
THE QUEEN'S AWARDS
FOR ENTERPRISE:
SUSTAINABLE
DEVELOPMENT
2022
50
Marwell
Wildlife
50 years of conservation
2021
Impact Report

Autumn
lady's-tresses
Spiranthes spiralis.

photo © Richard J Bullock

Contents

Our Work

THE QUEEN'S AWARDS FOR ENTERPRISE: SUSTAINABLE DEVELOPMENT 2022

Welcome to our review of charitable activities and impacts for 2021. 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.

The Queen's Award for Enterprise: Sustainable Development was a heartening recognition of our achievements in wildlife conservation, sustainability and education, and a fitting way to begin Marwell's 50th anniversary in 2022.

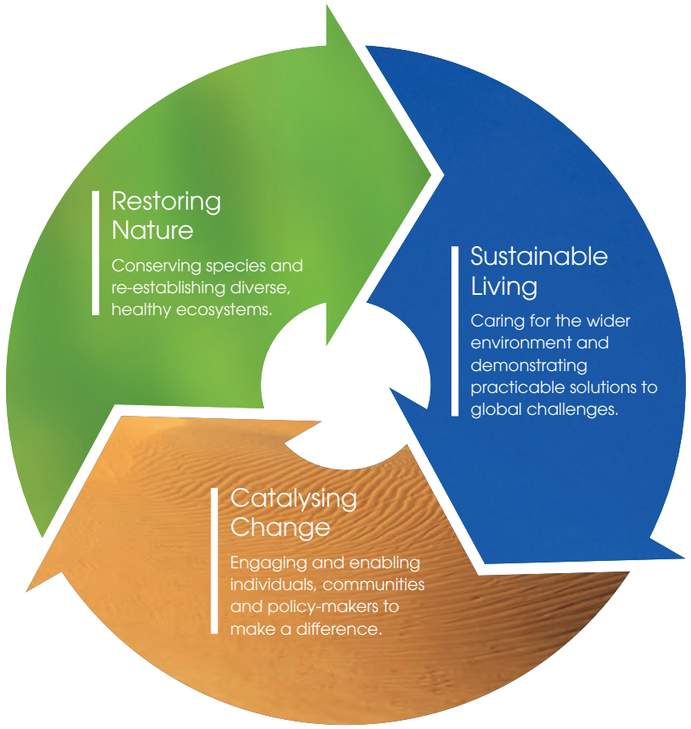
The global coronavirus pandemic disrupted all aspects of our charitable work for another year. Our teams continued to adhere to local restrictions wherever they worked to safeguard their own health and those around them. Ongoing travel constraints meant that international dialogue continued online, with some activities inevitably delayed. Nevertheless, with flexibility and resilience by all concerned, we made progress in many areas.

Ecological connectivity and restoration were important themes running through our work. Data from tracking Grevy's zebra in northern Kenya fitted with Global Positioning System (GPS) collars highlighted the challenges for fragmented populations and the importance of community conservancies for providing suitable habitat. Elsewhere, a preliminary analysis of aerial surveys in Kazakhstan revealed how human activity influences numbers and distribution of goitered gazelles.

As part of a national strategy for the conservation of the rare Barbary sheep, our Tunisia team led the translocation of animals from Oued Dekouk National Reserve to begin the process of re-establishing the species in Zaghouan National Park. In the UK, the release of Marwell-bred sand lizards on to the dry heath at Puddletown Forest in Dorset was another step in the right direction for one of Britain's rarest reptiles.

Positive welfare is important for conservation and ethically, and, as planned, we launched our new Animal Welfare Assessment Grid (AWAG) cloud-based software. We are the first, and currently only, organisation in the UK to adopt an objective, continuous monitoring system for assessing the welfare of zoo animals.

Progress towards carbon neutrality was advanced with the commissioning of our biomass energy plant that converts zoo animal manure and used bedding straw into heat. Once connected via a heat network to a series of buildings, we anticipate a saving of around 200 tonnes CO_2e per year. This and other examples of our sustainability work were showcased through events organised around COP26, providing an opportunity to share carbon footprinting and reduction experiences with receptive audiences.



Economic Impact

Our charitable delivery around the world is underwritten by resources generated by the operation of Marwell Zoo in Hampshire, which is 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' contribution to the regional economy.

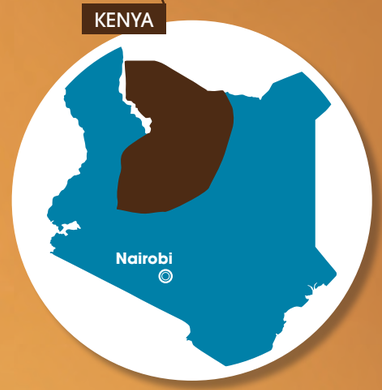
402,346 guests visited Marwell Zoo	**170** full-time equivalent employees	**£61.4** million Gross Value Added contribution to the economy	**800** jobs supported in the area	Over **1,500** local businesses supported by our supply chain

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.

Semi-natural lowland ecosystems in the south of England.

Southern Tunisian arid steppe and the Grand Erg Oriental.



Semi-arid and arid rangelands of northern Kenya.

Tian Shan mountain ecosystem bordering China, Kazakhstan and Kyrgyzstan.

Restoring Nature

Working in the far north of Kenya, our Community Scouts are helping to conserve the endangered Grevy's zebra *Equus grevyi*.

Restoring Nature

Plains to Peaks

17,000 km² of aerial survey data analysed, helping to understand human impacts on goitered gazelles.

Using data collected from aerial surveys covering an area over 17,000 km² in south-east Kazakhstan, our preliminary analyses showed that goitered gazelle *Gazella subgutturosa* numbers were largely determined by human influences (including numbers of people, land use and infrastructure). Larger populations of gazelles were found in areas with lower levels of human activity, and in these areas, availability of food was the next most important determinant. In areas of greater human activity, gazelles tended to occur where there were fewer roads, further highlighting the negative impact of people.

Our 'Plains to Peaks' project seeks to determine the status and distribution of goitered gazelles and understand threats across the species' ecosystem from open grasslands to mountain foothills. The species is thought to be declining throughout Central Asia, but more detailed information is needed to guide conservation action. Our study has also revealed patterns of gazelle distribution within protected areas, principally Altyn Emel and Charyn Canyon National Parks, where these animals are more influenced by vegetation and elevation. In Altyn Emel National Park, there appears to be key locations where various species occur, including other herbivores like kulan *Equus hemionus* and ibex *Capra sibirica*, and predators such as lynx *Lynx lynx*, wolf *Canis lupus* and snow leopard *Panthera uncia*.

