Session Abstracts

Session titles

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Bridging the Gap: Pathways, perspectives and problem-solving

Dr Marina Salas, Zoo Antwerp Centre for Research and Conservation

There is a lot of Animal Welfare research done within zoos that, if the results were applied, could potentially improve the life of animals in captivity. However, animal care and operation/logistic departments do not always apply the results from this research. How can we solve this? We will use real examples to present the issue and would like to discuss among the members of the group to get feedback on similar problems in other institutions. Finally, we will think on a solution or action to make together.

Development and use of Animal Welfare Assessments

Lisette van den Berg, Apenheul Primate Park Patricia ter Maat, Dutch Zoo Federation (NVD)

In zoos, we aim for the highest possible standard of animal welfare. However, 'welfare' can mean different things to different people. Therefore, an objective method is required to set the goals, assess how the animals in our care are doing, and what should be improved.

On request by the Dutch Zoo Federation ('NVD'), Apenheul Primate Park developed the 'NVD Dierenwelzijn Methodiek'; an animal welfare assessment method for collective use in Dutch zoos.
In this workshop, the development and implementation of this method in a multi-institutional setting will be discussed in more detail. We will explain how NVD zoos are encouraged to collectively assess animal welfare and work together sharing species-specific information on (behavioural) needs and - welfare indicators. Participants will learn how they can use welfare assessments to set goals and improve welfare on the short- and long-term, and how using the same method creates trans-disciplinary and multi-institutional collaboration.

Utilising the latest evidence-based management standards to empower and improve animal care practices through humane education

Sarah Bonser-Blake, Wild Welfare

What is a welfare standard? How can we ensure evidence-based welfare standards are engaging and accessible to provide a consistent level of good welfare for all animals under human care? How do we utilise humane education to do this? Wild Welfare's own Standard of Practice for Captive Wild Animals, developed through hundreds of peer reviewed papers and books, has been transformed for the very purpose of providing obtainable but detailed learning content based on the latest scientific research, through a digital and problem-based learning approach.

Identifying the barriers to providing good animal welfare standards and then practically applying up to date concepts and species knowledge to daily keeping activities, enclosure design, infrastructure and nutrition, can make a huge difference to an animal's well-being

This presentation will demonstrate, through relevant examples, how the programme utilises a standard based on up-to-date research to create a participatory learning approach that provides accessible and engaging opportunities in which animal care fundamentals can be learned and applied, bridging the animal welfare knowledge and skills gap to ensure best practice.

Animal Welfare Application developed by Nyíregyházi Állatpark (Sóstó Zoo)

Csaba Harsányi, Nyíregyházi Állatpark (Sóstó Zoo)

The authors, in collaboration with Nyíregyházi Állatpark Nonprofit Kft. - Sosto Zoo, developed an application for phone and tablet to enhance the measuring and monitoring of the welfare state of zoo animals.

This program offers tools for the animal care staff to carry out "inspections" or AUDITS for the species, specimen or animal group of interest and a separate form for the evaluation of the enclosures.
The results of the AUDITS feeds in a SharePoint site dedicated to the Animal Welfare Management of Sosto Zoo, whereby the managing team can
- check the forms submitted and streamline the responding task and actions in the daily operation of the responsible departments,
- follow the welfare state of the specimens they are interested in,
- compare the AUDIT results from the different staff persons from the different sections.

The app has an admin module to shape and edit the application according to the needs of the managing team. Flexibility is given to edit and change the questions in the welfare AUDIT and enclosure inspection forms and the corresponding task management.
This app is available for everyone who are given access by the institution's admin sharing the link via email.

ZAA's Welfare Assessment Process. An example of how science-based evidence and the Five Domains model can be practically applied in the field across the region

Nicolas de Graaff, Zoo and Aquarium Association Australasia (ZAA)

The ZAA Accreditation program utilises the Five Domains Model to assess and confirm positive experiences are occurring (i.e. positive welfare).

Participating organisations undertake a self-assessment against ZAA criteria, identify the evidence required to support their findings, and submit these for validation by a ZAA accreditation officer. Provision of evidence is necessary to (a) establish what is currently (scientifically) understood about the animal/species under assessment and (b) demonstrate what experiences the animals are currently having based on the established understanding. This assessment method has been successfully applied over numerous assessments across all taxa throughout the ZAA membership. Members performing the self-assessment are empowered with the ability to show how the welfare of their animals is positive based on demonstration of (a) and (b) above, regardless of species being assessed. With appropriate preparation many assessments can be completed within a day, and presentation of evidence enables fast and effective validation by an accreditation officer.

This presentation aims to share how ZAA achieves the above and how this may assist in the development of future welfare assessment systems.

Animal Welfare Recording Tool: A standardised framework for recording holistic animal welfare for all species

Emily Polla, Perth Zoo

Recording holistic animal welfare across all facets of the Five Domains, has become a priority for zoos & aquariums, both from the perspective of understanding and improving animal welfare, and to gather evidence for accreditation by regional zoo associations such as EAZA or ZAA. However, the recording of holistic animal welfare, both within and across species, is not always completed to its full potential, with priorities often being made that skew data collection towards particular species or sub-sets of holistic animal welfare, due to limited resources. This can lead to a lack of animal welfare

information for some species, particularly when it comes to recording observations that support positive animal welfare states.

To address this, Perth Zoo has developed an Animal Welfare Recording Tool (AWeRT) which is a standardised framework for recording holistic animal welfare within zoos and aquariums using ZIMS. The AWeRT is suitable for all species, from mammals to invertebrates, and encompasses all elements of the Five Domains. The AWeRT is easy for keeping staff to use, requires minimal time investment and has the potential to create consistency in animal welfare recording across sections within and between zoos and aquariums. Both individual level and species level observations are possible, with data comparable over time despite changes in animal groupings or exhibits. The data can be used to easily create graphs which show observable trends in factors affecting animal welfare, with the potential to inform animal management decisions relevant to animal welfare outcomes. The major elements of the AWeRT will be discussed in the presentation, as well as how the AWeRT can be implemented to provide balanced observations across all elements of holistic welfare.

