



THE QUEEN'S AWARDS
FOR ENTERPRISE:
SUSTAINABLE
DEVELOPMENT
2022



**Marwell
Wildlife**

50 years of conservation

2022

Impact Report



Silver-studded
blue butterfly
Plebejus argus.

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Our Work

Welcome to our review of charitable activities and impacts for 2022. Marwell Wildlife celebrated its 50th year in 2022, and we are delighted to have made significant impact through our conservation work throughout the year. In the following sections we share highlights of our work to restore nature, promote sustainable living and help catalyse changes needed to enhance nature's recovery for the benefit of people, wildlife, and the wider environment.

Taking our first steps since COVID-19 restrictions were lifted, at least here in the UK, we must recognise the immense effect this has had on all our lives. We must also acknowledge, with pride and gratitude, the passion and commitment with which the entire Marwell team has rallied to regain lost ground and move ahead with creativity, innovation and dedication to our mission.

We must also take a moment to remember those who are no longer with us. We are particularly saddened by the loss of our dear friend Dr Mark Stanley-Price in December 2022. Mark served on our Board of Trustees from 2008 to 2020, including as Chair of our Conservation Committee. Mark was a highly respected conservationist and with characteristic dedication he generously imparted his insight, knowledge, and wisdom. We offer our sincerest condolences to Mark's family and share our immense sadness with all those who knew and loved him.

Mark's legacy includes our achievements during, and indeed leading up to, 2022 which cut across all aspects of our conservation work. Notably, we calculated that we are exceeding carbon neutrality for our UK operation, factoring in the carbon being sequestered and stored by the woodland and grassland habitats that we manage for biodiversity and sustainable food supply for our animals.

Nevertheless, our small but important step reminds us that climate change continues to be an ever-present threat to us and the global biodiversity we rely upon. This remains in sharp focus through our

work on Grevy's zebra in northern Kenya, where ongoing and seemingly never-ending drought threatens the lives of people and their livestock and wildlife. Our teams and partners have been providing emergency food for the zebras and livestock in the communities we work with to reduce pressure on these increasingly fragile ecosystems. Through targeted fundraising we can sustain life for now, but without rain soon we will have to consider additional measures.

Our teams in the UK and overseas have worked hard to deliver innovations that can drive significant improvements to our conservation efforts. This includes the first welfare assessment for invertebrates that brings improvements to their care. In the field we have worked with engineering and data specialists to apply new technologies to conservation, such as uncrewed aerial vehicles (UAVs, or 'drones') for remote wildlife surveying and health assessments.

Innovations and knowledge exchange are vital to drive forward our next steps, aligned with our expertise in animal care, field-based conservation, and education. In 2022 we brought together these strengths and published our new Conservation Strategy for the next five years. This takes the unifying theme of Conservation Health as a focus for our efforts to Support Nature's Recovery. By bringing together elements of Health, Connection, and Innovation and Knowledge Exchange we set out our novel reframing of the role of progressive modern zoos in conservation.



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.





Where We Work

The opportunities to make significant local, regional and national conservation impacts in and around the zoo are aligned with our ability to engage communities, including our guests, with nature. Managing and using our own land sustainably, enhancing biodiversity and contributing to species and habitat conservation across the wider landscape are important to get right on our own patch.

Work in North Africa is focused in Tunisia, particularly the arid landscapes in the middle and south of the country, including the vast 'sand seas' of the Grand Erg Oriental. This provides an excellent base from which to assist with ecosystem and species recovery across the region. In East Africa, we are concentrated on northern Kenya, which is another arid environment with a host of highly adapted yet threatened species such as Grevy's zebra, but also presents numerous challenges for the people living in poverty. These unique ecosystems are at the forefront of many global challenges, including climate change.

Our experience at home informs and supports our international work, which focuses on places and people that are largely overlooked and under-represented. These places hold important wildlife populations in biologically and socio-economically fragile environments, with often marginalised communities. These are places with genuine need coupled with local aspiration for conservation, and the potential for scalable impact, including across international borders.

Elsewhere, we operate in the mountains and plains of Central Asia, with recent work in eastern Kazakhstan, in transboundary areas with neighbouring Kyrgyzstan and China. This theme of transboundary and regional cooperation is common to all our work, looking to enhance opportunities for species and ecosystem connectivity over large scales.

LEFT
Marwell's Field Co-ordinator Enrita Lesoloiya training Community Scouts in northern Kenya, who monitor threatened wildlife including the Endangered Grevy's zebra *Equus grevyi*.



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.

Queen's Award for Enterprise

In 2022 we were very excited to be awarded the Queen's Award for Enterprise: Sustainable Development. These awards are granted each year to organisations who have achieved outstanding performance in sustainability. Only 30 organisations nationwide received this award in 2022. The award recognises our dedication to the conservation of nature, particularly threatened species. It also acknowledges our extensive efforts to develop sustainable ways of working, such as using zoo waste to heat our buildings.

The award recognised that we:

- > Place sustainability at the heart of our business, including new approaches to retail and catering, to ensure ethical sourcing. This is supported by our educational messaging and leading by example.
- > Put our communities at the heart of our thinking, provide educational opportunities, and proactively build abilities and skills to address sustainability issues in the UK and internationally.
- > Focus our conservation efforts in areas of need where our expertise has the biggest positive impact.
- > Set out a demonstrably achievable goal to carbon neutrality, and actively make contributions to halt climate change and share our progress as an example to others.

including one of the UK's rarest reptiles, the sand lizard. Eelmoor Marsh is one of 28 sites across the south of England where sand lizard populations have been re-established by releasing individuals bred at Marwell Zoo.

In 2015, we launched our plan to achieve carbon neutrality by the end of our 50th anniversary year in 2022. This ambitious target reflects our holistic approach to sustainability and conservation which must address both our own impacts, and those of our suppliers and visitors, in addition to our direct action in habitats around the world.

With over one million school children having now participated in learning opportunities at Marwell, education was another cornerstone of this award. Spanning our partnerships with nature nurseries and universities, we support learning in young people from pre-school to postgraduate level, developing future generations of conservationists.

Ethical sourcing has been a priority for Marwell for many years, and we were delighted this was recognised in the Queen's Award. We stopped providing plastic bags in our gift shop in 2006 and have continued seeking further options to eliminate unsustainable products. For example, Marwell has now eliminated unsustainable palm oil; only sells fair trade hot drinks; has removed plastic bottles; sells products made from organic cotton and bamboo, and has recently introduced soft toys made from recycled plastic.

The award recognises our long-term commitment to conservation, sustainability, and significant achievements over the last 50 years. For example, our long-term support in Kenya, including working with community scouts, has helped to create a national strategy for the Endangered Grevy's zebra leading to population recovery. In the UK, over 25 years we have restored Eelmoor Marsh nature reserve in Hampshire as a lowland heath Site of Special Scientific Interest. It is now home to over 400 species of conservation concern,

> **RIGHT**
Marwell's Chief Executive, Dr James Cretney, being presented our Queen's Award for Enterprise: Sustainable Development by Deputy Lieutenant of Hampshire, Alan Titchmarsh MBE, VMH DL.





In addition to the Queen's Award, Marwell has had an award-winning year:



TOP LEFT
 Dr Judy Mann-Lang presenting our Chief Executive, Dr James Cretney, with the World Association of Zoos and Aquariums (WAZA) Sustainability Award 2022.

BOTTOM LEFT
 Lance Ingram, our Plants and Landscapes Team Manager, accepting Sparsholt College's Industry Insight Award in 2022, from BBC Countryfile's Tom Heap and Leader of Hampshire County Council, Councillor Rob Humby.

	 World Association of Zoos and Aquariums WAZA United for Conservation Environmental Sustainability Award		 BIAZA BRITISH IRISH ASSOCIATION OF ZOOS & AQUARIUMS Gold Award for Sustainability
	 BIAZA BRITISH IRISH ASSOCIATION OF ZOOS & AQUARIUMS Gold Award for Animal Husbandry, Care and Breeding		 BIAZA BRITISH IRISH ASSOCIATION OF ZOOS & AQUARIUMS Silver Award for Animal Behaviour and Welfare
	 BIAZA BRITISH IRISH ASSOCIATION OF ZOOS & AQUARIUMS Bronze Award for Exhibits		 Winchester Business Excellence Sustainability Award
	 Winchester Business Excellence Business of the Year Award		 bloop. Innovation Award for Sustainability
	 Little Ankle Bitters Hampshire Best Family Attraction Award		 SPARSHOLT COLLEGE HAMPSHIRE Industry Insight Award

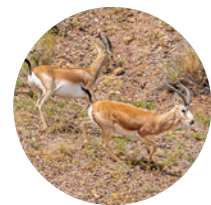


Restoring Nature

Eelmoor Marsh
SSSI is grazed
year-round by
our herd of
Highland cattle
Bos taurus, who
act as ecosystem
engineers to
maintain and
diversify the
habitats.

Restoring Nature

Plains to Peaks



Connecting Ecosystems in Kazakhstan for Goitered Gazelle Conservation

During 2022, we completed and reported on a project to understand the status of goitered gazelles *Gazella subgutturosa* in Kazakhstan (currently considered Vulnerable to extinction in the IUCN Red List of Threatened Species). By working with local partners (Institute of Zoology and Wildlife Without Borders Kazakhstan) in Almaty and providing training to personnel from key protected areas (see page 59 of the section 'Participation and Capacity Building'), we provided new population estimates for goitered gazelles in eastern Kazakhstan.

The main populations were in the protected areas of Altyn-Emel National Park (approximately 5,300

animals), and Charyn Canyon National Park (300 animals). We discovered previously unrecorded populations, including 300 animals near the Ketmen Ridge and 64 animals in the Karakum Sands. Importantly, we discovered 108 gazelles occupying designated sport and trophy hunting areas at Manul and Uzuntam, with around 300 more gazelles living outside any protected areas.