These records, and the analyses we are providing, have been shared with the authorities in Kazakhstan, and the International Union for the Conservation of Nature (IUCN), highlighting the factors limiting goitered gazelle numbers and assessing management options to mitigate further declines.

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

photo © Alexey Grachev, Institute of Zoology, Kazakhstan

> **RIGHT CLOCKWISE** (from top) Camera-trap images of goitered gazelle *Gazella subgutturosa*, lynx *Lynx lynx*, ibex *Capra sibirica*, snow leopard *Panthera uncia* and kulan *Equus hemionus*, coming to drink at an aqueduct in Altyn Emel National Park.

10
Barbary sheep
translocated to Zaghouan National Park.

Expanding the Range of the Barbary Sheep in Tunisia

The conservation translocation of 10 Barbary sheep *Ammotragus lervia* to Zaghouan National Park marked the beginning of an initiative to establish the species in this mountainous protected area. The operation, undertaken in partnership with the Direction Générale des Forêts, contributes to a national strategy for the conservation of this emblematic species.

Known locally as aoudad, the Barbary sheep or mouflon à manchettes, underwent a dramatic decline due to illegal, unsustainable hunting and habitat degradation, and is now considered Vulnerable to extinction in the IUCN Red List of Threatened Species. Only a few free-living groups of Barbary sheep remain in Tunisia, but it is hoped that the implementation of the national strategy will see the species return to more of the arid, mountain landscapes to which it is adapted.

The three male and seven female Barbary sheep were moved to Zaghouan National Park from Oued Dekouk National Reserve in southern Tunisia where, thanks to good management and protection, there is a growing population. In recent years, we also confirmed the presence of a breeding population of Barbary sheep in the mountains of Dghoumes National Park. It is likely that these animals have benefitted from the attention paid to the local area following our efforts to reintroduce scimitar-horned oryx *Oryx dammah* and North African ostrich *Struthio camelus camelus* which now inhabit the arid steppe to the south of the mountain range.

PARTNERS Direction Générale des Forêts (Ministry of Agriculture, Water Resources and Fisheries), Tunisia | Oued Dekouk National Reserve and Zaghouan National Park, and associated CRDAs (Commissariat Régional du Développement Agricole)

RIGHT
Barbary sheep *Ammotragus lervia* (top) are the latest of a number of species, including addax *Addax nasomaculatus* (bottom left), North African ostrich *Struthio camelus camelus* (bottom middle) and scimitar-horned oryx *Oryx dammah* (bottom right), we have helped to reintroduce to Tunisian protected areas.

photos © Marie Petretta and Tim Woodfine, Marwell Wildlife

Wildlife Monitoring in Northern Kenya

12,212
km
of patrol routes covered by Community Scouts in northern Kenya.

Our Community Scouts in the far north of Kenya covered a combined distance of 12,212 km during their year-round wildlife monitoring patrols, gathering information about 20 species of large mammals, including some threatened with extinction such as Grevy's zebra *Equus grevyi*. This included over 11,500 km of foot patrols; a 32% increase compared with 2020, despite severe drought bringing additional challenges for the team and their pastoralist communities.

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. Encouragingly, 19 of the observed species, including rare African wild dogs *Lycaon pictus,* cheetah *Acinonyx jubatus,* beisa oryx *Oryx beisa,* and Grevy's zebra, have been recorded annually since 2018. Whilst it is good news that such a diversity of species persists in a human dominated and environmentally uncertain landscape, poaching appears to be increasing and our team works closely with Kenya Wildlife Service and other local partners, like the Milgis Trust, to share information that might help the authorities and local communities seeking to conserve wildlife to address this issue.

Direct sightings of Grevy's zebra were lower this year with most occurring in December, possibly explained by the animals being dispersed while searching for food and water during the prolonged drought. It was, however, encouraging that around 20 – 30 Grevy's zebra were recorded taking advantage of supplementary hay provision each night as we supported those animals through this difficult period.

PARTNERS Kenya Wildlife Service | Wildlife Research and Training Institute (WRTI), Kenya | Grevy's Zebra Trust | Lewa Wildlife Conservancy | Milgis Trust | Northern Rangelands Trust | Mpatmpat Consultants Limited

photo © Tim Woodfine, Marwell Wildlife

Community Conservancies in Kenya are Vital for Grevy's Zebra

The importance of community conservancies for the survival of the endangered Grevy's zebra was highlighted by location and movement data analysed from 43 animals fitted with GPS collars over seven years across a study area of over 29,000 km². Two-thirds of suitable Grevy's zebra habitat occurred within community conservancies, reflecting the benefits of collaborative conservation efforts which focus on shared resources between people and wildlife.

Our study, carried out in collaboration with local partners, advanced our understanding of seasonal habitat suitability, further emphasised the importance of water and the impact of human activities on their movements. Despite travelling large distances (typically 95 km a week), the Grevy's zebra we tracked tended to remain within core areas and there is evidence of populations becoming isolated.

Land degradation, competition with livestock and infrastructure development are barriers to wildlife movements, so understanding the factors affecting population connectivity will help inform development in northern Kenya with Grevy's zebra and other threatened species in mind. Community conservancies appear to be vital for offering suitable habitat and movement corridors.

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ABOVE
Analysis of location and movement data from 43 GPS-collared animals found two-thirds of suitable Grevy's zebra *Equus grevyi* habitat occured within community conservancies.

PARTNERS University of Southampton | Kenya Wildlife Service | Wildlife Research and Training Institute (WRTI), Kenya | Lewa Wildlife Conservancy | Grevy's Zebra Trust | Princeton University | Northern Rangelands Trust

Habitat Restoration and Species Recovery in the South of England

photo © Nicholas Montegriffo

80% of north Hampshire's remaining bog early marsh-orchid population can be found at Eelmoor Marsh.

Maintaining and enhancing the variety of habitats at Eelmoor Marsh and Marwell is an ongoing process with ecological monitoring helping us to understand the status of valued species and habitats, and to inform adaptive management.

