4th International Symposium on Zoo Animal Welfare

Animal Welfare Innovations: Shaping the Future Together

2025

4th International Symposium ZOO ANIMAL WELFARE

MAY 19 – 21

BROOKFIELD ZOO CHICAGO

WELCOME TO BROOKFIELD ZOO CHICAGO!

Dear Friends and Colleagues,

Welcome to Brookfield Zoo Chicago! It is a pleasure to host you for the 4th International Symposium on Zoo Animal Welfare as we come together to explore innovative approaches to advancing animal welfare in zoos and aquariums. This year's theme, "Animal Welfare Innovations: Shaping the Future Together," underscores the importance of collaboration in our shared mission to enhance the lives of animals in professional care.

Animal welfare science continues to evolve, driven by cutting-edge research, new technologies, and a deeper understanding of the complex physical, emotional, and behavioral needs of the species we care for. At Brookfield Zoo Chicago, our commitment to animal welfare is at the core of everything we do, from habitat design and behavioral monitoring to veterinary care and species conservation efforts. This symposium provides a unique opportunity to exchange ideas, share best practices, and challenge ourselves to push the boundaries of what's possible in ensuring the highest standards of care.

Throughout this symposium, we will engage in discussions on critical topics such as:

- Innovations in monitoring and assessing animal welfare
- The role of human-animal interactions in welfare
- Advancements in enrichment, training and social management

The insights and expertise each of you bring to this symposium are invaluable. By working together across disciplines and institutions, we can continue to drive meaningful change and elevate animal welfare in ways that will shape the future of zoos and aquariums for generations to come.

Thank you for joining us, and I look forward to the conversations and collaborations ahead.

Sincerely,

Dr. Michael J. Adkesson
President & CEO
Brookfield Zoo Chicago

Monday, May 19, 2025

Grand Ballroom, Doubletree by Hilton, Oak Brook, IL

5:00 p.m. Opening Reception

7:00 p.m. Opening Remarks

7:10 p.m. **Keynote Address: Kaitlin Wurtz**
Harnessing AI for the future of animal welfare: innovations, challenges, and Ethical Considerations

Tuesday, May 20, 2025

Discovery Center, Brookfield Zoo Chicago, Brookfield, IL

8:00 a.m. Shuttle to Brookfield Zoo Chicago

8:45 a.m. Logistics

9:00 a.m. Welcome

9:15 a.m. Jason V. Watters
Measuring themental – the three needs model of animal welfare

9:35 a.m. Kyle Hetzel
The constructional approach to enhancing welfare across all species

9:55 a.m. Bethany L. Krebs
Animal affect, conditional reward probability, and the Bayesian brain

10:15 a.m. Copper Aitken-Palmer, Sathya Chinnadurai, Brittany Rizzo, & Tiffany Love
Safe Passage: Developing best possible practices for zoo animal transport

10:35 a.m. Break

11:00 a.m. Jason D. Wark & Katherine A. Cronin
Factors shaping giraffe behavior in U.S. zoos: A multi-institutional study

11:20 a.m. Lance J. Miller
Behavioral diversity as a positive indicator of animal welfare

11:40 a.m. Sandra M. Troxell-Smith, Alexis M. Hart, Jordyn Truax, Eness Meri, Zac Reynolds, & Jennifer Vonk
Beyond stereotypies: increased activity as a subtle indicator of welfare in captive elasmobranchs

12:00 p.m. Ashley N. Edes, Helen Boostrom, & Katie L. Edwards
Does IgA reflect the valence of stressful experiences? A case study in male gorillas at the Saint Louis Zoo

12:20 p.m. Lunch

1:30 p.m. Samantha J. Ward & Jeroen Stevens
ZooMood: a rapid assessment to measure zoo animal welfare.

1:50 p.m. Daniel García-Párraga, Jessica Carroll, Carlos Barros, & Mario Fernández
Wide-ranging intelligent system, based on biometric data, for animal behaviour and welfare control

2:10 p.m. Justine Partoon, Alexandra L. Whittaker, Mark Smith, Xin Yuan, & Peng Shi
Enhancing orangutan welfare: a multidisciplinary approach using innovative technologies

2:30 p.m. Aimee McDonnell & Alexis M. Hart
From data to decisions: Utilizing Microsoft Power apps to advance animal management and wellbeing

2:50 p.m. Break

3:15 p.m. Margaret Ramont, Cody Hickman, Tim Snyder, Sathya K. Chinnadurai, & Lance J. Miller
From Hatch to Fledge: Growth and development of sihek chicks at Brookfield Zoo Chicago

3:35 p.m. Alexis M. Hart, Aimee McDonnell, & Emily Simkins
New surroundings, new behaviors: sensory impacts of habitat relocation on zoo-housed bird species

3:55 p.m. David M. Powell, Eli Baskir, Beth Stark-Posta, & Monica Blackwell
Does flight restriction affect the behavior of waterfowl in zoos in ways that impact animal welfare?

4:15 p.m. Paul E. Rose & Sunyeong Lee
Inferring welfare changes with age—correlating flamingo life stages with potential welfare predictors

4:45 p.m. Poster Session

6:15 p.m. Shuttle to Doubletree by Hilton, Oak Brook, IL

Wednesday, May 21, 2025

Discovery Center, Brookfield Zoo Chicago, Brookfield, IL

8:00 a.m. Shuttle to Brookfield Zoo Chicago

8:45 a.m. Logistics

9:00 a.m. Allison M. Bailey & Meredith J. Bashaw
Participatory shelter design with red pandas

9:20 a.m. Charles P. Ritzler & Lance J. Miller
More than meets the eye: The impact of environmental conditions on pinniped behavior

9:40 a.m. Liam Kelly
Assessing shade availability and use across diverse zoo habitats using Accessible Technology

10:00 a.m. William A. Allen & Marieke C. Gartner
Evaluating the impact of cold weather on the behavior of captive black and white colobus monkeys (Colobus guereza)

10:20 a.m. Break

10:45 a.m. Shay Forget, Lindsey Kitchenham, & Georgia Mason
Habits, happiness or having no time? Exploring why 'enrichments' reduce stereotypic behaviour to different extents in different mice

11:05 a.m. Michelle Gygax, Bernhard Voelkl, Janja Novak, Stefanie Krebs, Georgia Mason, & Hanno Würbel
Measuring motivation in captive animals: new ways to assess 'enrichment' preferences

11:25 a.m. Georgia Mason & Prathipa Anandarajan
Good welfare is attractive: Mate choice result from differentially raised mice

11:45 a.m. Jiayi Cai & Georgia Mason
Courtship singing by male mice *(Mus musculus)* is predicted by independent effects of housing quality and testosterone related physical traits

12:05 a.m. Lunch

1:15 p.m. Sara Zalewski, Kylen N. Gartland, Bradley Barr, Jennifer Hamilton, & Grace Fuller
Education-based efforts to mitigate negative effects of visitor glass tapping on welfare of zoo-housed reptiles

1:35 p.m. Alexis M. Hart, Dominique Augustin, Sandra M. Troxell-Smith, & Molly McGuire
An open-door policy: Removing a visual barrier improved Bald Eagle welfare

1:55 p.m. Jennifer Hamilton, Wynona Shellabarger, Rick Wendt, & Grace Fuller
Can we build it? Yes, we can! Monitoring polar bear well-being during construction.

2:15 p.m. Break

2:40 p.m. Laurel B. F. Westcott, Jason DeLibero, Asaba Mukobi, Becca Van Beek, Kate Gilmore, & Nadja Wielebnowski
Investigating the impact of aound enrichment in two species of lemur (V. rubra & L. catta) based on physiological and behavioral responses - A pilot study

3:00 p.m. Lisa Lundin & Jenny Loberg
Does an enriched feeding regime affect social behavior in ring-tailed lemurs?

3:20 p.m. Cheryl Meehan, Brian Lynn, Jessica Sheftel, Louisa Radosevich, & Greg Vicino
The enriched experience project

3:45 p.m. Tour

5:15 p.m. Social Hour

6:15 p.m. Closing Reception

7:45 p.m. Shuttle to Doubletree by Hilton, Oak Brook, IL

Thursday, May 22, 2025

Brookfield Zoo Chicago, Brookfield, IL

10:00 a.m. to 5:00 p.m. Zoo Day: Brookfield Zoo Chicago

Note: All attendees can visit Brookfield Zoo Chicago for free with symposium lanyard. Transportation is on your own and options include Uber, Lyft, taxi, or bus.

Keynote Address

Harnessing AI for the future of animal welfare: innovations, challenges, and ethical considerations

Dr. Kaitlin Wurtz, Applied Ethologist and Animal Welfare Scientist, Purdue University

The integration of artificial intelligence (AI) and machine learning (ML) into animal welfare science is transforming how we monitor, assess, and enhance the welfare of animals in managed care. Advances in sensor technologies and high-throughput data analysis are enabling continuous, automated monitoring of behavior, physiology, and the environment, offering new opportunities for individualized care, precision management, and long-term welfare assessments. AI-driven approaches allow for the early detection of health concerns such as disease, injuries, and lameness, as well as emotional states through vocalizations, body posture, facial expressions, and environmental interactions. Beyond improving animal care, these technologies hold exciting potential for enhancing animal breeding programs, where individualized data can be leveraged to support welfare-centered decision-making. However, critical challenges remain. Expertise in animal welfare science is essential to ensure that meaningful data is collected and that it is interpreted in appropriate ways. Moreover, there is the concern that AI could contribute to the overemphasis on production efficiency at the expense of animal welfare. Practical barriers—including limited broadband access and computational infrastructure—must also be addressed for widespread adoption. Ethical considerations, such as data ownership, privacy, and the role of automated decision-making in animal management, further underscore the need for a thoughtful, multidisciplinary approach. As we shape the future of animal welfare together, AI presents tremendous opportunities to advance science-driven, welfare-focused innovations. By fostering collaboration between engineers, computer scientists, animal welfare scientists, and caregivers, we can ensure that these emerging tools are harnessed ethically and effectively to improve the lives of animals under human care.