"It's not always who's who in the zoo!"- how Keepers at Jerusalem Zoo have learned to utilise external connections in the non- animal community to increase animal welfare

Elly Neumann, Jerusalem Biblical Zoo, Benjamin Fainsod, Jerusalem Biblical Zoo

Whilst a core skill of zookeepers is to promote positive animal welfare, keepers often look to those in their own field to make advances in these areas.

Two projects were developed within the zoo utilising external stakeholders with no previous connections to the zoo or animal community, with outcomes that benefited both animals and people. Jerusalem Zoo's Carnivore department wanted to try and improve their goal -based enrichment process by adding in depth evaluations of enrichment use to their program.
This led to the department teaming up with the Azrieli School of Engineering who were in the process of planning projects for their final year Industrial and Management Engineering students. The students with no animal knowledge or experience had to complete a project in an area with large amounts of data.

A connection was made, and a project developed by the students to utilise camera technology to monitor exhibit use and then combine this with keeper records to identify if enrichment caused changes in exhibit use. The keepers aim was to encourage the animals to use areas of the exhibit they rarely used, and the goal of students was to use the data collected to quantify the use of the areas pre- and post-enrichment.

The Carnivore department also wanted to build on their strong training foundation, by developing a way of analysing and utilising the training records they kept.
Through the Azrieli School of Engineering, a keeper was given the opportunity to advance their analytical skills through attending an advanced course "Engineering applications using Excel".
The keepers then worked together to build a training record format that could be filled out by all keepers quickly and easily post training session and could then be analysed.
Through this analyses keepers could start to see the effects of various factors including different training session times, individual trainers effects on behaviour and motivation, location of sessions, and animal combinations.
This current and real time analyses improves the way the keepers interact with animals during training sessions and helps build a more positive training relationship and program.
This presentation will look at how these two projects improved the zoos enrichment and training programs and how two completely different fields came together to improve animal welfare.

Assessment from an animal's perspective. Changing the viewpoint to facilitate assessment of welfare using science-based evidence

Nicolas de Graaff, Zoo and Aquarium Association Australasia (ZAA)

Traditional welfare assessment methods rely on tangible animal-care/resource based measures, and the observers' opinions about it's appropriateness in context of the circumstances the animal is found in.

With the emergence of the Five Domains Model for assessing animal welfare, attention is now drawn to the subjective (mental) experiences an animal may have, and the challenges this brings to a welfare assessment in terms of establishing tangible measures for assessment. By considering the inter-relationship between assessing care provided to an animal and its potential mental experience, one can appreciate how concerns of anthropomorphism may arise (i.e. determining an animals subjective experience based on care provided does not lend much confidence or understanding to what the animal is subjectively feeling). However, by shifting focus away from measures of care provided and more towards measures of how the animal is responding to the care provided, along with science-based evidence to support interpretation of the animals' responses, assessment of welfare (with regards to its mental experiences) can be undertaken with confidence.

This viewpoint will be further clarified with real-life examples gained through the ZAA welfare assessment program, along with suggestions in how opportunities for positive welfare can be created through the care provided to the animal.

Session 2

Using the ZooMonitor Behaviour Recording App to Guide Evidence-based Animal Welfare Decisions

Dr Jason D. Wark, Lincoln Park Zoo, Dr Katherine A. Cronin, Lincoln Park Zoo

Come join us for a one-hour, hands-on workshop on the ZooMonitor app, an easy-to-use tool developed by Lincoln Park Zoo for recording the behavior and space use of animals. ZooMonitor is freely available to accredited zoos, aquariums, and sanctuaries and, since its release in 2016, ZooMonitor has now been adopted by over 300 organizations around the world, including more than 30 organizations accredited by the European Association of Zoos and Aquaria. We'll start by highlighting the importance of behavior data and review the basics of recording animal behavior. Next, participants will work in groups to design projects in the ZooMonitor app. We'll end the workshop with a group discussion on the successes and challenges in putting behavior data into action through evidence-based decision making. We hope this workshop encourages participants to expand their behavior monitoring efforts and inspires collaborative efforts across our community.

Behavioural studies to help at assessing welfare

Dr Caterina Spiezio, Regaiolli, Parco Natura Viva, Dr Barbara Regaiolli, Parco Natura Viva

The performance of a wide repertoire of species-specific behaviours can be an indicator of good psychological and physical well-being. However, scientific evidence and methods are needed to rigorously assess animal welfare and zoo-based research has become increasingly important for ex-situ conservation programs, husbandry and management. Data on animal behaviour can be useful to evaluate the effects of husbandry practice (e.g., enrichments, training) as well as to assess the impact of zoo visitors on different species. Different behavioural sampling methods can be used to collect data on animal behaviour. Students and researchers have time (and motivation) to collect large amounts of data on animal behaviour, conducting structured observation and cognitive testing. However, behavioural sampling methods such as spot checks are not time-consuming and can be used

also by people working in zoos, such as zookeepers, providing information on animal behaviour and welfare. This workshop will provide an overview and proactive discussion of different sampling methods and their applications in husbandry practice evaluation. Moreover, the importance of behavioural spot checks and their potential benefits in the study of zoo animal behaviour and welfare will be proposed and discussed.

Research on nocturnal behaviour and its impact on management and husbandry

Dr Anna Lena Burger, University of Frankfurt

Scientific zoo based research increased tremendously within the last decades. Behavioural studies thereby represent a reliable tool to assess animal welfare. Behaviour is defined as a displayed reaction of an organism to internal and external stimuli. How an animal copes with its biological characteristics and its environment is one of the most interesting questions within animal behaviour. As it is of major interest for zoos how their animals cope with their environment, our studies assess biological, environmental and social factors influencing nocturnal activity and sleep behaviour. Within multi-zoo studies we already observed more than 300 mammalian individuals in over 30 European zoos.

