate macroevolutionary and macroecological research on interactions involving Iberian mammals. Potential uses include: (i) identifying priorities for future research (e.g. species or areas lacking mammalian diet studies) or for conservation areas (based on food webs' complexity); (ii) assessing spatial patterns in Iberian predators' trophic interactions (e.g. biogeographical variation in species richness of Mammalian dietary guilds) and their correlates; and (iii) predicting the same patterns in new areas, or the effects of species loss on communities' trophic structure. So far, the 98.1% of IMID's entries are related to consumption and only 1.9% to dispersion (mostly of plant seeds by mammals), resulting in a mostly trophic interactions-based dataset. However, IMID should serve as a baseline for similar initiatives/datasets focusing on any type of interactions among species, fostering global and collaborative sharing, integration and maintenance of data between researchers interested in species interactions.

Bats in art: Pisa and Florence in the XIV century

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P412

Introduction This project aims to study the use of the bat image in Italian Medieval and Renaissance art, with particular reference to Tuscany and Umbria. A first article (2017) looked into the Renaissance period in Florence.

Methods The research started from publications on animals in art. The identified works are firstly examined looking for possible interpretations already produced by art historians and scholars of symbologies and then trying to find new ones.

Results This poster examines the image of the bat on a pluteus (panel) of the pergamon (pulpit) by Giovanni Pisano, a masterpiece of Gothic art in the Duomo, in Pisa. This church was badly damaged by fire in 1595, following which the pulpit (1302–1310) was dismantled and reassembled only in 1926. Two other frescoes, one in Pisa, the other in Florence, show depicted devils similar to bats. In Florence there are already tours going to discover unusual places in the city actually including images of bats on monuments, a useful opportunity for a more thoughtful approach also to their ecological role in nature.

Discussion The upper part of the pulpit consists of nine slightly curved plutei (panels) showing episodes from the Life of Christ. On one of these there are scenes of the Passion. In the lower part a villain holds a shield with the image of a bat as a coat of arms expressing the character and the nature of Christ's captors. It

is a cruel, threatening symbol well corresponding to the figure of this myrmidon who is about to grasp the Christ. In the traditional medieval view the bat is blind and indicates religious and/or moral blindness and the inaccessible knowledge of God. The bat is in some way a borderline figure, whose composite nature, conceived as "neither beast nor bird", is described in the Bible among the abominable and repugnant fowls, which are not to be eaten. Close to the Duomo we found the Camposanto (monumental cemetery). Inside there is "The Last Judgment and Hell" (1335–1340), fresco by Buonamico Buffalmacco (1290–1340). Next to a big devil, Lucifer, there is another one impaling the envious boiled in a cauldron. This green devil (this colour symbolizes the sin of envy) has the face very similar to a real bat, with large ears, while the lower limb (only one is visible) resembles that of a bird, with clawed fingers. Until the seventeenth century bats were considered birds. Another fresco (around 1387, by Spinello Aretino, Sacristy of the Church of San Miniato al Monte, Florence) shows a devil breaking the bell with which Benedict demanded food from his hermitage. Also in this painting the devil is rather similar to a real bat, from the lower limbs to the wings. At the end of the Middle Ages paintings were invaded by these devils, possibly originated from Chinese symbology and folklore.

Is *Lepus europaeus* native to Pianosa Island?F. RIGA¹, V. TROCCHI², F. GIANNINI³, C. GOTTI¹, N. BACCETTI¹¹ISPRA, Italian National Institute for Environmental Protection and Research, via V. Brancati 48, 00144 Rome, Italy. e-mail:

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P010

Introduction Genetic results indicate that the European brown hare population inhabiting Pianosa island carry the most common historical Italian haplotype. Considering autosomal markers, Pianosa brown hare and current Italian peninsular population are genetically distinct. The discovery of this ancient and possibly native population, isolated at least since the mid-nineteenth century, and not affected by modern translocation/restocking events, has a great relevance in conservation. In a previous study we found morphological differences in the skull between the Italian historical European brown hares than recent ones. With this work we intend to propose a first craniometric characterization of Pianosa's hares and their comparison with samples of four other populations.

Methods Craniometric characterization was assessed analyzing 128 skulls belonging to 6 different groups (21 Pianosa, 21 historical Italian Peninsula – before 1930, 53 modern Italian Peninsula, 20 South America, 13 East Europe). To avoid age variation, only adult hares (age class IV) were used. We recorded 21 cranial and mandibular linear measurements, from each skull using a digital caliper with an accuracy of 0.01 mm. The original data set was log transformed. The differences between groups was analyzed using Kruskal-Wallis test. Each group was tested against the null hypothesis that the median was the same across the categories, using the independent samples median test. The null hypothesis was rejected when an exact significance <0.05 was reached. When rejected, the test was considered statistically

significant. Furthermore we performed a principal component analysis to select the most explicative variables and used the first 5 component scores to implement a discriminant analysis between hare groups.

Results Nonparametric median test reject the null hypothesis that there are significant differences among groups of hares respect to centroid size of the measures ($p < 0.05$), the analysis of variance conducted on the 5 groups shows significant differences in 17 linear measures on 21. The discriminant analysis correctly classified 100% of hares inhabiting Pianosa, however, the other groups had a correct classified percentage ranging from 69.8% to 84.6%.

Discussion The Pianosa's *L. europaeus* population is well differentiated in the skull morphology compared to all the groups tested. Most of the cranial measures are significantly smaller, even compared to the historical samples of the Italian Peninsula. These morphological differences, together with those of autosomal markers, denote a long isolation period. However the historical information's report the hare presence in Pianosa already in 1835. The morphological condition of this hare population seems to correspond to the Island Rule, which leaves the island mammal populations free to evolve towards the body size most advantageous for exploiting local resources of energy in the diet, in the absence of effective predators and interspecific competition. Further studies are needed to reconstruct the history of this *L. europaeus* population, and ensure its conservation.

Healthy invaders do it better: loss of parasites in mammals introduced to ItalyC. ROMEO¹, A. CAFISO¹, E. FESCE¹, A. MARTINOLI², L.A. WAUTERS², P. LANFRANCHI¹, N. FERRARI^{1,3}¹Department of Veterinary Medicine, Università degli Studi di Milano, Milano, Italy. e-mail: claudia.romeo@unimi.it²Department of Theoretical and Applied Sciences, Università degli Studi dell'Insubria, Varese, Italy³Centro di Ricerca Coordinata Epidemiologia e Sorveglianza Molecolare delle Infezioni, Università degli Studi di Milano, Milano, Italy

P213

Parasitic infections are ubiquitous in wild animals, with most individuals having to cope with several parasite species. However, alien species often lose part of their parasite community during invasion due to stochastic processes, treatments during captivity or suboptimal environmental conditions. At the individual level, hosts will benefit from a reduced parasite pressure, as they may shift resources away from costly immune functions towards other activities, such as reproduction and growth. Consequently, the loss of parasites observed in many alien species is among the mechanisms that may explain why successful invaders often show improved performances in introduction ranges compared to native ranges (enemy-release hypothesis). We surveyed gastro-intestinal helminths infecting three invasive mammals introduced to Northern Italy (grey squirrels, *Sciurus carolinensis*; Pallas' squirrels, *Callosciurus erythraeus*; raccoons, *Procyon lotor*), to verify whether any loss of parasites that may have facilitated their invasion had occurred. We examined 504 grey squirrels, 74 Pallas' squirrels and 44 raccoons culled within alien species control programmes. Gastro-intestines were removed from carcasses, dissected and rinsed through a 0.03 mm sieve. The obtained material was examined under a microscope and the recovered helminths were identified through a combination of morphology and molecular tools.

