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Perspective

The Zoo Sphere of Influence Model

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ABSTRACT

In January 2023 we proposed the Zoo Sphere of Influence, a new model to represent the value of zoos/aquariums for species and society. This model set out to replace the 50-year-old perception of zoos/aquariums as fulfilling only the objectives of conservation, education, research, and recreation, and instead demonstrate the broad range of impacts zoos/aquariums have for species and society. The Zoo Sphere of Influence Model considers zoos/aquariums working at different scales (from local to international) and acknowledges a wide range of areas

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Aquarium
Role of zoos/aquariums

that they work. In addition to a visual representation of the value of zoos/aquariums, the initial paper proposed a proof-of-concept evaluation matrix that they could use to self-assess impact. Over a fifteen-month period, we trialled and developed the proposed model and assessment matrix through a global consultation and piloting process (this included piloting at 12 zoos, 5 international workshops/demos and a feedback survey that ran for 7 months). We have updated the model to include new sections on Indigenous Peoples & Local Communities (IP & LCs); Sustainability; and Diversity, Equity, Access, and Inclusion (DEAI). We have additionally updated the assessment criteria to incorporate key zoo/aquarium documents and have added a Core Values section reflecting the fundamental standards conservation zoos/aquariums should be fulfilling. This paper presents the updated version of the Zoo Sphere of Influence. We hope that the model will help zoos/ aquariums achieve the highest possible standard of practice and provide a means of recognising and celebrating these achievements.

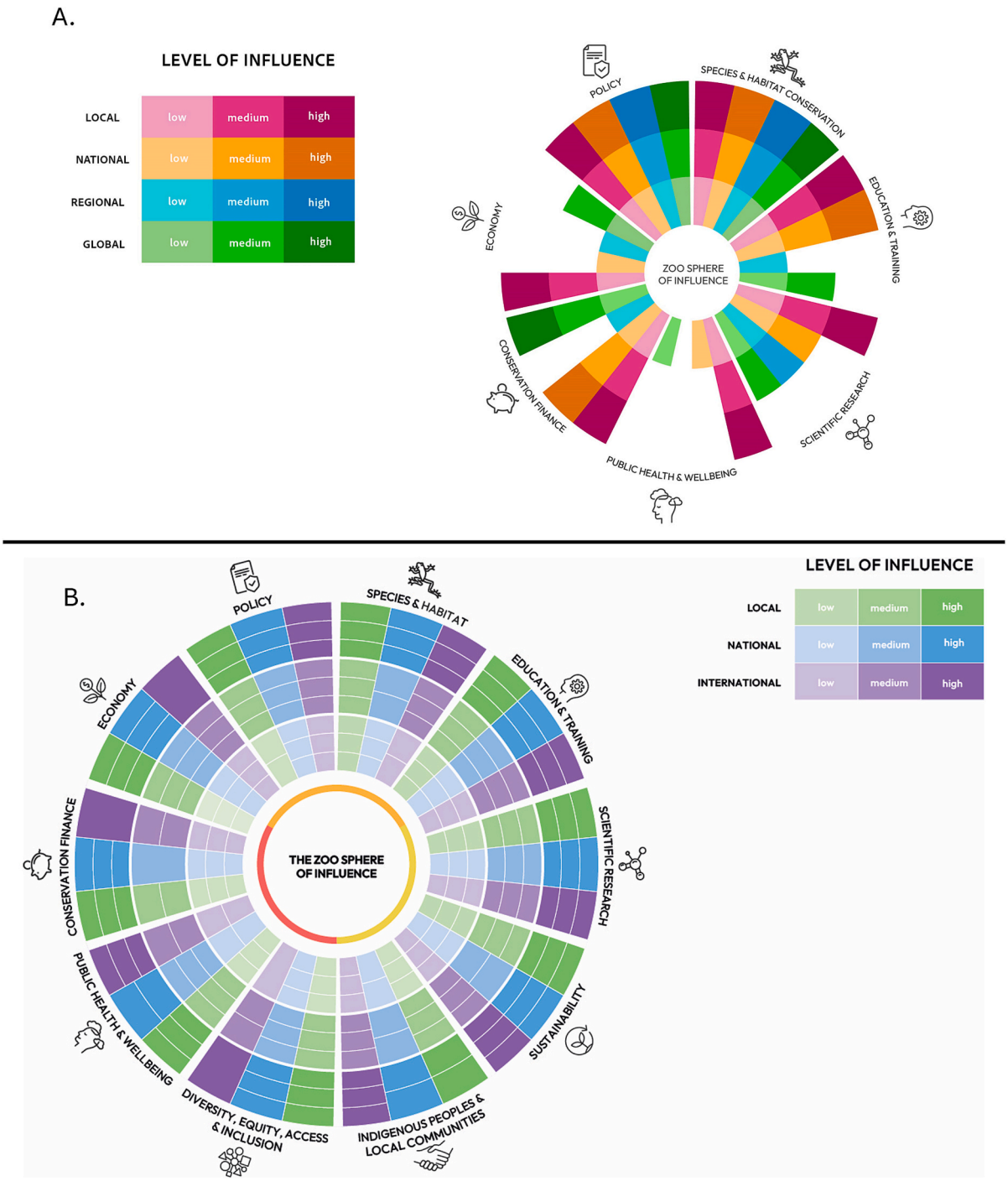

Fig. 1. A) proof-of-concept Zoo Sphere of Influence as proposed in Spooner et al. (2023), B) the updated Zoo Sphere Model.