Our research results provide detailed insights into a time of the day, which has been overlooked and underestimated for too long by ethologists. However, the use of modern techniques such as video recording, thermal imaging and night vision systems allow us to observe the nocturnal behavior of animals even during darkness. In this context, generating and interpreting activity budgets of a species provides an evident base for further research on influencing factors. Developing our own automated evaluation, using suitable deep learning methods, seems to be a forward-looking approach to analyze nocturnal behaviour of various species living in different zoos. Findings may help to close the gap of knowledge regarding nightly behavior of captive animals and results may improve management and husbandry guidelines of zoos.

Natural Biological Predictors of Positive Welfare Indicators in Captive Carnivores

Dr Samantha J. Ward, Nottingham Trent University

The development of evidence-based zoo animal welfare science techniques and the use of the 'five domains' have inspired zoos to move beyond just ensuring reduction of negative welfare states and to strive for provision of environments which maintain positive affective states and welfare. However, some studies have suggested that large captive carnivores are prone to poor-welfare, and are too specialist to house successfully in captivity. In particular, aspects of the natural behavioural biology of different carnivore species appear to predict the occurrence of negative welfare indicators such as stereotypies in captivity. Here we test whether natural behavioural biology can also predict rates of positive welfare indicators, or whether these are better predicted by zoo-related variables. We used pre-existing published data to test the hypothesis that ecological generalism pre-disposes species to good welfare in captivity.

We set up a database of activity levels (as a measure of positive welfare) of zoo Carnivora, along with our biological predictor variables (range of habitat preferences, latitudinal range and geographical range) and our zoo-based predictor variables (enclosure size, group size, rearing and presence of enrichment). From the database we analysed species medians of 19 different species using phylogenetic independent contrasts to test the role of biological variables; and activity rates of 77 individuals and 73 groups of those species using multiple regressions to test the role of zoo-related variables in positive welfare. The results will identify if there are species that are more likely to perform better in captivity than others, based on positive welfare indicators and will contribute significantly to our understanding of the suitability of species for keeping in zoological establishments. It advances knowledge beyond identification of species which may be pre-disposed to poor welfare and enables us to identify those who can experience positive welfare within a captive environment.

Ongoing research at Fota Wildlife Park: an examination of visitor experience and interactions, with implications for animal welfare and pro-conservation behaviour

Dr Courtney Collins, University College Cork

Maintaining optimum animal welfare in the zoo setting is of paramount importance. Yet, it is broadly accepted that large and noisy groups of visitors may disturb zoo-housed animals. Active or intense visitor interactions like shouting, banging and throwing objects may be the most disturbing to animals, with some animals displaying more aggressive, stereotypic and avoidance when these negative interactions occur. This could lead to reduced welfare in some captive animals. Although zoo staff complain that visitors harass animals by engaging in these types of behaviours, there is currently no quantifiable evidence on how widespread negative visitor interactions are in the zoo. This research project assesses the prevalence of negative visitor interactions in the zoo on a global scale. Participating institutions include Fota Wildlife Park, Ireland, Wildlife Reserves Singapore, Singapore, National Zoological Garden, South Africa and Ramat Gan Safari, Israel.

Visitors were observed across a range of species and enclosure types. Data were collected using behaviour sampling and every negative visitor interaction to occur in ten, 30-minute observation period at each enclosure was recorded. Negative interactions were defined as any visitor behaviour that was not compliant with the rules of the participating institution, such as banging on glass, feeding or touching animals. Enclosure type, visitor demographics and animal activity were also recorded. Data were analysed using a GLM to investigate which independent variables effect the prevalence of negative interactions and descriptive statistics were used to describe specific incidence of negative interactions in greater detail. Results are forthcoming and will lead to the development of strategies for the better management of visitors. Findings will ultimately enhance captive animal welfare by identifying negative interactions. The next part of this research will focus on animals' behaviour during negative visitor interactions.

An introduction to evidence-based animal training and welfare

Annette Pedersen, Copenhagen Zoo

When training new behaviours or addressing problem behaviours in our animals, we have for many years been adhering to the use of positive reinforcement-based strategies to ensure our animal's optimal welfare are met, when we are performing behavioural interventions. But what happens when we are challenged with fear responses and aggressive behaviours? Have we been overlooking something in the animal's body language, when implementing a positive reinforcement procedure?

Do we understand what is going on when we use the counter conditioning procedure to change a fear or aggressive response into a calm response? Are we really addressing the function of these behaviours and what does it take to make the reinforcement values high enough to be effective? Is this procedure the best choice to support optimal welfare for our animals or should we start looking in new directions? And what do we do when animals do not want to engage with us… at all?

This presentation will be an introduction to the Constructional Approach for addressing aggressive behaviour and fear responses as a new tool to increase animal welfare in training and when changing problem behaviour.

The procedure became known when Dr. Jesus Rosales Ruiz and his students from the Technical University of North Texas started using it with dogs in 2007. It has since then been refined and found its way to the exotic animal training by e.g., Barbara Heidenreich.