In grey squirrels we found 7 gastro-intestinal helminth taxa, most of which were detected only rarely (i.e. prevalence <5%) and had low intensity of infection. Parasite richness ranged from 0 to 3 species/host (mean: 0.77), with 62% of squirrels infected by at least one species. The most represented parasites were *Strongyloides robustus* (prevalence: 57%; mean intensity±SE:

23.1±0.8 worms/infected host). *Trichostrongylus* spp. (8%; 2.9±0.7) and *Rodentoxyuris sciuri* (6%; 18.2±13.5). In Pallas' squirrels we detected 6 parasitic taxa, but only 15% of the examined individuals were infected by gastro-intestinal helminths and we did not detect any coinfection (mean richness: 0.15 species/host). The most abundant parasites were *Rodentoxyuris sciuri* (5%; 2.25±1.5) and *Trichuris muris* (4%; 1±0). Finally, in raccoons we found a total of 11 parasitic taxa, 6 of which had prevalence >5%. Richness ranged from 0 to 6 species/host (mean: 1.25) and 70% of raccoons were infected by at least one species. The most represented parasites were *Strongyloides procyonis* (25%; 17.4±8.1 parasites/infected host), *Capillaria putorii* (23%; 7.9±2.4) and *Porrocaecum* spp. (14%; 24.8±9.7). Our findings show that grey squirrels, Pallas' squirrels and raccoons introduced to Italy harbour impoverished parasite communities compared to their native ranges. Grey squirrels and raccoons both retained two North American helminths, whereas Pallas' squirrels carried along from SE Asia a single nematode. Local parasites were detected only sporadically and in all the three hosts, especially Pallas' squirrels, we found many individuals that were completely free of gastro-intestinal helminth infections. Raccoons were the most parasitised host species, but considering their omnivorous diet and opportunistic behaviour, their helminth community still appears poor in terms of richness and intensity of infection. The present survey supports the premises for an enemy-release, suggesting that the establishment and spread of these three alien mammals may have been facilitated by a reduced parasite pressure.

Are Chiroptera influenced in the use of underground cavities by geomorphology and altitude? First insights from 28-year monitoring in Tuscany Region

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P901

Introduction Underground cavities are an important roost resource to a large proportion of bat species for all the year-cycle of temperate species. However, information on bat use exists for only a small fraction of cavities. The aim of our study is to unveil the influence of ecological and geomorphological parameters on cavity bat species selection in Tuscany Region.

Methods We used 28-year monitoring data. 509 bat site records were collected, 280 derived from long monitoring activities conducted mostly by the Natural History Museum of Florence; 124 from bibliography and 105 from recent activities of citizen science as ToscoBAT project that involve speleologists. We selected the 134 cavity (96 caves and 38 mines) where we determined bats at species level. Then, we analysed the relation among the ecological variables (G General; H Hibernation; R Reproduction; M Mating) and the geomorphological-topographical ones (rock type, morphology, DEM, etc.)

Results The majority of occupied caves were limestone; however, some were of marble (7%). For mines we did not evidence any prevalence in relation to the rock type. We identified 15 species *Barbastella barbastella*, *Eptesicus serotinus*, *Hypugo savii*, *Miniopterus schreibersii*, *Myotis bechsteinii*, *Myotis myotis/Myotis blythii*, *Myotis capaccinii*, *Myotis daubentonii*, *Myotis emarginatus*, *Myotis mystacinus*, *Pipistellus kuhlii*, *Plecotus austriacus*, *Rhinolophus ferrumequinum*, *Rhinolophus*

euryale, *Rhinolophus hipposideros*. The maximum number of species per cavity was 8 in the year-cycle. 80 cavities were used in H, and four of these cavities (two caves and two mines) are characterized by more than 1000 individuals. The H altitude varied from sea level to 1100 m a.s.l. with a higher concentration between 200 and 600 m a.s.l. In seven cavities we highlighted M at sea level of which two counted more than 100 individuals of three species. 20 cavities were R and altitude varied from sea level to 1190 m a.s.l. with the majority between 200 and 400 m a.s.l.

Discussion Altitude deeply influenced the use of cavities in relation to the year-cycle phase i.e. for M were selected mostly cavity at sea level. Rock type was important for caves but not relevant for mine use. Another important insight of our analyses is that the involvement of key stakeholders is useful to obtain data in a more effective way as since the beginning of ToscoBAT project (2014) the number of records increased of 20%. Our first insights evidenced how geo-morphology and altitude parameters can directly influence the use of cavities. Managing strategy of sites would have consequently to take into account also these important aspects in order to achieve conservation objectives in a more effective manner. This research will be implemented considering more deeply the influence of the different parameters on species cavity roost selection.

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The wolf is back: the situation in Lombardy Region at the beginning of 2018

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P016

Introduction Large carnivores are iconic species that raise issues concerning their conservation. Among them, the wolf is the one most represented in Italy. Until a few decades ago its distribution was confined in the Apennines, but more recently this species has naturally recolonized the Alps. In the western Alps, individuals from the Apennines arrived in Piedmont Region and in France at the end of the 90's, subsequently expansion continued eastward reaching central-eastern Alps. Lombardy includes most of the territory of the central Italian Alps and since the new century, sporadic presence of wolves has been recorded. As partner of the project LIFE12 NAT/IT/000807 LIFE WOLFALPS since 2014, the regional government of Lombardy started monitoring the presence and distribution of wolves on its territory.

Materials The monitoring scheme consisted in a snow-track survey protocol applied on a 10×10 km grid. During snow tracking all possible signs of presence were recorded (tracks, foot prints, scats). Other information of presence was recorded throughout the year (sightings, predations, pictures). The surveying method was systematic or opportunistic depending on the confirmed presence of the species. Active and intensive monitoring was carried out in grid cells where a pack was present, an active and extensive one in grid cells where single individuals were stable and finally non-active monitoring in areas where the presence of wolves was sporadic or not yet documented.

Results Between 2014 and 2018 more than 90 signs of presence

were recorded. In summer 2014 and winter 2014–2015, 12 signs of presence were recorded across the provinces of Sondrio and Brescia. During summer 2015 and winter 2015–2016, 28 signs of presence were registered in Sondrio province, and, for the first time in a new area in the northern part of the province of Como, close to the border with Switzerland. From May 2016 to 30 of April 2017 both areas of interests were confirmed with 19 signs of presence. Finally during summer 2017 and following winter, 32 signs of presence across four different local administrations were recorded and the presence of a stable pack was documented in a larger area in Como territories. Moreover during 2017 a dead wolf was found in Sondrio province.