Formal Presentation

Safe Passage: Developing best possible practices for zoo animal transport

Copper Aitken-Palmer, Sathya Chinnadurai, Brittany Rizzo, and Tiffany Love

The successful transport of zoo animals is a shared responsibility demanding meticulous planning and execution. Thousands of animals are transferred annually for breeding, population management, and emergencies, but current practices often prioritize logistical efficiency over animal welfare. Traditional standards, which merely ensured survival, are no longer acceptable. Modern zoological stewardship requires a fundamental shift, emphasizing the animal's well-being throughout the entire process. This includes rigorous pre-transport assessments of fitness for travel and destination suitability, coupled with species-specific welfare optimization during transit. To achieve this, we propose centering the animal in transport planning through deliberate, welfare-focused discussions. Critical elements include: clearly defining the animal's role at the destination, confirming its fitness for that role, analyzing and mitigating travel-related risks, improving communication among all zoo professions involved in transport and implementing robust acclimation strategies to facilitate a seamless transition post-arrival.

Evaluating the Impact of cold weather on the behavior of captive black and white colobus monkeys *(Colobus guereza)*

William A. Allen and Marieke C. Gartner

The Association of Zoos and Aquariums (AZA) provides care manuals and standards designed to reflect the natural history of captive-managed animals. These guidelines encompass aspects such as enclosure design and temperature ranges, ensuring that animals are housed in environments that align with their natural behaviors and needs. Zoo Atlanta is home to one of the largest captive-managed troops of black and white colobus monkeys *(Colobus guereza)*. Native to tropical regions, these monkeys often face climates in captivity that differ from their natural habitat. Understanding how varying weather conditions, especially colder temperatures, affect their behavior is crucial for improving their welfare in zoological settings. AZA standards recommend that colobus monkeys remain

indoors when temperatures drop below 45°F, potentially limiting their outdoor access and raising welfare concerns due to prolonged indoor confinement. Preliminary results suggest that colder temperatures (<59°F) were associated with increased feeding ($p = 0.0045$) and occasional social tension ($p = 0.0360$). This study examines how cold weather influences the behavior of colobus monkeys and evaluates whether they can safely remain on habitat at lower temperatures than AZA guidelines currently suggest. By analyzing their full behavioral repertoire during colder periods, this research seeks to provide insights that can inform best practices for enclosure design, temperature management, and care protocols, with the goal of enhancing primate welfare in seasonal climates.

Participatory shelter design withred pandas

Allison M. Bailey and Meredith J. Bashaw

Animals' choices provide meaningful information about their preferences, but providing animals with choices and interpreting their preferences can be challenging. Because of the physical and psychological comfort they provide, dens, shelters, and hiding locations are key habitat features for animals in human care and may be particularly important for small, cryptic animals like red pandas. However, not all shelters are equally desirable; position (height, exposure to direct sunlight, proximity to visitors), composition (material and insulation), and structure (number of enclosed sides, visual barriers, defensibility) affect the degree of comfort they offer. We used a two-stage process to identify preferred shelter characteristics for red pandas at the Central and Prospect Park Zoos. In Phase 1 we provided variety, leaving existing shelters in place and adding 3 more new shelters with different positions, compositions, and structures to each exhibit. The pandas' shelter use time and behavioral diversity allowed us to identify a single preferred shelter at each zoo. In Phase 2, we removed unused shelters, designed a new shelter based on the shared traits of the two preferred shelters, and added the new shelter to both exhibits. We systematically varied the height, roof style, and entry size of the new shelter and observed which conditions enticed the pandas to switch from their previously-preferred shelter to the new one. While some aspects of the new shelter consistently affected preferences at both zoos, other effects were unique to individual zoos and even individual pandas. Our observations reveal strengths and limitations of choice-based techniques for participatory design of exhibit features.

Courtship singing by male mice *(Mus musculus)* is predicted by independent effects of housing quality and testosterone related physical traits

Jiayi Cai and Georgia Mason

Housing quality (e.g. how barren or 'enriched' a cage is) may impair breeding by affecting welfare. In DBA/2 mice, well-resourced (WR) males from 'enriched' cages have been found to be more attractive as mates. Here we assess whether this reflects enhancement of their ultrasonic courtship singing, and whether effects are testosterone-mediated (inferred from traits measured post mortem). Singing was induced in 34 males (half WR) using female urine or, if needed, female mouse presence. All males sang, 24 to just urine. WR males showed no signs of higher testosterone: anogenital distances (AGDs) were no shorter and testes no heavier. Housing and test time interacted to predict singing to just urine: within males tested later in the day, WR subjects tended to not need female presence to sing. Shorter AGDs and heavier testes also increased chances of singing to just urine and predicted shorter singing latencies. If AGD was statistically controlled for, this showed again that compared to CH males, WR males sang more readily to just urine. Further, WR males' songs differed from CH males. They tended to have greater bandwidths; when testis weight was controlled for, they strongly tended to have higher peak frequencies; and a significant AGD*housing effect on peak frequency reflected that in short-AGD males, WR song peaks were significantly higher. Overall, WR males sang songs likely be more attractive to females; and tended to sing more readily to just urine (perhaps reflecting greater libido). Such housing effects were not testosterone-mediated (androgen-sensitive traits enhancing singing independent of housing). Enhanced singing by WR male mice from 'enriched' environments may thus contribute to their greater appeal as mates. This emphasizes the value of well-resourced, welfare-enhancing housing for natural, effective mating, and suggests that sex hormones are not the only mediators of such benefits.

Does IgA reflect the valence of stressful experiences? A case study in male gorillas at the Saint Louis Zoo

Ashley N. Edes, Helen Boostrom, and Katie L. Edwards

Glucocorticoids (i.e., cortisol, corticosterone) are often used to monitor and study stress in animals. However, researchers are encouraged not to rely solely on glucocorticoids to understand affective states, as acute fluctuations are not always synonymous with experiencing stress and glucocorticoids cannot be used to distinguish between positive (e.g., mating) and negative (e.g., aggression) stressors. The ratio of cortisol to dehydroepiandrosterone-sulfate (DHEA-S) may be a more sensitive indicator of stress response activity and has been proposed as an alternative to using glucocorticoids alone. Some human studies have shown that secretory immunoglobulin A (IgA), an immune protein, increases during positive experiences and decreases during negative ones, suggesting it may indicate the valence of stressors. To date, IgA has not been widely used in zoo research and findings have been ambiguous. In this case study, we are assaying fecal cortisol, DHEA-S, and IgA in western lowland gorillas *(Gorilla gorilla)* living in an all-male group during multiple social changes. We will compare changes in fecal cortisol and the cortisol/DHEA-S ratio to changes in IgA to determine whether IgA reflects the hypothesized valence of stressful experiences. For example, one silverback showed strong behavioral responses to the transfer of his half-brother and then later the death of a conspecific, both negative experiences that are likely to result in a decline in IgA if the biomarker reflects affective state. Since these events, the silverback has bonded with two new blackback males and has even been observed playing with them, positive experiences that should correspond to an increase in IgA. If IgA indicates the valence of stressors for animals in human care, it has the potential to be a transformative biomarker for understanding stress and wellbeing in zoo collections.

Habits, happiness or having no time? Exploring why 'enrichments' reduce stereotypic behaviour to different extents in different mice

Shay Forget, Lindsey Kitchenham, and Georgia Mason

Older animals long exposed to barren housing can develop treatment-resistant stereotypic behaviours (SBs): SBs that persist after housing is apparently improved by adding valued resources ('enrichments'). One possible cause is SB 'establishment': a hypothetical process wherein through high levels of repetition, SBs become inflexible habits. Alternatively, it could reflect a failure of the added resources to elicit interaction, or even to improve welfare at all. To test these ideas, 36 sister pairs of DBA mice were conventionally housed (CH) in lab cages for different periods (between 12 and 52 weeks), before one mouse per pair was rehomed to a small cage connected to a large, well-resourced (WR) enclosure known to be preferred by mice. Before and after rehousing, behavioural data were collected on SB characteristics, use of the new resources, and two welfare-relevant measures: anhedonia (loss of pleasure, inferred from sucrose ingestion) and anxiety (assessed in light-dark tests). Since both sisters were given new cagemates (a trio of young mice) to avoid living solo, we additionally monitored social interactions. To infer treatment-resistance, SB reduction was quantified as absolute and proportional reduction. As expected, SB reduction in WR conditions was significant ($rho = -0.62$, $p < 0.05$) and varied greatly (from complete abolition to a surprising 3-fold increase). Unexpectedly, SBs in control sisters also reduced after recaging (perhaps reflecting stimulation from their new cagemates) ($t35 = -0.081$, $p < 0.05$). No predictions of the 'establishment' hypothesis were met: for example, neither age, nor SBs being repeated more before rehousing, predicted any measure of treatment resistance ($p > 0.10$ in all tests). However, proportional SB reduction in WR mice was predicted by engagement with the new resources ($t34 = 4.084$, $p < 0.05$), as well as a combined 'engagement' measure ('active resource use + socialising with cagemates') ($t34 = 5.022$, $p < 0.05$). However, engagement with resources was seemingly unrelated to their likely welfare impact, at least as inferred from measures of anxiety and anhedonia ($p > 0.10$). Thus, why some mice engaged less with 'enrichments' and each other remains unclear; but these non-engaged mice did show the most treatment-resistant SB. Future work will assess whether some mice value 'enrichments' and social contact less than others and derive less welfare benefit from them (assessed from judgement bias).