The surveys suggest that goitered gazelle numbers are negatively affected by roads and human activity. Gazelle numbers tended to increase with higher levels of available vegetation, as indicated from satellite imagery. We produced maps of the relationships between gazelle numbers and their environment to reveal potential obstacles to animal movement. These maps have been distributed to government and protected area managers. In-person workshops are planned for 2023 to provide guidance on conservation and landscape planning for goitered gazelles. Our colleagues in Kazakhstan have also produced information brochures and web content to engage communities and other members of the public. They highlight the cultural and ecosystem importance of these gazelles across the region.

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



^ ABOVE Illustrations of goitered gazelles *Gazella subgutturosa* and snow leopards *Panthera uncia* from the front cover of brochures developed as part of projects to garner support for the conservation of these species.

Snow Leopards as a Living Symbol of Almaty

Since 2019, the status of snow leopards *Panthera uncia* living in the area of Almaty has been continually assessed. This work was carried out with our colleagues at the Institute of Zoology and Wildlife Without Borders Kazakhstan, supported by the IUCN's Save Our Species (SOS) fund. The work complements ongoing national snow leopard status assessments and conservation work in the mountains of Kazakhstan. Almaty is home to almost two million people and has encroached

further into snow leopard habitats which increases the risks to them as well as to people. In 2022, working with our colleagues we found that, of the estimated 160 snow leopards in Kazakhstan, 25 were identified as living within 30 km of the city, and five were living in the city itself.

The team started awareness campaigns, holding events in Almaty and online. They have also produced an informative brochure in Russian that has been distributed among city leaders and residents. It has resulted in several television and radio appearances to highlight the steps people can take to ensure snow leopards can continue to live peacefully in and around Almaty.

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

Emergency Drought Support for Grevy's Zebra in Northern Kenya



Northern Kenya has been suffering extreme drought conditions since summer 2021. The country has so far missed five rainy seasons causing problems for wildlife, livestock and people. Marwell combined efforts with the Grevy's Zebra Trust (GZT) and Kenya Wildlife Service (KWS) to purchase and deliver hay to areas where Grevy's zebra *Equus grevyi* are gathering.

In 2022, Marwell delivered over 1,500 bales of hay across four sites, feeding approximately 120 Grevy's zebra each day. These northern herds are small but are a vital stronghold potentially linking Kenyan and Ethiopian populations. Marwell has employed two Hay Monitors from the local communities that visit sites daily and monitor the animals' body condition as well as availability of forage and water for the remote herds. Our Monitors also set automatic cameras at feeding sites to track which zebra are using the hay. The cameras can record if other species are benefiting,

and we know this includes elephants *Loxodonta spp.* GZT is targeting over 500 Grevy's zebra further south (~18% of Kenya's Grevy's zebra) in the national reserves of Samburu, Buffalo Springs and Shaba and has provided over 20,000 bales. With costs increasing to almost US\$ 10,000 per week, GZT turned to Marwell for help in fundraising. As managers of the European *ex situ* programme for Grevy's zebra, Marwell sent out an emergency call for help and by the end of 2022, we received over £83,000 from zoos to provide ongoing support. We are hugely thankful to the generous donors that made this lifesaving work possible.

Regrettably, the drought has continued for so long that reports of deaths by starvation and incidents of poaching are still increasing. We are working closely with local KWS teams and communities to reduce the attacks on wildlife. Humanitarian aid is being facilitated to those communities facing the worst of the impacts, along with hay for livestock. We are urgently calling on stakeholders for greater action and support to protect these animals.

PARTNERS Kenya Wildlife Service | Grevy's Zebra Trust | Mpatmpat Consultants Limited

> RIGHT
With five failed rainy seasons, the Endangered Grevy's zebra *Equus grevyi* is relying on supplementary hay provided by the Grevy's Zebra Trust (pictured), and Marwell's scouts.



Wildlife Conservation and Monitoring in Northern Kenya



Despite the difficulties imposed by the severe long-term drought, our Community Scouts increased their efforts during 2022. Regular wildlife patrols were undertaken to record species and engage with livestock herders and other community members. In 2022, our scouts conducted an impressive 2,207 patrols (19% increase on 2021) covering over 13,000 km. These patrols focused on the Endangered Grevy's zebra, but 20 other species were also recorded. Dik-dik *Madoqua guentheri* and gerenuk *Litocranius walleri* were the most spotted species, both being seen more frequently than in previous years.

The black-backed jackal *Canis mesomelas* was the most sighted carnivore, but fewer were spotted than in previous years. There was a noticeable increase in observations for species like the aardwolf *Proteles cristata*, gerenuk, lion *Panthera leo*, aardvark *Orycteropus afer*, and spotted hyaena *Crocuta crocuta*. Worryingly, fewer carnivores and Grevy's zebra were observed compared to previous years. The scouts also recorded an increase in carcasses,

especially those of Grevy's zebra, ostrich *Struthio camelus* and lesser kudu *Tragelaphus imberbis*. The most likely causes of death were poaching or starvation due to the drought.

Declines in direct sightings of Grevy's zebra were probably due to animals gathering in fewer areas where they can still find water and pasture, some of which are problematic for our scouts to access safely. Our teams regularly attend community meetings to discuss insecurity and seek peaceful cooperation. We do know from monitoring our supplementary feeding sites, that at least 120 Grevy's zebra individuals are living in these areas.

Remote camera-traps placed by our scouts provide additional information to the patrols. A project by one of our postgraduate students, Connor Lacey, revealed differences in the timing of activity between Grevy's zebra and livestock populations, with livestock mostly active during the day and Grevy's zebra active at night, probably to avoid people. This presents a potential challenge as night-time activity places Grevy's zebra at greater risk of predation. Although the long-term implications of these findings remain uncertain, we are continuing to monitor and work with communities and partners to highlight and prevent population declines.

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



ABOVE
Camera-trap image of a herd of Grevy's zebra *Equus grevyi* drinking water at night.

TOP RIGHT
Our Community Scout, Lekupe, charging the GPS-enabled smartphone he uses to track his patrols and record information about wildlife and the environment.

BOTTOM RIGHT
Clockwise: gerenuk *Litocranius walleri*, lesser kudu *Tragelaphus imberbis*, spotted hyaena *Crocuta crocuta* and aardvark *Orycteropus afer*.



Conserving Priority Wildlife Species in Tunisian Protected Areas



TOP LEFT

It is over 35 years since the first scimitar-horned oryx *Oryx dammah* were released into their natural habitat in Tunisia. Currently, Tunisian protected areas support a metapopulation of 210 oryx.

BOTTOM LEFT

Reintroduced populations of the once nationally extinct North African ostrich *Struthio camelus camelus* produced healthy broods of chicks in 2022.

In 2022, Marwell's Tunisia team continued monitoring priority wildlife species across eight protected areas in close partnership with the Direction Générale des Forêts and the Commissariats Régionaux au Développement Agricole of Medenine, Tatatouine, Tozeur, Sidi Bouzid, Kebili, Gafsa and Sfax.

The Extinct In The Wild scimitar-horned oryx *Oryx dammah* has been re-established in Bou Hedma, Dghoumes and Sidi Toui National Parks (NPs) and Oued Dekouk National Reserve (NR). Our team visited each several times across the seasons to survey population sizes and body condition, analyse population data collected by park staff, and manage the camera-traps that monitor wider biodiversity. The analyses revealed approximately 210 oryx, despite the severe drought in the region impacting some of the populations.

PARTNERS Direction Générale des Forêts (DGF, Ministry of Agriculture, Water Resources and Fisheries) | CRDA and Forest Departments of Medenine, Tatatouine, Tozeur, Sidi Bouzid, Kebili, Gafsa and Sfax

North African ostriches *Struthio camelus camelus* have disappeared from most of their former range, with wild populations restricted to a few fragments. This desert-adapted sub-species went extinct in Tunisia in the late nineteenth century but has been reintroduced to three protected areas with an *ex situ* centre established in Orbata. 2022 was a good year with the recently reintroduced birds of Bou Hedma NP producing healthy chicks for the first time. The chicks are also doing well in Sidi Toui NP and Orbata NR. The nests in Dghoumes NP were raided by predators, partially driven by the drought and the reduction in their wider prey base. As sad as this is, it is indicative of a fully functioning ecosystem that can support a wide range of species. Overall, Tunisia now has 80 adults plus chicks for this once nationally extinct ostrich.

Our Tunisia team also conducted surveys and provided management advice for addax *Addax nasomaculatus*, slender-horned gazelles *Gazella leptoceros*, dorcas gazelle *Gazella dorcas*, and Barbary sheep *Ammotragus lervia*, to facilitate the management of these priority species.

Monitoring Aridland Biodiversity in Tunisia



^ ABOVE
Camera-trap images of a Critically Endangered addax *Addax nasomaculatus* and fennec fox *Vulpes zerda* and African golden wolf *Canis anthus* in Senghar-Jabbes National Park.

In 2022, we set up 15 automatic cameras in Senghar-Jabbes National Park, in the Tunisian Grand Erg Oriental, to detect native animals. After the first few months, fennec foxes *Vulpes zerda*, African golden wolves *Canis anthus*, hares *Lepus capensis*, and addax had become accustomed to the presence of the cameras, and we hope to observe more cryptic species soon.

This is the fourth Tunisian site where Marwell and Tunisia's Direction Générale des Forêts have deployed camera-traps. We initially used them to assess the adaptation of reintroduced scimitar-horned oryx, ostrich and addax to their environment, but they now also help us to evaluate wider biodiversity in the protected areas. Aridlands are extreme environments characterised by sparse vegetation and highly dispersed wildlife. Animals are mostly active at dawn and dusk and because of this, native species are rarely directly observed, and their status is not well known resulting in a misleading

PARTNERS Direction Générale des Forêts (DGF, Ministry of Agriculture, Water Resources and Fisheries) | CRDA and Forest Departments of Medenine, Tataouine, Tozeur, Sidi Bouzid, Kebili, Gafsa and Sfax

impression of species diversity and abundance. The absence of contemporary data limits the effectiveness of conservation action plans.