Discussion The Alpine wolf population is rapidly expanding and this phenomenon is involving also Lombardy Region. During the last few years a pack established itself in the province of Como in an area bordering Switzerland. Thanks to the great amount of information collected all over the alpine area during LIFE WOLFALPS project, it is foreseen that the presence and the distribution in Lombardy will increase in the next years, making active monitoring of the species in the current and in neighboring areas necessary. Moreover, for wolf conservation, it would be desirable that the monitoring scheme and the information will continued to be shared across all Italian administrations and that the LIFE WOLFALPS Alpine network for the Wolf monitoring will continue to operate in the future.

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Rooting activity of the wild boar in coppiced stands of a forested area of central ItalyM. SALVIETTI^{1,3}, S. GASPERINI¹, P. BARTOLOMMEI¹, A. BONACCHI^{1,2}, E. MANZO¹, R. COZZOLINO¹¹Fondazione Ethoikos, Convento dell'Osservanza, 53030 Radicondoli, Siena, Italy. e-mail: stefania.gasperini@ethoikos.it²U.R. Ecologia comportamentale, Etologia e Gestione della fauna, Dipartimento di Scienze della Vita, Università di Siena, Via P.A. Mattioli 4, 53100 Siena, Italy³Dipartimento di Scienze delle Produzioni Agroalimentari e dell'Ambiente, Università degli Studi di Firenze, Piazzale delle Cascine 18, 50144 Firenze, Italy

P214

Introduction The ongoing increase in ungulate abundance strongly influences ecosystem functioning worldwide. The wild boar *Sus scrofa* is known for its nesting, feeding and rooting activities that can severely affect a wide array of taxa and ecological processes. Although rooting is deemed to deeply alter habitats, some aspects of this activity are still to be explored. In this study, we aimed to investigate wild boar rooting activity in different forest management types in a forested area of central Italy. Furthermore, we evaluated the influence of the availability of a primary trophic resource (i.e. acorn) on the rooting activity of this species.

Methods We identified four forest management types in coppiced oak stands logged in different years, where we selected 12 sampling areas (three spatial replicates per management type). We measured the intensity of rooting by wild boars as the percentage of loose soil in each area, where we also estimated acorn production.

Results The intensity of rooting significantly differed among

both sampling areas and forest management types. In the high forest stand we recorded the highest mean percentage of loose soil. The rooting activity generally increased with age of logging (with the exception of the recently coppiced stand). We did not find any correlation between this resource abundance and rooting intensity, although we recorded low percentages of rooting in the management types with high acorn production. Finally, we did not record any significant seasonal difference in this activity, whose intensity did not increase in sampling sessions characterized by high acorn availability.

Discussion In accordance to our expectation, rooting activity varied among the forest management types. These differences were not related to different acorn production, indicating that the spatial and temporal availability of acorns did not exert a relevant role at influencing rooting activity. These results suggest that other habitat-related factors might influence rooting activity by wild boars.

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How to produce comparable data in conservation genetics for the Apennine brown bearE. SCARPULLA¹, A. ANTONUCCI², A. BOATTINI¹, R. LATINI³, N. MUCCI⁴, I. PIZZOL⁵, F. DAVOLI⁴¹Dipartimento di Scienze Biologiche, Geologiche e Ambientali (BiGeA), Alma Mater Studiorum - Università di Bologna, Italy. e-mail: erminia.scarpulla@gmail.com²Ente Parco Nazionale della Majella, Uffici "Tutela Valori Naturali e Ambientali" e "Monitoraggio e Gestione Biodiversità", Sede Operativa, Badia Morronese, Sulmona (AQ), Italy³Ente Autonomo Parco Nazionale d'Abruzzo, Lazio e Molise, Servizio Scientifico, Pescasseroli (AQ), Italy⁴Unit for Conservation Genetics (BIO-CGE), Department for the Monitoring and Protection of the Environment and for Biodiversity Conservation, Italian Institute for Environmental Protection and Research (ISPRA), Ozzano dell'Emilia, Italy⁵Regione Lazio, Direzione Ambiente e Sistemi Naturali, Area Conservazione e Gestione del Patrimonio Naturale e Governance del Sistema delle Aree Naturali Protette, Roma, Italy

P401

Introduction The Apennine brown bear (*Ursus arctos marsicanus*) is an Italian iconic endangered taxon, turned by prolonged isolation into a unique evolutionary unit, characterized by a low variability ($N_a=2.45\pm 0.16$) that requires a constant monitoring to assure its conservation. An issue in conservation genetics is the comparability of data produced by different labs with different methods to allow the creation of a common database and to establish standardised laboratory methods to be used in conservation actions. In the last decade, two different labs (WGI, Wildlife Genetics Internation, B.C., Canada and ISPRA, Italian Institute for Environmental Protection and Research) conducted the genotyping of the Apennine brown bear. For individual identification, these labs used 10 shared markers (STRs) plus sex, and two exclusive markers. In order to allow the comparison between the two databases and thus assure the reliability of future monitoring, we are updating the extant ISPRA database with the complete set of 14 markers used by both labs, by re-typing old and new samples collected by both labs.

Methods Two samples of DNA, that produced good quality data, were chosen for each individual genotype from national twenty-year reference database (ISPRA database). Where DNA sample was not available, it was extracted again from the biological sample using a robotic workstation for automated purification of DNA (QIACube, Qiagen Hilden, Germany) in conjunction

with the Qiagen spin-column kit DNeasy® Blood & Tissue. DNA was then amplified using PCR, with fluorescently labelled specific primers for the STRs to be added at the known genotypes (REN144A06 and CXX20), using the Qiagen Multiplex PCR Kit®. A multitube approach was used, with positive and negative controls in each step. STR fragments were detected and sized on an ABI Prism 3130XL Genetic Analyzer DNA sequencer. The different genotyping marker sets were then compared on the basis of average and expected heterozygosity, number of alleles, probability of identity, number of mismatch and individual identification.

Results Our preliminary results showed a substantial overlap of the individual genotyping carried out by the two labs. The comparison of the different marker sets shows an improvement, albeit not significant, of the discrimination capacity using the complete set of 14 STRs compared to the other STRs marker sets.

Discussion The addition of two loci to the routinely marker set used for the genetic long-term monitoring of the Apennine brown bear population, allows to increase the chance of individual identification and to lessen the probability of identity and shadow effect, an important goal in the conservation of a population characterised by a particularly low genetic variability as the Apennine brown bear.

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MaxEnt for modeling Italian Roe deer's (*Capreolus capreolus italicus*) environmental preferences in the Aspromonte National Park

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P316

Introduction Following a reintroduction project (2008), 75 Italian Roe deers (*Capreolus capreolus italicus*) were released in the Aspromonte National Park. In 2017 a monitoring project was started to check the expansion of the species within the protected territory and in the adjoining areas.

Methods The presence of the species was verified by using a non-invasive survey method. A grid composed by 910 plots (1×1 km) has been overlapped on the entire surface of the National Park and on the surrounding areas. In each Roe deer's field signs were sought by applying different census techniques: short linear transects, a scat detection dog, camera trapping, spot light census, census with thermal cameras and interviews to locals. To date, 306 plots (33.56%) inside the park's boundaries has been investigated and signs of clear presence of the species were georeferenced.