1. Introduction

For the past 50 years zoos/aquariums have been defined as fulfilling the four pillars of Conservation, Education, Research, and Recreation (initially proposed by Conway (1969) and further developed by others). Whilst revolutionary when first published, these pillars no longer reflect the multifaceted roles that zoos/aquariums fulfil in the 21st Century. In January 2023, we proposed the Zoo Sphere of Influence Model as a way of considering the impact of zoos/aquariums for species and society more broadly (Spooner et al., 2023) (Fig. 1A). This echoes the IUCN Species Survival Commission position statement (IUCN SSC, 2023), which describes zoos, aquariums, and botanic gardens as fulfilling a key role at the "intersection between *ex situ* and *in situ* conservation" and acknowledges the wide range of areas that they work including both direct conservation actions and societal influences. The Zoo Sphere of Influence Model (including the updates detailed in this paper) has been presented to, reviewed, and endorsed by the IUCN Species Survival Commission Steering Committee.

The initial paper (Spooner et al., 2023) demonstrated that zoos/aquariums have a broad impact across species and society detailing seven key areas that zoos work: Species and Habitat Conservation, Education and Training, Scientific Research, Public Health and Wellbeing, Conservation Finance, Economy, and Policy. We suggested that zoo/aquarium impacts could be depicted as a sphere with the zoo/aquarium at the centre and their influence radiating out from low to high impact (Fig. 1A). We also highlighted how zoos/aquariums do not exist in isolation but work within networks and have influence at different scales including the Local (onsite and local community), National, Regional (multi-national region e.g., Europe), and Global levels. The paper also proposed the idea of a matrix table which could be used by zoos/aquariums as an assessment tool with each section of the matrix mapping onto the Zoo Sphere of Influence model.

The initial paper was intended as an opinion piece to open-up conversations about zoos'/aquariums' roles and the need for a more representative model. In the weeks and months following the publication of *'The Value of Zoos for Species and Society: the need for a new model'* (Spooner et al., 2023), we received substantial positive feedback from the zoo/aquarium community indicating a desire to make the Zoo Sphere of Influence a viable tool for assessing and representing the roles of conservation zoos/aquariums in the 21st Century. As such, we began a formal consultation amongst the international zoo/aquarium community to ensure that the model represented global viewpoints.

This article presents the consultation process and subsequent updates to the model.

2. Methods

2.1. Consulting the zoo/aquarium community

A formal consultation period was held between 15 February 2023 and 15 November 2023 whereby feedback was sought on the model. We took a multi-pronged approach to gathering feedback including an open-access feedback survey, workshops, conference presentations, demos, and email correspondence (Fig. 2, Table 1).

The online consultation survey ran between April and November 2023 and was advertised through the World Association of Zoos and Aquariums' (WAZA) weekly newsletter as well as through conferences and workshops (Table 1, see supplementary materials for survey). The survey instrument included open-ended questions asking for feedback on each section of the model as well as overall comments. Respondents were also asked specific questions regarding whether to include a scoring system, and if the levels of influence (Local, National, Regional, and Global) were appropriate. Skip-logic allowed respondents to provide detailed feedback on individual sections as desired.

In addition to comments received through the survey and discussions at conferences and workshops, we received feedback directly via email. This included extensive comments from Zoos Victoria, and Zoos South Australia, Australia, and Woodland Park Zoo, U.S.A, as well as general feedback from numerous others. The zoos which gave us feedback and tested the model approached us directly with feedback and offers to pilot. We selected conferences and workshops through existing contacts with the aim of reaching an international audience. For example, workshops on the model were incorporated into planned meetings such as the Indonesian Zoos and Aquarium Association's (IZAA/PKBSI)