Can Natural Behaviour be a Welfare Issue? Long-term Patterns of Wounding in a Captive Group of Ring-tailed Lemurs (*Lemur catta*)

Prof Geoff Hosey, University of Bolton

Aggression is a normal and natural part of primate societies. Usually this involves low intensity interactions, but occasionally more severe aggression occurs, resulting in physical wounds. In wild ringtailed lemur groups, two phenomena (episodic targeting of aggression towards particular individuals and intense mating season fighting among males) involve escalated aggression and can cause severe woundings. Again, this is a natural part of these societies and should be expected in captive groups, but may lead to concerns if the captive environment caused excessive woundings. It is therefore appropriate to investigate whether woundings correlate with features of the captive environment. Here we report, using ZIMS records (now Species360), on longitudinal data from a captive lemur group over a period of 14 years, involving 116 animals. Of these, 52 animals received wounds from lemur aggression. For many years in the history of the group there were no reported woundings at all. Frequency of wounding was positively correlated with group size. Mean wounding rates of females were slightly higher than those of males in the first half of the year, but were greatly exceeded by those of males in the second half of the year, which is the breeding season for lemurs housed in the northern hemisphere. Wounds to females were located mostly around the face, hind legs and tail, while those of males were mostly around the face and arms, implying that they were caused during chasing in females and during fighting in males. Evidence of targeting and of male mating aggression was found. Lemurs should be monitored for targeting aggression and victims temporarily removed if identified; and the period October-November appears to be a high-risk time for male mating aggression.

Using infectious disease research to identify indicators of poor welfare for amphibians

Lola Brookes, Institute of Zoology/Zoological Society of London/Royal Veterinary College

Many amphibian species that are threatened with extinction, are held in captive collections. Some of which are even are used in reintroduction and research programmes, to help inform conservation strategies. This includes research into the diseases chytridiomycosis and ranavirosis, which are global threats to the survival of hundreds of species. Indeed, Infectious disease research poses as an excellent facilitator to understand and develop indicators of poor welfare for amphibians. At present how individuals are assessed within the confines of such work lacks definition, but by using the biological costs associated with pathogen exposure, we can begin to identify indicators that depict poor welfare and that can be used in subsequent research. Published information on pathogen challenge experiments can be intuitive for amphibian welfare assessments, but inconsistencies in experimental reporting and robust assessments, limit indicator validation. Expert knowledge and experience can provide face and content validation, identifying candidate indicators of poor welfare, which can then be tested experimentally. Importantly, monitoring of individuals should be non-intrusive, and not interfere with scientific questioning, making welfare assessments easy for animal care staff to undertake. This emphasises a need to focus on behaviour, or behavioural changes over time. Therefore, by working with ongoing in vivo testing, we conducted assessments of ranavirus exposed amphibians as they often die before the onset of known clinical signs. Through daily welfare checks and overhead cameras, behaviour and physical changes were compared to the pathological consequences of pathogen exposure. These results are now being used to determine which indicators are most reliable, repeatable, and valid for informing on poor welfare.

Session 3

Plenary programme in main auditorium, no abstracts provided.

Session 4

Nutritional behavioural management - specifying measurable aims

Prof. Marcus Clauss, University of Zurich

The workshop will emphasize the relevance of dietary and feeding regimes - from choosing diet ingredients to food presentation - for the managing of the behaviour of zoo animals.

Using a variety of sources collected by a literature search (please bring a laptop), we will showcase examples of how targets can be chosen, and then will discuss different solutions of how these targets can be met.

Half full or half empty? Using cognitive bias as a welfare tool

Dr Isabella Clegg, Animal Welfare Expertise, Dr Marieke Cassia Gartner, Zoo Atlanta

Cognitive bias tests can reveal whether animals make more optimistic or pessimistic judgements of ambiguous stimuli. They are thought to be one of the most valid tools for measuring welfare, where results show animals in poor welfare judge more pessimistically, and vice versa. While these tests have been widely applied to farm, domestic and laboratory species, only a few studies have taken place in zoos and aquaria. This workshop is designed to be a "how to" guide for applying cognitive bias tests in the zoo, and is aimed at any interested parties from students and caretakers to managers and Directors. We will explore the theory behind cognitive bias, look at past experiments, discuss how to manage the many uncontrollable variables in the zoo environment, and conduct an applied exercise where we run through how to design the tests for different species.

Animal training for welfare: Bridging the gap between science and practical application

Annette Pedersen, Copenhagen Zoo

Knowing about the science of behaviour and how to manage behaviour change - is that enough to ensure that we provide the optimal welfare for our animals when training them for day-to-day management and care? Is welfare only about the product and not the process?

How can we make our learning environment more effective and our training sessions a more positive experience for the animals? Do we set up our animals up for success by arranging the environment? Are we aware of our own mechanical skills and do we practice them before we conduct a training session?

Are we considering the natural behaviour of the species or capabilities of the individual, when planning a training procedure?

This workshop will provide tools to excel at practical application and show lots of video examples that will inspire and motivate you to improve animal welfare in your collection.

Making 'sense' of enrichment: Understanding animals' sensory needs - Sonar Stimulating Enrichment for Bottlenose Dolphins (Tursiops truncatus) as a case study.

Sabine den Ouden, Linköping University

Giving enrichment to animals under human care is of great importance for their welfare. There are many different types of enrichment that engage our animals in a multitude of ways. However, for most enrichment, the variability of their sensory world is often forgotten when implementing enrichment. Different species have different sensory needs and these are not always fully met when in human care. To let our animals explore and use the full range of their senses and, in turn, increase their welfare, sensory enrichment should be designed and used with our animals. While designing

enrichment there are certain questions that should be kept in mind, for instance, the range of a species' senses.

As a case study, we will have a look at a study conducted by me on sonar stimulating enrichment for bottlenose dolphins. The use of sonar is a crucial behavior for dolphins which is not fully challenged in pools of zoos. By presenting a sonar activated enrichment, we stimulated this behavior in the dolphins. Through the detection of sonar clicks by a hydrophone attached to a hose, which is connected to an acoustic switch, a high-pressure water outlet is opened. This will make the hose move through the water in a meandering way. Having this enrichment in its activated (functional) state, significantly increased the use of sonar by the dolphins. Besides this, it also stimulated some exploratory and hunting-like behaviors in the dolphins. These parameters were also influenced by the ejection of fish and/or gelatine strips from the hose.