With the aim to analyse the most probable trend of the distribution of the population, a prediction model of the presence of the Roe deer on the entire territory was elaborated using the MaxEnt Software. 14 environmental variables, like land use,

hydrography, viability and the Digital elevation model (dem), were compared with the collected signs.

Results A total of 147 signs of presence were collected, including scraps, rubs on trees, footprints, signs of grazing activity, faecal pellets, videos and direct sightings.

These data were not affected by the previous introduction and therefore perfectly comparable to an expanding population. In fact we could see how the expansion has interested other areas of the park, starting from the releasing point.

The variables with the greater influence on the prediction model are elevation and presence of ecotone.

Discussion The model represents the basis for choices about future investigations on this species inside the Park and the adjacent territory. Future surveys should aim to identify signs of presence in the predicted areas categorized as "most probable presence of the species" and also to validate the model by searching in all the other resulted categories, as the ones classified as "less probability of presence".

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Diurnal and nocturnal home range of Italian hares on Elba Island estimate by GPS technology

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P019

Introduction In 2015 a reintroduction project of Italian hares (*Lepus corsicanus* De Winton, 1898) started on Elba Island with the aim to recreate a wild population: 35 adult specimens, reared in the breeding center of the State forestry corp in Bieri (LU), were equipped with VHF collars and released in two different study areas. One subject was recaptured on Monte Perone, where the reintroduction was previously more successful, and equipped with a GPS collar. In the same way 3 reared animals were equipped with the same tags.

Methods The recapture session was performed in June 2017 with the help of 20 operators, trapping nets and VHF technology; the caught hare was a male released in December 2016 and, after the replacement of the VHF tag with a Followit GPS Tellus Micro Collar (weight 0.08 kg), he was immediately released. The 3 subjects (1 male and 2 females) reintroduced in December 2017, were fitted with the same collar model. All the tags were set to acquire a fix every 3 hour (8 fixes/day).

The hare recaptured in summer was monitored for 58 days, until battery discharge. Two of the hares released in winter were monitored, respectively, for 11 and 39 days, until their death. The

last one for 66 days, until the drop-off.

Diurnal and nocturnal home ranges were calculated with the HRT 2.0 plugin in ArcGis using the Kernel method (95%). Daily and Nightly fixes were based on seasonal sunrise and sunset times. The Mann-Whitney U test was applied to compare those areas. A modified Minta index was utilized to evaluate the overlapping percentages of the two home ranges.

Results GPS technology, unlike the use of VHF collars, allowed us to carry out a constant monitoring activity and to estimate the nocturnal home range of the hares. The average nocturnal and diurnal home range sizes are respectively 97.41 and 87.33 ha. Diurnal home range areas do not statistically differ from the nocturnal ones (U test=7, $p<0.05$) and the average overlapping percentage results 82.22%.

Discussion The results of the analysis suggest that the hares fulfill their needs without changing their home range between day and night time. In a study conducted in the Regional natural reserve of Monterano the average nocturnal home range size resulted 36 ha and the diurnal one 30 ha. In both cases the diurnal home range is smaller than the nocturnal one.

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Domestic cats in the diet of urban foxes in southern Tuscany (central Italy)D. SOGLIANI¹, E. MORI²¹Dipartimento di Biotecnologie, Università degli Studi di Verona, Strada Le Grazie 15, 37134 Verona, Italy²Dipartimento di Scienze della Vita, Università degli Studi di Siena, Via P.A. Mattioli 4, 53100 Siena, Italy. e-mail: moriemiliano@tiscali.it

P003

Introduction The red fox *Vulpes vulpes* is the most widely distributed carnivore of the world, showing a great behavioural adaptability. This species has been recorded in many habitats, ranging from mountains to coastal desert, woodlands and human settlements. Therefore, its diet may include a very large spectrum of food categories, depending mainly on their local, seasonal availability. Overabundance of food resources is considered as a major factor for the increase of urban foxes densities in Europe.

Materials and methods The diet of suburban foxes has been studied in Southern Tuscany (Central Italy), in the surroundings of two villages, Prata and Massa Marittima (province of Grosseto). Food habits of red foxes were assessed by analysing 200 scats collected monthly between July 2016 and July 2017, along fixed itineraries.

Results A significant seasonal variation in the diet was found.

Fruits (berries) and coleopterans prevailed in the warm months and were replaced by domestic cats (mostly kittens) in the cold ones. The high importance of the latter suggests opportunistic feeding behaviour of red foxes, which may switch their diet towards an easily accessible prey category. As a consequence, the trophic niche was quite large both in cold and warm months.

Discussion The presence of the domestic cat within the diet of suburban red foxes has already been reported in the scientific literature, but with very low frequencies and mainly due to consumption of road-killed individuals. In our work, domestic cats were frequently consumed, especially in cold months, maybe because of the remarkable presence of young kittens, more vulnerable, inexperienced and easy to be caught with respect to adult cats. The increased use of this food category in cold months may reflect the reduced amount of food alternatives.

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Badger (*Meles meles*, Linnaeus, 1758) sett activity in the S.N.R. of Bosco Nordio (North-East Italy)A. SPADA¹, C.M. BIANCARDI², J. RICHARD³¹Associazione Faunisti Veneti. e-mail: arianna.spada@gmail.com²LIBIAM, Dept. of Ciencias Biológicas, CENUR L.N., Universidad de la República, Paysandú, Uruguay³Agenzia veneta per l'innovazione nel settore primario

P204

Introduction Investigations to detect the mammal species present in the Strict Nature Reserve of Bosco Nordio had been carried out within 2015 and 2017. Different methods were employed (camera trapping, setts and burrows search by linear transects, scat search using specialized dogs), and one of the results was the census of badger (*Meles meles*) setts and latrines (used and not) and the detection of several individuals of this mustelid. These data allowed us to get an updated picture of the distribution of badgers within the Reserve, and plan new researches.

Materials and Methods Starting from spring 2017, for one year, two main badger setts have been monitored by camera traps, set to take 30 s video clips when triggered. The devices have been checked on a 3–4 weeks schedule. Video clips were downloaded and stored in separate folders, and ordered for date/hour. The events detected by the analysis of the video clips were stored in

a customized relational database (PostgreSQL) including all the setts and entrances data.

Results This study allowed us to collect a huge amount of information about sett activity, reproduction and activity patterns within the sett perimeter. We present some preliminary results, as the investigation is still running.

Discussion First data indicates in this area, differently to what happen in other population in UK and in continental Europe, a not-continuative use of the main setts on a year base. The activity usually begin after sunset, thus following a seasonal pattern, with the activities around the sett concentrated in the period just after emerging from the underground galleries. Yet, several cases of diurnal activity have been detected. Births appear to concentrate in the period between the end of February and the beginning of March.

Which roof over your head? Analysis of bat conservation measures in Stelvio National Park

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P023

Introduction Human activities are changing global ecosystems, modifying land cover and contributing to global warming. With increased urbanization, some species started to successfully exploit buildings and artifacts: this “urban wildlife” comprises species that are experiencing population declines and are listed as threatened by the IUCN. Among those species, bats play an important role, and should need the adoption of specific protection measures to contrast roost destruction during building restorations and favor new colonization. These measures should be developed according to studies concerning the specific needs of each species, especially in terms of roosting habitat. For bats, micro-climate is one of the most important factor affecting roost choice, especially during reproduction and hibernation.