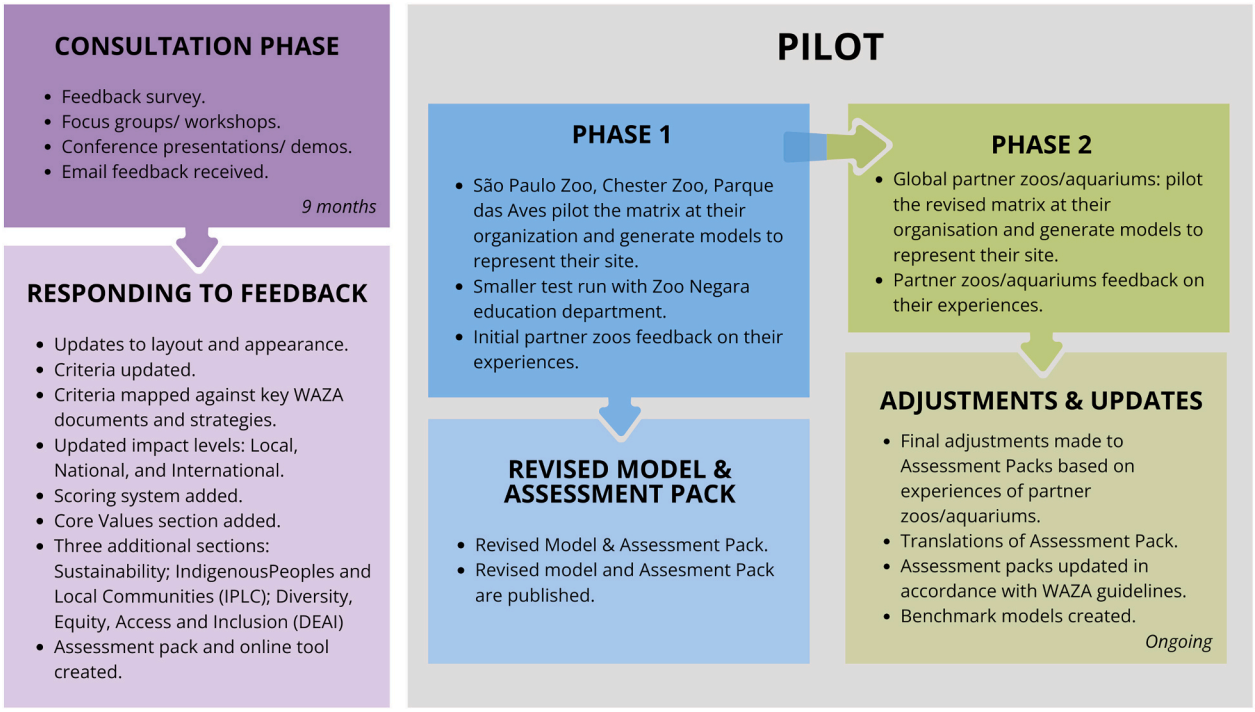

Fig. 2. Flow chart of the consultation process.

Table 1
Summary of feedback events.

Type of Feedback	Details	Location	Date	Experts	No. of individuals (approx.)	Site Size (Annual visitor numbers)
Workshops	International Zoo Educators (IZE) Conference	Wellington, New Zealand	October 2023	International zoo/aquarium conservation education experts	40	–
	Indonesian Zoos and Aquarium Association's (IZAA/PKBSI) Action Indonesia GSMP meeting	Indonesia	May 2023	South East Asian zoo/ aquarium leaders and field experts	20	–
	British and Irish Association of Zoos and Aquariums' (BIAZA) Regional Educators Meeting	Chester, U.K.	March 2023	U.K. zoo/aquarium conservation education experts	20	–
Presentations and Demonstrations	World Association of Zoos and Aquariums (WAZA) Annual Conference	San Diego, U.S.A.	October 2023	International zoo/aquarium leaders, business partners, and conservation experts	300	–
	European Association of Zoos and Aquaria (EAZA) Annual Conference	Helsinki, Finland	September 2023	International zoo/aquarium leaders and conservation experts	600	–
	BIAZA Annual Conference	Kidderminster, U.K.	June 2023	U.K. zoo/aquarium leaders	200	–
Consultation Survey	Advertised by WAZA newsletter and through conferences/ workshops	–	April – November 2023	International zoo/aquarium experts	24	–
Email feedback	Request for feedback sent to personal contacts and 'snowballed' out to colleagues	–	February – November 2023	International zoo/aquarium experts	25	–
	Direct email received by corresponding author	–				–
Pilot Phase 1	Workshops to test and finalise revisions to the model and assessment tool	Zoológico de São Paulo/ CPSG | CSS Brazil	2024	Zoo/aquarium whole site	–	~ 1.6 mil
		Parque das Aves, Brazil		Zoo/aquarium whole site	–	~ 800 k
		Chester Zoo, U.K.		Senior leadership team	–	~ 1.9 mil
		Zoo Negara, Malaysia		Education Department	–	~ 600 k
Pilot Phase 2	Large scale testing of the model and assessment tool	Temaikèn Foundation, Argentina	2024–2025	Education Department	–	~ 600 k
		Zoos SA, Australia		Zoo/aquarium whole site	–	~ 600 k
		Zoos Victoria, Australia		Zoo/aquarium whole site	–	~ 2.6 mil
		Zoológico de São Paulo/ CPSG | CSS Brazil		Zoo/aquarium whole site	–	~ 1.6 mil
		Parque das Aves, Brazil		Zoo/aquarium whole site	–	~ 800 k
		Toronto Zoo, Canada		Zoo/aquarium whole site	–	~ 1.3 mil
		Edmonton Valley Zoo, Canada		Zoo/aquarium whole site	–	~ 350 k
		Hannover Adventure Zoo, Germany		Zoo/aquarium whole site	–	~ 1.0 mil
		Zoo Negara, Malaysia		Education Department	–	~ 600 k
		Woodland Park Zoo, U.S.A.		Zoo/aquarium whole site	–	~ 1.2 mil
		Chester Zoo, U.K.		Zoo/aquarium whole site	–	~ 1.9 mil
		Wellington Zoo, New Zealand		Zoo/aquarium whole site	–	~ 250 k

Action Indonesia GSMP Meeting, and International Zoo Educators' (IZE) Conference. Following positive interest in the initial (Spooner et al., 2023) paper we were invited by WAZA to present at their annual conference in San Diego. We acknowledge that this will have introduced a bias in the feedback received, however, attempts were made to address this. For example, recognising the advantage of representation from every continent we made several attempts to engage African organisations for feedback and piloting, but unfortunately none of these were successful in the timescale involved. Smaller zoos/aquariums were included in the feedback questionnaire but none of them opted to be pilot organisations.

2.2. Pilot phase 1: Updating the model and matrix

We worked closely with Zoológico de São Paulo (hereafter São Paulo Zoo), and the IUCN SSC Conservation Planning Specialist Group | Center for Species Survival Brazil (CPSG | CSS Brazil), as well as Zoo Negara, Malaysia, to develop and test the model (Pilot Phase 1). These zoos came to us requesting that they be used as test sites.