Eelmoor Marsh Site of Special Scientific Interest

At Eelmoor Marsh, targeted restoration works were carried out to control invasive scrub across 2.62 ha of wet and dry heath; remove 0.88 ha of self-seeded pine trees *Pinus sylvestris* to create more open heathland; diversify the structure of 3.95 ha of grass and heathland; and reduce patches of dominant purple-moor grass *Molinia caerulea* tussocks to expose 0.9 ha of bare ground, encouraging regeneration of the seedbank. Further work was undertaken to suppress invasive bracken across 0.28 ha of heath during the summer. Conservation grazing with 11 Highland cattle *Bos taurus* and four Przewalski's horses *Equus ferus przewalskii,* continued as the principal approach to maintaining and diversifying valuable open habitats.

With 234 flowering spikes of bog early marsh-orchid *Dactylorhiza incarnata ssp. Pulchella,* Eelmoor Marsh now hosts 80% of the remaining population in north Hampshire, where it is only known in a total of three locations. Autumn lady's-tresses *Spiranthes spiralis* is another orchid that has declined across the country due to agricultural intensification and habitat loss. The species was first recorded at Eelmoor Marsh in 2016 and whether recovered from the seedbank or arriving by dispersal, conditions appear favourable with 63 flowering spikes counted in 2021 compared to just 21 seen in 2016.

Eelmoor Marsh is an important refuge for six species of insectivorous plants. Lesser bladderwort *Utricularia minor,* noted in the Red List for England as Vulnerable to extinction, has declined at almost every site in Hampshire outside of the New Forest but continues to do very well at Eelmoor Marsh with a large and stable colony. There were also good numbers of common butterwort *Pinguicula vulgaris,* which contrary to its name, is also categorised in the Red List for England as Vulnerable to extinction.

PARTNERS QinetiQ | Natural England | Forestry England

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ABOVE
Silver-washed fritillary *Argynnis paphia,* one of 24 butterfly species recorded at Marwell in 2021.

There were records of 32 butterfly species (31 in 2020) and 24 dragonfly species (23 in 2020) at Eelmoor Marsh in 2021. Numbers of the Nationally Vulnerable silver-studded blue butterfly *Plebejus argus,* the Nationally Scarce small red damselfly *Ceriagrion tenellum* and Nationally Uncommon keeled skimmer *Orthetrum coerulescens* remained strong.

Marwell Woods and Grasslands

Meanwhile, we continued to enhance tracts of Marwell's semi-natural ancient woodland and calcareous grassland. We thinned an area of 0.24 ha of larch *Larix decidua* to encourage regeneration of native broadleaved woodland from conifer plantation and undertook work to regenerate 1.09 ha of other woodland habitats. Our meadows provided over 2,400 bales of hay to feed hoofstock, with their manure being converted into biomass briquettes for producing low carbon heat.

It was an excellent year for orchids at Marwell. From just a handful of common spotted orchids *Dactylorhiza fuchsii* that were found in the periphery of a field when we began grassland restoration, a total of 721 flowering spikes were counted in 2021. This was indicative of the general status of wildflowers that can now be found flourishing across our land. We also had our first ever record of southern marsh orchid *Dactylorhiza praetermissa* occurring at Marwell, while other species such as bee orchids *Ophrys apifera* and pyramidal orchids *Anacamptis pyramidalis* were found in several new locations following changes in management.

A total of 24 butterfly species were recorded at Marwell in 2021. Records of green hairstreak *Callophrys rubi* were an encouraging indicator of grassland restoration, while strong numbers of silver-washed fritillary *Argynnis paphia* were likewise a good sign that woodland restoration is having the desired effect. With just a solitary small heath *Coenonympha pamphilus* recorded for the first time in 2015, the count of 36 in 2021 was good progress for this conservation priority species.

PARTNERS Forestry England | South Downs National Park Authority

Sand Lizard Reintroductions in the UK

76
juvenile sand lizards reintroduced to Puddletown Forest in Dorset.

We contributed 76 sand lizards *Lacerta agilis* for release on the dry heath at Puddletown Forest in Dorset. This was the second of a multi-year reintroduction initiative, with this cohort following the 151 Marwell-bred lizards that were released there in 2020.

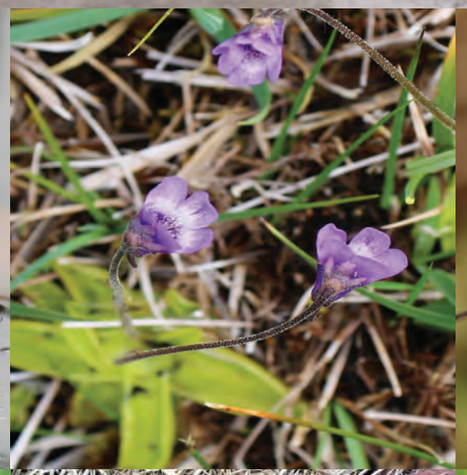
We hope that the Puddletown Forest heathland will become the 28th location at which Marwell-bred sand lizards have been successfully reintroduced to their former habitats. Meanwhile, monitoring at Eelmoor Marsh Site of Special Scientific Interest showed encouraging signs that sand lizards released there between 2017 and 2019 are dispersing across the suitable habitat and successfully breeding. Their chances were further improved through targeted ecological restoration to expand and enhance areas of ideal sand lizard habitat. Over 70 young sand lizards were retained and overwintered at Marwell with plans to release them alongside any new hatchlings in 2022.

PARTNERS Amphibian & Reptile Conservation Trust | Forestry England | Natural England | QinetiQ

TOP RIGHT
Sand lizards *Lacerta agilis* from our dedicated breeding project have now been reintroduced to 28 locations in the south of England.

MIDDLE RIGHT
In 2021, we observed very good numbers of scarce specialist bog plants including lesser bladderwort *Utricularia minor* (left) and common butterwort *Pinguicula vulgaris* (middle), and the Nationally Uncommon keeled skimmer *Orthetrum coerulescens* (right).

BOTTOM RIGHT
Sensitive management on Marwell habitats has encouraged a diversity of local wildlife species, such as pyramidal orchids *Anacamptis pyramidalis* (left), reptiles including grass snakes *Natrix helvetica helvetica* (middle), and important pollinators such as buff-tailed bumblebees *Bombus terrestris* (right).



photos © Tim Woodfine Marwell Wildlife, Richard J Bullock, Nicholas Montegriffo

photo © Jason Brown, Marwell Wildlife

Advances in Animal Welfare

10,000 animal welfare assessments processed, facilitated by new cloud-based monitoring software.