Methods From 2014 to 2017 we monitored 9 reproductive bat colonies located in buildings in the Stelvio National Park area. Three colonies hosted more than a single species and 6 a single species, for a total of 7 species monitored, of which 5 are included in the Habitats Directive Annex II. Occupied buildings were in different conservation state, from ruins to buildings restored during the present study. We evaluated the phenology of each colony from April to October, by monitoring bat presence on a monthly base, both with direct counting inside roosts (photographic counts) where feasible, and emergence counts with the help of digital counters and/or IR camera recordings, and by registering the number of newborns and parturition period. For

each site we recorded internal and external roost temperature on an hourly base.

Results For each colony we registered a direct relationship between inner roost temperature and bat presence, with maximum numbers during June and July, when also parturition occurred. For some species as the lesser horseshoe bat (*Rhinolophus hipposideros*), temperatures (both inner and outer) greatly influenced birth timing, with delayed births (up to a month) in colder years. In one colony, roof restoration changed the thermal profile of the attic where bats roosted, causing a decrease in the number of animals occupying the site, due to lowered temperatures especially in summer.

Discussion Roost microclimate can exert a great influence on reproductive bat colonies dynamics, especially in areas at the species’ distribution margins and in the case of thermophilous Mediterranean species as those we monitored. Building restoration in roosting sites should consider the importance of maintaining a thermal profile suitable for bat presence and reproduction. In our study area, several important roosting sites need urgent conservation and restoration actions: some important lesser horseshoe bat roosts located in ruins were recently included in a Site of Community Importance dedicated to their protection, and will be restored with a special attention to microclimate. The results achieved so far, finally, clearly show how a good monitoring scheme for bats can greatly improve their conservation.

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Action Plan for the conservation of bats in LombardyM. SPADA¹, S. MAZZARACCA¹, A. MOLINARI¹, S. BOLOGNA¹, D.G. PREATONI², A. MARTINOLI²¹Istituto Oikos, Via Crescenzago 1 Milano, Italy. e-mail: martina.spada@istituto-oikos.org²Unità di Analisi e Gestione delle Risorse Ambientali, *Guido Tosi Research Group*, Dipartimento di Scienze Teoriche e Applicate, Università degli Studi dell'Insubria, Via J.-H. Dunant 3, 21100 Varese, Italy

P008

Introduction Action Plans are essential tools for the conservation of endangered species, and in many cases their application has allowed the recovery of species at risk of extinction, ensuring their long-term persistence. The Action Plan for the conservation of bats in Lombardy, the first of its kind in Italy, has been developed as a preparatory action of the LIFE project Gestire 2020, whose leading partner is Lombardy Region. This Action Plan represents a first step towards the implementation of concrete actions for bat conservation in Lombardy. Target species of the Action Plan are the 18 bat species whose conservation status is considered critical, inadequate or unknown, according to the 3rd Regional report on the implementation of conservation Measures under Article 17 of the Habitats Directive.

Methods The Plan is the result of a participated process in which all the relevant stakeholders for bat conservation and management were actively involved, through specific workshops to identify objectives and evaluate possible actions.

Stakeholders' direct involvement is indeed mandatory for the creation of a relevant and effective instrument, whose goals are shared by all actors. The Action Plan shows an overview of national and international legislation concerning bats and reference documents for the management and protection of species at national, European and international levels and contains the Guidelines for the regional monitoring of the species. Essential part of the Action Plan is the analysis of pressure, threat and

conservation problems for each species present on the territory, used for the selection of the general objectives from which the actions were drawn up.

Results The main result has been the creation of a regional strategy for bat management and conservation with specific actions aimed at achieving the goals set. The Plan aims at: 1 increasing the managing capacity and resources of Managing Authorities and Wildlife Rescue Centers; 2 giving detailed information about bat conservation problems and related management actions to relevant technical figures like architects, foresters and speleologists; 3 strengthening the legislation regarding bat habitat management and conservation (e.g. forestry, mining, speleology, building); 4 raising public awareness on bat conservation problems; 5 increasing knowledge about bat distribution, status and threats. The Action Plan also include general information about habitat management for bats (agro-ecosystems, forests, urban areas, underground habitats).

Discussion The Action Plan represent an effective tool for bat management that needs to be implemented during the next 6 years, after a formal approval by the Regional Council. This Plan will give many effective instruments to the Regional Authority to better manage bat population and habitats and to raise awareness on bat problems, hopefully improving the conservation status of the target species.

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Roadkill problems and solutions: the case of Comunità Montana Valli del VerbanoM. SPADA¹, A. MOLINARI¹, F. BISI¹, S. ONETO², F. PIANEZZA², B. CHIARENZI¹¹Istituto Oikos onlus Via Crescenzago 1 Milano. e-mail: martina.spada@istituto-oikos.org²Comunità Montana Valli del Verbano Settore Agricoltura e Foreste Via Asmara 56 Luino (VA)

P005

Introduction Transport infrastructures can act as ecological barriers dividing wildlife populations. Recently, number of species and individuals killed on roads is increasing mainly due to the construction of new roads, changes in traffic condition and increasing wildlife population densities. Considering these features two issues become evident, the first one is the loss of biodiversity and habitat fragmentation due mainly to the barrier effects and the second one is the decrease of road safety. In this context, actions to prevent roadkills become fundamental.

Methods Data on car crash caused by wildlife during 2015 and 2016 has been analyzed and 5 different hot spots have been identified in northern Varese province. In this 5 hot spots between 2016 and 2018 we verified wildlife passages using camera traps. Due to the high frequency of the presence of ungulates close to the road, a modern roadkill prevention device has been installed to prevent animal crossing in each point when cars are approaching at high speed. We then used camera traps to test the functioning of one of the prevention device.

Results Across the 5 sites from 3 to 6 camera traps have been active in different seasons for a total of more than 1500 days. 12 different species have been detected: ungulates (roe deer, red deer, wild pig, mouflon), carnivores (fox, badger, stone marten), small mammals (hares, red squirrel, Pallas squirrel) and birds (common blackbird, eurasian jay). Presence and frequency changed according to season, site and to animal phenology. The roadkill prevention device worked properly, indeed animals approaching the road fled in the opposite direction.

Discussion Roadkills can be a serious problem for wildlife conservation, indeed roads represent a limit for animal movements and an important cause of direct mortality of several species. In our study sites ungulates represent one of the major problems both for the safety of drivers and for the economic costs that institutions must sustain in order to reimburse car damage. In the present study the devices to prevent and reduce accident seem to be effective.

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Comparing methods to estimate population size of Alpine marmot (*Marmota marmota*) in the Stelvio National Park

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P215

Introduction Robust estimates of abundance are of key importance for the conservation and management of wildlife populations, yet they are challenging to obtain in rugged and mountainous landscapes. Estimating abundance in Alpine marmot (*Marmota marmota*), a rodent widely distributed on the European Alps, presents additional difficulties due to behavioral aspects, like the semifossorial habit, and social aspects, such as the tendency to form groups or defend territories, which may violate several methodological assumptions. As the choice of the most appropriate methodology depends upon the behavioral characteristics of the target species and on the operative constraints imposed by field conditions, our project aims to compare the performances of different methods of abundance estimation.