Wide-ranging intelligent system, based on biometric data, for animal behaviour and welfare control

Daniel García-Párraga, Jessica Carroll, Carlos Barros, and Mario Fernández

We present a novel technique using wearable activity tracking devices to monitor animal behavior continuously 24/7. The device integrates a three-axis accelerometer and a thermometer, weighing only 7 grams, and is fully submersible up to 15 meters. It boasts a battery life of up to 5 months and a data storage capacity of 14 days. A key advantage of this system is its ability to transfer data automatically via a preconfigured smartphone app using Bluetooth, at a range of 15-20 meters and even through walls, without manual intervention. The device collects data at a frequency of 12 Hz, generating approximately one million data points per animal per day. Accelerometry and temperature data are automatically uploaded to the cloud when the device comes within proximity of a smartphone. The project also includes the development of an analytical software platform capable of converting accelerometry data into specific behaviors using species-specific algorithms. Proper attachment systems and device placement are essential to ensure accurate data collection, animal safety, minimal interference with natural behaviors, and ease of use. To date, algorithms for penguins, Dorcas gazelles and Komodo dragons have been calibrated by correlating accelerometry data with manual observational data collected using Zoo-Monitor®. The software is designed to generate activity budgets and issue alerts based on predefined thresholds for activity levels or specific behaviors. This tool aims to operate on portable devices, such as smartphones or tablets, with minimal time required for data interpretation, enabling daily use by animal caregivers, veterinarians, and curators. The goal is to facilitate comprehensive monitoring and analysis of daily activity budgets, caloric expenditure related to physical activity, and the quantity and quality of rest. Additionally, this methodology has shown potential in detecting and monitoring the progression of certain pathologies, such as aspergillosis in penguins, and assessing the effectiveness of environmental enrichment programs. We believe this innovative tool under development could become an invaluable resource for enhancing animal health and welfare monitoring in zoological institutions.

Measuring motivation in captive animals: new ways to assess "enrichment" preferences

Michelle Gygax, Bernhard Voelkl, Janja Novak, Stefanie Krebs, Georgia Mason, and Hanno Würbel

Knowing which 'enrichments' captive animals prefer is crucial for improving welfare. A way to measure this is via the costs animals will pay to use such resources. Subjects trained to leverpress or push weighted doors for access, for instance, can be exposed to gradually increasing prices (heavier weights/more required presses) until they stop paying, yielding a maximum price paid (MPP). Insights revealed by MPPs include that mink value swimming and cows, grazing. However, MPP measures have drawbacks, being discontinuous, time-consuming to assess, and hard to implement in zoos. Using mice as models, we therefore tested two alternatives in animals thwarted of expected resource access: number of door attempts made, and maximum force exerted (MFE). We housed two strains of 20 male and 20 female mice in 20 setups each with six chambers: one empty (control), five with resources (burrowing substrate, running wheel, climbing frame, elevated platform, gnawing stick). First, doors were blocked for 48h, while load cells recorded, on continuous scales, 'attempts' and how hard mice pushed at the doors (MFE). Next, after 48h of free access, access door-weights were increased every 24 hours up to each resource's MPP. Concordance tests showed close similarities between MPP and MFE, and good concordance between 'attempts' and both MPP and MFE. (Mixed models are now being run to check that such relationships are similarly strong across both strains/sexes and all resources). All measures, furthermore, revealed that mice strongly value burrowing opportunities and running wheels: resources typically absent in lab conditions. Relevant to zoos, our methodological findings show that which 'enrichments' are most preferred can be assessed by providing longterm free access, then temporarily thwarting animals to record how intensely they interact with an imposed barrier/obstacle. This method could be adapted for very diverse species, and so help improve welfare assessments in zoos.

Can we build it? Yes, we can! Monitoring polar bear well-being during construction.

Jennifer Hamilton, Wynona Shellabarger, Rick Wendt, and Grace Fuller

In 2023, the Detroit Zoological Society launched a seven-acre renovation project with all the noise, vibrations, and odd odors that come with construction. The footprint of the site lies adjacent to the Arctic Ring of Life, which houses a male and female polar bear. Due to the proximity of construction, all large equipment underwent a sound evaluation to determine a buffer zone during denning, and both bears settled into a normal winter season. However, as the female bear became more active in spring 2024, we began to see clear changes in indicators of their well-being, especially as the amount of time they spent pacing began to climb (May 2024, female: 57.9%; male: 26.3%) compared anecdotally to years past. In collaboration with a behavior consultant and a veterinary behavior consultant, we spent the next five months exploring the full impact of the construction. Both bears benefited from a robust behavioral husbandry protocol that aimed to provide enrichment promoting long duration of engagement and slow rate of satiation. The female also had a medical intervention consisting of a supplement and medication prescribed to her to help her process the new stimuli in her environment. To understand the outcomes of these interventions, behavioral results were monitored using two different observational methodologies, including in-person and video monitoring, and additional sound monitoring. With the husbandry changes implemented, we saw a reduction in the total amount of time that both polar bears spent pacing (July 2024, female: 30.8%; male: 0%). For the female bear, we also saw a reduction in the span of time pacing throughout the day, which ultimately led to a quietly denned bear with no pacing in the fall of 2024. Tackling a challenge of this size required collaboration between husbandry, welfare, and veterinary staff and presented multiple learning opportunities that helped us develop a protocol for improving well-being that is now being tested with other species.

An open-door policy: Removing a visual barrier improved bald eagle welfare

Alexis M. Hart, Dominique Augustin, Sandra M. Troxell-Smith, and Molly McGuire

Birds of prey are renowned for their excellent visual acuity, but they are often not given visual access consistent with their natural behavior when housed under managed care. Often, these birds are housed under managed care after sustaining injuries, which prohibits their return to the wild. In addition, many of these rescued raptors do not have the same history of acclimation to human presence as other zoo animals due to being wild-hatched. These factors lead to a potential welfare concern for raptors under managed care, which may not appropriately address their natural and individual histories. We assessed how the removal of a visual barrier (two large doors) may have affected behavior and space use of two bald eagles *(Haliaeetus leucocephalus)* housed at Zoo Miami. Before the visual barrier being removed, the eagles could not see people approaching their habitat from one out of two possible sides. We found that for one individual, stress behaviors such as gular fluttering significantly decreased after the removal of the visual barrier, and resting significantly increased. The birds also utilized their habitat more evenly after the visual barrier was removed and were seen at higher, more species-typical altitudes within the habitat. These findings suggest that increased environmental visual access for zoo-housed raptors may be a simple way to improve their overall welfare.

New Surroundings, New behaviors: Sensory impacts of habitat relocation on zoo-housed bird species

Alexis M. Hart, Aimee McDonnell, and Emily Simkins

A change in environmental stimuli has long been shown to affect zoo animal behavior. Changes in variables such as habitat complexity, management routine, or the presence of unfamiliar people can all occur on a daily basis in the type of dynamic environment that a zoo provides. Changes in these factors can affect overall animal wellbeing, though these changes remain seldom assessed in non-mammalian species. This study assessed how relocation of a white-bellied bustard *(Eupodotis senegalensis)* from a guest-facing habitat to one away from the public affected the frequency of target behaviors indicative of stress (namely pacing and alarm calling). A mixture of in-person behavioral observations and continuous camera footage were utilized. It was found that this change in scenery was associated with a significant decrease in time spent pacing ($V=127$, $p=2.28e-3$) and a significant decrease in bouts of alarm calling ($V=99$, $p=0.027$). In addition, it was found that this individual continuously demonstrated a "fleeing" response towards one of the two trains that would regularly pass by his new habitat, which was an unexpected result. Ongoing investigation has shown that both the color and sound of this train

may be influencing this behavioral response. These results support the notion that more data should be collected on how bird species are affected by environmental stimuli and how their unique sensory perceptions and natural history may impact their behavior.

The constructional approach to enhancing welfare across all species

Kyle Hetzel

This presentation explores the application of Goldiamond's Constructional Approach (CA, 1974) in enhancing animal welfare and its relevance to Applied Behavior Analysis (ABA) practices, specifically cases with nonverbal children. The Constructional Approach was first developed to treat clinically complex behavior problems such as delusions and hallucinations. The Constructional Approach focuses on building new behaviors instead of eliminating problematic ones. Despite the original publication of the Constructional Approach over 50 years ago, it has not been extensively applied in zoos. Zookeepers worked with behavior consultants, PhD's, and ABA practitioners to develop an application of the Constructional Approach to be used in a zoological setting. Before this, teams would focus on one approach to eliminating problematic or difficult behaviors and often resulting in no progress and additional stress. The Constructional Approach empowered both nonverbal humans and animals to be in control, making measurable increases in their overall welfare. Across multiple zoological institutions, the implementation of the Constructional Approach with multiple species, including goats, a steer, giraffes, and a kookaburra, were observed to utilize more of their enclosure space, exhibit an increase in species appropriate behaviors, and display a marked decrease in stereotypic and aggression-based behaviors. Improved welfare was further measured by a reduced need for manual restraint, increased voluntary participation in previously negative or invasive medical procedures and increased voluntary participation in all behavioral training sessions. The advancements made by zookeepers and animal professionals, and the subsequent Constructional Approach publications and presentations inspired ABA professionals to incorporate similar applications into practice with their human patients. This collaboration resulted in desired behavioral outcomes across species, suggesting a broader scope for the application of the Constructional Approach in both animal and human interventions to improve welfare.