Zoo Negara, Malaysia, provided feedback as to how their current provisions would fit the proof-of-concept matrix, and this information was used to develop the criteria further.

São Paulo Zoo, in partnership with CPSG | CSS Brazil piloted the model as a basis for their new development strategy and master plan. We worked extensively together to expand the initial model and assessment matrix and test it through a series of multi-day workshops at their site.

This was further trialled at Parque das Aves, Brazil, as part of their strategic planning, and at Chester Zoo, U.K., where the model and assessment matrix were tested amongst their senior leadership team.

In the process of developing new sections of the model we consulted experts, these included specialists in education theory, sustainability, Diversity, Equity, Access and Inclusion (DEAI), youth engagement, and Indigenous People and Local Communities (IP & LCs).

2.3. Pilot phase 2: Testing the model and assessment tools

Following this, the finalised Zoo Sphere of Influence model, a printable assessment pack, and an online tool (available at zoosphere.org) used to generate the model, were created and circulated to partner zoos/aquariums around the world to be further tested (Pilot Phase 2) (Fig. 2 & 3, Table 1). These materials were also examined by interested parties from the New Zealand Department of Conservation *Te Papa Atawhai*, IUCN CPSG, and WAZA.

The sites which piloted the model were medium to large zoos. We recognise that this is a potential limitation, but as pilot sites were self-selecting and approached the authors directly, this bias was unavoidable. We did, however, receive feedback from a number of smaller collections (<50,000 visitors per year) which helped inform development of the model.

3. Results: Changes made following feedback

All feedback was considered and where possible integrated into the updated model (Fig. 1B). The main changes are as follows:

3.1. Layout and appearance

The initial model included blank spaces where there were no proposed assessment criteria (Fig. 1A). This was criticised as being hard to interpret as representing 100 % of zoos'/aquariums' potential. We addressed this by creating a fully shaded sphere to represent maximum (100 %) potential (Fig. 1B). The model is also now colour-blind friendly.

3.2. More detailed criteria

Criteria have been added to each section to ensure a more complete assessment with up to 27 criteria per section (see supplementary materials: Assessment Pack). Where sections have fewer than 27 criteria, the scoring system and diagram have been adjusted so that a full sphere is maintained if a zoo/aquarium fulfils 100 % of the available criteria. Criteria are intended to reflect actions undertaken within the past 5 years.

The assessment criteria are also now linked to key WAZA documents (Barongi et al., 2015; Cerdan and Kahlon, 2023; Mellor et al., 2015; Thomas, 2020; WAZA, 2003, 2005, 2007, 2020a, 2020b, 2023a, 2023c, 2023b), the Global Biodiversity Framework (UNEP and CBD, 2022) and Sustainable Development Goals (United Nations, 2015).

3.3. Local, national, and international impact levels

The "Regional" and "Global" levels proposed in the initial paper have been combined into one "International" level. This addresses confusion over the term "Regional" being interpreted at different scales and alleviates prior concerns about some large countries falling into multiple categories, such as the U.S.A. being considered as both "National" and "Regional". In creating one "International" level, greater support is given for all work conducted across countries rather than prioritising only projects that are cross-continental. This additionally gives support for projects which focus on endemic species or where the zoo/aquarium themselves is based in a biodiversity hotspot.

The model is designed to encourage zoos/aquariums to focus on the areas where they can make the most impact. For example, a zoo/aquarium may choose to focus on a very specific campaign which targets their local area and will have perhaps a greater impact, given their resources, than supporting a generic national/international campaign. Other zoos/aquariums may focus at an international level as they have connections (e.g., through specific *in situ* projects) and can make the greatest impact in this area. The model can also serve as a starting point for reflection, helping institutions visualise their current areas of involvement and identify new or overlooked opportunities for contribution before defining a strategic focus.

Through tailored institutional planning and subsequent evaluation, zoos/aquariums can target areas where they have the most potential influence. This includes establishing areas of greatest need and devising solutions which meet organisational capabilities. Currently there is disparity between the areas that have access to the most funding, research, and expertise, and the areas of greatest species diversity and conservation need (Rodriguez et al., 2022). Better targeting of resources may help address these differences. Zoos/aquariums may also focus more on locally endangered, native species, where they can encourage maximal local engagement and have the most capacity to make an impact.

3.4. Scoring

Whilst there was a preference for implementing a scoring system for the model, this also raised concerns that scores could be misused and potentially misrepresent the work of individual zoos/aquariums. For example, whilst working with the local community may have significant conservation impact and protect key endemic species, these impacts could be masked by a scoring system which favours international activities. Further, a score alone would provide limited information about the actual actions that are being taken. As such, we have implemented a

Fig. 3. Distribution of feedback sites: conferences/workshops (squares) and piloting zoos/aquariums (triangles).

broad scoring system for each section, graded separately for local, national, and international levels. The authors do not intend the scores to be used for inter-zoo/aquarium comparisons and would strongly discourage their use in this way to avoid misleading conclusions being drawn.

3.5. Core values section

We received several requests for extra sections to be added to the model, these included: animal welfare, wildlife health, and staff wellbeing. Whilst these sections are critical principles for the successful operation of a zoo/aquarium, we did not feel they were explicit 'roles' of zoos/aquariums. Good animal welfare is fundamentally necessary to ensure the animals are healthy, breed successfully, and to ensure the species is conserved. It is not a zoo's/aquarium's role to be a provider of animal welfare but instead it is an expectation that good animal welfare underpins its operations. The same goes for staff wellbeing and wildlife health as without high standards in these areas, a zoo/aquarium will not be able to competently fulfil the criteria of the different sections of the model.

