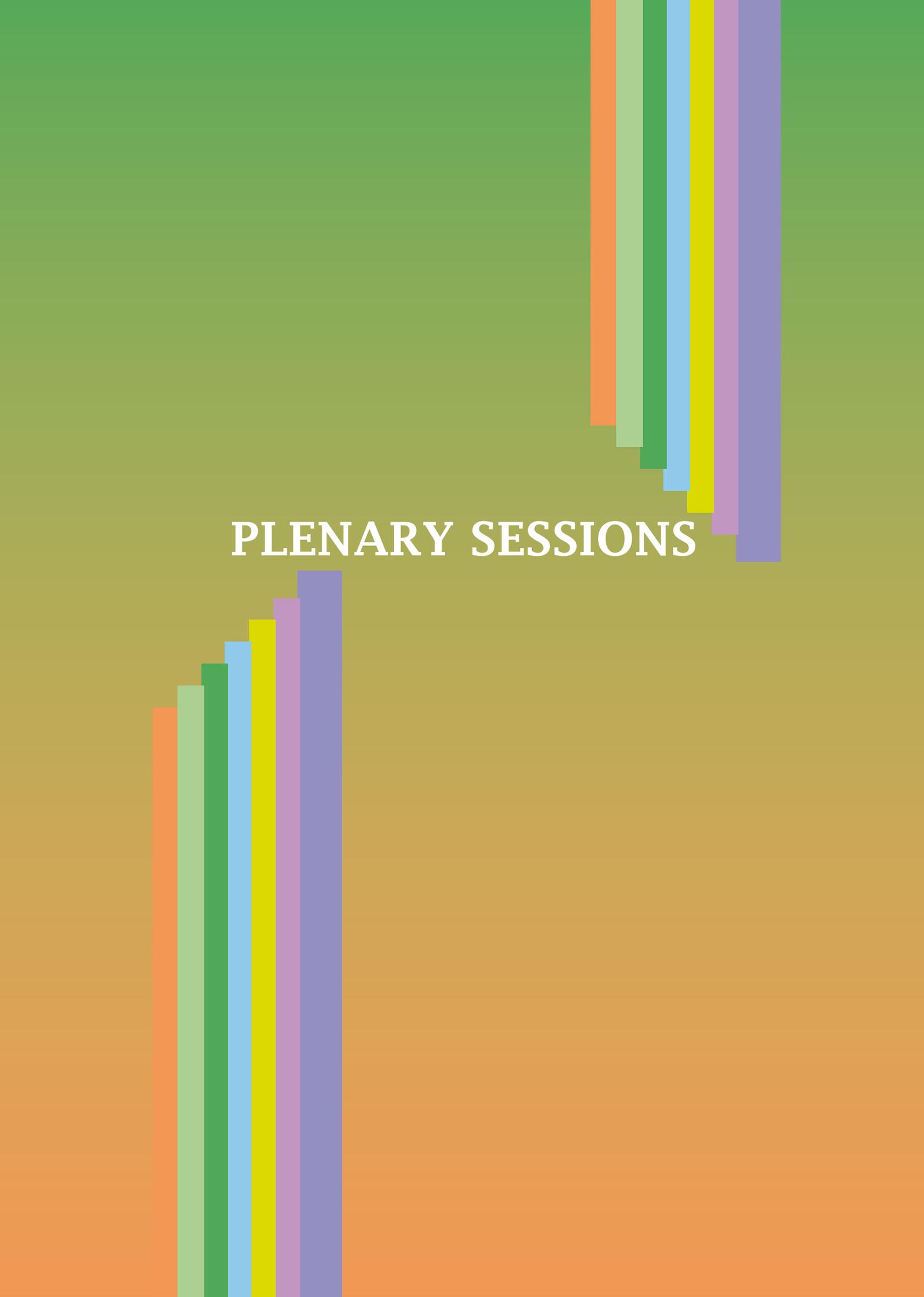


Abstracts

10th European Vertebrate Pest
Management Conference

Seville, 21 - 25 September 2015





PLENARY SESSIONS

FOLLOWING ALIEN BIRDS ALONG THE PATHWAY TO IMPACT

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Biological invasions by alien species represent one of the primary ways in which human activities are changing global biodiversity. Alien invaders can have substantial effects on the ecosystems into which they have been introduced, and on human economic and social enterprises in those same areas. Yet, not all species become invaders, and not all invaders have deleterious impacts, suggesting that there must be variation in factors that determine success or failure.

My talk will be divided into two parts. In the first, I will discuss how evidence from one particular taxonomic group, birds, helps us to understand what drives the invasion process by alien species. I focus on birds because old and new data are giving us new insights into the patterns and processes underlying invasions by species in this taxon. I will describe how new data are revising our view of the magnitude and extent of alien bird invasions, helping to trace the history of introductions, and identifying the drivers of alien species establishment and spread.

In the second part, I will consider variation in alien species impacts, and in particular present a new method we have developed to help evaluate and compare (and hopefully eventually to predict) the magnitudes of environmental impacts of different alien species. The method can integrate impacts that concern different levels of ecological complexity (from effects on individual behavior to ecosystem dynamics), measured on a wide range of metrics, across many different spatial and temporal scales. Our hope is that the method will help with efforts to determine and prioritize appropriate management actions for alien taxa with environmental impacts, and can also be extended to provide a similar tool for taxa with socio-economic impacts.

BIOLOGICAL CONTROL OF VERTEBRATES: BEYOND MYXOMATOSIS AND RABBIT HAEMORRHAGIC DISEASE

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Biological control of vertebrate pests is not widely applied because of difficulties in finding species specific agents and ethical and political issues related to perceived cruelty of diseases such as myxomatosis. Nevertheless, in an increasingly complex world, where vertebrate pest control can be expensive, or reliant on high levels of community action, it still remains an approach to be considered. Right now, in Australia, a case is being prepared for the release of a herpes virus specific to Koi carp. This will help clear major rivers of these invasive pests which currently make up 80% of the fish biomass at the expense of native species. Likewise, some scientists in Australia are also advocating wider use of dingoes (*Canis familiaris dingo*) to reduce numbers of introduced cats and foxes which are major predators of small native mammals. The debate on that continues.

This paper reviews results from previous releases of biological control agents, including economic and social benefits, but also considers lessons learned that facilitate future work. Not least among these is the public understanding of past successes that provides the support and expectation that future applications can be beneficial, not affect human health or have other detrimental side-effects. Perhaps of more interest from an academic perspective, the 'arms races' inevitably established between introduced viruses and hosts can be recorded in real time. This gives insights into other newly emergent diseases and an understanding of the evolution of resistance to diseases in general

For the future, new possibilities arise with each advance in gene technology. These ideas need to be explored even if they may not have final practical application. For example, it seems that viruses can be artificially selected in the laboratory for characteristics that could keep them ahead of the development of host resistance. Genetic advances also open up possibilities for using viruses that have a high impact on host populations but do not persist in the field. Although the need to re-release non-persistent viruses detracts from one of the main benefits of self-sustaining biocontrol, lethal biocides of this kind could reduce the risk that biological control agents of value in one country could be transferred to countries where they are not wanted.

Vertebrate biocontrol is often seen as an unusual or even exceptional approach to a problem, yet the last 20 years have seen steady progress within Australia. This has been achieved by building on past experiences and taking on innovative approaches. It is underpinned by a clear understanding that returns on investment can be very high when research outcomes are successful.

PRIORITIZING INVASIVE SPECIES ERADICATIONS

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Following the urging threat presented by invasive species worldwide and the dire limitation of conservation resources, a consensus is emerging that we need to undertake eradications more strategically to minimize biodiversity loss. In response to this, we present a very simple and flexible framework for prioritizing invasive alien species eradication programs, based on several, facultative steps at different scales. First, one should look at which places are the more likely to be invaded by the species of concern, at the global (macroscopic) scale. Different types of models can provide prioritization of places on Earth where invasive species are likely to be more important. Second, one should also prioritize according to temporal scale, as conservation should be planned for decades, and invasive threats change with climate changes and sea level rises. Recent work has shown that the places where biological invasions are very worrisome currently will not necessarily be the same as places where they will be a problem in 50 years. In addition, many places where invasive alien species could be eradicated may end up under water in the coming decades, thereby voiding conservation efforts there. Planning for biological invasions without accounting for climate change will result in mistaken choices of places of most interest. Third, at the ecological scale, one needs to account for feasibility, economic cost, reinvasion risk (natural or human-aided), ecological complexity (accounting for potential “surprise effects”) and conservation value. We present a simple framework equating these factors according to the weight managers give them, to rank places of concern according to final conservation gain. The choice of parameter weights may depend on the priority given to the different variables by managers, but this framework allows comparison of different weight given on different variables (eg costs vs reinvasion risk). We develop the concept of Surprise effects in alien eradication programmes, and we provide examples of how prioritization could be achieved according to different criteria of importance as appreciated by managers in diverse conditions.

USING RECOMBINANT GENETICS TO CONTROL VERTEBRATE PESTS: PROSPECTS AND CONSTRAINTS ON AN EVOLVING TECHNOLOGY

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Conventional methods for the control of invasive pests are generally effective only on small-space scales or short time frames. Classical biological control has proven to be an option for a few well-established pests, but for most the costs of a biological control program and the sparsity of suitable species-specific control agents have meant that longer-term efforts to reduce pest populations have largely been abandoned. Modern genetic technology could change this dynamic. In this talk, I review recent developments in the field and outline scenarios where recombinant options either alone or as part of a program of IPM has the potential to significantly reduce the impacts of invasive vertebrate pests. The essential genetic technology for recombinant pest control already exists for a wide range of problem vertebrates and planning for field trials is underway. However, whether the public will accept the deliberate release of vertebrates (as opposed to insects) genetically modified to inheritably spread genes causing infertility or increased mortality is not clear. There are also significant differences between genetic methods in terms of the trade-off between logistical feasibility and the apparent risks to non-target species and populations (a pest species in one place is often a valued native species somewhere else), which until overcome could severely limit the range of problem species against which recombinant options could be deployed.

WILDLIFE, LIVESTOCK, PEOPLE AND 'PESTS' IN SOUTHERN AFRICAN TRANSFRONTIER CONSERVATION AREAS: PROBLEMS AND PROSPECTS FOR MULTISPECIES SYSTEMS

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Fourteen transfrontier conservation areas (TFCAs), varying between 2,000 to 400,000 km² in area, are under development in southern Africa. Many of these areas include not only state protected areas and private or community conservancies, but also communal land under traditional small-scale agro-pastoralism. As a result, conflicts between people and wildlife occur in the form of crop raiding by large herbivores, losses of livestock to predators, and the transmission of diseases at the interface between wildlife, livestock and people. Elephants and lions in many of these areas occasionally kill people.

The wildlife-related problems faced by small scale, mostly subsistence, farmers living on the edge of protected areas within TFCAs are not trivial. The species primarily involved include elephants, hippo, buffalo, kudu, bushpig, baboons and large carnivores. During the height of the cropping season farmers may spend nights attempting to keep elephants out of their fields, but can still lose an entire crop in a night. Livestock have to be herded during the day and confined to bomas at night but even then animals are lost to lions, leopards and hyaenas. Loss of a cow or a goat can affect a household's ability to purchase food at the end of the dry season or to meet school fees. Mitigating measures to protect crops, such as electrified fences to protect fields, the use of chilli pepper barriers and beehives, have achieved varying levels of success. Protection of livestock at night can be achieved by using appropriately constructed mobile bomas that also serve to create nutrient hotspots in croplands or grazing areas.

TFCAs aim to facilitate the movement and migrations of wildlife across larger landscapes by establishing corridors and removing fences, which raises disease control issues at the wildlife-livestock-human interface at local, national and international scales. Several diseases are involved. The most important of which is Foot and Mouth Disease (FMD), which is transmitted from wildlife to livestock with serious impacts on beef exports to lucrative markets in Europe and North America. The primary wild host of FMD is the Cape buffalo - a species that is also of prime importance to the sport hunting industry and to financial returns from wildlife to local communities living with wildlife.

Given the problems of human-wildlife conflict and disease management, what are the prospects for people, livestock and wildlife at the interface in TFCAs? Can one farm in a zoo? Are alternative or compensating livelihood options available if wildlife is maintained outside of strictly protected areas?

Most TFCAs in southern Africa are located in agriculturally marginal lands suited to extensive animal production. The region's comparative advantage lies in its charismatic wildlife rather than in beef exports. However, livestock are an important component of rural livelihoods. The ecological and economic potential and prospects for multispecies animal production systems that combine both wildlife and livestock in southern African TFCAs will be examined in the light of existing human-wildlife and disease management conflicts.

NON-RANDOM PATTERNS AND TEMPORAL TRENDS IN THE TRANSPORT, INTRODUCTION AND ESTABLISHMENT OF EXOTIC BIRDS IN SPAIN AND PORTUGAL: IMPLICATIONS FOR MANAGEMENT

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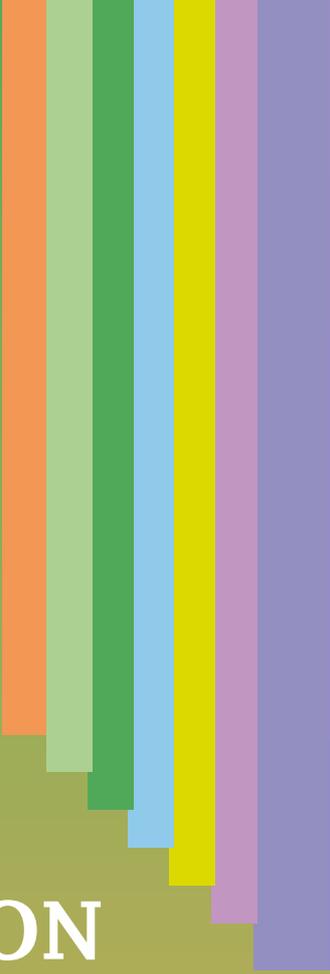
Characterising the process of biological invasion provides a critical baseline for determining which factors drive the successful spread of introduced species. The recognition that the invasion process is a succession of stages (uptake, transport, introduction, establishment and expansion), separated by barriers that act as selective filters preventing or allowing species to move on to the next invasion stage has been important in acknowledging that the most effective management option is to tackle invaders on their initial stages so that species that may not be taken up or transported do not have the opportunity to establish and become invasive. However, scientific attention has been mainly addressed to patterns and processes in the new range (establishment and expansion stages), with comparatively little effort devoted to understand pre-establishment stages. Using a regional comprehensive database of introduced species between 1912 and 2012 in Spain and Portugal, as well as information on species transported and introduction pathways, we have assessed the sources and magnitude of current avian invasions, and characterized the transitions between main invasion stages (transport, introduction and establishment) and its temporal evolution. Our findings show that the magnitude of transport, introduction and establishment of exotic birds is much greater than usually described at a regional level, and are also in line with the idea that most species fails to transit the different steps of the invasion process (the so-called ‘tens rule’). The temporal changes in taxonomic composition and biogeographic origin are broadly consistent with changes in societal demand, vectors of transport and introduction pathways relating to exotic species. While intentional introductions (e.g. game and ornamental taxa) were more common in the first decades, most recent introductions resulted from the accidental escape of traded cage-birds, mainly passerines and parrots. Contrary to deliberate introductions, which implied the capture, transport and rapid release of usually large numbers of individuals, trade-related accidental introductions have to cross a larger number of filters which also expand over longer periods of time. Thus, their invasive potential is higher than that of individuals belonging to captive-bred species which can be also recorded in the wild, although at a lower proportion and never establishing viable populations. Several differences between individuals could be responsible for such differences in establishment success, such as changes in antipredatory behavior and physiological profiles. Although Spanish and European bans may represent a successful management action against current avian invasions at a regional scale, international trade in birds continues to concern considerable numbers, mostly involving wild-caught individuals. Applying the precautionary principle, a worldwide ban on wild-bird trading should be seriously considered with the aim of preventing further avian invasions.

INTEGRATED MANAGEMENT OF BIRD PESTS IN THE URBAN HABITAT: LESSONS FROM THE STUDY OF FERAL PIGEONS AND MONK PARAKEETS

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The urban habitat is a quite recent ecosystem, with very special characteristics. Nevertheless, several species have become nicely adapted, to the extreme of becoming persistent pests. Two outstanding examples, which we review in this paper, are the Feral pigeon and the Monk parakeet, which exemplify a native and an exotic birds species. We analyse methods for censuring them in the urban habitat, with special emphasis on detectability, home-range and habitat use. We focus then on the limiting factors which may regulate each population. We analyse patterns of distribution of both species in Barcelona, showing that both species are more abundant in neighbourhoods with a high percentage of old people (which provide them food). Pigeons are also more abundant in areas with old buildings, which provide holes to nest, and parakeets in areas with abundant trees, which also provide nesting areas. We provide data on experiments in Barcelona, where we reduced in some areas Feral population size by 40% by reducing food availability by public information. We also provide population dynamics models from studies of capture/recapture in Monk parakeets which show that removing individuals is twice more effective than reducing reproductive success. Overall, data shows that reducing population size of urban avian pests is possible, but needs from integrated management efforts.



ORAL SESSION



Biological control of rodent
pests by promoting increased
raptor predation pressure

01

AVIAN PREDATOR MANAGEMENT FOR VOLE BIOLOGICAL CONTROL: POSITIVE AND NEGATIVE COLLATERAL EFFECTS ON RED-LEGGED PARTRIDGE ABUNDANCES

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Nest-box installation to increase raptor numbers is an environmentally friendly technique to prevent vole plagues in agricultural systems that may help to reduce the dangerous use of anticoagulants. However, the high abundance of raptors may produce undesired effects on other non-target species of economic interest.

Nest box installation on poles since 2009 increased population numbers of common kestrels *Falco tinnunculus* in our study agricultural areas, but also increased numbers of common buzzards *Buteo buteo* as they use poles as perches for hunting. We studied the effect of this raptor increase on the abundance of the red-legged partridge *Alectoris rufa*, a gamebird species of great socioeconomic interest in the Iberian Peninsula. For this purpose the abundance of kestrels, buzzards and partridges were monitored during five years by road surveys three times each year (April, July and November), in six agricultural areas of similar size (2000 ha each) and with (nest-box areas) and without (control areas) nest box installation. The three nest-box areas counted with 100 kestrel nest-boxes placed on poles.

Our results showed that kestrel and buzzard number increases seems to have a negative effect during spring time on partridge abundances. However, a positive effect of raptor increase on partridge abundance was observed during summer time with no obvious effects on partridge abundances during winter. We suggest that partridges tend to avoid the high density of predators during the breeding season while just after breeding (July), higher densities of non partridge-specialist predators might provide protection to partridges against larger size raptors.

02

USE OF BARN OWLS (TYTO ALBA) FOR SUSTAINABLE RODENT CONTROL IN FLORIDA SUGARCANE

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Florida sugarcane (interspecific hybrids of *Saccharum* species) is besieged by five major rat species and two species of mice, which may potentially inflict more than \$30 million dollars (US) in crop losses on an annual basis. In 1994, the University of Florida initiated a program promoting the use of barn owls (*Tyto alba*) as a sustainable means of rodent control. Barn owls are one of nature's most prodigious rodent predators, with a single nesting pair easily capable of capturing more than 1,000 rodents per year. However, native populations in south Florida remained suboptimal due to the general lack of nesting sites. Enhancing natural populations, the management program is predicated on placement of nesting boxes throughout the Everglades Agricultural Area (EAA), 200,000 hectares of farmland located on organic soils. Initially colonizing boxes three to four months following placement, barn owl populations have risen dramatically, and boxes are currently colonized within days of placement. Box colonization now approaches 100%, and with more than 500 boxes, the EAA presently supports some of the highest barn owl densities in North America (approx. 0.3 owls/km²). Rodent damage has been reduced significantly, and some sugarcane growers have completely eliminated the use of chemical rodenticides, namely zinc phosphide and several anti-coagulants. Along with this success, the UF Barn Owl Program has been used extensively for youth education and outreach, demonstrating how agriculture and wildlife can not only co-exist, but benefit one another.

03

PROMOTING INCREASED RAPTOR PREDATION PRESSURE ¿HOW MUCH DOES IT COST?

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The installation of nest boxes and artificial perches for birds of prey and owls belongs among the well-known methods for promoting increased predation pressure on rodent pests in the frame of ecologically based integrated control in agriculture and forest management. The efficiency of increased predation pressure of birds of prey and owls on rodent pests is widely discussed in the literature. Although a general consensus on this issue has not been adopted yet, the procedures to promote increased predation pressure of birds of prey and owls on rodent pests are quite often applied in agricultural and forestry practice. Data on the economic aspects of these methods of integrated control of rodent pests are extremely scarce. In this paper we evaluate the economic importance of biological control of rodent pests using methods based on cost-benefit analysis in the traditional agricultural region of Haná (Czech Republic), where the nest boxes and artificial perches for the Common Kestrel (*Falco tinnunculus*) and Barn Owl (*Tyto alba*) have been systematically installed since 1997. The comparison of the costs of installing and maintaining the nest boxes and artificial perches and the costs of chemical protection of agricultural crop by rodenticides shows that biological control reduces the costs of chemical protection by about 50 % in localities with a gradation of the Common Vole (*Microtus arvalis*). This result suggests large potential of the methods of biological control of rodent pests in the frame of integrated protection of agricultural crops from vertebrate pests.

O4

RAPTORS CONSERVATION PROGRAM AND BIOLOGICAL CONTROL OF RODENTS IN CHILE

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The purpose of this program is to promote the conservation of birds of prey in Chile and contribute to biological control of rodents, through the implementation of two approaches: rural development and public health; and supported by three transverse components: research, environmental education and training. The total target population until 2014 was 4,700 people. We have worked with the school community of 17 schools (4,400 people between teachers, students, and parents) through the implementation of an educational module (courses and toolbox) aimed at the conservation of raptors and biological control. This module has been used in 14 courses, and 23 toolkits were built, both aimed to professionals of the health, education, agriculture and farm owners (205 people). In research: (a) we study the role of barn owls in the biological control of pests agriculture, forestry (e, g, *Octodon bridgesi*) and Hantavirus reservoirs (*Oligoryzomys longicaudatus*). (b) Barn owl nest boxes were used in central and southern Chile. (c) We reintroduced and monitor barn owl specimens, using techniques of hacking and radiotelemetry evaluating its association with habitat and home range. (d) We developed techniques and procedures to make risk maps for Hantavirus in rural areas through Geographic Information Systems, to focus efforts on biological control of rodents. (e) We established the level of knowledge and awareness about birds of prey in rural population, adults and school children in southern Chile and its implications for biological control.

05

UTILIZING BARN OWLS *Tyto alba* IN AGRICULTURE AS AN ALTERNATIVE FOR RODENTICIDES ON A NATIONAL SCALE IN ISRAEL

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Barn Owls have long been used for rodent pest control by installing nesting boxes and by reducing rodenticide treatment. Previous studies showed that utilizing Barn Owls for controlling rodents in agriculture is economically effective. Therefore, the Ministry of Agriculture and Rural Development (IMARD), alongside with the Society for the Protection of Nature (SPNI), began a "National Barn Owl Project" to assimilate this practice with Israeli farmers. More farmers employed this system, adding nesting boxes and enjoying more Barn Owls hunting in agriculture. With the advance of the biological rodent control, an intrinsic decrease in rodenticide application was expected. This study examines these two opposite trends on a national scale, and on individual farms.

Compound 1080 (Sodium Fluoracetate) is the only rodenticide approved for use in open areas in Israel. Every purchase of the product requires a permit from IMARD. The records of the permits issued - both on a farm scale and on a national scale, are compared to the number of nesting boxes in the corresponding year.

Most farms utilizing barn owls either reduce their use of rodenticides to <10% of their previous amounts, or refrain from using them completely. On a national scale, the amounts were reduced by 80-90%, even during different rodent population phases. In addition, rodent populations are constantly being monitored and remain stable across the country.

This is encouraging, we're not there yet. The goal is to further diminish the use of rodenticides to a limited manner only where and when the biological control is struggling.

06

NEST-BOX SUPPLEMENTATION FOR EURASIAN KESTREL AND BARN OWL AS A BIOLOGICAL CONTROL TOOL FOR COMMON VOLE (*MICROTUS ARVALIS*) OUTBREAKS IN CROPLANDS IN NW SPAIN

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Biological control of rodents based on the management of raptor populations could aid to prevent or reduce agricultural damage by rodents, and therefore minimize the use of rodenticides. Recurrent common vole population outbreaks have been occurring in NW Spain during the last 40 years. These outbreaks have led to large-scale application of anticoagulant rodenticides. Since 2009, looking for a potential alternative to rodenticides, we installed a total of 300 nest-boxes over poles in three experimental areas of 2000 ha. Three nearby areas of similar extension and habitat were considered as control areas. Vole abundances were monitored three times yearly (late winter, summer and autumn) as well as the abundance of raptors, which was monitored by conducting kilometer index of abundance (KIA). The use of nest-boxes and breeding parameters for kestrels and barn owls were also recorded yearly.

During the study period, a large-scale vole outbreak occurred in 2013-2014 and a lesser population peak occurred during 2011. In the treatment areas, the supplementation of nest-boxes significantly increased the abundance of kestrels, especially during summer, and also increased buzzard abundance during winter. Vole abundance was lower or more stable in the experimental areas as compared with control areas during 2011, but differences were not detectable during the 2014 outbreak in two study areas. Overall, biological control by raptors may help to control vole densities in agricultural land but may require additional actions on large-scale vole outbreak years (increasing nest-box density, the size of the treatment area or using complementary environmentally friendly techniques).

07

THE USE OF HISTORICAL RECORDS OF BARN OWL PELLETS TO ANALYSE THE EVOLUTION OF ITS DISTRIBUTION IN AN AGRICULTURAL LANDSCAPE

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Predator-prey interactions are encouraged in crop-pests management as an alternative to pesticide treatments. Birds of prey such as barn owl (*Tyto alba*) are important in rodent-pest control. Unfortunately, barn owl populations suffered from a significant decline in Europe during the 20th century. The status of barn owl populations is now uncertain. Several initiatives in Spain intend to clarify this, but the information is still scarce and difficult to compile.