Materials and Methods Data collection will take place in a population within the Lombardy sector of the Stelvio National Park, between May and August 2018, and it will include: sessions of capture-mark-recapture, that imply to build individual capture histories, while collecting individual covariates (e.g. biometrical

measurements); sessions of mark-resight, in which observers will spot marked and unmarked animals from vantage points; sessions of line distance sampling along transects; sessions using double-observer methods from vantage points, in which two observers operate independent surveys.

Results A similar study had already been conducted in 2015 within the Stelvio National Park, in the Province of Trento, and showed that probabilistic approaches based on marked individuals yielded robust estimates of population size, while methods based on unmarked individuals tended to severely underestimate it. We expect a similar pattern to occur under different environmental conditions.

Discussion Our work will serve to verify the validity of previous results, and to investigate the use of specific methods that shall be adopted over larger geographical scale, thus contributing a robust, evidence-based approach to the conservation of the Alpine marmot in the protected area.

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The effect of ultrasound emission of Compact Fluorescent Lamps (CFLs) on bats

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P216

Introduction In recent decades an increasing number of studies have assessed the human impact on bats populations, in particular on the influence of light and acoustic pollution. These factors can alter feeding and reproductive behaviors, with consequences on survival. With this project we aim to investigate a further possible influence: energy-saving light bulbs (Compact fluorescent lamps, CFLs). Preliminary observations, confirmed by further investigations, showed the presence of an ultrasonic component in CFLs emissions in an interval ranging from 35 kHz to 50 kHz. There's an overlap between this interval and the frequency range used by bats, suggesting a possible influence.

Methods We focused on CFLs used for domestic and outdoor lighting because bats usually roost near these sites and can be exposed to CFLs emission. We investigated the perception and behavioral response of two bats species: *Hypsugo savii* and *Pipistrellus kuhlii*. The emission of CFLs was measured with Bat Detector (Pettersson D1000X) and the bulb was covered with black spray paint to prevent the light from affecting the test (the paint didn't affect sound emission). Each subject was placed under a soundproof plastic box for one minute, and then exposed to the emission for 3 minutes and the behavioral response was recorded. Then we analyzed the recordings using BORIS 2.9, which gave us the minimum distance of approach to the bulb and all behaviors considered indicative of perception of a stimulus

and attractive or repulsive response. The so obtained list was studied through the web tool BSA, which provides information about the frequency of each behavior and transitions from one to another.

Results The minimum distance showed an increase in presence of CFLs. The most expressed behavior was *Head movement* (investigation of the environment). In presence of the emission, *Head movement* was followed by the *Open mouth* behavior, which indicates perception and response by emission. All subjects showed an increase in the *Open mouth* frequency in presence of lamps. These behaviors makes us suppose that all tested bats perceive the emission and respond with a signal. We measured also an increase in the escape behaviors frequency. So we can assume that the emission is perceived as annoying, leading the subject to turn his back to the source and move away.

Discussion Bats that lived in urbanized contexts are often exposed to noisy sources that can have important consequences on the availability of acoustic information. In presence of a high background noise, or with continuous sound stimuli, bats can show a reduced success in feeding and reproductive activities, with consequent reduction of survival. So, we can assume that the acoustic disturbance caused by CFLs may influence the survival of the species exposed through alteration of success in foraging behaviors.

Toponyms predict recolonization and extinction patterns for large carnivores in Italy

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P903

Introduction The name given to places usually reflects the usage, the most striking natural features or particular historical events. In wilderness area we expect that names could be linked to the occurrence of animals and plants that people were used to see in their everyday life: for example name places such as “Cervara” are linked places used for hunting deers (*Cervo* in Italian), while “Rovereto”, “Roverè” are instead places linked to the presence of an oak species (*Rovere* in Italian). Charismatic animals, such as large predators, are likely to have been chosen to name places and they also occur in many flags and town emblems across Italy (Rome is one). In this paper we argue that it is thus more likely that a place was named after wolf or bear if the species was actually present in historical times.

Methods A list of dialectal names for bear and wolf were retrieved from an online vocabulary of Italian dialects.

Open Street Map (OSM) and the toponym map of Italy downloaded from the national cartographic portal (PCN) were queried with the selected words or pattern of letters from the previously identified list.

The queries were then refined by semi-automatic selection of the relevant name places, removing obvious artifacts of the queries. The remaining points were processed in order to obtain a Gaussian kernel distribution of the occurrence of the toponyms

for each species. This results was then overlapped with the past distribution (1950-present) of the two species obtained from published literature and assessed with K-statistics in GRASS GIS.

Results The query of the PCN map returned about of 2700 records, of which 709 were considered meaningful for the name linked to brown bear. The query on OSM instead yielded 523 records (valid 330) including name of places of bar, restaurants and toy shops. The query of PCN map using the words related to wolf returned 1636 records of which 1546 were valid. OSM results overlapped with those from PCN, thus only the results from PCN map were further processed. Name places carrying obvious reference to those carnivores are located all across Italy, with highest densities in the Alps and central southern Apennines and the lowest occur in the Po valley and the Islands. The pattern of the name places map overlaps with the pattern of contraction and expansion of the species over time. The minimum historical distributions of wolf and brown bears occurs at the highest densities of toponyms related to them.

Discussion Such an exercise can raise awareness in people about the past presence of the species in the Italian territory. The maps can be presented in discussions with stakeholders or during dissemination events to highlight the historical heritage of the territories and the cultural value of large carnivores.

Analysis of philopatry by biometric measures in Red Deer (*Cervus elaphus*) as a tool to identify different management areasC. VANNINI¹, F. PECCHIOLI², P. SEMENZATO³, P. LUPI⁴, S. NICOLOSO³¹“La Sapienza” Università di Roma, Dipartimento di Scienze della Terra. e-mail: chiara.vans88@gmail.com²Università degli Studi di Firenze, Dipartimento di Biologia³D.R.E.Am Italia via Enrico Bindi, 14 51100 Pistoia⁴Università degli Studi di Firenze, già Dipartimento di Scienze delle Produzioni Agroalimentari e dell’Ambiente (DISPAA)

P309

Deer damage management should be based on knowledge of their spatial behavior to implement actions aimed to reduce the local density of animals. Previous study showed that the female’s philopatric behavior in deer entails that localized removal of individuals may create persistent areas of low density. Therefore the knowledge of areas used by animals allows identifying different management areas, driving the remove actions. The aim of the present work was to verify the suitability of the use of biometric data to identify separate sub-populations in the study area, defining in turn of different management areas. We hypothesized that philopatry behavior of female red deer (*Cervus elaphus*) entailed a biometric characterization of different localized group. In particular, we hypothesized the presence of two different sub-population (mountain area and plain/hill area) with a low exchange of individuals in the study area.

To test this hypothesis, we performed the discriminant analysis comparing a few biometric parameters (such as weight of freshly killed, weight eviscerated, and length of hind foot) of individuals belonging to both sexes. The biometric data and their geolocations were collected on 561 male and 581 female red deer (age \geq 2) killed during the hunting seasons from 2000 to 2015 in Province of Pistoia (District Central ACATER – Area of the deer

of the Central Tuscan-Emilia-Romagna Apennine).