Animal Welfare Assessment Grid

In 2021, we launched the Animal Welfare Assessment Grid (AWAG) cloud-based software. By the end of the year, the 20 members of the team trained in its use had processed over 10,000 welfare assessments. Marwell is the first organisation in the UK to adopt this objective and continuous way of monitoring the welfare of zoo animals and is a global leader in this field.

By scoring factors associated with physical and psychological health, and the environment, along with veterinary and other management interventions, the AWAG produces a graphical means of understanding welfare of an individual animal or group over time based on a cumulative score. The system is adaptable to any species and those added during the year included white rhinoceros *Ceratotherium simum*, Nile lechwe K*obus megaceros*, pygmy hippopotamus *Choeropsis liberiensis* and yellow mongoose *Cynictis penicillata*. The team also added historic data for a number of species, such as Amur tiger *Panthera tigris altaica* and snow leopard, helping to assess the impact of the zoo's closure during COVID-19 lockdowns on animal welfare.

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

Animal Training

Throughout 2021, we successfully expanded our animal training programme to encompass new individuals and species. One of the highlights was being able to health check a geriatric female siamang gibbon *Symphalangus syndactylus* after she accepted a hand-injected sedative, reducing stress and risk for her and the animal care team involved. We were also, for the first time, able to deliver annual vaccinations to all our large carnivores via hand-injection, avoiding the need for prior sedation. Ten primates, a bokiboky *Mungotictis decemlineata* and five bearded reedlings *Panurus biarmicus*, were similarly treated with a new *Yersinia* bacteria vaccine in one morning.

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. The process takes time, a high degree of dedication and a keen understanding of animal behaviour but pays important dividends.

Positive Life Experience

Understanding species' natural history and matching the environment to their evolved biology is key to good health and welfare. Our 'positive life experience' programme is an adaptive approach to animal care recognising the need to continually reassess and enhance the habitats we provide for zoo animals in line with improved knowledge.

In 2021, our animal care teams successfully introduced 'bioactive' floors. These are mixtures of substrates including leaf litter that support an ecosystem of bacteria and fungi as well as worms, woodlice and other invertebrates. This helps to decompose food waste and animal faeces while providing natural foraging opportunities for animals and growing media for plants. Like any healthy ecosystem, a well-functioning bioactive floor is an environment in which no single species dominates but are all maintained in balance. Bioactive floors were added to the habitats for long-nosed potoroo *Potorous tridactylus* and swift parrots *Lathamus discolor,* golden lion tamarin *Leontopithecus rosalia,* blue-faced honeyeaters *Entomyzon cyanotis,* and wonga pigeons *Leucosarcia melanoleuca,* in tandem with other changes.

A combination of ultra-violet light and short-wave infrared heating were integrated into environments for flamingos *Phoenicopterus roseus,* ostriches *Struthio camelus,* swift parrots, blue-faced honeyeaters and wonga pigeons. This offered longer winter photoperiods, better approximating the natural light and warmth from the sun, and supporting vitamin D synthesis, immune function and visual acuity.

In recent years, natural history reviews have been undertaken for all species at Marwell. In some cases, this necessitates wholescale change, and our Energy for Life Tropical House is a good example of creating a totally new environment to suit the needs of multiple species. In other cases, we can make changes within existing spaces to enhance environments that were originally created with the best knowledge and intention at the time.

< ABOVE LEFT Bokiboky *Mungotictis decemlineata*, one of a number of species to receive a new *Yersinia* bacteria vaccine via hand-injection.

Sustainable Living

Our Energy for Life Tropical House is heated using biomass technology.

photo ©Jason Brown, Marwell Wildlife

Sustainable Living

Progress on Carbon Neutrality

We calculate our carbon footprint every year. By the end of 2020, our carbon footprint 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). Further progress was made towards our goal of carbon neutrality in 2021 through our new biomass energy plant, additional solar energy generation and calculation of the carbon sequestration value of Marwell's habitats.

Energy for Life

Our new biomass energy plant that turns zoo animal manure and used bedding straw into heat was completed and commissioned. The system, which we anticipate will reduce our carbon dioxide emissions by 200 tonnes per annum when fully operational, took years to develop as a bespoke solution and is unique in the UK and possibly a global first.

During the process, the animal manure and used bedding straw is macerated and then compacted to form a briquette which feeds a 400 kW boiler to produce the heat. The plant entered a testing phase in the winter as we refined the optimum operating conditions and trialled various combinations of manure from different animal species. At the same time, work began on the installation of a pipe network to supply heat to Marwell Hall, offices and some animal accommodation in addition to our Energy for Life Tropical House. On-site processing of this material also removes weekly lorry journeys compared to the previous means of disposal.

< **LEFT**
Completed and commissioned in 2021, our new energy biomass plant is anticipated to reduce our carbon dioxide emissions by 200 tonnes per annum.

Photo © Ed Parker

Towards a Better Environment

650K
kWhs
of electricity generated at Marwell since 2011, when we began using solar photovoltaic panels.

>250
tonnes
of carbon dioxide sequestrated from the atmosphere each year by our woodlands.

Solar Energy Generation

In 2021, we added a further 95 kWp of solar panels to Marwell rooftops, bringing the total on site to 170 kWp. Together these will generate around 150,000 kWh of electricity per annum; enough to power 40 typical households each year.

The new solar photovoltaic panels were installed in collaboration with Winchester City Council, providing energy to Marwell through a power purchase agreement and otherwise contributing to carbon reduction targets for the area. We began using solar photovoltaic panels at Marwell in 2011 and, with more arrays added since, have generated more than 650,000 kWhs of electricity on site.

PARTNER Winchester City Council

Carbon Sequestration

Using published figures to guide our calculations, we conservatively estimated that Marwell's woodlands sequestrate over 250 tonnes of carbon dioxide from the atmosphere each year. Together with our carbon reduction achievements to date and further work on renewable energy this year, it puts us on track towards our goal of carbon neutrality.

