



# IWEC 2025

## BOOK OF ABSTRACTS

Exchanging knowledge, sharing experiences, and strategising for the betterment of the future of all wild equids.



# CONTENTS

---

## Keynote Abstracts

Blending Indigenous Knowledge and Scientific Approaches for Effective Wild Equid Conservation	5
The risks of conservation success: Cape mountain zebra recovery introduces new challenges	6
Research and Training for the Conservation of the Critically Endangered African Wild Ass ( <i>Equus africanus</i> )	7

## Oral Presentation Abstracts

Investigating Drivers of Plain Zebra ( <i>Equus quagga</i> ) Movement in Ol Pejeta Conservancy: The Role of Forage and Predation	8
Far-ranging ungulate movements amid rapid linear infrastructure development in the Mongolian Gobi	9
Use of complementing Mobile and Computing Technologies to Assess Grevy's Zebra Distribution in Northern Kenya	10
WildCap: Autonomous Non-Invasive Monitoring of Animal Behavior and Motion	11
Satellite Telemetry and Remote Sensing for Land Use Planning and Grevy's Zebra Conservation in Northern Kenya	12
Changes in linear infrastructure behavior of Khulan in the South Gobi, Mongolia	13
Spatial ecology of feral horses in Wyoming, USA	14
The paradox of spring: Thyroid and glucocorticoid responses to cold temperatures and food availability in free living Carneddau ponies	15
Habitat-related factors that promote reproductive success among Asiatic wild ass ( <i>Equus hemionus</i> ) territorial males	16
Long-Term Impacts of Large Grazers and Climate on Grassland Ecosystems	17
Free-roaming horses exceeding appropriate management levels affect multiple vital rates in greater sage-grouse	18
Niche modelling predicts macroecological patterns of diet composition and population performance in Cape mountain zebra ( <i>Equus zebra zebra</i> )	19
Evaluation of seasonal and sex-specific dietary patterns of the reintroduced Asiatic wild ass in the Negev Highlands, Israel	20
Horse nutritional ecology in a North American cold arid steppe across 5 years of variable weather	21
Disease impacts for wild equids: involving disease principles and other problems into conservation projects	22
Who's your daddy? Male reproductive success strategies and female fidelity in two feral horse populations	23
Mean mares? Habitat features influence female aggression in the feral horse ( <i>Equus caballus</i> )	24
Factors affecting female wild ass ( <i>Equus hemionus</i> ) social associations under changing water source distribution	25
Multilevel society of free-ranging horses in Serra S'Arga, Portugal	26

Overmarking behaviour of zebra males: no scent masking, but a group cohesion function across three species	27
Physiological and Behavioural Response to Translocation in Wild Equids	28
Longitudinal monitoring of gut immune and inflammatory responses in a population of semi-feral equids using novel, non-invasive biomarkers	29
Supplementary Feeding and Rapid Post-Mortem Veterinary Response for Grevy's Zebra Survival: Lessons from the 2021-2023 Drought	30
Gastrointestinal Strongyles Egg Shedding in Wild Przewalski's Horses in the Chernobyl Exclusion Zone, Ukraine: Influence of Season, Age, Group Size, and Body Condition	31
Exploring the Relationship Between Parasite Infection and Body Condition in Wild Horses Across the Western United States	32
Anthelmintic resistance in parasites of wild equid: does "refugia" help?	33
Przewalski's horse conservation in Kalamaili National Park, China	34
Return of the Wild Horses to Kazakhstan and Mongolia	35
The Adaptive Significance of Zebra Stripes: Truly Nature's Multi-tool	36
Conservation genetics in species reintroductions: the Asiatic wild ass in Israel	37
A broader assessment: Porcine zona pellucida immunocontraception vaccine (ZonaStat-H) efficacy in seven free-roaming horse populations across western North America	38
Efficacy and reversibility of PZP immunocontraception in free-roaming Przewalski's horses	39
Fertility control for free-roaming horse populations: over 20 years of research using SpayVac®-equid	40
Behavioural and Ecological Monitoring in Przewalski's Horse Reintroductions: Standardized Research Methodologies for the New Kazakh and Mongolian Projects	41
From past to future: a socio-ecological framework for Persian onager reintroduction	42
Movements and Habitat Selection of Przewalski's Horses in Hustai National Park, Mongolia	43
Population dynamics of the Przewalski's horse ( <i>Equus ferus przewalskii</i> ) being reintroduced in Khomyn Tal National Park, Mongolia, compared to other reintroductions and its source population	44
Cross-pollinating ideas for mitigating the impacts of infrastructure on wild equids	45
Brief highlights of Przewalski's horse reintroduction to Hustai National Park, Mongolia: up to date after three decades	46
Managing wild horse herds with limited resources	47
Effects of Domestication: Productivity and Social Structure of Free-roaming Equids	48
Can Mountain Lion Predation Suppress Growth Rates of Feral Horses in the American West?	49
Community-led Regenerative Land Management as a Tool for Wildlife Conservation in Mixed-use Rangelands in Northern Kenya	50

## Poster Presentation Abstracts

---

Investigation of mortality in the <i>Equus ferus przewalskii</i> population of the Great Gobi B in Mongolia during the climatic challenges in the year 2022/2023	51
Ritual encounters between stallions in an island population of feral horses ( <i>Equus ferus caballus</i> )	52
Wait. IUDs for feral equids?	53
Animal welfare risk assessment and management plan for feral horses at Kaapsehoop, South Africa	54
Przewalski behavior problems in zoos and in the wild	55
Influence of landscape Features on Mountain lion ( <i>Puma concolor</i> ) prey selection in mixedprey communities	56
Population Dynamics, Sex Ratio, and Foal Survival of Misaki Feral Horses at Cape Toi, Miyazaki, Japan (2012-2016)	57
Rewilding ethology – Ten years of Behavioral and Ecological Monitoring of Semi-Feral Ungulates in the Czech Republic	58
Creating Vegetation Patches on Degraded Grevy's Zebra Habitat Using Semi-circular bunds: Lessons from a Voluntary Restoration Programme in Northern Kenya	59
The Northern Kenya Road Watch; Using Citizen Science to Inform Biodiversity-conscious Infrastructure Development	60
Shared intention and coordination behavior in mutual grooming of horses	61
Features of reproduction in an isolated population of the feral horses ( <i>Equus ferus caballus</i> )	62

---

# KEYNOTE ABSTRACTS

---

## Blending Indigenous Knowledge and Scientific Approaches for Effective Wild Equid Conservation

PETER LALAMPAA, GREVY'S ZEBRA TRUST

The conservation of wild equids globally faces unprecedented challenges, from habitat fragmentation to climate change impacts. Despite significant scientific advances, many conservation efforts struggle to achieve lasting outcomes. This keynote presentation argues that where people and equids share space and resources, effective conservation requires integrating rigorous scientific methods with indigenous knowledge systems that have sustained landscapes for generations.

Drawing on fifteen years of experience with the Grevy's Zebra Trust (GZT) in northern Kenya, this presentation demonstrates how bridging these knowledge systems has proven critical to conserving the endangered Grevy's zebra. With population numbers reduced from approximately 15,000 in the 1970s to around 3,000 today, innovative approaches that engage local communities as conservation leaders have been essential to stabilizing this iconic species.

The presentation examines GZT's community-centred model, where indigenous pastoralists – including Samburu, Turkana, and Rendille communities – serve as Scouts, Warriors, and Ambassadors. These teams combine traditional ecological knowledge with modern scientific monitoring techniques to protect Grevy's zebra across 10,000 km<sup>2</sup> of semi-arid rangelands. This integration has proven particularly valuable during drought responses, where indigenous understanding of landscape patterns combined with scientific data has saved hundreds of zebras while supporting vulnerable pastoralist families.

The Holistic Land and Livestock Management approach exemplifies this integration, blending traditional grazing practices with contemporary rangeland science to regenerate degraded landscapes that benefit both wildlife and people. Similarly, data collected by GZT's community teams as well as the Great Grevy's Rally represent successful citizen science initiatives that merge technology with community engagement to accurately monitor zebra populations.

Results demonstrate that this integrated approach delivers multiple benefits: stabilized zebra populations, improved rangeland health, enhanced community livelihoods, and increased local ownership of conservation. Critical success factors include respecting indigenous institutions, maintaining scientific rigor, and fostering genuine partnerships across knowledge systems.

The keynote concludes with a call to action for conservation practitioners to reimagine equid conservation by embracing indigenous perspectives and expertise alongside scientific approaches. By reconsidering our partnerships, methodologies, and knowledge hierarchies, we can develop more effective, equitable, and sustainable conservation strategies for wild equids and the landscapes they inhabit.

## The risks of conservation success: Cape mountain zebra recovery introduces new challenges

GRAHAM KERLEY\*, MARIENNE DE VILLIERS\*\*

\*Centre for African Conservation Ecology, Nelson Mandela University, South Africa

\*\* Biodiversity Capabilities Unit, CapeNature, South Africa

Conservation science is a crisis discipline, with relatively little attention focussed on the implications of success, in the face of the typical urgent need to increase numbers of threatened taxa. The Cape mountain zebra (CMZ) underwent a catastrophic decline in the 17<sup>th</sup> and 18<sup>th</sup> centuries due to overhunting and habitat loss, to a nadir of around 75 animals in the 1920s. This crisis led to conservation measures including the proclamation of a dedicated “Mountain Zebra National Park” near Cradock in 1931, and protection for the three other relict populations. Of the latter, only two (at Gamka and Kammanassie nature reserves) persisted. This protection resulted in rapid increases in the Cradock population, while the Gamka and Kammanassie populations remain small. This pattern reflects the fact that the latter two populations represent “refugee” populations in marginal, grass-poor habitat. The Cradock population growth allowed for the restoration across the historical distribution range, initially to other state-owned protected areas, and later expanded to private landowners. The private commitment to CMZ reflected their rarity value to landowners, but also the value in live trade and hunting. In the last decade, the global population exceeded 5 000 individuals distributed over at least 114 sub-populations, including nine extralimital sites. The growing population resulted in the 2019 downlisting of CMZ to Least Concern. The majority (~ 56%) of CMZ individuals are held in state-owned protected areas, but there are more sub-populations on private land. Governance of CMZ in the natural distribution range is spread across three provincial and one national body, as well as the private landowners. Emerging risks for CMZ include population fragmentation and isolation, small populations (with associated risks of inbreeding and genetic drift) and hybridization, these confounded by conflicting governance approaches and lack of financial incentives to establish new or grow existing subpopulations on private land. CMZ remains highly conservation dependent but the apparent recovery reduces conservation resources. This paradox highlights the risks inherent in numerical conservation assessments and the need to manage for the long-term persistence of threatened taxa by lifting our baselines to achieve truly viable populations.

# Research and Training for the Conservation of the Critically Endangered African Wild Ass (*Equus africanus*)

PATRICIA D MOEHLMAN

The critically endangered African wild ass (*Equus africanus*) is the world's most threatened wild equid. Historically, the species was widespread in north and north-east Africa, but its range is now restricted to Eritrea and Ethiopia, and possibly Egypt, Sudan, Djibouti, Somaliland and Somalia. An estimated 600 individuals remain within its documented range of 23,000 sq km.

DNA was extracted from fecal samples collected from animals in Eritrea and Ethiopia. Mitochondrial DNA haplotypes and microsatellite genotyping indicate that there is and/or has been gene flow between the populations in Ethiopia and Eritrea. These analyses did not detect any admixture of genetic material between domestic donkeys and African wild ass.

Major threats to its survival are hunting, habitat loss, and potential competition with livestock for forage and water.

The research and training program for the conservation of this threatened species started in 1994 and has been focused on Ethiopia and Eritrea. Support has been provided for MSc and PhD research and education. This research has provided information on population size and distribution, limited information on natality and survivorship, projection of population sustainability for the next 50 years based on historical rainfall and climate change projections, drinking behavior and the costs of accessing water per age and sex class and the overlap of forage utilization with livestock. Maximum entropy (Maxent) modelling based on direct observations of African wild ass locations, bioclimatic data and topography was used to determine suitable and optimum habitat for this species in the Danakil desert of Ethiopia and Eritrea. Presence of African wild ass and area of suitable habitat provided an estimate of population density and size.

The establishment of science based protected areas for the African wild ass is critical for their future population viability. The involvement and support of local people for conservation activities is essential. This has included training, equipping and employing local Afar pastoralists as community wildlife scouts. Local knowledge concerning resource requirements in this arid habitat is fundamental for understanding and managing the area for the benefit of both wildlife and local communities.

# ORAL PRESENTATION ABSTRACTS

---

## Investigating Drivers of Plain Zebra (*Equus quagga*) Movement in Ol Pejeta Conservancy: The Role of Forage and Predation

STEPHEN GACHAGUA, [NAIROBI UNIVERSITY, BORANA CONSERVANCY, BENJAMIN MUHOYA, PRINCETON UNIVERSITY

Plain zebra (*Equus quagga*) movement patterns are influenced by various ecological factors, yet the role of predation risk in shaping these behaviors remains underexplored. My study investigates how forage availability, predation risk, and seasonal variation influence zebra movement in Ol Pejeta Conservancy (OPC), Kenya. The findings so far reveal that forage abundance alone is not a major determinant of zebra distribution. However, seasonality significantly affects forage quality and distribution, indicating that zebras are more responsive to temporal changes in resource availability.

More notably, my study revealed the influence of predation risk on zebra movements. We observed that zebras tend to avoid high-risk predation areas, particularly those frequented by lions (*Panthera leo*), instead favoring the dense *Euclea divinorum* thickets along the conservancy's edges. In these areas, zebras aggregated into larger groups, likely a behavioral adaptation to reduce predation risk through increased vigilance and dilution effects. This supports the concept of a "landscape of fear," where prey species alter their habitat selection and group sizes in response to perceived threats, even at the expense of optimal foraging.

These behavioral adjustments underscore the intricate balance between predator avoidance and resource acquisition, contributing to the broader understanding of prey movement ecology. The results of this study have implications for conservation strategies, not only for plain zebras in Kenya but also for other rewilding efforts, such as predator reintroduction in the U.S., where similar predator-prey dynamics (e.g., wolves and bison in Yellowstone) could reshape ecosystem interactions.

Future research will explore how predation risk influences zebra health through a microbiome survey, aiming to assess changes in microbial diversity across varying predation landscapes. Preliminary data that we generated at the Mpala Research Center suggest notable variation in microbial diversity, which we hypothesize may be linked to predation stress and movement patterns. I hope that my work will offer insights for managing prey species in predator-rich environments.



# Far-ranging ungulate movements amid rapid linear infrastructure development in the Mongolian Gobi

**NANDINTSETSEG DEJID<sup>1</sup>, BAYARBAATAR BUUVEIBAATAR<sup>2</sup>, PETRA KACZENSKY<sup>3,4</sup>**

<sup>1</sup>Senckenberg Biodiversity and Climate Research Centre, Frankfurt am Main, Germany.

<sup>2</sup>Wildlife Conservation Society, Mongolia Program, Ulaanbaatar, Mongolia

<sup>3</sup>University of Veterinary Medicine, Vienna, Austria,

<sup>4</sup>Department of Forestry and Wildlife Management, Inland Norway University of Applied Sciences, Rena, Norway

Mongolia's recent mining boom has resulted in a need for transportation corridors, and from 2020-2022, nearly 1000 km of railways were built in the Gobi region alone, right through the core area of the largest remaining global populations of threatened Asiatic wild ass and goitered gazelles and also impacting the Gobi part of the range of Mongolian gazelles. Although potential crossing structures were implemented, the lack of information about their placement and design, partial fencing, and steep embankments raise concerns over the barrier effect of these new infrastructure corridors and the efficiency of crossing structures.

Using pre- and post-construction tracking data we provide a first rapid assessment of the immediate impact of the new railway on ungulate movements. In order to evaluate behavioral responses of ungulates to the presence of novel railways we compiled GPS movement data from ongoing monitoring of Asiatic wild ass, goitered gazelle, and Mongolian gazelle gathered information on potential crossing structures and their types and dimensions. We then analyzed the frequency of railway encounters, successful crossings, and the cumulative length of railway tracks traced by individual animals. Key findings revealed that khulan, goitered gazelle, and Mongolian gazelle frequently encountered difficulties in crossing the new railways, either being forced to retreat without crossing, or walking along the railway tracks for extended distances in search of suitable crossing areas. Although potential crossing structures such as open-span bridges and box culverts exist along the railways, movement data from the post-construction periods suggest that these are either not suitable or do not occur numerous enough to mitigate the barrier effects of steep railway embankments or fenced railways.