To acknowledge the critical nature of these values we have now included a Core Values section in the model. The Core Values section sits as a foundation ring within the centre of the model (reflecting its fundamental role). The criteria for these Core Values are based on WAZA guidelines principally in the areas of the zoo/aquarium site, animal husbandry, core animal welfare, health and safety, and staff (Mellor et al., 2015; WAZA, 2003, 2005, 2007, 2020b, 2023a, 2023b). We also wish to acknowledge that conservation was not included amongst the Core Values, as the current WAZA guidelines, on which this section is based, prioritise operational and institutional foundations. Nonetheless, conservation is widely recognised as a cross-cutting principle that informs multiple aspects of the model.

In many countries, fulfilment of these Core Values will be automatically addressed through licensing requirements, however, as not all countries have a licensing process, the Core Values section provides a guideline as to expected baseline standards for conservation zoos/aquariums. As they represent the basis of conservation zoo/aquarium practice, Core Values should be addressed prior to assessing other sections of the model.

3.6. Three additional sections

3.6.1. Sustainability

Whilst the topic of sustainability was woven throughout the initial (Spooner et al., 2023) model, there was strong support for it to become a section on its own. Sustainability is fundamental to ensuring the longevity of the sector and is a role that many zoos/aquariums have already prioritised. We believe giving sustainability its own section encourages zoos/aquariums that have not yet embedded this into their practices to increase their focus on this area, whilst simultaneously providing a means for those organisations that already address sustainability to showcase their efforts. Additionally, by considering sustainability in a broad sense it provides targets to enable zoos/aquariums to strive for best practice. Sustainability is multifaceted and includes Environmental Protection, Economic Viability, and Social Equity.

Environmental Protection has become synonymous with the term sustainability and is focused on encouraging positive environmental actions. Many zoos/aquariums have embraced this aspect through conservation education programmes (Mann et al., 2018; Pearson et al., 2014), onsite energy and transport initiatives (Woodland Park Zoo, 2024; Zoo Leipzig, 2023), and policy change campaigns (Environmental Investigation Agency, 2018).

Economic Viability ensures that the zoo's/aquarium's business strategy is sustainable over time. It considers aspects such as avoiding high staff turnovers and investing in skills development. Examples include developing research skills and facilities (such as endocrinology laboratories) within zoos/aquariums (Chester Zoo, 2024b); growing animal fodder onsite (Cincinnati Zoo and Botanical Garden, 2024; Scott, 2018) or connecting communities with trusted information about sustainable technologies and practices (for example, Loro Parque is using renewable energy to offset its power and contributes to the power supply of the Canary Islands (Loro Parque, 2024), Chester Zoo's partnership with Mitsubishi Electric helps decarbonise heating at the zoo and demonstrate sustainable technology to the public, through installations of heat pumps (Mitsubishi Electric, 2024) and Edinburgh Zoo's 'solar meadow' generates electricity for the zoo and provides education on the technologies being used (RZSS, 2024)). Economic Viability focuses on the stability and sustainability of resourcing; this is considered from a skills perspective. In contrast Economy, which has its own section, takes a financial approach and considers the role of the zoo/aquarium as a business and tourism destination in terms of financial contribution to the economy.

Social Equity seeks to ensure that all aspects of zoo/aquarium practice support positive outcomes for people. This includes areas such as education and engagement, promoting sustainable livelihoods and ensuring that supply chains are promoting good labour practices.

Given the range of activities undertaken, and large numbers of products used within a zoo/aquarium, including animal feeds, veterinary supplies, and what is sold to the public, achieving sustainability across the whole supply chain is a big ask. However, zoos/aquariums should be aspiring to be leaders in this area as their consumption practices have the potential to reach hundreds of millions of visitors. If zoos'/aquariums' actions can motivate behaviour change amongst their visitors, the potential impact would be substantial. Further, if they can influence sustainability policy, action can be achieved at national and international scales, beyond zoo-going audiences. This impact has already been demonstrated through work on, for example, deforestation free commodities (Chester Zoo, 2022) and reducing the illegal trade in wildlife (Silver, 2022).

3.6.2. Diversity, equity, access & inclusion (DEAI)

There was strong support for including a Diversity, Equity, Access, and Inclusion (DEAI) section, as many zoos/aquariums viewed this as a primary goal of their organisation. Zoos/aquariums are working to broaden their access to ensure individuals from different socio-economic groups and communities can access their sites and benefit from all the services that they provide (Fields, 2022). Similarly, they are implementing events such as autism awareness days, quiet hours (Charleston, 2023), sign-language interpreted talks and tours (London Zoo, 2024), and many other events to ensure that individuals with additional needs can access and feel welcome at their sites.

DEAI also applies to the zoo/aquarium workforce. In recent years there has been growing celebration of diversity including zoo/aquarium representatives participating in national celebrations of sexual and gender diversity (Borck, 2022), as well as supporting diversity of race, cultures, religions, and other characteristics. This has been supported by an increase in DEAI policies by zoo/aquarium membership bodies (Kubarek et al., 2020; Tugend, 2021).