Assessing shade availability and use across diverse zoo habitats using accessible technology

Liam Kelly

Shade availability is a critical environmental factor for zoo animal welfare, influencing thermal comfort, behavior, and habitat use. This presentation highlights a geospatial and shade use approach to evaluating and optimizing shade availability in two distinct habitat types: an arboreal habitat for mixed-species lemurs and two large savannah habitats for zebras and wildebeest. Using Quantum Geographic Information System (QGIS) and ZooMonitor, we conducted a comprehensive analysis of shade patterns and shade utilization by the animals in these habitats. QGIS was employed to map and model daily shade distribution, while ZooMonitor provided data on animal shade use and habitat use in relation to available shade. Together, these tools identified shade deficiencies and habitat preferences, guiding strategic interventions such as tree planting, structural modifications, and artificial shade installations. Although post-implementation analysis of the suggested solutions is still forthcoming, this presentation emphasizes the replicability of the methodology using accessible technology. Additionally, it underscores the importance of ongoing shade evaluation as habitats evolve and seasonal changes affect shade availability. These findings have already empowered the animal care team to develop and implement targeted shade solutions, improving animal welfare while preserving habitat functionality. This presentation will explore the practical application of QGIS and ZooMonitor for proactive habitat management and demonstrate how technology-driven insights can support welfare-focused decision-making. By leveraging environmental data, this approach aligns with modern standards in zoo welfare and habitat design, offering a model for continuous improvement and innovation in zoos worldwide.

Animal affect, conditional reward probability, and the Bayesian brain

Bethany L. Krebs

Behavioral ecology provides numerous examples of how animals gather information about the current environment and adapt their behaviors accordingly. Specifically, by collecting information and applying what they learn, animals of many species optimize how

they spend their time based on current conditions and their previous experience. Animal care staff in zoos often follow predictable routines, and therefore the distribution of events throughout an animal's day is unequal – events such as feedings, training sessions, or shifting are more likely to happen at certain times of the day. Over time under human care, we expect an animal gains some understanding of the frequency and approximate timing of these regular management events. That is, animals are likely sensitive to what events happen when, and whether care staff presence in a given time period indicates potential reward. In the language of Bayesian modeling, the animal develops its own sense of the prior probability distribution of events in its daily life. Animals likely also understand the conditional probability of reward associated with specific conditions. Given the presence of a caretaker and/or the time of day, their behavior may reflect their perception of conditional probability of reward in that time period rather than the absolute probability of reward across the full day. For example, an animal receiving 10 visits from care staff in a day who is fed at 5 has a 50% chance of reward across the whole day. If 5 of the 10 total visits happen after 3 PM and 5/5 of the visits after 3 PM provide a reward regularly, we may expect the animal to exhibit anticipation starting from 3 PM due to its perceived 100% chance of reward once a keeper shows up. This concept has significance for animal welfare assessments., An animal anticipating a high conditional probability of reward may be perceived to be exhibiting an 'apparently functionless' response to their environment and be labeled stereotypic. Highly motivated animals may express intense anticipation that may not have an obvious cause to their caretakers. This concept provides a simple way to assess the conditional probabilities of reward animals experience, and provides solutions for modifying animals' prior expectations for rewarding events in their daily lives to improve welfare and deter undesirable behaviors.

Does an enriched feeding regime affect social behavior in ring-tailed lemurs?

Lisa Lundin and Jenny Loberg

Ring-tailed lemurs live in complex social groups with female dominance, particularly around feeding. Agonistic and aggressive behaviors are a natural part of their lives and may negatively affect animal welfare. If animals are preoccupied with behaviors such as foraging, aggressive behaviors can be reduced. However, feeding can potentially induce aggressive behaviors due to wanting access to high value resources. The impact of an enriched feeding regime on behavior, in particular foraging and agonistic behaviors, was investigated in a group of ring-tailed lemurs in Sweden during 2023-2024. The aim was to see if enriched feeding added resource competition and therefor agonistic behavior. Lemurs were studied in the spring after birth of new offspring and before access to their outdoor enclosure and in late fall when keepers perceived there was a lot of agonistic behaviors and instability in the group. Feed was either easily accessible, scattered on fixed structures, or spread out in different types of feeding apparatuses, making it more difficult to access food. Lemurs had free access to foliage, hay and water. Both continuous and interval sampling were used, for different types of behaviors, and all behaviors were recorded in ZooMonitor. Preliminary results show number of vocalizations was higher on enriched days, which is also true for agonistic vocalizations. This confirms keepers' perception of enrichment sometimes causing more aggression within the group. However, other agonistic behaviors were rare and did not increase on enriched days. Foraging behavior increased and non-visible decreased on enriched days, while most other behaviors were unaffected. There were also indications that season and time of day affect lemur behavior. Even though welfare implications of increased agonistic vocalizations should not be disregarded, there is not enough evidence in this study that an enriched feeding regime increases agonistic behavior in ring-tailed lemurs.

Good welfare is attractive: Mate choice result from differentially raised mice

Georgia Mason and Prathipa Anandarajan

Females have generally evolved to prefer mates with traits suggesting good fitness (e.g., large body size, signs of good health). In captivity, however, stress from suboptimal housing may compromise such traits, potentially lowering males' attractiveness as mates (as previously shown in rats, mink, zebrafish, and two fly species). We investigated this in DBA/2mice *(Mus musculus)*, predicting that compared to males who are conventionally-housed (CH) in small laboratory cages, females will preferentially seek out as mates higher welfare males from well-resourced (WR), 'enriched' conditions. After a small-scale pilot test, we used 12 dyads of male littermates, these pairs of brothers being split and differentially-raised (as either CH or WR) from 4 weeks of age. At 12 weeks old, 12 oestrous female sister pairs (again half CH, half WR) were each present-

ed with a dyad of differentially-raised brothers, with one placed in each arm of a T-maze (the position of WR and CH brother being varied across trials). The females' choice behaviour was videoed and analyzed blind to male housing. Analyses showed that females spent on average 1.5 times longer near WR males than their CH brothers, sniffing them for nearly twice as long: a significant preference now present across all females regardless of their housing. Overall, as predicted, WR males were thus more attractive (with how and why yet to be determined, but see Cai and Mason for a potential role of male courtship songs). Furthermore, when subsequently housed for mating in male-sister-pair trios (6 WR, 6 CH), WR trios were also more likely to have litters. For problematic breeding programmes (and the many cases where planned matings fail to occur), improving welfare via housing quality may thus help improve reproductive success, not least by enhancing male attractiveness. We suggest enhanced male attractiveness could also improve welfare and maternal care in females: topics for future research.

From data to decisions: Utilizing Microsoft power apps to advance animal management and qellbeing

Aimee McDonnell and Alexis Hart

As zoological institutions continue to advance on-site animal welfare programs, the demand for technological innovations to assist with monitoring and tracking various welfare parameters across time for individuals and species continues to grow. While multiple platforms are utilized across the industry, with some institutions relying on more than one platform, it can take considerable staff resources to utilize these platforms effectively. In addition, it can be a challenge with limited time and resources to integrate different types of data into one location, for staff to be able easily access and interpret the information, and to make evidence-based decisions regarding animal care and welfare. Microsoft 365 is a product family that utilizes cloud-based services to enhance productivity and collaboration, and it has become commonplace in the modern workspace across industries. By using the Power Automate Platform, the Jacksonville Zoo and Gardens was able to create an animal welfare management tool which optimizes and automates information. The tool creates automated workflows that incorporate other Microsoft platforms like Microsoft Forms, Excel, Outlook, and Power BI to present data from multiple different animal care teams in one user-friendly SharePoint site. This information includes data from animal welfare assessments, behavioral observations from ZooMonitor, and behavioral husbandry records and evaluations. With this tool, care staff not only have an easy way to complete daily records regarding animal care and welfare, but they can easily access and interpret the information through use of summary dashboards. More importantly, the information is automated to update in real-time as information is submitted, leading to more proactive wellbeing discussions and actions from care staff. This presentation will provide a demonstration of the types of information that can be integrated across Microsoft platforms, and how it can be accomplished using Power Automate.

The enriched experience project

Cheryl Meehan, Brian Lynn, Jessica Sheftel, Louisa Radosevich, and Greg Vicino

Over the past several decades, environmental enrichment has been implemented in various ways within zoological settings. A progressive approach re-envisions enrichment as part of an outcome-based care model, which emphasizes creating experiences that allow animals to exercise agency by engaging with their surroundings. Animals bring perceptual abilities, cognitive skills, and behavioral competencies to these experiences, and when the environment offers the right opportunities, animals can adapt to challenges and meet their own needs. When animals demonstrate agency, they exhibit wellbeing through behavior, influencing guest perceptions and enhancing learning outcomes. The Enriched Experience Project (EEP) is a professional development initiative aimed at building the capacity of zoological teams to transition toward outcome-based care. This presentation will share case studies from three AZA-accredited institutions where animal care staff participated in EEP. We will discuss impacts on animal behavior, guest perceptions, and staff confidence. Results will include analyses of animal behavior observations with and without EEP interventions, guest survey results on empathy and conservation intent, and staff reflections on shifting practices to embrace outcome-based care.