Our study is among the first to document the behavioural responses and movement patterns of ungulates to a newly constructed railways with potential crossing structures. Our findings provide important insights for the conservation of large-scale animal movement in the Gobi, but are also relevant for other far-ranging ungulate species worldwide.

# Use of complementing Mobile and Computing Technologies to Assess Grevy's Zebra Distribution in Northern Kenya

TONY ORWA<sup>1\*</sup>, REDEMPTA NJERI<sup>1</sup>, GABRIEL LEKULA<sup>1</sup>, JOHN LEKISHE<sup>1</sup>, JOEL LONGOONYO<sup>1</sup>, JOSHUA LABARAKWE<sup>1</sup>, DAVID W KIMITI<sup>1</sup>

<sup>1</sup>Grevy's Zebra Trust, P.O. Box 15351-00509, Nairobi, Kenya,

\*Corresponding author

The Grevy's zebra is one of Africa's most endangered large mammals and is currently categorized as endangered by the IUCN and is listed on CITES Appendix I. The primary, significant threats to the Grevy's zebra population today are habitat loss and fragmentation due to rangeland degradation, and loss of connectivity due to infrastructure development. As land degradation and climate stochasticity work in concert to reduce existing forage resources, these populations more than ever are forced to use the landscape in reactionary and often erratic seeming patterns. Identifying important Grevy's zebra habitats -especially dry season refuges and critical corridors- is critical to developing and executing sustainable conservation projects. While collaring programs are crucial to this endeavour, they do not give granular information about demographic distribution, group size, and body condition.

As such, the Grevy's Zebra Trust employs a vast network of community members who help patrol this vast landscape, providing us with critical context for areas that we cannot always easily survey. Across our area of operations, we have various groups of community monitors that carry out different tasks based on the unique challenges in the respective landscapes they work in. This network of Scouts, Warriors, and Ambassadors carry out surveys multiple times a week and record their observations on their mobile phones through the Spatial Monitoring and Reporting Tool (SMART). This conservation platform is accessed by field teams via a dedicated smartphone app that is customized for each team with the ability to load several different configurable models. This data is currently providing important insight into critical habitats that are being used by Grevy's zebra and will hopefully allow us to identify seasonal patterns around their use of the landscape.

We are also currently using ArcGIS products, primarily Survey123 and ArcGIS Online to collate and visualize mortality data, which allows us to track and analyze trends in natural and human-related Grevy's zebra deaths and ascertain whether our impact models for reducing these mortalities are suitable. We will showcase these systems and their current and potential applications for Grevy's zebra conservation and beyond.

# WildCap: Autonomous Non-Invasive Monitoring of Animal Behavior and Motion

AAMIR AHMAD<sup>1</sup>, ERIC PRICE<sup>1</sup>, PRANAV KHANDELWAL<sup>1</sup>, VIOLA KEREKES<sup>2</sup>, PETER CSOBAN<sup>2</sup> AND DANIEL I. RUBENSTEIN<sup>3</sup>

<sup>1</sup>University of Stuttgart and Max Planck Institute for Intelligent Systems, Germany

<sup>2</sup>Hortobágy National Park, Hungary

<sup>3</sup>Princeton University, USA

## Extended Abstract

Inferring equid behavior such as standing, grazing, running, or interacting is essential for addressing ecological questions. Additionally, real-time estimation of equid 3D pose and shape can aid in disease diagnosis, health profiling, and even higher-resolution behavior analysis. However, inferring pose and behavior in the wild without markers or sensors is highly challenging. Current state-of-the-art methods either require physical markers (e.g., GPS collars) or rely on stationary camera traps. Not only do these methods pose danger to the animals due to tranquilization and physical interference, but their scope is also difficult to extend to a larger number of individuals in vast environments and over longer time periods.

In WildCap, we have developed autonomous systems [1, 2] for estimating equid behavior, pose, and shape without interfering with the animals. Our innovative solution uses a team of intelligent, vision-based aerial robots, or drones, to detect [5], track, and follow the animals for pose and behavior estimation [3,4]. Robots include helium-based airships and multi-rotor drones designed for this purpose. We have developed autonomous decision-making methods [1,6] for our robots that enable them to compute and execute flight paths, maximizing tracking accuracy of the animals.

The WildCap system has been successfully tested<sup>1</sup> in the Pentezug reserve of the Hortobágy National Park (HNP) in Hungary, where it autonomously tracked endangered Przewalski's horses in a 3,000-ha semi-wild environment. Our behavior inference method [3,4] has been demonstrated<sup>2</sup> on Grévy's zebras using drone-acquired videos at the Mpala Conservancy in Kenya. This approach allows us to accurately estimate long-term activity budgets (e.g., time spent grazing, vs, walking) and movement patterns. Such insights are crucial for local authorities to manage human activities effectively, ensuring designated grazing areas for livestock while minimizing wildlife conflict. We also conducted flight experiments to quantify how drone noise affects the natural behavior of equids and other species in the same landscape.

Ongoing and future work includes developing behavior-driven autonomous flight planning and control for robots, as well as the large-scale deployment of the WildCap monitoring system in HNP and the Mpala conservancy.

# Satellite Telemetry and Remote Sensing for Land Use Planning and Grevy's Zebra Conservation in Northern Kenya

LIZBETH MATE<sup>1</sup>, TANYA LANGENHORST<sup>1</sup>, DAVID KIMITI<sup>2</sup>, REDEMPTA NJERI<sup>2</sup>

<sup>1</sup>Marwell Wildlife,

<sup>2</sup>Grevy's Zebra Trust,

<sup>3</sup>Kenya Wildlife Service,

<sup>4</sup>Wildlife Research and Training Institute

The Grevy's zebra (*Equus grevyi*) is critically endangered, with its global population having declined by approximately 80% over the past 40 years. Currently, more than 92% of the remaining Grevy's zebra population resides in Kenya, with smaller, isolated groups found in Ethiopia.

Kenya's core Grevy's zebra population inhabits Samburu, Isiolo, and Marsabit counties in northern Kenya, regions threatened by large-scale infrastructure developments, including the Lamu Port-Southern Sudan-Ethiopia Transport (LAPSSET) Corridor and County Integrated Development Plans (CIDP), which will cut through vital habitats and pose one of the most significant emerging threats to the species.

In response, a study titled "Cumulative Impacts of Infrastructure Development on Grevy's Zebra and Lions" evaluated the movements of these species under various development scenarios along the LAPSSET Corridor. Results indicate movement declines of up to 50% for Grevy's zebra under a 'no mitigation' scenario. This reduces to just 5% under a 'mitigated impact' scenario.

To further understand the impact of these developments, 20 Grevy's zebras were collared in September 2023 across six locations. Using satellite telemetry, the study aimed to identify critical habitats essential for the zebras' distribution, dispersal, and movement, and to provide insights into why these areas are crucial. These data intend to inform conservation and land-use planning decisions at both local and national levels, guiding the implementation of targeted mitigation strategies.

In the first quarter of 2024, 76.4% of GPS fixes from 18 collared Grevy's zebra were within community lands, 21.2% within protected areas, and 2.4% within County Conservancies. The movement data confirmed the presence of a wildlife corridor between Shaba National Reserve and Buffalo Springs National Reserve across the main highway A2. Nine incidents of wildlife-vehicle collisions were recorded along the A2 road.

This presentation will outline the details of the collaring exercise and analysis of the movement data. It will discuss mitigation strategies aimed at securing corridors along wildlife hotspots and water resources for the conservation of Grevy's zebra in northern Kenya.

# Changes in linear infrastructure behavior of Khulan in the South Gobi, Mongolia

NILANJAN CHATTERJEE<sup>1</sup>, BAYARBAATAR BUUVEIBAATAR<sup>2</sup>, JOHN PAYNE<sup>3</sup>, KIRK OLSON<sup>4</sup>, OTGONSUREN AVIRMED<sup>2</sup>, JUSTINE SHANTI ALEXANDER<sup>2</sup>, THOMAS MUELLER<sup>1, 4, 5</sup>, PETRA KACZENSKY<sup>6</sup>, AND NANDINTSETSEG DEJID<sup>1</sup>

<sup>1</sup>Seckenberg Biodiversity and Climate Research Centre, Frankfurt, Germany,

<sup>2</sup>Wildlife Conservation Society (WCS), Mongolia Program, Ulaanbaatar, Mongolia,

<sup>3</sup>Blue Dot Research LLC,

<sup>4</sup>Conservation Biology Institute, National Zoological Park, Smithsonian Institution, Front Royal, VA 22630, USA,

<sup>5</sup>Goethe University Frankfurt, Frankfurt, Germany, <sup>6</sup>Inland Norway University of Applied Sciences, Elverum, Norway

Anthropogenic barriers alter and disrupt animal movements, and are extremely challenging obstacles for long-ranging ungulate species. Understanding these disruptions and mitigating adverse impacts on wildlife requires knowledge of species-specific habitat needs and behaviors. How different linear features such as roads, railways and fences affect ungulate behaviors may differ greatly in relation to the feature permeability and disturbance, which in turn may be shaped by differences in physical structure or human activity. In the rapidly developing South Gobi region of Mongolia, linear infrastructure is expanding at an unprecedented rate, creating barriers for wildlife.

We assessed the interactions of 99 Mongolian Wild-Ass (*Equus hemionus hemionus*) also known as Khulan at different types of linear infrastructures (roads, railways) and anthropogenic presence (mines) in the South Gobi of Mongolia between the years 2013 and 2024. We calculated the number of interactions between the khulan trajectories and linear features and further categorized them into different behavioral responses (normal vs altered). Using a generalized mixed-effects model, we analyzed the factors influencing Khulan infrastructure crossings, including traffic volume, infrastructure type, time of day, and proximity to linear features.

Our results revealed significant Khulan behavioral changes in response to different linear infrastructures. Khulan took notably longer steps when crossing these features, with paved roads exhibiting the highest traffic volumes proving to be the least permeable. Moreover, these roads were typically crossed at night during periods of low traffic. Frequency of altered movement behavior around linear infrastructure increased three- to fourfold over a ten-year period.

Highly mobile species utilize resources across vast landscapes, and we found strong evidence that linear infrastructures are severely impacting khulan movement behaviors in the South Gobi. These altered behaviors, driven by barriers, likely reduce access to quality forage, ultimately jeopardizing fitness and survival. Our research findings emphasize that the various linear infrastructures being developed in the South Gobi is altering behavior and creating challenges for animals whose ability to move across the landscape is crucial to their survival. Mitigation measures of linear infrastructure must be initiated to preserve connectivity to ensure the survival of khulan and other species in the region.

## Spatial ecology of feral horses in Wyoming, USA

JACOB D HENNIG<sup>1,2</sup>, JEFFREY L BECK<sup>2</sup>, J DEREK SCASTA<sup>2</sup>

<sup>1</sup>School of Natural Resources & Environment, University of Arizona,

<sup>2</sup>Department of Ecosystem Science & Management, University of Wyoming

Population sizes of feral horses (*Equus ferus caballus*) in the western United States far exceed appropriate management levels set to balance herd and land health. Managers need information concerning movement patterns, habitat selection, and space use overlap to develop appropriate management strategies, yet this information is lacking for most feral horse populations in the country. To address this knowledge need, we attached global positioning system (GPS) transmitters to horses ( $n = 30$ ) residing within the Adobe Town Herd Management Area in southern Wyoming, USA, from 2017–2019. We used GPS location data to assess daily movement distances, home range sizes, and space use relative to management area boundaries. Furthermore, we compared seasonal habitat selection at both broad and fine spatiotemporal scales of feral horses to sympatric species that may be vulnerable to horse-induced habitat alteration, the greater sage-grouse (*Centrocercus urophasianus*) and pronghorn (*Antilocapra americana*). Feral horses moved approximately 9.0 km per day (SE = 0.3), and had mean home range sizes of 40.2 km<sup>2</sup> (SE = 6.7). In summer 2017 (May – September), horses spent 45.9% of their time outside of designated management boundaries but use outside of these boundaries was scant following a muster in October 2017. At the home-range scale, horses selected lower mean shrub heights and flatter slopes year-round, and closer proximity to water during spring and summer seasons. Pronghorn displayed similar selection indices to horses, but also avoided oil and gas well pads. Greater sage-grouse habitat selection was most similar to horses during the summer season, when both species selected proximity to water. At the movement-step scale, horses selected flatter slopes, greater herbaceous cover, greater forage production, closer proximity to water, and farther proximity to oil and gas well pads. Meanwhile, pronghorn also selected flatter slopes, greater herbaceous cover, and forage production, but also selected lower shrub heights and exhibited no selection for distance to water. Our data provide the first comprehensive assessment of feral horse spatial ecology in Wyoming. We show that horses possess large home ranges and can regularly leave designated areas if left unmanaged. Additionally, horses exhibit strong spatial overlap in with species of concern and may pose a risk to the conservation of these populations. Our work can be used in the development and implementation of management practices to help sustain both feral horse populations while conserving native flora and fauna.

# The paradox of spring: Thyroid and glucocorticoid responses to cold temperatures and food availability in free living Carneddau ponies

JESSICA GRANWEILER (A), JURGI CRISTÓBAL-AZKARATE (B), NATHAN MORTON (A), RUPERT PALME (C), SUSANNE SHULTZ (A)

In seasonal environments, maintaining a constant body temperature poses challenges for endotherms. Cold winters at high latitudes, with limited food availability, create opposing demands on metabolism: upregulation preserves body temperature but depletes energy reserves. Examining endocrine profiles, such as thyroid hormone triiodothyronine (T3) and glucocorticoids (GCs), proxies for changes in metabolic rate and acute stressors, offer insights into physiological trade-offs. We evaluated how environmental conditions and gestation impact on faecal hormone metabolites (fT3Ms and fGCMs) from late winter to spring in a free-living population of Carneddau ponies. Faecal T3Ms were highest in late February and March, when temperatures were lowest. Then, fT3Ms concentrations decreased throughout April and were at the lowest in May before increasing towards the end of the study. The decline in fT3M levels in April and May was associated with warmer weather but poor food availability, diet diversity and diet composition. On the other hand, fGCM levels did not display a clear temporal pattern but were associated with reproductive status, where pregnant and lactating females had higher fGCM levels as compared to adult males and non-reproductive females. The temporal profile of fT3Ms levels highlights metabolic trade-offs in a changing environment. In contrast, the ephemeral but synchronous increase in fGCM concentrations across the population suggest a shared experience of acute stressors (i.e., weather, disturbance or social). This multi-biomarker approach can evaluate the role of acute stressors versus energy budgets in the context of interventions, reproduction, seasonality and environmental change, or across multiple scales from individuals to populations.

# Habitat-related factors that promote reproductive success among Asiatic wild ass (*Equus hemionus*) territorial males

AMOS BOUSKILA<sup>1,2</sup>, NITAI SHIFRONI<sup>1</sup>, NOA KAN LINGWOOD<sup>2</sup>, DANIEL I. RUBENSTEIN<sup>3</sup>, ALAN. R. TEMPLETON<sup>4</sup>, SHIRLI BAR-DAVID<sup>2</sup>

<sup>1</sup>Life Science Department, Ben-Gurion University of the Negev, Beer-Sheva,

<sup>2</sup>Mitrani Department of Desert Ecology, Ben-Gurion University of the Negev, Midreshet Ben-Gurion,

<sup>3</sup>Department of Ecology and Evolutionary Biology, Princeton University,

<sup>4</sup>Department of Biology, Washington University in St. Louis

The Asiatic wild ass (*Equus hemionus*), a near-threatened species reintroduced in the Negev Desert, Israel, exemplifies territorial polygyny, where dominant males defend territories that presumably provide resources for visiting females that may mate. Territory quality may reflect the male's fitness. However, the habitat-related factors associated with territory quality and male reproductive success (number of offspring) remain largely unknown. This study aimed to investigate the relationships between habitat factors and the reproductive success of territorial males.

Over three years, we collected feces in the Negev Highlands, identifying dominant males genetically, providing between 1 to 11 locations each. Points near water sources and identified outliers were excluded from the analysis. We compared the distribution of points that formed male territories with randomly distributed points within the study area. We calculated the distance from each water source to the centroid of recaptures for each individual and assessed the NDVI value of their territories. Multiple linear regression was employed to evaluate the effects of centroid distance to the nearest water source and NDVI on male reproductive success, derived from genetic identification of offspring feces.