The Museum of Zoology of the University of Navarra has collected more than 80.000 records of small mammals from pellet sampling over the last 40 years. This comprises the most extensive database about the community of small mammals in Navarra, and constitutes a good registry of the historical presence of owls in this area. This study tackles the change in the distribution of the barn owl by comparing sampled historical sites with a complete new resampling of the agricultural landscape of the middle section of Navarra.

More than 200 potential sites were checked for pellets and classified according to the presence of remains of barn owl. Results varied considerably depending on the type of building. Old sampling sites, in or about urban nuclei, resulted in a very low success rate, while most of the new sites, located far from the influence of the urban areas, evidenced the activity of the species.

Overall, results show a clear change in distribution pattern that might arise from the loss of traditional nest sites and from changes in traditional land uses.

08

PREY CONSUMPTION BY A LARGE AGGREGATION OF BARN OWLS IN AN AGRICULTURAL SETTING

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Barn Owl/Rodent Study

This study measured the effect of a concentrated population of barn owls, *Tyto alba*, on a rodent population in a 100-acre vineyard near Elk Grove, CA. In 2011, 11 out of 20 nest boxes became occupied by breeding pairs. These 22 adults fledged 44 young, creating a total of 66 owls hunting the vineyard by late summer. In 2012, 18 out of 25 boxes became occupied. These 36 adults fledged 66 young for a total of 102 birds on the vineyard. Nocturnal observations revealed the owls hunted the study area heavily. Monthly pocket gopher surveys using the mound-count method indicated as barn owl numbers increased, rodent numbers declined. Pellet analysis showed diet was comprised mainly of pocket gophers, *Thomomys bottae*, (83%) and voles, *Microtus californicus*, (16%). In 2013, an infra-red camera was installed in a box occupied by a pair and three chicks to record the total number of prey deliveries: 316 deliveries, or 105.33 per chick, were recorded over the first eight weeks of the nine-week developmental period resulting in an estimated consumption of 4635 rodents in 2011 and 6952 in 2012 by the young in their first eight weeks. Adding in conservative estimates of adult consumption over the 165 day breeding season, and consumption by chicks in their ninth week of development, total number of prey taken over the two year period was estimated to be 22,440 rodents. Cost analysis showed an average cost of \$4.99 per rodent trapped versus \$.27 per rodent taken by barn owls.

ALTERING WOODPIGEON HUNTING PRACTICES TO REDUCE CROP DAMAGE IN FLANDERS

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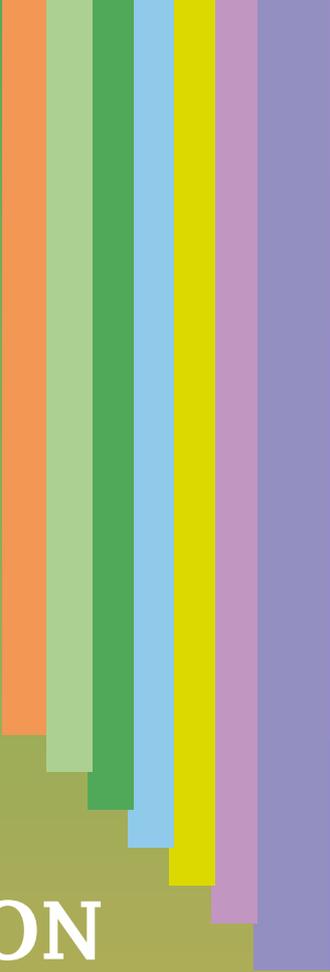
Research Institute for Nature and Forest (INBO)

Woodpigeons are a well-known and major cause of crop damage in Flanders. This damage is mainly attributed to the breeding population, while currently, hunting predominantly targets wintering birds. To obtain a higher impact on the local population and on crop damage, a shift towards summer shooting would be needed. In this project, we examined if a less restrictive summer hunt and a prolonged opening season (until the end of March) could result in such a shift. These measures were tested in three management units and two adjacent GMU's were monitored as reference.

During a three year period, hunting records for woodpigeon were collected in all five GMU's to determine whether or not summer shooting had increased and the winter/summer ratio had shifted. Woodpigeons shot in March were sampled to assess which proportion belonged to the summer population through DNA and isotope analysis. Gonad analysis was also performed to determine the onset of the breeding season.

Our results showed a clear increase in summer shooting in the test area, with summer shooting approaching 60%. Woodpigeons shot in March were not yet breeding and only 20 to 40% did not belong to the summer population.

In conclusion, the changes in legislation clearly led to alterations in actual woodpigeon shooting by the hunters and March shooting mainly targeted non-breeding summer birds. An implementation of these measures could therefore help to impact population development and mitigate crop damage.



ORAL SESSION



Urban pest management

09

NON-SYNONYMOUS VKORC1 POLYMORPHISMS IN THE HOUSE MOUSE (*MUS MUSCULUS* SPP.), NORWAY RAT (*RATTUS NORVEGICUS*) AND ROOF RAT (*R. RATTUS*) IN THE U.S.

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According to surveys conducted in the U.S. in the 1980s, which employed non-choice LD50 feeding trials, the house mouse (*Mus musculus* spp.), the Norway rat (*Rattus norvegicus*), and the Roof rat (*R. rattus*) have developed anticoagulant rodenticide resistance in the U.S. Resistance testing was done when the first generation anticoagulant (FGAR) warfarin was the primary chemical rodent control agent. Resistance was found to be geographically widespread in the U.S. and locally common. However, ~30 plus years later the current status of resistance in the U.S is unknown. Vitamin K 2,3 epoxide reductase subcomponent 1 gene (*Vkorc1*) is now known to be a primary genetic factor underlying resistance to FGARs and some second-generation anticoagulants (SGARs), and the genotyping of rodents for *Vkorc1* mutations has been shown to be useful to infer resistance. Here, by analyzing hundreds of rodent samples from dozens of locations in the US, we survey the distribution of *Vkorc1* protein coding sequence single nucleotide polymorphisms (SNPs) and resulting amino-acid changes in the house mouse, Norway rat, and Roof rat. Based on the presence of well-studied *Vkorc1* non-synonymous SNPs we infer locally high levels of resistance in Norway rats and house mice, but results for the Roof rat do not allow inferences on the presence of *Vkorc1*-mediated resistance as of now. We discuss the origin and spread of mutations in North America and Europe in the context of gene flow between the continents as inferred from neutral genetic markers.

O10

FACTORS DRIVING THE PRESENCE OF WILD BOAR (SUS SCROFA) IN THE URBAN AREA OF BARCELONA

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Wild boar (*Sus scrofa* Linnaeus, 1758) is an ungulate mammal with a broad historical distribution range and great adaptation ability. In the last years, wild boar has experimented a geographic and demographic expansion throughout the world, probably due to a combination of socio-economic and ecological changes. This has driven to an increase in human-wild boar interactions also in urban and peri-urban areas. This study was developed in the municipality of Barcelona, ranging from the seashore to the border with Collserola Natural Park (CNP), from where wild boars mainly penetrate into the city. From 2010 to 2014, the location and date of wild boar presences in the urban area of Barcelona were registered. Pseudo-absences (PA) were created in the study area as a control to assess the factors driving the presence of wild boars in the urban area of Barcelona. Boosted regression trees (BRT) were used to assess the relationship between the response (wild boar presence) and nine predictor variables: date, temperature, rainfall, distance to the CNP, presence and surface of urban green areas, distance to a watercourse, distance to cat colonies and landscape fragmentation. Aggregation of presences was also evaluated. Preliminary results show presence aggregation, a temporal pattern and a relationship between presence location and the distance to the CNP, the surface of urban green areas and the degree of fragmentation of the urban area. This knowledge will allow the establishment and evaluation of future measures to prevent or decrease wild boar presence in the urban area of Barcelona.

O11**LONG-TERM MANAGEMENT OF AN URBAN GULL POPULATION**HARTLEY, G. ⁽¹⁾; COULSON, J. ⁽²⁾; COULSON, B ⁽²⁾; LINDSAY, S. ⁽³⁾; TAYLOR, M. ⁽³⁾

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Gulls first began nesting in the town of Dumfries in the mid-1980s. Across most of the intervening years, the gull population, comprised mainly of Lesser black-backed (*Larus fuscus*) gulls, has continued to increase, alongside growing numbers of complaints from members of the public. In 2008, an Urban Gull Task Force consisting of gull and wildlife management experts and representatives from Central and Local Governments, whose aim is to explore all options available to tackle the problem of gulls in Dumfries, was established. 2015 will represent the seventh year of sustained action during which an integrated pest management approach has been applied, using a combination of biological, cultural and physical control methods. The various strategies adopted to resolve the problems associated with urban gulls, and to manage the gull population will be presented.

Keywords: urban gulls; integrated pest management; Lesser black-backed (*Larus fuscus*) gull.



ORAL SESSION



Control methods and
alternatives

012

A HISTORICAL PERSPECTIVE ON THE EFFECTS OF TRAPPING AND CONTROLLING THE MUSKRAT (*ONDATRA ZIBETHICUS*) IN THE NETHERLANDS

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Musk rats are considered a pest species in the Netherlands, and a year-round control programme is in effect. Currently there is a large scale experiment going on in the Netherlands to study the effect of manipulating harvest intensity of muskrat on damage to dikes. As a background to this, we examined the effects of trapping and controlling the muskrat in the Netherlands from a historical perspective (period 1941-2013). Different provinces were invaded by muskrat decades later than other, and the investment per province in terms of field hours differed greatly. We hypothesized that contrasting trends should be found between the number of muskrats caught in different provinces over time.

In the analysis we distinguished between three different phases in muskrat population development, from 1) 'contamination to peak harvest' and subsequent phases towards 2) 'sufficient control' or 3) 'total control'. An increase in field hours during the first phase, led to an increase in the number of muskrats being caught. During the second phase, an increase in invested field hours led to a decrease in catches. The results suggest that muskrat control measures do have an effect on the muskrat populations. Yet, not all of the changes in the trends seem to be caused by changes in the number of field hours invested. The quality of the management seems to play a very important role as well. The study emphasizes the need for experimentation, to be able to answer our question on the effectiveness of the control measures more firmly.

O14

MUTATIONS IN THE VKORC1 GENE OF THE NORWAY RAT (*RATTUS NORVEGICUS*) CONFERRING RESISTANCE TO ANTICOAGULANT RODENTICIDES IN THE UNITED KINGDOM

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Historically, practical resistance to anticoagulants in rodents (indicated by the inability to control populations with anticoagulant rodenticides) has been reported across much of the UK, with different types of resistance resulting from mutations of a single dominant autosomal gene. In early studies, resistance was confirmed in the laboratory using feeding tests and blood clotting response tests on live wild caught animals; studies that are difficult to conduct, and that are both expensive and time consuming. The advance of molecular techniques in the last decade has enabled researchers to conclusively identify the mutation(s) associated with the different resistance foci, using either tissue samples or droppings. Such studies, which involve the identification of single nucleotide polymorphisms (SNPs) in the VKORC1 gene, do not involve handling live animals, can be conducted rapidly, are inexpensive, have no humaneness issues, and unlike earlier tests, can distinguish between homozygous and heterozygous resistant animals.

In the present study, samples were collected from Norway rats (*Rattus norvegicus*) from different locations in the UK, and DNA from the VKORC1 gene was sequenced in order to identify the resistance mutations present. The geographical distribution of these mutations was then mapped using ArcGIS in order to delimit individual resistance foci. Results indicate a previously unsuspected level of L120Q, Y139C and Y139F resistance spread across numerous counties. These data allow stakeholders to take a more informed approach to rodent control and potentially reduce the risk of selecting for resistant animals through the application of ineffective rodenticides.

O15**FREE FEEDING OF WILD-CAUGHT NORWAY RATS WITH A NON-TOXIC LIQUID BAIT RESULTS IN COMPROMISED FERTILITY**

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Rat pests cause extensive crop loss, property damage, and are vectors for diseases. Poisons are the commonly used method for reducing wild rat populations, however, there are numerous drawbacks to this method of pest control. A more desirable approach would be a method of impairing reproductive function. We have developed a non-toxic palatable liquid bait with two active ingredients (AI). One causes ovarian failure in female rats, whereas, the other causes infertility in males and females. The objective of this study was to assess the potential of this bait as a method of wild rat pest control. Male and female wild caught Norwegian rats were housed and given continuous access to empty bait (control) or AI bait (treatment). For 3 breeding cycles males (n=10/grp) and females (n=10/grp) were housed as treatment-matched pairs for mating, and separated for 2 weeks to allow pups to be born and counted. For a 4th breeding cycle, control females were crossbred with treated males, or treated females were crossbred with control males. In mating rounds (1-3) mean litter size was different ($p < 0.001$) between groups (control, 9.73 ± 0.73 pups/litter; treated, 0.43 ± 0.28 pups/litter). Litter sizes were reduced ($p < 0.05$) in the cross breeding round relative to control treatment-paired breeding (4.90 ± 1.64 pups/litter, control females X treated males; 6.11 ± 1.41 pups/litter, treated female X control male). These results demonstrate that consumption of active bait impairs fertility in wild caught female and male rats, and support fertility control as a novel alternative to the use of rat poisons.

O16

THE LARGE-SCALE REMOVAL OF MAMMALIAN INVASIVE ALIEN SPECIES IN NORTHERN EUROPE.

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The eradication of mammalian invasive alien species (IAS) is increasingly used as a management tool. Numerous examples exist of successful eradications, typically from small islands (<10km²), but there are also a few examples from more extensive areas. This paper reviews large scale mammalian IAS removals from Northern Europe (Great Britain (GB), Ireland and Belgium), drawing on 14 large programmes undertaken since the 1930s, of which 12 (86%) were considered successful, a similar rate to that observed on islands. They include five geographically distinct muskrat eradications, coypu, Himalayan porcupine, Pallas' squirrel, two grey squirrel programmes of which one was unsuccessful, and four American mink programmes, of which one failed. In each case the control was primarily based on the daily checking of static traps. The cost of eradication was best predicted by area, with the number of animals removed adding only a modest improvement to the estimate. The cumulative cost of removal increased with geographical area whilst the cost per unit area decreased; similar relationships to those previously described from island eradications. Crudely, a doubling of area controlled resulted in a 10% reduction in cost per unit area, although there was no evidence that cost-effectiveness had increased through time. Reviewing these programmes, three different objectives were apparent, true eradication; complete removal to a barrier or buffer zone with ongoing control to prevent recolonization; and local control to limit damage or spread. Large-scale programmes bring challenges of scale, uncertainties around costs, the definition of their objectives and confirmation of success, a need to improve efficiency and different considerations for managing the risks of recolonization. The costs of such large scale programmes may be reduced by novel technologies or increased use of volunteer effort. The high costs support the rapid response to new invasions as best practice to reduce the environmental, financial and welfare costs of such large scale control.

O17**THE POTENTIAL OF COUMATETRALYL ENHANCED BY CHOLECALCIFEROL IN THE CONTROL OF ANTICOAGULANT RESISTANT NORWAY RATS**

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We evaluated the potential of cholecalciferol as an enhancer of the first generation anticoagulant coumatetralyl in the Westphalia warfarin resistant strain of the Norway rat characterized, by the Tyr139Cys polymorphism on the VKOR enzyme. Feeding trials in the laboratory confirmed a significant level of efficacy, which was corroborated by field trials in the Münsterland resistance area. Field trials were conducted with bait containing coumatetralyl at 375 mg/kg and cholecalciferol at 100 mg/kg. Before the treatment with this combination, the frequency and level of resistance was assessed by BCR-tests. Control success was 94 per cent when a large rat infestation comprising 46 per cent resistant animals was treated. In another field trial, a rat population which survived a preceding treatment with bromadiolone was treated with the combination. 43 per cent of rats survived the bromadiolone treatment. The subsequent treatment with the combination reduced the initial infestation to four per cent. The combination of coumatetralyl and cholecalciferol is a promising approach in resistance management besides the most potent second generation anticoagulants, in particular when environmental risks like secondary poisoning are concerned.

O19

ERADICATING GREY SQUIRRELS FROM URBAN AREAS: AN INNOVATIVE DECISION MAKING APPROACH BASED ON LESSONS LEARNT

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Despite the well-documented ecological and socio-economic impacts of the Eastern grey squirrel *Sciurus carolinensis* in its non-native European range, projects aiming at its eradication are often opposed by the public and raise severe social conflicts, as occurred in Genoa, Italy, for the removal of animals from an urban park.

The LIFE U-SAVEREDS Project is aimed at eradicating grey squirrels from an area of about 50 km² in Central Italy, from which the species could invade the entire Apennine region. The distribution of grey squirrel largely overlaps the urban and suburban areas of Perugia, and therefore the Project risks to face strong oppositions by citizens.

Based on lessons learnt from previous projects to limit negative public response, U-SAVEREDS initially focused on the analysis of the social background. A questionnaire was administered to verify the attitude of citizens towards humane removal of animals, and it proved to be a key-tool to identify the challenges of the project and to develop an appropriate Communication Plan. In this adaptive and dynamic approach, local Agencies were involved to establish a direct communication line with the general public and a conflict manager was charged to guide the technical staff in addressing the concerns of the public, finally leading to the development of a multidisciplinary, spatially-explicit approach to decision making. The case of removal of grey squirrels from urban areas thus provides an innovative example of how to face the challenges of invasive species eradication now posed by the EU Regulation entered into force in January 2015.

O20

DISTRIBUTION OF VKORC1 SINGLE NUCLEOTIDE POLYMORPHISM IN WILD MUS MUSCULUS DOMESTICUS IN FRANCE

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Anticoagulant rodenticides are commonly used to control rodent pests all over the world. These pesticides inhibit one enzyme of the vitamin K cycle, *Vkorc1*, and thus prevent blood clotting and cause death by haemorrhage. Resistance to anticoagulants was first observed in Scotland in 1958, and more potent anticoagulants have been developed to overcome this obstacle. Resistance to anticoagulants were shown to be linked with mutation in the *Vkorc1* gene. In Europe, resistance was detected in *Rattus norvegicus* and in *Mus musculus domesticus* populations and were associated to specific mutations of *Vkorc1* gene. In France, resistance to anticoagulant rodenticides was never described and distribution of *Vkorc1* mutations in mice is still unknown. This study draws a map of SNP found in *Vkorc1* in *Mus musculus domesticus* from different areas of France. 217 mice samples were collected from PCOs in 25 out of 90 French départements. From genomic DNA extracted from tail, *Vkorc1* gene was amplified by PCR and sequenced to detect potential mutations. VKORC1 deduced amino acids sequences were thus expressed in *Pichia pastoris* and inhibition constants towards various rodenticides were determined. Previous reported mutations were observed in France. Nevertheless, two novel mutations and four double mutations of *Vkorc1* gene were detected. Double mutations of *Vkorc1* was never described in other species. Some of these mutations were clearly associated to resistance and others were surprisingly inactivating mutation.

O21

ANNUAL VARIATION IN THE DENSITY OF RABBITS IN THE HIGH MOUNTAINS OF THE ISLAND OF TENERIFE AND IMPLICATIONS FOR ECOSYSTEM CONSERVATION IN THE TEIDE NATIONAL PARK

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Teide National Park

The European rabbit (*Oryctolagus cuniculus*) is a herbivore introduced in Tenerife centuries ago. It is distributed virtually throughout the island, although it is rare in forest ecosystems. On the coast, lowlands and summits over 2,000 meters of altitude is an essential piece of hunting.

In the Teide National Park are captured rabbits all the years in August, September and October, as a management strategy to prevent their proliferation. This is crucial since here lives a endemic plant of high palatability to the rabbits, *Spartocytisus supranubius*, wich is the shrub dominant in the high mountain of the island.

The annual average density of rabbits in 12 sampling stations located in the Teide National Park in 2014 was 2.1 ± 0.1 rabbits / ha, with a marked seasonal fluctuation. In November, December and January this density was similar to or less than one rabbit/ha, but in July grew almost up to three rabbits/ha (2.9) and in August reached 3.4. The population density was reduced in October thanks to catches made under the control program promoted by the Park, and in December and January the density fell further -to less than one rabbit/ha-, possibly due to climate rigour of the mountains.

Two rabbits/hectare as soon as in March, is a grazing pressure lethal for the regeneration of *Spartocytisus*. Start the Control actions of rabbit populations in this month instead of in August, would be an more effective management measure to prevent an excessive increase of densities in the following months.

O22

ENCAPSULATED SODIUM NITRITE FOR FERAL PIG CONTROL

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In New Zealand and worldwide feral pigs are a serious threat to biodiversity and agriculture as well as being a known vector for disease. Control options are generally limited to hunting, trapping, fencing and the use of toxins in some countries. The use of the toxins 1080, warfarin and phosphorus to control feral pigs have come under fire due to concerns over welfare and residues and the need to develop more humane and safer toxins has been identified. Pilot trials, carried out by the Invasive Animals Cooperative Research Centre, on pigs in 2006 showed that sodium nitrite (SN) delivered by gavage and freely consumed in bait caused death through methaemoglobinemia. SN appeared to be humane, with deaths following bait consumption occurring within two hours, with unremarkable poisoning signs. SN whilst effective is unpalatable due to its salty taste and encapsulation or taste masking is necessary to overcome this and ensure adequate bait is consumed. A method of encapsulation developed by researchers at Connovation Ltd in New Zealand enabled successful free feeding cage and field trials on pigs to be completed. A bait containing this encapsulated SN was registered in New Zealand in 2013 for the control of feral pigs and brushtail possums. The results from these initial trials and learnings post registration are to be presented in this talk. Registration trials with this formulation of encapsulated SN are now underway in the USA and Australia.

O23

TECHNOLOGY ADVANCES FOR VERTEBRATE PEST ERADICATION

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Internationally, over the last 20 years the number of tools available for the control of small mammals has declined. Through the efforts of research we have bucked this trend in NZ and retained and developed new tools. Three new toxins have been extensively researched and registered with NZ EPA and MPI for field use, namely para-aminopropiophenone (PAPP) in 2011 for stoats and feral cats, zinc phosphide for possums in 2012 and encapsulated sodium nitrite (ESN) in 2013 for possums and feral pigs. The development of PAPP and ESN, coined red blood cell toxins, developed for humaneness, represent the first new vertebrate pesticides registered for field control of mammalian pests anywhere in the world for > 25 years. Research on rodenticides including norbormide continues, and more effective killing systems are being researched, and the first successful field trials of resetting toxin delivery devices for possum and stoat control were completed in 2013 and 2014. Improved deployment strategies, integration of humane and selective toxins, lures of greater potency and improved killing devices aided by species' recognition will transform ground control for endangered species protection. Aerial application of PAPP will greatly extend the range of stoat control. Our goals are shifting to enable reduction in density of rat, stoat and possum populations to zero over large scales (i.e. elimination at landscape scale), and to hold these at zero through detection and response including the use of new technologies for perimeter control as part of barrier systems for conservation.

O25

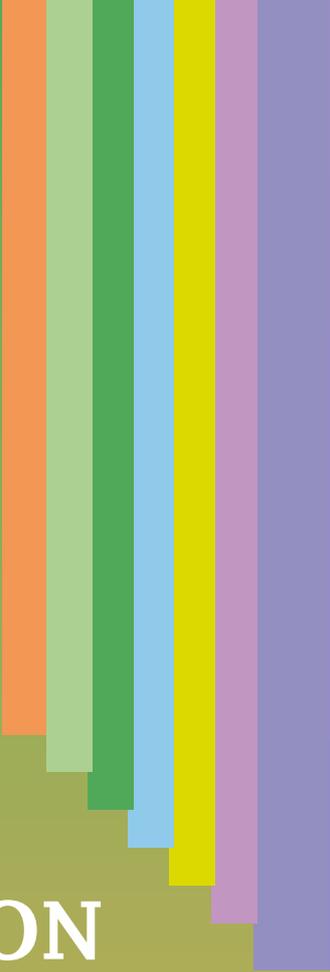
STUDY OF THE EFFICIENCY OF ANTICOAGULANT RODENTICIDES TO CONTROL *MUS MUSCULUS DOMESTICUS* INTROGRESSED WITH *MUS SPRETUS* VKORC1

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Anticoagulant rodenticides are commonly used to control rodent pests all over the world. They specifically inhibit VKORC1, an enzyme essential for the recycling of vitamin K, and thus prevent blood clotting and cause death by haemorrhage. *Vkorc1* gene coding for this enzyme was described in 2004. Numerous mutations of this gene were reported in humans and rodents, and some lead to resistant to rodenticides phenotype. In *Mus musculus domesticus*, two major mutations (i.e., p.L128S and p.Y139C) are observed in Europe and are associated to severe resistance to at least the first generation AVKs. Moreover, in mice, natural introgression of *Vkorc1* gene from *M. spretus* in the genome of *M. musculus domesticus* was reported. This natural introgression implied the substitution of 4 amino acids in *M. musculus*. This study described the *ex vivo* characterization of VKOR activity in natural introgressed-mice and its correlation with the phenotype observed *in vivo*. Wild mice homozygous for the 4 mutations were trapped in France and bred in our animal facilities. Male and female mice were fed with baits containing whether difethialone, brodifacoum, difenacoum, flocoumafene, chlorophacinone, bromadiolone, or coumatetralyl and mortality was evaluated. Liver microsomes were prepared to characterize inhibition of VKOR activity by these different anticoagulants. VKOR activity in introgressed-mice was found to be similar to that measured in *M. musculus* homozygous for wild type *Vkorc1*. Factor of resistance to rodenticides induced by the introgression were evaluated and resistance factors were comprised between 2 and 175, according to the sex and the molecules.