Our aim is to absorb more carbon dioxide through our land and habitat management at Marwell than we emit operating as an organisation, including all emissions from energy, waste, water and travel. In 2021, we took a first look at the carbon sequestration capacity of different habitats across our land. Native woodlands are reliable carbon sinks, in addition to their biodiversity value, and data is available from previous studies to draw on for our calculations. However, semi-natural open habitats also store appreciable amounts of carbon in their vegetation and soils, so our tracts of grassland will also be making an important and complementary contribution.

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ABOVE
Marwell's semi-natural ancient woodlands.

Water Conservation

We traced and repaired two major leaks in the park helping to reduce water consumption by 17% compared to 2020. Repairs to aging underground pipework, a problem encountered nationwide, are an important aspect of our Water Conservation Plan which also includes water saving initiatives and rainwater capture.

Action on Single-Use Plastics

Two more water bottle filling stations were installed to encourage guests to refill their own bottles and reduce single-use plastic waste. We stopped selling water in plastic bottles when we installed the first of our water bottle re-filling stations in the park. While there is a financial implication, this is outweighed by the environmental benefits of reduced plastic and reduced supply chain carbon.

Making Use of Food Waste

During 2021, we sent 4.7 tonnes of food waste for anaerobic digestion to produce biomethane having introduced collections around our catering outlets and staff kitchens. Our catering teams try hard to get portion sizes correct to minimise plate waste and are careful not to overproduce. Despite this a certain amount of preparation waste (vegetable peelings etc) is unavoidable and we were pleased, after a long search, to find this sustainable solution which meets our needs.

Catalysing Change

"Children attending the Kids Love Nature Kindergarten at Marwell enjoy exploring our surrounding woodlands during sessions with our Nature Interpreter."

photo © Katherine Dewsnery, Marwell Wildlife

Catalysing Change

Natural Curiosity

302
curriculum-linked
sessions delivered to primary and secondary school pupils in 2021 through our new education hubs.

School Visits

Over 14,000 children visited Marwell with their schools during the 2021 calendar year, up from just 6,159 in 2020. Although still considerably below the 40,000+ we regularly welcomed each year before the pandemic, it was encouraging to see the enthusiasm and speed with which school groups sought to return to Marwell once circumstances allowed.

Following trials in late 2020, we started to roll out our new educational offer which allows teachers to select from a range of shorter, focused sessions at various locations around the zoo. Each 'education hub', suitable for Early Years Foundation Stage (EYFS) through to Key Stage 3 (KS3), offers the option of four national curriculum-linked topics: 'Conservation', 'Adaptation', 'Classification' and 'All About Animals', with an additional 'Rainforest' topic also available in the Energy for Life Tropical House and Science & Learning Centre hubs. This new modular system not only provides a COVID-safe, predominantly outdoor, learning environment but also greater flexibility for teachers who can choose to book multiple hubs, layering their learning around a single topic or exploring different topics at each location. In total, 302 hubs were run in 2021.

Although adaptations to our educational offer were a necessary response to the ongoing pandemic, initial feedback has been positive, and we expect that many lessons learnt will be carried forward. This includes recent adaptations to our Key Stage 4 (KS4) and A-Level conference sessions, which now provide greater opportunities for students to take their learning from the lecture theatre out into the zoo.

Catalysing **CHANGE**

BELOW
Our new educational offer allows teachers to select from a range of shorter, focused sessions at various locations around the zoo.

Learning Online

Downloads of our education materials, up 140% in 2020 compared to the previous year, fell back to within normal parameters in 2021 - highlighting the value of these resources during the height of the pandemic, when families and teachers sought novel ways to bring home learning to life and complement children's schoolwork.

Meanwhile, changes to our website to promote access to scientifically accurate information about eight key animal species found at Marwell resulted in a 42% increase in views compared to the previous year. New information was provided for: giraffe *Giraffa camelopardalis;* snow leopard; pygmy hippopotamus; white rhinoceros; meerkat *Suricata suricatta;* Linné's two-toed sloth *Choloepus didactylus;* Amur tiger and Humboldt penguin *Spheniscus humboldti.*

photo © Emma Fletcher, Marwell Wildlife

photo © Katherine Dewdney, Marwell Wildlife

photo © Corporal Leituai, Kenya Wildlife Service

>240
nature interpretation sessions enjoyed by children attending the Kids Love Nature Kindergarten at Marwell.

Animals Guide Outdoor Learning

Following previous restrictions, children attending the Kids Love Nature Kindergarten at Marwell returned to a jam-packed schedule of outdoor learning in the park and in our surrounding woods and meadows. Planned visits to see animals in the zoo prompted the children to explore subjects ranging from animal classification to conservation. Meanwhile, seasonal topics were explored in our woodlands and meadows with the help of plush toy 'animal guides'.

The animal guides prompted conversations with the children about what local animals might have encountered or noticed that week. It was hoped that having a physical character to relate to would help the children to develop and strengthen their understanding and relationship with the land. This began with the badger in summer, the frog in autumn and the deer in winter, with the sequence of seasons to be completed by the owl in springtime in 2022. The planned activities encompassed themes such as interconnectivity, habitats, resources, behaviour and fieldwork, and sparked curiosity in the children to follow new lines of enquiry.

The outings gave social opportunities, encouraged thoughtfulness towards nature and each other, opportunity to experience guided and independent exploration, teamwork, show perseverance and develop resilience. The use of games, stories and the occasional song helped the children explore much more than the adaptations and behaviour of their animal guides.

The age of some badger setts helped the children to consider the passing of time, they estimated tree height and took photos of a chosen space after 100 seconds, minutes and days. The frog guided the children to find plants at different stages of their lifecycle, life in the leaf litter and to discover the microbes on their fingertips after they saw what they had grown on agar jelly! The deer had the children look at the structure of wood, make nests and set camera-traps. As the yearly cycle starts again, the animal guides will appear in different seasons, giving a whole new perspective.

PARTNER Kids Love Nature

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ABOVE
Sessions led by our Nature Interpreter offer a rich variety of learning experiences in our zoo and woodlands.

49
children from Anderi Primary School in Samburu enjoyed a special trip to Lewa Wildlife Conservancy.

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ABOVE
Primary school children in northern Kenya exploring the topic 'living things around us'.

Outreach in the Far North of Kenya

Expanding our activities to include children from Kargi in Marsabit County, and a special trip to the Lewa Wildlife Conservancy for the children of Anderi Primary School in Samburu County were highlights of our school outreach programme in northern Kenya.