Since the beginning of this project in 2018, the thousands of photos taken each month have already confirmed the presence of Rüppell's fox *Vulpes rueppellii* in the Tunisian Great Erg, and the Barbary sheep and striped hyaena *Hyaena hyaena* in Dghoumes National Park. We have also gained an understanding of the co-existence and competition between species, and their daily and seasonal activity patterns. This is the first time that such an intensive level of wildlife monitoring has been implemented in North Africa. By working with our local partners, we have trained people at each site to use camera-traps, and collect and interpret data.

Overall, the use of camera-traps to monitor the biodiversity of protected areas benefits a wide range of people, including park managers, researchers, students, local communities, and policy makers, and helps target conservation action to maximise impact.



Habitat Management on the Marwell Estate

^ ABOVE
Marwell's grasslands are managed to provide a sustainable source of hay for our animals.

During 2022 we continued to manage the woodlands and grasslands on the Marwell estate, maintaining good habitat conditions in accordance with the Countryside Stewardship and Forestry schemes to which we are committed. Essential to this work is ongoing action to maintain public rights of way that allow local communities to enjoy our landscapes.

A key part of habitat management is seeking approaches for their sustainable use, in particular the provision of food for our animals in the zoo.

Our woodlands produce browse for species such as giraffe *Giraffa camelopardalis* and okapi *Okapia johnstoni* and we estimate sustainable extraction of approximately 120 m³ of material. We have also planted a further 4.5 hectares of native woodland to provide more browse in areas that will increase connectivity for biodiversity across our estate.

Our grasslands are managed as low-input biodiversity rich meadows, from which we are able to sustainably cut hay as food for our smaller herds of antelope. In 2022 we cut approximately 700 bales of hay (over 2,000 m³). By using our land to provide food we not only reduce costs, but we also strengthen our sustainable supply chains.

Habitat Restoration and Species Recovery at Eelmoor Marsh SSSI



The rewilding of Eelmoor Marsh SSSI (Site of Special Scientific Interest) continues to be a flagship project for Marwell. Lowland heath is a rare and threatened habitat type found in the south of England, across Hampshire, Dorset and Surrey. Eelmoor's unique mix of dry and wet heathland, grassland, mire, and woodland is an important part of the wider landscape, providing shelter for many species that are struggling across the country.

In 2022, restoration works were carried out to control scrub across 7.95 ha and prevent it from encroaching onto the heathland. Scots pine *Pinus sylvestris* and silver birch *Betula pendula* were removed to prevent seeding and create a more open heathland. Additionally, 3.07 ha of heather *Calluna vulgaris* was mown to create diversity in the age, structure, and height to benefit the different microhabitats of many species.

The 79 ha site is also grazed year-round by our herd of ten Highland cattle *Bos taurus* and two Przewalski's horses *Equus ferus przewalskii* acting as ecosystem engineers to maintain and diversify the habitats.

PARTNERS QinetiQ | Natural England | Forestry England

Elderly gorse *Ulex europaeus* that no longer provided suitable habitat was removed from the north of the site, adjacent to the area where sand lizards *Lacerta agilis* have been released. As well as providing more habitat for the lizards, this practice will create more open heathland for key species such as the silver-studded blue butterfly *Plebejus argus* for which Eelmoor is a stronghold, and Annex 1 bird species such as woodlark *Lullula arborea*, nightjar *Caprimulgus europaeus* and Dartford warbler *Sylvia undata*.

Another target area with a rich community of rare botanical colonies was cleared of 1.24 ha of gorse and scrub to encourage species such as the pale dog-violet *Viola lactea*, petty whin *Genista anglica*, field chickweed *Cerastium arvense*, and lesser centaury *Centaureum pulchellum*.

Lastly, 605.1m of ditch edges were strimmed across existing common butterwort *Pinguicula vulgaris* and pale butterwort *Pinguicula lusitanica* sites which have been thriving at Eelmoor for many years. Some pines were also felled around certain ditches to reduce the shading of overgrown waterbodies that would be beneficial for many *Odonata* species and botanicals such as bladderworts *Utricularia australis*.



Historical Species Trends at Eelmoor Marsh SSSI



ABOVE
Przewalski's horses *Equus ferus przewalskii* graze Eelmoor Marsh, along with a herd of Highland cattle *Bos taurus*.

In 2022 we collated and began analysis of historical datasets from 1995 onwards, to identify long-term trends that can be used to inform future habitat management at Eelmoor Marsh SSSI. When compared to trends across Hampshire, it appears that some uncommon butterfly species are thriving at Eelmoor: most notably the silver-studded blue, the common blue *Polyommatus icarus*, the dingy skipper *Erynnis tages*, the grizzled skipper *Pyrgus malvae*, and the white admiral *Limenitis camilla*.

While previously widespread across southern Britain, white admiral populations have seen a dramatic decline in the last 20 years. However, it was discovered in 2013 at Eelmoor and the small

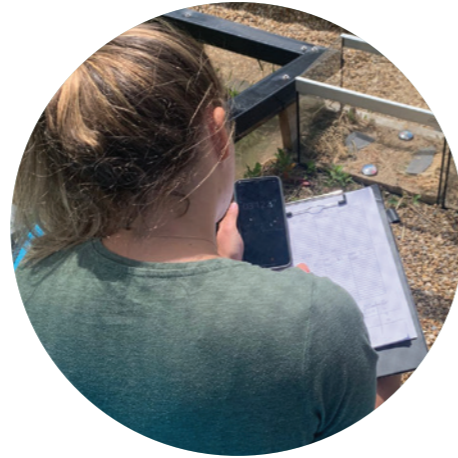
population has been staying steady ever since. We hope further analysis will shed light on which habitat features are important for this species at Eelmoor, to ensure that our management is targeting this rare butterfly.

In 2022, ten butterfly species and seven *Odonata* species were recorded. Species included the clouded yellow *Colias croceus*, an occasional visitor to the site, and numerous graylings, *Hipparchia semele*, an uncommon species that is found in high numbers at Eelmoor.

Early analysis has already shown that some *Odonata* populations are struggling, most notably the blue damselfly species, such as the blue-tailed *Ischnura elegans* and common blue *Enallagma cyathigerum*. This allows us to plan 2023 management accordingly, focusing on opening up overgrown waterbodies and reducing shading to provide more suitable habitat for this community.

PARTNER QinetiQ

Sand Lizard Populations in the South of England



Post-release population monitoring was continued at Eelmoor Marsh SSSI in 2022 to determine sand lizard distribution after reintroduction, with sightings recorded throughout the summer and two 8-month research projects, focusing on sand lizard biology and distribution throughout southern England, were also undertaken by our postgraduate students.

^ ABOVE AND RIGHT
Postgraduate student Morven Smith measured social behaviour and response to environmental conditions within our *ex situ* population of sand lizards *Lacerta agilis*, one of Britain's rarest reptiles. The findings of her study will help guide best practices for sand lizard reintroduction efforts.

Morven Smith measured social behaviour and response to environmental conditions within our *ex situ* population of sand lizards. Stable behaviour types, in response to climate, were identified among adult sand lizards, promoting a range of reactions to changes in environmental conditions. Across populations of sand lizards, differences in how individuals respond to climate challenges could underpin adaptive processes and promote species survival in the future. Fascinatingly, juveniles did not exhibit stable reactions to climate, suggesting that younger lizards remain more flexible in their interactions

with the environment. For release planning, these findings confirm that releasing juveniles for reintroduction is best practice as behaviour is flexible during this life history stage so individuals are more likely to survive a wider range of extremes. To encourage this individual variation in response to changes in climate, we recommend that reintroduction managers select sites that can host a range of microclimates in order to maintain behavioural diversity within the population.

James Barton's postgraduate research sought to identify and map suitable habitat in Dorset, Hampshire and Surrey for sand lizards. As habitat specialists that have suffered dramatic population declines in Great Britain due to habitat loss and fragmentation, remaining populations of sand lizards are isolated and rely on human intervention to connect them. Knowing where to focus attention is vital to their long-term persistence. This study showed that creating habitat corridors in priority areas will improve habitat connectivity for sand lizards within Dorset, Hampshire, and Surrey.

PARTNERS University of Southampton | QinetiQ | Natural England | Amphibian & Reptile Conservation Trust



Advances in Animal Welfare



Animal Welfare Assessment Grid

The 'Animal Welfare Assessment Grid' (AWAG) is a tool for assessing the welfare of *ex situ* animals, producing a graph that illustrates animal welfare standards based on scoring factors associated with physical and psychological health, environment, and veterinary and other management interventions. Having previously modified the system for use with our primates, large carnivores, and various hoofstock species, in 2022 we adapted this tool further, for use with cephalopod molluscs (such as cuttlefish and octopuses) and decapod crustaceans (such as crabs and lobsters) (from now on referred to as cephalopods and decapods).

Earlier this year, the UK government formally acknowledged cephalopods and decapods as sentient (able to feel and experience things, for example, feel pain and experience fear) in the new 'Animal Welfare (Sentience) Bill', highlighting the need for a welfare monitoring tool for *ex situ* management of these species. Working with an MSc student from Imperial College London, we adapted and trialled the AWAG at both Marwell Zoo, where the focus was on our red-clawed crayfish *Cherax quadricarinatus*, and the National Marine Aquarium, with positive results. This is the first time that an impartial scoring system has successfully been used to monitor the welfare of invertebrates and we were delighted this work was published in *Animals* (full details on page 53).

Since the launch of the AWAG cloud-based software (2021), which allows data to be uploaded to the system quickly and easily via a phone or tablet and analysed in real time, over 27,000 welfare assessments have been added for over 50 species, including mountain bongo *Tragelaphus eurycerus isaaci*, coppery titi monkey *Plecturocebus cupreus*, and clouded leopard *Neofelis nebulosa*.

