Marwell Wildlife

2020 Impact Report

Marsh helleborine *Epipactis palustris*.

photo © Martin Wilkie, Marwell Wildlife

Contents

Our Work

Welcome to our review of charitable activities and impacts for 2020. In the following sections we share highlights of our work to restore nature, promote sustainable living and help catalyse changes needed to improve the fortunes of people, wildlife, and the wider environment.

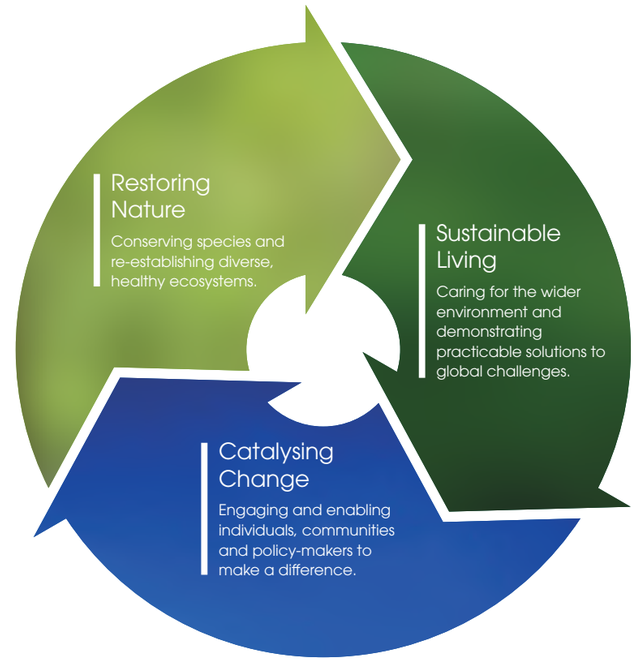
Inevitably, every aspect of our work was disrupted by the emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus responsible for COVID-19 and the ensuing global pandemic, with consequences for our finances, timeframes and working practises. However, our teams, wherever they work, were careful to follow legal and public health requirements to help combat this devastating pandemic. While the magnitude of our impact and pace of progress was not as we might have wished, the flexibility and fortitude exhibited by our teams and partners meant that we nevertheless achieved much against the odds.

Our work in the UK and internationally highlighted the different scales at which we operate. At the molecular level, advances in our understanding of the genetics of reintroduced desert antelopes are now informing management of their meta-populations, with lessons for species conservation elsewhere. Species like the silver-studded blue butterfly, sand lizards and insectivorous plants are doing well under our stewardship in relatively small patches of land in the south of England, showing what we can accomplish with modest resources and long-term commitments. Meanwhile, our work to understand the status of goitered gazelles in Kazakhstan and slender-horned gazelles in Tunisia was a reminder of the vast tracts of land these animals need for their survival and why conservation must span landscapes beyond protected areas and political boundaries.

By the end of 2020, our carbon footprint was 77% below that of our baseline year in 2008 as we made progress towards our goal of zero carbon. We made some impressive savings in water consumption following closer monitoring and targeted intervention, while our Environmental Management System was recertified for the 11th consecutive year.

Education and engagement are normally about bringing people together, but these activities were necessarily curtailed or adapted throughout 2020. Where fieldwork wasn't possible, our cohort of students undertaking the MRes Wildlife Conservation in collaboration with the University of Southampton took advantage of our long-term datasets to produce some novel and exciting research projects. Similarly, our veterinary team created virtual lectures, workshops and clinical rounds for students from the University of Surrey School of Veterinary Medicine as they adapted teaching to the prevailing circumstances. We saw a doubling in the number of early years foundation stage, primary and secondary curriculum-linked materials downloaded as families accessed education resources to support schoolwork at home.

Our efforts to influence policy and practise continued as we engaged governments and statutory agencies internationally on a range of issues. We came together with colleagues from the UK's other large charitable zoological institutions to articulate our collective value in the wake of coronavirus restrictions and seek governmental support through these difficult times.



Economic Impact

Our charitable delivery around the world is underwritten by resources generated through the operation of Marwell Zoo in Hampshire, which is itself a centre for enjoyment of nature, learning, sustainability and scientific endeavour.

Marwell's presence and direct expenditure in the local economy brings further value because of the goods and services supported through our supply chain, plus the extended spending habits of employees and visitors in the area. We use standard tourism multipliers to estimate the sum of this direct, indirect and induced expenditure, expressed as our 'Gross Value Added' (GVA) contribution to the regional economy. Because of coronavirus social restrictions during 2020, there may have been changes in the spending habits of individuals and businesses that could have affected this model. However, calculating GVA provides us with a helpful comparison to previous years. The effect of the pandemic on our economic impact and jobs was tangible, but despite disruption, Marwell continued to make a significant contribution to the regional economy:

311,839 guests visited Marwell Zoo (544,684 in 2019)

174 full-time equivalent employees

£60.2 million Gross Value Added contribution to economy (£64.4 million in 2019)

over **800** jobs supported in the area (1,100 in 2019)

Over **1,500** local suppliers

Where We Work

Internationally, we work with local stakeholders in places that are largely overlooked and under-represented, but hold important wildlife populations in biologically and socio-economically fragile environments. These are places with genuine need coupled with local aspiration for conservation, and the potential for scalable impact, including across international borders. It is also important that we get it right on our own patch, managing and using our own land sustainably, enhancing local biodiversity and contributing to species and habitat conservation across the wider landscape.

SOUTH OF ENGLAND

Semi-natural lowland ecosystems in the south of England.

TUNISIA

Southern Tunisian arid steppe and the Grand Erg Oriental.

KENYA

Semi-arid and arid rangelands of northern Kenya.

CENTRAL ASIA

Tian Shan mountain ecosystem bordering China, Kazakhstan and Kyrgyzstan.

Restoring Nature

The vast Grand Erg Oriental (great eastern sand sea) is home to a diversity of desert-adapted wildlife, including the endangered slender-horned gazelle *Gazella leptoceros* which needs help to recover from disturbance and illegal hunting.

photo © Tim Woodfine, Marwell Wildlife

Restoring Nature

photo © Saltore Saparbayev, Kazakhstan

photo © The Wildlife Institute, Beijing Forestry University

Plains to Peaks

10,000 km² area covered during aerial survey of goitered gazelles.

Aerial surveys in early summer, covering almost 10,000 km², marked the beginning of a project to assess the population and distribution of threatened goitered gazelles *Gazella subgutturosa* as part of a wider goal of restoring arid steppe and mountain ecosystems and connectivity in south-eastern Kazakhstan.

Estimates from this initial work suggest 250 to 300 individual gazelles are living outside of protected areas, with densities ranging from 0.04 to 1.2 animals per km².