Our results indicated that male territories were significantly closer to water sources than random points ( $p < 0.001$ ). Moreover, male reproductive success was negatively correlated with both distance to water and NDVI. We hypothesize that the negative correlation with NDVI arises because NDVI in this region reflects perennial vegetation, while wild asses primarily consume dry annual plants during the breeding season. This study highlights the critical role of water sources in determining the reproductive success of territorial males. During the hot and dry breeding season, females require daily drinking, and the proximity to water sources increases the value of a male's territory. This result emphasizes the importance of providing several water points in the Negev highlands to provide opportunities for more males to contribute to future generations. We are currently developing an alternative index to reflect annual vegetation for future analyses of territory quality.



# Long-Term Impacts of Large Grazers and Climate on Grassland Ecosystems

VIOLA KERÉKES<sup>1</sup>, PÉTER CSOBÁN<sup>1</sup>, TAMÁS GÁBOR<sup>1</sup>

<sup>1</sup>Hortobágy National Park Directorate, Hungary

Large grazers were once an integral part of European grasslands but disappeared due to human activity. In recent years, a growing number of rewilding initiatives across Europe have aimed to restore these lost ecosystems. Hortobágy National Park launched such a project in 1997, introducing Przewalski's horses and reconstructed aurochs into a 3,000-hectare area to maintain the grasslands with semi-wild grazers and minimal human intervention. To monitor the impact of these large grazers on vegetation, habitat maps were created in both 2000 and 2019, and demographic data was continuously collected, with GPS coordinates recorded whenever possible.

A comparison of the two habitat maps revealed a significant decrease in reed and marsh vegetation over this period. This change could be attributed to the increasing number of large grazers (which peaked at over 800 in 2018) or the rise in the average temperature, which increased by almost 1°C from the start of the project until 2020. The habitat use of Przewalski's horses also shifted as their population density grew and the climate warmed. At the beginning of the project, long-grass habitats were typically used in autumn and spring, when fresh vegetation emerged following rainfall. In contrast, during summer and winter, these areas were avoided by grazers due to the high fiber content of the dry grasses.

More recently, however, horses and cattle have been grazing more frequently in long-grass areas during the winter, likely because the short-grass vegetation has been overgrazed. In summers with lower-than-average rainfall, we even observed a daily movement pattern between two distant points in the reserve—between watering holes and grazing sites—probably because grazing was no longer possible near the watering points.

These observations suggest that long-term monitoring is essential for understanding the combined effects of global warming and the increasing number of grazers, as this can heighten the risk of overgrazing.

## Free-roaming horses exceeding appropriate management levels affect multiple vital rates in greater sage-grouse

JEFFREY L. BECK<sup>1</sup>, MEGAN C. MILLIGAN<sup>2</sup>, KURT T. SMITH<sup>3</sup>, PHILLIP A. STREET<sup>4</sup>, AARON C. PRATT<sup>5</sup>, CHRISTOPHER P. KIROL<sup>1</sup>, CAITLYN P. WANNER<sup>1</sup>, JACOB D. HENNIG<sup>1</sup>, JONATHAN B. DINKINS<sup>6</sup>, J. DEREK SCASTA<sup>1</sup>, PETER S. COATES<sup>7</sup>

Since passage of the Wild Free-Roaming Horses and Burros Act of 1971, federal agencies have been responsible for managing free-roaming equids in the United States. Over the last 20 years, management has been hampered by direct opposition from advocacy groups, budget limitations, and a decline in the public's willingness to adopt free-roaming horses (*Equus caballus*). As a result, free-roaming equid numbers have increased to >3 times the goal of 26,785 (horses and burros [*E. asinus*] combined), the cumulative sum of the appropriate management levels (AML) for all 177 designated herd management areas (HMA) managed by the Bureau of Land Management. This increase is one of the causes of greater sage-grouse (*Centrocercus urophasianus*) population declines, owing to habitat alteration from free-roaming equids exacerbated by ongoing drought. To evaluate potential demographic mechanisms influencing these declines, we compiled survival data from 4 studies in central Wyoming, USA, including 995 adult female (first-year breeders or older) sage-grouse during the breeding season, 1,075 nests, 372 broods, and 136 juveniles (i.e., overwinter survival for fledged young), from 2008–2022. During this period, we also obtained population information for free-roaming horses from 9 HMAs used by grouse in our sample. Population estimates for horses for these HMAs ranged from 59% to 7 times of the maximum AML (AML<sub>max</sub>). Sage-grouse monitored outside HMAs represented control populations and, because we assumed they were not exposed to populations of free-roaming horses, we set values of AML<sub>max</sub> to zero for all grouse located outside of HMAs. To evaluate whether free-roaming horses were negatively affecting sage-grouse, we modeled daily survival of breeding age females, nest, broods, and juveniles. There was strong or moderate evidence that overabundant horses negatively affected nest, brood, and juvenile survival. When horse abundance increased from AML<sub>max</sub> to 3 times AML<sub>max</sub>, survival was reduced 8.1%, 18.3%, 18.2%, and 18.2% for nests, early broods (≤20 days after hatch), late broods (>20 days to 35 days after hatch), and juveniles, respectively. These results indicate increasing free-roaming horse numbers affected vital rates for important life stages of sage-grouse, and that maintaining horse numbers below AML<sub>max</sub> would reduce negative effects to sage-grouse populations.

# Niche modelling predicts macroecological patterns of diet composition and population performance in Cape mountain zebra (*Equus zebra zebra*)

BRITNELL J.A<sup>1</sup>, KERLEY G.I.H<sup>1</sup>, ANTWIS R. SHULTZ S<sup>2</sup>.

<sup>1</sup>Centre for African Conservation Ecology, Nelson Mandela University, Gqeberha, South Africa

<sup>2</sup>School of Earth and Environmental Sciences, University of Manchester, Manchester, UK

A species' niche can be conceptualised as an  $n$ -dimensional set of conditions within which it can persist indefinitely. Local population dynamics and species' distributions are spatial outcomes of the interaction between the environment and the physiological, morphological and behavioral traits that determine a species' niche. Niche theory thus provides a framework to predict species' distributions and population dynamics at macroecological scales. The core-periphery hypothesis predicts niche cores should be associated with greater survivorship, reproductive output and population performance rates compared to marginal habitats at niche edges.

We use Cape mountain zebra (*Equus zebra zebra*) to evaluate whether niche centrality is associated with population trends, resource availability and diet across a core-periphery gradient. Population growth rates and densities declined progressively towards niche peripheries. Niche peripheries were grass and forage poor and Cape mountain zebra consumed more phylogenetically diverse diets dominated by non-grass families. In core habitats, they consumed grass-rich diets, and female reproductive success was higher.

This niche edge model is correlative and identifies energy or nutrient availability as key potential mechanisms limiting the species' performance and distribution. We extend our work using biophysical and bioenergetic modelling to estimate the Cape mountain zebra's potential range based on its functional traits (physiological, morphological and behavioral). These mechanistic niche models will predict the environmental conditions under which Cape mountain zebra cannot maintain thermoregulation, water balance and positive energy budgets. Our combined correlative and mechanistic niche framework provide an unprecedented opportunity to estimate local population dynamics and the distribution of equid species globally, while identifying the mechanisms that limit their performance in past, present and future climates.

## Evaluation of seasonal and sex-specific dietary patterns of the reintroduced Asiatic wild ass in the Negev Highlands, Israel

SHRUTARSHI PAUL, NAAMA SHAHAR, Yael AVIDAN, OREL BARDA, MERAV SEIFAN AND SHIRLI BAR-DAVID

Reintroduced large herbivores significantly influence ecosystem structure, species diversity, and functioning, necessitating careful monitoring. The population of Asiatic wild asses (Near Threatened by IUCN) in the Negev Desert, Israel, has been steadily increasing, raising concerns about habitat degradation due to overgrazing and trampling. While diet reflects these interactions, limited data exist on the seasonal, spatial, and sex-specific dietary patterns of this population. In this pilot study, we assessed dietary patterns using field surveys and DNA metabarcoding. We collected 252 fresh wild ass samples (158 males and 52 females identified by molecular assays) in spring and summer across the species' range in the Negev Highlands. Metagenomic analysis revealed no significant differences in alpha diversity based on sex, season, or location ( $p > 0.05$ , PERMANOVA). However, beta diversity analysis indicated distinct dietary compositions related to sex and season ( $p < 0.05$ , PERMANOVA). In summer, the diet included annual plants like *Erodium*, *Schismus*, and *Avena*, along with perennials such as *Helianthemum*, *Noea*, and *Atriplex*. The spring diet primarily comprised annuals. Generalized Linear Mixed Models (GLMM) showed that beta diversity of genera was influenced by sex, season, and physical distance, with closer samples exhibiting similar compositions regardless of season or sex ( $p < 0.05$ , Wald Chi-square test). Summer samples displayed higher beta diversity, likely due to the compulsive consumption of resources, whereas spring allowed for more selective feeding as a result of availability of abundant preferable vegetation, in line with optimal foraging theory. Interestingly, males exhibited greater dietary diversity than females across both seasons. This may reflect social dynamics, as males maintain territories near water sources, granting access to varied vegetation, while females tend to cluster around accessible resources, leading to a less diverse diet. We recommend further studies combining dietary analysis with field vegetation monitoring to enhance understanding of resource selection and improve adaptive management strategies for large herbivores.

# Horse nutritional ecology in a North American cold arid steppe across 5 years of variable weather

JOHN DEREK SCASTA

Globally, free-roaming equids often inhabit harsh and extensive rangelands. These rangelands are often characterized by limited and variable precipitation patterns leading to highly variable forage resources in both quantity and quality which yields a nutritional landscape that is complex, challenging, and constantly changing. Here we present a 5-year study (2020-2024) of seasonal (summer and winter) sampling of horse (*Equus ferus caballus*) diet and plant nutrition from an extensive area in southeastern Wyoming, USA. The study area is a ~6,000-ha ranch that has been grazed by ~200 to 400 horses since 2005 and native wildlife species such as white-tailed prairie dogs (*Cynomys leucurus*), pronghorn antelope (*Antilocapra americana*), and mule deer (*Odocoileus hemionus*). The landscape is co-dominated by native shrubs (*Artemisia*, *Chrysothamnus*, *Ericameria*, *Rhus*, *Sarcobatus*) and C3 and C4 perennial grasses with alkaline soils. The climate is characterized as a cold arid steppe according to the Köppen-Geiger climate classification. The climate classification includes long cold winters and frequent dry conditions during which forage quality and quantity can both be constrained by growing conditions. We sampled horse diet quality using near-infrared reflectance spectroscopy of fecal material (f.NIRS), horse diet composition using DNA metabarcoding of fecal material (f.DNA), plant nutrition quality using NIRS, plant nutrition quantity using clipping and weighing, and rangeland botanical inventory using line point intercept (LPI; summers only). The study period included 1 drought year, 1 deluge year, and 3 average years. Forage quantity tracked with growing season precipitation patterns with greater production (730 kg/ha) in the deluge year, lower production (197 kg/ha) in the drought year, and average precipitation year production in the middle (407 kg/ha). Forage quality (protein, energy, and digestibility) and horse diet quality (fecal N and P) was strongly explained by seasonality with significantly more optimal forage and diets in the summer compared to winter and with available forage quality in the winter below critical levels. Horse botanical diet composition was diverse with additional seasonal patterns evident. Integrated soils, plant, forage, and diet sampling can help to better understand how to manage free-roaming horses in extensive and harsh environments with severe seasonal limitations.

# Disease impacts for wild equids: involving disease principles and other problems into conservation projects

ERIN L GOODRICH, DVM, DACVPM , ROLFE M RADCLIFFE, DVM, DACVS, DACVECC

Disease plays an important role in both domestic and wild animal populations. Infectious diseases may reduce population size, affect genetic diversity, promote host coevolution as well as threaten the survival of endangered species. Factors including nutrition, environment, behavior, population dynamics and contact with other species may also negatively affect conservation projects.

The authors summarize the reported infectious and non-infectious diseases and other problems of wild equids. This information provides a tool for conservation teams to account for disease in their management programs.

The following areas deserve review when preparing conservation plans:

1. Assess infectious diseases of local domestic and wild animals as well as humans that may act as a reservoir for infection
2. Assess infectious diseases of reintroduced equids that may be transmitted to wild or domestic animals at the release site
3. Consider non-infectious diseases that may affect populations of wild equids
4. Evaluate nutrition and water resources of the wild equid populations in the reintroduction process
5. Review the local release site habitat and environmental conditions that may affect reintroduced equids
6. Understand behaviors and population dynamics of re-introduced and wild equids
7. Consider contact with the same and other species that may lead to disease, predation or other problems
8. Employ appropriate diagnostic testing strategies to investigate morbidity and mortality events
9. Preventative actions based upon the risks assessed above:
10. Vaccinate for infectious diseases affecting wild equids based upon known endemic diseases, local exposure and other risk factors
11. Administer anthelmintic treatment based upon parasite-host relationship, diagnostic results and risk at reintroduction site
12. Assess and ensure adequate nutrition, water and habitat at the reintroduction site and reassess in the event of severe environmental conditions
13. Solve problems involving behavior, herd dynamics or interactions with local human populations
14. Assess risk from other species at release site, such as predation
15. Perform post-reintroduction monitoring and disease surveillance

The authors present two case summaries to illustrate the inclusion of disease principles and other problems into conservation projects: 1) Przewalski horse reintroduction in Altyn Dala, Mongolia and 2) Kulan reintroduction in Central Kazakhstan.

# Who's your daddy? Male reproductive success strategies and female fidelity in two feral horse populations

SARAH R. B. KING<sup>1</sup>, MARY J. COLE<sup>1,2</sup>, AND KATHRYN A. SCHOENECKER<sup>2</sup>

<sup>1</sup>Colorado State University, Fort Collins, USA and in cooperation with the U.S. Geological Survey, Fort Collins Science Center, CO, USA., <sup>2</sup>U.S. Geological Survey, Fort Collins Science Center, CO, USA

Polygynous mating systems result in intense competition between males for access to females and reproductive success. Through observations and genetic analyses of paternity in two populations of feral horses in the western United States we tested published hypotheses related to multi-male groups and explored effects of male strategy on reproductive success and behavior. We recorded monthly group composition in two feral horse populations in Utah, USA (Conger and Frisco Herd Management Areas) between 2017 and 2020, additionally recording behavior at Conger. Hair samples and fecal samples resulted in genetic confirmation of dam and sire and known sire status at conception of 119 foals at Conger and 40 at Frisco. At Conger these foals were sired by 35 males, and 17 males at Frisco, with 5 males at each site siring 44-45% of foals in our sample. Multi-male groups were observed in both populations, although were less common at Frisco. We determined 4 adult male statuses: harem stallions and bachelors (associating with females or males respectively), and multi male statuses of lieutenant (associating with a harem stallion and females) and tag (following a harem group but not associating with them). At Conger 86% of foals were sired by a harem stallion, and 95% at Frisco; few foals (3% at Conger; none at Frisco) were sired by lieutenants or tags. Multi-male groups were not larger or more stable in terms of female group changes, and did not produce more foals than single male groups. We found a positive relationship between affiliative interactions among adult males and females and both male reproductive success and tenure length as a harem stallion, but no equivalent relationship with agonistic interactions. There was no relationship between agonistic interactions and male reproductive success, and females in multi-male groups received more aggression than single male groups, mostly in the form of herding. We did not find support for any of the posited hypotheses in the literature related to multi-male groups. Differences between horse populations relative to male roles may reflect local adaptations within polygynous systems and multi-male groups may be an artifact of social bonding.

## Mean mares? Habitat features influence female aggression in the feral horse (*Equus caballus*)

CASSANDRA M.V. NUÑEZ

It is unclear how habitat features alter animal response to social instability. Only by uncovering such interactions can we fully understand the evolutionary drivers and fitness consequences of sociality across species. We capitalize on a management-induced manipulation of social stability in an island population of free-ranging feral horses (*Equus caballus*), living across three distinct habitat types. We tested whether female group changing behavior (a reliable measure of social instability) affected 1) their female-female aggression, 2) their rank within female dominance hierarchies, 3) the stability of female hierarchies (in the groups they joined and/or left), and 4) how habitat characteristics shape these responses. Females changing groups more often received more aggression from other females, but only when habitat features such as visibility and freshwater distribution were considered. We found no association among female group changing behavior and the aggression initiated, female rank, or the stability of female dominance hierarchies. Our work reveals that animal responses to social instability are nuanced and impacted by the surrounding habitat. A better understanding of these impacts can elucidate the evolutionary drivers of sociality and may prove useful in mitigating unintended effects of our management practices.