Age is also an important aspect of inclusion, and many zoos/aquariums are recognising this. For example, volunteer programmes support individuals from across the age spectrum and provide opportunities for cross generational engagement in conservation (Fraser et al., 2009; Smith et al., 2018). Some zoos/aquariums employ Youth Boards to empower young people, as the next generation of conservationists, to learn how to express their opinions and have a real impact on conservation from an early age (Chester Zoo, 2024a; Melbourne Zoo, 2024; The Zoo Louisville, 2024).

If zoos/aquariums are to be seen as reputable voices amongst the conservation community, they need to be trusted by the public and be viewed as part of the communities they serve. It is, therefore, essential that zoos/aquariums engage with and embrace DEAI as part of their role in society.

3.6.3. Indigenous peoples and local communities (IP & LC)

In addition to adding a DEAI section, we received requests from several zoos/aquariums internationally to include a section on Indigenous Peoples & Local Communities (IP & LCs), including zoos/aquariums in the U.S.A., Canada, Australia, and New Zealand. This section is focused on building relationships with these groups and raising the profile of 'hidden' voices within conservation, including those who may not be defined as 'Indigenous' by national governments. We acknowledge that relationships will differ depending on the context, for example, whether a zoo/aquarium is situated on Indigenous land, whether there are IP & LCs within the locality or within conservation sites, and whether the zoo/aquarium has a history of colonialism. In including this section, we hope to raise awareness across the whole zoo/aquarium community and acknowledge it as a global concern and not just an issue for zoos/aquariums where IP & LCs are present. Its inclusion also allows those who have already engaged extensively in the topic and who are working closely with IP & LCs to receive appropriate recognition.

Zoos/aquariums have benefited from colonialism, with many situated on land seized from Indigenous groups and filled with descendants of species collected from across the globe (Bowers and Richmond, 2023). Some early zoos even included displays of Indigenous peoples as anthropological exhibits (Bancel et al., 2004; Luna, 2023). Colonialism has impacted species extinction, including increasing invasive species, hunting species to extinction, and altering habitats through changes in land use (Hymas et al., 2021; Lightfoot et al., 2013). However, this is still an area seldom discussed. As is happening within museums (Brulon Soares, 2021), zoos/aquariums have a responsibility to acknowledge their past in order to develop positive relations going forward. Some zoos have already embraced this responsibility by conducting and publishing extensive research into their histories (Maier-Wolthausen and Jahn, 2024; Eicher et al., 2019). Whilst recognising the historic impacts of colonialism is important, they only feature in a couple of the assessment tool criteria and are included as part of developing strategies for moving forwards. This positive action approach is intended to encourage zoos/aquariums to think how they can proactively ensure equitable representation rather than simply acknowledging that unequal representation has existed in the past.

Zoos/aquariums need to consider the way IP & LCs are portrayed in their exhibits (Sithole et al., 2021). There is a tendency to display generic mud huts, 'tribal' masks, and 'ethnic' patterns, especially within African exhibits (Luna, 2023, Osayimwese, 2015, Sithole et al., 2021). Some portrayals create the impression that IP & LCs are uneducated and are the primary cause of wildlife decline (Luna, 2023; Osayimwese, 2015). Whilst often intended to elicit experiential learning or a sense of cultural emersion, these exhibits potentially create misconceptions or stereotypes towards Traditional communities, as well as of entire regions and racialised groups (Luna, 2023; Sithole et al., 2021).

In contrast, some zoos/aquariums work with their local IP & LCs to co-create resources (Sithole et al., 2023; Walters et al., 2024), such as Auckland Zoo's (*Rawhi Whakaaturanga o Tamaki Makaurau*) inclusion of the Māori language in signage and educational materials (Auckland Zoo, 2024), and Taronga Zoo's acknowledgement of the Cammerraigal and Wiradjuri people as customary owners of the land on which their zoos/aquariums are situated. The Seattle Aquarium has partnered with the Muckleshoot Tribe to co-create a new section of its site and promote local species as well as deepen connections with Local Communities and Indigenous Peoples (Seattle aquarium, 2024).

Even if a zoo/aquarium is not within an area with IP & LCs it will likely house species of cultural or spiritual significance (Bowers and Richmond, 2023). Whilst it may not be possible to accommodate all IP & LC viewpoints (e.g., some IP & LCs do not support conservation biobanking (Aramoana and Koea, 2020)), and there are logistical challenges to overcome (e.g., CITES regulations and health and safety), several zoos/aquariums have embraced relationships with IP & LCs. These include involving the Yurok Tribe in Californian condor releases (Smith, 2020; Yurok Tribe, 2023), returning or loaning feathers and other body parts to Indigenous groups for ceremonial use (Thomas, 2011), and holding a Traditional farewell ceremony for a deceased grizzly bear (Veterinary Practice News, 2023).

Conservation can benefit from adopting a 'Two-eyed seeing' approach (Rapp Learn, 2020; Bartlett et al., 2012), by combining western science with Indigenous Knowledge (IK) and Traditional Ecological Knowledge (TEK) (Aikenhead and Ogawa, 2007; Rapp Learn, 2020). Additionally, by ensuring support from the whole community (including IP & LCs) conservation projects are more likely to be successful in the long-term.

Acknowledging IP & LC perspectives and working with IP & LC groups are key steps for individual zoos/aquariums. At the National and International levels, zoos/aquariums should develop and uphold fair and equitable access and benefits agreements (such as the Nagoya Protocol (Convention of Biological Diversity, 2011)), ensure data sovereignty and free, Prior Informed Consent especially when working directly with IP & LCs, as well as maintaining the principles of the OCAP (Ownership, Control, Access and Possession) (FNIGC, n.d.).