PARTNERS University of Surrey | Reuben Digital | National Marine Aquarium | Imperial College London

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ABOVE
The Animal Welfare Assessment Grid is now being used to monitor the welfare of decapod crustaceans, like the red-clawed crayfish *Cherax quadricarinatus*.



Animal Training

Throughout 2022, we continued to expand our animal training programme for veterinary and husbandry purposes to encompass new individuals and species. We have been able to build on the training programme that began in 2021 for our annual vaccinations with the primate and small mammal and veterinary teams. Twenty-eight primates were successfully vaccinated in one morning, without needing to resort to physically handling the animals. Our okapis have recently started a training

programme to cooperate in veterinary procedures so that samples can be taken without the need for sedation, with success for the male, Nuru. Animal care teams are working hard to also achieve this with the three female okapis in early 2023.

For the improvement of animal welfare and staff development, we have established an internal Animal Trainer programme, composed of both a theory and a practical element. This is to increase consistency in training knowledge and methods across the zoo. Four members of the animal management team have passed to date, with many others following on.

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ABOVE
Our okapis *Okapia johnstoni* were among the species to benefit from our animal training programme in 2022.



Glow Marwell

In 2022, we launched our first winter light event, *Glow Marwell*. As a brand-new event, careful planning was required from the outset to limit impact on animal welfare. We developed a risk assessment to identify the species and individuals most likely to be at risk. A variety of measures were put in place to reduce the potential impact.

This included:

- > Avoiding flashing or fast-moving lights
- > Limiting the use of UV light to areas away from animal enclosures

- > Blacking out animal house windows
- > Having marshals to keep guests moving past species of concern
- > Initiating a desensitisation programme for the animals for both the lights and noise/presence of guests outside of usual opening hours.

The animals at Marwell were monitored closely by our animal management team throughout the event, using CCTV, camera-traps, and direct observations. All the data that was collected will be analysed alongside previous welfare assessments using the Animal Welfare Assessment Grid. These results will feed into the plans for *Glow Marwell 2023*. Extensive collaboration and teamwork has meant the impact of *Glow Marwell* on animal welfare appears to have been mostly negligible and any issues identified, albeit few, were addressed promptly and successfully.



TOP LEFT
Moon chairs at *Glow Marwell*, our first winter light event.

BOTTOM LEFT
Clouded leopard *Neofelis nebulosa*, whose enclosure was carefully redesigned to replicate their wild habitat and encourage natural behaviours, contributing to positive life experiences for our animals.

Positive Life Experience

One of our major habitat development projects of 2022 was redesigning the Amur leopard *Panthera pardus orientalis* enclosure for a new, highly arboreal medium-sized cat species, the clouded leopard. Understanding species' natural history and matching the environment to their evolved biology is key to good health and welfare and promoting positive life experiences. The in-depth design process by the carnivore and habitat teams not only focused on visually replicating the species' wild habitat but providing the opportunities for the animals to express species-

specific wild behaviour such as climbing and resting at height, in addition to using *ex situ* research to reduce human impact on welfare, through the extensive provision of low-level planting.

Other improvements to habitats have been made over the last year to increase positive life experiences. One example is natural branching in primate exhibits that flexes and moves when used, encouraging natural locomotion, behavioural adaptation and development of muscles. We have also completed the installation of feed poles in the giraffe paddock and developed bio-floors in the cusimanse *Crossarchus obscurus* habitat, along with ultra-violet light and shortwave infra-red heating to extend the photoperiod to better resemble their wild habitat.



Sustainable Living

Marwell is leading the way in sustainability with *Energy for Life*, our Tropical House and biomass Energy Centre.

Progress on Carbon Neutrality



Carbon Neutrality

We are delighted to have achieved our ambition to become carbon neutral for our operational emissions in 2022, our 50th anniversary year.

By the end of 2022 our new Energy Centre was starting to replace the oil-fired heating in many of the zoo's major buildings including *Energy for Life* (our Tropical House), Marwell Hall, offices, the okapi house, and *Life Among the Trees* (See *Energy for Life*). Our carbon footprint for 2022, our first full year of trading post pandemic, was 497

tonnes CO₂e. Our carbon footprint remains 71% lower than our comparative baseline of 1,705 tonnes CO₂e in 2008.

In 2021 we started calculating the amount of carbon absorbed by our woodlands. In 2022 we also calculated the carbon stores in our grassland, pasture, and new tree planting areas. We estimate that our landscape currently stores over 7,500 tonnes of carbon and absorbs (sequesters) 547 tonnes CO₂e each year. This exceeds our estimated operating carbon footprint by 50 tonnes CO₂e meaning that we are currently absorbing more carbon from the atmosphere than we are producing.



Energy for Life

The installation of the heat network from *Energy for Life*, our Tropical House, to Marwell Hall, offices, the okapi house and *Life Among the Trees* was completed in September, meaning low carbon heat was delivered to all buildings for the first time. We've achieved this through our award-winning Zoo Poo initiative, which effectively uses the energy from a waste product we have in abundant supply. Briquettes burned in our biomass boilers are made up of hoofstock waste and old bedding, which has proved a valuable source of eco-friendly fuel.

An extension to the heat network has been installed to our former tropical house, which is currently being upcycled to create a year-round experience of fragrance and intricate texture of vegetation against a backdrop of a new multi-species habitat called *Thriving Through Nature*. This will open in 2023 and will be heated with low carbon heat from the start.

Initially, the heat for the network was supplied from the woodchip boiler and then switched to the big animal waste boiler when the weather turned colder in December. The introduction of this low carbon heat network resulted in oil consumption dropping from over 10,000 litres in autumn 2021 to less than 2,000 litres for the same period this year.

PARTNER Environ



Solar Energy Generation

The new solar panels installed in partnership with Winchester City Council lived up to expectations generating

nearly 88,000 kWhs of electricity in 2022. Solar panels across the zoo now contribute 9% of Marwell's total electricity consumption each year.

PARTNER Winchester City Council

*Yew Taxus
baccata.*

Towards a Better Environment



Ethical Sourcing

We started selling a small number of soft toys made from recycled plastic in 2020. Our range was expanded in 2021 and 2022 and we now stock 131 different toys made from recycled plastic. These make up 80% of all the soft toys we now sell.

The recycled plastic toys are sourced from Keel Toys Ltd who were vetted against our Ethical Sourcing Policy to ensure that they are taking steps to minimise their impact on the environment and treat their workers fairly, wherever in the world they may be. Our ethical sourcing policy is applied across all of our purchases, not just in the gift shop. This ensures that our tea and coffee is fair trade, our ice cream is organic, paper and wood products are made from timber that is sustainably sourced and we only use and sell products containing sustainable palm oil.



Green Travel

After a break of two years the Marwell Bus from Eastleigh, the M1, was back in operation for summer 2022 and the number 69 bus from Winchester stopped at Marwell on Sundays. Over 3,000 people travelled to Marwell by bus

reducing road congestion, local air pollution and transport carbon emissions.

Around half of bus users didn't own a car, either through choice or due to low income, so the bus makes Marwell accessible to this section of the community. For the remainder, who would otherwise have driven to Marwell, their bus journeys saved approximately 5 tonnes of CO₂e.

PARTNER Three Rivers Rail Partnership

Environmental Standards

We are pleased once again to have retained our certification to Environmental Standard ISO14001 following a two-day audit in July. This international standard provides a framework for us to ensure we have identified all our potential impacts on the environment and have a process

in place to minimise, mitigate or eliminate each of them.

Being audited by an independent auditor provides an important check of our performance to confirm nothing has escaped our notice and that we continue to improve year on year. Marwell has been continuously certified since 2009 and is one of only a handful of zoos to achieve this standard.

> RIGHT
We take pride in the fact that 80% of the soft toys we sell are made from recycled plastic, while our Marwell-branded reusable water bottles are made from recycled milk cartons.



Catalysing Change

Over 33,000
pupils visited
Marwell with
their schools
in 2022.

million



Catalysing Change

Natural Curiosity



Outdoor Learning

Kids Love Nature (KLN) Kindergarten at Marwell Zoo received an 'Outstanding' Ofsted rating in 2022. The report described it as having

'a rich and ambitious curriculum and exceptional opportunities to learn about the environment.'

Marwell's collaboration with KLN is a great example of the ongoing support we provide to our local community. The number of sessions delivered in the zoo and surrounding countryside, exploring

PARTNER Kids Love Nature

our native wildlife and exotic animals, are back to pre-pandemic levels with more than 300 sessions delivered in 2022.

Our sessions are based around inspiring curiosity and developing positive relationships with nature. We work to help children feel connected to nature and ultimately influence their actions throughout their lives to become 'caretakers of the planet'. Activities that directly affect the environment help to build such relationships. For example, in 2022 the children joined in with our plants and landscapes team collecting and using leaves to help make sustainable and welfare-positive bio-floors in animal enclosures. Children also planted bulbs around the zoo and collected information about local bumblebee and reptile numbers to understand trends, develop science skills and provide valuable information to share with our conservation team.



School Zoo Visits

In 2022 over 33,000 pupils visited Marwell from 687 schools. Our A-Level conference weeks continued to be popular with 521 students attending from 18 colleges, in addition to which 137 international students representing

schools from India, Japan, China, South Africa, Australia and Europe visited as part of the Round Square International Conference.

This year we celebrated 40 years since our education programme started. Two years after it was established, the programme was officially recognised by Hampshire County Council.



Special Needs and Accessibility for Schools

We have developed a new workshop specifically for children with special educational needs (SEN). This works to the Department for Education's revised 2021 framework of Engagement Model and Pre-Key Stage 1 and 2 requirements. Also in 2022, we provided nine SEN students with appropriate

and specialised work experience opportunities.

In 2015 we became the first UK zoo to be registered as Makaton Friendly. Makaton is a programme that uses symbols, signs and speech to enable people to communicate. To support this, in 2022, we increased the level of Makaton competency for our public facing staff and re-implemented the wide availability of communication fans designed to facilitate non-verbal communication.