How to maximize foraging opportunities for parrots: a case study

Mandy Beekmans, Utrecht University

Foraging enrichment is considered an effective tool to stimulate species-typical foraging behaviour and to reduce abnormal (repetitive) behaviour. However, for parrots in captivity, foraging opportunities are commonly limited, with parrots often spending less than one hour per day on foraging, compared to 4-8 hours per day spent on foraging behaviour in the wild. This lack of foraging opportunities in particular has been linked to the development of feather damaging behaviour in parrots, which foraging enrichment can help to reduc. However, currently available enrichment strategies are not able to naturalize foraging times and may therefore not suffice to meet the parrots' foraging requirements. In addition, currently available foraging enrichment often stimulates a single aspect of foraging, while the behaviour in fact comprises of a multitude of different activities including *e.g.* travelling, searching, selecting, extracting, processing, and the actual consumption of food. These activities can be categorised in two phases: appetitive and consumptive behaviour. We therefore designed a foraging enrichment for parrots, which consisted of two components that respectively stimulated appetitive and consumptive behaviours, and studied its effect on foraging times in 12 grey parrots (*Psittacus erithacus*). The two-component enrichment was (tentatively) able to increase daily foraging times from 2 h/day (control condition) to 4 h/day, while the separate components increased daily foraging times to 3 h/day. Hence, through stimulation of both appetive and consumptive behaviours, the two-component enrichment was able to increase daily foraging times to produce natural time budgets in captivity. While further studies are needed to investigate the importance of individual foraging activities for parrots, and evaluate whether naturalized time budgets can more effectively eliminate abnormal behaviours, findings of this study emphasize that efficacy of foraging enrichment can be increased by incorporating and combining multiple foraging activities typical for the species.

Visitor Perceptions of animal welfare

Marjo Priha, Helsinki Zoo

To justify their existence zoos must provide the best possible quality of life of all animals in their care. Animal welfare is becoming central to the strategies and assessments of zoos worldwide and communication and education about this subject is also gaining more attention. Effective and open communication about animal welfare should be based on understanding of species-specific welfare issues. To develop education concerning animal wellbeing, it is necessary to recognize prevailing visitor perceptions and possible misinterpretations of the subject. Visitors' perceptions should be

grounded on knowledge and recognition of the work zookeepers do for improving welfare; open communication about the compromises connected to animal keeping in zoos is also essential.

In my presentation I will give a short review of research on visitor perceptions about animal welfare carried out and present my ideas to compliment the surveys in my own freshly started PhD studies. Much of the data on visitors' perceptions about animal welfare in zoos focus on felines, primates and smaller mammals but the perceptions about the wellbeing of reptiles, amphibians, birds or other mammals are much less well known. By analysing and comparing the data from visitors and zookeepers my aim is to develop appropriate communication and education of animal welfare issues in zoos. The overall goal of my PhD is to improve the quality of animal welfare and to encourage more open and unbiased discussions and messaging about animal welfare among the zoo community and its audiences.

Waddling Together: Informing Penguin Management with a Multidisciplinary Research Program at the Detroit Zoo

Dr Grace Fuller, Detroit Zoological Society

The Polk Penguin Conservation Center (PPCC) at the Detroit Zoo is one of the world's largest penguin facilities, with residents including more than 75 penguins of 5 species. The Zoo is also home to the Center for Zoo and Aquarium Animal Welfare and Ethics (CZAAWE). In 2015, researchers from CZAAWE initiated a longitudinal, multidisciplinary study exploring how the design of the PPCC and the former Penguinarium affected penguin welfare. The foundation of this program is daily observational data on penguin behavior collected by CZAAWE staff, volunteers, and animal care staff. Under this umbrella, research offshoots have included: evaluating the benefits of cataract surgery for aging penguins; investigating mechanisms by which transitioning sub-Antarctic and Antarctic penguins to natural light sources has impacted their feather condition; and increasing pool use. These studies have assessed welfare across multiple domains with activities ranging from using flipper-mounted time-depth recorders to log swimming behavior, to measuring heat loss via infrared thermography, to analyzing corticosterone in naturally molted feathers. Animal care staff participation is critical at all phases to ensure meaningful impacts. Animal care staff provide feedback on study design and train observers to recognize important behaviors. They also collect detailed records on penguin behavior (e.g., food intake and nesting behaviors) and physical condition, sometimes facilitated by positive reinforcement training (e.g., scale training for weights). Formal and informal observations from animal care staff are vital to interpret data and implement recommended changes, which have included habitat modifications and husbandry procedures like pool feeding. Barriers to collaboration include summarizing large amounts of behavioral data on a rapid timeline, as well as misalignment between broad observer ethograms and subtler cues animal care staff use to assess individual welfare. Despite these challenges, weaving together multiple perspectives and lines of evidence allows managers to make evidence-based decisions that promote great welfare.

Session 5

Pain – why does it matter and what can we do about it?

Dr Heather Bacon, University of Central Lancashire Veterinary School

Pain is a key contributor to poor welfare in zoo animals, and may often be underdiagnosed due to a lack of validated pain assessment methods, or due to misunderstandings in how different species may demonstrate signs of pain. Thus an understanding of signs of pain in zoo species, pain physiology and the management of different types of pain, is essential to promoting good welfare in zoos. It is not known what percentage of the domesticated animal species suffer from pain but poor pain management has been suggested as a significant welfare problem across all species under human care

(Rioja-Lang et al., 2020). The diversity of species housed in zoos and their unique physiologies and behaviours mean that evidence-based recognition and thus pain is often challenging to adequately recognise and manage in zoo species.

This interactive workshop will use a mixture of pre-learning, quizzes, and team-based problem-solving to address the challenge of pain management in zoo animals. You will be introduced to pain physiology, recognition, assessment and treatment options, and encouraged to use your own knowledge and experience to develop constructive solutions to a real-life case.