ORAL SESSION



Agricultural and silvicultural
pest management

O26**ALTERING WOODPIGEON HUNTING PRACTICES TO REDUCE CROP DAMAGE IN FLANDERS**

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Woodpigeons are a well-known and major cause of crop damage in Flanders. This damage is mainly attributed to the breeding population, while currently, hunting predominantly targets wintering birds. To obtain a higher impact on the local population and on crop damage, a shift towards summer shooting would be needed. In this project, we examined if a less restrictive summer hunt and a prolonged opening season (until the end of March) could result in such a shift. These measures were tested in three management units and two adjacent GMU's were monitored as reference.

During a three year period, hunting records for woodpigeon were collected in all five GMU's to determine whether or not summer shooting had increased and the winter/summer ratio had shifted. Woodpigeons shot in March were sampled to assess which proportion belonged to the summer population through DNA and isotope analysis. Gonad analysis was also performed to determine the onset of the breeding season.

Our results showed a clear increase in summer shooting in the test area, with summer shooting approaching 60%. Woodpigeons shot in March were not yet breeding and only 20 to 40% did not belong to the summer population.

In conclusion, the changes in legislation clearly led to alterations in actual woodpigeon shooting by the hunters and March shooting mainly targeted non-breeding summer birds. An implementation of these measures could therefore help to impact population development and mitigate crop damage.

O27

CROP DAMAGE IN TIME AND SPACE & RESOLVING CONFLICT BETWEEN FARMERS AND WILD BOARS IN NORTHEASTERN POLAND

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The objective of this study was to characterize the factors affecting the level of wild boar-related damage in north-eastern Poland where the average population density of wild boars is 90.5 individ./1000 hectares of forest. During three years (2012 - 2014) the data was collected in 25 hunting districts in the Braniewo county, in total area of 1250 km², where the proportion of fragmented forest was 25%. The damage was found in 17 different crops, over the average annual area of 327.8 hectares, with monetary value of 144,390 euro. The highest proportions in the area of damaged crops were noted in meadows (23.9%), followed by rape (21.5%), and maize (17.9%). In March-April, 41.6%, and in July-August - 33.4% of the total area of all damaged crops were recorded. The mean distance of damaged crops from forest border was 384 m, whereas the maximum distance - 998 m. Within the belt spanning from 0.8 to 1.0 km away from the forest border, it was chiefly the maize which was damaged. The level of damage was positively correlated with the density of population ($r=0.794$), providing supplemental fodder ($r=0.871$), and with the relative density of forest-farmland ecotone index ($r=0.636$). In order to resolve the conflict between farmers and wild boars, the population density of the latter should be reduced dramatically, supplemental feeding should stop, and the number of female yearlings having offspring in summer should be reduced via high levels of harvesting piglets between October and January.

O28

ECOLOGICAL AND ECONOMIC ASPECTS OF THE IMPACT OF UNGULATES ON FORESTS

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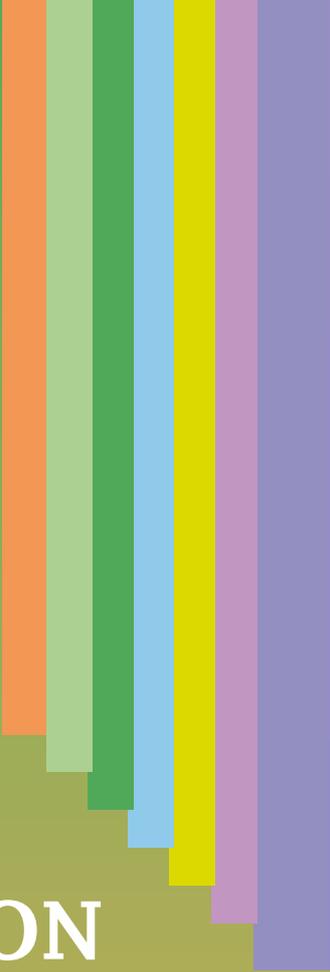
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The assessment of the effect of ungulates on their habitat, including forest damages, remains one of the most contentious problems arising amongst foresters, game managers, and nature conservationists. The great majority of the forests in Europe are managed for commercial purposes and many of them in the same time act the part of protection or recreation. Consequently ungulates can cause sensitive damage in reforestations. The elevated populations of ungulates, can result in the change of the ecologically favourable forest stands. Overpopulation of the ungulates can impede natural forest regenerations. A specific problem of the forest-ungulate interaction is the negative effect on continuous cover silviculture. However, the complexity of the interaction between forests and ungulates is demonstrated by many studies which show a lack of close correlation between the density of ungulates and forest damages.

The majority of damage in Europe is caused by red deer and roe deer, although wild boar also can cause damage mainly in natural regenerations. This kind of damage leads to problems connected with nature conservation. On the other hand the interrelation of ungulates and forest affects forest management profitability.

The ecological and economic impacts of browsing are summarized in this presentation. It is argued that the effect of browsing of seedlings and bark stripping of pole stands is quite contradictory and should be assessed carefully both on the level of the individual tree as well as the regenerated forest stand. Factors affecting the occurrence and extent of damages caused by ungulates are discussed.



ORAL SESSION



Ecologically based pest
management

029

MONITORING COMMENSAL RODENT POPULATIONS WITH CAMERA TRAPS: HOW NOT TO FILL YOUR HARD DRIVE IN SIX WEEKS.

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The use of automated camera traps has become increasingly recognised as a powerful research tool for the study of wild animal populations. In particular, the approach has proven useful for investigating the distribution of rare or elusive species, while some studies have also sought to develop methods for determining species abundance from camera trapping data. Thus far, these studies have focussed primarily on large to medium sized wild animals including ungulates. We investigated the potential for using camera traps to determine activity indices for commensal rodents living in high density populations on livestock farms, and sought to compare these indices against previously calibrated survey methods. We found a positive correlation between activity indices from camera trap data and population estimates from established survey methods for Norway rats and house mice. We subsequently used camera traps to investigate the impact of providing landowners with training on managing commensal rodent populations on their premises, and in investigations of the role of commensal rodents in the maintenance of Salmonella prevalence on pig units. The work so far indicates that camera traps are a viable tool for monitoring commensal rodent populations, and also that they provide useful data on other wildlife found on livestock farms, which could help to refine risk models for exposure of non-target wildlife to rodenticides, as well as evaluating the potential for transmission of pathogens and parasites from farm wildlife to livestock.

O31

ECOLOGICALLY BASED MANAGEMENT OF GRASSLAND SMALL MAMMALS

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Since 2007, the European REACH directive makes industry responsible for assessing and managing the risks for humans and the environments posed by chemicals. National plans (e.g. Ecophyto in France) and regulations more and more aim at reducing the dependence of farmers on pesticides. Small mammal population surges pose a number of problems in various domains such as agriculture, forestry, health and conservation. However, a large number of small mammal pest species are actually important key stone species in their native range. They maintain large densities of various species of predators that may be of conservation value and legally protected. Unconditional chemical control of grassland rodents often induces unacceptable consequences on non-target fauna and poses inextricable problems to various stakeholders of regional ecosystems. The water vole (*Arvicola scherman*) and the common vole (*Microtus arvalis*) are two grassland species that may reach large population densities and cause heavy damage to grassland and crops. Here we present the results of long term inter-sectorial research carried out since the late 1980s, aiming at identifying the key ecological factors that may help grassland vole control. In Franche-Comté, France, this led to the development of integrated methods (a “toolbox”), now implemented by farmers, inspiring national regulations to conduct more sustainable control of grassland rodents. Application of such methods to *A. terrestris* populations decreased the quantity of bromadiolone bait used per hectare by 8, the area treated by 6, and led to a subsequent drastic reduction of the impact of vole control on non-target species.

O32

GENETIC POPULATION STRUCTURE TO EXPLAIN THE SPREAD OF ANTICOAGULANT RODENTICIDE RESISTANCE OF NORWAY RATS (*RATTUS NORVEGICUS*) IN GERMANY

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Knowledge about migration is essential for an effective management regarding resistance of commensal rodents to anticoagulants. The polymorphism Tyr139Cys of the VKORC1-gen leads to resistance to anticoagulants of *R. norvegicus* in Germany. Rat control has failed increasingly, particularly in areas with frequent applications of rodenticides. Nothing is known about the spread of resistance genes by migration of individuals. We investigated both, the frequency of the resistance gene by ArmsPCR and the genetic distance using fragment length polymorphisms of nine single sequence repeat markers to determine spatial distribution of Norway rats within the German resistance area. Tissues of 189 Norway rats derived from 13 farms were investigated. Distances between the farms ranged from 0.7 to 37.6 km. Resistant individuals were found at all farms but in different abundances. We found great differences in resistance rate between farms in spite of low geographic distances. While the relationship between individuals, expressed by Loiselle's coancestry coefficient, was highest within farms the genetic relationship decreased significantly with the geographic distance. There were indications for isolation by distance. Related individuals were found within a mean radius of 4 km. The investigated rat population could be split into 5 subpopulations which were relatively homogenous in their internal Tyr139Cys frequency. Subpopulations' Tyr139Cys frequencies were significant different. Subpopulations provided a better explanation of the spatial heterogeneity in population structure and Tyr139Cys spread than the allocation of the animals on farms. Differences in rodenticide management and physiogeography of the investigated area could explain for these effects.

O33

LOCAL POPULATION DYNAMICS OF SMALL MAMMAL COMMUNITIES IN AGRICULTURAL LANDSCAPES OF SW EUROPE: DENSITY-DEPENDENCE AND RELATIONSHIPS WITH CLIMATE.

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Understanding the ecological factors that determine the population growth rate of rodent populations is fundamental in order to study population dynamics, and to predict and better manage population outbreaks. This is particularly important for species that spill over diseases or cause significant crop damages when overabundant, like common voles in NW Spain. Using six-years of seasonal (three times a year) abundance data (July 2009-March 2015), we investigated weather variables influencing local seasonal population dynamics of *Microtus arvalis*, *Apodemus sylvaticus*, *Mus spretus* and *Crocicidura russula*. In that way, we used General Linear Models (GLM) to explain variation in seasonal population growth rates (PGRs) of each species with abundance and climate variables (average temperature and monthly accumulated precipitation in spring, summer, autumn and winter). Winter was the most critical period for all species, as winter temperature positively influenced winter PGR. Moreover, winter temperature positively influenced spring PGR in *M. arvalis* and *C. russula*, suggesting that warmer winters benefited vole and shrew population growth during both winter and spring. On the other hand, precipitation was crucial for summer PGR in common vole, shrew and wood mouse, while winter precipitation influenced spring PGR in *M. spretus*. We discuss species-specific traits (e.g. diet, size and metabolism...) that can explain how climate affects population dynamics. These results allow a better understanding of how weather affects the local population dynamics of small mammals in a typical community of Mediterranean farmlands in south-western Europe.

O34

LONG-TERM TRENDS IN RODENT DAMAGE AND ENVIRONMENTAL CORRELATES IN FORESTRY

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Several rodent species can damage forest trees especially at young tree age in afforestation. Summer and winter damage was assessed by forest authorities for up to 45 years based on visual estimates of the number of damaged hectares in the central Federal states Thuringia (TH) and Saxonia (SA). Long-term trends of damage patterns suggest continuously fluctuation in the number of hectares damaged by common voles (*Microtus arvalis*), field voles (*Microtus agrestis*) and bank voles (*Myodes glareolus*) during the last decades.

Beech mast, snow cover and rodent abundance were suspected to influence damage intensity. Data were available for continuous periods of 9-41 years. In most cases winter and summer rodent abundance were correlated to beech mast in the previous year. The number of days with snow cover and rodent abundance did not correlate with rodent damage in summer and only occasionally with rodent damage in winter (some effect in TH but not in SA).

It is concluded that beech mast is a good indicator of rodent abundance in several rodent species in central Germany. Rodent damage to forestry seems to depend on other environmental parameters than rodent abundance and snow cover and if there is a correlation regional differences matter. As a result, predictions of rodent damage to forestry cannot be based solely on these parameters and further work is required to identify suitable environmental drivers.

O35

DENSITY-, AGE-DEPENDENT REPRODUCTION AND DISPERSAL PARTIALLY COMPENSATES CULLING EFFORTS OF INVASIVE NON-NATIVE AMERICAN MINK

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Management aiming to reduce the density of invasive species must overcome compensation through density dependence in the vital rates of culled population. In some circumstances however, compensatory responses (i.e. declining per capita growth rate as population density decreases) may operate at very low density through e.g. inefficient mate location and contribute to the suppression of culled populations. In addition, in fragmented or spatially heterogeneous populations, there is scope for compensatory dispersal to occur, with individuals migrating to habitats with lowered density and reduced competition for resources.

Using data from a large-scale, 6 years of control effort of the invasive non-native American mink (*Neovison vison*) in Scotland, we analysed density dependent changes in female fecundity and mink dispersal. We found evidence of strong compensation but not depensation in female mink fecundity with the probability of conceiving (average 0.81) and litter size (average 5.52 pups), increasing as the density of females, but not males, declined. In addition, we found a senescent decline in fecundity which, given culling of mink and subsequent reinvasions resulted in a younger population, added further to density dependent compensation in fecundity. Mink dispersal was also compensatory and responded to density gradients, with mink choosing partly depleted (but not empty) good-quality patches as first choice. Despite compensation through both reproduction and dispersal, the control strategies were sufficiently adaptable and robust so as to overcome compensatory responses and suppress densities of mink on a large-scale.

O36

BREEDING ON A ROLLER COASTER: REPRODUCTION PATTERNS IN FLUCTUATING POPULATIONS OF COMMON VOLES (*MICROTUS ARVALIS*) FROM SOUTHERN EUROPE

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Reproduction is the most fundamental mechanism for maintaining life over time. In Rodents reproduction rates are typically high, although temporal changes in the reproductive output of individuals are an important component of population change. In populations that periodically experience strong fluctuations in abundance, reproductive strategies and performance can change dramatically when populations are rising as compared with when are dropping down. Across the northern hemisphere, arvicoline rodents (i.e., voles and lemmings) typically show strong irruptive (often cyclic) fluctuations in abundance, which ultimately determine the maintenance of biodiversity at several trophic levels. Besides their key ecological role, some species are also considered as agricultural pests in farming environments when their numbers exceed certain abundance thresholds; such is the case of the common vole in Europe. This species has recently colonized the extensive semi-arid agricultural plains of NW Spain (Castilla-y-León region), and periodic outbreaks have followed ever since in the region. Ecological knowledge of these novel populations of farmland voles still is scarce, which jeopardizes effective sustainable management. Quantifying the temporal variation of significant biological processes, such as reproduction, is paramount in order to progress with the practical knowledge that can be use to manage vole populations. Here, we describe basic phenotypical parameters (body mass), reproductive condition (descended testes or pregnancy) and relative proportions (sex ratios) of both male and female common voles during a 6-year study (2009-2015) in intensive farmland from NW Spain. We discuss the patterns of variation found across several vole populations and contextualize their usefulness in management terms.

037

**POST HARVEST IMPACTS OF RODENTS IN MYANMAR:
HOW MUCH RICE DO THEY EAT AND DAMAGE?**SINGLETON, GRANT ⁽¹⁾; HTWE, NYO ME ⁽¹⁾; MAW, PYAI PHYO ⁽²⁾

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In Myanmar, farmers harvest their monsoon rice crop and then stack it in bundles on levee banks for 1-6 weeks to await threshing. After threshing and drying, rice grain for sale and household consumption is stored loosely within a bulk granary. Seed for the next rice crop is stored in polyethylene bags and traditional bamboo baskets. This study examines the impacts of rodents on the quantity (consumed) and quality (partially eaten) of grains and seeds during piling in the field, and in grain stores. The main rodent pest in fields, *Bandicota bengalensis*, stores grain in burrows. The loss of grain to rodents during piling in the field was measured by excavating burrows. In grain stores, baskets with known quantities of rice were monitored every 2 weeks for moisture content, weight loss, and rodent-damaged grains. The loss to seeds stored for the next crop, was assessed in three different types of bags. The mean amount of grain stored inside a burrow was 8.7 ± 5.7 kg/pile and the loss of grain during piling was 3%. Mean losses of stored grains in 2013 was $10.6 \pm 1.2\%$, and in 2014 was $1.2 \pm 0.4\%$. For the rice seed, the highest rodent damage occurred in traditional farmer bags. To reduce impacts of rodents in fields after harvest, IRRI has introduced early maturing varieties and improved post harvest practices. To reduce the impact of rodents in grain stores, community management of rodents has been promoted, and affordable rodent-proof stores piloted.

O38

HABITAT PREFERENCES BY PESTS TO IMPROVE POPULATION CONTROL: THE CASE OF POSSUMS IN A NEW ZEALAND DRYLAND ECOSYSTEM

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Introduced brushtail possums are controlled in New Zealand to mitigate their spread of bovine tuberculosis in livestock. The habitats of possums in dryland areas of the South Island differ in many respects to those in the rest of New Zealand, such as abundant rocky outcrops, open grasslands and dense shrublands. We investigated the movements and habitat preferences of possums in these habitats to identify where possums aggregate following population control. We measured habitat use at two large sites using GPS collars attached to 50 possums, and peanut butter-infused cards that had been chewed by possums. One site had moderate possum control, and was surrounded by high possum numbers. The other site had intensive control in and around the site, and had fewer possums. No preference for habitat types was apparent at the moderately-controlled site, but at the intensively-controlled site, possums selected rock and shrubby habitats, and avoided open grassy areas. Preference for rocks and shrubs at this site slowly increased throughout the year following control, presumably because the lower density of possums reduced competition for these preferred sites. This preference for shrubs and rocks is likely to benefit population control if poison bait stations are focussed on these habitat types.

O39

USING INTERNET SEARCH ENGINES TO ASSESS SPATIAL AND TEMPORAL CROP DAMAGES CAUSED BY EUROPEAN RABBITS IN SPAIN

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The European rabbit (*Oryctolagus cuniculus*) is native to the Iberian Peninsula, where it plays key ecological roles, and is an important small game species. However, as occurs in most of the countries where the species was introduced, rabbits are regarded as pests in many Iberian regions, causing damage to crops and infrastructures. In this study, our main goal was to explore rabbit damage in Spain spatially, and temporally. We identified cases of rabbit damage by using Google search engine. In particular, we searched for terms that stemmed from the following keyword combinations (in Spanish): rabbits and pest, rabbits and damage, rabbit and crops, and rabbit and overpopulation. According to our results, rabbit damage occurred in northern, central and southern Spain. In addition, online reports of rabbit damage increased notably from 2004 to 2010; ~90% of the records were dated between 2007 and 2009. This suggests that rabbits could have recovered in some areas after the rabbit population crash caused by haemorrhagic disease at the end of the 1980s. There were two main peaks of rabbit damage records in spring and summer, coinciding with the main period of crop growth and the highest rabbit abundance in the year, respectively. Most records obtained through our searches referred to rabbit damage to vineyards and cereal crops. These results suggest that conflicts between farmers and other stakeholders over rabbit management could occur across wide geographic areas in Spain and that they may have increased in recent times.

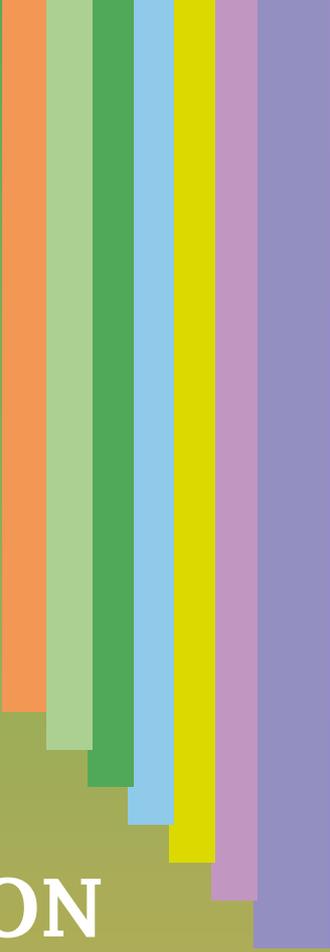
O51**FACTORS AFFECTING REPRODUCTION OF
ECTOPARASITES OF WILD RODENTS: PATTERNS,
CAUSES AND CONSEQUENCES.**

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The main evolutionary motivation of every species, including parasitic, is to increase its reproductive success, a goal that is achieved via various adaptations to specific ecological conditions, biotic and abiotic. Using flea parasites on wild rodents as a model system, we investigated the effects of host environment, host identity, host sex, host age and host reproductive state on flea reproductive success in terms of both quantity and quality of offspring. In this presentation, we will demonstrate that all these factors affect flea reproduction. These effects are then reflected in the level of flea abundance. We will discuss host-related and parasite-related mechanisms of these effects. Furthermore, parasites at different stages of this cycle have neither the same requirements nor the same possibilities and constraints. As a results, the effect of an abiotic (e.g., ambient temperature) or biotic (e.g., host identity) factor on flea individuals belonging to one stage of the cycle may be transformed or compensated by the effect of the same or another factor on individuals belonging to another stage of the cycle. Therefore, we will discuss also various trade-offs in flea reproduction



ORAL SESSION



Zoonoses and parasites

O40

RECOVERY OF COMMON VOLE POPULATIONS (MICROTUS ARVALIS) AFTER RODENTICIDE APPLICATION

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Common voles (*Microtus arvalis*) are the most important vertebrate pest species in Europe and can cause tremendous crop loss in agricultural landscapes during outbreaks. In Germany, controlling common voles with rodenticides is limited to one application per year. It is unclear how this restriction affects management and when timing of bait application is optimal. Field data are required to verify management decisions in realistic circumstances.

Although there has been detailed research on population development and dynamics of common voles there is hardly anything to be found on recovery mechanisms after rodenticide application. The same is the case for other rodent species. This project deals with recovery mechanisms, recovery time and rate as well as with dispersal behavior after zinc phosphide treatment for common vole management.

Treatments were conducted in July 2014 and March 2015. No reduction of population size was detected after the treatment in July as the population density kept growing. Contrary results were found after rodenticide application in March when population size crashed to a minimum of 2 individuals per hectare. However, populations recovered to almost pre-treatment levels within 8 weeks after the application.

It is concluded that rodenticide application is more successful in early spring than in summer. It seems doubtful that a once-off application of zinc phosphide can sustainably reduce common vole populations. Further work is necessary to identify impact of treatment scale and the relevance of nearby source habitats such as field margins

O42

RODENT CONTROL AS A MEAN TO FIGHT LASSA FEVER IN UPPER GUINEA?

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Lassa fever is a viral haemorrhagic fever, endemic in parts of rural West Africa including Guinea, Sierra Leone, Liberia, Mali and Nigeria. The disease is affecting 200,000-300,000 persons with 5,000-10,000 fatalities per year. Lassa virus (LASV) has a rodent reservoir, *Mastomys natalensis*, and is transmitted to humans through contact with *M. natalensis*, their body fluids or droppings. Treatment options are limited. There is no vaccine, so that prevention has to be based on reducing the contact between humans and infectious *M. natalensis*. From earlier studies in Guinea we know that *M. natalensis* is particularly abundant in houses during the dry season, thus presumably increasing the risk for transmission to humans. It has furthermore been suggested that Lassa prevalence in rodents increases with their abundance. Therefore, reducing the abundance of rodents could decrease the occurrence of Lassa fever in humans by decreasing the exposure of humans to *M. natalensis*, and by decreasing the proportion of infectious rodents. In a high endemic zone in Guinea, we conducted an experimental study with 3 outcome variables: rodent abundance, LASV prevalence in the rodent population, and human incidence. We preliminarily present here the two first outcomes and suggest rodent elimination as a possibly sustainable way to fight Lassa fever. In Upper Guinea, we have chosen 6 villages; 3 as control and 3 for the intervention using rodent poisoning (anticoagulant) to reduce the abundance of *M. natalensis*. Samplings 1, 2, 3 and 4 were performed in November-December 2013, March-April 2014, March 2015 and April-May 2015, respectively. Samplings 1 and 2, then 3 and 4 were separated by the intervention. The rodent abundance was estimated before and after the intervention to measure the efficiency of rodent elimination. Intervention 1 showed a decrease of abundance from 11-14% to 3-5%. Intervention 2 showed a decrease of abundance from 4-14% to 2%. This suggests that the intervention was effective, but incomplete. In parallel, we investigated the Lassa virus prevalence for each sampling using a combination of 2 PCR tests. First results show that intervention 1 modified the prevalence from 4-20% (5/52-8/39) to 0-33% (0/10-4/12). This suggests that even in very small population there can still be LASV positive animals. This confirms our idea to reinforce the rodent elimination by improving the methodology to keep the rodent population low all year long. Several consecutive years of rodent elimination will be likely necessary to produce a measurable decrease in the incidence of the disease.

This project is funded by the German Research Foundation DFG FI 1781/1-1

O43

RABBIT HAEMORRHAGIC DISEASE AND MYXOMATOSIS EPIDEMIOLOGY IN AN ONGOING 19 YEAR STUDY OF THE AUSTRALIAN TURRETFIELD RABBIT POPULATION

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Australia has introduced two diseases for control of the European rabbit (*Oryctolagus cuniculus cuniculus*). Myxomatosis was released in 1950 and rabbit haemorrhagic disease virus (RHDV) became established in 1995. Both diseases were initially extremely effective in controlling the rabbit. A recent study reported the combined agricultural benefits of these diseases to date have been worth \$AU70 billion. However, the effectiveness of both diseases has changed over the years, with research suggesting development of resistance in the rabbit, with associated genetic changes in the viruses. In addition, a benign calicivirus (RCV-A1) has recently been described and found to have some protective benefits against RHDV. This talk will discuss the results of an ongoing 19 year epidemiological study of the interactions, timing and variable impacts of these viruses, as well as highlight current efforts through the Invasive Animals CRC to examine *Eimeria* parasites and other novel diseases as additional control agents for this Australian pest animal.