While the authors of the model are not from IP & LC backgrounds, we sought extensive feedback from a range of individuals with connections to IP & LC groups. However, we still lack representation from these 'hidden' voices. Building working relationships and trust with communities takes time. We hope that in future the criteria for this section will be created by IP & LCs themselves.

3.7. Assessment pack and online tool

The final update to the model is the creation of a printable assessment pack and an online assessment tool (available at www.zoosphere.org and in the supplementary materials). These allow zoos/aquariums to generate their own versions of the model.

4. Using the model

An individual zoo/aquarium or several zoos/aquariums collectively can be placed in the centre of the Zoo Sphere with their level of influence radiating out from low to high impact. Separate rays represent influence at each impact level (Local, National, International). These rays are grouped into sections representing the 10 main areas that zoos/aquariums work.

Each criterion of the assessment matrix (see supplementary materials) relates to a cell on the model visual. Once a zoo/aquarium fulfils a criterion that section of the model can be filled (this can be done manually in the printed assessment pack or using the online tool (available at www.zoosphere.org and in the supplementary materials)). Depending on which of the criteria are completed, the model generated will display a combination of filled cells and gaps (see Fig. 4). This allows zoos/aquariums to visualise their strengths and identify areas for improvement. In addition to depicting a zoos'/aquariums' current Zoo Sphere, zoos/aquariums can use the model for planning, by plotting their intended progression and visualising future outcomes. This was tested at São Paulo Zoo and Parque das Aves, Brazil, as part of their institutional planning:

In 2023, following its transition from a public to a public-private entity, São Paulo Zoo, and São Paulo Botanical Garden, Brazil, required an institutional plan to demonstrate planned developments to investors and establish objectives and activities for the next decade. This process, led by CPSG | CSS Brazil and based on CPSG Principles and Steps (CPSG, 2020) and the Zoo Sphere tool, involved active, multidisciplinary collaboration from professionals across the institution. An initial institutional diagnosis using the Zoo Sphere criteria was refined in the workshop, where activities were evaluated for initiation, expansion, reduction, discontinuation, or maintenance. Each activity was then prioritised as high, medium, or low. Finally, five actions per Sphere section were selected for further assessment, with those rated as very

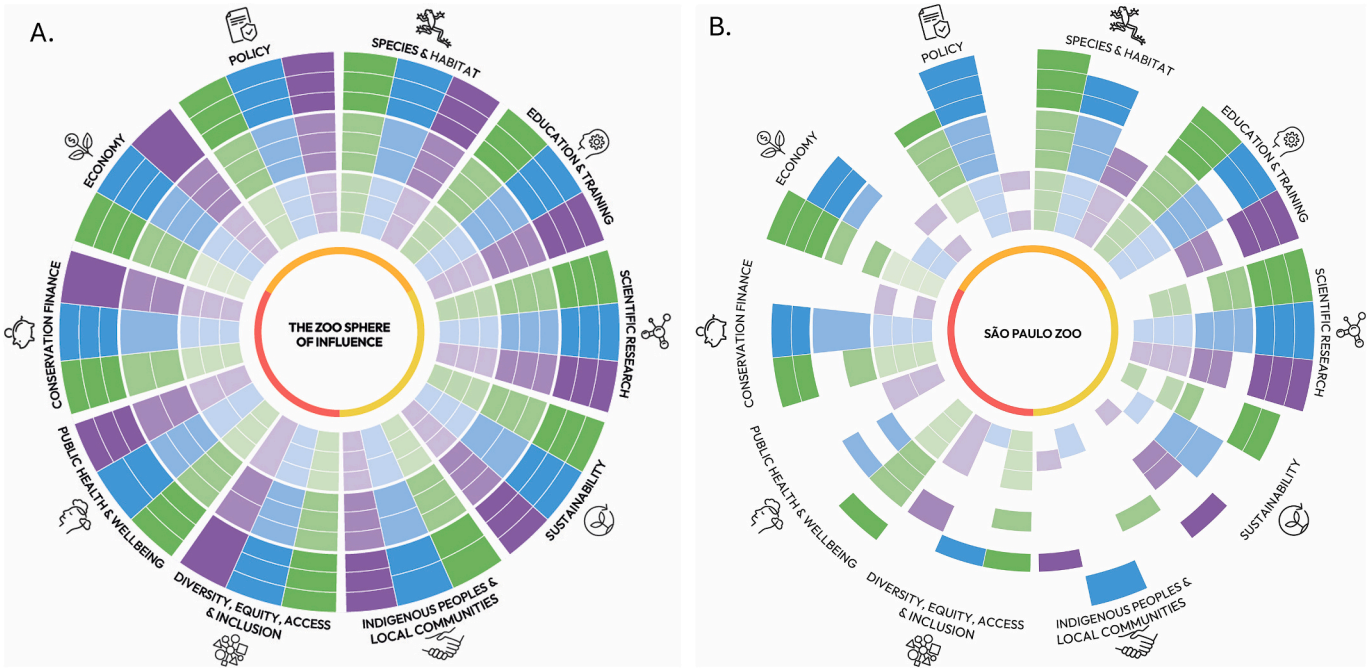

Fig. 4. A) The (updated) 'Zoo Sphere of Influence' model demonstrating 100 % of a zoos'/aquariums' potential impact. The colours indicate the level of influence (green = local, blue = national, purple = international), the strength of colour (moving from the inside outwards) indicates the intensity of impact (pale = low impact, medium = medium impact, dark = high impact). Each coloured block represents fulfilment of a specific criteria in the matrix table (Assessment Pack) (see supplementary materials). B) Example of São Paulo Zoo's current Sphere of Influence based on assessment conducted November 2023. Only those criteria which have been fulfilled by the zoo are coloured. Note that it is not necessary to complete all sections linearly.

high priority scheduled for implementation over the next five years.