“I have learned how to save water and natural resources and came across many animals that I have never seen before in my life, like rhinos, buffalos and warthogs. I saw a nest which has been built by a hamerkop, a bird that builds the biggest nest in the world. And we promise you that, when we go back to our school, we will plant many trees and not cut down any others. Thank you.”



Conservation Education in Northern Kenya

The challenges for people and wildlife in Samburu North and Marsabit regions of Kenya are significant, particularly during a long period of drought. Social tensions, wildlife decline and increased poaching are all symptoms of these struggles. Our outreach programme in schools has shown us that children had little or no understanding of wildlife and the connections between the environment and their communities. This is why during 2022 we have offered new experiences to several schools in the region, both outdoors and in the classroom.

Our team spoke about Grevy’s zebra conservation in northern Kenya to a class of 20 from Lpartuk Secondary School in Maralal. These students are now discussing how to set up a wildlife and environmental club at the school. A tour to Samburu Bird Sanctuary and Kisima

Dam allowed children to learn about wetlands and the importance of monitoring wildlife. We were invited to join Lonjorin Primary School to give lessons about animal diversity and ecology, where students learnt about the connections between living things and patterns in plants and animals often occurring together.

Following last year’s success, we were able to send another two schools, Arge and Lonjorin, to Lewa Wildlife Conservancy. Forty children and their teachers were able to experience wildlife close-up, often for the first time. We supported Lpartuk Secondary School with fuel for their school bus and arranged a tour of Lewa for 38 students and their teachers, where they visited for three days. The children were able to experience a diversity of wildlife and develop a greater understanding and connection to nature.

We had hoped to restart sessions for children who are unable to attend school while they care for their family’s livestock. Sadly, the extreme drought has resulted in many of them moving long distances from their home to find forage for their animals.

ABOVE AND LEFT
During a trip to Lewa Wildlife Conservancy, children from Arge and Lonjorin primary schools enjoyed wildlife game drives and learned about sustainability and conservation.

PARTNERS Lewa Wildlife Conservancy | Northern Kenya Conservation Education Working Group | Mpatmpat Consultants Limited



Further Education



Connecting People with Nature

In 2022, our interpretation and public engagement team of trained staff and volunteers engaged with an estimated 34% of all guests across the zoo, providing meaningful and interesting information about our animals, our conservation work, and the natural world. In our Tropical House, themed as *Energy For Life*, we estimate that 45% of guests benefited from talking to a member of our team, who were frequently referred to as 'very friendly' and 'knowledgeable'. Topics of conversation included tropical ecology, sustainable energy, and climate change. The team also helped guests to spot and find out more about our sometimes elusive sloth *Choloepus didactylus* and the other inspiring wildlife around them.

Almost a fifth of these meaningful guest engagements (20,000+) occurred around our

evolution-themed exhibit at the giraffe house, with guests expressing positive feedback with respect to our team and their experience. Additionally, 97% of guests participating in our giraffe animal experience said they would recommend it to family and friends. Common words participants used to describe the feelings of experiencing the giraffe up close were 'joyful', 'in awe', 'compassionate', 'amazing', and 'appreciative'. For some people, such experiences can be life-changing, and we never underestimate the potential of our animals to affect people deeply and enhance their appreciation and care for nature.

This year also saw a wealth of new content supporting the zoo experience such as our informational guidebook, an informative science-backed BRICKOSAURS! Evolution trail and sculpture display, in-depth informational panels for our new clouded leopards, conservation content and messaging for our new train tour, as well as an exhibit celebrating 50 years of Marwell's conservation work. This year has also seen us using QR codes directing to online content to provide additional background information for our guests.

^ ABOVE
Our zoo is a great place to foster optimistic and positive connections between people and nature.

Further Education in Horticulture

Over the course of 2022, our plants and landscapes team shared their knowledge and practical experience with Horticulture students at Sparsholt College. While at Marwell, students honed their skills and gained first-hand experience of environments and operations they might encounter in future employment.

Through sessions run with the Sparsholt staff, the students covered plant management, including proactive plant care and pest and disease controls, and landscape planning, from an initial concept design through to a final product with its associated maintenance. Practical teaching was integral, including planting bulbs and tree

saplings, and preparing cuttings and collecting seeds for wildflower areas and supporting seasonal soft and hard landscaping. Students are well prepared for careers in areas such as landscaping construction, garden maintenance, pests and disease management, nurseries, and planning and design.

Long-term partnerships like ours with Sparsholt directly address current national deficits of skilled professionals within the sustainable landscaping sector. To further support this effort, our Plants and Landscapes Team Manager is an active member of Sparsholt's Industry Liaison Group helping to tailor course content to ensure relevance to future employment.

In recognition of more than 13-years ongoing collaboration between Marwell and Sparsholt teams, we were delighted to be awarded the Industry Insight Award in 2022.

^ ABOVE
White deadnettle
Lamium album.

PARTNER Sparsholt College

Higher Education

During 2022 our scientists supervised and facilitated 12 undergraduate and 18 postgraduate research projects, including supervision for students in Kenya, Tunisia, Kazakhstan and China. Our science team also taught over 250 university and college students, contributing to academic qualifications in the UK and internationally.

MRes Wildlife Conservation

We were delighted to see our 2021 MRes intake graduate this year at the University of Southampton's wonderful ceremony at the Guildhall, celebrating a fantastic year of achievements. The majority of students achieved Distinctions or Merits, and two students earned special awards: James Barton received the University of Southampton Dean's Award for achieving exceptionally high grades throughout his programme year, and Jamie Pantling received the Peter Brough Award for his project on ecosystem benefits of rewetting Eelmoor Marsh.

Following successful completion of the taught first semester, our students undertook their independent research projects in 2022:

- > One study used data collected by our Community Scouts in Kenya to understand interactions between livestock and Grevy's zebra, with findings highlighting the importance of access to waterholes.
- > At Eelmoor Marsh, a study showed that areas subjected to rewetting management have higher levels of soil organic carbon than

areas not yet under similar management practices, providing options for our SSSI site, and similar mire habitats, to make greater contributions to carbon sequestration and climate change mitigation planning.

- > Drawing on our long history of sand lizard reintroductions and conservation, a study assessed connectivity of fragmented populations of sand lizards to enhance population sustainability in Hampshire and Dorset. A second project examined individual responses in sand lizard behaviours revealing differences in the impact of weather on how individuals use their environment. Both sand lizard projects have important implications for future releases.
- > Our on-going work on *ex situ* population management was enhanced by two MRes projects, the first examining life-history trait adaptations in zoo-based populations of scimitar-horned oryx, and the second taking a novel multi-species approach to evaluate the conservation health potential of *ex situ* management programmes.

The quality of scientific research across our MRes in 2022, resulted in three papers being developed for publication. We were pleased to see research from a previous MRes project published in 2022 (Smith *et al*, 2022).

PARTNER University of Southampton



"My MRes research about *ex situ* populations in a wider conservation context will help inform priorities for zoo-field conservation, and enabled me to step into a role within Marwell's conservation team, focusing on antelope conservation and *ex situ* management programmes."

Sophie Whitemore, MRes Wildlife Conservation 2021/22



"After graduating in 2018, I worked for various conservation charities, including ORCA and Hampshire and Isle of Wight Wildlife Trust, carrying out ecological surveys to monitor biodiversity. I am now back at Marwell, working as an Ecologist and helping to manage our rewilding site in Farnborough and our local woodlands.

The ecological and practical skills I learned through the course have enabled me to create biological impacts within various charities, and inspired me to induce social change. I love writing, and since graduating I have built a freelance business writing environmental articles for magazines, websites, and books. Communication is key to spreading social impact, and I value being able to share knowledge in a way that everyone can access, regardless of their involvement with science."

Carla Broom, MRes Wildlife Conservation 2017/2018



Veterinary Medicine

The veterinary team continued to provide teaching for the University of Surrey's School of Veterinary Medicine. This year we welcomed 23 final year students onsite for teaching in zoological medicine. Each student spent a four-week elective with the veterinary team, participating in clinical work, pathology and workshops on topics ranging from nutrition to animal training. Each student also undertook a research project, focusing on a topic of interest to the team, including the impact of zoo events such as *Glow Marwell* on animal behaviour, contributing to future risk assessments. The work of

one student contributed to a published paper: 'An Approach to Assessing Zoo Animal Welfare in a Rarely Studied Species, the Common Cusimanse.' Another student's work on enclosure usage by our meerkat group led to the implementation of a new heat lamp in the enclosure.

The veterinary team also provided a series of lectures at the veterinary school, for 140 fourth year students on topics including nutrition, anaesthesia and species-specific husbandry and medicine. These students also visited the zoo in small groups for a zoo licensing workshop, covering legislation and critical appraisal of Marwell's exhibits. Our conservation team provided further lectures and workshops on *ex situ* programmes and reproductive management and fundamentals of conservation biology.

PARTNER University of Surrey

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ABOVE
During their clinical zoo medicine electives, University of Surrey final year veterinary students are involved in every aspect of our vet team's work.

Conservation Health Tutorials

Our Director of Conservation, Professor Philip Riordan, was asked to provide tutorials to a group of six students on the Human Sciences course at University of Oxford. This course is

PARTNER University of Oxford

taught by specialists from across disciplines and Phil delivered tutorials on Conservation Health, covering the interactions between wildlife and human activities. This theme is underpinned by a publication in 2022 (Davies *et al*, 2022 - see p.53) and is a central pillar in Marwell's new Conservation Strategy.

Trainee Teachers

Over 100 trainee primary school teachers from The University of Winchester visited Marwell to learn about how our education team use activities and workshops to engage and inspire school groups.

We provided a taught session on the planning and delivery of our education programme, as well as the procedures for managing school visits to the zoo. This first-hand experience will guide new teachers on the importance of linking learning beyond the classroom.

Placements

In 2022 we provided a diversity of placement opportunities across conservation, animal behaviour, animal management and education, supporting key projects and programmes, and enabling students and other early-career personnel to enhance their knowledge and gain practical experience.