Behavioral diversity as a positive indicator of animal welfare

Lance J. Miller

Historically, the field of animal welfare has utilized negative indicators of welfare (e.g., stereotypic behavior, stress hormones) to assess animals living in managed settings. However, a lack of negative welfare indicators does not demonstrate that an individual animal is thriving. As zoos and aquariums monitor the welfare of their collections, it is critical to have valid measures of positive welfare to ensure that individual animals have the opportunity to thrive. Fortunately, there is a growing body of evidence that behavioral diversity may be a positive indicator of animal welfare. The underlying theory is that if behavioral diversity is high, there is an increased likelihood that we are meeting the animal's behavioral needs. If behavioral diversity is low, an animal may be demonstrating lethargy or stereotypic behavior, both of which can be signs of compromised welfare. Presentation will highlight three areas of research that historically support behavioral diversity as a positive indicator of animal welfare. These areas include: 1) behavioral restriction, 2) an examination of behavioral diversity during animal management practices thought to be associated with positive welfare (e.g., environmental enrichment and animal training), and 3) relationships with other indicators of welfare.

Enhancing Orangutan qelfare: a multidisciplinary approach using innovative technologies

Justine Partoon, Alexandra L. Whittaker, Mark Smith, Xin Yuan, and Peng Shi

The intersection of technology and animal welfare science offers a unique opportunity to enhance animal welfare assessments in zoological settings. A collaboration between the University of Adelaide's School of Electrical and Mechanical Engineering, School of Animal and Veterinary Science, and Zoos South Australia, is focused on using advanced AI technologies to track and analyse orangutan behaviour, facilitating a deeper understanding of their welfare. Initially, our project employed a multi-camera system, combined with deep learning techniques, to monitor animal movements. Following promising results from this first phase, we advanced to a second phase, incorporating facial recognition technology to improve identification accuracy. We are also implementing a Delphi consensus method to validate the welfare inferences arising from the results of the coded processes, ensuring robust and reliable data collection. By gathering extensive video data from Adelaide Zoo, we aim to refine our analytical models and establish a comprehensive behavioural assessment framework. This multidisciplinary approach not only enhances the monitoring of orangutans but also sets a precedent for similar studies across various species, ultimately contributing to improved animal welfare practices in zoos and for ex situ animals more generally. This collaboration between engineering, veterinary science, and animal care professionals is pivotal in advancing our understanding of animal welfare, leading to more informed assessments and more effective management of the welfare of zoo animals.

Does flight restriction affect the behavior of waterfowl in zoos in ways that impact animal welfare?

David M. Powell, Eli Baskir, Beth Stark-Posta, and Monica Blackwell

The impact of flight restriction on the welfare of captive birds has been long debated. We conducted studies at two zoos on multiple flighted and flight-restricted waterfowl species. In study one involving non-individually identifiable birds, we found that flight behavior was rare but was more common in on open lakes compared to an aviary where there was space for flight. Enclosure type (lake or aviary) and associated husbandry appeared to impact behavior more than flight status, as observations of the same, flighted species in both habitats revealed more foraging and aggressive behavior on lakes and more resting, preening, swimming and non-aggressive social behavior in the aviary. In study two involving individually identifiable mandarin ducks *(Aix galericulata),* we found that flight status only affected swimming and vocalization behavior, with flighted birds swimming more than flight-restricted birds and flight-restricted birds vocalizing more than flighted birds. There were sex, time of day, and seasonal effects on behavior. There were no differences in body weight, morbidity, or mortality between flighted and flight-restricted birds in study two. Flight and flight attempt behaviors were rare in both studies and varied with enclosure type. We conclude that flight restriction results in limited behavioral differences and no effects on health, and thus has minimal, if any, effect on behavioral and health indicators of welfare in waterfowl species.

From hatch to fledge: growth and development of sihek chicks at Brookfield Zoo Chicago

Margaret Ramont, Cody Hickman, Tim Snyder, Sathya K. Chinnadurai, and Lance J. Miller

The sihek (Guam kingfisher, *(Todiramphus cinnamominus)* has persisted entirely in managed care since the breeding program was established in the 1980s. Understanding the growth and developmental milestones of the sihek from hatch to fledging is critical to enhancing conservation efforts and improving management practices that promote positive welfare. In this study, we summarized data collected on the growth patterns, developmental milestones, sex differences, and rearing differences in sihek chicks raised at Brookfield Zoo Chicago from 1989-2023. We found that female chicks were significantly larger than males at fledging, although pre-fledging growth curves did not differ by sex. In addition, hand-reared chicks reached fledging significantly earlier than those supplemented/parent reared. Additionally, we found that hatch weight was a significant predictor of survival to fledging, highlighting the importance of collecting weight data at all stages of life. These insights into sihek development in managed care provide invaluable data for the development of welfare-focused management practices that improve the success of conservation efforts while also prioritizing the wellbeing of each individual chick.

More than meets the eye: The Impact of environmental conditions on pinniped behavior

Charles P. Ritzler and Lance J. Miller

Zoo-housed pinnipeds are well-known to develop optical pathologies (Colitz et al., 2010; Miller et al., 2012). Pinniped eyes are adapted for low light, underwater conditions (Nakamura et al., 2021), but these species' management and housing in zoos regularly expose them to lighting situations and contexts that may be atypical from their natural history. Recent survey work has indicated that pinniped eye issues have been correlated with behavioral (aggression, public presentations), physiological (history of eye disease, leptosprirosis), and environmental (pool salinity, UV index, pool paint color) variables (Colitz et al., 2019; Nakamura et al., 2021). Brookfield Zoo Chicago is currently conducting a study of 2.6 California sea lions and 3.3 grey seals examining how environmental variables that have correlated with optical issues (shade availability, surface temperature, UV index, and light reflectance value) vary over the course of one year, and how that variance affects pinniped space use and behavior. Behavior observations are conducted every two weeks, with group level data, as well as the current shade conditions, collected three times per day. In conjunction with the three behavior observation sessions, surface temperature is collected across 10 different zones in each of the four pinniped habitats, as well as UVA and UVB index. Finally, light reflectance values (LRV), collected via a handheld colorimeter, of four different paint colors are collected from saturated areas of the deck to simulate the reflectance experienced underwater in the habitats' pools. These data will provide further insight into the connection between zoo housing conditions and pinniped optical pathologies, potentially allowing zoos to make renovations or design choices in future spaces optimize the health and welfare of their pinnipeds. This presentation will specifically discuss the results of the first half of the study, started in October 2024, and plans going forward.

Inferring welfare changes with age-correlating flamingo life stages with potential welfare predictors

Paul E. Rose and Sunyeong Lee

Zoos can artificially inflate the lifespans of animals in their care. Evaluation of care needs for elderly individuals is important to protect positive welfare states and keep quality of life (on balance) good. Some species naturally live for many decades, and we should be mindful of how such animals present signs of aging. Flamingos (Phoenicopteriformes) are an example of long-lived bird that is commonly housed in zoos. We investigated age-related changes to behaviour and physical condition within several flocks of captive flamingos. By observing 75 flamingos from five species across different age groups—young, middle-aged, and old—we aimed to identify age-related changes in activity levels, body condition, enclosure usage and social (flock) position. Our results revealed significant age-related differences in preening and sitting behaviours. Physical condition, including locomotion, balance, plumage quality, and neck visibility, all declined with age, suggesting that such visible signs of aging could indicate health status. A Principal Component Analysis identified key predictors between behaviours and physical conditions that could be grouped to illustrate important components of flamingo welfare. Our analysis revealed strong associations between

body condition descriptors and behaviours. These results underscore the importance of using multiple indicators of bird welfare assessment and the need for species-specific, evidence-based approaches in animal care in zoos (especially for geriatric individuals and those entering senescence). We hope that our approach of developing observational techniques to identify potential physical and behavioural indicators of bird welfare could be extended for use in other long-lived birds housed in ex situ facilities.

Beyond stereotypies: Increased activity as a subtle indicator of welfare in captive elasmobranchs

Sandra M. Troxell-Smith, Alexis M. Hart, Jordyn Truax, Eness Meri, Zac Reynolds, and Jennifer Vonk

While stereotypic behavior has long been used as a primary indicator of welfare concern in captive animals, more subtle behavioral signs may also be important to monitor, particularly in under-researched species. Elasmobranchs, including sharks and rays, are significantly underrepresented in behavioral and welfare research, despite their obvious popularity in aquariums and zoos. Here, results of a two case studies will be presented (one focused on a dogfish shark, and one evaluating several species of rays) that suggest that increased overall activity in response to environmental and crowd size variables may provide a subtle indication of negative welfare state in elasmobranchs. Importantly, these trends are individually based, also highlighting the importance of monitoring welfare at an individual, rather than species level. While more research is needed to fully determine whether activity increases may be considered positive or negative in these species, we nevertheless suggest that changes in activity levels should be monitored in addition to more conspicuous stereotypic behaviors in future elasmobranch welfare research. Understanding species natural history, and monitoring a breadth of biologically relevant welfare indicators (including subtle ones) is essential for improving management practices and welfare standards for elasmobranchs under human care.

ZooMood: a rapid assessment to measure zoo animal welfare

Samantha J. Ward and Jeroen Stevens

Animal welfare in zoological settings has emerged as a critical priority, driven by evolving societal ethics, legal frameworks, and increasingly stringent requirements from national and international zoo associations. Despite growing recognition of welfare importance, significant challenges persist, particularly for smaller zoos with limited resources and expertise and managing to keep abreast of advancements in welfare science. One area of advancing zoo animal welfare research lies within qualitative behaviour assessment (QBA), whereby animal-based adjectives are scored to produce data linked to Mellor's fifth domain (mental state). Whilst this method is successful, it has not yet been applied widely across zoos. This research introduces 'ZooMood', an innovative mobile application designed to democratise advanced animal welfare assessment through a user-friendly, scientifically validated qualitative behavioural assessment (QBA) platform. Leveraging Mellor's fifth domain of animal welfare (mental state), ZooMood provides a rapid, comprehensive welfare evaluation tool for all animal-facing zoo staff. The app enables quick, systematic scoring using 16 validated behavioural descriptors, allowing assessments to be completed in under two minutes without direct continuous observation. Preliminary data demonstrates the app's efficiency and potential to transform welfare monitoring across diverse zoological settings. Zoos are now being recruited to allow for the next stage of testing across different countries as well as languages. This will highlight ZooMood's potential to standardise and streamline animal welfare assessment, particularly for institutions with limited specialised resources. This approach represents a significant advancement in making sophisticated welfare monitoring accessible, efficient, and actionable across the zoological community.