O44

UNDERSTANDING THE ROLE OF A TUBERCULOSIS (TB) RESERVOIR PEST: POSSUMS AND TB IN NEW ZEALAND NATIVE FOREST

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Wildlife reservoirs of infection hamper efforts to eradicate bovine tuberculosis (TB) globally. In New Zealand, the wildlife reservoir principally responsible for TB persistence is the Australian introduced brushtail possum (*Trichosurus vulpecula*). However, the possum is generally regarded as a relatively solitary species. With TB being rapidly killed in the environment, this raises questions about how infection persists in possum populations. To investigate, we carried out disease transmission trials over three years in an uncontrolled possum population in New Zealand native forest, using grids of live-catch cages to monitor populations. Each year we caught, experimentally challenged with *Mycobacterium bovis* (the causative agent of TB), and released 16 individual adult possums at their capture locations. A strain of TB different from the local background strain was used for challenges, to allow secondary cases of infection due to transmission from challenged individuals to be identified. Surrounding populations were monitored for six months post-challenge after which they were sub-sampled for post-mortem examination for disease, with tissue samples cultured to confirm *M. bovis* presence and allow strain-type identification. Wide variation in estimated possum to possum TB transmission rates was observed, with most estimates being insufficient for disease persistence. Some challenged individuals would have survived for longer than our trials allowed, suggesting potential for further transmission events that are not considered in our parameter estimates. A potential link between greater ongoing transmission, and longer survival of male possums challenged when in better body condition, is suggested by the data.

O45**PHASE AND DENSITY-DEPENDENT PREVALENCE OF HANTAVIRUS INFECTION IN BANK VOLES IN 2003-2013**

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The bank vole (*Myodes glareolus*) is the host for Puumala hantavirus, a zoonotic virus that causes hemorrhagic fever in humans. In Northern Sweden, hantavirus human cases are common, and bank vole populations exhibit 3-4 year cycles with distinct phases: increase, peak, decline (and in four year cycles: low). We use our long term data-series on small mammal densities in a 100 km by 100 km area and serological data from 2003-2013 to discuss the relationship between bank vole density and hantavirus prevalence in bank voles during spring and fall. We also discuss phase-dependent virus prevalence, reporting that hantavirus prevalence in spring is cyclical and peaks just before peak bank vole densities in autumn. We show that both bank vole density and hantavirus prevalence can help predict future risk of hantavirus infections for humans.

O46

SEASONAL CHANGES IN THE INFLUENCE OF POPULATION DEMOGRAPHICS ON HANTAVIRUS INFECTIONS IN TWO RODENT RESERVOIR SPECIES

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Rodent-borne hantaviruses are a major issue in public health. Predicting infection risk simply through host abundance has been shown to exhibit great variation between and within rodent host/hantavirus systems. It is therefore imperative to understand the roles of seasonal and density-dependent demographic factors, ie. the impact of seasonal heretogeneities of functional groups to the virus transmission within the host population.

Here we present results on seasonal changes in demographic drivers (age, sex, reproductive activity) of hantavirus transmission in the two most common rodent host/hantavirus systems (Bank vole (*Myodes glareolus*)/ Puumala virus; Common vole (*Microtus arvalis*)/ Tula virus) in Germany. Trapping was conducted during 2010-2013 in four federal states with 3 woodland (*Myodes*) and 3 grassland (*Microtus*) replicates per state and 3,246 individuals tested for hantavirus-specific antibodies.

There was strong seasonality in the probability of carrying antibodies for different functional groups for both species. For *M. glareolus*, demographics played a significant role during summer and autumn, while for *M. arvalis* these were restricted to autumn when populations on grassland reach their peak densities. A clear impact of hantavirus-specific maternal antibodies was found during peak reproduction in summer for *Myodes* populations. No such impact at any level could be demonstrated for the *Microtus* system. In both systems older individuals and males were associated with higher seroprevalence.

These results highlight underlying similarities and dissimilarities of hantavirus transmission in two different hantavirus/reservoir systems, and the need to consider seasonality of functional groups, in future efforts to understand hantavirus transmission and predict human infection risks.

O47

SURVEY FOR ZOOZOTIC PATHOGENS IN NORWAY RAT POPULATIONS FROM EUROPEAN CITIES

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The Norway rat *Rattus norvegicus* represents an important reservoir of various zoonotic pathogens. Previous studies have demonstrated infections with Seoul hantavirus (SEOV), multi-drug resistant bacteria, *Leptospira*, *Yersinia*, *Rickettsia*, *Bartonella* and *Streptobacillus* spp. in wild Norway rats. In addition, orthopox virus and SEOV infections have been detected in pet rats of different geographic origins. A recent next-generation sequencing-based investigation in rats indicated several viral pathogens with zoonotic potential, but also novel viruses with still unknown zoonotic potential (Sachsenröder et al., 2014, J. Gen. Virol. 95,2734-2747).

Here we describe a survey of 440 rats from five different European countries for leptospires, rickettsiae, orthopox viruses and SEOV. PCR-based investigation revealed *Leptospira*-positive rats at nine sites in three countries. The average prevalence was 13.6% with a range of 5.1% to 36%. SecY sequencing of five samples detected *Leptospira interrogans* and a subsequent MLST analysis identified the sequence type 17, which corresponds to the serovar *Icterohaemorrhagiae*. *Rickettsia*-DNA was detected only in one of the 286 rats investigated. Sequencing of the partial *ompB* gene indicated *Rickettsia helvetica*. The rickettsia-infected rat was also positive for *Leptospira interrogans*. PCR-based analysis of rat samples failed to detect any orthopox virus-specific DNA and SEOV-specific RNA.

In conclusion, study results indicate a broad geographical distribution of *Leptospira* infections in rats within Europe underlining the need for further investigations to assess the public health relevance. In contrast, rickettsia, orthopox virus and SEOV infections seem not or only very rarely to occur in the present wild rat populations.

O48

ECHINOCOCCUS GRANULOSUS AND OTHER ZONOTIC PATHOGENS OF PERI-URBAN WILD DOGS IN SOUTH-EAST QUEENSLAND, AUSTRALIA

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In Australia, wild dogs are readily found within urban and peri-urban zones, particularly in south-east Queensland. Wild dogs traverse within a very close distance to houses, frequently visit household backyards, and use common and highly populated areas such as school grounds and parklands (Allen et al., 2013). Such close geographical proximity to these locations leads to the question of potential public health impacts. Although we are aware that wild dogs are capable of harbouring zoonotic pathogens, their prevalence and any associated risk factors remain largely unknown and unexplored. Data on targeted zoonotic diseases amongst peri-urban wild dogs has been collected utilising faecal samples, blood samples and whole dog carcasses provided from council management programs within north-eastern New South Wales and south-eastern Queensland. Necropsy, microbiological and molecular methods were used for detection and identification of pathogens. Preliminary results suggest *Echinococcus granulosus* is the most common pathogen carried by peri-urban dogs (52%, n=198) which is highly significant in terms of public health risks. Identifying clusters and risk factors that influence the presence of *E. granulosus* are currently being investigated using epidemiological methods. Other common intestinally identified pathogens include *Spirometra erinacei*, *Toxocara canis*, Hookworms and *Taenia* spp at 33%, 5%, 5% and 3.3%, respectively. Results from these investigations will provide some insight to into the potential public health risks but also lead to more informed management programs for wild dogs in peri-urban areas.

O49

HELMINTH FAUNA OF INVASIVE AMERICAN MINK (NEOVISON VISON) IN LITHUANIA

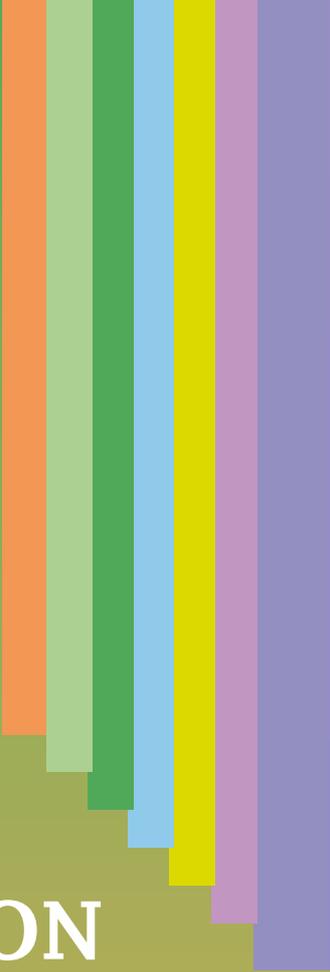
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The American mink (*Neovison vison*) is an invasive semiaquatic species introduced to Europe from North America in 19th century. It has been introduced for the purpose of fur farming. Due to massive and continual individual escapes, farm damages also caused by hurricanes and fires, deliberate or accidents releases, feral mink was successfully acclimatized in the wild of many parts of Europe. Free American minks are found in Lithuania since 1950. The study of parasitism related to American mink invasion in new regions is important due to possibility of introduction of new parasites to endemic host and transfer of endemic parasites to new host. The aim of our research was to explore helminth fauna of invasive American mink in Lithuania. Helminth fauna was compared with results from another European countries. In Lithuania helminth fauna consists of trematoda: *Isthmiophora melis* and *Strigea strigis* mesocercaria, and nematoda: *Eucoleus aerophilus*, *Aonchotheca putorii*, *Crenosoma schachmatovae* and *Molineus patens*.

Keywords: Invasion, American mink, Lithuania.



ORAL SESSION



Consequences of control on
non-target species

O50

DIROFILARIASIS - THE NEW ZONOSIS IN LITHUANIASABUNAS, VYTAUTAS⁽¹⁾; PAULAUSKAS, ALGIMANTAS⁽¹⁾; RADZIJEVSKAJA, JANA⁽¹⁾; JOKUBAUSKIENE, G.⁽²⁾

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Dirofilariasis is a group of zoonotic parasitoses caused by species of the genus *Dirofilaria* and transmitted by mosquitoes. *Dirofilaria* infections in Europe caused by *D. immitis* and *D. repens*. Parasites can infect wild and domestic canines, felines, and humans. Dogs are the main reservoirs. Climatic changes and an increase in the movement of reservoirs have an impact on the spread of dirofilariasis into previously non-endemic areas. In Lithuania, six human cases of *D. repens* infection were recorded during 2011-2014. However, the data on this zoonotic infection in Lithuania are still scarce. Blood samples of 2180 randomly selected dogs presented in small animal clinic during 2014-2015 were investigated for filarial parasites. The species of the microfilariae were determined on the basis of their morphometrical characteristics and the Diff-quick staining technique applied to blood smears and using Modified Knott's test. Microfilariae were detected in blood smears of thirty-four (1.6%) dogs. For differentiation and accurate identification of the filarial species we also used PCR and pan-filarial primers (DIDR-F1, DIDR-R1) that amplify fragments of different length of the internal transcribed spacer region 2 (ITS2) of the ribosomal DNA from six different filarial species. Sequence analysis confirmed *D. repens* in all of investigated samples. In order to investigate wild Canidae as possible reservoirs for zoonotic filariae, foxes (*Vulpes vulpes*) and raccoon dogs (*Nyctereutes procyonoides*) killed on roads or during the hunting seasons 2014-2015 were examined. Splenic blood smears and blood coagula were used for detection of microfilaria in morphological and molecular diagnostics, respectively.

O52

THE USE OF BROMADIOLONE TO CONTROL VOLE OUTBREAKS IS PASSED ON TO NON-TARGET SPECIES: IMPLICATIONS FOR CONSERVATION POLICIES.

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Population fluctuations of rodents are common across Europe. Outbreaks of these populations are at the hub of conservation policies since they cause agricultural losses but increases abundances and reproductive outcome of their predators. This issue has become of particular relevance in southern Europe, where peaks of abundance of common voles (*Microtus arvalis*) results in agricultural damages, claiming an urgent control of these outbreaks by affected farmers. Local government encouraged the use of rodenticides, particularly bromadiolone, despite its effect on non-target species in wild populations is unknown. Here, we targeted two populations of common kestrels (*Falco tinnunculus*) in central Spain where bromadiolone was spread out to reduce the impact of vole outbreaks. Kestrels are a suitable species to tackle this issue because they feed mainly on voles in the study area. We explored first whether the use of bromadiolone to control vole outbreaks can be detected in blood of nestlings of kestrels breeding in affected areas and second, any potential association with body condition of these nestlings. Our results show that bromadiolone was detected in blood in 17.6% of the sampled chicks (n=113) and that those chicks with bromadiolone (mean±SE: 1.41±0.37 ng/ml) were in worse condition (lower body mass). According to our results, the use of bromadiolone to reduce vole abundance may have a knock-on effect on vole predators as this rodenticide can reach vole predators, perhaps worsening nestling condition, a key aspect for individual survival. We recommend, undoubtedly, dismissing the use bromadiolone as measure to control population outbreaks of voles.

O53

ANTICOAGULANT RODENTICIDES: FROM PREY TO PREDATOR

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Anticoagulant rodenticides (AR) can cause wildlife poisoning, but underlying pathways of AR transfer from bait to prey to predators are often unknown. We investigated exposure small mammals and estimated AR exposure risk for barn owls (*Tyto alba*) based on small mammal exposure and barn owl diet. Furthermore, we screened liver samples of prey cached by barn owls, their pellets and carcasses of predators for ARs to verify the suggested pathway. We analyzed local parameters affecting AR exposure in red foxes on a regional scale to identify AR sources spatially.

High AR residue concentrations of non-target small mammals occurred mainly close to the baiting area (15m), whereas lower concentrations occurred up to 87m. *Apodemus* and *Crocidura russula* regularly carried residues, sometimes in high concentrations, whereas exposure in *Microtus* was low. Risk to barn owls was expected to be high in autumn when owls increasingly preyed on *Apodemus* whereas risk was low in summer when *Microtus* was main prey. AR exposure of barn owl pellets was rare, but confirmed in 13% of prey items collected from nest boxes. Furthermore, 36% of predatory birds and owls and 60% of red foxes (*Vulpes vulpes*) carried AR residues across Germany. AR occurrence in foxes was correlated to the percentage of urban area and livestock density.

Our results demonstrate primary and secondary AR exposure of non-targets and reveal likely AR pathways in wildlife. This creates an important knowledge base for the adjustment of risk mitigation strategies. (funded by German Federal Environment Agency grant #371063401)

O54

RODENTICIDE EXPOSURE RISK FOR PREDATORS MODELLED ON LANDSCAPES

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Widespread secondary poisoning with anticoagulant rodenticide (AR) has been recorded in predatory species in many countries, e.g. Denmark, despite regulatory measures to prevent exposure non-target wildlife species. To elucidate the causes of the extensive exposure of predators we modelled the exposure risk for mustelids under different scenarios for AR usage at landscape levels.

In Denmark, an estimated 33% of all buildings in rural areas are treated with ARs annually to control rats and mice, and until 2012 ARs could be used in forestry and Christmas tree to control voles. Model experiments were performed to evaluate exposure risk 1/ with and without AR usage away from buildings, e.g. in forestry, and 2/ the effect of AR baiting frequencies in and around buildings.

The AR exposure risk varied with species' home-range size and landscape composition, all mustelid territories were exposed to ARs in all landscapes annually. Cessation of AR use in forestry and Christmas trees reduced the exposure risk by 0-3% depending on species and landscape. These model projections agree with empirical data on AR prevalence in stone marten (*Martes foina*) and polecat (*Mustela putorius*). Reducing baiting frequency at buildings by 50% and 75% resulted in 0.5-12% of mustelid territories being unexposed annually depending on species and landscape structure.

We conclude that chemical rat control in and around buildings may result in the widespread poisoning of predators. To reduce the exposure rate significantly the baiting frequency of buildings must be reduced radically, and alternative rodent control methods may need to be implemented.

O55

ANTICOAGULANT POISONING OF NON-TARGET SPECIES: HAVE THINGS CHANGED AFTER IMPLEMENTATION OF THE BIOCIDAL PRODUCTS? A FRENCH SURVEY

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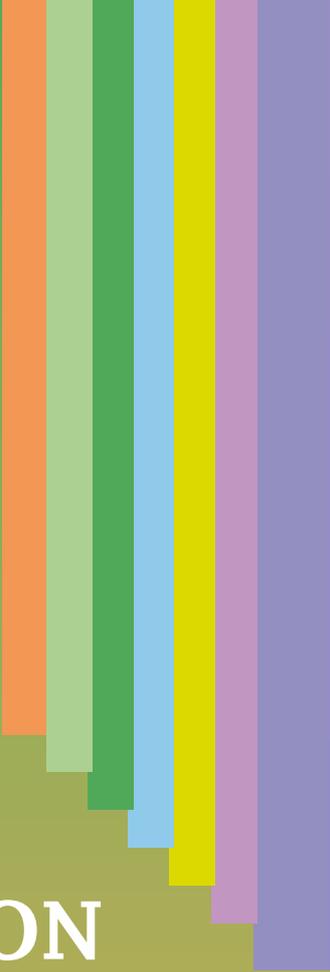
Vetagro Sup - Campus vétérinaire

Anticoagulant rodenticide (AR) poisoning is one of the most common cause of primary poisoning in domestic animals but also identified in secondary poisoning cases in wildlife. Starting in 2009, all products have been revised and granted marketing authorizations with a new set of risk mitigation measures in Europe. The purpose of this study is to analyze long-term series of poisoning cases and to determine if the implementation of the biocidal product directives resulted in changes in the pattern of poisoning.

This survey has been conducted using two datasets from the French Animal Poison Control Center and the Toxicology Diagnostic Laboratory of the Veterinary College of Lyon (France). Both structures have been collecting data over more than 30 years and have a unique joint expertise in dealing with animal poisoning.

Each case is assessed and classified as “poisoning” (exposure, amount of exposure, time to onset of signs, clinical signs are consistent with poisoning with AR) or “suspected poisoning” when some criteria are not met. The toxicology laboratory is the reference laboratory for wildlife suspected poisoning cases.

Cases collected between 2003-2008 and 2009-2014 will be analyzed and time series analyses will be used to compare the prevalence of AR poisoning in different species, with all products authorized in France as biocidal products over the study period. Information on the circumstances of exposure will be discussed for primary poisoning. In wildlife, information on species, products involved, time-series analyses (long term and recent trends) and geographical are will be presented.



ORAL SESSION

Invasive vertebrates



O56

RISK ASSESSMENT OF PLANT PROTECTION PRODUCTS FOR BIRDS AND MAMMALS UNDER THE CURRENT EUROPEAN LEGISLATION: `FIELD STUDIES¿ AS USEFUL TOOLS FOR REFINED RISK ASSESSMENTS

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The risk assessment for Plant Protection Products (PPP) on Birds and Mammals is carried out under the EU regulation 1107/2009 and follows the guidance document issued by EFSA (EFSA 2009). This guidance outlines a first-tier assessment procedure for a large range of scenarios including different crops at different growth stages, and types of pesticide uses (e.g. granules, seed treatment, and sprays). Each scenario is a combination of ecological characteristics of exposed species and other factors relevant to exposure. In most cases the assessment results in a toxicity-exposure-ratio (TER) as an indication of risk. If concern is raised regarding lower tier assessments it may be possible to refine the risk assessment with a range of options, e.g. refined dietary exposure assessments using realistic data on the ecology of relevant species or perform 'field studies'. 'Field studies' can be conducted to measure residue concentrations, generate targeted ecological data, or to assess effects of the product following experimental applications before authorization (i.e. applications made as part of a regulatory study). 'Field studies' refers also to 'active monitoring' of effects following applications of authorised products in agricultural practice named 'post-registration studies' which address remaining uncertainties or check the efficacy of risk mitigation measures. The presentation will give examples from various pre- and post- field monitoring studies conducted by Bayer CropScience and explain how useful these different approaches were to supplement the risk evaluation with information from real field uses of products on exposure and effects.

O57

GENETIC MONITORING AS A TOOL IN THE MANAGEMENT OF INVASIVE SPECIES: AMERICAN MINK CONTROL ON THE SWEDISH COAST

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Eradication and population reductions are often used to mitigate the negative impacts of alien invasive species and protect biodiversity. However, monitoring the effectiveness of alien species control programs is necessary to evaluate efficacy of control methods, especially during long-term management. Genetic monitoring could provide valuable insights into temporal changes in demographic, ecological, and evolutionary processes in a managed invasive population. Effective control methods should cause a decrease in genetic diversity and/or effective population size of the targeted alien species and an increase in population genetic structure over time. We used genetic data from American mink (*Neovison vison*) to determine whether removal of this predator on Koster Islands archipelago and the nearby Swedish coast affected genetic variation between 6 consecutive years of trapping. On Koster Islands allelic diversity decreased (from on average 4.53 to 3.55), genetic structuring increased, and effective population size did not change. Mink from the Swedish coast showed no changes in genetic diversity or structure, suggesting stability of this population over 6 years of trapping. Across all years effective population size was higher on the coast than on the islands. Migration rates from the islands to the coast were almost two times higher than from the coast to the islands. Most migrants leaving the coast were localised on the southern edge of the archipelago, as expected from sea current direction between the two sites. Genetic monitoring provides valuable information on temporal changes in invasive populations that can be used to evaluate and improve control programs.

O58

COPING WITH A MULTI-TROPHIC INVASION COMPLEX: ANTICIPATING COUNTERINTUITIVE RESULTS OF ALTERNATIVE CONTROL STRATEGIES

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Biological invasions on islands often involve the establishment of multiple invasive species, forming invasion complexes. Invasion complexes intensify the threats posed by single invasive species on native biota and may result in counterintuitive effects after management actions. In this study, we evaluated the importance of two types of facilitative effects among four invasive species established on a continental island: (1) facilitation of small herbivores (rabbits) by larger ones (deer and horses), and (2) hyperpredation, i.e. apparent competition between native and invasive prey (seabirds and rabbits, respectively) mediated by an invasive predator (mink). For this purpose, we combined field observations (rabbit demography, mink abundance) and experiments (rabbit and ungulate exclusions) with demographic modeling. Results of herbivore exclusions, together with a peak in rabbit abundance following a horse mortality event, suggest that resource competition predominates over facilitation, at least in the short term (two years). Mink's reliance on invasive prey (rabbits) when native prey (breeding seabirds) are not available results in hyperpredation effects. Simulations indicate that (1) in the absence of control programs, gulls are likely to become extinct within a short period of time (one or two decades), and (2) the most effective control strategy is simultaneous control of rabbit and mink. Given the likelihood of counterintuitive consequences, however, regular reevaluation of the control strategy chosen is strongly suggested. Our results stress the need for adaptive designs of control strategies when facing invasion complexes.

O59

ERADICATION OF COMMON MYNAS ACRIDOTHERES TRISTIS FROM DENIS ISLAND, SEYCHELLES, AND EARLY RESPONSES OF NATIVE SPECIES

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Introduced Common Mynas *Acridotheres tristis* inhabit most islands of the central Seychelles archipelago. Denis Island (143 ha) is one such island and, following the eradication of cats and rats, four species of rare endemic birds were introduced to establish insurance populations. Discovery of nests and adult Seychelles Warblers *Acrocephalus sechellensis* being attacked by mynas led to an attempt by Seychelles NGO Green Islands Foundation to eradicate mynas, starting in May 2010 in collaboration with WildWings Bird Management. In early 2015 the eradication was completed after three phases of intensive trapping and latterly by shooting.

Monitoring of the numbers of the endemic birds demonstrated an increase in three species and a change in behaviour of the fourth following reduction in myna numbers. There is circumstantial evidence of an increase in the numbers a breeding seabird, White Tern *Gygis alba*, and in 2014 Lesser Noddies *Anous tenuirostris* bred for the first time. This illustrates the clear benefits of eradicating small island populations of Common Mynas on native fauna.

This paper describes the methods used and their efficacy, along with the problems encountered and needs for undertaking future eradications. The main constraints on the Denis Island eradication were (i) the inability of the NGO to provide sufficient time for project management to assure adequate funding and the recruitment, retention and replacement of volunteer fieldworkers, and (ii) interference with the trapping programme by large numbers of non-target species.

O60

MONK PARAKEET SPREADING AND FIRST CROP DAMAGE REPORTED IN ISRAEL AND MALAGA (SOUTHERN SPAIN). IS IT TIME TO SOUND THE ALARM?

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The Monk parakeet, *Myiopsitta monachus*, is a very common cage bird native to South America, which has been exported in big numbers all around the world becoming invasive in Europe, America and Asia. Crop losses of up to 45% and 28% have been registered in its native and invasive ranges respectively. In Europe, several self-sustained populations have been established in temperate countries. Basic data about population size, distribution and possible impacts are needed to establish preventative measures if necessary. In March 2015 we studied the little-known population of Israel, collecting data from bibliography and local birdwatchers, visiting the known breeding areas, covering around 398 Km². We found 519 nests, counted the number of chambers and estimated the use of these holes at night, to finally calculate an estimated population of 1821 +- 342 individuals. We analysed the potential crop damage risk, quantifying the cropland included in a considered home range of 3 km long. Some superficial crop damage has been reported in the area last year. Finally we compare the results with the well-known Monk Parakeet population of Malaga (Southern Spain), similar in size, where the population trend is known and some crop damage has been reported last year. For the moment, there are no management plans in any of these sites, but the exponential growth, the fast spreading and the high extent of cropland exposed seem strong enough arguments to sound the alarm about the species in the Mediterranean basin, including the emerging populations of Greece and Morocco.

O61

TACKLING THE AMERICAN BULLFROG *LITHOBATES CATESBEIANUS* INVASION IN FLANDERS, NORTHERN BELGIUM

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American bullfrog *Lithobates catesbeianus* is one of the world's worst invasive species and suspected to cause substantial ecological damage around the globe through predation, competition and pathogen transmission. The species has been introduced in Flanders at the end of the 1990s. Since then the population has been expanding its distribution area, and now holds an area of occupancy of 17 km². The largest stronghold is a (meta)population in a river valley where a large reproducing population in a complex of several hundreds of - largely private - ponds used for recreational fishing and gardening is present. The north of the province of Antwerp is home to a few smaller isolated populations. To halt the spread, and reduce its impact on native biota, regional and local authorities, ngo's, conservation managers, a social economy company and scientists worked together in the cross-border EU co-funded Interreg project Invexo (www.invexo.be). Attempts were undertaken to eradicate the smaller populations, using a variety of active trapping techniques. Research was performed into cost-effectiveness of double fyke nets. This catching gear is relatively cheap, easy to handle and know has documented catchability for both larval and adult stages, thereby offering some perspectives for integrated control of populations. Management followed a holistic approach, integrating active removal with habitat management by introduction of native predatory fish, which has been shown to increase the general quality of the aquatic habitats involved. Meanwhile, risk analysis was performed for bullfrog in Belgium in order to underpin legislative action to prevent new incursions.