A significant difference of the mean of each biometric measurement ($p\leq 0.05$) between individuals killed in the mountain and in the plain/hill area was found only in females. On the contrary, males of different areas did not differed significantly ($p\leq 0.05$). However, the discriminant analysis did not highlight a strong discriminating power of the biometric parameters used. Our results showed that, unlike the males, female deer exhibit some degree of philopatry, consistently with the presence of the two sub-populations identified a priori.

Despite, these findings suggest that a greater number of biometric parameters have to be considered to increase their discriminating power. Nevertheless, it emerged that use of biometric data collected from killed animals may be used to distinguish different management areas. The applicability of this approach is higher with the increase of geographic area considered, and it is not efficient for small areas comparable to home range size used by social groups. Future studies that consider biometric data on a wider geographical scale are strongly recommended to improve potentiality of this method to drive the deer harvest in management actions.

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Predation on pheasant eggs by mammals: monitoring by camera trapping of natural and artificial nests

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P020

Introduction In recent years, the population of the pheasant (*Phasianus colchicus*) is undergoing a generalized decline which raises many questions in the wildlife management environment. The main causes are probably to be found in the weather conditions, anthropic disturbance and strong predation, even from species so far undervalued from the point of view of the real impact on eggs and chicks.

Methods The research was carried out within the ZRC Terra Rossa in the province of Pisa. The project involved the use of 5 different models of photo traps. To monitor the “natural” nests, 17 pheasant females from a local hunting company were equipped with radio-collars. The animals were initially monitored three times a week and subsequently, during the hatching period, up to four times a week. In case of death, the remains of the animals have been recovered to determine the causes. Nevertheless, if the immobility of the animal was due to the hatching, the position of the nest was detected, and the eggs counted trying to cause the minimum disturbance, furthermore photographic documentation of the site was acquired, and any characteristics of the nest were noted. Artificial nests (n=18) were made with the purpose to imitate the natural ones as much as possible. Approximately, 10 eggs for each nest were purchased from a wild game farm and artificial sites were arranged only

after a careful preliminary analysis of the pheasant's fixes with radio collars.

Results In total 8 natural nests were monitored through camera traps; overall, the cameras were active for 142 days, detecting 21793 files between images and videos, of these, 48 useful for filming different species. The main predator we have been filmed is the fox (*Vulpes vulpes*). The monitoring days were a total of 422 and produced 7872 videos, with 277 useful videos, which allowed us, to uniquely identify the predatory species of the 18 artificial nests positioned.

Discussion The fox is a predator of eggs both for natural nests and for artificial nests, it is also the most detected species in the act of removing the eggs or destroying the nest. This last information is confirmed by various works on the feeding of the fox. Both the wild boar (*Sus scrofa*) and the badger (*Meles meles*) are predators of eggs exclusively of artificial nests. It can be hypothesized that these two mammals may have difficulties in finding natural nests and, on the other hand, they are facilitated in detecting the artificial ones. This facilitation may depend on odorous traces left by the operator during the arrangement of the artificial nest. From the elaboration of the obtained data there seems to be some link between the predation time and the nature of the nest (natural or artificial).

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Monitoring by radiotracking of a wild rabbit (*Oryctolagus cuniculus*) restocking group in area of Agrigento (Sicily): preliminary analysis of survival

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P317

Introduction European wild rabbit (*Oryctolagus cuniculus*) is one of the most widespread species in the world among the mammals and it is considered an endemic species of the North-Western Mediterranean. In Sicily, it is the main prey for several predators and a popular small game species. Recently his range on the island has been reduced and fragmented, local extinctions have also been recorded. The main causes of the decline of the Sicilian population are three viral diseases: myxomatosis, viral haemorrhagic disease (RHVD) and a new form of viral hemorrhagic disease (RHVD2). As part of pest control plan, nine wild rabbit were translocated from the historic site “Valle dei Templi” in Agrigento to another suitable area within the borders of Agrigento. This contribution reports the analysis of the post-release behaviour of rabbits by use the radio-tracking technique.

Methods The experimentation was divided into three operational phases. Phase 1 – capture and monitoring in the quarantine fence, during which: biometric data of the nine rabbits were collected; vaccines against RHVD2; the blood samples were withdrawn; the microchips inserted; the ear tags attached and, one week before the release, radio collars were attached. Phase 2 – release and monitoring in the study area. Within a month, starting from 26/06/2017, 18 field trips were made and, using the

radiotracking, the positions of the animals were detected. Phase 3 – Data analysis using the QGIS software.

Results None of the individuals (n=9) died in the quarantine period. Before the release, weight changes occurred independently from the possession of the radio collars. 67% of the specimens died occurred within the first week after release. The mortality curve obtained by the non-parametric method of Kaplan-Mayer recorded an 83% mortality within four weeks after release.

Discussion The survival rate (17%) and the mortality curve are comparable to that obtained in the similar project which took place in 2007 at Cianciana (about 30 km away from our study area) (14%) and in other similar studies. The high early mortality in the current project can be the consequence of the high stress experienced by the rabbits during the translocations. As previously suggested by other authors, the main recommendations from this experiment for future wild rabbit translocation projects are: vaccinate individuals before release; introducing the individuals directly at the entrance of wild rabbit burrows; dedicate the greatest monitoring efforts during the first 10 days of release; evaluate carefully the number of individuals to be released: creation of wildlife areas for the protection of the species at regional level.

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The life of M1, an Italian wolf affected by Canine Distemper Virus: release and monitoring by GPS telemetry

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P212

Introduction M1, a 3-year-old Italian grey wolf (*Canis lupus*), was found in the countryside of Umbria (Central Italy) on 29 March 2016, exhibiting serious neurological symptoms, such as ataxia, lateral recumbency, and pedalgae. After excluding trauma and poisoning, principal infective diseases were investigated, showing serological positivity to IgM for Canine Distemper Virus (CDV). Polymerase Chain Reaction (PCR) was performed on biological samples and confirmed the infection with Articular strain of CDV, which induces a high rate of mortality in wild animals. M1 was subjected to long-term hospitalization associated with constant health monitoring. The clinical condition of M1 rapidly improved and the control test for viral RNA showed negativity from September 2016. Full recovery from CDV was definitely confirmed by further check-ups.

Methods Since the release of an animal affected by this serious disease presents lots of risks, M1 was equipped with a GPS and VHF tracking collar (Followit Tellus Medium). In order to understand how M1 reacted and adapted to the release in nature, his GPS-track was analysed with the aim to investigate his day-night behaviour and habitat choice.

Results The release was successfully accomplished on 24 October 2016 in a non-hunting area, nearby the place where it had

been found. M1 was monitored for 45 days and he walked 197 km within an area of 93991 ha (Minimum Convex Polygon). During the first three weeks, M1 showed high motility, covering more than half of the total. The highest motility was recorded at night, while the lowest during the day (night 120 km, day 17 km, twilight 60 km); M1 walked closer to houses at night (average distance night=285.0 m, average distance day=426.2 m), as well as to streets (average distance night=493.8 m, average distance day=647.1 m) and chose to use forests and grassland at night ($\chi^2=310.35$; $p<0.001$), while it selected forests, avoiding grasslands and riparian vegetation ($\chi^2=87.444$; $p<0.001$) during the day.