Thermal imaging: an introduction and demonstration

Dr Helena Telkänranta, Arador Innovations

This is a lecture on the basics of how thermal imaging works and how thermal cameras can be used at zoos to monitor animal health and welfare. Thermal imaging, also known as infrared thermography, is a technology for remote measurement of surface temperatures using a thermal camera. Some veterinarians utilise it to detect local inflammation, nerve damage and a few other health conditions that affect local skin, eye or hoof temperature. It can also provide information on heat stress and hypothermia. One of the benefits of the technology is that it can be used at a distance without disturbing animals. The main challenge is that several environmental factors also affect surface temperature in similar ways. Expertise is therefore needed to distinguish informative findings from environmental artefacts. Learning to use it accurately requires much longer training than one hour, but this demonstration will provide the participants with an overview that will help them decide whether learning thermography would be useful in their work.

Animal welfare and conservation breeding programmes: linking ex situ welfare with breeding and reintroduction success

Dr María Díez-León, Royal Veterinary College, University of London

An estimated one million species are currently at risk of becoming extinct due to anthropogenic factors, which has led to increasing numbers of endangered species requiring supplementation from conservation breeding programs. However, these programmes are far from perfect. For example, up to 80% of recommended breeding pairs fail to produce offspring or even copulate, with ex situ born individuals in at least one species particularly at risk of copulatory failure. Infant mortality can also be high, with poor maternal behaviour often cited as a cause. In addition, reproductive success varies with facility, suggesting that management and husbandry also play a role. Further, when ex situ-born individuals are released into the wild, they are less likely to survive than wild-born counterparts for reasons consistent with captivity-induced ontogenetic effects. Here I review evidence on how negative welfare states experienced ex situ might underlie these issues, including effects of early life stress on attractiveness, maternal behaviour, offspring health, and development of cognitive skills, as well as frustrated motivations induced by current environments. I will argue that improving animal welfare ex situ - thus shifting the focus from population-level management in these programmes to the individual - can result in more successful conservation breeding programmes, and provide examples of how this can be achieved, as well as highlighting limitations and cases where individual welfare and conservation goals might clash. This paper will focus on aggression and abnormal repetitive behaviours - linked to compromised reproduction, cognition, and welfare - as examples of how enhanced animal welfare may lead to improved conservation breeding.

Short-term effects of feeding enrichment on salivary cortisol and behaviour in zoo primates

Dr Audrey Maille, Museum National d'Histoire Naturelle

Environmental enrichment has become a major management tool to prevent boredom resulting from a restriction of resources in captive environments. Numerous studies have demonstrated enrichment efficiency in stimulating naturally-occurring behaviours on a long-term basis and reducing chronic stress. However, few researches ever aimed at assessing short-term effects of enrichment on physiological and behavioural indicators of welfare. And yet, providing scientific evidence of any positive influence of enrichments right after their delivery to the animals is of crucial importance for zookeepers in their efforts to validate them, as they are merely able to dedicate few moments to the observation of animals.

In la Menagerie zoo and Paris Zoological Park (MNHN), we monitored short-term influences of feeding enrichment in three primate species: Guinea baboons (Papio papio, N = 3), Bolivian squirrel monkeys (Saimiri boliviensis, N = 6) and L'Hoest's monkeys (Allochrocebus lhoesti, N = 9). We collected saliva samples 20 minutes after sessions of enriched feeding (seeds in mazes, tubes, balls, crates) or control feeding (seeds on the ground), and we recorded behaviours 30 minutes before and after those feeding sessions. Salivary cortisol tended to be lower after enrichment as compared to control in baboons, while there was no variation for the two other species. We also showed significant behavioural changes related to enrichment: affiliation increased in both squirrel and L'Hoest's monkeys, feeding increased in baboons, and stereotypic locomotion decreased in squirrel monkeys. Noteworthy, we found contrasting results between the species regarding self-directed behaviours, which decreased after enrichment was delivered to baboons and squirrel monkeys whereas they increased in L'Hoest's monkeys, probably in relation to social competition for accessing food. Our results provide evidence for short-term positive effects of feeding enrichment in three primate species, and highlight the importance of using multiple animal-based measures for assessing how environmental resources affect animal welfare.

Behavioural Indicators of Reptile Welfare Gleaned from Studies of Major Life Events

Jennifer Hamilton, Detroit Zoological Society

Reptile species have diverse natural ecologies and sensory abilities. Therefore, they may have diverse needs rooted in differing perceptions of the world around them. However, there has been limited research exploring reptile welfare in zoos and aquariums. Behavioral indicators validated for other taxa are not well explored in reptiles, leading to difficulty interpreting observational data. Through four studies conducted at the Detroit Zoo, we aimed to explore four behavioral indicators in the context of reptile welfare: time spent visible to the observer, time spent hiding (i.e., with over half their body covered by substrate or habitat furniture), investigation, and space use. Small groups of reptiles were observed during different life changes, such as after-hour events, a temporary zoo closure, construction, and a habitat modification. When combined, individuals from fourteen species, representing the orders of Crocodilia, Squamata, and Testudines, were included in these behavioral assessments. Reptiles showed significant changes in these indicators, but behavioral trends were not always consistent across studies. Additionally, the valence and intensity of results varied depending on the species. Although these results suggest there is not a one-size-fits-all indicator of welfare for reptiles, the choices they make about using their enclosures are informative about their welfare states.

Dolphin-WET: a new holistic approach to evaluate the welfare of bottlenose dolphins (Tursiops truncatus) under human care

Dr Katrin Baumgartner, Zoo Nuremburg

The welfare committee of the European Association for Aquatic Mammals (EAAM) has united a group of experts on welfare science, cetacean biology, zoo medicine and husbandry across Europe, with the aim to develop a protocol for the evaluation of bottlenose dolphin (Tursiops truncatus) welfare called Dolphin-WET. The integration of the multidimensional aspects of welfare is inspired by Mellor's Five Domains model (Mellor, 2016) and the protocol's hierarchical structure by the Welfare Quality®, following: Overall welfare assessment > Principles > Criteria > Sub-criteria > Welfare indicators. The tool consists of 5 principles, 22 criteria and 42 sub-criteria. Each sub-criteria is measured using resource- and/or animal-based indicators, prioritizing the latter. All indicators are scientifically validated or based on management/clinical-based expertise - as well as information provided by records and surveys. A toolbox describing the practical applications will be included. Importantly, the present protocol does not allow compensations between Principles or between Criteria or Sub-Criteria from the same Principle. Where one section (Sub-Criteria or Criteria) is missing or failing, the upper-related level cannot be considered optimal or fulfilled and will need to be addressed. Moreover, the protocol is intended to assess the welfare status of individual dolphins not for a single point in time but covering the entire year with 3 months under review for each application.