The project is supported with a grant from the International Union for the Conservation of Nature's (IUCN) Save Our Species (SOS) programme to work with local conservation teams. To assist with the survey undertaken south-east of Altyn-Emel National Park and extending to the border with China, the Kazakh military kindly donated helicopter time.

The largest groups of gazelles comprised 20 to 30 individuals, seen on the grasslands north of the Tian Shan mountains. While it is encouraging that some larger herds still occur, the majority of sightings were of single animals or pairs with the worrying implication that animals have become scattered and isolated over large areas. This could be a seasonal pattern and subsequent surveys in winter will explore aggregation behaviours more fully. Nevertheless, we remain alert to threats to the long-term future of the species by reducing breeding opportunities, while increasing risks from inbreeding, predation, disease, and habitat degradation.

Together with an understanding of current restrictions on the movements of gazelles, these assessments will be used to help develop and undertake collective actions with a wide range of stakeholders to improve and protect the ecosystems that people, gazelles and other wildlife rely on.

PARTNERS Institute of Zoology, Ministry of Education and Science, Kazakhstan | Wildlife Without Borders, Kazakhstan | IUCN Save Our Species

Snow Leopard Landscape Use

Long-term datasets from the Qomolangma (Mount Everest) region of the Himalayas and the Qilian Mountains on the north-east edge of the Qinghai-Tibetan Plateau showed how snow leopards *Panthera uncia* vary in their use of these mountain habitats depending on climate, the natural environment and human footprint, with implications for the conservation for these threatened big cats.

Working with colleagues in China and writing in the journal Ecology and Evolution, findings from the study are critical to understanding the habitat niche of snow leopards. Human settlements appeared to have a greater impact on snow leopard behaviour in the Qilian Mountains, whereas the complex topography and river network influenced their occurrence around Qomolangma. However, climate was shown to be a constant influence, highlighting the sensitivity of snow leopards and their ecosystems to changes across their range.

In Kazakhstan, camera-trap images revealed that during local coronavirus restrictions snow leopards, and other predators including lynx *Lynx lynx* and brown bears *Ursus arctos,* returned to areas near Almaty where they were previously displaced by human activities. Our colleagues at Wildlife Without Borders Kazakhstan and the Institute of Zoology began a project with our support, and a grant from the IUCN SOS programme, to improve conservation engagement with the citizens of Almaty. The expanding city pushes closer up against the Tian Shan mountain habitats of snow leopards and the team are working to improve awareness and promote sustainable tourism and other income generating activities that might otherwise cause problems.

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ABOVE
Goitered gazelles *Gazella subgutturosa*, focal species for a new project in south-eastern Kazakhstan.

Camera-trap image of a snow leopard *Panthera uncia* taken in the Qilian Mountains, Gansu Province of China.

PARTNERS NABU Germany and Kyrgyzstan | Wildlife Institute, Beijing Forestry University, China | Almaty State Nature Reserve, Kazakhstan | Institute of Zoology, Ministry of Education and Science, Kazakhstan | National Academy of Science, Kyrgyzstan | Wildlife Without Borders, Kazakhstan

Cryptic Carnivores and Other Aridland Wildlife

26 new camera-traps set up in Sidi Toui National Park, Tunisia.

Presence of the desert adapted Rüppell's fox *Vulpes rueppellii* in Jbil National Park and more frequent records of striped hyaena *Hyaena hyaena* in Dghoumes National Park were highlights of ecological monitoring and studies in Tunisian protected areas. Meanwhile, systematic camera-trap surveys were extended to Sidi Toui National Park increasing capacity to assess the biodiversity of semi-arid steppe and desert ecosystems.

Despite its large range, Rüppell's fox remains under-studied and has proven to be extremely elusive in Tunisia which might reflect its cryptic nature or that it exists in very low numbers. It was, therefore, exciting to confirm the presence of this species from camera-trap images in Jbil National Park, where it co-exists with African golden wolves *Canis anthus* and fennec foxes *Vulpes zerda*, and probably red fox *Vulpes vulpes*. It is only in the last couple of years that we have started to pick up good evidence of usually shy striped hyaenas in Dghoumes National Park. We're hoping that more frequent images of this species in 2020 reflects improving conditions resulting from the long-term restoration of this protected area.

Based on the methods established in Dghoumes and Jbil, a network of 26 remote camera-traps was set up in Sidi Toui National Park following training of park staff. Not only will this enhance monitoring of reintroduced scimitar-horned oryx *Oryx dammah* and North African ostriches *Struthio camelus camelus* but should result in greater understanding of local wildlife populations and produce data that is comparable with other sites. Following their training and provision of a laptop, the protected area team have already downloaded good images of dorcas gazelles *Gazella dorcas*, red fox, African golden wolf, African wild cat *Felis silvestris*, crested porcupine *Hystrix cristata*, hare *Lepus capensis*, desert hedgehog *Paraechinus aethiopicus*, spur-thighed tortoise *Testudo graeca nabeulensis* and various species of rodents, birds and other reptiles.

PARTNERS Direction Générale des Forêts (Ministry of Agriculture, Water Resources and Fisheries), Tunisia | Bou Hedma, Dghoumes, Jbil and Sidi Toui National Parks and associated CRDA | University of Tunis El Manar

photos © Marwell Wildlife

> **RIGHT** Camera-trap images of African wild cat *Felis silvestris* (top), Rüppell's fox *Vulpes rueppellii* (bottom) and striped hyaena *Hyaena hyaena* in Tunisian protected areas.

Genetics Inform Management of Reintroduced Aridland Antelopes

553
samples
analysed to understand the genetics of scimitar-horned oryx and addax antelopes.

Results of extensive and pioneering studies revealed that each population of scimitar-horned oryx *Oryx dammah* and addax *Addax nasomaculatus* that we have helped to reintroduce to a network of protected areas in Tunisia makes a differing and valuable genetic contribution for the conservation of their respective species. These and other important conclusions, drawn from genetic profiles of animals in Tunisian protected areas and compared to their counterparts in captivity across the world, are now helping to inform *in situ* management of both these species of aridland antelopes.

To date, the application of genetic techniques has been under-utilised in the monitoring and management of animal reintroductions and translocations, so our studies on scimitar-horned oryx and addax provide unique insights into the real-world outcomes of re-establishing populations in nature. Our work has helped validate the widely used pedigree-based method of selecting individual animals for reintroduction which aims to maximise genetic diversity and minimise inbreeding in founder populations. By understanding differences in the genetic make-up of currently isolated reintroduced populations, we can now make clear recommendations for moving animals between protected areas to ensure gene flow and reduce future risks of inbreeding, or even establish corridors connecting populations. It has also been possible to identify genetic lineages in the global captive populations of both species that could augment reintroduced herds. For example, we now know that scimitar-horned oryx in the UAE could make a valuable genetic contribution to populations of animals in Tunisian protected areas.