O62

THE STRETCH TOWARDS ERADICATION OF RUDDY DUCKS IN EUROPE, AN UPDATE TO 2015

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Recommendation No. 149 of the Convention on the Conservation of European Wildlife and Natural (Bern Convention), adopted on 9 December 2010, should result in the implementation of the actions of the “Action Plan for the Eradication of the Ruddy Duck in the Western Palearctic, 2011 - 2015” (Cranswick & Hall, 2010). Concerning Ruddy Ducks in the wild, main target was the total eradication of the species in 2015 by elimination of at least 50% of the total population present on each country. Although a significant delay in the control measures took place in some mainland countries (Robertson et al. 2015), culling actions have been intensified after the “Expert Meeting on the Implementation of the Action Plan for the eradication of the Ruddy Duck in Europe”, held in Wageningen (the Netherlands) in October 2014. Here we present an update to 2015 breeding season of numbers still present in Europe and a summary of eradication efforts made in Spain, Belgium, The Netherlands, France and the United Kingdom since the eradication action plan approval. The bulk of the European breeding population is now at France, with smaller numbers in UK, Belgium and the Netherlands. Sightings in Spain have decreased to single short-stayers observations, and no breeding or hybridization with White-headed Duck events have occurred since 2004. A major coordination not only between European countries, but also among regional governments is recommended to reach the total eradication target.

O63

CHANGES IN THE RANGE EXPANSION OF THE EUROPEAN STARLING (*STURNUS VULGARIS*) IN ARGENTINA DURING THE LAST 10 YEARS (2005-2014)

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First observations of the European Starling (*Sturnus vulgaris* L.) in Argentina are in 1987-88 at wooded areas of Buenos Aires city and at 21 km from here. In 2005, the bird was established along the Atlantic coast, 120 km from first observations and up to 30 km inland; an average progression of 7.5 km/year from 1987 to 2005.

The evolution of the distribution of the species during the last 10 years (2005-2014) is reconstructed, based on bibliographic information and own data. Currently, the Starling breeds on the NW following the Parana river upstream at a rate of 33-44 km yr⁻¹, and several points in the W/SW (rate up to 66.6-72.2 km yr⁻¹); although few individuals had been observed at new breeding areas (< 3-12 birds). In any case, this expansion increase the original breeding grounds around 100 km from Buenos Aires capital during the 90's. The bird has an average of 2,1 birds/km at the old breeding grounds, whereas decrease up to 0,1-0, 2 birds/km at distances greater than 100 km from its original presence.

The high rates of expansion could be explained by the flat configuration and great areas of marshlands/pasture grounds of the country, being the starlings primarily adapted to these habitats. If the species reach higher population levels, it could be a pest along areas devoted to corn, grape and fruits in the western part of the country.



POSTERS SESSION



Agricultural and silvicultural
pest management

P2

IMPORTANCE OF A MINERALS CONTENT IN BARK ON RED DEER BARK-STRIPPING IN BEECH FORESTS

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There is general agreement that bark-stripping by red deer is observed mainly during the winter period and it is related with reduction in food resource availability. However, in this studies we observed bark-stripping by red deer on beech forest during the early summer. This damages were caused in the same areas every year, while almost identical beech forest in the same area remained undamaged. In order to assess which factor affects deer food preference we analysed landscape characteristic and minerals content in the bark in beech forest thicket with and without deer pressure in Northern Poland. Places with high intensity of bark-stripping were characterized by over 80% tree damages, whereas near located similar forests were free from any damage. Unfortunately, landscape characteristics did not explain deer preferences for such particular beech forest thicket. However, we found that in one forest district bark consumed by red deer contained more calcium, whereas in another one more phosphorus and potassium.

Our study has made a new brick to the understanding the bark-stripping phenomena by red deer and shows that deer may select bark of the tree not only when the food is scare. In our opinion red deer in the beginning of breeding season may search mineral contents for at least two reasons: stags for antlers building and hinds for lactation.

It seems that searching by deer for minerals depends not only on the individual requirement, but mainly on the local availability of these minerals as well as on food resources.

P3

OVERPOPULATION OF COMMON VOLE *MICROTUS ARVALIS* IN AGRICULTURAL FIELDS IN SERBIA

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Common vole *Microtus arvalis* is the most frequent and most harmful Eurasian vole. It is an herbivorous species with considerable needs for high-protein food. Its pronounced environmental adaptability is responsible for its spreading from places of its original habitation (non-agricultural areas, clearings and pastures) into agricultural fields, especially wheat and alfalfa crops. There is a tendency of its cyclic overpopulation. The last common vole overpopulation event in agricultural areas of Vojvodina Province in Serbia occurred in the mid-1980s.

A number of factors, including climate as the most decisive one, initiated in 2012 and 2013 a strong selection pressure on common voles. At the beginning of 2014, high frequency of common voles was reported on nearly 300,000 ha of arable fields, while overpopulation (more than 50 000 animals/ha) was detected on some 3,000 ha. Overpopulation area was located in central parts of the Vojvodina, Banat region. Initial significant increase in their frequency was found in alfalfa and all winter cereals (wheat, barley and oat) during the early spring. As the summer months approached, significantly higher vole numbers were detected also in soybean, maize, sunflower and sugarbeet crops.

Yields of grain and fresh green biomass of all cultivated crops sustained ensuing economic losses, reaching as much as 100% in fields with confirmed vole overpopulation. Besides the damage caused to field crops, which was most evident during vegetation, increased vole frequency was also observed in orchards, in which damage will be assessed during the 2015 vegetation season.

P4

SAVI'S PINE VOLE POPULATION DYNAMICS IN ORCHARDS

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The Savi's pine vole (*Microtus savii*) is the most widespread vole species of Italy. It is a fossorial species, living in open areas, orchards, forage and cereal crops. These characteristics make it an ideal model species in order to understand possible impacts of agricultural practices, including the use of plant protection products. To address these issues, two populations were monitored monthly by means of live traps in peach orchards (1 in Emilia-Romagna and 1 in Tuscany), from July 2014 to March 2015. All trapped animals were individually marked. Capture data were analysed with the software MARK. The population density estimated from the trapping program was compared with that estimated by counting active holes in the orchards. Density ranged from 43.7 ind./ha to 13.9 ind./ha at the study area in Emilia-Romagna and from 37.9 ind./ha to 6.1 ind./ha in Tuscany. The mean number of juveniles per trapped females was highest in Tuscany. Demographic trend of this species would allow the establishment of monitoring and controlling protocols in crops where it may be considered a pest.

P5

WILD BOAR (SUS SCROFA) MANAGEMENT: AN AGRICULTURAL/ECOLOGICAL NEED OR A MEAN TO PLEASE HUNTERS? A CASE STUDY IN THE PROVINCE OF RIETI (ITALY)

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The interaction of the wild boar with agricultural-forestry productions and some components of the ecosystem is the main factor requiring an annual management plan for the species. This determines a sharp contrast between the needs of the agricultural sector and the expectations of the hunting world. Farmers require the minimization of damage and the containment of the species within the limits of the agro-forestry density. Hunters try to keep the wild boar population in such conditions to ensure abundant hunting in current and future hunting seasons. In fact, hunter's teams safeguard nuclei of reproductive boars in the assigned areas, stopping the killing on purpose in the latter part of the hunting seasons. This illegal behaviour prevents the completion of the annual plans of taken boars. A study performed in 2008 showed that the teams declared on average 54% of the animals actually hunted. The adoption of a new provincial regulation, putting at risk the preservation of the assigned hunting areas, changed hunter's attitude in the declaration. In this new context, preliminary data of an on-going study similar to the 2008 one show that: 60-70% of killed animals are declared; 31.4% of the teams declares 50% less than the assigned animals; 6.7% declares all the assigned animals even without having taken them; 15.3% of the teams declares they took more animals than those assigned (average=8.71animals/team; S.D.=±5.98).

P6

REPRODUCTION OF FOSSORIAL WATER VOLES (ARVICOLA SCHERMAN CANTABRIAE) IN APPLE ORCHARDS: IMPLICATIONS FOR THEIR POPULATION CONTROL

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The fossorial water vole *Arvicola scherman cantabriae* is a key pest in apple orchards in Asturias (NW Spain). To plan a suitable strategy for its population control is necessary to know its reproductive cycle and reproductive outcome. Sampling was carried out in ten apple orchards from two localities (Villaviciosa and Nava) throughout two years (February 2011-January 2013). Sexual characteristics of 823 voles were analysed to obtain information on the variation of the breeding characteristics of this population during this period. Pregnant females were found in all months, with no significant intra- or inter-annual differences in their number. Accordingly, immature specimens were also found along the whole year. Therefore, in the study area, *A. scherman cantabriae* breeds continuously throughout the year. Testicle volume (TV) and seminal vesicle length (SVL) showed significant intra-annual variations, but these variations did not seem to affect the reproductive potential of the population. The average number of embryos per female was 3.8 ± 0.12 (SE), distributed in litters formed by 1-9 embryos. Moreover, the potential number of litters per adult female was 7.3, what implies 27.7 offspring per female during a single breeding season. According to our results, as reproduction and recruitment of mature specimens are continuous along the whole year, population control practices (poisoning, trapping, fences) should also be extended to the whole year. Finally, population control actions should be properly coordinated between farmers to prevent a continuous orchard colonization.

P7

EFFECTS OF CROP IDENTITY AND BIOMASS OF GRAIN SPILLED IN STUBBLES ON PEST-BIRD ABUNDANCE IN THE PAMPAS OF CENTRAL ARGENTINA

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The Argentine Pampas is one of the richest agricultural regions of the world. Eared Dove (*Zenaida auriculata*), Monk Parakeet (*Myiopsitta monachus*), and pigeons (*Patagioenas picazuro* and *P. maculosa*) have become major pest-bird species of standing crops in agricultural landscapes of Argentina. However, little is known about abundance of these species after harvest, considering that spilled grain in stubbles may contribute to sustain granivorous bird populations. The aim of this study was to assess the effects of crop identity and the amount of grain spilled in stubbles on pest-bird abundance. During 2011-2013, we randomly sampled 167 plots (spring-summer: stubbles of wheat -N=45- and barley -N=33-; autumn: soybean -N=50-, corn -N=26- and sunflower -N=13-). In each plot we established a 600x100m transect in order to record pest-birds. We sampled grains spilled at each plot and calculated biomass. Mean biomass of grains spilled by plot ranged between 150±16 kg/ha for wheat and 293±105 kg/ha for corn, whereas all pest-birds were more abundant in autumn (3.8±1.1, 1.4±0.4 and 0.4±0.1 ind/ha) than in spring-summer (1.2±0.3, 0.5±0.2 and 0.3±0.1 ind/ha for doves, parakeets and pigeons, respectively). Generalized linear mixed models revealed that abundance of all species were associated with the identity of crop rather than biomass. During spring-summer, doves and pigeons were more abundant in wheat stubbles, whereas during autumn, doves were more abundant in sunflower and parakeets in corn stubbles. These results show a relative greater influence of crop identity rather than biomass of spilled grains available in stubbles on the abundance of pest-birds.

P8

PALATABILITY, EFFICACY AND MYCOBIOTA ANALYSIS OF THE EXTRUDED AND WAX BLOCK RODENTICIDES EXPOSED TO URBAN AND FARM AREA CONDITIONS

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Laboratory studies were conducted to evaluate the mycobiota, palatability and efficacy of wax block (Klerat® 20g) and extruded block (TalonXT® 20g) after field exposed per 30 days in urban area, concrete silo and poultry; placed in bait stations. Palatability and efficacy evaluation followed the manual of protocols of the Brazilian National Health Surveillance Agency (ANVISA) used a total of 48 adults *Rattus norvegicus* of Wistar strains, weighing 240 ± 15 g. The mycobiota were analyzed by the direct plating method of the blocks fragments on Sabouraud agar. It was performed with 10 samples replicates per formulation and area. In two-choice food trial to extruded block, the rats consumed were satisfactory and efficacy after bait exposition in urban area, concrete silo and poultry were 100%, 91.7% and 91.7%, respectively. In two-choice food trial to wax block, the rats consumed were satisfactory and the efficacy were 83.3% in all both studied areas. The mycobiota analysis showed 100% of *Rhizopus* spp. in the samples extruded and wax blocks in concrete silo area. In the poultry area samples of extruded and wax blocks showed predominance of *Penicillium* spp. (80%), *Cladosporium* spp. (60%) and *Aspergillus* spp. about 70%. The samples of extruded and wax blocks from the urban area showed the predominance of *Penicillium* spp. (60 and 20%, respectively) and *Fusarium* spp. (20 and 80%, respectively). The samples of blocks control showed only yeasts. Fungal contamination did not interfere on the palatability. This information is valuable to effective rodent control program and forecast durability of baits.

P9

PREDICTION OF AGRICULTURAL GAME DAMAGE OF SOME LARGE MAMMALS

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We've investigated databases of agricultural game damage in Hungary, Zala County caused by red deer, wild boar, roe deer. We've developed a model to predict the probability and measure of game damage. We've created a digital interface enabling the farmers to collect information on the expectable game damage typical to their own land. The effect on game damage of forest cover, plant type cultivated by the farmer, size of the crop-field, distance of the crop-field from the forest has been investigated. The development of game damage of previous years has been analyzed and prediction made for the next years in function of climatic changes. Regarding the financial compensation of game damage we've found linear correlation ($p=0.015$) with the Pálfai drought index. Increasing drought index correlates with increasing financial compensation because in years of drought the amount of crop decreases so the price of the crop increases thus increases the game damage compensation as well. Using the model can be prognostised the amount of financial game damage compensation of the next decades. We've succeeded to find relation between forest cover and agricultural game damage: with increasing forest cover ratio grows the agricultural game damage ($p=0.032$). Besides forest cover ratio the size of the crop-field also influenced the measure of the game damage: the smaller the crop-field size and the closer to the forest is the higher the game damage is ($p=0.032$). Due to the model the measure of the game damage became predictable in Zala County.

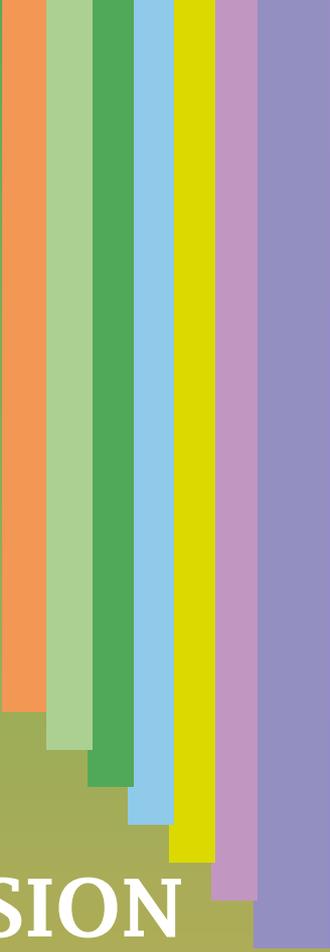
P10**CONSEQUENCES OF TRAPPING ON FEMALE BODY CONDITION IN FOSSORIAL WATER VOLE POPULATIONS ACCORDING TO THEIR GENETIC ISOLATION**

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The fossorial water vole *Arvicola scherman cantabriae* is a key pest in apple orchards in Asturias (NW Spain). These orchards are immersed in a mosaic landscape with irregular topography, leading to a significant isolation among populations. A continuous removal of specimens by trapping might impose a physiological stress for remaining voles, which may lead to a decrease in their reproductive potential. Therefore, the consequences of trapping on the body condition of female voles were evaluated according to the genetic isolation of their populations. The study was carried out from 2011 to 2014 in three apple orchards located in Asturias. The body condition index (BCI) of 227 not pregnant adult females was calculated as the difference between measured body mass and the theoretically expected body mass corresponding to the head and body length. The genetic diversity and inbreeding coefficient of each population was assessed by genotyping 12 microsatellite loci. Populations from two orchards showed a decrease of the BCI of remaining females under continued trapping. Genetic data revealed inbreeding effect and lower genetic diversity than expected. In the third population, however, the BCI of remaining females was not affected by trapping and genetic data indicated outbreeding effect and higher genetic diversity than expected. Our data reveal that trapping can decrease the BCI of remaining *A. scherman cantabriae* females, possibly due to the physiological stress resulting from lack of the male mate. A certain level of population isolation related to the landscape may delay the re-establishment of the couples enhancing this stressful situation.



POSTERS SESSION



Biological control of rodent
pests by promoting increased
raptor predation pressure

P11

PRELIMINARY RESULTS OF THE EFFECT OF RAPTOR NEST BOXES IN DRYLAND AGRICULTURAL LANDSCAPES DURING A COMMON VOLE OUTBREAK

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During last decades, the common vole (*Microtus arvalis* Pallas) colonized the agricultural lands of the Spanish northwestern plateau, where population outbreaks have occasionally caused significant crop damages. In these agro-eco-systems, there is an apparent imbalance in the relationship between avian predators and prey, probably influenced by a lack of adequate areas for the establishment, breeding and hunting of raptors. This is one of the causes that may be influencing common vole population dynamics, and causing crop damages. Thus, landscape modification to increase natural vole avian predators, could be an environmentally-friendly preventive tool to be considered into an integrated pest management strategy. An important question to be answered is the efficacy of this measure during a vole outbreak, when vole numbers would increase faster than those of their predators.

Two different locations (Osorno la Mayor and Villarramiel) were provided with 100 nest-boxes (50 for barn owl and 50 for common kestrel) distributed in a 2000 ha surface. The effect of boxes in voles was studied considering the different habitats linked to these agricultural zones, including crops and vole reservoirs. During the campaign 2013/14, a common vole outbreak was detected in these areas. Considering the period between sowing and harvesting winter crops, data of distances, densities, raptor occupancy and breeding in nest-boxes, were used to generate informative covariates to be related with indexes of vole activity. In this contribution, preliminary results about the effect of the implementation of nest-boxes for raptors on the evolution of common vole abundance are reported.

P12

RESPONSES OF MALE AND FEMALE COMMON VOLES (MICROTUS ARVALIS) TO CONSPECIFIC SCENT MARKS: A FIRST STEP TOWARDS A NEW CONTROL METHOD OF THEIR POPULATION DENSITY

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Chemical signals are the main communication channel in small mammals and are implied in many aspects of their behaviour. Thus, conspecific odours could have the potential to attract individuals to massive trapping systems. This is a control method that is increasingly used in invertebrate plague control but that remains mainly unexplored for rodents. Through scent marking, individuals obtain information about the presence of conspecifics in a given area, and this is the main mechanism of intrasexual competence in mammals. We have experimentally examined chemosensory behaviour of male and female common voles in response to scent-marks of other males or females during the main breeding season. Individual voles were introduced 5 min in a Y-maze with conspecific odour in one of the arms and control odour in the other. Their behaviour was recorded by video-camera and the overall time spent on each arm calculated. Experimental males spent similar time in areas marked with conspecific male odour or control odour, what do not suggest any preference or avoidance of areas used by other males. However, males spent significantly more time in the arm marked with female odour as compared with a control odour. In the case of females, they always spent more time in the arm marked with conspecific odour, either of males or females, than in the control odour. These results suggest that attracting females to traps with conspecific scent could potentially be a more profitable strategy than attracting males.

P13

BIO-SYSTEMATICS OF DIPTERA NECROPHAGOUS ON CARRION OF A JACKAL (CANIS AUREUS) IN A SEMI-ARID AREA BORDJ BOU ARRERIDJ, ALGERIA

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During bio-systematic study of Diptera scavengers in semi-arid zone in Ain Soltane, (Bordj Bou Arreridj) from summer 2013, the bio-ecology of necrophagous Diptera, two techniques have been implemented, those of stuck and catches by hand cartons. These were placed near a carcass jackals (*Canis aureus*) set experimentation outdoors. The capture Diptera scavengers is also handmade. The remarkably effective glue traps were captured on the 1965 Diptera decomposing corpse. The Diptera took part of 6 species distributed between 5 families, including those of Calliphoridae, Muscidae, Piophilidae, and Sarcophagidae. From the first days the first squad is dominated by Calliphoridae noted with common green bottle fly *Lucilia sericata* (AR% = 87.11%). The other species, *Musca domestica*, *Muscina stabulans*, *Sarcophaga africa* and *Piophila casei* seem to be part of the first cohort.

Keywords: Diptera scavengers, Jackal, *Musca domestica*, *Lucilia sericata*, Bordj Bou Arreridj.



POSTERS SESSION



Consequences of control on
non-target species

P14**SECONDARY POISONING IN POLECAT (*MUSTELA PUTORIUS*) AND STONE MARTEN (*MARTES FOINA*)**BAERT, KRISTOF⁽¹⁾; VAN DEN BERGE, KOEN⁽¹⁾; JANSEN, IVY⁽¹⁾; GOUWY, JAN⁽¹⁾; CROUBELS, SISKI⁽²⁾; CASAER, JIM⁽¹⁾

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The use of anticoagulant rodenticides (AR) can lead to secondary poisoning in non-target wildlife species like various predators. As in Belgium each year approximately 600 tons AR are used we examined the liver of 150 polecats and 75 stone martens for the presence of 8 different AR-residues using a validated LC-ESI-MS/MS method: warfarin, coumatetralyl, chlorophacinone, bromadiolone, difenacoum, brodifacoum, flocoumafen and difethialone. Almost all animals were road kills, collected from 2006 to 2012. About 77% and 81% of the livers of respectively polecat and stone marten contained AR residues. The maximum (median) concentration was 3,813 µg/g (0,133 µg/g) for polecat and 1,370 µg/g (0,213 µg/g) for stone marten, while the maximum number of different AR residues detected simultaneously in one animal was six. 42% of the animals reached the cut-off of 0,2 µg/g from which survival probability starts to decrease and intoxication could be expected. Statistical analysis did not reveal any relationship between the sum of the residue levels and season, species nor age but demonstrated a significant effect of the interaction between season and species. For a subset of adult male polecats (n=54) found dead in spring we analysed their residue level against the fitness of the animal expressed as body-condition (function of eviscerated weight and total length), mesenterial fat (g), kidney- and subcutaneous fat index. None of the observed variation in these condition variables could be explained by changes in residue concentrations. Hence we assume that the condition variables considered here are not altered by secondary poisoning.

P15

INFLUENCE OF GLYPHOSATE ON THE DEVELOPMENT OF COMMON TOAD (BUFO BUFO): TESTS OF THE ACTIVE SUBSTANCE AND A HERBICIDE PRODUCT

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As a typical species of the European agricultural landscape the Common toad (*Bufo bufo*) is potentially threatened by pesticide exposure. Even modern perennial agrochemical use is accompanied by a high exposure risk. However studies on the influence of pesticide exposure to European amphibian species are rare. For that reason we tested in an acute toxicity study the influence of the herbicide Roundup® PowerFlex and its active ingredient (a.i.) glyphosate in high and environmentally relevant doses on survival and development of Common toad. In the laboratory eggs were exposed to Roundup® PowerFlex or glyphosate for 24h or 96h for comparing to untreated control groups. Rate of hatching individuals and size, weight and survival rate during time to metamorphosis were determined. The preliminary results show that response to high dose treatment showed expected severe effects on examined variables of tadpole development. Environmental relevant doses seemed to have no effects. Systematic toxicity studies are necessary to assess the risk of European amphibian species due to the lack of suitable and comparable data. Standards for laboratory tests should be developed and single and mixed pesticide exposure scenarios on environmentally relevant level should be done for risk assessment of different species living in the current agricultural landscape.

P16**TEMPORAL VARIATION OF WATER VOLE EXPOSURE TO BROMADIOLONE FOLLOWING THE RECOLONIZATION OF A TREATED PLOT**

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The anticoagulant rodenticide bromadiolone is widely used as plant protection product to control Water vole outbreaks in European grasslands. Following a treatment, vole population declines rapidly and reaches very low density 3 weeks after bait applications. Then, the plot could be recolonized by voles coming from surrounding plots. When buried in artificial galleries, the persistence of bromadiolone in baits has been showed to be short (DT50 ~ 3 to 6 days). However, baits may be stored in cavities by voles, which increases dramatically the persistence of bromadiolone in the environment (DT50 from 25 to 43 days, Sage et al. 2007, Environ. Pollut. 147). In this study, we aim to document the exposure to bromadiolone of Water voles recolonizing a plot several months after a treatment. To simulate the recolonization, some water voles were trapped alive in non-treated grasslands and marked. Then, they were reintroduced in an experimental plot 1.5, 3 and 6 months after bait application, trapped during the 7 to 10 days following their re-introduction and bromadiolone residues were measured in their tissues. Measured residues were compared to those measured by Sage et al. (2008 STOTEN 407) in voles trapped during the days following bait application. Most of the time, concentrations were lower, but our results show that bromadiolone may persist in vole populations during several months after a treatment and thus, may lead to chronic exposure of wildlife to low doses of rodenticides.



POSTERS SESSION



Control methods and
alternatives

P17**DIFFERENT TYPES OF USE OF WILDLIFE RESOURCE
DEPENDING ON THE FOREST MANAGEMENT ACTIVITIES**

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The study object are local populations of ungulate species on the area of commercial hunting and the corresponding species on the area of usual hunting of Prienai Forest Enterprise. As the professional hunting ground for commercial hunting I selected the area of Punia Pinewood. Hunting grounds rented by hunting clubs for usual hunting are situated in the southern part of Prienai Pinewood. There are five ungulate game species as Moose (*Alces alces*), Red deer (*Cervus elaphus*), Fallow deer (*Dama dama*), Roe deer (*Capreolus capreolus*) and Wild boar (*Sus scrofa*). The data of the harvested animals and hunting intensity since 2009 were obtained from the Ministry of Environment and census data from certain hunting grounds. The census data of game species were analysed calculating game density and hunting density per 1,000 ha. For comparison of data, the statistical analysis was used.