# Factors affecting female wild ass (*Equus hemionus*) social associations under changing water source distribution

NOA YAFFA KAN-LINGWOOD<sup>1</sup>, ALAN TEMPLETON<sup>2</sup>, DANIEL RUBENSTEIN<sup>3</sup>, AMOS BOUSKILA<sup>4</sup>, SHIRLI BAR-DAVID<sup>5</sup>

<sup>1</sup>Mitrani Department of Desert Ecology, Ben-Gurion University of the Negev, Midreshet Ben-Gurion, Israel, 849900, noayaffakan@gmail.com, <https://orcid.org/0000-0002-6484-6887>

<sup>2</sup>Department of Biology, Washington University, St. Louis, USA, 63130, temple\_a@wustl.edu, <https://orcid.org/0000-0002-0167-845X>

<sup>3</sup>Department of Ecology and Evolutionary Biology, Princeton University, New Jersey, USA, 08544, dir@princeton.edu, <https://orcid.org/0000-0001-9049-5219>

<sup>4</sup>Life Science Department, Ben-Gurion University of the Negev, Beer-Sheva, Israel, 84105, bouskila@bgu.ac.il, <https://orcid.org/0000-0002-0850-4460>

<sup>5</sup>Mitrani Department of Desert Ecology, Ben-Gurion University of the Negev, Midreshet Ben-Gurion, Israel, 849900, shirlibd@bgu.ac.il, <https://orcid.org/0000-0001-8103-041X>

Climate change and human activity limit natural water source availability, especially in arid environments. One solution is artificial water source management, which provides a drinking source but also impacts space-use patterns, demography, and reproduction. Hence, it is crucial to understand species' social structures and their response to such management. We studied factors affecting Asiatic wild-ass females' (*Equus hemionus*) social associations following water source management in the Negev Highlands, Israel. Using a network approach based on genotypes, we correlated sociality, genetic relatedness, and reproductive success and examined the geographical locations of females relative to new water sources. A social network was constructed based on female encounters and was correlated with genetic relatedness and reproductive success. From 2,014 fecal samples collected between 2020-2023, we identified 100 unique female genotypes, with n=57 showing strong social ties. The final networks comprised 57 female genotypes with strong social ties. Significant correlations between sociality and genetic relatedness were found across years ( $p < 0.001$ ), but no statistical correlation was found with reproductive success ( $p = 0.831$ ). The spatial analysis revealed that females with strong social associations tend to revisit similar areas within and across years. Since there were strong social associations between non-relatives, this may contribute to inbreeding avoidance.

# Multilevel society of free-ranging horses in Serra S'Arga, Portugal

TAMAO MAEDA<sup>1,2</sup>, RENATA MENDONÇA<sup>2,3</sup>, PANDORA PINTO<sup>2</sup>, MONAMIE RINGHOFER<sup>4</sup>, RAQUEL GODINHO<sup>5, 6</sup>, SATOSHI HIRATA<sup>2</sup>, AND SHINYA YAMAMOTO<sup>7</sup>

<sup>1</sup>Research Center for Integrative Evolutionary Science, The Graduate University for Advanced Studies (SOKENDAI), Kanagawa, Japan,

<sup>2</sup>Wildlife Research Center, Kyoto University, Kyoto, Japan,

<sup>3</sup>Centre for Functional Ecology - Science for People & the Planet, Department of Life Sciences, University of Coimbra, Coimbra, Portugal,

<sup>4</sup>Faculty of Life and Environmental Sciences, Department of Animal Sciences, Teikyo University of Science, Yamanashi, Japan,

<sup>5</sup>CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, InBIO Laboratório Associado, Campus de Vairão, Universidade do Porto, Vairão, Portugal.,

<sup>6</sup>BIOPOLIS Program in Genomics, Biodiversity and Land Planning, CIBIO, Campus de Vairão, Vairão, Portugal.,

<sup>7</sup>Institute for Advanced Study, Kyoto University, Kyoto, Japan

A multilevel society represents a complex social structure characterised by nested levels of social organisation, where small core units aggregate to form higher-level social organisations. In equine, it is known that several species, such as plains zebra, Przewalski's horse, and a subspecies of Asian wild ass, forms a multilevel society. However, multilevel society of domestic horses is yet to be investigated. In this study, we examined the social structure of free-ranging horses in Serra D'Arga, Portugal. The spatial data obtained from drone observation indicated that the multiple units (harems) actively gather to make a social aggregation and variation of association index among units was significantly higher than permuted dataset data. The results indicate that the horses have higher-level social organization to make a two-tiered multilevel society. We further investigated if horses show preferences for related individuals. We examined the genetic relatedness of 167 genotyped individuals over a seven-year period and compared it with the unit composition and inter-unit proximity/association data obtained from drone observations. Neither relatedness nor the direct evaluation of first-degree relatives showed any clear correlation with either intra- or inter-unit relationships. This finding represents the first documented case of absence of kin preference in a multilevel society. It suggests that a multilevel society could be established without bonds among relatives and emphasises the need to investigate non-kin relationship formation. This observed tendency differs from that of a related species, the plains zebra and Przewalski's horse. Further comparisons with other equine species or other free-ranging horse populations are necessary to reveal the factors that influence kin structures in a multilevel society.

# Overmarking behaviour of zebra males: no scent masking, but a group cohesion function across three species

JAN PLUHÁČEK<sup>1,2,3</sup>, VLADIMÍRA TUČKOVÁ<sup>4</sup>, AND SARAH KING<sup>5</sup>

<sup>1</sup>Department of Biology and Ecology, Faculty of Science, University of Ostrava, Chittussiho 10, 710 00 Ostrava, Czechia,

<sup>2</sup>Olomouc Zoo, Darwinova 29, 779 00 Olomouc, Czechia,

<sup>3</sup>Department of Ethology, Institute of Animal Science, Přátelství 815, 104 00 Praha - Uhřetěves, Czechia,

<sup>4</sup>Department of Zoology, Faculty of Science, University of South Bohemia, Branišovská 1760, 370 05 České Budějovice, Czechia,

<sup>5</sup>Natural Resource Ecology Laboratory, Warner College of Natural Resources, Colorado State University, Campus Delivery 1499, Fort Collins, USA

In most mammalian studies exploring overmarking behaviour a sexual selection hypothesis is favoured, especially when overmarking by males. More specifically in equids, most studies explain overmarking by stallions as territory marking for territorial species (i.e. Grévy's zebra) and as intra-male competition aiming to mask the scent of receptive females in harem dwelling species (i.e. mountain and plains zebra). Nevertheless, two objections to the scent-masking hypothesis were raised: stallions overmark mares outside of reproductive season and, they do not overmark all female eliminations. Thus, the results in the literature are conflicting. In this study we tested two hypotheses that could explain overmarking by males: (i) as a part of sexual selection, more specifically to mask scent of receptive females, and (ii) as a form of communication serving to aid group cohesion. We observed each of the three zebra species in eight different herds at four zoos. In total we recorded 1395 eliminations (760 defecations, 635 urinations) performed by 78 individuals including 8 stallions. Stallions investigated 248 eliminations and overmarked 124. The rate of overmarking by stallions was higher than those of all other sex and age categories. Stallions of all species overmarked all age and sex categories, except Grévy's zebra stallions did not overmark foal eliminations. In contrast to our first hypothesis, when attracted to the elimination stallions overmarked non-oestrus females more often than oestrus ones. Thus, our results did not support the hypothesis that overmarking by males has a sexual selection function, but it could be explained by the group cohesion hypothesis. Based on our results, it seems that overmarking by equid males plays a greater role in intra-specific communication than in intra-sexual competition. In addition, this behavior might play different roles in different species based on their social organisation.

# Physiological and Behavioural Response to Translocation in Wild Equids

GABRIELLA DAVIES<sup>1</sup>, KATHRYN ELSE<sup>2</sup>, VIOLA KEREKES<sup>3</sup>, JESSICA IRVING<sup>1</sup> & SUSANNE SHULTZ<sup>1</sup>

<sup>1</sup>School of Earth and Environmental Sciences, The University of Manchester, UK,

<sup>2</sup>Lydia Becker Institute of Immunology and Inflammation, Faculty of Biology Medicine and Health,

<sup>3</sup>Hortobágyi National Park, Hungary

Wildlife translocations, the intentional movement of individuals between sites, are a vital tool in species management. Moving individuals can boost genetic diversity, bolster existing populations, and reintroduce species to historic ranges. Translocations also help reduce human-wildlife conflict, control overpopulation, and mitigate habitat destruction. Despite their widespread use, translocation success is often mixed, and failures are underreported due to a publishing bias towards positive results. One potential reason for failure is the impact of the stress individuals experience during the intervention, which can manifest through costly physiological, immunological and behavioural responses.

Here, we assess these responses during the translocation of two equid species—Przewalski's horse (*Equus ferus przewalski*) and Hartmann's Mountain zebra (*Equus zebra hartmannae*).

We used a toolbox of faecal stress, metabolic, reproductive, inflammation and immunological biomarkers. Post-release, individuals show an increase in faecal glucocorticoids and thyroid hormone, indicating acute stress and elevated metabolic rate. Additionally, individuals display signs of immunosuppression, with changes in pro-inflammatory faecal cytokines, including IL-6 and TNF $\alpha$  and IL-10, an anti-inflammatory marker. Reproductive capacity also appears compromised. Oestrous cycle dysfunction, indicated by irregular faecal progesterone and oestrone levels, following translocation may delay pregnancy and limit subsequent population growth. Behaviourally, individuals exhibited increased vigilance and reduced resting periods, further signs of distress and reduced welfare.

Our results highlight the impact of translocation on individual fitness in wild equids and underscore the importance of post-release monitoring. Non-invasive faecal biomarkers offer an accessible tool to assess both pre- and post- release well-being. Understanding and mitigating the negative effects of these interventions on individual health and reproduction are critical for effective management.

# Longitudinal monitoring of gut immune and inflammatory responses in a population of semi-feral equids using novel, non-invasive biomarkers

IRVING, J.<sup>1</sup>, ELSE, K. J.<sup>2,3</sup>, BURTON, A.M.<sup>1</sup>, CRUICKSHANK, S.M.<sup>2,3</sup>, COYTE, K.<sup>2,4</sup>, SHULTZ, S.<sup>1,2</sup>

<sup>1</sup>Department of Earth and Environmental Sciences, Faculty of Science and Engineering, University of Manchester, Oxford Road, Manchester, M13 9PL.,

<sup>2</sup>Lydia Becker Institute of Immunology and Inflammation, Faculty of Biology, Medicine & Health, University of Manchester, M13 9PL.,

<sup>3</sup>Division of Immunology, Immunity to Infection and Respiratory Medicine, Faculty of Biology, Medicine & Health, University of Manchester, M13 9PL.,

<sup>4</sup>Division of Evolution, Infection and Genomics, Faculty of Biology, Medicine & Health, University of Manchester, M13 9PL.

Equids have co-evolved with a community of mutualistic, commensal and parasitic microbes and parasites. Gastrointestinal nematodes are ubiquitous parasites that can cause deleterious effects on host fitness at high abundance. However, nematodes can play a beneficial role in modulating host immune reactivity and depressing inflammatory pathways. Here we evaluate the relationship between seasonal nematode egg shedding in semi-feral Carneddau ponies and host gut inflammatory and immune responses. We predicted that if host immune state regulates parasite burdens, we should see immunotolerance (e.g. IL-10) highest when host condition/energy balance is poor (i.e. late winter/early spring) and active immune responses (e.g. elevated Th2 and inflammation) when ponies have the highest energy reserves (i.e. late summer).

We applied a validated toolkit of pro- and anti-inflammatory cytokine and immunoglobulin markers to a longitudinal faecal dataset with egg shedding rates. Nematode egg shedding peaked between late Summer and early Autumn and was lowest in winter. Carneddau ponies had elevated anti-inflammatory/Treg (IL-10) throughout late winter and early spring, which coincided with a temporal increase in shedding rates. In the summer, ponies switched to a more pro-inflammatory state (higher IL-6 and TNF- $\alpha$ ) and an increase in Th2 immunoglobulin (IgG3/5) in the late autumn, which corresponded with the peak in shedding.

These results suggest that immune state appears to respond to both extrinsic (i.e. resources and thermoregulation) challenges and intrinsic (i.e. nematode fecundity and egg shedding rates). Mixed Th1/Th2 and pro-inflammatory responses peak in late summer-early autumn when both egg shedding and pony condition are highest, suggesting that ponies may permit burdens to increase until they are in an energetic state that allows them to invest in parasite clearance. Conversely, Th2/Treg responses are strongest in winter when ponies are most nutritionally stressed.

This study presents the first multi-faceted characterisation of seasonal immune state changes in a semi-feral equid population. The relationship between energy stress and Treg suggests a causal link between gastrointestinal nematode burden and host immunocompetence. Parasite shedding rates have long been assumed to be parasite driven. These results suggest that host condition and immunocompetence may play a key role in nematode population dynamics.

# Supplementary Feeding and Rapid Post-Mortem Veterinary Response for Grevy's Zebra Survival: Lessons from the 2021-2023 Drought

BELINDA LOW MACKEY<sup>1\*</sup>, MESHACK KIBIWOTT<sup>2</sup>, ANDREW LETURA<sup>1</sup>, GABRIEL LEKULA<sup>1</sup>, BABYLON LETIROK<sup>1</sup>, LIZBETH MATE<sup>3</sup>

<sup>1</sup>Grevy's Zebra Trust,

<sup>2</sup>Lewa Wildlife Conservancy,

<sup>3</sup>Marwell Wildlife,

\*Corresponding author

This presentation examines the successful emergency conservation interventions implemented during the severe drought of 2021-2023, with a focus on the intensive supplementary feeding program led by the Grevy's Zebra Trust and Kenya Wildlife Service from July to November 2022 in three national reserves. We sustained approximately 500 Grevy's zebra daily across these reserves, distributing over 24,000 bales of hay and nearly 2,000 kg of nutritional supplements. Despite the extreme conditions, our targeted efforts resulted in a remarkably low 10% mortality rate among the supported population. The presentation will detail our adaptive nutrition protocols, including the strategic addition of molasses, lucerne, and mineral supplements based on veterinary expertise. We will discuss our systematic approach to reducing interspecific competition with oryx and buffalo, as well as intraspecific competition. A significant and unexpected finding was the high helminth burden in foals, which led to the development of a novel deworming protocol. This case study provides critical insights into successful emergency response strategies for endangered equids during extreme climate events and demonstrates how targeted interventions can significantly enhance survival outcomes for Grevy's zebra populations facing climate-related threats.

# Gastrointestinal Strongyles Egg Shedding in Wild Przewalski's Horses in the Chernobyl Exclusion Zone, Ukraine: Influence of Season, Age, Group Size, and Body Condition

KATERYNA SLIVINSKA<sup>1,2</sup>, DANIEL KLICH<sup>3</sup>, VITALII DEMESHKANT<sup>4</sup>

<sup>1</sup>Museum and Institute of Zoology of Polish Academy of Sciences, ul. Twarda 51/55, 00-818 Warsaw, Poland, e-mail: horsecez@gmail.com,

<sup>2</sup>I.I. Schmalhausen Institute of Zoology of National Academy of Sciences of Ukraine, B. Khmelnytskogo 15, 01030 Kyiv, Ukraine,

<sup>3</sup>Warsaw University of Life Sciences - SGGW, Institute of Animal Sciences, Department of Animal Genetics and Conservation, ul. Ciszewskiego 8, 02-786 Warsaw, Poland, E-mail: daniel\_klich@sggw.pl,

<sup>4</sup>Wrocław University of Environmental and Life Sciences, Chelmonskiego 37/41, 51-630, Wrocław, Poland, e-mail: demeshkant@gmail.com

In 1998–1999, the wild horses were introduced to the Chernobyl Exclusion Zone (CEZ) from the Askania Nova Biosphere Reserve in Ukraine. Currently, about 130 Przewalski's horses roam freely across the grasslands of the CEZ. These horses form groups, either harems or bachelor groups, with group sizes ranging from 2 to 20 individuals.

The aim of this study was to investigate the differences in gastrointestinal strongyles egg shedding in relation to group size, age, sex, and body condition of Przewalski's horses in the CEZ across different seasons.