Discussion M1 showed vitality and feeding ability. He alternated long periods of motility with brief periods of rest. This may depend on the need of finding a territory free from other wolves. This need may also force M1 to move to built-environments. However, as expected, he maintained distance from houses during the day.

Unfortunately, on 8 December 2016, M1 lost his GPS collar. We found it after 20 days immersed in a river: it is very likely that M1 was killed and the collar was thrown into the water.

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Interreg NAT2CARE Project: Activation of Citizenship for Restoration and Conservation of N2K Cross-Border Areas Italy-Slovenia

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P006

Anthropic activities in human dominated landscapes, are causing widespread biodiversity loss and declines in ecosystem condition worldwide. The intensification of agricultural and silvicultural practices, land abandonment and other land uses such as recreation and hunting, represent potential threats which may lead to conflicts between stakeholder livelihoods and biodiversity conservation. Biodiversity loss is a matter of great concern among conservation scientist, but the wherewithal to reverse this trend is generally lacking. One reason, is which nearly half of the world's people live in urban areas and are disconnected from nature. Ecological restoration is considered as one of the best strategies to increase the provision of ecosystem services as well as reversing biodiversity loss. Collaboration among partners belonging to different countries, may represent an effective tool to prevent and/or reverse this phenomenon. Anyway, social and cultural barriers can make interaction difficult and, consequently, reduce the effectiveness of each conservation action.

The aim of the Interreg NAT2CARE Italy-Slovenia project is to promote the biodiversity preservation in Natura 2000 Areas belonging to the three project partner parks: Giulian Pre-Alps Regional Natural Park, Friulan Dolomites Regional Natural Park, and Triglav National Park, involving the realization of specific actions focused in avoiding the risk of fragmentation, reduction and biodiversity loss. The project started in early 2018 and will last until the middle of 2020. The research program will have to contribute to define, apply and evaluate innovative monitoring

protocols, regarding the presence and management of mammal species of community and conservation interest (brown bear, grey wolf, lynx, wild cats, golden jackal, otter and mustelids, chamois, alpine ibex and other ungulates), identify and promote ecosystem services, and carry out awareness-raising, environmental education and active citizenship engagement, also in monitoring activities. A key feature of the project is the transboundary dimension concerning the implementation of the planned actions, as all the animal species that are being monitored move easily from one country to another in a territory characterized by habitats with very similar characteristics. For this reason, the approach should be applied at transboundary level and a common protocol will be followed. Monitoring actions should also consider and evaluate the effect of bird presence, habitats, and human activities, and the research project will have to develop methods, addressed to citizens and stakeholder, which allow them to spread the goals and the methods used, as well as the intermediate and final results achieved, mainly through the realization of a communication plan, which involves the use of social networks, the publication of digital and paper material, brochures' drafting, and advertising campaigns. Considerable importance is given to implement useful methods, with the aim to increase the knowledge and awareness of citizens, stakeholders and managers, concerning the issues of biodiversity and wildlife conservation, making them the main suppliers of information, for achieving technical and scientific results.

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Spatial distribution of Eurasian red squirrels and Siberian chipmunks at the Sigurtà Garden Park (Valeggio sul Mincio, Verona, NE Italy)

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P211

Introduction Alien squirrels are widely known to threaten native similar species by means of interspecific competition. In most cases, alien species are larger or shows the same size of native ones; in these cases, the former displaces or reduces the population viability of the latter.

Materials and Methods In our work, we analysed whether the distribution and dispersion of alien Siberian chipmunks within the Sigurtà Garden urban park changed after the spread of native Eurasian red squirrels throughout a 20-year period. Distribution of both species in Decade 1 (1997–2006) and Decade 2 (2007–2017) was estimated through a citizen-science approach. We compared habitat use of both species in Decade 1 and Decade 2.

Results Woodlands and sparse trees were selected by both spe-

cies in both decades, whereas red squirrels selected tree lines in Decade 1, when they started to colonize the park. Records and extent of occurrence of *Sciurus vulgaris* increased throughout the park, whereas those of *Eutamias sibiricus* decreased between decades. Conversely, a number of records of Siberian chipmunks has been recorded since 2015 outside the border of the Sigurtà Garden Park, along the riverbanks of the Mincio river.

Discussion Differently from what is usually observed with alien squirrels, the spread of the native species is pushing the introduced one towards the opposite direction of its expansion front. Therefore, further individuals of the Siberian chipmunks might occur along the Mincio river in the proximate future, and an addressed monitoring/control program should be carried out to prevent/manage the invasion by this species.

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Small mammal species-diversity on the west banks of the Piave river (Belluno, NE Italy)

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P009

Introduction The distribution of small mammals has been for long overlooked for conservation and management studies, despite being an important part of the ecosystems. Furthermore, most data on rodent diversity and distributions are based on raptor bird pellets, which provide a slapdash information on distribution, as often feeding areas by these birds may be far away from the pellet collection sites.

Materials and Methods In summer 2017, we analysed the pattern of small mammal distribution in the upper Piave valley, in the province of Belluno (municipalities of Trichiana and Limana), by using trapping and visual methods; trapped specimens have been measured and weighed. Three transects of 40 Sherman traps baited with nutcream and sunflower seeds were set up. Furthermore, 45 hair tubes were also placed to survey arboreal species, during the same time period. Cryptic species of wood mice *Apodemus* spp. were identified through genetic analyses.

Results A total of 4 rodent species were trapped through Sherman traps in 2230 day-traps, involving 183 individuals: 161 yellow-necked mice *A. flavicollis*, 2 striped-backed mice *A.*

agrarius, 17 bank voles *Myodes glareolus* and 3 edible dormice *Glis glis*. The hair-tube survey revealed also the presence of the Eurasian red squirrel *Sciurus vulgaris*, the hazel dormouse *Musccardinus avellanarius*, the garden dormouse *Eliomys quercinus*, the black rat *Rattus rattus* and the invasive Siberian chipmunk *Eutamias sibiricus*. European hedgehogs *Erinaceus europaeus* and Norway rats *Rattus norvegicus* were recorded mostly within the human settlements in Limana and Trichiana.

Discussion According to our screening, the yellow-necked wood mouse was the most abundant ground-dwelling rodent at lower altitudes, whereas the bank vole predominated at higher altitudes (Valmorel plateau). Where striped-backed mice were present, yellow-necked mice were about 10% smaller, suggesting a potential competition. The red squirrel was the most abundant tree species, with the garden dormouse and the hazel dormouse only recorded at the highest altitudes (>750 m). Finally, the alien Siberian chipmunk, previously widespread in the study area, is disappearing, with evidence only for one hair-tube, and the few individuals remained live in semi-captive conditions.

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HYSTRIX
the Italian Journal of Mammalogy
Volume 29 (Supplement) • 2018

Edited and published by Associazione Teriologica Italiana

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XI Congresso Italiano di Teriologia
Firenze, 20–22 Giugno 2018

Riassunti: Comunicazioni e Poster