A one-year placement student is developing a project that contributes to our understanding of animal activity patterns in the zoo, with reference to species of particular guest interest. Two shorter term placements contributed to a series of animal behaviour assessments, including the impact of

our winter event *Glow Marwell*. All three gained experience in animal behaviour observation techniques including the use of various pieces of technology (e.g., camera-traps and CCTV) for data collection, and data analysis skills.

A two-week placement within our education team in the summer, helped to develop and trial a new hub evaluation process, enabling instant school group feedback on our educational delivery in the zoo. As a qualified secondary school science teacher, he also helped evaluate our online resources and session content for Key Stage 3 students.

Finally, in 2022 we welcomed 14 animal keeper work experience placements from University Centre Sparsholt, as part of our long-running commitment to provide this partner-based opportunity.

PhD Students in 2022



Stephanie Brien

Stephanie entered the final academic year for her PhD at the University of Edinburgh's Roslin Institute and the Royal (Dick) School of Veterinary Studies. Her research on the immunogenetics of scimitar-horned oryx *Oryx dammah* is being conducted in collaboration with Marwell Wildlife and the Pirbright Institute. Despite challenges posed by Covid-19, Steph has collected a unique set of samples and by late 2022 was awaiting results from laboratory analyses.



Mohamed Khalil Meliane

Khalil's PhD at the University of Tunis El Manar explores the functional diversity of Saharan ecosystems in Tunisia. In 2022, he was busy analysing and writing-up his results and has been lead author of six published articles, with a view to submitting his doctorate thesis in 2023.



Joe Lambert

Joe was awarded his PhD from Beijing Forestry University for his thesis 'The response of bird and lizard communities to ecosystem engineering by plateau pika *Ochotona curzoniae* and its control: Implications for conservation'. Joe's research, for which he received supervisory support from the Marwell conservation team, has resulted in several important publications.



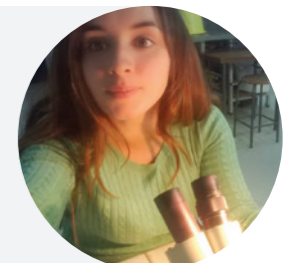
Maimounatou Ibrahim

Maimouna became the first woman to obtain a PhD at the University of Diffa, Niger, for her research about the 'Preliminary characterization of a site for the reintroduction of the North African ostrich: example applied in Koutous, Niger'. Maimouna, Site Manager of Sahara Conservation's North African ostrich *Struthio camelus camelus* breeding center in Kellé, Niger, was supported by Marwell's Marie Petretto, based in Tunisia.



Linus Kariuki

Linus, Head of Species Programmes at Kenya Wildlife Service and Secretary to the Grevy's Zebra Technical Committee, began his PhD at University of Nairobi. Linus is studying the impact of environmental change on movements of Grevy's zebra *Equus grevyi* in northern Kenya, with supervisory support from the Marwell conservation team and colleagues in Nairobi.



Amira Saidi

Amira, a Tunisian ecologist working for Marwell, carried out fieldwork in Jbil and Senghar-Jabbes National Parks in 2022, as part of her PhD at the University of Tunis El Manar. Her research examines the role of darkling beetles *Tenebrionids* in arid ecosystems and their importance for restoring these fragile environments.

Surveying the Sahara's Grand Erg Oriental for slender-horned gazelles *Gazella leptoceros*. PhD student Mohamed Khalil Meliane was lead author of a resulting publication in the *Journal of Arid Environments*.

Knowledge Exchange



Conservation Science in 2022

During 2022 we published ten peer-reviewed journal articles from our research and conservation work, the majority of which were open access to ensure that their contents can be widely shared. Conservation science is a highly collaborative discipline, where we achieve high-quality results through cooperation with national and international partner organisations. Our 2022 articles were produced through collaboration with 45 co-authors, from 30 conservation organisations, universities, government agencies, NGOs (Non-Governmental Organisations), and institutes across nine different countries. The articles covered subject areas as diverse as behavioural ecology, conservation genetics, animal and human health (one health), population connectivity, animal welfare, wildlife monitoring, and conservation prioritisation reflecting the wide expertise of Marwell staff.

Taxonomically, the articles focused on key questions and conservation action for addax, African golden wolf, capybara *Hydrochoerus hydrochaeris*, cephalopods (octopus, squid, cuttlefish, and nautilus), common cusimanse, decapods (crabs, lobsters, shrimp etc), dorcas gazelle, Grevy's zebra, large herbivores, North African ostrich, pika *Ochotona spp.*, red fox *Vulpes vulpes*, scimitar-horned oryx, slender-horned gazelle, and striped hyaena, providing fundamental information on which to develop further action and increased conservation impact.

The articles published in 2022 build on a long history of conservation science at Marwell. This discipline is essential to evaluate ongoing conservation work and develop new ideas and concepts that can drive conservation action forward creating new solutions to old, and new, problems. Since 2006, Marwell's track record includes 108 articles in 65 different peer-reviewed journals, achieved through the collaboration with 212 global partners from 34 countries in Europe, North America, Asia, Africa and Oceania.

The articles have been influential both in terms of guiding conservation practice, but also in providing a foundation for others' work in the same subject area. We can see some of this impact by looking at how often our articles have been cited in other publications. Google Scholar includes scientific reports and books in addition to peer-reviewed journals, and reports that our articles have been cited 1,896 times to the end of 2022, demonstrating our contribution to fundamental areas of conservation science and impact.

The publications cover work on 77 taxonomic groups from invertebrates such as dung beetles to amphibians and reptiles, and birds and mammals with a focus on key species including scimitar-horned oryx, Grevy's zebra, and African lions. Our conservation science has included species both within zoos and aquaria, and in their natural habitat in their indigenous range across 13 countries in the UK, South America, Asia, Africa and Oceania.

Our ongoing collaborations with national and international partners will continue to build a strong evidence base for conservation decision-making, ensuring a sound foundation for our work along with the necessary information to adapt management for maximum conservation impact.

2022 Peer-Reviewed Journal Publications

Davies, K., Lim, M., Qin, T. & Riordan, P. (2022)

CHANS-Law: preventing the next pandemic through the integration of social and environmental law. *Int Environ Agreements* 22: 577-597.
<https://doi.org/10.1007/s10784-022-09566-7>

Dicks, K.L., Ball, A.D., Banfield, L., Barrios, V., Boufaroua, M., Chetoui, A., Chuyen, J., Craig, M., Al Faqeer, M. Y., Garba, H. H.M., Guedara, H., Harouna, A., Ivy, J., Najjar, C., Petretto, M., Pusey, R., Rabeil, T., Riordan, P., Senn, H.V., Taghouti, E., Wachter, T., Woodfine, T. & Gilbert, T. (2022)
Genetic diversity in global populations of the Critically Endangered addax (*Addax nasomaculatus*) and its implications for conservation. *Evolutionary Applications* 00: 1-15.
<https://doi.org/10.1111/eva.13515>

Free, D., Justice, W.S.M., Smith, S.J., Howard, V. & Wolfensohn, S. (2022)
An approach to assessing zoo animal welfare in a rarely studied species, the common cusimanse *Crossarchus obscurus*. *Journal of Zoological and Botanical Gardens*. 420-441.
<https://doi.org/10.3390/jzbg3030032>

Mellane, M.K., Petretto, M., Saidi, A., Gilbert, T. & Nasri-Ammar, K. (2022)
Daily and seasonal activity patterns of the dorcas gazelle, scimitar-horned oryx, North-African ostrich and canids in an arid habitat. *African Journal of Ecology* 2022; 00:1-22.
<https://doi.org/10.1111/aje.13089>

Mellane, M.K., Petretto, M., Saidi, A., Riordan, P., Woodfine, T., Guedara, H., Mahdhi, S. & Gilbert, T. (2022)
Finding slender-horned gazelles in the Sahara's Grand Erg Oriental, Tunisia. *Journal of Arid Environments* 208: 104874.
<https://doi.org/10.1016/j.jaridenv.2022.104874>

Mellane, M.K., Saidi, A., Petretto, M., Woodfine, T., Riordan, P. & Gilbert, T. (2022)
Sedentarization of the striped hyaena *Hyaena hyaena* in Dghoumes National Park, Tunisia. *Oryx* 56 (5): 649-650.
<https://doi.org/10.1017/S0030605322000837>

Narshi, T.M., Free, D., Justice, W.S.M., Smith, S.J. & Wolfensohn, S. (2022)
Welfare assessment of invertebrates: Adapting the animal welfare assessment grid (AWAG) for zoo decapods and cephalopods. *Animals* 12: 1675. <https://doi.org/10.3390/ani12131675>

Smith, C.V., Gilbert, T.C., Woodfine, T., Kraaijeveld, A., Chege, G., Kimiti, D., Low-Mackey, B., Mufinda, M., Ngene, S., Rubenstein, D., Wandera, A. & Riordan, P. (2022)
Population and habitat connectivity of Grevy's zebra *Equus grevyi*, a threatened large herbivore in degraded rangelands. *Biological Conservation* 274: 109711.
<https://doi.org/10.1016/j.biocon.2022.109711>

Borkowski, E.A., Justine Shotton & Smyth, J.A. (2022)
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Selected Summaries from 2022 Publications

CHANSLaw: preventing the next pandemic through the integration of social and environmental law

Kirsten Davies, Michelle Lim, Tianbao Qin & Philip Riordan

Zoonotic viruses have sacrificed hundreds of millions of people throughout human history. There are currently 1.7 million unidentified viruses estimated to be circulating in mammal and bird populations. It is likely that another of these will transmit to people, heralding the start of the next pandemic—one potentially more deadly than COVID-19. This article calls for pre-emptive protection of the natural environment and its regenerative systems as the first fundamental step in the prevention of future epidemics and pandemics. We identify the need for a legal shift in epidemic and pandemic responses, and call for the incorporation of international environmental agreements to prevent the initial viral spillover from animal to human populations. We propose a strategy of strengthening existing agreements and a coupling of legal disciplines, such as health and environmental law, and introduce Coupled Human and Natural Systems (CHANS) Law to frame the required integration across legal instruments to regulate inextricably human-nature connections and advocate for the development of a Convention on Epidemics and Pandemics.