Fecal egg counts (FECs) were performed using the McMaster technique, with a sensitivity of 25 eggs per gram (EPG) of feces. The mean FEC (average number of EPG per infected animal) and prevalence (percentage of animals infected) were calculated for each horse and assigned to either 'harem' or 'bachelor groups.' The age class and sex of each individual were recorded, and clinical signs associated with parasitism, such as body condition (categorized as slim, fat, or regular) and poor coat condition, were noted. A total of 118 horses from 21 groups (14 harems, 4 bachelor groups, and 3 unknown groups) were examined.

The prevalence of strongyles infections ranged from 66.7% to 100%. In samples collected during the spring season, the mean FEC of strongyles was  $555.2 \pm 414.5$  EPG, with a prevalence of 100%. In samples collected during the autumn season, the mean FEC of strongyles averaged  $142.1 \pm 95.1$  EPG, with a prevalence of 89.1%.

Additionally, eggs of *Parascaridae*, *Habronematidae*, and *Anoplocephalidae* were found in the feces. No observable clinical signs of parasitism were noted among these wild horses. All horses had a 'regular' body condition score and typical coat condition. In spring, feces contained over three times the number of strongyles eggs compared to autumn. Group size was positively correlated with strongyles FECs, while age was not statistically significant in this study.

The results broaden the understanding of parasite infections in wild horses. The study was funded by the MSCA4Ukraine.

# Exploring the Relationship Between Parasite Infection and Body Condition in Wild Horses Across the Western United States

GRAHAM GOODMAN

Over 80,000 free-roaming horses graze alongside native wildlife in the sagebrush steppe and grasslands of the western United States. These animals receive no veterinary care and very little is known about their disease status. We combined traditional parasitology techniques such as fecal flotations with next-generation sequencing (NGS) approaches and drone technologies to investigate how parasitism affects the body condition of free-roaming horses across space and time. We sampled six herds across a range of environments on a semiannual ( $n=5$ ), or monthly ( $n=1$ ) basis to look for seasonal and environmental patterns of infection. Consistent with studies of free-roaming horses in other regions, our data suggest that horses in Utah host incredibly diverse parasite communities. Notably, although deworming campaigns have substantially reduced *Strongylus vulgaris* infection in domestic horses, this highly pathogenic nematode was common in free-roaming horses. Parasite burdens were also correlated with herd size and a variety of environmental conditions such as annual average temperature and precipitation. Although preliminary, our data also suggests seasonal patterns of egg deposition and that the intensity of infection affects free-roaming horse body condition to a lesser extent than domestic horses. Our findings have important implications for the management of these animals as well as spillover risk for domestic horses.



# Anthelmintic resistance in parasites of wild equid: does “refugia” help?

TETIANA A. KUZMINA<sup>1,2</sup>, ALZBETA KONIGOVA<sup>1</sup>, NATALYA S. ZVEGINTSOVA<sup>3</sup>, VITALIY A. KHARCHENKO<sup>2</sup>, YAROSLAV SYROTA<sup>1,2</sup>

<sup>1</sup>Institute of Parasitology, Slovak Academy of Sciences, Hlinkova 3, 040 01, Kosice, Slovakia,

<sup>2</sup>I. I. Schmalhausen Institute of Zoology NAS of Ukraine, 15, Bogdan Khmelnytsky street, Kyiv, 01054, Ukraine,

<sup>3</sup>F. E. Falz-Fein „Askania Nova” Biosphere Reserve, 15, Parkova street, Askania Nova, Kherson region, 75230, Ukraine

Nematodes of the order Strongylidae are the most common parasites of wild and domestic equids worldwide. The main method of strongylid control in domestic horses is anthelmintic treatment; wild equids in natural reserves and protected areas are usually not dewormed. However, despite the lack of dewormings, in some cases, anthelmintic resistance (AR) may emerge in strongylids in wild equids.

We conducted a survey on four equid species kept under semi-free conditions in the Askania Nova Biosphere Reserve, Ukraine: plains zebras (*Equus burchelli*), Grévy's zebras (*E.grevyi*), donkeys (*E.asinus*) and horses (*E.caballus*). Fecal Egg Count Reduction test (FECRT) was applied to analyze the manifestations of AR in strongylids to benzimidazole (BZ) anthelmintics. AR was detected in strongylids of all equid species; the FECRT results were: in *E.burchelli* - 69.4%, *E.grevyi* - 72.7%, *E. caballus* - 61.1% and *E. asinus* - 45.2%. Analysis of long-term data (2009–2019) also revealed a decrease in BZ efficacy against strongylids from 97.6% to <75%. We suppose that the emergence of resistant strongylids in wild equids in the Reserve is associated with “refugia”, when free-living stages of parasites (eggs and larvae on pasture) escape influence of dewormers. In theory, concept of “refugia” means of delaying the evolution of AR in parasites. However, in this case, we observed that access of working horses to the Reserve's enclosures facilitated the transmission of resistant strongylids from domestic horses to wild equids. Therefore, “refugia” did not delay the development of AR, but on the contrary, facilitated the spread AR parasites. Ten cyathostomin species (*Cyathostomum catinatum*, *Cylicocyclus nassatus*, *C.ashworthi*, *C.leptostomus*, *Cylicostephanus calicatus*, *C.goldi*, *C.longibursatus*, *C.minutus*, *Coronocylus labiatus*, *C.labratus*) were found to be resistant.

Our results are the first detection of BZ-resistance in strongylids in wild equids kept in the Askania Nova Reserve. We did not have an opportunity to examine the wild Przewalski's horses (*E. ferus przewalskii*) kept in the Reserve. However, we suspect the possibility of the spread of AR strongylids in this wild equid species.

The study was partially supported by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project Nos. 09I03-03-V01-00015 and 09I03-03-V01-00046.

## Przewalski's horse conservation in Kalamaili National Park, China

QING CAO, MEL SONGER, YONGJUN ZHANG, JIANMING YANG, JICAI LI, PETER LEIMGRUBER, DEFU HU, DAN RUBENSTEIN

It is the 24th anniversary of the reintroduction of Przewalski's horse (*Equus ferus przewalskii*) in Kalamaili National Park (KNP), China. By 2024, the released population has exceeded 350, most of which are free-roaming and have naturally dispersed to two new sites. We first review the three stages of the reintroduction history: soft release (2001-2008), translocation (2009-2020), and full release (2021-present). Then, we focus on Przewalski's horse's adaptation in KNP. As a cold desert, KNP has limited water and food supplies. The released horses also face potential competition from Khulans, which are superior in both numbers and arid adaptation. Moreover, snowstorms and seasonal pastoralism pose new threats in winter. Still, Przewalski's horse has managed to establish a unique niche that improves its fitness while reducing competition and threat impacts in KNP. In the end, we discuss the species' future in China based on lessons learned from its reintroduction.

## Return of the Wild Horses to Kazakhstan and Mongolia

**DOBIÁŠOVÁ B., BOBEK M., OYUNSAIKHAN G., SALEMGAREYEV A., TURGAMBAYEV D., BERNÁTKOVÁ A., KOMÁRKOVÁ M., ŠIMEK J., ČECHLOVSKÁ K., KALIYEV D., KRIVOSHEYEVA A., WARD S., KERN C., ŠTYCH P., LAŠTOVIČKA J., BATTUR B., BATTSETSEG B., VOTÝPKA J.**

The Przewalski's horse (*Equus ferus przewalskii*) was listed as Extinct in the wild in 1996 and as Endangered since 2011 thanks to ongoing reintroduction efforts in Mongolia and China.

Return of the Wild Horses Project by Prague Zoo has started in 2011 with first 4 horses transported to Khomyn tal and followed by transports to the Great Gobi B Strictly Protected Area in Mongolia. Over 9 years in total 38 horses has been successfully transferred and reinforced established projects. Based on previous experiences a new project was initiated in Kazakhstan's Torgay region in June 2024. This project is a part of the broader effort to restore the original steppe ecosystems in Central Kazakhstan and marks a historic return of the Przewalski's horse to a region where it disappeared from even before its scientific discovery. The initial transport from Europe (Czechia, Germany) included one stallion and six mares. The aim is to transport a total of 40 horses over five years in close cooperation with EAZA Ex situ Programme (EEP).

In addition to Kazakhstan, the 4<sup>th</sup> reintroduction project is being prepared in the steppe of eastern Mongolia in Numrug SPA. The site selection has been a subject of cooperation among Przewalski's horse experts and research institutes deploying remote sensing and local field surveys. The establishment of the new reintroduction site is fully consistent with the national reintroduction methodology, and in response to capacity limits in existing sites in Mongolia.

Extensive research accompanies both new reintroduction efforts, focusing on the Przewalski's horses' adaptation and their impact on the local environment after their release.

The reintroduction projects are being implemented in close international cooperation of European zoos, nature conservation organisations and local governmental agencies. These initiatives demonstrate how coordinated efforts can revive endangered species and restore their populations and original habitats.

## The Adaptive Significance of Zebra Stripes: Truly Nature's Multi-tool

DANIEL I. RUBENSTEIN, ANDREW GERSICK, LILLY REISINGER, KAIA TOMBAK, BRENDA LARISON

How the bold black and white stripes of zebra evolved is an enduring question in evolutionary biology. Many hypotheses have been proposed for the evolution of striping. Each, however, has focused on a single hypothesis championing one function. Four contested hypotheses dominate: 1) evading predators; 2) avoiding biting flies; 3) maintaining social cohesion; and 4) avoiding overheating. We show that a unitary explanation for why zebras are striped is unlikely because multiple selective forces are at work. These stem from zebras needing to forage more than their ruminant competitors because of the poor forage they feed on, and the less efficient hindgut fermentation system they use for extracting nourishment from that forage. We show that stripes enable zebras to *simultaneously* solve three problems created by the need to maximize time spent foraging. By hanging at opposite ends of a 2m. long plexiglass box mixed pairings of dried hides of solid colored bovids and striped skins of plains and Grevy's zebras, we showed that biting stable flies landed significantly less often on striped zebra skins than on bovid skins. In addition, surface and internal temperatures were significantly lower for 10-liter water bottles covered in black and white striped cloth rather than those covered with all white or all black cloth. Both temperatures were also significantly lower for donkeys painted with black and white stripes as opposed unpainted donkeys. Both findings suggest that zebras should be able to spend more time grazing in full sun without incurring costs associated with acquiring disease or overheating than unstriped equids or solid coat-colored ungulates. With respect to avoiding predation, coat color luminosity appears to affect survival. Highly luminous all white zebra puppets pulled in front of safari-park chasing lions were caught before reaching the end of the course significantly more than all grey or striped puppets of equivalent, but much lower, luminosity. At the very least, 'dull' puppets—those mimicking grey wild asses or striped zebras—survived better than 'bright' ones; pelage coloration likely impacts survival. Our experiments show that multiple environmental selective forces together help shape the extraordinary pelage of zebras.

## Conservation genetics in species reintroductions: the Asiatic wild ass in Israel

SHIRLI BAR-DAVID<sup>1</sup>, NOA KAN LINGWOOD<sup>1</sup>, LILITH ZECHERLE<sup>1,2</sup>, DANIEL I. RUBENSTEIN<sup>4</sup>, AMOS BOUSKILA<sup>2</sup>, ALAN. R. TEMPLETON<sup>5</sup>

<sup>1</sup>Mitrani Department of Desert Ecology, Ben-Gurion University of the Negev, Midreshet Ben-Gurion

<sup>2</sup>Liverpool John Moores University, Byrom Street, Liverpool L3 3AF, UK

<sup>3</sup>Life Science Department, Ben-Gurion University of the Negev, Beer-Sheva

<sup>4</sup>Department of Ecology and Evolutionary Biology, Princeton University

<sup>5</sup>Department of Biology, Washington University in St. Louis

Conservation reintroductions are a frequently used management tool for the recovery of endangered species. However, many reintroductions fail to establish viable populations. Genetic aspects have been identified as an essential factor in the long-term persistence of reintroduced populations. Yet, little is known about how different reintroduction strategies affect the genetic viability of a population and the long-term reintroduction success. We applied genetic tools to investigate the reintroduction of the Asiatic wild ass (*Equus hemionus*) in the Negev desert. Founders of the population were sourced from two different subspecies. Genetic analyses showed that the populations display high levels of subspecies admixture and that population genetic parameters indicate a relatively high genetic variability compared with other reintroduced *E. hemionus* populations. These findings suggested that the highly controversial practice of subspecies admixture may be beneficial to reintroduction success. Furthermore, we applied methods from landscape ecology to uncover that habitat characteristics impact individual habitat selection but not genetic relatedness across the landscape. These findings suggested that landscape configurations pose no barrier to gene flow in the reintroduced population and that the observed genetic structure of the population may be a result of strong polygyny social structure and high fidelity of individuals to the scarce water sources. We further monitored the impact of active water source management in the Negev. Parentage analyses revealed that the number of breeding males increased following the increase in the number of available water sources. Moreover, the geographic locations of some breeding males implied establishment of new territories next to new water sources, increasing the numbers of males contributing to the population's gene pool. This, in turn, may increase the population effective size, helping to maintain its genetic diversity. Our study demonstrates the importance of understanding species genetic makeup to be applied for the long-term success of conservation reintroductions.

# **A broader assessment: Porcine zona pellucida immunocontraception vaccine (ZonaStat-H) efficacy in seven free-roaming horse populations across western North America**

**KAYLA A. GRAMS<sup>1</sup>, KIM M. FRANK<sup>1</sup>, MELISSA M. ESSER<sup>1</sup>, ALLEN T. RUTBERG<sup>2</sup>, KATHRYN A. SCHOENECKER<sup>3</sup>**

<sup>1</sup>The Science and Conservation Center, ZooMontana, Billings, MT, USA,

<sup>2</sup>Center for Animals and Public Policy, Cummings School of Veterinary Medicine at Tufts University, North Grafton, MA, USA,

<sup>3</sup>U.S. Geological Survey, Fort Collins Science Center, Fort Collins, CO, USA

In the United States, free-roaming horse population management has incorporated the use of gather and removal, and contraception. Remotely delivered porcine zona pellucida (PZP) immunocontraception of individual female horses has been applied across North America and is well recorded and documented on Assateague Island National Seashore, Maryland, USA, and a few other locations. However, to refine location-specific PZP treatment protocols large scale multi-center studies are needed of porcine zona pellucida (ZonaStat-H) effectiveness under a variety of field conditions and challenges, including yearly variation in horse accessibility, vaccine storage ability, and reversibility after multiple booster doses. The objective of this study was to evaluate variation in vaccine effectiveness based on number of booster doses, the timing of doses, individual herd variation, dosage interval, and multi-year treatment effects. In addition, we aimed to evaluate vaccine reversibility. Data from seven wild horse populations across the western United States including the Little Book Cliffs Wild Horse Range, Colorado; McCullough Peaks Wild Horse Range, Wyoming; Pryor Mountain Wild Horse Range, Montana; Sand Wash Basin, Colorado; Spring Creek Basin, Colorado; Onaqui Mountain, Utah; and Salt River Herd, Arizona, were evaluated. Herds were selected based on the ability of field personnel to identify each mare, apply the vaccine remotely, and document the effectiveness of the vaccine. All included study areas relied on dedicated NGO groups working cooperatively with government agency personnel. In each herd location effectiveness was established based on individual mare foaling rates over multiple years. Data collected included mare identification, type of PZP vaccine adjuvant applied (e.g. modified Freund's Complete Adjuvant or Freund's Incomplete Adjuvant), delivery system, injection location, vaccine site reactions, field storage methods, and foaling rates. The results of these analyses will contribute to free-roaming horse population modeling systems (i.e. PopEquus, USGS Fort Collins Science Center, USA) and help guide and refine field vaccine application programs.