This important knowledge is the culmination of several years of effort to process and analyse samples from 83 scimitar-horned oryx and 108 addax in Tunisian protected areas, and a further 119 scimitar-horned oryx and 243 addax from around the world.

PARTNERS Direction Générale des Forêts (Ministry of Agriculture, Water Resources and Fisheries), Tunisia | Dghoumes, Bou Hedma, Jbil, Sidi Toui and Senghar-Jabbes National Parks, and Oued Dekouk and Haddej National Reserves and associated CRDA | Al Ain Zoo | The Royal Zoological Society of Scotland | San Diego Zoo Wildlife Alliance

photo © Marwell Wildlife

Hope for Slender-Horned Gazelles?

Ground surveys covering a distance of 200 km undertaken with experienced local trackers, and discussions with communities, provided vital signs that the Endangered slender-horned gazelle *Gazella leptoceros* persists in remote areas of the Tunisian Grand Erg Oriental.

Encouragingly, constructive discussions with stakeholders have shone a light onto a possible way back for the species, for which there is a great deal of local support, particularly in opposing incursions by poachers coming from outside of the area. Indeed, local opinion suggests that a shift from traditional, sustainable hunting practices to indiscriminate poaching using quadbikes day and night has been an important factor driving catastrophic decline of this desert adapted species.

Because of the perilous status of the slender-horned gazelle, we have also been providing technical and logistical support to protected area managers to safeguard isolated populations of this species elsewhere in Tunisia. In 2020, this included moving two pairs of gazelles from Sidi Toui National Park to a new breeding centre at El Gonna, near Sfax, as part of a plan to produce animals for the augmentation of wild populations.

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ABOVE
Endangered slender-horned gazelles *Gazella leptoceros* pictured in Sidi Toui National Park, Tunisia.

PARTNERS Direction Générale des Forêts (Ministry of Agriculture, Water Resources and Fisheries), Tunisia | Sidi Toui, Jbil and Senghar-Jabbes National Parks and El Gonna National Reserve and associated CRDA

Wildlife Monitoring in Northern Kenya

8,700 km of patrol routes covered on foot by Community Scouts in northern Kenya.

Our Community Scouts continued year-round monitoring of wildlife and the environment in the far north of Kenya, covering a combined distance of 11,589 km (including over 8,700 km on foot) while adhering to social distancing protocols.

Following the drought of 2019, this remote part of northern Kenya experienced further pressure with a widespread plague of desert locusts and localised over-grazing as the movements of semi-nomadic pastoralists were restricted by measures imposed to reduce spread of SARS-CoV-2, the virus that causes COVID-19. As a likely consequence, there were increased reports of poaching prompting meetings with our colleagues at the Kenya Wildlife Service and Milgis Trust, resulting in greater information sharing and patrol effort to protect threatened species.

Nevertheless, a total of 22 mammalian species were recorded by scouts using GPS-enabled smartphones, with results broadly consistent with previous years. Dik-dik *Madoqua guentheri* and gerenuk *Litocranius walleri* remained the most commonly sighted of the herbivores and black-backed jackals *Canis mesomelas* the most commonly sighted of the carnivores (as in 2018 and 2019). For a third consecutive year, scouts consistently recorded presence of a range of carnivores within this remote semi-arid landscape, which are important indicators of the underlying health of the ecosystem. Species included: leopard *Panthera pardus pardus*, spotted hyaena *Crocuta crocuta*, striped hyaena *Hyaena hyaena*, cheetah *Acinonyx jubatus*, black-backed jackal, African wild dog *Lycaon pictus*, caracal *Caracal caracal*, serval *Leptailurus serval* and aardwolf *Proteles cristata*.

This continued monitoring by our network of scouts is improving our understanding of wildlife and interactions with people and livestock in this under-studied part of Kenya.

PARTNERS Kenya Wildlife Service | Grevy's Zebra Trust | Lewa Wildlife Conservancy | Milgis Trust | Northern Rangelands Trust

Restoring **NATURE**

Earning Our Stripes

32,517 images of Grevy's zebra held in national Stripe ID database, providing a wealth of research and monitoring material.

It has been fifteen years since we began using novel stripe identification software to monitor Grevy's zebra *Equus grevyi* in northern Kenya. The database now holds over 32,000 images of Grevy's zebra, taken over the years from across their range, helping to monitor changes in population sizes and how animals move between different locations.

Each individual Grevy's zebra has its own unique stripe pattern akin to our own fingerprints. By identifying individuals, we can estimate how many there are in a given area, understand their relationships and see how they use the landscape when they are spotted in various places. Examining photographs of these animals was once slow and laborious. However, the Extract Compare software, developed by our colleagues at Conservation Research Ltd, helped automate the process using digital images and comparing them to others stored in a database. We have used the system routinely since launching it in Kenya in 2005, principally for community-based monitoring of Grevy's zebra across our remote study area in the far north of Kenya, while also supporting its use by partners including Grevy's Zebra Trust and Lewa Wildlife Conservancy. A total of 32,517 images of Grevy's zebra had been accumulated in the database by the end of 2020, providing a wealth of research and monitoring material.

Following the prolonged drought in 2019 and the need to provide supplementary feed for Grevy's zebra in the worst affected areas, we received encouraging reports from our Community Scout teams that animals across our study area were in better health and breeding successfully despite further environmental impacts. Fewer Grevy's zebra were seen in 2020 compared to 2019, but this may be explained by lower patrol effort and dispersal of animals due to patterns in forage and water availability.

PARTNERS Kenya Wildlife Service | Grevy's Zebra Trust | Lewa Wildlife Conservancy | Conservation Research Ltd

Habitat Restoration in the South of England

An assessment by Natural England confirmed that the whole of Eelmoor Marsh Site of Special Scientific Interest (SSSI) remains in 'favourable' condition, meaning that habitats and features are in a healthy state and conserved by appropriate management. Further tree planting, ongoing restoration of Marwell's semi-natural ancient woodlands and management of chalk grassland helped enhance the value of our own land for local wildlife.