Ongoing pandemic restrictions, and severe drought forcing young herders to travel much further from their homes in search of pasture for their livestock, constrained much of our education outreach in northern Kenya in 2021. However, following the recent expansion of our community wildlife monitoring activities into Kargi in Marsabit County, the team took the opportunity to engage 48 local primary school children, encouraging them to explore the topic of 'living things around us'. Met with enthusiasm, further sessions are planned for 2022.

A special visit to the Lewa Wildlife Conservancy was facilitated for 49 children from Anderi Primary School. Our team has been visiting the school since 2016 and in the intervening time, they have established their own wildlife club, carrying out activities like camera-trapping and bird feeding to find out more about their local wildlife. This commitment helped make them the lucky recipients of a visit to Lewa, kindly sponsored by the Disney Wildlife Conservation Fund. During their first ever school trip, the group enjoyed wildlife viewing drives, learnt about the importance of wildlife to the environment and the country, and explored the issue of water conservation. Inspired by the experience, the children have since planted trees around their school and continued to discuss these topics with other children and their wider community.

PARTNERS Lewa Wildlife Conservancy | San Diego Zoo | Northern Kenya Conservation Education Working Group

Higher Education

Our scientists supervised and facilitated 39 undergraduate and 24 postgraduate research projects during the year and taught over 670 university and college students, contributing to academic qualifications in the UK and internationally.

MRes Wildlife Conservation

In October, we welcomed nine new students to our MRes Wildlife Conservation programme, run in collaboration with the University of Southampton.

The programme was paused for the 2020/21 academic year in support of University of Southampton's COVID-19 mitigation plan, to allow planning for lectures and field courses during pandemic conditions. As a result, our team of Conservation Biologists were able to successfully deliver a full programme of in-person teaching for the new cohort throughout the first semester. Our field course, typically undertaken in Kenya, was instead delivered in Northumberland by our team, with support from the Northumberland Wildlife Trust and Forestry England. The students also took advantage of our own woodlands and visits to Eelmoor Marsh Site of Special Scientific Interest to support their development of field techniques.

PARTNER University of Southampton

photo © Tim Woodcock, Marwell Wildlife

ABOVE
MRes students take advantage of our surrounding woodlands to practice their field techniques, including setting up camera-traps.

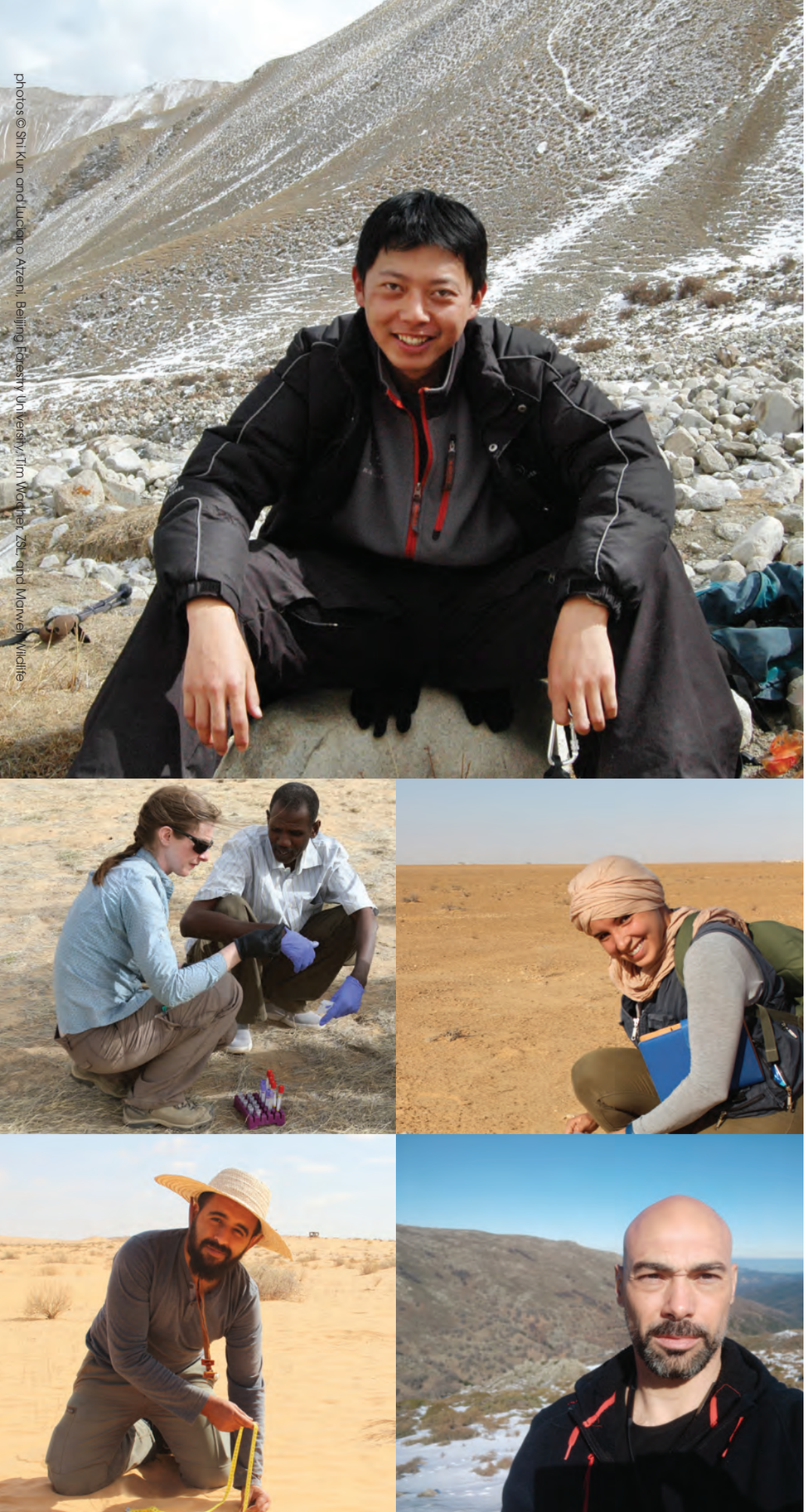
Veterinary Medicine

Our teams taught and provided practical experiences for over 270 students from the University of Surrey School of Veterinary Medicine, welcoming many students back in person. We also opened our dedicated veterinary seminar room and workspace, completed in early 2020 but previously unused due to COVID-19 teaching restrictions.