The protocol is currently being developed by both compiling the latest and updated dolphin welfare indicators and taking advantage of the unique possibilities that both the indicators and the entire protocol can be validated by using the EAAM resources in terms of animals, facilities and expertise.

The Enrichment Revolution: Impacts of a stimulating enrichment program on behaviour and welfare, using marine mammals as a case study

Dr Isabella Clegg, Animal Welfare Expertise

Enrichment for dolphins in zoos and aquaria has traditionally focused on simple, floating objects with limited use of foraging devices and natural behaviour stimulation. In the last 5 years there has been evidence of significant change in this regard in some facilities, and the beneficial impacts on dolphin behaviour and welfare are starting to be published. Such enrichment programs are increasingly stimulating the advanced cognitive capabilities of dolphins and encourage more natural, below-water foraging behaviours. This talk focuses on the implementation of a new enrichment program for the 27 common and Indo-Pacific bottlenose dolphins (Tursiops truncatus and T. aduncus) at Sea World Australia to demonstrate these effects. Behavioural data was collected before, during and after the program implementation, totalling 2826 observations which comes to 22,000 minutes or 815 minutes/dolphin. ZooMonitor and OERCA were used to collect the behavioural and enrichment engagement data. We found that the time spent interacting with an EED increased from 30% to 45% of observed time. During the same period, we saw a small reduction in Abnormal Repetitive Behaviours from 1.7% to 1.5% of observed time, and a reduction in anticipatory behaviour before sessions from 9.5% to 5.9%. In over 60% of enrichment sessions, the dolphins were recorded as being highly engaged or having sustained interest, and in over 90% of sessions they showed at least a brief interest. Whilst the program is still ongoing, the cited changes in behavioural welfare parameters and others indicate that the more variable and stimulating enrichment program has increased dolphin welfare in this population.

Welfare implications of circadian and circannual cycles: A giant panda case study

Kristine Gandia, University of Stirling

The circadian clock influences many aspects of animal welfare including metabolism, breeding, and behaviour. In captivity, these rhythms can be used to understand animals' needs and make changes

to management accordingly. However, for captive giant pandas there is limited information on their diel and annual cycles. Determining these rhythms is especially important for vulnerable species (like giant pandas) because management of their circadian rhythms can result in the promotion of positive welfare and increased reproductive success. To determine these rhythms in captive giant pandas, we measured and analysed observational behavioural data of zoo-housed giant pandas for one year utilising live camera footage from zoos across the world (n=6). The worldwide distribution of the study pandas gives us the unique opportunity to investigate how housing giant pandas within and outside of their latitudinal range can affect circadian rhythmicity and behaviour. Focal sampling was completed for each giant panda (n=13) once a month using 10-minute sessions with 30-second intervals every hour to form an estimate of one full 24-hour cycle for that month. Preliminary results (December 2020 – June 2021) suggest that i) a similar activity pattern to wild conspecifics is displayed, with three peaks of activity in 24 hours, ii) there are clear seasonal changes in reproductive behaviours and activity level, and iii) stereotypic behaviours are concentrated in the early morning. Further analysis will include a time series analysis of the full year and modelling to determine the effects of age, sex, environmental factors and latitude on the diel and annual cycles of behaviour. The results can provide zoo staff with the data necessary for anticipating the changing needs of giant pandas on a daily, monthly, and annual scale so that management can be adjusted accordingly, positive welfare promoted, and conservation efforts furthered.

Session 6

Animal welfare from the animal's perspective

Dr Jake Veasey, Care for the Rare

Evidence suggests that animal management priorities and husbandry guidelines are frequently out of step with the psychological needs of wild animals. In this workshop we'll provide some examples to illustrate this point, and take delegates through an interactive assessment to help identify the needs of a well-known species. Its hoped this will help delegates structure their thinking about welfare-based priorities.

Converging animal welfare science

Dr Samantha J. Ward, Nottingham Trent University, Prof Geoff Hosey, University of Bolton

Advances in animal welfare science have led to a high number of studies being published for farm, laboratory and zoo animals, with a huge breadth of innovative topic areas and methodologies. Each industry takes a different approach due to the variety of constraints that each group brings. From diuscussions of Ward & Hosey (2019), this workshop aims to address the gaps across welfare science research between industries and across the world. Where does zoo welfare research shine? How can we influence farm/lab welfare researchers with what we have discovered from zoo welfare research? Where can the zoo industry learn from farm/lab research? How can we distil more collaboration, facilitate knowledge transfer and share good practice worldwide?

A systematic review of the use of technology to monitor animal welfare in zoo animals: is there space for improvement?

Dr Alessia Diana, DAFNAE, University of Padova

A top priority of modern zoos is to promote wildlife conservation and to ensure animal welfare (AW). Thus efforts towards improving zoo AW monitoring are increasing. Welfare assessments are generally performed through more traditional approaches by employing direct observations and data collection that are time-consuming and require trained specialists. These limitations may be overcome through automated monitoring using wearable or remotely placed sensors, cameras or microphones.