## **Efficacy and reversibility of PZP immunocontraception in free-roaming Przewalski's horses**

**KINGA KASZAP, PRANAV C. KHANDELWAL, VIOLA KERÉKES**

Immunocontraception with Porcine Zona Pellucida (PZP) is a popular management tool for regulating ungulate populations. Given the expanding use of PZP, it is important to understand its effects on different species, and its efficacy as a fertility control agent in real-world scenarios. We summarise the efficacy and reversibility of PZP treatment on a free-roaming Przewalski's horse population in the Pentezug Reserve, Hungary. Our analysis is based on 10 years of data (2013-2023), during which 171 females were treated. According to the PZP protocol, horses receive a "primer" and a "booster" dose in the first year, timed based on the onset of breeding activity, followed by an additional booster the next year. However, due to difficulties of treating wild animals, adhering to this timeframe is not always possible. We assessed a) the impact of vaccines' timing on first-year efficacy, b) changes in cumulative efficacy over time and c) whether horses regain fertility after successful treatment (as defined by 3 consecutive years of infertility). Our results suggest that the timing of the two initial doses strongly influences first-year efficacy. Females who received both doses on time were less likely to be pregnant (~90% efficacy) the following year than those who received the booster after the prescribed time window (~60% efficacy). Cumulative efficacy among treated females increased up to 93% by year 4, but showed a declining trend thereafter, although later years' results are tentative due to small sample sizes. We had sufficient data to investigate reversibility for 26 females, 9 of which regained fertility based on our criteria. We found no influence of age or number of doses received on whether horses returned to fertility after treatment. Overall, PZP is an important tool for regulating this population, with timing of the initial doses appearing key for successful treatment. Our study also highlights the importance of consistent monitoring of individuals to identify factors influencing the efficacy of PZP, enabling treatment to be tailored to the individual, and thereby improving population-level outcomes.

## Fertility control for free-roaming horse populations: over 20 years of research using SpayVac®-equid

URSULA BECHERT, DVM, PHD, SPAYVAC FOR WILDLIFE, INC., MADISON, WISCONSIN, USA

As wildlife populations become increasingly confined to smaller ranges, they can become locally overabundant, resulting in conflicts with humans and negative effects on other species. Free-roaming horses are particularly challenging to manage, because populations can grow at 15-20% annually, their habitats are diverse, stakeholders have different objectives, and people hold strong opinions about how horses should be managed (if at all). The Bureau of Land Management currently manages free-roaming equids in the U.S. mainly by removing horses, which are then either adopted by private individuals or sent to long-term holding facilities. Using fertility-control together with removals offers the best potential for success, and implementation challenges are site-specific, based on terrain and other variables. SpayVac®-equid is a porcine Zona Pellucida (pZP) contraceptive vaccine that uses liposomes to encapsulate antigens and initiate an enhanced immune response, resulting in multi-year, single-dose efficacy. In a study initiated in 2003, mare pregnancy rates dropped to 0, 17, 17, and 17%, respectively, 1–4 years after a single dose of SpayVac®-equid (n=12), compared to 75, 75, 88, and 100% for controls (n=8). In a subsequent study, 93% of treated mares (n=14) ceased cycling as evidenced by significantly lower serum concentrations of progesterone and smaller ovaries with fewer follicles compared to controls (n=7). The direct effects on the ovaries of treated horses appear to represent a second mechanism of action for pZP, in addition to interference with sperm binding. Fertility of SpayVac®-equid-treated mares in a third trial was 13, 47, and 43% for years 1–3 post-vaccination (n=30), compared to 100, 97, and 100% of controls (n=30;  $p < 0.001$  each year). A fluorescent bead-based assay distinguished IgG isotype responses against pZP. Mares from this study that were continuously infertile for 4 years (n=14) had higher IgG4/7 antibody titers during years 1 and 2 post-vaccination ( $p < 0.05$ ), and levels were higher during year 5 compared to year 4 ( $p < 0.02$ ). The objective of a current ongoing study is to assess immune response and contraceptive efficacy resulting from different injection sites (i.e., neck and rump). Preliminary results suggest there are significant differences in immune response and estrous cyclicity based on injection site.



# Behavioural and Ecological Monitoring in Przewalski's Horse Reintroductions: Standardized Research Methodologies for the New Kazakh and Mongolian Projects

BERNÁTKOVÁ A., KOMÁRKOVÁ M., BOBEK M., DOBIÁŠOVÁ B., ŠIMEK J., ČECHLOVSKÁ K., SALEMGAREYEV A., KALIYEV D., PUTILIN A., SIDOROVA T., OYUNSAIKHAN G., DALAITSEREN S., SHARKHUU A., TUGSUU N., DARINGANGA M., KREISINGER J.

Once extinct in the wild, Przewalski's horse is now listed as Endangered thanks to ongoing conservation efforts with horses successfully reintroduced to Mongolia and China. In 2024, a significant conservation effort commenced in Kazakhstan's Altyn Dala region to reintroduce Przewalski's horse. This initiative involves the transportation of seven individuals from Europe, with plans to relocate a total of 40 horses over the next five years. This project is part of a broader strategy to reestablish the species in its natural habitat, with a similar initiative planned for eastern Mongolia. These reintroduction efforts are coupled with extensive research programs designed to monitor the horses' adaptation to their new environment, the initial state of the reintroduction site and the potential ecological impact of the horses in the long-term perspective.

The research emphasises the importance of consistent methodologies across all sites to collect comparable data on horse behaviour, habitat use, and ecological changes. Specifically, behavioural research in Kazakhstan is conducted daily, where all horses are individually identified and observed. Video recordings and notes in SMART are made at regular intervals throughout the day, ensuring comprehensive coverage of the horses' activities. The research also includes health checks, body condition scoring, parasite load, microbiome changes and monitoring of social interactions and aggressive behaviours, which are critical for understanding the horses' social dynamics and well-being.

Furthermore, the research plan extends to environmental monitoring. Vegetation monitoring involves assessing plant diversity and distribution across various habitat types to help determine the influence of horses' presence on the environment. Regular and long-term soil and water monitoring allows for assessing subtle changes in the quality and composition. The research also considers the potential influence on selected invertebrates, like pollinators, and vertebrates, i.e. other ungulates and their predators.

Standardising these research approaches in the two reintroduction sites in Kazakhstan and Mongolia aims to generate robust data that will guide future conservation strategies and potentially support effective ecosystem restoration. The multidisciplinary nature of the research, integrating behavioural studies with ecological assessments, is important for ensuring the success of these reintroduction efforts.

# From past to future: a socio-ecological framework for Persian onager reintroduction

MAHMOUD-REZA HEMAMI<sup>1</sup>, AZITA REZVANI<sup>1</sup>, PETRA KACZENSKY<sup>2</sup>

<sup>1</sup>Department of Natural Resources, Isfahan University of Technology, Isfahan 84156-83111, Iran

<sup>2</sup>Inland Norway University of Applied Sciences, Department of Forestry and Wildlife Management, Stor-Elvdal, Norway

The Persian wild ass (*Equus hemionus onager*) has experienced a significant decline in its historical range due to human activities and habitat loss. Reintroducing this species is a crucial conservation goal requiring a comprehensive assessment of habitat suitability and social acceptance. This study developed a socio-ecological index to identify potential reintroduction sites in Iran. A biological index was established by evaluating habitat suitability across historical, current, and future timeframes, considering climate change, land use alterations, and landscape connectivity. Local communities' attitudes towards onager reintroduction were assessed, revealing negative sentiments in areas where conflict with onagers has occurred. To better understand the socio-economic factors influencing local acceptance, we developed a conflict risk model (CRM) incorporating livestock density, road density, human population density, proximity to agricultural land, and ecological footprint. To establish the final socio-ecological model we assessed the overlap between areas with low conflict risk, as indicated by the CRM, and regions where prioritized for reintroduction based on the biological index using Weighted Linear Combination method in ArcGIS 10.3. Our findings reveal that climate and land use change could lead to a substantial loss of suitable habitat for the Persian wild ass by 2050, reducing the availability of suitable habitats within protected areas. Prioritization of reintroduction sites indicates that the majority of suitable patches are located in unprotected areas. To facilitate reintroduction efforts, we recommend initiating conservation initiatives in areas designated for protection by the Department of Environment. Expanding protected areas on a national scale could further support the conservation of this important population in the long term.

# Movements and Habitat Selection of Przewalski's Horses in Hustai National Park, Mongolia

TSOGT BATZAYA<sup>1</sup>, MELISSA SONGER<sup>2</sup>, KATE JENKS<sup>3</sup>, JOHN MCEVOY<sup>2</sup>, DORJ USUKHJARGAL<sup>4,1</sup>, NILANJAN CHATTERJEE<sup>5</sup>, ANTHONY SEVEQUE<sup>5</sup>, THOMAS MUELLER<sup>2,5,6</sup>, AND NANDINTSETSEG DEJID<sup>5</sup>

<sup>1</sup>Hustai National Park, Ulaanbaatar, Mongolia, <sup>2</sup>Smithsonian Conservation Biology Institute, Front Royal, VA, USA, <sup>3</sup>Minnesota Zoo, Apple Valley, MN, USA, <sup>4</sup>Department of Biology, School of Art and Science, National University of Mongolia, <sup>5</sup>Seckenberg Biodiversity and Climate Research Centre, Frankfurt, Germany, <sup>6</sup>Goethe University Frankfurt, Frankfurt, Germany

The Przewalski horse (*Equus ferus przewalski*), also called takhi in Mongolian, was previously classified as “Extinct in the wild (EW)” by the IUCN Red List. Through successful reintroduction programs at various sites, including Mongolia (since 1992) and China (since 2001), the status for Przewalski's horse was revised to “Critically Endangered (CR)” in 1996 and then species is reclassified to Endangered (EN) in 2014. Most free-ranging mature individuals in the wild are found in Hustai National Park (HNP), Mongolia. This suggests that HNP is a critical conservation location for Przewalski's horse and effective conservation management is a key requirement for the long-term survival of this population.

Understanding the movements and habitat selection of takhi in HNP is needed in order to identify priority areas for conservation, improve habitat connectivity, and inform effective conservation management. In this study, we aimed to better understand seasonal movements and habitat selection of takhi. We used GPS tracking data of 20 female takhis across distinct harem groups collared in 2016, 2017 and 2019. Monitoring periods ranged from 251 to 1,046 days (mean 657 days) per individual, while the number recorded GPS locations ranged from 6,304 to 30,785 (mean = 20,645). For each individual, we quantified seasonal movement patterns and season-specific habitat selection of takhi, accounting for individual variability.

Daily displacement varied with season, ranging from winter ( $3.65 \pm 2.04$  km/day), spring ( $5.38 \pm 2.48$  km/day), autumn ( $7.02 \pm 3.48$  km/day), and summer ( $7.31 \pm 2.94$  km/day). Habitat selection was substantially different across seasons. In summer time, takhi selected for mountain steppes at higher altitude, while they selected for river valleys at lower altitudes with higher protection from wind during winter time, favoring thermoregulation over potential forage.

The seasonal differences in habitat selection and movement patterns displayed by takhi are critical for survival. Deepening our understanding of movement patterns and habitat selection of this species is fundamental for efficient management strategies and conservation success of this endangered species, as well as the potential selection of new re-introduction sites.

# Population dynamics of the Przewalski's horse (*Equus ferus Przewalskii*) being reintroduced in Khomyn Tal National Park, Mongolia, compared to other reintroductions and its source population

MUNKHBAT TSERENDORJ<sup>1</sup>, NARANGARAV ENKHJARGAL<sup>2</sup>

<sup>1,2</sup>Khomyn Talyn Takhi, Bayanzurkh District 1-st Khoroo, Seoul Business Center 703 Ulaanbaatar 13381, Mongolia

The endangered Przewalski's horse (*Equus ferus Przewalskii*) has been reintroduced to Khomyn Tal National Park in Mongolia since 2004. The efforts to bring back Przewalski's horse into the wild were aimed at safeguarding the species, understanding its behaviour and ecology in the wild and improving our knowledge of its history. The reintroduction program started with 26 horses transported from Le Villaret, France and Prague Zoo, Czech Republic. The population has now grown to 155 individuals without any significant deaths, but some emerging issues need attention. Today, the population is freely roaming within a fenced area of 14,000 hectares without grazing competition with domestic animals. With the population steadily increasing, however, the limited space leads to social stress and food scarcity, which could affect female fecundity. It is crucial to identify factors influencing fecundity and mortality in these populations. Genetic diversity and inbreeding are becoming emerging concerns for this closed population, affecting overall reproductive success. Immediate action is needed to address the genetic bottleneck. Gathering direct evidence from free-living populations can be challenging due to observational limitations. This paper compares the population dynamics of the wild horses in Khomyn Tal National Park with other populations in Mongolia and its source population in Le Villaret, France, where there are no predators and no transmission of infectious diseases from domestic horses.

## Cross-pollinating ideas for mitigating the impacts of infrastructure on wild equids

SARAH CHILES (GZT), DAVID KIMITI (GZT), PETRA KACZENSKY

The connectivity of wild equid habitat is increasingly at risk due to the development of linear infrastructure, including oil pipelines, roads, railways and fences. This is driven in part because wild equid habitat in many cases overlaps with oil and mineral reserves. In Kenya, the Lamu Port-South Sudan-Ethiopia Transport (LAPSSET) Corridor, designed primarily for the export of oil from northern Kenya and South Sudan, includes an oil pipeline, highways and railways, and transects Grevy's zebra habitat. The current and potential impacts of this development on Grevy's zebra include habitat fragmentation and degradation, corridor obstruction, and ultimately genetic isolation. Over the last six years, Grevy's Zebra Trust has taken a proactive approach to working with authorities for the mitigation of impacts of both existing and proposed infrastructure on Grevy's zebra. This session will highlight this case study on Grevy's zebra as well as that of the Asiatic wild ass\*, which is similarly affected by infrastructure development for resource extraction. After case-study presentations, the session will follow a dynamic format, inviting presenters and attendees to a) compare the issues and solutions presented in the case studies and b) to participate in generating a shared set of solutions and proposed actions for mitigating the impacts of infrastructure on wild equids.

## Brief highlights of Przewalski's horse reintroduction to Hustai National Park, Mongolia: up to date after three decades

DORJ USUKHJARGAL<sup>1,2</sup>, TSOGT BATZAYA<sup>2</sup>, TSERENDELEG DASHPUREV<sup>2</sup>, GANBOLD UUGANBAYAR<sup>2</sup>, TSEREN-OCHIR TSERENDULAM<sup>2</sup>

<sup>1</sup>Department of Biology, School of Arts and Sciences, National University of Mongolia, <sup>2</sup>Hustai National Park, Mongolia;

The Przewalski's horse (PH, *Equus przewalskii*) is the world's last and only remaining wild horse species that was first discovered in science in 1881 based on a skull found in Mongolia. Between 1898 and 1903, 88 foals from the Mongolian Gobi were captured, with 53 successfully transported to Europe. However, only 13 of these foals had descendants, causing the extinction of the last wild population in the wild in 1969. Yet, after two decades, eight different sites across four countries began reintroducing them to preserve the only remaining wild horse.

The Hustai National Park (HNP) in Mongolia is one of the primary reintroduction sites. Between 1992 and 2000, 24 stallions and 60 mares were transported in five occasions. Seventy-six (90%) of them spent two years in six different electrocuted acclimatization enclosures before being released into nature under the name "soft release," with a survival rate of 60-100%. Eight (10%) of them were immediately released into nature under the name "hard release," with a survival rate of only 30%. The last harem was released into the wild in 2002, and since 2003, we have eliminated all acclimatization enclosures facilitating the species' naturalization and conservation in the wild. At the moment, human intervention is highly limited; it can be considered a natural population.

Since then, numerous encouraging outcomes are documented associated with the reintroduction and conservation of PH. First, the PH was listed as 'Extinct in the Wild' by the IUCN until its successful reintroductions in 2008, which downgraded the status to 'Critically Endangered and Endangered' in 2011. Second, resident wildlife species in this national park increased sharply under the conservation of umbrella species, with 50 red deer in 1992, 2,000 red deer in 2024, 7,000 marmots in 2003, and 14,000 marmots in 2018. Third, migratory wildlife species, such as 1,000-2,000 Mongolian gazelles and 100-200 Argali wild sheep, inhabited the park by themselves. Fourth, we attempted to develop community-based conservation by establishing more than 30 conservation communities and hiring over 70% of our staff from local herders, who actively participate in nature conservation. In essence, by conserving a single species, we managed to protect an entire ecosystem, along with establishing a community-based conservation program within the national park.

## Managing wild horse herds with limited resources

KIMBERLY M. FRANK<sup>1</sup>, KAYLA A. GRAMS<sup>1</sup>, MELISSA M. ESSER<sup>1</sup>

<sup>1</sup>The Science and Conservation Center, ZooMontana, Billings, MT, USA

One of the challenges of controlling a free-roaming horse (*Equus caballus*) herd, on public or private lands, is the lack of resources whether it be personnel, time, or budget. In the U.S., free-roaming horses can be found on lands managed by the Bureau of Land Management, Forest Service, National Park Service, native tribes, and states. Free-roaming horses can also be found on private land owned or managed by a non-profit organization.