Factors shaping giraffe behavior in U.S. zoos: A multi-institutional study

Jason D. Wark and Katherine A. Cronin

Giraffes are an iconic species and one of the most commonly housed megafauna in zoos. Past multi-institutional efforts have expanded our knowledge of giraffes but, as these studies have often included a small number of zoos or brief data collection periods, our broader understanding of factors that influence giraffe behavior remains incomplete. In this study, we observed the behavior of giraffes (n=66) across AZA-accredited zoos (n=18) over the course of one-year to identify significant predictors of behavior. Specifically, we evaluated organizational factors related to husbandry and care (habitat size, herd size, public feeding opportunities), temporal factor (time of day), environmental factors (temperature and weather), and individual factors (age, sex) using generalized linear mixed effects models. Separate models were constructed for each study behavior (browsing, extractive foraging, other feeding, ruminating, oral stereotypy, inactive, and locomotion) for observation sessions when giraffes were housed exclusively outdoors (n=6,507) and indoors (n=1,823). Across models, the most common significant predictors of behavior were time and temperature. Organizational and individual factors played a smaller role in giraffe behavior. Although habitat size varied drastically across study zoos, with the largest habitat being more than 500 times bigger than the smallest, this did not appear to have a significant impact on most behaviors, with only some differences in feeding behaviors being observed. Similar to other studies, the time spent displaying oral stereotypic behaviors was negatively correlated with time spent in feeding behaviors, reinforcing the importance of promoting feeding and foraging behaviors in giraffes. We discuss these results in detail and their implications for giraffe care.

Measuring the Mental – The three needs model of animal welfare

Jason V. Watters

Animal welfare science and application is prone to short bursts of progress – usually centered around a new welfare model – followed by extended periods of status quo wherein the prominent model makes no further progress as it appears to have an insurmountable weakness. Many practitioners indicate that the mental domain of the Five Domains model of animal welfare is immeasurable. Those applying this model sometimes revert to measuring provisioning in the four domains indicative of animals' physical state. The mental state is then inferred based on the assumed emotional outcomes of these first four domains. Particularly in good zoos, it can be easy to overestimate individuals' welfare as the provisioned environment may be rich with ample substrate for potential positive welfare – whether the animal emotionally benefits from it or not. Core, evolutionarily old emotions are both mechanisms and outcomes of behavior. As such, expressed behavior is the key to understanding the mental state. The Three Needs model posits that animals need to investigate, acquire rewards, and manage their own processes to achieve a positive welfare state. Meeting each of the three Needs results in positive affect, and behaviors associated with doing so are observable. A comprehensive observation program can thus measure individuals' mood-like state (long-term affect).

Investigating the impact of sound enrichment in two species of Lemur *(V. rubra and L. catta)* based on physiological and behavioral responses - a pilot study

Laurel B. F. Westcott, Jason DeLibero, Asaba Mukobi, Becca Van Beek, Kate Gilmore, and Nadja Wielebnowski

The influence of various types of sounds as a potential source of enrichment was investigated for two species of lemur: ring-tailed lemur *(Lemur catta)* and red-ruffed lemur *(Varecia rubra).* Three sound types were used as possible enrichment: spoken word, generic rainforest noise, and species-specific lemur call-backs. Behavioral responses and fecal glucocorticoid metabolite (fGM) concentrations were recorded between September 2020 and January 2021, and results associated with each sound type were compared against each other and against periods of silence. There were significant differences in exhibit use based on sound type, as well as some minor, yet also significant, differences in behavior responses, but no significant correlation between fGM concentrations and sound type. However, variability in weather with cold and rainy days during the study period may have had a significant impact on behavior and/or exhibit use responses. A repetition of this study in warmer weather was conducted in 2023 and data analyses are currently underway to provide a more definitive impact of sound type.

Education-based efforts to mitigate negative effects of visitor glass tapping on welfare of zoo-housed reptiles

Sara Zalewski, Kylen N. Gartland, Bradley Barr, Jennifer Hamilton, and Grace Fuller

Visitor presence can result in visual and auditory stimuli potentially aversive to animals living in zoos and aquariums. Visitors may engage in inappropriate behaviors, one of the most prominent of which is glass tapping. This study aimed to explore the impact of glass tapping on indicators of welfare in reptiles residing at the Detroit Zoo, as well as evaluate the effectiveness of prohibitive versus empathetic signage on mitigating the frequency and intensity of glass tapping. We collected behavioral data using 10-minute live focal follows with 1-minute instantaneous scans in 2022 and 2023 for a total of 197.3 hours of data with even sampling across the two signage conditions. Behaviors were recorded for eight individuals representing five species across three reptile orders. Average hourly rates of both loud ($r=0.48$. $N=1571$, $p<0.0001$) and silent ($r=0.79$, $N=1571$, $p<0.0001$) glass tapping increased with crowd size. Rates of both loud ($S=553933.50$, $Z=-7.09$, $p<0.0001$) and silent ($S=506461.00$, $Z=-10.91$, $p<0.0001$) glass tapping were significantly lower in the empathy signage condition compared to the prohibitive signage condition. Guest behavior and density also had a measurable impact on reptile behavior. The glass lizards *(Pseudopus apodus)* spent less time investigating with increased silent glass tapping and crowd sizes. The Arrau turtle *(Podocnemis expansa)* spent less time investigating as the rate of loud glass tapping increased. The Catalina Island rattlesnake *(Crotalus catalinensis)* and the dwarf caiman *(Paleosuchus palpebrosus)* demonstrated a trend towards increased inactivity with increased silent glass tapping. Although these results are promising, many shifts in animal behavior between signage conditions did not reach statistical significance. This suggests that the presence of signage may have positively impacted guest behavior, but the reduction of glass tapping may not have reached a threshold where we can see demonstrable improvements in animal welfare.

Poster Presentations

1. Developing a cognitive bias test for orangutans

Eridia Pacheco and Marieke Gartner

Cognitive bias testing is a noninvasive method for assessing emotional states by evaluating how emotions influence decision-making in animals. This method is useful for advancing animal welfare in zoos, where understanding emotional wellbeing is essential to improving care and management. Cognitive bias involves training individuals on two distinct cues, signaling a positive outcome (e.g., food reinforcement) and a negative outcome (no reinforcement). Once the animals have learned these cues, we can begin testing and introduce an ambiguous cue. The animals will respond optimistically or pessimistically, providing insight into their emotional state. After individuals complete the training phase, the test is quick and can be conducted when needed, making it a flexible tool for ongoing, noninvasive welfare monitoring. This study explores the feasibility of using cognitive bias with orangutans, examining how personality integrates with results and comparing them to subjective wellbeing assessments. Preliminary testing at Zoo Atlanta with two orangutans revealed challenges with traditional methods, as the individuals could not get past the training phase. We revised methodologies and advanced three individuals through training to the testing phase, ultimately testing their response to ambiguous cues. Cognitive bias testing can support personalized care by providing efficient and individualized insights into emotional states.

2. Is oxytocin a relevant indicator of prosocial behavior in ex situ rhinos?

Drew M. Arbogast, Kelly Chimpen Mac Leod, Louisa A. Rispoli, Terri L. Roth, Lara C. Metrione, and Elizabeth W. Freeman

The neuropeptide hormone oxytocin facilitates reproductive and prosocial behaviors and may also regulate stress and psychological state, making oxytocin a potentially useful positive indicator of animal wellbeing. This study used a previously validated enzyme immunoassay (Arbor Assays, Ann Arbor, MI) to measure plasma oxytocin concentrations across ex situ populations of the critically endangered black rhino *(Diceros bicornis)* and near-threatened white rhino *(Ceratotherium simum)*. Monthly samples from black (n=20M.18F)

and white (n=22M.42F) rhinos across 34 North American facilities were collected for one year. Samples were extracted via acetonitrile protein precipitation and assayed in duplicate. Inter- and intra-assay CVs were <15%, and quality control samples extracted consistently (CV<14%; n=23). Freeze-thaw trials showed minimal variation, with consistent oxytocin concentrations observed after six freeze-thaw cycles (CV=9.7%). Linear mixed models explored potential relationships between species, sex, age, and subjective rhino temperament scores from caregivers. Preliminary results showed a positive relationship between affiliative score towards humans and oxytocin in black rhinos ($p<0.05$), suggesting the potential importance of human-rhino relationships in a species historically managed as solitary. In socially-housed white rhinos, an interaction between age and sex ($p<0.05$) influenced oxytocin such that concentrations increased with age in females but decreased in males. This result may reflect the natural history of females to establish companionship with subadults and other females, while adult bulls tend to have more transient interactions. Results warrant further investigation of alternative explanatory variables (e.g., behavioral frequencies, socio-environmental conditions) for a better understanding of how oxytocin may reflect the social wellbeing of rhinos in human care.