In 2024, Parque das Aves, Brazil, developed its strategic and operational planning for the next five years. The planning process, also led by CPSG| CSS Brazil began with a virtual diagnostic phase that used an asynchronous analysis based on the Zoo Sphere tool and a SWOT (Strengths, Weaknesses, Opportunities, Threats) questionnaire. This was followed by two in-person workshops held in April and August 2024. The first workshop aimed to assess the diagnostic results, agree upon institutional strategic goals, and identify strategic actions aligned with processes implemented at São Paulo Zoo. The second phase focused on refining and validating the goals, actions, and operational plan.

Reflections and lessons learned from using the Zoo Sphere tool in institutional planning at these two zoos show that it is an invaluable asset for diagnostics. It provides a clear visualisation of well-performing areas and those in need of improvement, aiding in the development of strategic objectives and actions. The criteria within the Zoo Sphere tool cover a wide range of zoo-related areas beyond conservation, such as DEAI, sustainability, and education. However, it does not encompass other essential domains like commercial operations, institutional culture and human resources management. While this limitation aligns with the Zoo Sphere's intended purpose, it serves as a reminder that to address the whole zoo's/aquarium's operational areas, additional tools may be necessary for a more comprehensive institutional planning approach.

One area that was debated was whether we should include a separate section covering Visitor Experience. We were concerned that including a specific section on Visitor Experience as a direct societal role would reinforce historic stereotypes of zoos/aquariums existing primarily for the entertainment of the public. Instead, we have acknowledged the Visitor Experience role by including this as a cross-cutting objective. For example, by impacting the Economy through Tourism, and influencing Health and Wellbeing by providing a venue for families and friends to connect. In this way, we hope to encourage zoos/aquariums that are currently solely focused on Visitor Experience to embrace steps towards conservation or societal aims, thereby raising standards across the sector.

In creating an assessment tool informed by the global zoo/aquarium community and by international zoo/aquarium standards, we hope the model can be widely adopted and will demonstrate the impacts zoos/aquariums fulfil globally. The model is designed to support all zoos/aquariums irrespective of size and location. We recognise that some zoos/aquariums which have only recently begun addressing conservation and welfare objectives may not currently score highly in their own Zoo Sphere models. However, as zoos/aquariums work together as networks, we hope that these zoos/aquariums can seek support from those conservation zoos/aquariums who already excel in particular areas. Thus, collectively, the zoo/aquarium sector can improve standards and ensure the sustainability of zoos/aquariums for the future. The next step is to use the Zoo Sphere to create national and international benchmarks of these impacts which can help justify conservation zoos/aquariums in the 21st Century, inform future development, and ultimately promote best practice.

We acknowledge that individual criterion will need to be updated in response to changes in international standards, however, the model visual is robust enough to remain a valid representation of conservation zoos/aquariums even if the underlying assessment criteria are updated.

5. Conclusions

Following a period of consultation and testing by zoo/aquarium experts from across the globe, we have updated the Zoo Sphere model to include 10 sections (Species & Habitat Conservation; Education & Training; Scientific Research; Sustainability; Indigenous People & Local Communities (IP & LCs); Diversity, Equity, Access & Inclusion (DEAI); Public Health & Wellbeing; Conservation Finance; Economy; and Policy) plus a set of Core Values. The model is founded on an updated matrix of criteria (see supplementary materials: Assessment Pack) informed by WAZA documents and international standards. We have also developed a self-assessment pack and online tool (available at zoosphere.org) to help zoos/aquariums apply the model at their sites.

The Zoo Sphere model is intended to help zoos/aquariums raise

standards and uphold best practice. We hope the model is used by zoos/aquariums internationally, regardless of their size and available resources. We recognise that zoos/aquariums across the world are at different stages in their development. By developing an international assessment tool, we hope to support zoos/aquariums unsure where to begin, as well as valuing organisations already providing best practice in many areas.

We have demonstrated how the Zoo Sphere can in aid in conservation planning and evaluation. Zoos/aquariums can self-assess their current Sphere of Influence including their scores in each section and use these to frame next step planning. As such, the Zoo Sphere provides a measurable way of tracking impact. It also allows zoos/aquariums to consider their roles holistically and decided which areas to prioritise.

Our next steps are to ensure accessibility of resources by publishing self-assessment packs in multiple languages. We also intend to create a benchmarking function to allow the global priorities of zoos/aquariums to be assessed, identify gaps, and support zoos/aquariums in improving their provisions for species and society.

CRediT authorship contribution statement

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Sarah L. Spooner reports financial support and article publishing charges were provided by Chester Zoo. Sarah L. Spooner reports a relationship with Chester Zoo that includes: consulting or advisory, employment, and travel reimbursement. Susan L. Walker reports a relationship with Chester Zoo that includes: employment. Simon Dowell reports a relationship with Chester Zoo that includes: employment and travel reimbursement. Andrew Moss reports a relationship with Chester Zoo that includes: employment. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.biocon.2025.111429.

Data availability

Data will be made available on request.

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