One form of management is fertility control using the PZP (*porcine zona pellucida*) immunocontraceptive vaccine, which when injected into mares induces antibodies that interfere with fertilization and prevent pregnancy. The vaccine, which also includes an adjuvant, can be delivered remotely by a dart. Mixing vaccine and darting is done by trained government personnel or trained volunteers.

We describe here successful partnerships between volunteers from non-governmental organizations working collaboratively with federal and state governmental agencies. The NGO partners are often local non-profit groups already advocating for a herd in the area. Projects considered here are located at the Little Book Cliffs Range, Colorado; McCullough Peaks Range, Wyoming; Pryor Mountain Range, Montana; Sand Wash Basin, Colorado; Spring Creek Basin, Colorado; Onaqui Mountain, Utah; and Salt River, Arizona.

These collaborations are successful because local groups are passionate and have a strong interest in protecting free-roaming horses, wildlife, and the health of the rangeland. They work together with the agencies under carefully crafted management plans to achieve common goals of reducing the number of roundups for population control and having a healthy, thriving herd. The NGO volunteers its time and resources to identify the horses, treat mares with PZP, collect post-treatment data, and help educate the public about the project. The agency facilitates the work of the NGO to the extent possible. This model is advantageous because all stakeholders can be involved, promoting collaboration rather than adversarial relationships, and volunteers help distribute workload and reduce the direct costs to the government agencies. The horses benefit too.

# Effects of Domestication: Productivity and Social Structure of Free-roaming Equids

KATHRYN A. SCHOENECKER<sup>1,2</sup> AND SARAH R.B. KING<sup>2</sup>

<sup>1</sup>U.S. Geological Survey, Fort Collins Science Center, Fort Collins, CO USA; schoeneckerk@usgs.gov; 262-227-2561,

<sup>2</sup>Colorado State University, Ecosystem Science and Sustainability, Fort Collins, CO USA; srbking@colostate.edu;

Domestication results from the selection for *tameness* in a species. One of the potential effects of being protected and fed by humans over time can be the reduction in a species' responsiveness to environmental cues and feedbacks. Many traits are affected by domestication; it is related to physical characteristics such as curly tails, floppy ears, curly hair, cranial modulation, and coat color variation. Species that were once domesticated by humans and subsequently released or escaped are defined as feral. They maintain numerous traits associated with domestication and becoming free-roaming does not return a species to its "wild" phenotype. Free-roaming horses and donkeys display multiple characteristics of domestication, particularly when compared to the Przewalski's horse (*Equus przewalskii*), and the non-domesticated relative of donkeys, the African wild ass (*Equus africanus*). We collected data from two free-roaming horse populations in Utah, USA and two free-roaming donkey populations in Utah and Arizona, USA from 2016-2020. We quantified demographic metrics including age of first reproduction, population growth rate, and survival rates, and compared these metrics to their non-domesticated relatives. We also collected behavior data and recorded social interactions and social structure of these 4 populations. Horses and donkeys are phylogenetically distinct species with different evolutionary histories; their ancestral forms have different social systems related to adaptations to different ecosystems. We tested whether these two equid species would exhibit similar social interactions and express their ancestral social systems when living in a feral state. We found species differences between horses and donkeys, as well as higher age of first reproduction, population growth rate, and survival rates compared to native wild equids. Social structure of horses and donkeys was similar to their non-domesticated origins. Free-roaming horses and donkeys have adapted to life in the wild in their new environments, yet still show evidence of their domestication history in their unusually high reproductive rate. However, phylogenetic history seemingly plays a strong role in the behavioral ecology of a species, even after they are domesticated and become feral.



# Can Mountain Lion Predation Suppress Growth Rates of Feral Horses in the American West?

BY DAVID C. STONER<sup>1</sup>, BRIAN FOLT<sup>2</sup>, KATHRYN A. SCHOENECKER<sup>3</sup>

<sup>1</sup>Dept of Wildland Resources and the Ecology Center, Utah State University, Logan, UT, USA,

<sup>2</sup>U.S. Geological Survey Cooperative Fish & Wildlife Research Unit, University of Nevada, Reno, NV, USA,

<sup>3</sup>U.S. Geological Survey, Fort Collins Science Center, Ft Collins, CO, USA

Feral horses (*Equus caballus*) are widely distributed throughout the arid regions of western North America. These animals are protected by federal law, which in conjunction with high survival and population growth rates, has allowed them to become invasive in parts of their current range. Although Federal agencies are required to hold populations at an ecologically-determined "Appropriate Management Level" (AML), socially acceptable control methods are either ineffective, or infeasible at large scales. Thus, practitioners have raised the question of whether natural solutions, such as mountain lion predation, could limit or regulate horse numbers at or below AML. To address this question, we used a combination of simulation modeling and empirical results from a 4-year field study in the southern Great Basin to determine sensitivity of horse demography to predation. We built an age-based, female-only, post-breeding population model to: (1) evaluate the sensitivity of horse population growth rates to reductions in juvenile, yearling, and adult survival rates, (2) estimate the reduction in survival necessary to stabilize population growth, and (3) use these values to estimate growth rates in a feral horse population subjected to chronic predation. Contrary to expectations, we found that foal and yearling survival rates had the greatest contributions to lambda. Model results indicated that predation would need to reduce survival rates of these age classes by 60-80% for  $\geq 5$  years to decrease populations to AML. Empirically, mountain lion predation averaged 0.55 and 0.33 horses / week during summer and winter, respectively. Of those individuals that succumbed to predation, 63% were foals, 12% yearlings, and 14% adults. This resulted in an estimated removal of 177 foals / year, or  $\sim 61\%$  of the annual foal crop. Mountain lion predation had negligible impacts on yearlings and adults, but reduced foal survival by 40-60%/yr. Predation at these levels could reduce lambda from 18% to 10% / yr, but could not bring populations to AML, or stabilize growth rates. Nevertheless, results suggest that horse herds subjected to predation may grow at slower rates, which has implications for programmatic costs, social conflicts over management, and expansion of horses into new habitats.

# Community-led Regenerative Land Management as a Tool for Wildlife Conservation in Mixed-use Rangelands in Northern Kenya

ANDREW LEKISANYAL<sup>1</sup>, JOSEPH LETOLE<sup>1</sup>, DOMINIC LEPARMARAI<sup>1</sup>, PETER MARLENI<sup>1</sup>, BABYLON LETIROK<sup>1</sup>, REDEMPTA NJERI<sup>1</sup>, ANDREW LETURA<sup>1</sup>, PETER LALAMPAA<sup>1</sup>, DAVID KIMITI<sup>1</sup>

<sup>1</sup>Grevy's Zebra Trust

The Grevy's zebra (*Equus grevyi*) is one of Africa's most endangered large mammals and is currently categorized as endangered by the IUCN Equid Specialist group. The future of the Grevy's zebra is intrinsically linked with the resilience of pastoral communities in northern Kenya, which is the majority of the species' range. Both are threatened by land degradation and fragmentation, restricted access to water, insecurity, and disease. Recognising that the survival of Grevy's zebra depends on its ability to co-exist with people living in northern Kenya, GZT puts communities at the centre of designing and driving conservation efforts. Our role is to support resilience practices and help communities adapt to modern realities so that they can protect their resources for pastoralism and wildlife to thrive. GZT invests in working with communities at the village and conservancy levels to address overgrazing, the root cause of land degradation, through Regenerative Grazing and Land Management, which improves the health of soils and plants by using livestock as a management tool. Livestock are used to regenerate land in two ways: 1) planning their movement through the landscape so that plants are given sufficient time to recover; 2) Harnessing their husbandry to reincorporate litter and dung into the soil subsurface and promote vegetation patch creation. Our rangelands team engages communities through various channels, including novel Village-Based Committees (VBC), Grazing Committees, Grassland Champions, learning site exposure tours, and morans (warriors) training. These meetings focus on strengthening community institutional structures and fostering ownership of rangeland regeneration and management practices. Through strengthening and capacity building of the VBCs specifically, we have been able to make stride in securing pasture during the wet season which has enabled implementation of regenerative grazing.

Despite disruption by drought, we have observed clear positive differences in vegetation metrics from 2020 to 2023 as well as between our treatment and control sites. We present our unique community-led approach, results from our current vegetation monitoring, Grevy's zebra responses to the improved forage, and our vision for scaling these outcomes to the wider Grevy's zebra range.

# POSTER PRESENTATION ABSTRACTS

---

## Investigation of mortality in the *Equus ferus przewalskii* population of the Great Gobi B in Mongolia during the climatic challenges in the year 2022/2023

ANGELA BECSEK<sup>1,2</sup>, BANZRAGCH BATTUR<sup>3</sup>, DALAITSEREN SUKHBAATAR<sup>4</sup>, ADILBISH ALTANCHIMEG<sup>3</sup>, GURDORJ SOYOLMAA<sup>3</sup>, URANBILEG NYAMDOLGOR<sup>3</sup>, RUTH BAUMGARTNER<sup>1</sup>, JEAN-MICHEL HATT<sup>5</sup>

International Takhi Group (ITG) and Mongolian University of Life Sciences, Ulaanbaatar

The steadily growing population of the *Equus ferus przewalskii* (EFP) in the Mongolian Great Gobi B (GGB) demonstrates successful reintroduction efforts over the past 32 years. However, the effects and consequences of climate change and a climatic phenomenon called *dzud* has been shown to challenge the EFP population in the GGB in the past and will become increasingly important in the future. *Dzud* events are characterized by particularly dry summers that are followed by extremely cold winters, often with high snow cover. During the 2022/2023 *dzud* winter a large decline in the EFP population size was believed as individual animals disappeared, allocated to new harems or were found dead. A thorough investigation was initiated where large areas of the GGB were searched for carcasses and GPS location, sex and age were recorded for dead animals. When possible, a postmortem examination was conducted. Here we describe the findings during this investigation period in early 2023.

Between December 2022 and May 2023 153 individuals of a total population size of 407 animals were either found dead (n=66) or disappeared and were classified as dead (n=87). Carcasses were found mainly in a 4-5 km radius around water holes emphasizing relative conservative use of home range during harsh weather conditions. The proportions of males and females among the deceased equids were equal. Mainly yearlings ( $\leq 1$  year old), juveniles (<5 years old) and aged (>15 years old) EFP deceased. Postmortem examination was conducted in 24 animals and revealed poor body condition with reduction or absence of intraperitoneal and organ-associated adipose tissue. There was no evidence of gross structural abnormalities or infectious diseases in any of the equids. However, multiple species of gastrointestinal parasites were found which could have contributed to the weakening of individual animals. Despite histopathologic analysis was hindered by autolytic changes in most of the samples, main findings were compatible with starvation and included lymphoid and myocardial atrophy, and subepicardial gelatinous fat atrophy.

In conclusion the 2022/2023 *dzud* caused death or disappearance of 153 individuals. Postmortem and histopathologic examination of 24 individuals indicated starvation and freezing as cause of death.

# Ritual encounters between stallions in an island population of feral horses (*Equus ferus caballus*)

MARIIA EVSTIGNEEVA<sup>1</sup>, NATALIA SPASSKAYA<sup>2</sup>

<sup>1</sup>Faculty of Biology, Lomonosov Moscow State University, Moscow, Russia,

<sup>2</sup>Zoological Museum, Lomonosov Moscow State University, Moscow, Russia

Ritual encounters between stallions of different categories were studied in an island population of feral horses (the "Rostovsky" State Nature Biosphere Reserve, Rostov Region, Russia), namely between members of a bachelor group, between bachelors of different groups, and between bachelors and harem stallions. High frequency and a variety of ritual encounter repertoires were observed. We analyzed several thousand interactions that have been recorded over a number of years. Two basic behavioral patterns were identified, namely ritual exits (without contacts between individuals) and ritual encounters. Several scenarios for ritual encounters were described: short and long (consisting of several series), with mild (threats) and direct aggression (including fights), as well as peaceful interactions (grooming, play, and invitations to engage in these activities).

Frequencies of both ritual encounters in general and their specific variants were shown to depend on certain characteristics of the animals, including their individual age, social status and hierarchical rank, as well as the time they spent in a bachelor group. These differences may also depend on some population parameters, such as stability of social structure, the number and age composition of bachelors during a given time period.

Ritual encounters constitute one of the manifestations of the competition for social and hierarchical status among stallions. At the same time, they may serve as a means for reducing within-population aggression.

## Wait. IUDs for feral equids?

C GRADIL CAROLYNNE, J JOONÈ KARL HOOPES CHRISTOPHER J. DAVIES

Fertility control of feral equids is multifaceted. A single solution is unrealistic. The abstract highlights five pilot studies with 6-15 horses conducted in Australia and the US.

Hormone-free self-assembling intrauterine devices (iUPOD; CuiUPOD) were used. There was evaluation of i) device retention; ii) contraceptive efficacy; iii) fertility following device removal; iv) effects of device on estrous cycle periodicity; v) abundance of biofilm on devices after removal from the uterus; vi) Endometrial biopsies before and after device placement and vii) antimicrobial effect.

### Study 1:

- iUPODs showed a high retention rate. Endometrial integrity was not significantly affected by the device.
- Fertility post-device retrieval was not affected by the device and 100% of mares bred in the following breeding season conceived.
- iUPODs are easy to detect with an inexpensive metal detector, a cell phone, or visualized with ultrasound.
- The iUPOD design decreased the risk of damage to the cervix with a streamlined magnetic retrieval technique.

### Study 2:

- Retention rate with the 40 × 16 mm size iUPOD was 100 %.
- The iUPOD *immediate* contraceptive efficacy was 100 %.
- Reversibility was observed within 30 days post-device retrieval.

### Study 3:

- An iUPOD is an effective contraceptive under pasture breeding conditions.
- Veterinarians with no prior experience with the devices can successfully manage their use in equids.
- iUPODs can be successfully removed from mares and breeding soundness can return.

### Study 4:

- The iUPOD successfully prevented the establishment of potential pregnancies in all treated mares.
- Treated mares showed lengthened luteal phases and predominantly sterile endometritis in association with the devices.
- Mean serum cortisol concentrations were lower in mares carrying iUPODs than in control mares.

### Study 5:

- A 30-day exposure to copper devices resulted in no clinical signs of infection in mares inoculated with *S. zooepidemicus*.
- As the concentration of copper increased, so did the antimicrobial effect.
- CuiUPODs show promise in mitigating antimicrobial-potential resistant bacteria.

These results are encouraging for the use of the iUPOD/CuiUPOD as a safe and practical reversible fertility control in feral equids.

# Animal welfare risk assessment and management plan for feral horses at Kaapsehoop, South Africa

MERIJN HEMELS<sup>1</sup>, VIVIAN C. GOERLICH<sup>2</sup>, MACHTELD C. VAN DIERENDONCK<sup>1,3</sup>

<sup>1</sup>Faculty of Veterinary Medicine, Department of Clinical Sciences, Utrecht University, Utrecht, Netherlands,

<sup>2</sup>Faculty of Veterinary Medicine, Department of Population Health Sciences, Utrecht University, Utrecht, Netherlands,

<sup>3</sup>Faculty of Veterinary Medicine, Department of Veterinary and Biosciences, Ghent University, Ghent, Belgium.

Although equine welfare topics have been researched quite extensively over the last years, the welfare of free-roaming and feral horse populations has had less attention so far. While feral horse's life conditions and behavioural characteristics are often presented as the model for domesticated horses' welfare, feral horses can be exposed to welfare threatening conditions, as well. These welfare risks can be both naturally occurring and/or induced by human presence. The aim of this research was to explore the exposure to welfare risks and benefits in a feral horse population in Kaapsehoop, South Africa in 2024. We used the EFSA methodology (*Guidance on Risk Assessment for Animal Welfare*) and an adapted version of the Five Domains Model. Animal-based and resource-based welfare indicators were carefully selected for practical use and for this particular population. Direct visual observations were most important for animal-based welfare indicators and ground surveys for the resource-based indicators. Maps, meteorological data and field condition reports were available for additional resource-based data. Semi structured interviews with several different types of stakeholders were used to retrieve additional data for a larger number of topics and over a larger period of time. Preliminary results showed positive welfare indicators, such as all-year availability of sufficient good fresh drinking water, care of local stakeholders and good hoof health. Negative indicators related to welfare risks were identified, such as the endemic African Horse Sickness, tick-related diseases and burn injuries due to wildfires. Human-related risks included injuries from illegal snares used for smaller animals, car accidents and systemic illnesses due to feeding inappropriate food. Furthermore, conservational concerns could be expressed with an estimated population decline from about 200 to 100 individuals over the past 5-8 years. African horse sickness has identified as one of the major causes of loss, but inbreeding and other causes could possibly be contributing to the decline as well. Further research is needed. The welfare risks and benefits will be scored and prioritised in a management plan. Risk strategy will be discussed, as well as proposals for improvement of animal welfare and how to measure "success" of potential interventions.