It was found that on the area of public hunter clubs, the main game species are roe deer and wild boar. Their local populations are used intensively because of the high densities. Meanwhile, the population abundance remains fairly stable at the permissible density level

On the professional hunting grounds, the main game species are red deer and wild boar. Considering the commercial mission of these grounds, the largest numbers of game are keeping. The most eligible are trophy adults. The conclusion is that on the professional hunting grounds, the local populations of wild boar and red deer are used unreasonable and their density exceeds permissible level.

P19

ARTERIAL CALCIFICATION: THE MAJOR BIOLOGICAL COST OF THE RESISTANCE TO ANTICOAGULANT RODENTICIDES

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The Y139C mutation in *Vkorc1* gene is frequently observed in wild rat *Rattus norvegicus* in Germany and Denmark. In old rat carrier for this mutation, aortic and renal calcifications were observed (Kohn et al, 2008). Spontaneous precipitation of calcium phosphate is a natural tendency due to the fact that calcium and phosphate are supersaturated in all extracellular fluids. As a consequence, calcium phosphate precipitation has to be inhibited. Different proteins such as matrix Gla protein, gla-rich protein and osteocalcin are low molecular weight proteins able to diffuse into extracellular matrix to inhibit the calcification process around collagens or elastins. These three proteins are vitamin K-dependent proteins and so contain gamma carboxyglutamic acid (GLA) residues. These GLA residues confer to these proteins a high affinity for calcium. The gamma carboxylation process is dependent on vitamin K and a vitamin K deficiency leads to the loss of the functional properties of these proteins and particularly the loss of the inhibition properties towards calcium phosphate mineralization. In this study, we show results explaining the involvement of Y139C mutation of *Vkorc1* in the occurrence of a vitamin K deficiency in rat carrier for this mutation, and we present the kinetics of the vitamin K-dependent arterial calcification. Arterial calcification appears, as a consequence, as a major biological cost associated to anticoagulant rodenticides conferred by Y139C mutation.

P20

EFFICACY OF DIFENACOUM AGAINST HOUSE MICE CARRYING TYR139CYS AND LEU128SER/TYR139CYS VKOR-VARIANTS

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The VKOR-variants Leu128Ser and Tyr139Cys are the chief cause of anticoagulant resistance occurring in house mice. Recent studies have revealed that the two polymorphisms occur simultaneously in the *vkorc1* gene exon 3. Difenacoum efficacy against animals with that type of VKOR-variant had not been determined in house mice before the present study.

Fifteen house mice were used in a no-choice feeding test, according to standard EPPO (2004) methodology. The animals were fed for 21 days on baits that contained difenacoum 0.005%. Seven months earlier, all animals had survived a 21-day long bromadiolone (0.005%) no-choice feeding test, and sequencing of their *vkorc1* gene had revealed the presence of Tyr139Cys in eight and Leu1258Ser/Tyr139Cys VKOR-variant in seven animals. In our present study, all animals were given daily fresh baits and their daily consumption was measured. Water was available ad lib.

None of the animals survived the no-choice feeding test. All animals carrying Leu128Ser/Tyr139Cys died after eight days, and all carrying Tyr139Cys died after twelve days. Animals with the combination Leu128Ser/Tyr139Cys had a greater tolerance to difenacoum than Tyr139Cys-carrying animals as the former had 0.74 gg-1 bw average sum bait consumption and the latter 0.63 gg-1 bw.

Our preliminary tests showed that difenacoum 0.005% was effective against house mice carrying Tyr139Cys and Leu128Ser/Tyr139Cys. Tests involving more animals are planned to clarify the level of tolerance of house mice to difenacoum and the effect of the former treatment with bromadiolone.

P21**CURRENT SCENARIO OF BROMADIOLONE RESISTANCE IN RATTUS RATTUS POPULATIONS IN PUNJAB, INDIA**

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The house rat, *Rattus rattus* is a serious pest worldwide. The anticoagulant, bromadiolone is widely used to bring down its population effectively. Development of resistance to bromadiolone has been reported in several countries, but there is no such report from India. During present study, a total of 100 rats collected from seven different poultry farms in district Ludhiana, Punjab were screened for development of resistance to bromadiolone based on feeding and blood clotting response (BCR) tests. For the purpose, rats were fed on doses equivalent to LD50 (2.10g/100g bw for male and 3.67g/100g bw for female rats) and twice the LD50 (4.2g/100g bw for male and 7.34g/100g bw for female rats) of 0.005% bromadiolone bait. Prior to dosing and after 48hr of dosing, blood of rats was collected to record prothrombin time (PT), international normalized ratio (INR) and percent coagulation activity (PCA). Rats having PT less than 65s, INR less than 4.0 and PCA more than 20 were suspected to be resistant. In overall, 36% rats out of the total collected were suspected to be resistant, Rats having INR less than 2.5 and died after 26-72 days of dosing were proceeded for molecular analysis of VKORC1 gene. Nucleotide sequencing of one susceptible and two resistant rats revealed no single nucleotide polymorphism (SNP). None of the sample under study showed complete nucleotide homology with previously reported nucleotide sequences of *R. rattus*. Therefore sequences of VKORC1 gene under study can be considered to be novel sequences that have not been reported earlier.

P23

MANAGEMENT OF THE PEST SPECIES: WHAT WAS PLANNED AND NOT DONE FOR THE BOAR IN THE PROVINCE OF RIETI (LAZIO, ITALY)

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Road accidents, damages to forests, agriculture and birds nesting on the ground, indicate that the wild boar (*Sus scrofa*) is the most problematic species in the province of Rieti. The National Law 157/1992 and the Lazio Regional Law 17/1995 assign the wildlife management to the Provincial Administration (AP) and the "Ambiti Territoriali di Caccia" (ATC). During 2011-2013 AP and ATC registered 560 damage events (annual mean 188; SD=±23.07) for a total of 352508 Euros (635 Euro/event). Regulations of boar hunting establish that ATC communicates the acquired knowledge on the species every six months to the AP. The ATC three-year wild boar management plans expect the annual monitoring of the species to determine the status and its ongoing dynamics. This was ignored in the last three years. The status of the species is unknown, damages are unsustainable, the social conflict grows, technical advices are needed, and no one takes responsibility for not achieving the objectives. The National Law 394/1991 establishes that protected areas must adopt management plans to bring back and maintain the boar density within sustainable values (agro-forestry density). In the "Riserva Naturale Regionale dei Laghi Lungo e Ripasottile" (3000ha) during 2011-2013 113 boar damage events were registered (36ha; 40000 Euros). This area expects a management of the boar density, approved by technical/scientific State committees, but not implemented because of lobbies (e.g., hunters, often outside the protected area) interests.

P24

DAMAGE FROM SMALL RODENTS IN CROATIAN FLOODPLAIN FORESTS

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During the outbreak years small rodents (subfam. Murinae and Arvicolinae) impede natural regeneration of Croatian floodplain forests. Over the last 33 years damage was reported on ca. 4000 ha/outbreak year. Reported damage is caused on seeds, stem and roots of young plants, mainly pedunculate oak (*Quercus robur* L.) and narrow-leafed ash (*Fraxinus angustifolia* Vahl.). Nevertheless, the mere observation of damage and rodent presence is the most common method of evaluating rodent abundance in Croatian forestry while systematic monitoring of the two is generally missing. Monitoring of rodent populations along with the quantitative and qualitative analysis of rodent damage made to root system of pedunculate oak saplings collected from the Sava river basin in Central Croatia, showed that even during the years of low rodent abundance, nearly a quarter of analysed plants suffered from the reduction of root volume (max. 77%), root length (max. 97%) and number of root tips (max. 96%) depending on the plant age and height. Research also pointed out the importance of continuous rodent monitoring for better understanding of annual and seasonal damage and prediction of young tree damage in floodplain forests.

P25**CRITICAL ANALYSIS OF RODENTICIDE-IMPREGNATED SUNFLOWER SEED BAITS WITH BRODIFACOUM: LABORATORY TESTS**

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Rodenticide-impregnated sunflower seed baits containing brodifacoum have been widely used in Brazil to control rats. In order to evaluate their quality, 13 commercial baits were investigated on their active ingredient (a.i.) concentration, palatability and efficacy. The experimental procedures of palatability and efficacy followed the manual of protocols of the Brazilian National Health Surveillance Agency (ANVISA). It was used a total of 192 adult *Rattus norvegicus*, Wistar strain, weighing 250 ± 15 g. The a.i. concentration of 8g from 25g packing baits was analyzed by HPLC liquid chromatography with external standardization in a visible ultraviolet detector, wavelength 260 nm, RP18 column, mobile phase: methanol + water + acetic acid (90% + 10% + 1.5%) v/v flow 1mL.min⁻¹. The declared content of brodifacoum on the label was confirmed in 11 products (84.6%). All 13 products were palatable, but only five (38%) were effective against the rodents, that is, killed more than 90% of the tested animals. Twelve animals were used for each product. Such inefficacy may be due to failures in the seed impregnation process. In this context selling products of unsatisfactory performance affects the rodent control, which may endanger public health and the environment.

P26

TAKING ON BAIT UPTAKE: FACTORS INFLUENCING BAIT CONSUMPTION RATES

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Management of pests' species for several purposes such as improving sanitary conditions through vaccination and population control by using toxicants or immunocontraceptives requires the use of baits. Once a species-specific bait and delivery system are developed maximizing bait uptake by target population is critical to the cost-effectiveness of the measure, thus factors that influence bait uptake besides bait density should be studied.

Wild boar is considered a pest due to its increasing abundance, its negative repercussion over environment and other species and its animal health implications (maintenance and transmission of some diseases: animal tuberculosis, African swine fever etc).

This data is obtained in the context of a field vaccination trial and compares bait uptake in two settings in Montes de Toledo (located in Spanish plateau) among three different years.

Relation between bait uptake (measured by presence of a chemical marker in blood samples of hunted wild boar) and population variables (abundance, aggregation and management), remaining baits registration the morning after deployment and climatic variables among years are tested. Results suggest that abundance and management have a significant influence on bait uptake.

Knowledge on these factors coupled with field specific logistics and tactics based on the species ecology and behavior and habitat characteristics (climate, seasonal availability of resources) could benefit decision-making regarding baiting densities in baiting campaigns. Optimization of baiting strategies could make the difference when considering the feasibility of applying a particular measure large-scale.

P27

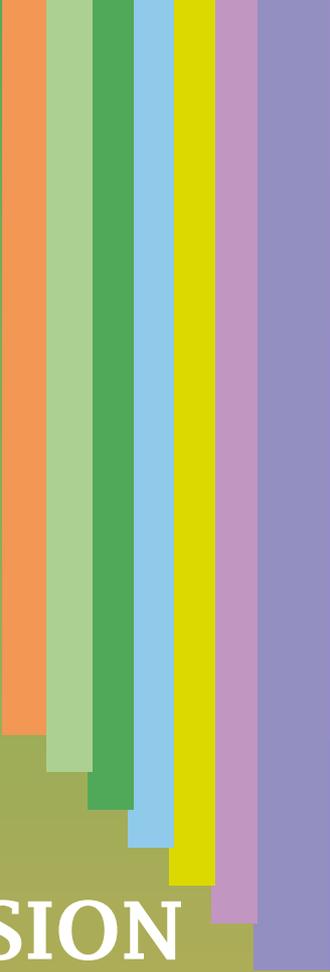
DISTRIBUTION OF VKORC1 SINGLE NUCLEOTIDE POLYMORPHISM IN WILD RATTUS RATTUS IN FRANCE AND SPAIN

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Anticoagulant rodenticides are commonly used to control rodent pests all over the world. These pesticides inhibit one enzyme of the vitamin K cycle, Vkorc1, and thus prevent blood clotting and cause death by haemorrhage. Resistance to anticoagulants was first observed in Scotland in 1958, and more potent anticoagulants have been developed to overcome this obstacle. Resistance to anticoagulants were shown to be linked with mutation in the Vkorc1 gene. In Europe, resistance was detected in *Rattus norvegicus* and in *Mus musculus domesticus* populations and were associated to specific mutations of Vkorc1 gene. Resistance in *Rattus rattus* populations are not described in Europe and mutations of Vkorc1 gene was never reported. This study draws a map of SNP found in Vkorc1 in *Rattus rattus* from different areas of France, Spain and Belgium. 242 *Rattus rattus* samples were collected from PCOs in 13 out of 90 French départements, in 4 farms in Spain and in 2 sites of Belgium. From genomic DNA extracted from tail, Vkorc1 gene was amplified by PCR and sequenced to detect potential mutations. VKORC1 deduced amino acids sequences were thus expressed in *Pichia pastoris* and inhibition constants towards various rodenticides were determined. Eight mutations of Vkorc1 gene were detected. These mutations were never described in *Rattus norvegicus* or *Mus musculus*. Some of these mutations were clearly associated to resistance, others were surprisingly inactivating mutation.



POSTERS SESSION



Ecologically based pest
management

P28

CAN WE RELATE COMMON VOLE ABUNDANCE VARIATIONS TO CROP DAMAGE?

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Ever since the common vole (*Microtus arvalis* Pallas) started to colonize the lowland farmland areas of Castilla y León (NW Spain) in the 70's, recurrent population outbreaks have occurred leading at times to important crop damage. For ecologically based management to be effective, it is necessary to act preventively and design strategies adapted to different contexts. With this aim, the Regional Government in Castilla y León started in 2007 a protocol of continuous monitoring of the vole populations throughout the region. Nevertheless, not enough information currently exists to relate vole abundance changes to the damages that finally occur. Determining the relationship between vole abundance and crop damage would help predicting damage from population changes, and hence defining threshold levels upon where to act to reduce economic impacts, optimizing management processes.

We analyse the geographical distribution of damage caused by common voles in the agricultural campaign 2013/2014 (during which a vole population outbreak occurred in different areas of the Region), and relate it to vole abundance estimates based on activity signs. Vole abundance estimates were gathered regularly throughout the region from November 2013 (winter crop seeding) until August 2014 (harvest of those crops), both within crop fields, in reservoir areas (alfalfas and meadows), and in dispersion lines (tracks and grassy field edges). Crop damage was assessed in 2895 fields throughout Castilla y León, of 19 different crop types. With this approach, we aim to identify factors predicting damage in different crop types, and vole abundance threshold levels for early management action

P29

CLEANING FIELD BOUNDARIES AS A PREVENTIVE MEASURE TO REDUCE COLONIZATION OF COMMON VOLES IN CROP PLOTS

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Farmland landscape in the Spanish northwestern plateau is characterized by a network of thin grassy boundaries and edges surrounding and connecting crop plots. These boundaries, in a homogeneous landscape where natural vegetation areas are limited, constitute typical common vole (*Microtus arvalis* Pallas) reservoirs, and also dispersal lines when crop plots do not have enough vegetation cover. Presence of voles in such boundaries usually do not cause significant damages in surrounding crops, but when an outbreak occurs voles colonize also crop plots from these boundaries. In outbreak years, cleaning vegetation in boundaries when most farmers are ploughing surrounding soil for preparing to sow, or when crops have not yet developed (very low plantlets not covering ground), could prevent or decrease subsequent crop colonization (thus minimizing damages and economic impact), through different mechanisms (e.g. minimization of the territory surface with optimal habitat for vole survival and breeding; reduction of dispersal ratio through alteration of adequate tracks; increase to exposure to avian predators due to decrease of protective cover). We assess in this contribution the influence of cleaning boundaries on common vole colonization and activity in neighboring plots. Our results indicate that, when compared with control plots, cleaning vegetation cover in boundaries has a short term effect reducing vole activity directly in boundaries, and a medium-long term effect reducing colonization and activity in surrounding plots during crop development. We also discuss the effect of two cleaning strategies (physical soil removal and burning) in two different crop types (pluri-annual forage and annual grain crop).

P30

STATISTICAL ANALYSIS OF RODENTICIDE RESISTANCE IN THE BROWN RAT (*RATTUS NORVEGICUS*) IN FLANDERS

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Between 2003 and 2010 two 3-year screening periods were conducted to monitor rodenticides resistance in Flanders. Resistance was determined by means of genetic mutations. The aim of the study was to get an idea about the degree of resistance in Flanders, whether there were differences between the 12 river basins, and whether the resistance was increasing over time.

Several statistical analyses were performed on these data. Since multiple rats per location were caught, on the one hand aggregated results (presence/absence of resistance) per location were analysed using glm, while on the other hand glmm were used on the rat-level to incorporate correlations between rats from a single location.

Results showed a huge difference in resistance between river basins (some being almost completely resistant, while in others resistance was nearly zero). Correlation is strongest between rats within a location, but in screening II variograms showed that a strong correlation was also present between nearby locations (<6km).

The number of locations (resp. rats) per river basin ranged from 2 to 54 (resp. 2 to 151) for screening I, and from 4 to 65 (resp. 11 to 110) for screening II. Due to these small numbers, estimates of the proportion of resistance was inaccurate for some river basins. Also, evolution of resistance over time was not analysed, since data collection in both screening periods was not comparable. A follow-up monitoring program, with enough rats and locations per river basin, has been designed to answer all question more accurately in the future.

P31

BIRD DAMAGE IN AGRICULTURE THE DEVELOPMENT OF A BIRD REPELLENT

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In agriculture the consumption of seeds and seedlings by birds causes substantial harvest and income losses. Besides they consume toxic baits, which are applied for managing other species, leading to unintentional intoxications of birds. A sustainable method to prevent undesirable bird feeding could be a repellent consisting of plant extractions. Our projects' aim is to develop such a bird repellent with focus on the use of this product as a seed treatment. A systematical screening of various plant extractions was the first step. Clearly repellent plant extracts were identified in food- and seedlings-choice tests with pigeons and pheasants in aviaries. The same applies for a field test with crows. The experimental results will be presented and consequences will be discussed.

The project is funded by the Federal Ministry of food, agriculture and consumer protection decided by the German Bundestag.

P32

EVALUATING THE ASSOCIATED IMPACTS OF VERTEBRATE PESTS ON AGRICULTURAL COMMODITIES: SPATIALIZING ECONOMIC INCENTIVES FOR MANAGEMENT

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Understanding key ecological relationships between vertebrate pests and their environment is critical for strategic management of pest species. Vertebrate pests can cause considerable damage to agricultural production and extensive resources are often directed towards minimising those impacts. Yet spatial understanding of pest threats, and how they respond to management, is limited at the regional scale where much decision-making is undertaken. Similarly, the costs resulting from these impacts can vary spatially depending on different environmental and economic drivers, making it difficult to draw satisfactory conclusions from current state and national impact studies. We combine expert knowledge and spatial data into Bayesian networks to create suitability maps and identify areas of potential high impact from vertebrate pest occurrence. We model the economic costs and effects of different management scenarios with the impacts of varying degrees of pest damage on different agricultural commodities when management does not occur. We demonstrate this with two case studies, the European rabbit (*Oryctolagus cuniculus*) and feral pig (*Sus scrofa*), impacting agricultural systems in southern Queensland, Australia. Our model structure allows end-users to choose the management strategies and the desired agricultural commodity spatially limited to the areas of suitable growth across the region. Model outcomes deliver a distribution of costs for each modelled commodity scenario, giving end-users a range of costs unique to each agricultural region. Using ecological knowledge to understand the species' interaction within the environment and economic drivers to capture impact, our scenario modelling allows for immediate relevance to community users to aid in model understanding.

P33

A CONTRIBUTION FOR THE CALIBRATION OF AN ABUNDANCE INDEX USEFUL FOR LARGE-SCALE MONITORING OF COMMON VOLE

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Common vole (*Microtus arvalis* Pallas) recurrent population outbreaks have led to significant crop damages in the agricultural areas of Castilla y León (Spain), where over 5 million hectares are devoted to crops, meadows and pastures. Monitoring abundance changes, essential to efficiently implement preventive actions, in such a large area requires reliable but simple, cheap and quick monitoring tools. Methods based on activity signs can cover this need, but do not provide estimates of population density unless they are calibrated for specific environments. Capture-recapture trapping methods are considered the best way for estimating vole population density, so are useful for calibrating other methods, but results could be influenced by many factors: differences in individual capture probability according to sex, age or previous capture history; weather conditions; capture effort; home range size and shape in relation to trap distribution, etc. Careful flooding of burrows in a controlled surface provokes a disturbance for the individuals inside burrows, which they thus tend to flee; this behavior is independent of the factors affecting trapping methods mentioned above. If well done, mortality due to flooding is negligible and individuals trying to go outside are easily captured. In this contribution, an abundance index based in activity signs, usable for large scale-common vole monitoring, is calibrated with the minimum number of individuals alive provided by parallel controlled burrow flooding. A significant polynomial relationship between both methods has been detected ($R^2=0.79$). We use this relationship to establish confidence limits to estimates of population density in relation to abundance levels.

P34

SURVEILLANCE OF VECTOR-BORNE DISEASES IN ROMANIA

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The infections with West Nile virus and malaria transmitted by mosquitoes, and Lyme borreliosis and encephalitis transmitted by ticks are public health problems in Romania in the context of the present global climatic and other environmental changes.

The circulation of West Nile virus is endemic in Romania on large territories, and infections appear continuously as sporadic cases and occasionally severe outbreaks. There is a permanent risk of malaria re-appearance because of the simultaneous presence of the abundant local populations of anopheline vectors and the imported malaria cases. The Lyme borreliosis and tick-borne encephalitis have shown significant recent increase in incidence, mainly because of the changes in human behaviour in relation to the environment as in the rest of Europe.

The prevention and control of these vector-borne diseases is needed in Romania. Their surveillance includes confirmation of human cases and their treatment when it is possible but this does not interrupt the disease transmission.

The ecological surveillance is the essential activity for the prevention and removal of these diseases. Our investigations focused on the understanding of the ecological factors of the transmission of the pathogens by its vectors in space and time and mapping of risk areas of these four vector borne-diseases in Romania, and the interruption of the transmission cycles of these diseases by permanent monitoring and control of vectors mainly in anthropic ecosystems and habitats.

The national programmes for the surveillance and control of these diseases are applied in Romania.

P35

SPATIAL BEHAVIOR OF MICROTUS SAVII IN CENTRAL ITALY AGRO-ECOSYSTEMS

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The Savi's pine vole (*Microtus savii*) is an endemic to Italy fossorial rodent. It is considered an agricultural pest but has been the object of very few studies. Even fewer studies address its spatial behavior and until now information on its space-use patterns are very scanty. It is important, though, to understand this species' spatial behavior, to improve its management and prevent the damages it can cause to agricultural crops. Therefore, during a capture-mark-recapture study in 2 peach orchards of Central Italy, we collected data on various aspects of its spatial behavior.

We measured the maximal distance linear voles covered between recaptures during a short-term (6 days of trapping) and a long-term period of several months. Mean distances were compared according to sex, age classes and breeding condition to see if some animals move more than others. Preliminary data show greater covered distances for the species than reported in literature.

Then we calculated the mean distance between the centroids of the range (evaluated as the minimum convex polygon of trapping points) to assess voles' site fidelity during different months and according to sex and age classes.

Lastly, we considered the concentration of capture events in space and time, to detect the presence of family groups.

These findings will help our knowledge of Savi's vole behavior and use of space, and it will provide useful information for its management and control.

P36**EFFICIENCY OF ANORGANIC-BASED MICE OLFACTORY REPELLENT**

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The study concerns the execution of behavioral tests on wild mice (*Mus musculus domesticus*) to validate an organic-based repellent product. The experiments were contemporarily carried out, side by side with in vivo field traps and by a behavioral experimental design in cage, using two (A & B) different repellents mixtures of natural oils unpleasant to rodents, in order to verify the animal reactivity to smell in the time. The organic repellents were adsorbed on neutral corn support and packaged in breathable tissue. The mice were positioned in a neutral site without repellent and baits, free to move forward two areas with baits, but just one with repellent. Time spent in the two areas was the object of investigation.

In external environments the capture rate was measured. In these experiments live traps contained attractive baits, while, half contained also the repellent.

Results in cage showed that repellent A is efficient to keep out the animals ($p = 0.001$, Mann-Whitney/Monte Carlo) respect to B and control.

In tests carried out in the field, it was observed that in 100% of cases in which the organic repellent was present in the trap, the mice did not enter (neither ants, i.e. *Linepithema humile*).

The experiments demonstrated that the repellent organic product A was associated to an acceptable efficiency, but further technological research will be required to improve potency of the repellent. Moreover, additional tests will be carried out to compare the efficiency of this organic repellent with a known and popular product (i.e. camphor).

P37

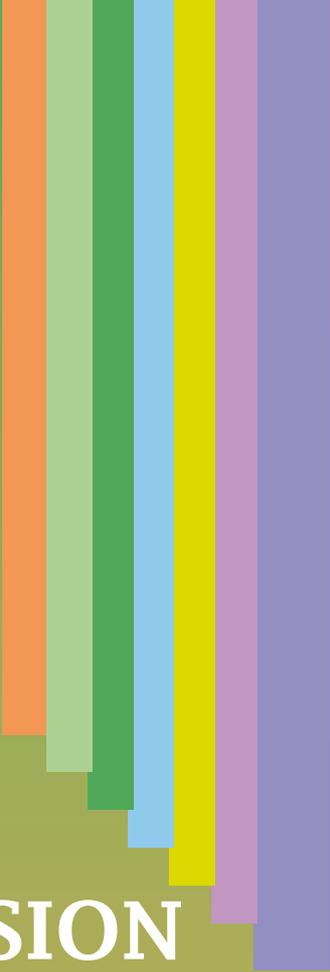
SPATIOTEMPORAL DISTRIBUTION OF BURROWS OF COMMON VOLE IN AGRICULTURE LANDSCAPES.