Final year students joined us for their Zoological Medicine intramural rotation, spending four weeks with our team gaining experience in a variety of disciplines ranging from clinical veterinary work and welfare through to animal nutrition and record keeping. This was delivered through a combination of practical work, a research project, journal clubs and workshops.

A series of lectures on zoological medicine related to various taxa were recorded for fourth year students, while online content was created on contraceptive methods and animal nutrition for third year students. Workshops focussing on the Zoo Licensing Act were also delivered through lectures and practical sessions over 10 weeks during which students critiqued animal enclosures.

PARTNER University of Surrey, School of Veterinary Medicine



photos © Shi Kun and Luciano Atzeni, Beijing Forestry University, Tim Wacher, ZSL and Marwell Wildlife

< **TOP LEFT**
Wang Jun was awarded a PhD from Manchester Metropolitan University for his research on snow leopard *Panthera uncia* ecology in Qilianshan National Park, between Gansu and Qingahi province on the north-eastern edge of the Qinghai-Tibetan Plateau, China.

< **MIDDLE ROW LEFT**
Stephanie Brien, pictured here discussing sample collection protocols with Dr. Mouctar from the Chadian Veterinary and Livestock Research Institute, continued her PhD research on immunogenetics of scimitar-horned oryx *Oryx dammah*, in collaboration with the University of Edinburgh's Roslin Institute and the Royal (Dick) School of Veterinary Studies, and the Pirbright Institute.

MIDDLE ROW RIGHT
Amira Saidi, a PhD student at the University of Tunis El Manar, continued her research on the diversity and ecological function of arthropods in southern Tunisia.

< **BOTTOM ROW LEFT**
Mohamed Khalil Meliane, also a PhD student at the University of Tunis El Manar, advanced his research focused on managed ecosystem function and resilience in the desert of southern Tunisia.

BOTTOM ROW RIGHT
Luciano Atzeni was awarded a PhD from Beijing Forestry University for his work investigating landscape drivers of distribution, genetic diversity and connectivity in a snow leopard *Panthera uncia* population from Qilianshan National Park, China.

Participation and Capacity Building

Upgrading Wildlife Monitoring Technology in Northern Kenya

Our Community Scouts in northern Kenya continually collect data on wildlife and the environment during their regular patrols in remote locations. Twenty-two scouts were trained in the use of upgraded wildlife monitoring and reporting technologies to improve data collection, transfer and analysis.

Since 2017, the team have been using GPS enabled mobile phones to record information about wildlife and the environment and to track their regular patrols. This has been based on 'SMART' (Spatial Monitoring And Reporting Tool); an open source and freely available software application making it possible to collect, store, share and analyse ecological data. We were keen to benefit from advances in the software and a new extension that makes transfer of data from the field quicker and easier. Hence, with the help of the national SMART trainer in Kenya, our Community Scouts received tuition on the use of the updated mobile phone application.

Because of the software upgrade and scout training, we have shifted from having to manually download data each month in the field to receiving it directly via the internet. Although scouts may need to move to locations where an internet connection is available, this has resulted in an improved rate of data transfer and analysis, and therefore ability to share critical information in a timely manner with our scouts, Kenya Wildlife Service and other stakeholders.

PARTNERS The Zoological Society of London (ZSL) | Mpatmpat Consultants Limited

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BELOW
Over 4,000 hours were contributed by our volunteers in support of our mission in 2021.

Marwell Volunteers

We are very grateful to our dedicated team of 134 volunteers who, despite reduced opportunities and the collective uncertainties we all experienced in 2021, were able to contribute over 4,000 hours of their valuable time to support our mission.

Once again, our volunteers played a critical role in helping ensure that guests had a safe and enjoyable visit, capitalising on the opportunity to share their knowledge and passion for wildlife, whilst managing the safe flow of visitors.

Developing Strategies for Species Conservation

Our teams and partners in six countries came together online to discuss effective wildlife conservation strategies, assessing current situations and creating theory of change models for their respective areas of interest.

Following earlier workshops highlighting the importance of continued stakeholder engagement, we drew on WildTeam's Strategy Development for Wildlife Conservation approach to set out a step-by-step process for: 1) documenting a clear, shared understanding of the current situation and then 2) articulating the desired conservation impact and how they plan to achieve this. The next step is to complete theory of change models and accompanying evaluation frameworks. This is particularly important for some of the more ambitious, complex and long-term initiatives we are working with partners to develop. This includes positive conservation outcomes for large carnivores in Central Asia, desert antelopes in North Africa, and Grevy's zebra in Kenya.

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 | Beijing Forestry University, China

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ABOVE
Online workshops focused on strategy development brought together our teams and partners from the UK, Kazakhstan, Kenya, Tunisia, Bhutan and China.

photo © Lydia Cross, Marwell Wildlife

Multiplying Impact

COP26

With the 26th United Nations Climate Conference (COP26) taking place in Glasgow, we showcased our carbon reduction work and shared our experiences of how to measure and reduce carbon footprints.

Case studies on our Energy for Life biomass system were shared via the Greater South-East Energy Hub and Carbon Copy websites as part of the COP26 Regional Roadshows. Our carbon reduction successes were shared at events for Hampshire County Council, the Association of Science & Discovery Centres, and the Public Sector Sustainability Summit. We presented guides on calculating carbon footprint for the Hampshire Sustainable Business Network, British Association of Zoos & Aquaria, and helped the World Association of Zoos & Aquariums create a simple guide to carbon reduction. Meanwhile, a video on the movement of viruses under the influence of climate change that we created as part of the interpretation for our Energy for Life science gallery, in collaboration with the Pirbright Institute, was made available to delegates in Glasgow.