However, in this fast-developing field, the level of automated AW monitoring used in zoos is unclear, and hence requires a literature review. We aimed to investigate research conducted on the use of technology for AW assessment in zoos with a focus on real-time automated monitoring systems. A systematic literature search was performed using the databases PubMed and WoS. Three concepts (1. zoo animals; 2. use of technology; 3. animal welfare) and associated keywords were defined. Publications were imported to Mendeley and, following removal of duplicates, evaluated according to a list of exclusion criteria. The search led to 19 publications of which the full text was screened and information noted. The earliest publication was published in 2009, with 66.7% of the remaining between 2015 and 2019 and 33.3% in the last two years. Studies most often focused on mammals (89.5%) with elephant as the most studied species (36.8%) followed by primates (21%). Most studies were carried out in the USA (63.1%) followed by Australia (10.5%). The most used technologies were camera (52.6%) and wearable sensors (31.6%) which were mainly used to measure behaviour (68.4%). Algorithms to monitor AW were reported in two publications. This research area is still young in zoos and mainly focused on large mammals. Despite an increase in publications employing automated AW monitoring in the last years, the potential for this to become a useful tool needs further research.

Why we're still talking about carcass feeding carnivores: why we need to publish research to inform evidence-based zoo animal welfare!

Prof Vicky Melfi, Hartpury University
TBC

Gradual improvements in longevity for zoo-held mammals during the last century: evidence of welfare improvement?

Dr Morgane Tidière, Species360 Conservation Science Alliance

The "one plan approach" suggests combining in situ and ex situ conservation plans to increase the probability to reverse, or at least slow down, global extinction rate. However, keeping animals under captive conditions for conservation purposes should not be at the expense of their welfare. In human demography, two metrics related to the distribution of age at death in a population (life expectancy and lifespan equality) are directly linked to the improvement of their living conditions (health and socio-economic level) and then their welfare. As animals living under human care in modern Zoos and Aquariums (Z&A) benefit from similar improved conditions, a comparable improvement is expected in the last 150 years, indicating an improvement of their condition of life and then their welfare. Using sex-specific data from Species360 for several mammal species, our findings confirm that efforts made by Z&A to improve knowledge, management and welfare of these species are directly observable through the gradual improvement of their life expectancy and lifespan equality over time. Although there is still room for improvement, conditions provided by Z&A in the recent period allow for instance females of polar bear and California sealion to reach the maximum potential of longevity of the species. These results confirm that the gradual improvement of life condition is observable not only in human populations but also in animals living under human care, and they are encouraging for Z&A.

Aiming for the better welfare - using IoT-devices in collecting evidence of the environmental conditions and animal activity

Dr Kirsi Pynnönen- Oudman, Helsinki (Korkeasaari) zoo

More and more information is needed on the environment and animal behavior to be able to guarantee good welfare of the captive animals. Long-time measurements of the circumstances, such as illumination, noise and temperature are needed, as well as activity data of animals over extended periods of time.

IoT devices provide possibilities to collect large amounts of data over extended periods of time (Big data). The method itself is unexpensive and can also monitor animal activity in a non-invasive way. Visualizing the data is relatively easy, but Big Data analysis need special expertise that is sometimes difficult to find.

Examples are given of measurements during the circumstances during the animal transfers and long-term measurements of the living conditions of exotic animals. Data have been collected on the behavior of tortoises, and the incubation activity of the large birds of prey and the measurement of noise levels at the zoo premises. The challenges of this method are discussed.

Genetic profiling for animal welfare - A case study of paternity testing in gibbons

Lauren Lansdowne, University of Leicester

Genetic profiling can validate pedigrees, and quantify genetic diversity / inbreeding within captive populations. We have developed 12 autosomal microsatellite markers that can be used to DNA profile gibbon species. The panel has successfully profiled individuals in all gibbon species so far tested (11 species across 3 genera). The panel's cross-species utility allows for a single protocol to be used for all DNA profiling, avoiding the need for species-specific testing. In the case study reported here, the panel conclusively resolved an issue of uncertain paternity in a group of Siamang gibbons (Symphalangus syndactylus) housed at the Cotswold Wildlife Park (UK). By using these newly developed microsatellite markers to assign paternity with existing DNA samples, it was not necessary to capture and anaesthetise the potential sires, procedures which carry significant potential health risks. This case study demonstrates how genetic testing can be used to ensure appropriate management decisions, safeguarding the health and welfare of the animals.

Effect of a Reliable Cue on the Intensity of Anticipatory Behaviour

Dr Jason Watters, San Francisco Zoological Society

The intensity of animals' anticipation to known positive rewards is related to their reward sensitivity and has been suggested as a 'self-report' of well-being. Increasing information available to animals regarding the timing of events may improve animal well-being by increasing animals' understanding of their environment. In this sense, gaining relevant information can be intrinsically rewarding to animals. We were interested in whether providing information about timing of daily events could be sufficient to improve animal welfare as measured through anticipatory behaviors. If gaining reliable information is intrinsically rewarding, we would expect the addition of a reliable cue would decrease anticipation before the cue, although the animal may show intense anticipation after cue and before the event. Alternatively, if the cue only allows the animal to predict the arrival of events and is minimally rewarding itself, the addition of the cue may not change the intensity of anticipation, but could result in more temporally organized behavior.

We assessed whether adding a reliable signal before daily positive reinforcement training sessions improved the welfare of a California sea lion (Zalophus californianus), as measured by his anticipatory behavior towards the training sessions. We evaluated the anticipatory behavior of the animal under two conditions: Baseline and Signal. During Baseline conditions, the sea lion received normal husbandry, which included 3 daily training sessions - 2 unscheduled, and 1 scheduled. During Signal conditions, care staff played an audio tone 3 minutes before both unscheduled sessions began.

Providing a reliable cue did not reduce the intensity of the anticipatory behavior. However, the temporal dynamics of anticipation changed. The anticipatory behavior became more organized, showing a higher correlation with the onset of the session. The variance in duration of the behavior also decreased, suggesting anticipation compressed into a shorter period. We discuss the implications for animal welfare and husbandry.