Genetic diversity in global populations of the Critically Endangered addax *Addax nasomaculatus* and its implications for conservation

Kara L. Dicks, Alex D. Ball, Lisa Banfield, Violeta Barrios, Mohamed Boufaroua, Abdelkader Chetoui, Justin Chuyen, Mark Craig, Mohammed Yousef Al Faqeer, Hamissou Hallou Mollam Garba, Hela Guedara, Abdoulaye Harouna, Jamie Ivy, Chawki Najjar, Marie Petretto, Ricardo Pusey, Thomas Rabeil, Philip Riordan, Helen V. Senn, Ezzedine Taghouti, Tim Wachter, Tim Woodfine & Tania Gilbert

There are fewer than 100 wild addax remaining, yet thousands are maintained in *ex situ* populations, which can provide animals for reintroductions such as those in Tunisia since the mid-1980s. Genetic data are needed to define the relationships between and within different populations, so we collected samples from wild, reintroduced and *ex situ* addax. Our results show that the remnant wild populations retain more genetic diversity than the entirety of the *ex situ* populations across Europe, North America and the United Arab Emirates, and the reintroduced Tunisian population. However, each population carried unique diversity. Our results highlight a vital need to conserve the last remaining wild addax, and we provide a genetic foundation for integrated conservation strategies to prevent extinction and optimise future reintroductions.

An approach to assessing zoo animal welfare in a rarely studied species, the common cusimanse *Crossarchus obscurus*

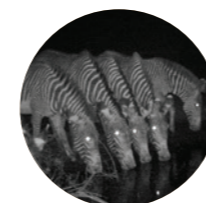
Danielle Free, William S. M. Justice, Sarah Jayne Smith, Vittoria Howard & Sarah Wolfensohn

Objective welfare assessments have a fundamental role in ensuring that positive welfare is achieved and maintained for *ex situ* animals. The Animal Welfare Assessment Grid (AWAG), a welfare assessment tool, has been used for a variety of domestic and exotic species. It combines both resource- and animal-based measures but relies heavily on knowledge of the species to effectively assess welfare. Many zoo species are understudied in the wild due to their cryptic nature or habitat choice; therefore, the published literature needs to be supported with *ex situ* behavioural observations and records. Here we adapted previously published AWAG templates to assess the welfare of the common cusimanse at Marwell, validating this approach to welfare assessments for a species where the published literature is scarce.

Sedentarization of the striped hyaena *Hyaena hyaena* in Dghoumes National Park, Tunisia

Mohamed Khalil Meliane, Amira Saidi, Marie Petretto, Tim Woodfine, Philip Riordan & Tania Gilbert

The distributions and densities of large carnivore populations in southern Tunisia contracted with the historical expansion of agricultural activities, and human-carnivore conflict and persecution. By the end of the 20th century, the striped hyaena *Hyaena hyaena*



was vulnerable to extinction across its Mediterranean range and rare in Tunisia with no confirmed sightings in southern parts of the country. Marwell established a camera-trap grid in the 80 km² Dghoumes National Park (NP) as part of biodiversity assessments and post-release monitoring for reintroduced scimitar-horned oryx *Oryx dammah*, dorcas gazelle *Gazella dorcas* and North African ostrich *Struthio camelus camelus*. Here we found that striped hyaenas were increasingly encountered throughout 2020 and 2021. Our findings suggest a largely sedentary population of hyaenas in Dghoumes NP. Our ongoing monitoring will provide more information about the ecology of hyaenas and other less known species in southern Tunisia.

Finding slender-horned gazelles in the Sahara's Grand Erg Oriental, Tunisia

Mohamed Khalil Meliane, Marie Petretto, Amira Saidi, Philip Riordan, Tim Woodfine, Hela Guedara, Sassi Mahdhi & Tania Gilbert

North-African slender-horned gazelles *Gazella leptoceros* are facing extensive poaching pressure. Remaining populations occur in Saharan habitat between Tunisia and Algeria. Access to the species' distribution range in both countries is limited by difficult terrain and strict permitting requirements. We explored a mix of aerial (1,365 km) and ground transects (351 km) to monitor the Grand Erg Oriental which covers the species' range in Tunisia. Only footprints were observed during the aerial survey over the southern part of the study area. The ground survey in the northern part revealed more conclusive results with evidence and observation of one couple, one group of three and another of four individuals. Our results confirm the presence of a slender-horned gazelle population in Tunisia yet support the need for immediate intervention to halt its decline. *Ex situ* conservation is essential to the species' future survival and continuous monitoring of the wild range is recommended.

Welfare assessment of invertebrates: Adapting the animal welfare assessment grid (AWAG) for zoo decapods and cephalopods

Tanya M. Narshi, Danielle Free, William S. M. Justice, Sarah Jayne Smith & Sarah Wolfensohn

The use of decapods (e.g. lobsters and crabs) and cephalopods (e.g. octopuses and cuttlefish) by humans for food, experimentation and education is increasing. Growing evidence that these species can experience emotions has highlighted the need for a tool to monitor their welfare *ex situ*. This study adapted a welfare monitoring tool, the Animal Welfare Assessment Grid, that has been successfully used with a variety of mammal and bird species, for use with decapods and cephalopods. This tool was then trialed at a zoological institution (Marwell Zoo, Winchester, UK) and, for the first time, a public aquarium (National Marine Aquarium, Plymouth, UK), with the intention of showing how data collected on invertebrates in a zoological environment can be both efficiently and easily applied to implement positive welfare. This study highlights how evaluating the welfare impact of management processes using animal-based indicators can lead to improved welfare outcomes.

Population and habitat connectivity of Grevy's zebra *Equus grevyi*, a threatened large herbivore in degraded rangelands

Chelsea V. Smith, Tania C. Gilbert, Tim Woodfine, Alex Kraaijeveld, Geoffrey Chege, David Kimiti, Belinda Low-Mackey, Mathew Mutinda, Shadrack Ngene, Dan Rubenstein, Anthony Wandera & Philip Riordan

Land degradation, competition with livestock, infrastructure development, and climate change have reduced habitat availability and population connectivity for many wildlife species. The Endangered Grevy's zebra illustrates the decline and fragmentation of large mammalian herbivore populations, with extensive population loss across their range in northern Kenya and Ethiopia. A better understanding of the factors influencing population connectivity and movement patterns of Grevy's zebra, highlighted in national strategies, offers valuable insights for other threatened species. Using location and movement data for Grevy's zebra from GPS collars deployed between 2010 and 2017, we analysed population connectivity and zebra movement across northern Kenya. Connectivity models highlighted potentially isolated populations, with reduced seasonal connectivity being most apparent between north to south distribution areas. These results will help inform sustainable land management planning in northern Kenya and offer support for Grevy's zebra conservation actions. The results also provide insights that can be applied to other large herbivores occurring in this region and in arid or degraded environments elsewhere.

Participation and Capacity Building



Marwell Volunteers

We are hugely grateful to the support of our dedicated team of 119 volunteers who fulfilled a diversity of duties across the organisation and collectively contributed over 5,500 hours of their time in support of our mission in 2022.

This included our public engagement volunteers who share their vast knowledge about our animals, conservation work and the natural world with zoo guests; our animal and veterinary department volunteers who support the work of our hoofstock, carnivore and veterinary teams, as well as aiding record keeping and other administrative tasks; our volunteer gardeners who work alongside our plants and landscapes teams; our reception, communications and admin volunteers who all deliver critical functions that help keep us running; our supporter team volunteers who run the tombola and our guest services volunteers who ensure the park is clean and guests have all the information they need to enjoy their day at Marwell. We thank you all!

Business Generosity

Our popular corporate volunteering programme returned this year, with 25 businesses across the region contributing the skills of 293 employees and over 1,100 hours of their time to support a variety of activities.

Their collective efforts included tasks such as clearing and filling around 100 one-tonne bags with leaves, which can be composted, used as leaf mulch or added to animal enclosures to help create 'bio-active' floors that support an ecosystem of bacteria and fungi as well as worms, woodlice and other invertebrates, simulating a natural forest floor environment and encouraging natural foraging opportunities; planting tree whips, that may also provide browse for our animals, as well as approximately 10,000 English bluebell *Hyacinthoides non-scripta* and snowdrop *Galanthus nivalis* bulbs that add a splash of seasonal colour and support species biodiversity; along with landscaping tasks such as helping to install hurdle fencing.

The programme not only facilitates our work but, we hope, gives volunteers a fun and educational day out and, with bookings filling up fast, we look forward to welcoming many more groups in 2023.



Peer-to-Peer Training for Wildlife Management Staff in Tunisia

As part of Marwell's long-term and ongoing collaboration with the Tunisian Direction Générale des Forêts (DGF) for the conservation of priority Sahelo-Saharan species, in 2022 we enhanced our training programme for protected area management teams. We trialed a series of peer-to-peer training sessions involving exchange between parks to allow guards to share experiences with their counterparts.

In 2022, three courses involving 15 people were organised on the theme of wildlife monitoring using automated cameras. These resulted in an improvement in the perceived value of conservation work, with participants requesting involvement in further conservation activities. We will continue this programme and seek improvements for habitat and species conservation including for scimitar-horned oryx, addax, and the North African ostrich.

ABOVE
Local guards from Tunisian protected areas participated in peer-to-peer training sessions focused on monitoring wildlife using automated cameras.

PARTNERS Direction Générale des Forêts (DGF, Ministry of Agriculture, Water Resources and Fisheries) | CRDA and Forest Departments of Medenine, Tataouine, Tozeur, Sidi Bouzid, Kebilli, Gafsa and Sfax



^ ABOVE
There was an enthusiastic response to literacy and numeracy training provided to our network of Community Scouts in northern Kenya.