Maintaining and enhancing the variety of habitats at Eelmoor Marsh takes continual effort, so targeted works were carried out to control invasive scrub across 5.6 ha of wet and dry heath; remove 1 ha of self-seeded pine trees to create more open heathland; diversify the structure of 5.2 ha of wet heath; and reduce patches of overly dense purple moor grass *Molinia caerulea*, to expose a total of 1.2 ha of bare ground to encourage regeneration of the seed bank. Further work was carried out to improve conditions for rare bog plants along 370 m of ditches. Conservation grazing intensity was increased with the acquisition of another four Highland cattle *Bos taurus* to help maintain the extent of valuable open habitats that have been gradually recovered at Eelmoor Marsh. This brought the total number of livestock on-site to 11 Highland cattle and four Przewalski's horses *Equus ferus przewalskii*.

Records of 31 species of butterfly and 23 species of dragonflies and damselflies (*Odonata*) matched observations from the previous year. Counts of the nationally vulnerable silver-studded blue butterfly *Plebejus argus* were particularly strong in 2020, reflecting a growing population and the favourable status of its habitat on site. Meanwhile, dark green fritillary *Argynnis aglaja* was seen for a third consecutive year, while there were good numbers of other priority species such as small heath *Coenonympha pamphilus* and grizzled skipper *Pyrgus malvae*. The nationally scarce small red damselfly *Ceriagrion tenellum* appears to have recovered from low numbers following the drought in 2018, and it was a similarly excellent year for the nationally uncommon keeled skimmer *Orthetrum coerulescens*. Five other dragonfly species of conservation concern that have appeared sporadically at Eelmoor Marsh over the years were all recorded in 2020: beautiful demoiselle *Calopteryx virgo*; hairy hawker *Brachytron pratense*; common goldenring *Cordulegaster boltonii*; downy emerald *Cordulia aenea*; and blue featherleg *Platycnemis pennipes*.

In the wetter parts of the site, insectivorous plants, round leaved sundew *Drosera rotundifolia*, long leaved sundew *Drosera intermedia* and pale butterwort *Pinguicula lusitanica*, were abundant and spreading in response to previous habitat restoration. Conservation grazing maintained good conditions for species such as marsh helleborine *Epipactis palustris*, early marsh orchid *Dactylorhiza incarnata*, marsh clubmoss *Lycopodiella inundata* and bog St. Johns wort *Hypericum elodes*. Priority species of bird, including breeding nightjar *Caprimulgus europaeus*, Dartford warbler *Sylvia undata*, and hobby *Falco subbuteo*, as well as water rail *Rallus aquaticus* and cuckoo *Cuculus canorus* were among the ornithological highlights of the year.

Meanwhile, we continued to enhance tracts of Marwell's semi-natural ancient woodland by removing nearly 1 ha of larch to encourage regeneration of native broadleaved woodland, and restored hazel coppice across an area of 0.35 ha. A total of 1,850 tree whips were planted across 3.5 ha of land as part of a long-term plan to create secondary woodland habitat and sequestrate carbon.

photo © Tim Woodfine, Marwell Wildlife

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ABOVE
Azure damselfly *Coenagrion puella*, one of 23 species of *Odonata* recorded at Eelmoor Marsh in 2020.

PARTNERS QinetiQ | Natural England | Forestry Commission | The Hampshire and Isle of Wight Wildlife Trust | The Woodland Trust

New Location for Sand Lizard Reintroduction

The dry heath at Puddletown Forest, Dorset was the focus of a new reintroduction project for the rare sand lizard *Lacerta agilis*. We contributed 151 lizards, including 134 hatchlings and 17 yearlings, to support the first of a multi-year release aimed at re-establishing the species in former habitat. All going well, we look forward to Puddletown Forest becoming the 28th successful reintroduction site for Marwell-bred sand lizards in the south of England.

Monitoring of sand lizards reintroduced to Eelmoor Marsh Site of Special Scientific Interest continued with encouraging results including evidence of egg-laying and wild hatched juveniles. Meanwhile, the sand lizard breeding colony at Marwell produced 152 eggs from 19 clutches, resulting in 142 healthy hatchlings.

> **RIGHT**
> Marwell's Rachel Gardner releasing sand lizards *Lacerta agilis* at Puddletown Forest in Dorest, alongside our partners Amphibian and Reptile Conservation Trust and Forestry England.

PARTNERS QinetiQ | University of Southampton | Natural England | Forestry England | Amphibian & Reptile Conservation Trust | Surrey Amphibian and Reptile Group

photo © Jason Brown/Marwell Wildlife

Advances in Animal Welfare

photo © Jason Brown, Marwell Wildlife

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ABOVE
Black-and-white ruffed lemurs *Varecia variegata*, Linné's two-toed sloth *Choloepus didactylus* and siamang gibbons *Symphalangus syndactylus*, some of the species monitored using the Animal Welfare Assessment Grid in 2020.

During the last year we progressed the practical use of the novel Animal Welfare Assessment Grid and collaborated on development of cloud-based software, advanced the application of animal training to enhance welfare, and tested the use of artificial intelligence to monitor behaviour of tigers.

Animal Welfare Assement Grid

By scoring factors associated with physical and psychological health, and the environment, along with veterinary and other management interventions, the Animal Welfare Assessment Grid (AWAG) produces a graphical means of understanding welfare of an individual animal or group over time (cumulative welfare score).

Having previously tested the technique and established its use with several species, it was further adapted for monitoring siamang gibbons *Symphalangus syndactylus*, Linné's two-toed sloth *Choloepus didactylus*, giraffe *Giraffa camelopardalis rothschildi*, meerkats *Suricata suricatta* and black-and-white ruffed lemurs *Varecia variegata*. A number of individual welfare assessments were also completed to monitor the positive welfare impact of changes in husbandry management (e.g. the introduction of a new feeding regime for large carnivores) and to understand impacts of animals being moved between locations in the zoo (e.g. moving two siamang gibbons to a new enclosure).

With proof of concept completed, we set a new goal of using the AWAG for routine monitoring of all species under our care, collaborating on the development of cloud-based software for use in zoos to enable real time data collection and analysis. Following rapid progress, we hope to launch this in 2021.

PARTNERS University of Surrey, School of Veterinary Medicine | Reuben Digital

Animal Training

Learning is a natural biological process that has evolved to provide organisms with an evolutionary advantage. As a result, animals are constantly looking for cues in their environment to act on for their benefit. This principle sits at the heart of our work to encourage zoo animals to participate voluntarily in aspects of their own care and management, resulting in improved welfare.

There were several successful examples of this positive reinforcement training during the year. A female golden lion tamarin *Leontopithecus rosalia*, a female white-faced saki monkey *Pithecia pithecia* and a male bokiboky *Mungotictis decemlineata* were motivated to enter and become accustomed to their respective transport crates, avoiding the need for physical capture. Other golden lion tamarins, white-faced saki monkeys and long-nosed potoroos *Potorous tridactylus* were trained to stand on weighing scales for health monitoring. An Amur leopard *Panthera pardus orientalis*, Amur tiger *Panthera tigris altaica* and cheetah *Acinonyx jubatus* were successfully encouraged to receive vaccinations or preparation for healthcare interventions.