3. Do abnormal behaviors statistically co-occur in adult chimpanzees?

Jessica C. Whitham, Katie Hall, and Lance J. Miller

For years, welfare researchers have made a concerted effort to mitigate the abnormal behaviors performed by professionally managed chimpanzees. Traditionally, welfare scientists pool abnormal behaviors (e.g. abnormal stances/postures, repetitive stereotypic behaviors) into subcategories to design user-friendly, practical welfare assessments. However, pooling may lead to the development of heterogeneous subcategories comprised of behaviors that do not statistically co-occur. The current study investigated the co-occurrence of abnormal behaviors in adult chimpanzees by collecting data on 41 subjects residing in 16 facilities accredited by the Association of Zoos and Aquariums. We utilized both regression analyses and principal component analysis (PCA) to examine the following abnormal behaviors: self-directed hair pluck, idiosyncratic body manipulations (e.g. self-patting, eye-poking), and idiosyncratic movements/postures (e.g. head-bobbing, rocking). We discovered: 1) no significant relationships between the behaviors when conducting regression analyses, 2) none of these behaviors loaded on to the same PCA component. These results indicate that self-directed hair pluck, idiosyncratic body manipulations, and idiosyncratic movements/postures do not statistically co-occur and are therefore heterogeneous. The lack of positive relationships suggests that the abnormal behaviors examined in this study may have unique triggers and treatments. Therefore, researchers should score/analyze these behaviors separately in future studies of chimpanzees. Ultimately, the goal is to identify the triggers for specific abnormal behaviors and to then introduce tailored interventions to the environment and/or husbandry routine.

4. Attempting to redirect feather destructive behavior: Providing tailored enrichments utilizing 3D printing

Emily R Walco and Bethany L Krebs

Feather destructive behaviors can be a form of 'self-soothing' for animals engaging in them, and as such can be hard to decrease or eliminate entirely. Often these types of behavior are problem of degree rather than the behavior itself being problematic. Grooming and preening behaviors are normal and necessary, however over expression of these behaviors can be cause for concern. If the animal has other outlets to express the behavior that directs it away from their own body (or that of a conspecific, as in one case presented here), this can provide a needed behavioral outlet for the individual while decreasing the frequency at which the behavior is self- or conspecific-directed. We designed and presented enrichment items, including 3D-printed designs, to animals in hopes of providing an alternative outlet for feather destructive behavior that allows them to engage in their self-soothing behavior without the potential for injury or damage. We present preliminary data on several case studies of providing 3D-printed enrichments to animals exhibiting feather destructive behaviors.

5. Developing a welfare strategy at Dublin Zoo

Lucy Rutherford

It is the responsibility of zoos to evaluate and understand the welfare of animals housed in their care. Animal welfare is a fast-growing science and remains a top priority and research area wzithin zoos. Historically, physical health and the minimisation of poor welfare states were seen as the sole components of animal welfare assessments. In recent years, there has been a shift towards emphasising the promotion of positive welfare states. The notion that animals should be "thriving, not just surviving" is apparent both within the literature and across the zoo community. This Strategy was created as a way of enhancing Dublin Zoo's commitment to animal welfare and to highlight the steps we are taking to ensure high standards of welfare for the animals housed in our care. This Strategy sets out the goals that we aim to achieve by 2031 which is our bicentennial. One of the first steps in developing a Welfare Strategy has been to decide upon our definition of welfare. Existing definitions of animal welfare such as "How an animal is coping with the conditions in which it lives, subjective feelings and experiences, physical health" (WAZA, 2016); "The state of being comfortable, healthy or happy" (AZA, 2022) and "How well an individual fares of goes through life" (Broom, 2022) were reviewed. This Strategy has been developed collaboratively alongside members of the veterinary and animal care teams at Dublin Zoo.

6. Incorporating personality for positive zoo animal welfare

Lucy Rutherford, Lindsay Murray, Lisa Holmes, and Ellen Williams

Personality is the essence of individuality in animals. It affects individual behaviours, perceptions and lived experiences. Being able to reliably assess personality in animals holds the key to understanding individual differences. Application of this knowledge is a key consideration for the provision of individual-level management of animals. A key aspect of the definition of animal personality is 'consistency over time'. Yet, despite the range of studies assessing elephant personality, there is a lack of consistency within methodologies and personality is usually assessed at a single point in time. Here, we examine personality data from adult members of the Asian elephant *(Elephas maximus)* herd at Chester Zoo at five separate time points, across a ten-year period (2013 – 2023). Data were analysed in terms of the instruments used to measure personality (differences in questions/items across assessments, presentation of the personality assessments, raters), and changes over time in elephant personality assessment scores. This presentation will consider key findings from this work including personality adjectives and factors affecting inter-rater reliability of the tools. It will conclude by discussing how these findings have contributed to PhD research conducted in collaboration with Dublin Zoo which is focused on the development of a novel personality and welfare tool to assess the lived experience of elephants in human care. Preliminary data on keeper perceptions at Dublin Zoo of what constitutes positive elephant welfare will be discussed. Catering for animals on an individual basis is paramount in evidence-based management of animals. Inter-rater reliability across personality adjectives is highest when keepers are involved in scale development, reinforcing the importance of collaboration between scientists and animal caregivers in building tools for evidence-based management decisions over the lifetime of animals.

7. Understanding red panda *(Ailurus spp.)* wellbeing through personality: Utilizing keeper-completed questionnaires to characterize temperament

Sarah M. Huskisson, Kristina M. Delaski, Nucharin Songsasen, and Elizabeth W. Freeman

Red pandas *(Ailurus spp.)* are commonly managed in zoos as part of conservation programs but can be sensitive to the array of environmental variables (e.g., noise) present in such settings. Individual differences in personality can influence how animals interact with and respond to their environments, making the evaluation of personality a crucial aspect of managing animal wellbeing. In this study, we sought to characterize red panda personality with temperament assessment questionnaires completed by animal care staff. For these assessments, adult red pandas (1 year of age or older) were scored across 29 traits by a minimum of two animal care staff members. Ratings for each trait were assigned on a scale ranging from 0 (never performs the behavior) to 10 (always performs the behavior). Data collection is still underway for this study. Results will be analyzed with a principal component analysis (PCA), using the medians of each individual's ratings. To the best of our knowledge, these methods have not yet been employed to evaluate red panda personality. This research, therefore, may provide additional insights into managing the wellbeing of red pandas in human care.

8. The ruture of ambassador animal care: a holistic approach to welfare with welfare assessments and nonlinear analysis

Brittany Brown and Kyle Hetzel

Improving animal welfare is a critical objective in both ethical and practical terms, particularly in environments where animals participate in daily ambassador work. Enhancing animal welfare through utilization of welfare assessments provides a structured and evidence-based framework for identifying the needs, behaviors, and conditions of animals. These assessments can guide improvements in housing, care, and management practices by ensuring that animals' physical and psychological needs are met concurrently. When multiple welfare challenges are identified, changing one factor at a time maybe the initial solution applied by welfare practitioners. We argue that when the goal is to improve welfare, trying multiple interventions at once is called for. While welfare assessments contribute to the understanding and the enhancement of animal welfare through objective evaluation, they are most often utilized at the end of animal's life, as opposed to at the start of a behavioral change. A case study at Oakland Zoo's petting yard, which is home to 15 goats and 3 sheep, utilized welfare assessments as a tool in conjunction with nonlinear contingency analysis. Nonlinear contingency analysis aims to understand the complex interactions between multiple variables that contribute to, and maintain, a learner's behavior. It recognizes that relationships between variables and behavior can be interconnected and complex. Ambassador animals in petting yard settings can be exposed to various stressful events such as traditional livestock handling which relies on manual restraint and herd management instead of the individual. By increasing opportunities for choice, and a deeper understanding of these nonlinear contingencies, keepers identified subtle, yet critical stressors and benefits in animal habitats, leading to development of more effective interventions and management strategies. These changes, supported by data, showed animals exhibited less boredom, stress, and frustration related behaviors, leading to improved overall mental and physical wellbeing. As more zoos begin to focus on ambassador animals and their welfare it is becoming more apparent that proactive welfare assessments paired with a nonlinear contingency analysis is paramount.

9. Current captive species management- a worry for waterbirds?

Robert Kelly and Paul Rose

Behavioural ecology must synergise with captive management to ensure enclosure design and husbandry supports species' ecological needs and promotes natural behaviour. Despite waterbird (e.g. Anseriformes and Phoenicopteriformes) prevalence in captivity, research into current management practice impacts on behaviour and welfare are overlooked in favour of more charismatic species, including primates. Understanding waterbird natural history is also vital for reproduction. For instance, housing flamingos in flocks encourages synchronised group display performances critical for reproductive success. However, identifying enclosure features necessary to support natural behaviours, whilst considering factors like restricted flight remains to be explored. Zoo stakeholders, with their acquired expertise can help determine which enclosure design features are most important, and why natural behaviour can infer bird welfare states. By utilising a choice-based conjoint analysis survey, we aim to capture the perceptions of captive waterbird stakeholders (e.g. private keepers and zoo professionals) to understand whether captive waterbird needs are promoted in current management practices. Survey participants select a full-profile concept based on combinations of levels (e.g. diet adequacy) within ten enclosure design and husbandry attributes, including diet. The results yielded utility and importance values, indicating the perceived importance of levels within each attribute, and overall importance of each included attribute. Preliminary data from all respondents indicates that areas to seek refuge within the enclosure and enclosure size are the most prioritised features. The findings will help assess current waterbird management practices and provide zoos with the insights needed to develop more standardised, science-based approaches to enclosure design and husbandry. This will support zoo professionals at the core of captive waterbird care and enhance conservation efforts.