Supporting our Community-Based Wildlife Scouts

As reported last year, our Community Scouts in Kenya have now upgraded to SMART Mobile to better record, transmit and analyse wildlife data from their daily patrols. This is more technical than the previous software and requires a degree of literacy that our scouts did not have. Therefore, in addition to regular refresher training sessions, in 2022 we initiated literacy and numeracy training for our entire scout network.

Two primary school teachers from the local communities were employed to teach basic reading, writing, and numeracy skills. Over a

four-day period, using song and dance as well as more traditional methods, our scouts, both men and women, some with their babies in arms, took their first steps in the world of literacy and numeracy. Most of them had never held a crayon or pencil before in their life and yet, they wrote on the black board in front of their applauding colleagues. All of them enjoyed the school time and took home books and pens to practice before their next session in December.

Our Field Coordinator also arranged for a member of a Savings and Credit Cooperative Society (SACCO) to visit the scouts in the field and discuss with them how to open accounts and manage their finances. The scouts are very happy about Marwell's help with banking and literacy training. These newfound life skills will allow them better opportunities and independence in their daily lives.

In 2022 we welcomed a new Field Assistant to support scouts, communities, and provide technical help with camera-trapping for Stripe ID. Sakimba Lesoloyia from Baragoi, Samburu North, previously studied for a Bachelor of Science in Agroforestry and Rural Development at Kabiaga University and then decided, unusually, to remain in his local community. Sakimba is a great addition to our team, providing help to our scout network on a regular basis, especially with the new software and technical issues of phones and camera-traps, while also working closely with our Data Manager.

PARTNER Mpatmpat Consultants Limited



Training in Wildlife Monitoring for Protected Area Staff in Kazakhstan

As part of our IUCN Save Our Species project on goitered gazelle in Kazakhstan, our team undertook training sessions for park staff to improve monitoring across key sites of Altyn-Emel and Charyn National Parks. During 2022, four training sessions were carried out involving a total of 73 protected area staff. Techniques included camera-trapping for carnivores, such as snow leopard, and for general wildlife assessments, and standardized transect

counts for wide-ranging species such as goitered gazelle, wild horses (kiang) *Equus kiang* and saiga antelope *Saiga tatarica*. Both parks now have better wildlife management procedures in place and have improved the quality of information for these species that will help with their conservation efforts.

From these improvements our teams have provided new goitered gazelle population estimates, with 5,300 animals in Altyn-Emel National Park and 300 animals in Charyn National Park. Previous estimates varied, but their reliability was often in doubt. From this point the Kazakh teams have much better estimates to work with.

^ ABOVE
Training in wildlife monitoring techniques has led to improved population estimates for goitered gazelle *Gazella subgutturosa* in Altyn-Emel and Charyn National Parks, Kazakhstan.

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

Multiplying Impact



IPBES

As official observers to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and with Marwell team members designated as Experts, we joined the Ninth Plenary session in Bonn, Germany.

Key outcomes from this meeting included the scoping and refinement of two methodological assessments: diverse conceptualization of multiple values of nature and its benefits, including biodiversity and ecosystem functions and services; and the impact and dependence of business on biodiversity and nature's contributions to people. Steps towards better engagement with the Intergovernmental Panel on Climate Change (IPCC) were also covered.

Population Management

Marwell is a long-standing member of the Population Management Advisory Group (EPMAG) - a working group of the EEP Committee, which supports and advises on the functioning and development of EAZA Ex Situ Programmes (EEPs) and long-term animal collection planning. In support of the development of a mentoring system for this group on which Marwell is leading, a large survey was undertaken in six European languages (Czech, English, French, German, Polish and Spanish).

The aim was to allow as many EEP-coordinators as possible to respond in a language they are comfortable with and so far the survey has had over 180 replies. The Mentoring Group will now analyse the results and find out for which topics Population Managers need most support and in which form they would prefer to receive it, be it in-person mentoring/classes, online resources and training in a variety of languages, self-teaching sessions or simple information documents. All this should lead to better management of the endangered *ex situ* populations in European zoos.

Grevy's Zebra Technical Committee (GZTC)

Marwell has been a member of the Grevy's Zebra Technical Committee (GZTC) since its initiation. The GZTC is a collaboration among six organisations committed to conserving Grevy's zebra, mandated by Kenya Wildlife Service (KWS) to review and implement all Grevy's zebra conservation, management and research proposals to support and fulfil the national Grevy's zebra conservation strategy. During 2022, the GZTC has reviewed the provision of supplementary feed to

zebras during the drought, and decided to provide KWS veterinary help to particularly weak animals.

The subject of drought affected all activities. For example, the committee agreed that planned GPS collaring to better understand Grevy's zebra movements and connectivity (following the previous study, Smith *et al.* 2022) should not be undertaken at that time to avoid any extra pressure to potentially already weakened animals. Similarly, discussions about the next national survey for this species led to a delay until 2024 to allow the landscape and Grevy's populations to recover from the drought.

Use of Uncrewed Aerial Vehicles (UAVs) for Wildlife Conservation

Marwell led a field mission and hybrid workshop to develop use of UAVs for wildlife conservation in Kenya.

With colleagues at University of Southampton's School of Biological Sciences, School of

Geography and Environmental Science, the In-situ and Remote Intelligence Sensing Centre of Excellence, and SofonUAV, we convened a wide range of partner organisations near Lewa Wildlife Conservancy in Kenya. We introduced and demonstrated the potential of combined UAV technologies and remote-sensed imagery to key Kenyan stakeholders; and explored pathways for long-term technology transfer and capacity building in Kenya. This work is ongoing and further work is being planned for 2023.

ABOVE
Marwell's Professor Philip Riordan convened partner organisations for a workshop to explore the application of UAVs for wildlife conservation in Kenya.

IUCN Species Survival Commission Antelope Specialist Group (ASG)

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.

ASG is a global network of specialists concerned with the conservation, monitoring, management, and the study of antelopes. In the latter part of 2022, we had the opportunity to employ one of our MRes Wildlife Conservation graduates as a zoologist to augment the work of the programme office. In 2022, Marwell supported the ASG co-chairs in their work on addax conservation in Niger and the concerted action for Sahelo-Saharan ungulates as part of the Convention on the Conservation of Migratory Species of Wild Animals (CMS).

The Sahelo-Saharan Interest Group (SSIG)

Marwell's UK- and Tunisia-based teams participated in the annual Sahelo-Saharan Interest Group (SSIG) meeting held online

due to COVID-19 restrictions. The SSIG is an annual forum for 'like-minded individuals and institutions' interested in sharing knowledge, building partnerships, and encouraging conservation action in the arid areas of North Africa.

Action Planning for Addax

In 2022, we published the results of the genetic analysis of addax reintroduced in Tunisia with our partners at Royal Zoological Society of Scotland (RZSS), the Direction Générale des Forêt (DGF), San Diego Zoo Wildlife Alliance, Al Ain Zoo, Zoological Society of London, Environment Agency - Abu Dhabi, Ministère de l'Environnement et de la Lutte Contre la Désertification, Niamey, Niger, the University of Southampton, and

Sahara Conservation. The study constitutes an unprecedented comparison of different populations at global scale and provides a solid basis for conservation action planning.

Based on these findings, Marwell worked with the IUCN SSC Antelope Specialist Group and the DGF to define Tunisia's contribution to the regional roadmap for addax conservation. This, along with Marwell's wider work with addax in Tunisia, has been integrated into the submissions for the 3rd regional seminar of the CMS for the conservation of the Sahelo-Saharan megafauna to be held in Morocco in 2023.

Sustainability Events

Creating a sustainable world requires action by everyone and Marwell continues to support and encourage local and national businesses in their own sustainability journeys. In 2022 we organised and participated in a range of online and in-person events for businesses, zoos,

aquaria and other visitor attractions sharing our experiences and suggesting how these could apply to others.

Topics in 2022 included: action on carbon; packaging recycling responsibilities; sustainable transport; becoming a circular economy business; Marwell's carbon reduction journey, and how to boost climate impact. These were attended by 146 people and a further 327 have since viewed the recordings of the events on YouTube.

Addax *Addax nasomaculatus* in Jbil National Park, Tunisia.

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Looking to the Future

As we progress into 2023, we are guided by our new five-year Conservation Strategy 2023-2028. We are redefining the role of modern progressive zoos in the 21st-century and Supporting Nature's Recovery by aligning our work with a new concept of Conservation Health. We contend that conservation actions led by zoos, focusing on people, animals, and ecosystems, are interventions to assist nature's recovery from the current crisis. We propose Conservation Health to encompass an interdependencies-based, and conservation-focused approach, placing our zoo at the heart of this solutions-focused strategy.

Our strategy is centred around three themes: **Health, Connection, and Knowledge Exchange and Innovation**; these respond to clear needs and reflect our unique position at the juncture of species, people, and ecosystems. Linking Marwell's unique skills, networks, and interests, we will work with nature to provide solutions to many of the world's greatest challenges.

Focus on Health will use our zoo and wider work to benefit the psychological health of people, and the health and welfare of animals. We will employ new approaches to enhance the resilience and health of people, wildlife and ecosystems.

Connection identifies and overcomes the barriers to nature's recovery, be they physical, political or social, bringing together partners and working to achieve sustainable solutions. We will foster optimistic and positive connections between people and nature, between partners, between habitats and throughout ecosystems.

The success of our strategy relies on **Knowledge Exchange and Innovation**. We will overcome barriers to sharing knowledge, accepting that people need the confidence to share and accept ideas, overcoming social, political, and cultural obstacles. Our organisation and partners are rich in knowledge and capable of forming powerful collaborative communities of practice. Applied to Conservation Health, we will create a culture of innovation, using and developing technology and expertise to provide practical and sustainable solutions.

▲
ABOVE
 Our new Conservation Strategy is available to download from our website.



Bee orchid
Ophrys apifera.



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