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ABOVE
Amur tiger *Panthera tigris altaica*, subject of an IBM Extreme Blue Summer Internship project looking at monitoring animal welfare using artificial intelligence.

Monitoring Tigers with Artificial Intelligence

Courtesy of an IBM Extreme Blue Summer Internships team, video footage of two Amur tigers was used to train software to differentiate between individuals, determine their behaviour and pinpoint their locations at any given time. This resulted in a working prototype of a system that has the potential to automatically monitor animal welfare in zoos and other settings or track the fortunes of threatened species in their natural habitats to support their conservation. The real-time data can also be displayed for interpretation purposes, enhancing zoo visitor experience and education.

PARTNER IBM

Sustainable Living

Managed to enhance local biodiversity, Marwell's woodlands and fields also provide sustainably harvested browse and hay for zoo animals with the resulting waste soon to be converted to low carbon heat.

photo ©Tim Woodfine, Marwell Wildlife

Sustainable Living

Towards a Better Environment

77%
reduction
in our carbon
footprint
since 2008.

Progress Towards Zero Carbon

Our carbon footprint in 2020 was 77% below that of our baseline year in 2008 (1,705 tonnes CO_2e in 2008 compared to 391 tonnes CO_2e in 2020), taking us steadily towards our goal of zero carbon.

Further progress was made following the first full year of heating our Tropical House with woodchip, which reduced our footprint by another 55 tonnes CO_2e. After achieving planning consent at the end of 2019, we began construction of a new energy centre and took delivery of a biomass boiler to convert waste straw bedding and herbivore dung into thermal energy. Due for commissioning in early 2021, the energy centre will initially heat the Tropical House and then supply Marwell Hall, our veterinary offices and a range of animal accommodation following installation of a planned district heat network. On-site processing of waste will remove the need for lorry journeys and replace fossil fuel heating for all the connected buildings, reducing our carbon emissions another 100 tonnes in the process. As part of our 'Energy for Life' project, Marwell's carbon reduction journey is just one aspect of our broader interpretation of the flow of energy through life, the challenges of powering modern lifestyles and the consequences for the global climate.

Saving Water

New remote logging equipment allowed us to monitor water consumption more closely and identify leaks in aging underground pipes. Focused efforts to undertake a series of repairs and replace whole sections of pipes throughout the year resulted in savings of 1,000 m^3 of water per month.

Like much of the UK's water infrastructure, our own underground pipe network is aging and in need of repair and upgrade. Until recently, we achieved considerable reductions in water consumption through changes in practise along with water capture and storage including the 100 m^3 underground storage system that supplies our Tropical House. Since then, the number of leaks in deteriorating pipes counteracted these efforts, prompting a focus on water monitoring, leak detection and repair. In our location, water percolates through the ground into a large aquifer from which we extract a limited and sustainable amount each year. However, much of the county's mains water is drawn from the River Itchen and the River Test so it's important we do our bit to reduce pressure on these precious ecosystems and the species reliant on them. Our Water Conservation Plan sets out the steps we are taking to reduce direct and virtual water consumption, and to capture rainwater on site.

photo © Kevin Morse, Marwell Wildlife

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ABOVE
Our 440 KW biomass boiler was delivered and installed in the 250 m^2 energy centre.

Environmental Standards

We retained certification of our Environmental Management System against the ISO14001 internationally recognised standard for the 11th consecutive year.

This systematic way of measuring and monitoring our environmental performance has been pivotal for setting objectives, making tangible improvements and guiding policy. For example, waste recycling carried out by visitors to Marwell increased by around 650% over the decade between 2009 and 2019, while the introduction of our Ethical Sourcing Policy has helped mitigate environmental impacts and enhance the social contribution of a wide range of products and materials from retail and catering stock to construction materials and animal feed.

Catalysing Change

Marwell's Head of Conservation Biology, Phillip Riordan, together with our partners from Wildlife Without Borders and the Institute of Zoology, Kazakhstan before coronavirus restrictions.

photo © Saltanat Sapdrbayev Kazakhstan

Catalysing Change

Natural Curiosity

140%
increase
in downloads of our online learning resources compared to 2019.

Education and engagement are normally about bringing people together, but these activities were necessarily curtailed or adapted throughout 2020. Downloads of our education materials more than doubled as learning went online and families accessed resources at home, while we adapted experiences for school groups that did make it to the zoo, children attending the Kids Love Nature Kindergarten at Marwell and our junior membership, the Wild Explorers Club.

Adapting for Schools and Learning Online

Over 40,000 children ordinarily participate in our education activities each year, but just 6,159 were able to visit Marwell with their schools in 2020 with 80% of them enjoying their experiences before the first national lockdown in March. Accordingly, the 135 national curriculum linked workshops we ran were just a fraction of the usual number. For those visiting in the latter part of the year, we trialled the use of outdoor learning hubs allowing teachers to book shorter focussed sessions with members of our team in various locations.

Our online learning resources were collectively downloaded 17,752 times during 2020, an increase of 140% compared to the previous year. Of these, 94% (16,703) were unique downloads. The most popular resources, and those showing the greatest year on year increases, were materials linked to early years foundation stage and primary national curriculum. This included cross-curricular materials supporting maths, literacy, science, geography and art. Key science topics selected were habitats, animal classification, adaptation, and life cycles. On average, the number of downloads of curriculum related materials nearly tripled compared to 2019 suggesting they reached wider audiences as families sought novel ways to bring home learning to life and complement their children's schoolwork.

135
nature interpretation sessions
enjoyed by 71 children attending the Kids Love Nature Kindergarten at Marwell.

Treasure Trees and Other Tales

Children attending the Kids Love Nature Kindergarten at Marwell were treated to a rich variety of experiences, exploring our woodlands and fields, and the zoo when circumstances allowed. Woodlands are natural playgrounds and outdoor classrooms, providing the opportunity for young children to develop their motor skills and explore with their senses, finding living things and tell-tale signs of animal activities, while inspiring creativity.

Searching for woodland 'treasures' was a firm favourite, encouraging two to five year-olds to look for and examine objects that appealed to them, whether the rich colours and texture of lichens growing on sticks, delicate leaf skeletons, or soft, downy feathers. Learning that all these things were part of the fabric of life in the woods, the children chose 'treasure trees' as locations to deposit their findings and share their feelings about the day's experiences, returning to these special places many times.