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Knowledge about spatial structure of populations is fundamental in Ecology, particularly in pest-species for its consequences on the dynamic of metapopulations and their management. *Microtus arvalis* is considered a pest-species that frequently produces agricultural damages in vast areas of Europe. Our goal is studying the spatiotemporal distribution of burrows of common vole in 8 circular study areas (200m of radius) situated in agricultural areas of Castilla y Leon (Spain). We geo-referenced and measured size (number of entrances) and activity of more than 9500 burrows during three different sampling seasons (spring, summer and autumn) during 2012. We also examined the relationship between the crop type and management of the crops fields and linear elements of the agricultural landscapes (field edges with wild vegetation). We use Kernel density estimator (KDE) and spatiotemporal points-patterns analysis. The results show the importance of the kind of crop and management in the spatiotemporal distribution of common vole populations. Specific elements of landscapes as margins and perennial crops (e.g. alfalfa) could be considered source areas from where common vole could colonize empty habitats. Our results allow us to propose management actions destined to pest control of spatial structured population of this species.



POSTERS SESSION

Human - animal social conflicts



P38**WOLF DEPREDATION ON DOMESTIC SHEEP IN ESTONIA ¿ IMPROVED PREVENTIVE MEASURES VS ¿TRADITIONAL¿ FARMING**

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Wolves are common throughout the Estonia (>45 000 sqkm) including the bigger islands. Reproductions occur in all counties with the number of annual reproduction units around 20. Damage caused to livestock (mainly on sheep, occasionally on dogs, goats, cattle and horses) is primary reason of the wolf-human conflict. To reduce the conflict and build tolerance, Estonia developed a depredation and damage prevention measures compensation program.

In human-wolf coexistence management priority focus has been paid to improvement of husbandry practices, different damage prevention measures, farmers responsibility and training, general community education and information.

P39

APMV-1 TRANSMISSION IN GAMEBIRD FARMS BY NUISANCE SPECIES IN CENTRAL SPAIN.

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Some passerine and columbiform species are considered nuisance on livestock farms including poultry, and can carry pathogenic viruses and bacteria. Newcastle Disease (ND) due to pathogenic strains of aPMV-1 is a worldwide distributed viral disease that causes serious economic losses in poultry. High biosecurity and vaccination are preventive measures in industrial poultry production. These measures are not applied in gamebird farms where contact between wild and farmed birds is frequent. To study the risk of aPMV-1 transmission by sympatric species to farmed red-legged partridges in central Spain, we used a commercial competition ELISA kit to detect antibodies against aPMV-1 in sera from wild birds (n=177), including rock pigeon (*Columba livia*), wood pigeon (*Columba palumbus*), eurasian collared dove (*Streptopelia decaocto*), eurasian magpie (*Pica pica*) and song thrush (*Turdus philomelos*). To test for NDV exposure and the effect of aggregation on farms and release estates on NDV transmission we additionally tested sera from farm-raised partridges (n=385), partridges harvested in hunting estates where partridges are released regularly (n=73) and from partridges hunted or captured in “release-free” hunting estates (n=93). High prevalence was found in sympatric birds, especially in rock pigeons (64.5 %, n= 30) and passerine birds (56.2 %, n= 73). Seroprevalence in farmed partridges (14.85%) and estates with releases (21,9 %) were significantly higher (X^2 test, $p < 0,05$) than in partridges from “release-free” states (4,3 %). Exposure to sympatric wild NDV carriers and aggregation due to intensive farming may be important risk factors for NDV outbreaks, thus enhanced biosecurity is recommended

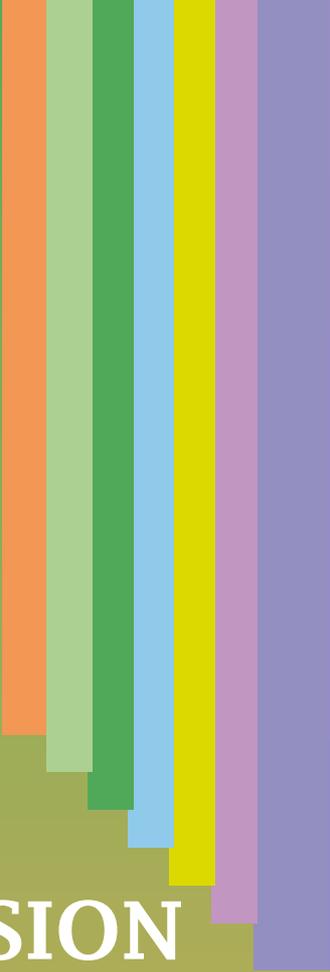
P40**PATHOLOGY OF THE WOLF - HUMAN CONFLICT IN FINLAND**

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The Finnish wolf population is estimated to consist of ca. 220-245 individuals in 2015. Interaction between humans and wolves can lead to conflicts, most notably wolf attacks on reindeer, livestock and hunting dogs. Wolves seen close to human settlement can cause significant fear in local people even in the absence of concrete damages. The Finnish Wildlife Agency can grant special permissions to hunt wolves which cause repeatedly damages and the police can issue hunting permissions in more urgent situations. Continuous trouble with a protected species may also manifest in illegal action. Wolves found dead or shot because of illness or disturbing behaviour are examined in the Finnish Food Safety Authority Evira. A routine necropsy is performed and, since 2012, the carcasses have been x-rayed. In 2012-2015, we examined carcasses of 39 wolves. The most common cause of death was traffic accident (31%). Five wolves (13%) were illegally killed. In addition, old gunshot wounds (lead shots) that were not immediately lethal were found in seven (18%) wolves. 11 wolves were killed by a police permission: six for repeatedly visiting yards, four for animal protection (signs of trauma or disease) and one for causing danger to people. Most (72%) of these wolves were juvenile individuals. Findings suggest that illegal shooting of wolves occurs fairly often. Wounded animals may become nuisances when they look for easy food near houses. The latest management plan of the Finnish wolf population tries to tackle the problem in multiple ways.



POSTERS SESSION

Invasive vertebrates



P41**A BRIEF REVIEW ON ALIEN VERTEBRATES AND VERTEBRATE PESTS IN TURKEY WITH AN OVERVIEW TO RODENT MANAGEMENT**YIĐIT, NURI⁽²⁾; OLAK, ERCÜMENT⁽²⁾; ÖZEREN, SANIYE CEVHER⁽²⁾; SAYGÝLÝ, FULYA⁽¹⁾; GÜL, NURSEL⁽²⁾

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More than twenty five alien and potential invasive fresh water fishes have been reported in Turkey. Of these, seven were recorded from inland water as alien and two as translocated. Eighteen fishes from Mediterranean and three from Black Sea were previously reported to be invasive or alien. Eight fishes were determined as alien in our long term observations in Mediterranean Sea; Puffer fish and Vanikoro sweeper were evaluated as very successful invaders. Two reptile species are known as alien; Rea-eared slider is imported species from south western rivers, other “Istanbul lizard” is transported species and is known Marmara region in Turkey. Four bird species are alien and potential invaders; Laughing dove, Ring-necked parakeet, White-spectacled bulbul and Common myna. One mammalian species “Myocastor coypu” is alien and introduced to two rivers in Turkey.

According to the rodent management report released in 2013 for agricultural areas, 1.202 kg zinc phosphide was used to rodent control in 73 provinces of Turkey; Konya province took the lead with 400 kg zinc phosphide and 19956 kg poisoned bates. Only anticoagulant rodenticides are permitted to use in urban areas. The toxicities on black rat and brown rat with 50 mgr/kg doses of Brodifacoum, Bromadiaolone, Chloropacinone, Difenacoum and Difethialone caused death after three days poisoned baits given. No resistance was observed in both black and brown rats. Other potentially pest such as snakes, Egyptian fruit bat and Porcupine were not legally permitted to control procedures in Turkey.

Key words: Alien vertebrates, rodent control, Turkey

P42

THE INVASIVE SPECIES PSEUDORASBORA PARVA (CYPRINIDAE) IN ALGERIA: INTRODUCTION HISTORY, PHENOTYPIC ELASTICITY, DISPERSION AND POTENTIAL THREATENED IMPACT ON FRESHWATER FISH DIVERSITY

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The mediterranean region is known as one of the global invasion hotspot (between six commonly cited), with an important proportion of non native freshwater fish. Since 1920 until now in Algeria, for several reasons (through aquaculture programmes, for biological control, accidentally, etc.), the aquatic ecosystems (rivers, wetlands, dams... have been subject to several introductions even though the management of these species and their impact on ecosystems is until now unknown. Are the freshwater ecosystems suffering of biodiversity loss? In this survey, the evolution history of *P. parva* (cyprinid fish introduced accidentally (through the carp program between Algeria and China) is discussed. The dispersal model of the species and the threatened impact on the continental fish fauna is analysed.

Key words: invasive species, fresh water fish, biodiversity loss, Algeria

P43

ERADICATION OF AN INVASIVE PALLAS'S SQUIRREL *CALLOSCIURUS ERYTHRAEUS* (RODENTIA, SCIURIDAE) POPULATION IN FLANDERS (NORTHERN BELGIUM)

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Despite a growing catalogue of eradication projects, documented successful vertebrate eradications on the mainland remain scarce. Reporting on successful campaigns is crucial to counter pessimism on ambitious programmes to tackle invasive species and to allow conservation practitioners, wildlife managers and scientist to learn from previous experience. Moreover, there is a need for basic information on the effectiveness of control methods and management strategies that can be used. In this note we report on a successful low-tech eradication campaign of a local population of Pallas's squirrel *Callosciurus erythraeus*, a species of tree squirrel with documented ecological and socio-economic impacts in its invasive range. The population was eradicated from a suburban park of about fifteen hectares using baited mesh wire life traps, in five consecutive capture campaigns between October 2005 and January 2011. Using maximum likelihood estimation from catch-effort data we calculated initial densities in the park at 3 squirrels ha⁻¹. Although control started quickly and the extent of the invasion was limited, the campaign took over five years and required an estimated investment of over €200,000 including 1,5 years of post-eradication surveying. We provide basic data on the methods used to eradicate this invasive rodent. Critical success factors and possible improvements with respect to the specific context of this case are discussed. Adding this species to the list of species of EU concern currently under development could provide incentive to minimise impact of this tree squirrel at the continental scale.

P44

MERIONES LIBYCUS, MERIONES SHAWI AND MERIONES CRASSUS: SAHARAN RODENTS CHARACTERIZED BY A SEASONAL REPRODUCTION

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Meriones libycus, *Meriones crassus* and *Meriones shawi* are nocturnal rodents, the seasonal cycle of reproduction is characterized by a short period during spring and in the beginning of summer, and a long phase of sexual quiescence from the end of summer until the end of winter.

The comparative analysis of soluble proteins from seminal vesicle homogenates of these three rodent species during the breeding season showed three major proteins with a same apparent molecular weight of 21 kDa designated as MLVSP21 (*Meriones libycus* seminal vesicles protein of 21 kDa), MSVSP21 (*Meriones shawi* seminal vesicles protein of 21 kDa) and MCVSP21 (*Meriones crassus* seminal vesicles protein of 21 kDa).

More recently, one major androgen protein with a same molecular weight POSVP21

(*Psammomys obesus* seminal vesicles protein of 21 kDa) was purified and characterized in seminal vesicles of other Saharan rodent *Psammomys obesus*. Its site of synthesis was determined and its peptidic sequence was analyzed. This protein was identified, such as transgelin. Using polyclonal antibodies directed against POSVP21 we showed an immunological homology with POSVP21.

MLVSP21, MSVSP21, and MCVSP21 are localized by immunohistochemistry and identified by applying a proteomic approach. Our results indicated that the isolated proteins MLSVP21, MSSVP21 and MCSVP21 seem to correspond to the same protein: the transgelin.

So that transgelin can be used as a specific marker of these rodent physiological reproduction mechanisms.

P46

ACTIVITY PATTERNS OF INTRODUCED NONNATIVE BARBARY SHEEP (*AMMOTRAGUS LERVIA*) IN SOUTHERN DINARIDES, CROATIA

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During year 2002 five Barbary sheep (three females and two males) of unknown origin have been illegally released in the southern Dinaric region (Mosor Mountain; 1.339 m a.s.l.) of Croatia. To date, however, little is known about the activity patterns of free range nonnative Barbary sheep. Therefore, on 11 of March 2015 two individuals (one male and one female) were caught in the net and tagged with GPS-GSM collars as a part of the larger ongoing GPS telemetry study. GPS collars were set to record a position every full hour, 24-hours per day. Female (4 years old) was killed by the wolves at night (23:45) on 22 of March 2015, just 11 days after GPS-tagging. Therefore we did not analyze its GPS data. Male (3 years old) abandoned vicinity of capture-release location 18 days after the release, moved approximately 15 km toward the south-east along mountain ridge of Mosor and settled down. His average daily sum of traveled distances was only 1.64 km. His circadiurnal locomotion activity typically exhibits two pronounced peaks, first one in the morning (6:00 am) and second one in the evening (20:00 pm), and two periods of low activity, first one lasting from 2:00-4:00 am, and second one during midday (11:00-14:00). Results of daily activity of Barbary sheep can be described as a bimodal which is typical pattern described in chamois populations. Our study was based on a small number of animals but still is one of the first GPS studies on free range Barbary sheep.

P47

MANAGEMENT ASPECTS OF WILD BOAR (SUS SCROFA) IN “PARCO REGIONALE DEI COLLI EUGANEI” (PADOVA) - YEARS 2007-2014 (ARTIODACTYLA, SUIDAE).

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The wild boar reappears, in the Colli Euganei, in 1997 as the result of clandestine releases. Over time, to better manage this established allochthonous presence, on the basis of information provided by the public Institutions operating in the area, the Park Authority has established operating procedures for containment of the species that involve the use of mobile cages, appropriately placed, which act as a trap for the wild boars and, when possible, with the implementation of direct culling by stalking, or night seeking with halogen lamp. Captured or killed animals are treated according to standard health protocols. Since 2007 to present, on each sample, are executed biometric reliefs agreed with ISPRA including the detection of the weights (full and empty), the length of the back foot and the identification of the age through the examination of mandibles and the comparison with the table of tooth eruption. Surveys on adult females also include the notation of the number of nipples pulled, the possible presence and number of corpora lutea and, if pregnant, the count of the fetuses and the measure of their length.

Here we expose, commenting, data collected by gender and age group of 6,032specimens of wild boar caught in the period 2011-2013.

P48**A LARGE SCALE FIELD EXPERIMENT TO STUDY ALTERNATIVE MANAGEMENT STRATEGIES OF MUSKRAT ONDATRA ZIBETHICUS POPULATION CONTROL**

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Muskrats are considered a pest species in the Netherlands, and a year-round control programme is in effect. The muskrat control programme offers excellent opportunities for applied biological studies and currently there is a large scale management experiment going on in the Netherlands to study the effect of manipulating harvest intensity of muskrat (catching effort, or time invested trapping) on potential and actual damage of dikes and waterfronts. The experiment takes place in 117 areas (5*5 km) that were selected in a stratified random way. Aim of the programme is to obtain insight into the costs and benefits of harvesting at different levels of intensity for different seasons, landscapes and population densities, as well as to gauge the publicly acceptable level of damage per region of interest. These aspects are identified as the major gaps in knowledge that hamper proper policy making for muskrat management at the moment. The background of the field study is described in a theoretical paper on population dynamics of Muskrats in the Netherlands (Bos & Ydenberg 2011). During the experiment experimental variation is created in possibly one of the most influential independent variables (time invested), and additional information is gathered on sex ratio and age of musk rat caught.

P49

THE INVASIVE POTENTIAL OF MICE: AN ECOMORPHOLOGICAL APPROACH

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Assessment of invasive potential of rodents is necessary to predict species' dispersal and to develop successful strategies of rodent pest management. The characteristics of a species' with high potential for expansion include the ability to utilize a wide spectrum of food (Ehrlich, 1989). Insights into trophic adaptations in rodents might be gained from studying the patterns of dentition and jaw morphology. The studies in this area include the analysis of skull morphology (Samuels, 2009; Firmat et al, 2010), dental morphotypes and morphometrics (Martin, 2010; Croft et al, 2011), the structure of tooth enamel (Koenigswald, 1980; Koenigswald, Sander 1997; Vieytes et al., 2007), and the patterns of dental microwear (Nelson et al., 2005; Townsend, Croft, 2008; Rodrigues et al., 2009). Here, we use these approaches to analyze trophic adaptations in three species of mice, which are widespread and abundant in the central part of Northern Eurasia (Ural Mountains and adjacent plains). We chose the model species as follows: *Mus musculus* (a synanthropic species), *Apodemus (A.) agrarius* (agrophilous, non-synanthropic), *Apodemus (S.) uralensis* (non-synanthropic, non-agrophilous). We present the results of a comparative study of skull morphology and dentition, which was fulfilled taking the ecological peculiarities of the model species into account. Ecological and morphological determinants of the invasive potential of the three mice species in the study area are discussed.

The work was supported by the Russian Federation President Grant for young scientists MK-331.2014.4 and the Russian Foundation for Basic Research (research grant 14-04-32018

P50

THE GOLDEN JACKAL *CANIS AUREUS* - NEW ALIEN SPECIES IN BALTIC STATES

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Golden jackal (*Canis aureus*) was recorded for the first time in Baltic countries in Estonia in 28.02.2013 and three specimens of golden jackal were hunted in Latvia in 2014. The first golden jackal was hunted in Lithuania in 07.02.2015. The species was identified using morphological and mitochondrial DNA control region (CR1) analysis. The golden jackal has already been declared an invasive species in Baltic States. In Lithuania, hunting of these animals has been permitted throughout the year. Few studies in the past have revealed golden jackal potential role as carriers of zoonotic diseases and intestinal helminthes parasites. In present study presence of tick-borne pathogens and other parasites in golden jackal specimen have been investigated. No pathogens (*Anaplasma phagocytophilum*, *Babesia* sp., *Bartonella* sp.) were found in spleen of golden jackal. However, the flukes *Apophallus donicus*, nematodes *Uncinaria stenocephala*, and unidentified individuals of class Cestoda have been detected. Helminths *A. donicus* and *U. stenocephala* are not new species for Lithuania and/or neighboring territories. The diet of jackal consists of plants, invertebrates and vertebrates.

P51

JUVENILE DISPERSION PATTERNS OF THE INVASIVE MONK PARAKEET IN BARCELONA

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Dispersion is a key issue in determining the expansion range and speed of exotic invasive pest species. The monk parakeet (*Myiopsitta monachus*) is an invasive species in Europe and North America which is expanding its range causing increasing economical and ecological concerns. To date we know very few about the dispersion behavior of this species. In the present study we analyzed the juvenile dispersion of monk parakeets in Barcelona. We marked 259 chicks from 178 active chambers with numbered collar marks. We obtained 168 recoveries from 37 different juveniles. In the first year of age (2004) the mean dispersion distance was $1114 \pm 190\text{m}$, and the mean maximum dispersion distance was $1363 \pm 211\text{m}$. These values are similar to the dispersion distances found within the species natural distribution range. However, we found that in the next four years of age (2005-8) the dispersion distances in Barcelona were significantly lower ($743 \pm 337\text{m}$ and $844 \pm 343\text{m}$). We also found differences in dispersion distances among nest families but not among siblings. Our results suggest that the juvenile monk parakeets make long prospective dispersion movements during the first year of age, but after that they settle nearer to their birth site and they only show movements within their home range. These results are very useful to understand the causes of the pattern of territorial expansion range of the monk parakeets in Catalonia (SE Spain), which has been both slow but continuous during the last decades, with an exponential population growth.

P52

PHENOTYPIC VARIATION IN AN INVASIVE RODENT, *MICROTUS ROSSIAEMERIDIONALIS*, CASUALLY INTRODUCED ON THE HIGH ARCTIC ARCHIPELAGO OF SVALBARD

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The sibling vole, *Microtus rossiaemeridionalis* (= *M. levis* or *M. epiroticus*) is a temperate arvicoline rodent, which undergoes range expansion via casual introductions by humans. A human-mediated invasion of *M. rossiaemeridionalis* on Svalbard in the first half of the 20th century provides an opportunity to explore the effects of isolation on phenotype under severe environmental conditions far beyond the species' natural range. The patterns of phenotypic variation may, in turn, be reflective of the processes after the invasion event. We study cranial and dental size and tooth morphology in 124 voles captured on Svalbard (Spitsbergen) in 1997-2005 and compare the data to 12 populations throughout northern Eurasia. We show that environmental circumstances allow the species on Svalbard to keep the size and morphology similar to the mainland conspecifics for at least 50 years. At the same time, the island population exhibits some morphological features of a captive population, such as the increased frequency of rare morphs and presence of animals with overgrown incisors. Although phenotypically different from the mainland conspecifics (due to increased frequency of rare morphs), the population of *M. rossiaemeridionalis* on Svalbard provides no evidence to support the idea of initial rapid evolution related to colonization. The limited spatial extent and environmental homogeneity of suitable habitats on the island allowed the species to initially multiply but not to diversify so that the species exhibits phenotypic conservatism but suffers the consequences of small population size. The study is supported by Russian Foundation for Basic Research (14-04-00614).

P53

ASSESSING COINCIDENCE BETWEEN AREAS WITH ALIEN SPECIES AND PRIORITY CONSERVATION AREAS FOR VERTEBRATE GROUPS IN A MEDITERRANEAN HOTSPOT

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Risk maps summarizing the landscape suitability of novel areas for invading species can be valuable tools for preventing species invasions through preventive conservation plans, since avoiding future invasions is less difficult and costly than the control or eradication of already-established populations. These risk maps are based on the identification of environmental variables affecting alien species distribution. In this study, this technique, was used to establish the areas that had a higher risk of being colonized by alien species, and then overlap these areas with priority conservation zones characterized by a higher vertebrate species richness. GIS techniques and spatially explicit predictive modelling were applied to determine habitat suitability for the diversity of vertebrate alien species in Spain. Our results showed that urban land uses and the distances to big cities and some climatic variables such as Mean Diurnal Range´´, ´´Isothermality´´ or ´´Mean Temperature of Driest Quarter´´ were key features to predict the distribution of alien species. Moreover, the numbers of native and alien species were positively correlated in accordance with the acceptance hypothesis that predicts a higher number of both native and alien species when more micro niches are available. We also identified Potential Conflict Areas, which have higher values for the number of both native and predicted alien species. Many of the identified potential conflict areas coincide with protected areas, which further aggravates the problem as these areas are often home to endangered species which may be adversely affected by the emergence of alien species.

P54

CHANGES IN POPULATION NUMBERS OF BREEDING WATERFOWL AFTER THE EXPANSION OF AMERICAN MINK IN POLAND

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There are many factors which can explain decline in waterfowl populations. One of the most important is the increased predation resulting from introduction of alien carnivores. In birds, the dynamics of their population numbers is particularly dependent on the impact of predators which depredate broods and hunt fledglings. Heavy predation may lead to high brood losses and to the abandonment of nesting sites. The rapid decrease in breeding success and decline of several waterfowl populations, as well as the changes in distribution of local nesting populations, triggered by the predation of invasive American mink *Neovison vison*, have been documented in many areas in Europe but mostly for sea birds. In Poland, the expansion of feral mink populations begun at the end of 1970s but the colonization of new regions is still ongoing, however, no coordinated large-scale studies have been undertaken to demonstrate relation between the abundance and predation of American mink and long-term changes in population numbers of waterfowl. The studies conducted recently at lakes, ponds and rivers in various regions of Poland enabled to define the present geographical range and population densities of American mink and to estimate long-term changes in numbers of breeding populations of selected waterfowl species (by comparisons with archival data). Significant decline in densities of breeding populations of some waterfowl species (e.g. the coot *Fulica atra*) has been recorded. The spatio-temporal relationship between changes in numbers of breeding waterfowl and geographical range and densities of American mink has been confirmed in most regions of Poland.

P55

THE OCCURRENCE OF THE INDIAN HOUSE CROWS IN JEDDAH, SAUDI ARABIA: THEIR ENVIRONMENTAL AND HEALTH PROBLEMS

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The spread of the Indian House Crow *Corvus splendens* outside its natural distribution is known and mentioned by several authors (Bundy et al., 1989; Gallagher, 1979).

Introduction of this Indian crow to Saudi Arabian cities has been reported from most coastal cities and states of the Arabian Peninsula: Kuwait; Bahrain; Ras Tanura and Dhahran, Saudi Arabia; United Arab Emirates; Muscat, Oman; Aden, Yemen; and Jeddah by the Red Sea.

Pest status for these birds is acquired since increasing in numbers of individuals are recorded and successful breeding has been established in most areas of Jeddah, Saudi Arabia.

Environmental and Health problems were considered, discussed, and well known in most local media and among public, therefore a scientific research was started to study and solve such problems.



POSTERS SESSION



Others

P56

COMPERATIVE EFFECTS OF DIFENACOUM AND BRODIFACOUM ON THE ULTRASTRUCTURES OF RAT LIVER CELLS

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Cytotoxic effects of Difenacoum and Brodifacoum on rat livers were examined by transmission electron microscope (TEM). Rats were divided into four groups (n=5 in each group): control and 24 hours, 4 days, 7 days treated groups. Single dose (0.8 mg/kg) of Difenacoum and (0.2 mg/kg) of Brodifacoum were administrated to rats by gastric gavage. The lysosome, enlarged perinuclear space and Rough Endoplasmic Reticulum (RER) cisternae in the liver hepatocytes and Kupffer cells in the irregular shaped sinusoid were observed in 24 hours Difenacoum treated rat liver. Whereas, Brodifacoum treated livers additionally represented vacuoles, mitochondrial cristae melting, nucleolar chromatin clumping of the hepatocytes, and hemolyzed erythrocytes. The same findings were detected in the both 4 days treated groups. The loss of cytoplasmic material, shrinkage of mitochondria, discontinuous RER cisternae in the liver hepatocyte were observed in the 7 days Difenacoum treated group. Unlike effects of Difenacoum, Brodifacoum caused to numerous vacuoles and lipid droplets, disordered mitochondrial shape, nuclear chromatin clumping and invagination of nuclear envelope. Sinuzoids of both anticoagulants treated livers were contained accumulation of dense material, lipid droplets, cells with pycnotic nucleus and hemolyzed erythrocytes. As a results, brodifacoum caused severe effects on in the liver cells than that of those Difenacoum.