10. Challenges and opportunities in understudied species research: An AZA survey on reptiles and amphibians

Jason D. Wark, Darren E. Minier, Jennifer Hamilton, Louisa M. Radosevich, Clara Arndtsen, Erika Bauer, and Candice Dorsey

There has been increasing interest in the wellbeing of reptiles and amphibians by zoos and aquariums in the AZA. These species and other non-mammalian

taxa have historically received less research attention as compared to mammals and have been described collectively as "understudied species". Although many reasons exist for why research on understudied species may have lagged, two important considerations are the unique technical (i.e., how do you identify welfare) and perceptual (i.e., do welfare concerns exist) challenges faced by these species. To explore these topics and potential opportunities for research, a survey was sent to researchers and animal care staff at AZA-accredited zoos and aquariums. This survey focused on factors influencing research on reptiles and amphibians, as a pilot investigation suggested a discrepancy between these taxa. The survey closed in January 2025. Data analysis is in progress and preliminary findings will be shared first with symposium attendees. We hope this evaluation can broaden our understanding of current views and practices toward reptiles and amphibians and guide future research efforts.

11. Snakes in the glass: Do ambush and pursuit predators use hides differently when presented with prey versus predator sounds?

Jennifer Vonk, Amity Jordan, Jacob Pappas, David Leibowitz, and Nyla Griffin

It is important that snakes are provisioned with a safe place to hide in their habitats given the noise that is prevalent in captive settings. Little is known about how snakes perceive and respond to sound. We observed 16 snakes of 11 species that could be classified as ambush or pursuit predators for the use of their hides when presented with the sounds of prey and predator species. We presented eight sounds (frogs and mice for prey and hawks and wolves for predators along with control sounds from the same species that were matched in pitch and frequency) across a series of 16 four-trial sessions. On each session, the snakes were presented with one predator and one prey sound along with their controls. We predicted that ambush predators would enter their hides when they heard both prey and predator sounds and that pursuit predators would enter their hides when they heard predators but exit their hides when they heard prey sounds. Control sounds were used to provide a better understanding of the features of the stimulus that might prompt behavior given how little is known about snakes' response to auditory stimuli. Although the snakes were largely inactive, we found that all snakes froze more, were more likely to be in their hides, and were less likely to make any response for animal versus control sounds. Contrary to predictions, they did not respond differently to prey versus predator sounds. Ambush and pursuit predators differed in their responses to the stimuli but these differences did not reach significance. Future work on snakes' response to auditory stimuli is needed as sounds may cause stress in captive settings.

12. Digging into naked mole-rat care: Opportunities to promote natural behavior through habitat design

Natasha K. Wierzal, Lou Keeley, Mason Fidino, and Katherine A. Cronin

Designing appropriate zoo habitats for fossorial species can be challenging as digging, a highly motivated behavior, can be destructive in zoo environments. This is particularly true for naked mole rats *(Heterocephalus glaber)*, who, like other rodents, have extremely strong incisors and are capable of chewing through stone. Recently, we evaluated the impact of a dig pit on naked mole rat behavior (Wierzal et al., 2024). We found that when given access to moveable substrate, either in the form of loose substrate or a dig pit of hard-packed clay for tunnel excavation, frustrated, barrier-directed behaviors and aggressive social interactions decreased, and exploratory behaviors and affiliative social interactions increased. Here, we discuss different considerations in habitat design for naked mole rats, including the construction of dig pits and appropriate lighting. In addition, we present new information on carbon dioxide levels in naked mole rat habitats, an understudied environmental parameter that may be important for this species. Though naked mole rats are an especially unique species, many of these findings may be beneficial for other fossorial species.

13. Feeder animal welfare: A new frontier

Shannon O'Brien

Feeder animals (live animals that are used as food for other animals) often far exceed the number of collection animals in a zoo or aquarium. As an example, at Lincoln Park Zoo tens of thousands of live invertebrates are delivered to the zoo each week. Feeder animals are typically in a zoo's care for a brief amount of time (a couple of days to weeks); however, the sheer volume of animals provides a unique opportunity to make a large positive welfare impact. Lincoln Park Zoo recently created a Welfare Discussion Tool for feeder animals, one for invertebrates and one for fish with the goal of refining feeder animal care and enhancing their

welfare. Implementation of the tool for feeder animals revealed that welfare scores varied markedly across the zoo and across species, which led to the revision of care protocols for feeder animals. This presentation will cover the process, challenges, and successes of developing and implementing welfare assessments for feeder animals.

14. The provision of browse and its impacts on the health and welfare of animals at the zoo

Margaret Ramont, Nicole Principe, Rachel Prostko, Jennifer Watts, Sathya K. Chinnadurai, and Lance J. Miller

Browsers are animals that consume significant proportions of leaves, twigs, and bark from woody plants. These species have evolved morphological, physiological, and behavioral adaptations to subsist on a specialized diet. In zoos and other managed care facilities, the provision of browse in appropriate amounts helps promote positive animal welfare. Feeding on browse fulfils behavioral needs and reduces stereotypies, promotes satiety, and provides opportunities for dietary choice and control. However, there are several obstacles that can prevent institutions from providing browse, including physical and chemical hazards, palatability issues, and the difficulty in quantifying the nutritional value of browse. In addition, providing large enough quantities of browse can be challenging, and fresh browse may be especially difficult to provide for zoos in temperate climates. We describe the methods currently utilized to preserve browse and discuss their strengths and weaknesses. We recommend areas of future research for browse provision in zoos.

15. Progress towards 24/7 wellbeing

Joseph Golden

Over the last two years, The Maryland Zoo has begun developing programs designed to evaluate and improve animal wellbeing on a 24/7 schedule. When beginning this process, the zoo identified two major challenges. The first challenge was our inability to know what the animals are doing when staff aren't physically present. This led to the installation of cameras across the zoo and implementation of a volunteer/intern program that would review the footage and collect data. The second challenge we faced was that the environments that we provide for our animals are static when we are absent, consequently offering less reinforcers relative to when we are present. To combat this challenge, we established an engineering program with the mission of developing and innovating technology that would lead to dynamic animal environments. Examples of developed technology include timed feeders, data loggers that evaluate enrichment, and automated experiences that allow the animal to control outcomes in their environment over the entire course of a day.

16. Bridging boundaries: Transdisciplinary approaches to zoo animal welfare research and education

Alexandra L. Whittaker, Justine Partoon, and Kim Harvey

This case study describes a transdisciplinary collaboration that brought together engineers, animal scientists, and keepers to design, for a range of zoo-based projects encompassing the creation of enrichment devices, and providing alternate strategies for encouraging natural behaviors. The project demonstrates a successful collaboration between an academic institution and zoological park, with multiple groups of students interacting with, and learning from different groups of stakeholders. The presentation will describe the approach taken, lessons learned and suggestions for others embarking on these sorts of collaborations. The projects began with joint workshops, where animal scientists shared behavioral insights. Engineering students then brainstormed ideas for devices and methods considering the behavioural domains we wished to encourage and sought further guidance from keeping staff. Then prototype devices was created with the aim of encouraging problem-solving, cooperative behaviour and mimicking natural behaviors, creating opportunities for extended engagement. Current studies utilise behavioral assessment on the animals' engagement with the device, time-budget changes, and habituation to the devices. This involves conducting baseline measures, followed by recording of engagement frequency, types of enrichment interaction, and other behavioural indicators, such as play and social interactions, using an ethogram-based approach. Qualitative studies will explore staff perception of the value of the devices for animal welfare, and feasibility for use in the exhibit. These projects underscore the value of a transdisciplinary approach in zoo animal welfare, where insights from a multi-stakeholder group converge to improve captive animal experiences and provide evidence-based approaches to animal care.

17. Social bonds and sudden losses: behavioral change across taxa after the death of a conspecific

Alexis Hart and Aimee McDonnell

As the population of zoo animals in the United States continues to age, many facilities are learning how to handle animal deaths and their impacts on staff as well as other conspecifics. While the zoo community is starting to learn how animal carers cope with these losses, something than remains largely unaddressed is how animals respond to the death of a member of their social group, especially in non-primate species. This study examined the changes in overall behavior in four species after the death of a conspecific: two African lions *(Panethera leo)* after the death of their mother, two female Grevy's zebras *(Equus grevyi)* after the death of a male conspecific, seven reticulated giraffes *(Giraffe reticulata)* after the death of the oldest individual in the herd, and a female rhinoceros hornbill *(Buceros rhinoceros)* following the death of her mate. All individuals in this study had baseline behavioral data collected for other research projects, which allowed for pre- and post-death comparisons of the focal individuals after these unexpected losses. When examining the species and their various social patterns, our results varied from being expected to unexpected based on natural and individual history. This study suggests that animal species may be affected by death more than previously thought, and extra attention should be paid to the behavior of zoo animals after a member of their social group passes.

18. Progress in species-specific welfare assessments at the zoo: findings from a decade of applying the C-Well Assessment

Isabella L. K. Clegg and Rhiannon L. Schultz

Welfare assessments for zoo animals vary from multi-species risk evaluations to species-specific, animal-based assessments. The latter have traditionally been more challenging to develop and implement, primarily due to the need for time-intensive data collection and difficulties with standardisation. The Cetacean Welfare Assessment (C-Well), established a decade ago, has been applied globally more than 30 times across five cetacean species, with several facilities conducting repeated assessments. Here we describe the first results and detail how the framework has evolved over a 10-year period. Results indicate that overall C-Well scores increased with repeated assessments, and were also significantly correlated with increased pool volume per animal, higher group sizes, and higher affiliative behaviour frequencies. We summarise the updates made to the C-Well in line with the latest research, and describe how the approach has been adapted to non-cetacean species to form a series of "Zoo-Well" assessments. By sharing our experiences from repeated applications of the C-Well and Zoo-Well frameworks, we aim to support similar efforts that collect animal-based welfare data in order to improve welfare outcomes.

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