Prior to the first national lockdown, the children became fascinated by snakes, learning first-hand about their physiology, adaptations, diets and natural habitats with our herpetologists; experiences they continue to spontaneously recall months later. In total, 71 children enjoyed 135 special nature interpretation sessions throughout the year.

PARTNER Kids Love Nature

Exploring the Small but Mighty!

Whether together or at home, members of our junior membership Wild Explorers Club enjoyed a range of activities on the theme of 'small, but mighty'. They explored how small actions (and small humans!) can make a big difference; how small organisms play important ecological roles, and just how big some things can grow from small beginnings!

The younger children (aged 4-8) became citizen scientists, documenting 'signs of spring' as part of an annual effort to build a picture of Marwell's phenology, while learning how data collected by individuals of all ages and backgrounds can feed into much larger datasets that help scientists answer real-world questions. The same group looked at animals in the Tropical House, discovering how organisms are connected through food webs, and how each one is important for maintaining a healthy ecosystem. A special native trees session was held for the older age group (9-12) which included helping our Plants & Landscapes team to plant small whips to grow a big hedge and estimate the heights of fully grown trees around the park.

Adapting to social restrictions when unable to meet in person, we provided downloadable trails and activities for families to follow in the zoo or at home prompting our Wild Explorers to consider little things they can do to help wildlife and the wider environment.

Higher Education

Our scientists supervised and facilitated 15 undergraduate and 39 postgraduate research projects during the year and taught nearly 300 university and college students, contributing to academic qualifications in the UK and internationally.

MRes Wildlife Conservation

Students and their supervisors overcame enormous challenges to deliver highly successful outcomes to our MRes Wildlife Conservation in collaboration with the University of Southampton. Ten students graduated from the course in 2020 with the majority of them being awarded distinctions, reflecting the quality of research undertaken.

Travel restrictions imposed in response to the coronavirus pandemic forced students to adapt and, in most cases, entirely rethink their initial project plans. However, this impressive cohort still made direct contributions to our programmes of work in Central Asia, Kenya and the UK, with a number of them utilising and demonstrating the value of our long-term datasets. Research topics included: socio-political characteristics facilitating transboundary conservation of snow leopard; application of a rapid ecosystem service assessment to inform management decisions at Eelmoor Marsh Site of Special Scientific Interest; habitat suitability and connectivity for the hazel dormouse in the south of England; contributions of citizen science for understanding species distribution trends in northern Kenya; the post-release monitoring of sand lizards; responses of primates to anthropogenic disturbance; and spatial ecology of Grevy's zebra in northern Kenya.

To date, 53 students have completed the MRes Wildlife Conservation, which is purposefully designed to provide a pathway to the professional competences and the personal development and confidence needed to have real impact in the world. Following their studies, nearly half (47%) were employed in a conservation role within a year of graduating and a further quarter (23%) went on to undertake a PhD or further research. Many students have successfully communicated their findings to key project partners and the wider conservation community or published their research in academic journals.

PARTNER University of Southampton

photo © Manwell Wildlife

> **RIGHT**
MRes Wildlife Conservation students developing their fieldwork skills during part of their course in Kenya in January, prior to coronavirus restrictions.

Veterinary Medicine & Animal Behaviour

To ensure continued educational provision during a year when opportunities for on-site, practical engagement were limited, our veterinary team provided remote learning opportunities for 137 fourth -year BVMSci students and virtual zoological medicine intramural rotation electives for 13 final-year students from the University of Surrey School of Veterinary Medicine.

Adapting to the circumstances, lectures, workshops and even clinical rounds were delivered to veterinary students online with live Q&A and other interactive sessions encouraging participation. Meanwhile, three animal behaviour work placement students joined the team in person when possible and otherwise participated remotely. This helped progress a series of data collection exercises and studies to evaluate animal behaviour, including understanding effects of closing and re-opening the zoo on a selection of species.

PARTNERS University of Surrey | University of Exeter

Trainee Teachers

Over 120 trainee teachers, across primary and secondary education, accessed training and professional development opportunities at Marwell during the first quarter of 2020.

Designed in collaboration with the University of Southampton, special 'Focus Days' provided 39 secondary trainee teachers with insights into biodiversity and conservation, learning outside the classroom and teaching students with special educational needs. Meanwhile, 83 primary trainee teachers from the University of Winchester joined us to find out more about our conservation work and educational opportunities for school groups.

PARTNERS University of Southampton | University of Winchester

> TOP RIGHT
In collaboration with the University of Edinburgh's Roslin Institute and the Royal (Dick) School of Veterinary Studies, and the Pirbright Institute, **Stephanie Brien** continued her PhD research on the immunogenetics of scimitar-horned oryx in Tunisia.

> BOTTOM NEAR RIGHT
We assisted **Maimounatou Ibrahim**, a PhD student at Université de Niamey and Site Manager for the Sahara Conservation Fund at Kellé in Niger, as she progressed her research on the breeding of North African ostriches for reintroduction.

> BOTTOM MIDDLE RIGHT
Amira Saidi (top) and **Khalil Meliane** (bottom) continued their PhD studies, with the University of Tunis El Manar. Amira's research focuses on the diversity and ecological function of arthropods, whilst Khalil's research focuses on managed ecosystem function and resilience in the desert of southern Tunisia.

> BOTTOM FAR RIGHT
Rachel Gardner was awarded a PhD for her work on factors influencing post-release movement and survival of reintroduced sand lizards in collaboration with the University of Southampton.