IUCN World Conservation Congress

The IUCN World Conservation Congress brings together governmental, civil society and indigenous peoples' member organisations to take decisions related to major conservation issues. Participating in the process, Marwell co-sponsored six motions that were adopted as resolutions:

- **WCC-2020-Res-047-EN**
  Law enforcement regarding commercial trade in tigers and tiger parts
- **WCC-2020-Res-064-EN**
  Promoting conservation through behaviour-centred solutions
- **WCC-2020-Res-072-EN**
  Importance for the conservation of nature of removing barriers to rights-based voluntary family planning
- **WCC-2020-Res-079-EN**
  Linking *in situ* and *ex situ* efforts to save threatened species
- **WCC-2020-Rec-086-EN**
  Strengthening mutual benefits of mobile pastoralism and wildlife in shared landscapes
- **WCC-2020-Res-102-EN**
  Improving process and action to identify and recover 'Extinct in the Wild' species.

photo © Tim Woodfine, Marwell Wildlife

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ABOVE
Scimitar-horned oryx *Oryx dammah*, classified as Extinct in the Wild on the IUCN Red List of Threatened Species. "Improving process and action to identify and recover 'Extinct in the Wild' species" was one of six motions co-sponsored by Marwell that were adopted as resolutions at the IUCN World Conservation Congress.

High Potential Opportunity Animal Health

Working with colleagues across the region, we contributed to the development of a High Potential Opportunity proposition to encourage international investment and meet the growing demand in animal health innovations across surveillance, disease detection and intervention, animal wellbeing, and clinical services. Led by the Department for International Trade and Enterprise M3, the initiative reflects a thriving animal health sector across Hampshire and Surrey.

Population Management

As a member of the European Population Management Advisory Group (EPMAG) - a working group of the EEP Committee, which is concerned with the functioning and development of EAZA *Ex Situ* Programmes (EEPs) and long-term animal collection planning - Marwell is leading the development of a new mentoring system for Population Managers.

With the European zoo network spanning many different countries and hence languages, and training sessions typically delivered in English, new Population Managers can often struggle with a deeper understanding of the finer details of their roles. The new system will provide support in the form of mentors who speak the same language, are from a similar cultural background and are familiar with similar species. It is hoped that this will lead to improved management of the endangered populations across the European zoo network.

photo © SotonUAV, University of Southampton

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ABOVE
Exploratory flights using uncrewed aerial vehicles (UAVs), with high resolution and thermal cameras and acoustic sensors, focused on white rhino *Ceratotherium simum*, Grevy's zebra *Equus grevyi* and scimitar-horned oryx *Oryx dammah* that live together in one of Marwell's large paddocks.

Sahel and Sahara Interest Group

Members of our UK and Tunisia based teams participated in the annual Sahel and Sahara Interest Group meeting (SSIG), presenting outcomes of our work in Tunisia. Held for the first time online due to COVID-19 travel restrictions, SSIG has been an annual forum for all those working in wildlife conservation within the arid areas of North Africa since its inaugural meeting at Marwell in 2001. Facilitated by the Sahara Conservation Fund, the meeting provides an opportunity to bring people together to share ideas and projects, and to continue a strong tradition of collaboration on behalf of Sahelo-Saharan wildlife and people.

IUCN Species Survival Commission Antelope Specialist Group

Marwell continued to host the Programme Office for the IUCN SSC Antelope Specialist Group, the world's leading body of scientific and practical expertise on the status and conservation of all antelope species.

Grevy's Zebra Technical Committee, Kenya

Members of our UK and Kenya teams participated in meetings of the national Grey's Zebra Technical Committee sharing analyses of Grevy's zebra movements based on GPS collar data. Building on this dataset, committee members agreed that further work was needed to refine our understanding of Grevy's zebra movements in relation to planned infrastructure developments and to produce recommendations to mitigate potential impacts on this endangered species.

Addax Conservation, Tunisia

Members of our UK and Tunisia based teams held a workshop with Tunisia's Direction Générale des Forêts to deliver the results of studies on the genetics of reintroduced addax and the implications for the Tunisian populations. This was followed by a series of workshops with local teams in each protected area that holds addax. Plans to develop a Tunisian national conservation action plan for this critically endangered desert antelope are now underway.

Exploring the Potential for Uncrewed Aerial Vehicles in Wildlife Conservation

During 2021, we teamed up with engineers and specialists in uncrewed aerial vehicles (UAVs) from University of Southampton to explore innovative methods of wildlife survey and monitoring to support conservation. The team includes experts from the university's Centre of Excellence for In-situ and Remote Intelligent Sensing (IRIS), SotonUAV and the Ecology and Evolution research group in the School of Biological Sciences.

Preliminary tests were undertaken at Marwell, aimed at assessing the merit and potential of the technology for species detection. Pre-flight site assessments and planning were carried out with our Animal Management and Conservation teams, leading to exploratory flights using a UAV with high-resolution and thermal cameras, and acoustic sensors focusing on white rhino, Grevy's zebra and scimitar-horned oryx that live together in one of Marwell's large paddocks. Following a successful initial trial, the IRIS team are looking at ways to automate flights and data processing that can be tested in the field in 2022 and hopefully lead to more efficient large-scale monitoring of sparsely distributed species in remote locations.

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PARTNERS

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Bou Hedma National Park
Branféré Parc Animalier et Botanique
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IUCN Save Our Species
IUCN Species Survival Commission Antelope Specialist Group
IUCN Species Survival Commission Conservation Translocation Specialist Group
IUCN Species Survival Commission Equid Specialist Group
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Sidi Toui National Park
SMART Partnership
SotonUAV
South Downs National Park Authority
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photo © Saltore Saparbayev, Kazakhstan

Looking to the Future

Stepping into 2022 marks Marwell's 50th anniversary. The organisation has evolved from a breeding centre for endangered species to having international operations restoring threatened species and ecosystems, promoting sustainable living and catalysing changes needed to bring about a better environment.

Conservation is a collaborative process and, as ever, we share our experiences and successes with many partners. This will remain important as we all try to navigate through challenging times for people, wildlife, and the wider environment.

While we celebrate the many achievements recognised by the Queen's Award for Enterprise: Sustainable Development, it is time to take stock and refresh our plans so that Marwell continues to adapt and remain relevant in a rapidly changing world. Blending biological, environmental, and social impact remains a good model going into the future, but the world needs us all to be more ambitious – not just achieving but surpassing carbon neutrality; not just saving but having a vision for thriving wildlife! Let's see what the next half century brings!

photo © Tim Woodiffe-Marwell Wildlife

> **RIGHT**
Addax *Addax nasomaculatus.*

For further information
marwell.org.uk/conservation

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marwell.org.uk/publications

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