Key Words: Difenacoum, Brodifacoum, Rat, Liver, Transmission Electron Microscopy (TEM).

P57

DISTRIBUTION AND SIZE OF STRAY DOGS PRESENCE IN THE «RISERVA NATURALE DEI LAGHI LUNGO E RIPASOTTILE» (LAZIO, ITALY): BASIC KNOWLEDGE TO PLAN MANAGEMENT

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This study was conducted in the Riserva dei Laghi (RNRLLR), area covering 29.42 km² over 6 municipalities, where stray dogs (*Canis lupus familiaris*) are a big problem with negative repercussions on healthcare. They are potential predators of species of conservation concern and livestock, they can cause genetic contamination of the Wolf (*Canis lupus*) currently monitored in RNRLLR, and can also attack humans. These problems seek for good understanding of stray dogs so as to plan appropriate management. The study was conducted by monitoring the area. The surveyed dogs were classified according to: the location of interception, the aggregation (individuals, herds) and race. The monitoring consisted of the survey of 11 paths (biweekly) of 3 km (33 km in total; mean density of the path 1 km/km²). These preliminary results are derived from the processing of data from the first 11 surveys between 17/09/2014 and 05/05/2015. 58 stray dogs were intercepted in total (mean/survey 5.27; SD=±3.55): 17 sheepdogs and 39 mongrels. The presence of stray dogs seems constant, with 1 to 11 subjects intercepted during the surveys conducted so far. In 14 cases the dogs were aggregated into herds, consisting of 2 to 6 individuals. The mean mileage index of abundance for all surveys is $0.03 < IKA < 0.33$ (SD=±0.11). The stray dogs are not uniformly distributed in the monitored area, more populated regions have $0.33 < IKA < 1.33$ (mean 0.75; SD=±0.34).

P58

THE CHANGED STRATEGIES IN THE CLAIMING OF HUNTED WILD BOARS IN THE PROVINCE OF RIETI (ITALY)

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We report a two-year study aimed to verify how the claiming of hunted Wild Boar changed in the province of Rieti since the new management methods implemented by the provincial administration. The survey was based on 15 hunting teams, just under 12% of the total number of teams operating in the area. For each hunt of these teams we collected: the number of animals actually killed and the number declared on the hunting reports. An analysis performed in 2008 showed a vast difference in the behaviour of the teams, finding that only 54% of the boars actually killed were declared in the province of Rieti. This was done to avoid the disposal fee and the veterinary inspection. Since 2013 each team get assigned a maximum number of animals to hunt, and since 2014 the updated provincial regulations establish the possibility to revoke the hunting areas assigned to the teams if they do not complete the annual plan of hunted animals. In the last two years this changed the attitude of the teams in declaring the animals taken. This study indicates that, on average, teams declare about 45% of the animals actually taken. 27% of the teams declares regularly the taking, 10% declares more than the actual taking, 13% declares the number of assigned animals even if they actually take more boars (sometimes 1200% more than the assigned number).

P59

SCIENTIFIC RESEARCH FOR AN ENVIRONMENTALLY FRIENDLY MANAGEMENT OF COMMON VOLE OUTBREAKS IN AGRICULTURAL AREAS OF NORTHERN SPAIN: A BBVA FOUNDATION PROJECT

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Common vole outbreaks in Castilla y Leon have been usually managed by extensive use of rodenticides and wild vegetation burning, what can become a serious environmental problem for non-target species when applied intensively in wide areas. Thus, the identification of alternative management techniques of common vole outbreaks is a crucial element for the conservation and restoration of biodiversity in these agrarian ecosystems, among the most important in Europe. An ongoing program using next-boxes for raptors have been already experimentally implemented since 2009. This program has been well accepted by farmers and partially succesful regulating common vole densities, but recent information has shown that this technique may require complementary actions in the areas or years where maximum vole densities are reached. Looking for this complemetary management techniques, we are starting an applied research program based on three central ideas: 1) Starting experimental reasearch about the role of weasels (*Mustela nivalis*) in common vole population dynamics; 2) investigating the role of linear transport infraestructures in the demography, dispersal and potential isolation of common vole populations, testing the efficacy of water traps as specific control systems for these linear habitats; and 3) Evaluating the use of chemical communication as a control system, in combination with multiple capture traps.

P60**ESTIMATION OF ABUNDANCE OF WILD BOAR (SUS SCROFA) IN DOÑANA NATIONAL PARK BY CAMERA TRAPS DOÑANA**

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The overabundance of wild boar (*Sus scrofa*), can lead to different conflicts between hunting managers, farmers, conservationists and the general public. It is essential to know in detail the densities / abundances to implement proper management. So far, it has not been a single standardized method for determining the abundance or boar density applicable and valid in most situations. This is because their nocturnal and elusive behavior, and the methods used for other wild ungulates, do not produce reliable results. This study was conducted in Doñana National Park (South West Spain, DNP) where wild boar population is of concern regarding disease (tuberculosis) and conservation issues. The objective of this research was the determination of the density of wild boar in the DNP by camera trapping method (application of gas diffusion model to without identifying animals, Rowcliffe et al., 2008) and compare with the traditional method based on dung counts along linear transects (FBII) and nocturnal transect method and application of distance sampling (MMD). There was a positive and significant correlation between the results of sampling distances, and those obtained by the method of camera traps. Besides the density values obtained for each area with both methods were very close, suggesting high accuracy in the estimate. Camera trapping method (with application of gas diffusion model to without identifying animals) resulted a promising method to standardize a comparable, affordable and reliable for most situations along wild boar distribution, for which previous information on spatial ecology in particular regions are needed.

P61

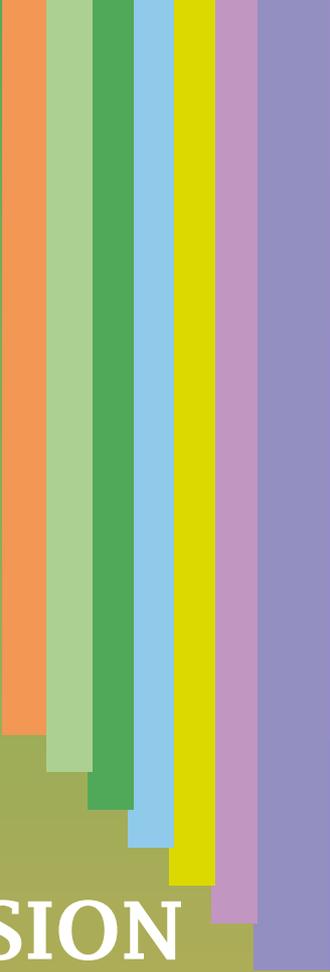
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Since 2009 the Ecophysiology Laboratory at Estación Biológica de Doñana (EBD) is providing support for EBD researchers and other institutions for the analyses of animal samples. Collaborations with private companies and public health services have provided further support for the development of the laboratory. The current services of the laboratory include quantification of biochemical parameters, oxidative stress parameters, parasite and antibody detection, quantification of some components of the immune system, respirometry or telomere dynamic analyses. The implemented techniques include ELISA, flow cytometry, gas chromatography, seroneutralization, etc... More than 36 researchers and 60 projects have used the services of this laboratory.



POSTERS SESSION

Urban pest management



P63

WILD RODENTS IN THE BIG CITIES IN THE MIDDLE URALS

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Rodents play a considerable role in the transmission of infection agents, which are dangerous to human and which cause many diseases. The aim of the study was to determine the rodent species distribution and abundance in two cities, Ekaterinburg and Nizhny Tagil (Middle Urals, Russia), in relation to potential epidemiological risk for urban population. The sampling was done in 2009 - 2014 in summer and early autumn seasons on 20 plots including residential areas in central parts of the cities and zones of urban parks and gardens. In some localities the sampling was done during several years. Five species of wild rodents (*Microtus rossiaemeridionalis*, *M. arvalis*, *Clethrionomys glareolus*, *Apodemus agrarius* and *A. uralensis*), which are typical for the rodent fauna of the Urals, are revealed in the studied plots. The high density of some species in the plots of relatively small area in central parts of the two cities was observed. The presence of ecto- (fleas, ticks) and endoparasites (helminthes) in animals indicated the highest levels of infestation of wild rodents in residential areas in central parts of the cities in comparison with urban parks and gardens.

Results of the study show the presence of potential epidemiological risk for urban population of the Middle Urals, the source of which may be the wild rodents inhabiting the territories of the cities.

The study was supported by RFBR N° 14-04-00614.

P64

**TROPHIC PREFERENCES OF CL. GLAREOLUS IN
NATURAL AND URBAN POPULATIONS IN THE MIDDLE
URALS**

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Clethrionomys glareolus widely distributed in Europe and considered to be more common in nemoral forests, where the species inhabits a wide range of zonal habitats. According to modern data, *Cl. glareolus* expands its range to the northeast and now it is present in boreal forests of the Urals and Western Siberia. It is also revealed in urban areas, in particular in public gardens, parks and green belts. We studied trophic preferences of *Cl. glareolus* in natural habitats and urban areas in the Middle Urals (Russia). Bank voles were captured in a dark coniferous forest (Visim State Biosphere Reserve) and in a mixed oak-birch forest (Nizhneirginskaya oak forest). Also the samples from the patches of pine forests in the urban area of Ekaterinburg city were studied. To characterize voles' diet, we used stomach content analysis and dental microwear analysis based on studying the scars on molar enamel resulting from different abrasive properties of food. A comparative study of *Cl. glareolus* trophic preferences in natural and urban populations allows us to reveal and describe the preferred habitats in a big city which are considered as sources of zoonotic agents. It determines the importance of our results for epidemiologic studies and human health risk assessments. The work is supported by the Russian Foundation for Basic Research (research grant 14-04-32179).

P65**RESISTANCE OF NORWAY RATS (*RATTUS NORVEGICUS*) TO ANTICOAGULANT RODENTICIDES IN HUNGARY**

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First generation rodenticides have been in use in Hungary since the mid 60-ies. Coumatetralyl based formulations were the first to appear, while rodenticides containing warfarin active substance have become less widespread. The application of bromadiolone and other second generation anticoagulant actives started afterwards.

Anticoagulant resistant strains of *Rattus norvegicus* were regularly reported in the past decades in Western-European countries, but records from Eastern-Europe are scarce. In two regions of Hungary small numbers of rat corpses were collected in 2006-2007, of which 33% - 44 % proved to carry Y139C mutation in the VKORC-1 gene.

In 2014-2015 nearly 80 rat corpses were collected at multiple sites in the capital and in agricultural facilities in Hungary where rat control efficiency problems had occurred. The samples were subjected to comparative SNP analysis of the VKORC-1 locus. Again, our findings proved the occurrence of Y139C mutation in the studied populations of tested specimens; nearly one third were hetero- and nearly one third homozygous carriers, respectively. No other mutations known for causing warfarin-resistance in rats were detected in our study. Wild type rats represented cca. 44 % in the studied populations.

The results obtained cannot be regarded as representative since the rat corpses originated decisively from sites where efficiency problems were found. Hence, considering that qualified PCOs have been working at these sites for a long time, our findings seem to refute the view of certain registration authorities stating that increasing resistance to anticoagulant rodenticides is due to rodent control performed by amateurs.

P66

MODELING TO MANAGE.

**EVALUATION OF WILD BOAR (SUS SCROFA)
MANAGEMENT STRATEGIES THROUGH POPULATION
STOCHASTIC MODELS IN A MEDITERRANEAN PERI-
URBAN AREA.**

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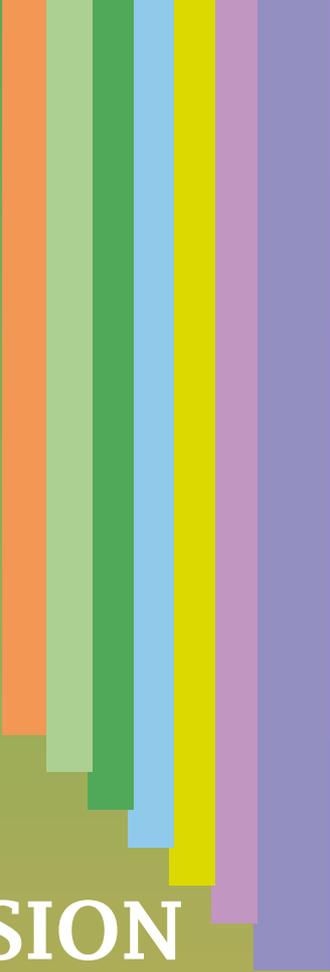
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In Mediterranean ecosystems, as worldwide, wild boar (*Sus scrofa*) populations have increased their densities, spreading even to peri-urban and urban areas and thus rising human-wildlife conflicts. Several studies show the difficulties to manage wild boar populations due to their great adaptability, a reproductive strategy similar to rodents rather than other ungulates also combined with different human factors.

The Collserola Natural Park (CNP), located inside the populated metropolitan area of Barcelona, maintains a harvested wild boar population, which has become habituated to humans and can be found in urban areas habitually. Both direct and indirect supplementary feeding are almost unlimited, boosting wild boar reproductive rate and therefore abundance, which has increased progressively to nearby doubling in 2014-2015 the population estimated in 2013-2014.

The aim of this study is developing stochastic models of the wild boar population of CNP using Population Viability Analysis (PVA) with different scenarios, evaluating the population response to different management strategies. Population parameters were estimated from hunting data and transects provided by the CNP. PVA were performed using Vortex software.

The preliminary results derived from the models developed, showed the effectiveness of the different management actions prior to undertaking them. The most efficient measures were those addressed at reducing carrying capacity (K), as well as juvenile (<1 year) male and juvenile and yearling (<2 years) female survival rates. Therefore, decreasing K and increasing selective harvest of target individuals are recommended as the most effective and critical management actions in order to control the CNP wild boar population.



POSTERS SESSION

Zoonoses and parasites



P70**PREVALENCE OF BOVINE TUBERCULOSIS LESIONS IN THE SLAUGHTERHOUSE EL HARRACH (ALGIERS)**BELAKEHAL, FAIZA ⁽¹⁾; HAMDI, TAHA MOSSADAK ⁽¹⁾; ZENIA, SAFIA ⁽¹⁾; NAIM, MALEK ⁽²⁾

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The study carried out at the slaughterhouse of El Harrach in Algiers during the months of July and August 2013, aims to estimate the prevalence of the bovine tuberculosis lesions in the slaughterhouse during this period. 1167 bovine carcasses are inspected to search the suspected macroscopic tuberculosis lesions. For each carcass the lymph nodes, organs and the target tissues were inspected and incised. A suspected lesion of tuberculosis were observed, sampled and then stored about 62 (5.31%) carcasses including 18 females (29.03%) and 44 males (70.97%). The lesions were observed on 46 animals (74.19%) aged less than 5 years and on 16 animals (25.81%) over of more than 5 years. The samples taken shall be the subject of a subsequent study by the macroscopic research of bacilli and the bacteriological investigation by culture, the results will be communicated later. These results show that bovine tuberculosis is still present in Algeria, despite the implementation of an active strategy to eradicate the disease by the public authorities. This pathology remains a major health, zoonotic, economic and political problem. Many questions remain to be answered and the research needs persist to get to eradicate the disease in Algeria.

Keywords

Bovine tuberculosis, prevalence, lesions, slaughterhouse, zoonosis

P71

PRESENCE OF P.OBESUS (RESERVOIR OF ZCL) IN NORTHERN ALGERIA

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Zoonotic cutaneous leishmaniasis appeared in native focus for the first time in north of Algeria. (Boudrissa et al., 2012). The investigations around patients allowed us to report the presence of P.obesus in this northern region. The colonies of this rodent are located on Gypso-saline marl on which grow Chenopodiaceae, exclusive food for this rodent.

P.obesus is the main reservoir of ZCL (Belazzoug, 1986 a), it is present around the saline lake in the steppe region and the dayas and alluvial terraces in the Saharan major wadis. This new location expanded its vital territory to the semi-arid and sub-humid floor.

Northern Algeria is a grain-oriented area and therefore a favorite territory for Meriones shawi, knowing that this rodent is also a reservoir for ZCL (Belazzoug, 1986 b), so this is an important factor, putting a high population in the risk of transmission of this zoonosis.

Different epidemiological aspects of the disease and ecology of the rodent were discussed in this communication.

CRYPTOSPORIDIUM SCREENING USING KINYOUN TECHNIQUE IN CORVUS CORNIX IN TEHRAN, CAPITAL OF IRAN

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Cryptosporidium is an intestinal protozoan parasite prevalent in a wide range of mammals. It has been recorded in many hosts including wild and domesticated animals. Determining the infected animals could be a useful way to identify the potentially infective sources of the parasite. Fifty *Corvus cornix* from Tehran, capital of IRAN, examined in this survey. Collected fecal specimens were examined microscopically for the presence of acid-fast cryptosporidia in the Kinyoun stained smears. Among 50 tested animals oocyst shedding were found in 12 animals (24%) by the Kinyoun stain method. It is still unclear if a zoonotic transmission may occur between *Corvus cornix* infected with *Cryptosporidium* and humans. Nevertheless *Corvus cornix* are harboring the *Cryptosporidium* and should expect as a potential source of cryptosporidiosis in immunocompromised hosts.

Cryptosporidium, *Corvus cornix*, kinyon acid fast

P73

PESTS AND THE CITY: ON THE POTENTIAL ROLE OF EXOTIC AND NATIVE BIRD PESTS ON THE TRANSMISSION OF MOSQUITO-BORNE PATHOGENS

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Avian pests are becoming an ecological and sanitary concern in urban areas due to their role in the transmission of pathogens. The exotic Monk Parakeets (*Myiopsitta monachus*) has dramatically increased its abundance during the last years, currently being considered an invasive exotic species according to both Spanish state and European regulations. Due to their high abundance in urban areas, Monk Parakeets in addition to Feral Pigeons (*Columba livia*) may represent an important source of blood for mosquitoes cohabiting in the area, potentially affecting the circulation of vector-borne pathogens. Here, we studied the role of these bird pests as feeding sources of mosquitoes and their potential effect in the transmission of pathogens in Barcelona. We used the DNA isolated from the abdomen of engorged female mosquitoes to: i) identify their origin by the amplification of a fragment of COI gene (the barcoding region) and ii) identify the presence of avian malaria parasites. We found that the mosquito feeding preferences differed between species, with *Culex pipiens* feeding on both humans and birds, including the pest species Monk Parakeets and Feral Pigeons. Furthermore, blood parasites were found in mosquitoes feeding on bird pest species, supporting their potential role on the circulation of avian pathogens. These results provide valuable information on the role of exotic and native bird pest species on the dynamic of transmission of pathogens in urban areas, which may be useful to develop plans for monitoring and control of these species and reduce risks on animal and public health.

P74

VALIDATION OF THE PUUMALA VIRUS RAPID FIELD TEST FOR BANK VOLES IN GERMANY

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The predominant hantavirus species in Europe is the Puumala virus (PUUV). It is most commonly transmitted by bank voles (*Myodes glareolus*) and an infection can cause nephropathia epidemica in humans.

Our aim was to validate a rapid field test for PUUV infections in rodents in Germany, which is based on a recombinant antigen of a Finish PUUV strain (Sotkamo). Test results of the rapid field test were compared to Enzyme Linked Immunosorbent Assays (ELISA), which were done using recombinant antigens of PUUV strains from Germany (Bavaria), Sweden (Vranica/Hällnäs) and during further procedures also the homologous Sotkamo strain. Bank vole populations were monitored by live-trapping from 2013-2015 in two PUUV endemic regions of Germany (North Rhine-Westphalia and Baden-Wuerttemberg). Blood samples were directly analyzed for PUUV-specific antibodies with the rapid field test and later in the laboratory with the different ELISAs.

Test efficacy was calculated from sensitivity and specificity of the rapid field test in comparison to the standard laboratory ELISAs and was 90-94% depending on PUUV strain, which seems satisfactory for most purposes.

A rapid field test would facilitate short-term estimation of PUUV seroprevalence in bank vole populations. This can aid health authorities in the future to quickly assess the current risk of human PUUV infection based on PUUV seroprevalence in the rodent reservoir.

The study is commissioned and funded by the Federal Environment Agency (UBA) within the Environment Research Plan of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) (grant number 3713 48 401).

P75**BEECH FORESTS AS NATURAL FOCI OF PUUMALA AND DOBRAVA VIRUS IN CROATIA**

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Puumala (PUUV) and Dobrava (DOBV) are the main causative viruses of haemorrhagic fever with renal syndrome (HFRS) in Croatia. The main rodent reservoirs of hantaviruses in Croatia are the yellow-necked mouse (*A. flavicollis*), striped field mouse (*A. agrarius*) and bank vole (*M. glareolus*). In Croatia European beech (*F. sylvaticae*) is the tree species with largest areal and distribution over 36% of forest area. Beech forests are mostly found in highland and mountain areas and hosts a large number of small mammal species. For the purpose of this study rodents were captured using snap traps within four year period in beech stands at two different locations with the total of 11 trapping grids. Rodents were screened for hantaviruses using nested RT-PCR. Results show that yellow-necked mouse and bank vole are dominant species in beech forests of Croatia and both make 99 % of total captures. PUUV was detected in 90/181 (50%) bank voles and DOBV in 13/243 (5%) yellow-necked mice. Number of hantavirus positive rodents was positively correlated with their abundance. High abundance of hantavirus positive rodents was found in two years following beech mast. For the same years with increased rodent abundance high number of human HFRS cases was reported which confirms the influence of beech mast on rodent abundance and increasing human cases.

P76

ANAPLASMA PHAGOCYTOPHILUM VIRULENT GENOTYPES IN WILD RUMINANTS; A POSSIBLE RISK FOR HUMANS IN CENTRAL ITALY

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Human granulocytic anaplasmosis (HGA) is an emerging tick-borne zoonosis worldwide caused by *Anaplasma phagocytophilum*. However, as for many tick-borne diseases, the epidemiological cycle is also associated to climate, vegetation and of course to the presence of vertebrate reservoir hosts. Aimed to assess the spread of the bacterium in wild ruminants and feeding ticks in Central Italy, a total number of 87 spleen samples and 77 *Ixodes ricinus* collected from the same carcasses were screened for *Anaplasma phagocytophilum* by using Real Time PCR. *A. phagocytophilum* DNA was detected in 75%, 67% and 54% of the carcasses of red deer (*Cervus elaphus*), Apennine chamois (*Rupicapra pyrenaica ornata*) and roe deer (*Capreolus capreolus*) respectively, whereas it was detected in the 31,2% of the *Ixodes ricinus* collected from the same animals. The presence of *A. phagocytophilum* DNA in the Apennine chamois represents the first report for this Italian endemic subspecies. The goal of the present study was also to identify virulent genotypes circulation related to HGA also in order to assess possible risk for humans. Indeed, positives samples were characterized by sequencing a portion of the *groEL* gene. Two *A. phagocytophilum* lineages could clearly be delineated from the phylogenetic tree. Four sequences from red deer, 2 from *Ixodes ricinus* and 1 from Apennine chamois clustered into lineage I together with those previously described as virulent genotypes related to HGA.

P77

BREEDING SEASON OF THE SUNDEVALL'S JIRD (MERIONES CRASSUS) DESERT RODENT. A FACTOR TO LIMIT TRANSMISSION OF PATHOGENES IN DESERT AREA

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Rodents are large reservoirs of many pathogens like virus, and cutaneous Leishmania. In most cases, the reproduction phenology of the parasite reservoir is unknown which makes difficult control against parasites. In this study, we analyse the seasonal breeding cycle of an important reservoir of cutaneous Leishmania living in desert area. Sundevall's Jird (*Meriones crassus*) is a nocturnal granivorous desert rodent generally considered to be the main reservoir and host of Leishmania infections. To better understand the interactions between parasitism and host reproduction, we studied seasonal variations of testis, seminal vesicles weight and glandular and plasmatic androgens, in adult male Sundevall's Jird. In this species, there is a seasonal cycle of the endocrine function of testis, characterized by a minimum activity in autumn, a recovery in winter, a maximum at the beginning of spring and a regression in summer. It seems that there is a correlation between seasonal breeding and propagation of parasites in adult male *Meriones crassus*. Better understanding of breeding activity in the wild should facilitate the implementation of effective control strategies of desert rodent reservoirs of Leishmania in desert area.

Keywords: Desert rodent-Seasonal reproduction, testis and vesicles seminal weights, Plasma and glandular androgens, Parasite, Leishmania.

P78**PREVALENCE OF LEISHMANIASIS IN ADOPTED DOGS IN THE MURCIA COUNCIL ZOOZOTIC DISEASES MUNICIPAL CENTRE**

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Leishmaniasis is an endemic zoonosis in most of the Spanish territory. Leishmaniasis is caused by the protozoan leishmania parasites which are transmitted by the bite of infected sand flies (*Phlebotomo* spp). The most important reservoir of *Leishmania* protozoan in these areas is the dog and therefore should be the main target of control measure.

The Murcia Council Zoonotic Diseases Municipal Centre is in charge of the stray dogs collection as well as the unwanted dogs. A physical exam and serological tests are performed in these animals. Healthy dogs are included in the adoption programme. An enzyme-linked immunosorbent assay (ELISA) for detection of *L. donovani* or *L. infantum* antibodies in canine whole blood is performed.

This paper applies the results from the dogs that were checked in the Centre within the adoption programme over a two years period. 491 asymptomatic dogs were tested of which 70 were positive. This means an overall leishmaniasis prevalence of 14,26%. Prevalence was 14,81% (16/108) during 2013 and 14,10% (54/383) during 2014.

Leishmaniasis is part of those diseases which still requires improved control tools. This report concludes that a public health control campaign is necessary to reduce the prevalence of canine leishmaniasis.