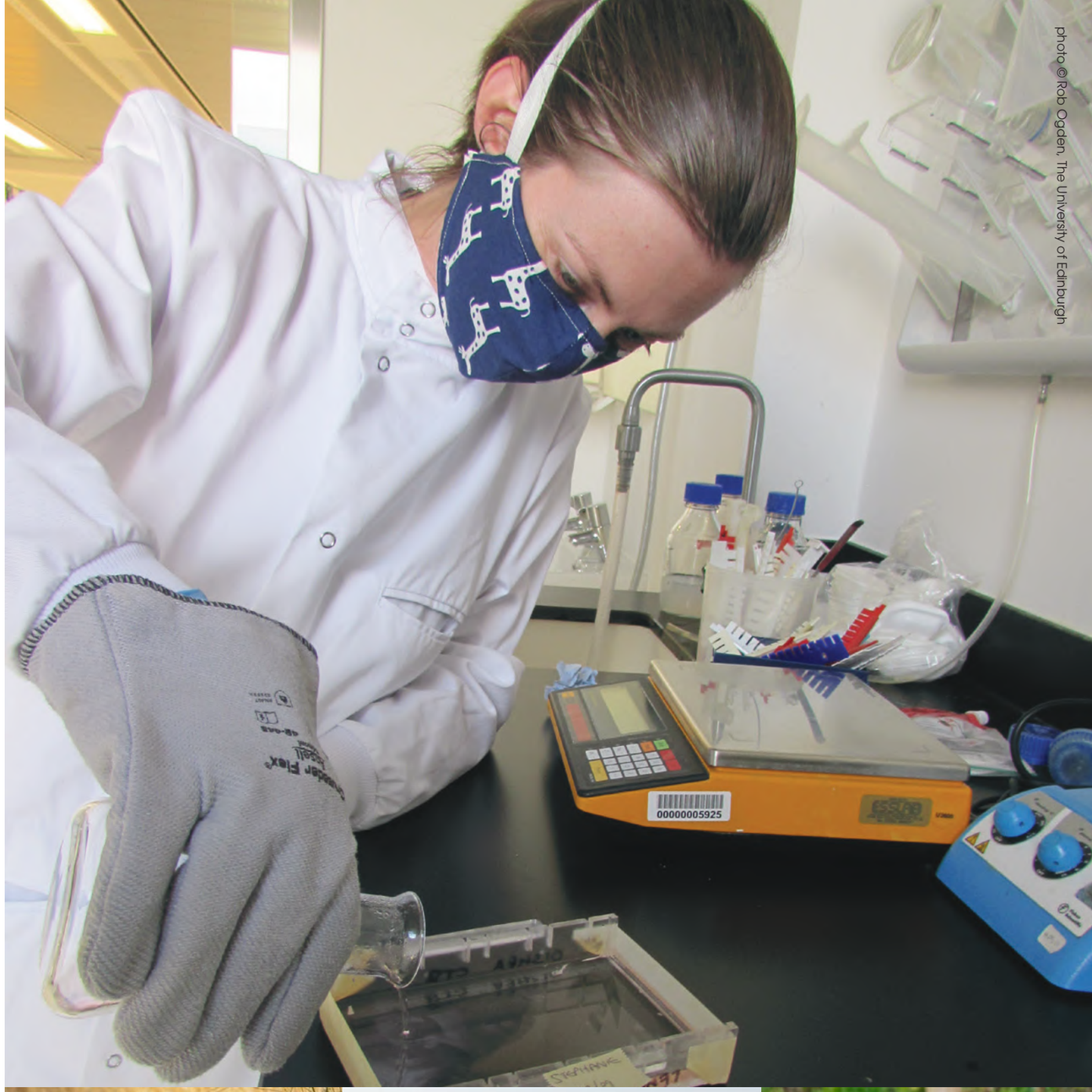

photo © Rob Ogden, The University of Edinburgh

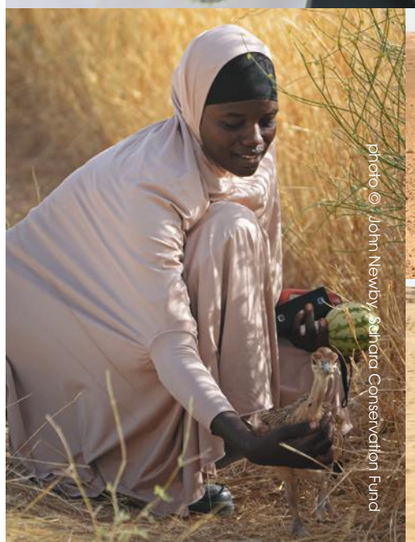

photo © John Newby, Sahara Conservation Fund

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Participation and Capacity Building

Marwell Volunteers

Our 143 volunteers are instrumental to our success and, despite reduced opportunities in 2020, they collectively gave 4,296 hours of their valuable time. This was particularly important to help ensure Marwell remained a safe and enjoyable place for guests to visit at a time when many were keen to be outdoors and connect with nature.

Encouraging and facilitating guests to adopt social distancing and hygiene measures became the highest priority for the majority of 2020. This relied on our entire team being flexible, taking on new duties, adhering to new hygiene protocols and continually using face coverings and other personal protective equipment. Despite a very different way of doing things, the flow of guests was managed efficiently and with great skill and warmth, as the team took the opportunity to share their knowledge and passion for the animals and related topics.

Socially distanced but regular interactions with guests produced some unplanned but welcome benefits. Through this engagement and by encouraging closer observations of environments, guests often saw more animals and took more notice of their behaviours. For example, guests visiting our Tropical House reported seeing many more species by slowing their pace and being more observant after engaging with a member of our team.

> **RIGHT**
One of our dedicated volunteers engaging with guests in the Energy for Life Tropical House, whilst ensuring social distancing protocols are maintained.

photo © Tim Woodfine, Marwell Wildlife

Developing Strategies for Stakeholder Engagement and Species Conservation

A series of online workshops brought together teams in five countries to share their experiences and help develop strategies for wildlife conservation. This involved collaboration between 25 conservationists representing our own teams and partners in the UK, Africa and Central Asia.

With support from an IUCN SOS grant for the conservation of goitered gazelles, plans were in motion to facilitate a strategic planning process and engage key stakeholders in Kazakhstan. Having been forced to move online because of travel restrictions, we took the opportunity to extend the offer to teams in Tunisia, Kenya, Bhutan and the UK.

Through these workshops, which broadly follow WildTeam's Strategy Development for Wildlife Conservation approach, we began talking to the teams collectively about applying and adapting best practice guidance to further develop their thinking about projects ranging from conservation of snow leopards and goitered gazelles in Kazakhstan; addax and scimitar-horned oryx in Tunisia; Grevy's zebra in northern Kenya; tigers in Bhutan to native species in the south of England.

Following an introductory session, the workshops looked at stakeholder analysis and engagement. Participants were introduced to tools to help them better understand the various perspectives, values and motivations of people and institutions with vested interests in their respective environments, and to make informed decisions about which groups to engage, and how best to engage them, in the strategy development process. Despite working with different species across vastly different landscapes, the workshops led to a natural sharing of ideas, knowledge and experiences amongst teams and to shaping some common thinking.

Building on this initial work, future workshops will focus on comprehensive situation analyses and developing theories of change; setting out the steps needed to bring about desired conservation outcomes and how this will be monitored and measured.

PARTNERS Wildlife Without Borders, Kazakhstan | Institute of Zoology, Ministry of Education and Science, Kazakhstan | Paro Forest Division, Department of Forests and Park Services of Bhutan

> **RIGHT**
Our online workshops brought together teams from Kazakhstan, the UK, Bhutan, Tunisia, and Kenya to share experiences and help develop their respective conservation strategies.