## Przewalski behavior problems in zoos and in the wild

**KATHERINE A. HOUP**

College of Veterinary Medicine, Cornell University Ithaca NY 14853

Przewalski horses can present with a variety of abnormal behaviors. One mare exhibited cribbing behavior. She cribbed on the backs of her herd mates. Her son cribbed, but only when confined away from his mares. One of a pair of Przewalski foals born by embryo transfer to pony mares, and weaned at 6 months, suckled on the ear of her half-sister. Tail chewing is apparently a stallion behavior.

Stereotypic pacing was observed in a stallion housed in isolation. The most distressing behavior is foal killing by stallions and was observed in a zoo and in released Przewalski's in the wild in China. That behavior is usually observed to occur when the stallion is not the sire of the foal, but, in at least one case the stallion was the sire.

# Influence of landscape Features on Mountain lion (*Puma concolor*) prey selection in mixedprey communities

HANNAH KLUGMAN

Utah State University – Masters in Ecology

Advised by David Stoner, Kate Schoenecker and Andre De Lima Moraes

Project Partners: U.S. Geological Survey and Nevada Department of Wildlife

Mountain lions (*Puma concolor*) are obligate carnivores capable of hunting large-bodied prey. Their habitats are often characterized by steep heavily forested landscapes and areas occupied by mule deer (*Odocoileus hemionus*). Across the American west they exhibit considerable spatial overlap with feral horses (*Equus caballus*), an abundant non-native prey species. There have been several studies examining the effects of a non-native predators on native prey populations, yet there is little research investigating how a native predator might adapt its habitat use and foraging strategies in response to abundant non-native prey. Previous research (Iacono et al. 2024) conducted in my study area, a 3,158 km<sup>2</sup> region of Lincoln County Nevada, revealed horses to be 32% of mountain lion diet but showed high variation in the proportion of horse in individual diet compositions. The objective is to determine whether mountain lions hunt opportunistically, choosing habitat that maximizes their likelihood of success regardless of species, or if they hunt selectively for a particular prey species, choosing habitat that maximizes their encounter rate with one prey. I will map the relative vulnerability of both feral horse (HV) and mule deer (DV) using prey species identified at kill sites. My analysis will compare predation events to habitat features through spatial overlay of vulnerability maps and satellite imagery, measuring within mountain lion home ranges to determine if: (1) Mountain lions are selecting deer (their native prey) and opportunistically predating horses (HV < DV) or if (2) Mountain lions are selecting landscape features that facilitate a successful hunt, opportunistically taking what is available. Results will aid state and federal agencies charged with managing invasive and native species in rapidly changing ecosystems.



# Population Dynamics, Sex Ratio, and Foal Survival of Misaki Feral Horses at Cape Toi, Miyazaki, Japan (2012-2016)

IKUO KOBAYASHI<sup>1</sup>, MASARU AKITA<sup>2</sup>

<sup>1</sup>Faculty of Agriculture, University of Miyazaki, Japan, <sup>2</sup>Kushima City Hall, Miyazaki, Japan

The aim of this study is to investigate the population size, sex ratio, birth rate, and one-year survival rate of foals of the Misaki feral horses at Cape Toi in Miyazaki Prefecture, Japan. The Misaki horse, a native Japanese breed, is managed as a free-ranging herd within an approximately 500-hectare cape extending into the Pacific Ocean. Due to its rarity, it is designated as a National Natural Treasure. Although each horse is individually identified, they live in a largely unmanaged state with minimal human intervention. Existing reports indicate that data on the reproductive rate and foal survival rate of feral horses are scarce and limited, with considerable variation depending on habitat location and size. This study utilized data collected over a five-year period from 2012 to 2016. Based on previous surveys of this horse herd, mature stallions were defined as those aged 4 years and older, and mature mares were defined as those aged 3 years and older. The average population size was 93 horses, ranging from a minimum of 87 horses in 2012 to a maximum of 102 horses in 2016. The male-to-female ratio was 1:1 in 2012, but the ratio of mature females was consistently higher from 2013 to 2016, reaching a maximum of 1:1.52 in 2016. The birth rate among mature mares was 57%, with the highest rate being 77% in 2015 and the lowest rate being 44% in 2014. The one-year survival rate of foals born during this period averaged 68%, with the highest rate being 80% in 2015 and the lowest rate being 53% in 2016. To manage populations in restricted reserve areas effectively, it is essential to understand the variations in these demographic indicators. The results of this study show that each indicator fluctuated from year to year, suggesting that further research is needed to clarify the factors contributing to these variations.

# Rewilding ethology – Ten years of Behavioral and Ecological Monitoring of Semi-Feral Ungulates in the Czech Republic

MARTINA KOMÁRKOVÁ<sup>1</sup>, KATEŘINA ŠANDLOVÁ<sup>2</sup>, ANTOINE BERCY<sup>1</sup>, ANEŽKA MALÁ<sup>1</sup> AND FRANCISCO CEACERO<sup>1</sup>

<sup>1</sup>Faculty of Tropical AgriSciences, Czech University of Life Sciences Prague, Czech Republic. <sup>2</sup> Department of Zoology, Faculty of Science, University of South Bohemia, České Budějovice, Czech Republic

Since 2015, a rewilding/refaunation initiative has been underway in the Czech Republic, utilising large ungulates to promote biodiversity restoration in protected areas and former military zones (n = 15). Three species, such as the horses (*Equus caballus*), back-bred aurochs (*Bos taurus*), and European bison (*Bison bonasus*), are integrated as natural grazers to manage highly diverse landscapes from dry steppes to wetlands and forests (over 750 ha). This project is distinguished by its complexity, with multiple research teams, including botanists, entomologists, parasitologists, ecologists, and ethologists, involved from the outset to comprehensively monitor animals and their environmental impact. The semi-feral living conditions of these ungulates, with minimal human interference but the possibility of manipulating the herd's structure, offer a rare opportunity to observe natural behaviours and inter-species interactions akin to those in the wild.

Our research focuses primarily on the behaviour and ecology of the ancient breed of Exmoor ponies (n = 177 in 2024), living in different herd structures and group sizes from several individuals to more than 30 horses, including harems, bachelor groups, and all-female groups. Trained observers have been collecting long-term data through individual recognition of animals with known breeding histories. Key aspects of our study include hierarchical dynamics, affiliative, play and agonistic behaviours within herds, courtship patterns, parental care strategies, particularly the role of stallions in offspring development, antipredator responses, grazing patterns, and hoof health. This project provides critical insights into both animal behaviour in semi-natural conditions and the role of large ungulates in enhancing biodiversity through natural grazing processes.

# Creating Vegetation Patches on Degraded Grevy's Zebra Habitat Using Semi-circular bunds: Lessons from a Voluntary Restoration Programme in Northern Kenya

ANDREW LETURA<sup>1\*</sup>, DAVID W KIMITI<sup>1</sup>, ANDREW LEKISANYAL<sup>1</sup>, PETER LALAMPAA<sup>1</sup>, REDEMPTA NJERI<sup>1</sup>

<sup>1</sup>Grevy's Zebra Trust

The Grevy's zebra (*Equus grevyi*) is one of Africa's most endangered large mammals and is currently categorized as endangered by the IUCN Equid Specialist group and is listed on CITES Appendix I. The main threat to Grevy's zebra recovery and conservation as well as indigenous community livelihoods is rangeland degradation across their natural habitat. The Grevy's Zebra Trust (GZT) was founded in 2007 with a mission to conserve the Grevy's zebra. GZT has focused its work on pastoral lands where Grevy's zebra share space and resources with indigenous communities. As a result of rangeland degradation, livestock displaces wildlife on increasingly scarce grazing areas, leading to declines in wildlife populations and increased human-wildlife conflict with predators, as the wild prey base diminishes. The resulting lack of rangeland resilience to increasingly erratic weather patterns can lead to significant livestock and wildlife mortality, especially during drought events resulting in a negative socio-economic impact on indigenous communities.

GZT's Impact Model for Rangelands is built on the premise that rangeland restoration, community land use planning, and external collaborations and partnerships will lead to improved rangeland health, characterized by stable soils and increased vegetation cover. Beginning in 2021, GZT started piloting a new approach that had been tested by a company called JustDiggIt in the Amboseli ecosystem. This involved the construction of semi-circular water and sediment-trapping earth structures called bunds, berms, or half-moon micro basins. Bare ground areas with gentle slopes were selected for construction, with bunds constructed perpendicular to water run-off channels with the open concave facing upslope. In certain areas, these bunds were also reseeded with *Cenchrus ciliaris*. Restoration work was carried out across 190 acres in Westgate and Kalama conservancies in Samburu East, with over 18,000 individual bunds constructed by Community members. We showcase the successes of these bunds after rainfall was received, the lessons learnt where the bunds failed, and the current efforts to scale up these voluntary interventions across the Grevy's zebra range.

# The Northern Kenya Road Watch; Using Citizen Science to Inform Biodiversity-conscious Infrastructure Development

REDEMPTA NJERI<sup>1\*</sup>, ANDREW LETURA<sup>1</sup>, TOBY OTIENO<sup>2</sup>, MATTHEW MURUANA<sup>2</sup>, SARAH CHILES<sup>1</sup>, DAVID W KIMITI<sup>1</sup>

<sup>1</sup>Grevy's Zebra Trust, P.O. Box 15351-00509, Nairobi, Kenya,

<sup>2</sup>Ewaso Lions, PO Box 14996-00800, Nairobi, Kenya,

\*Corresponding author

The Grevy's zebra (*Equus grevyi*) is one of Africa's most endangered large mammals with its total population having declined by approximately 80% over the past 40 years. Over 90% of the remaining individuals are found only in northern Kenya, in the mixed-use Laikipia-Samburu-Marsabit-Meru (Ewaso) ecosystem. One of the greatest threats to wildlife in this ecosystem is habitat loss due to land degradation and changes in land use, especially human settlement and infrastructure development. The Isiolo-Marsabit-Moyale A2 highway cuts across this mixed-use ecosystem, affecting key species such as lion (*Panthera leo*), elephant (*Loxodonta Africana*), and reticulated giraffe (*Giraffa reticulata*)

The A2 road is part of LAPSET, a regional flagship project that has boosted tourism and improved trade and access to remote areas. However, safety on the road remains a challenge as the A2 bisects wild and domestic animal corridors. Vehicle collisions with animals have led to vehicle damage, as well as injuries and deaths of people and wild and domestic animals. The Grevy's Zebra Trust (GZT) and Ewaso Lions (EL) started a Citizen Science programme to address this challenge by monitoring animal-involved vehicle collisions and road kills along the highway. Since 2010, partners using A2 road have been collecting data on road kills and wildlife sightings along the road. Between January 2010 and June 2023, 83% of road kills involved wild animals, many of which are endangered, while 17% involved domestic animals.

In early 2023, these data were presented to the Kenya National Highways Authority (KeNHA), and the Kenya Wildlife Service, with discussions taking place on how to retrofit various points along the highway with speed reducing rumble strips and warning signage. In late 2024, these conversations have moved into the implementation phase, with scoping and geolocation happening in late September.

We will explore the trends in roadkill records since the project started, the implementation of a Survey123 data collection system, our data tracking dashboards, and the collision mitigation measures that have been proposed and approved. We will also explore our engagement with policy makers, the lessons learned, and the successes and challenges of the process.

# Shared intention and coordination behavior in mutual grooming of horses

AYUMI OGAWA<sup>1</sup>, TAMAO MAEDA<sup>2</sup>, RENATA MENDONÇA<sup>1,3</sup>, PANDORA PINTO<sup>1</sup>, MONAMIE RINGHOFER<sup>4</sup>, SHINYA YAMAMOTO<sup>1,5</sup>

<sup>1</sup>Wildlife Research Center, Kyoto University, Japan,

<sup>2</sup>Research Center for Integrative Evolutionary Science, The Graduate University for Advanced Studies (SOKENDAI), Japan,

<sup>3</sup>Centre for Functional Ecology - Science for People & the Planet, Department of Life Sciences, University of Coimbra, Portugal,

<sup>4</sup>Faculty of Life and Environmental Sciences, Department of Animal Sciences, Teikyo University of Science, Japan,

<sup>5</sup>Institute for Advanced Study, Kyoto University, Japan

Social animals establish social relationships within a group through allogrooming. Many animals engage in unidirectional grooming with role exchange. Some primates and a limited number of mammals, such as equids and bats, groom each other simultaneously (i.e., mutual grooming). Equids are unique in that their grooming is almost exclusively mutual. Mutual grooming is a very efficient form of grooming compared to unidirectional grooming, as both participants can benefit from grooming simultaneously. The functional significance of mutual grooming has been studied mainly in primates and has been shown to strengthen affiliative relationships and maximize short-term benefits. However, the question remains as to why mutual grooming is so rare across animal species, despite its functional significance and efficiency. To date, few studies have explored this puzzle either theoretically or empirically. Here, we hypothesized that mutual grooming requires individuals to coordinate their behavior and share their intentions with their partners, which requires a high level of cognitive ability, and that this need for advanced cognitive ability is a factor in the rarity of mutual grooming across animal species. In this study, we investigated details of interactive behavior in mutual grooming in horses. We recorded 136 hours of videos of feral horses living in groups at Cape Toi in Miyazaki Prefecture in Japan, and analyzed whether shared intentions among participants were observed at the onset of mutual grooming. In non-human primate coordination, mutual gaze is thought to be especially important for behavioral coordination; accordingly, our analysis focused on “mutual attention”, meaning that both parties were in a position to accept grooming and exchange gazes. We also examined the effects of inter-individual relationships (e.g., proximity, dominance hierarchy) on the frequency of signal communication for sharing intentions. By clarifying shared intentions and cooperative behavior in mutual grooming in horses, this study can provide new insights into the rarity of mutual grooming across species. Additionally, it may offer a novel perspective on the evolution of cooperative behavior from the broader viewpoints of comparative cognition.

# Features of reproduction in an isolated population of the feral horses (*Equus ferus caballus*)

POLINA VYUCHNAYA<sup>1</sup>, EKATERINA PARAFENYUK<sup>2</sup>, NATALIA SPASSKAYA<sup>3</sup>

<sup>1</sup>L.K.Ernst Research Center for Animal Husbandry, Podolsk, Russia, <sup>2</sup>Biology Faculty, Lomonosov Moscow State University, Moscow, Russia, <sup>3</sup>Zoological Museum, Lomonosov Moscow State University, Moscow, Russia

Feral horse populations may have a more complex reproductive system than presumed by a strictly harem structure, although limited evidence has been accumulated so far to support this (Kaseda et al., 1982; Bowling, Touchberry, 1990; Eggert et al., 2010; Gray et al., 2012).

The Vodny Island horse population (the “Rostovsky” State Nature Biosphere Reserve, Rostov Region, Russia) has been isolated for over 50 years. To assess participation of stallions of different social status in breeding, paternity was determined using molecular genetic methods for a few foals in the questionable cases for the few preceding years, and for all the foals born in 2022: this was the year when many young stallions remained within their natal harem bands. For this study, biographical data on each individual and the history of social groups were collected during a long-term comprehensive monitoring of the population, including also ethological observations.

Previous studies on this population have shown that there have been individual cases of inbreeding, bachelors have not participated in reproduction, whereas leaders of the alien harem bands might participate in breeding in harem groups with a long-term constant composition (Spasskaya et al., 2022). New studies indicated that bachelor stallions might obtain paternity (a single case was recorded), and young stallions who have not left their natal harem bands were much more actively involved in reproduction than expected, siring at least 20% of the foals in the population in 2022. Reproduction of subdominant stallions in multi-male bands was confirmed.

In general, it has been shown that in the studied isolated population, the number of sexually mature stallions participated in reproduction was 17% higher than that in the cases of a strict harem structure. A larger number of males leaving offspring may contribute to increasing genetic diversity in such a small isolated population.