Multiplying Impact

Saving the Last Wild Addax

At the invitation of the Niger Government and with support of an IUCN SOS Rapid Action Grant, we organised an expert consultation focussed on saving the last wild addax and the future of the Termit and Tin Toumma National Nature Reserve (TTTNNR).

The team, comprising representatives of the IUCN Species Survival Commission Antelope Specialist Group (ASG) and the IUCN West and Central Africa Programme was warmly welcomed by the authorities for talks in Niamey. The resulting report proposed a series of recommendations to support conservation of addax and another related and Critically Endangered species, the dama gazelle *Nanger dama*. Changes in the boundary of the TTTNNR have since been made, while engagement with key non-governmental organisations, multi-lateral funding agencies and private sector stakeholders are ongoing in an attempt to unlock the resources and collaborations needed to protect these rare animals over vast tracts of desert habitat.

Global Snow Leopard and Ecosystem Protection Progamme (GSLEP)

An online meeting of the Global Snow Leopard and Ecosystem Protection Programme (GSLEP) steering committee included a high-level ministerial session with representatives of all 12 snow leopard range states.

We hosted a 'Partner Kiosk' highlighting our recent work assessing socio-political characteristics facilitating transboundary conservation for snow leopards, and including a case study from Almaty, Kazakhstan, on the impacts of development and urbanisation.

Great Grevy's Rally

As a member of Kenya's Grevy's Zebra Technical Committee (GZTC), we co-organised and participated in the third 'Great Grevy's Rally' (GGR); a novel citizen science event to undertake a snapshot census of this endangered species across its north Kenyan range.

Held every two years, GGR brings together communities, landowners, scientists and tourists to photograph as many Grevy's zebra as possible over two consecutive days using 'mark-recapture' methodology to estimate the number of animals seen. In 2020, nearly 700 people participated in the event (compared to 212 in 2018), forming 160 teams spread over an area of 30,000 km^2. The Marwell team covered the remote landscape to the north, where Grevy's zebra are more sparsely distributed, supported by volunteer motorcyclists from the local community, Milgis Trust and Ndoto Conservancy, and with aerial cover from Kenya Wildlife Service. Publication of the results from the GGR is due in 2021.

photo © Sahara Conservation Fund

photo © Wildlife Without Borders Kazakhstan

> **RIGHT**
> Addax *Addax nasomaculatus* in Termit and Tin Toumma National Nature Reserve, Niger.
>
> Grevy's zebra *Equus grevyi* in northern Kenya.
>
> A snow leopard *Panthera uncia* pictured in the mountains close to the Kazakh city of Almaty.

Multiplying Impact

Population Management

Migration of large datasets that underpin the pedigree-based *ex-situ* breeding recommendations for Grevy's zebra and scimitar-horned oryx to a new cloud-based system was completed in 2020. Using the Zoological Information Management System (ZIMS) for Studbooks will directly connect institutional and pedigree records, making these datasets more robust and up to date, helping to improve species management.

We also contributed to the publication of a new regional collection plan offering guidance to members of the European Association of Zoos & Aquaria (EAZA) on *ex-situ* conservation priorities and support for *in-situ* conservation efforts for all equid species.

Sustainability Forums

Following one live event in early 2020, Winchester Sustainable Business Network meetings went online for the remainder of the year drawing a total of 400 attendees from local businesses, government and non-governmental organisations.

Meeting titles and topics for 2020 were: "Getting Smart with Cutting Carbon"; "Net Zero Carbon for SMEs"; "Sustainability in Fashion and Textiles" as part of Winchester Fashion Week; "Sustainability – the New Normal?"; and "The New Green Deal". Holding online events brought larger audiences and extended reach beyond the local area while reducing the travel impacts of bringing people together. On the other hand, many regular attendees missed the networking and site visit opportunities of in-person events so it's likely that a mixture of the two approaches will be adopted in future.

Societal Value of Britain's Large Zoos and Aquariums

We came together with colleagues from the UK's other large charitable zoological institutions to articulate our collective value to Government in the wake of coronavirus restrictions and seeking support through these difficult times.

photo © Jason Brown, Marwell Wildlife

^
ABOVE
Marwell was one of the UK's nine large charitable zoological institutions which came together in 2020 to articulate our collective value to the Government in the wake of coronavirus restrictions.

Through a joint position paper, we set out the wide-ranging social, environmental and economic benefits of our work in the UK and internationally, converting visitor attraction and membership income into significant levels of ordinarily sustainable funding for global biodiversity conservation and human wellbeing that would not otherwise be available for these critical causes.

In the year prior to the pandemic, the nine institutions collectively hosted over eight million visits and spent over £200 million across their regional economies. Despite the challenges, we continue to care for over 85,000 individual animals including those representing some of the most threatened species on Earth, while maintaining our commitments to a plethora of conservation, education and development projects around the world, contributing to broader outcomes such as the United Nations Sustainability Goals, targets set by the Convention on Biological Diversity, and indeed the UK's own 25-year Environment Plan.

Our paper proved important for informing debate in Parliament, providing a reference point for regular dialogue with the Department for Environment, Farming & Rural Affairs and was used by colleagues internationally to support discussions with their own governments. Being heard is important and this is an ongoing process as we emerge from the pandemic seeking to rebuild our finances and sustain our societal impacts.

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PARTNERS

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IUCN Species Survival Commission Antelope Specialist Group
IUCN Species Survival Commission Equid Specialist Group
IUCN West and Central Africa Programme
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photo © Katherine Cowlard, Marwell Wildlife

Looking to the Future

The emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus responsible for COVID-19, was a stark example of our changing relationship with nature. It is the third documented spillover of an animal coronavirus to humans in only two decades that has resulted in a major epidemic. It is also a warning that there may be more zoonotic disease transmission to come as humans are increasingly exposed to wild animals through encroachment and disruption of natural habitats and because of persistent, alarming levels of wildlife trade.

Human, animal and ecosystem health are inextricably linked. This is why much of our work now focusses on the need to restore healthy, functioning ecosystems that not only provide us with fresh air, water, food and medicine but regulate climate and protect us from disease and other catastrophes. That direct work can only be successfully sustained if we help realign society's relationship with nature and an appreciation of the way it functions. This requires a breadth and depth of effort ranging from the need to engage with governments and other key decision-makers through to the opportunities we create for children to connect meaningfully with nature.

All of these themes will resonate during an important year ahead which includes the IUCN World Conservation Congress, the 15th meeting of the Conference of the Parties to the Convention on Biological Diversity, and the UN Climate Summit.

> **RIGHT**
Nationally vulnerable silver-studded blue butterflies *Plebejus argus* at Eelmoor Marsh.

photo © Nicholas Montegriffo, Marwell Wildlife

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