

Review

# The Societal Value of the Modern Zoo: A Commentary on How Zoos Can Positively Impact on Human Populations Locally and Globally

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**Abstract:** Modern zoos and aquariums have evolved greatly since the end of the Second World War, to become centres of conservation excellence and scientific institutions for the study of animal behaviour, ecology, husbandry management. Whilst the impact of zoos and aquariums to biodiversity conservation, population management and advancement of species care is well documented, their positive impacts on society (including the communities that they are located within) is less well known. The four established aims of the modern zoo—Conservation, Education, Recreation (Engagement) and Research—provide a strong foundation for wider review and critique of the societal value of zoos and aquariums. This article synthesises what such value may be, and how it could be measured, from a systematic review of the literature pertaining to each of these four established aims. It also recommends areas of future scientific inquiry to further study the wider impact of zoos on their local communities and on human populations and behaviour more generally. Including Wellbeing as a fifth aim of the modern zoo would also cement their wider societal value. Further scrutiny of the societal value of the modern zoo enhances the value of the zoo’s living collection and the green spaces that it manages to provide accessibility to biodiversity and nature-centric education essential to long-term, planetary friendly human behaviour change.

**Keywords:** modern zoo; education; conservation; research; engagement; green spaces; valuing nature; biophilia



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## 1. Introduction

Zoos and aquariums (hereafter “zoos”) are some of the most perennially popular of tourist attractions [1], with an estimated, collective, global audience of 700 million visitors annually [2]. This enormous public reach provides zoos with a unique platform to encourage their audiences to engage with important messages such as biodiversity conservation, planetary health and human wellbeing, and sustainable living. Whilst the first “scientific zoo” (i.e., a learned society for the study and observation of zoology) dates from the creation (1826) and opening (1828) of the Zoological Society of London [3], the idea of the modern zoo, with defined goals and a public engagement/conservation-focussed mission statement, is a post-Second World War entity [4]. The original aims of the modern zoo and aquarium—Conservation, Education, Recreation and Research [5,6]—form the basic structure of this article; a foundation to review the zoo’s work around such aims to highlight its relevance to, and positive impacts on, human society and community. Since

the start of the 21st Century, there have been calls to include welfare as another aim of the zoo [7], to emphasise the importance of welfare-positive husbandry provided to all species under human care. Alongside an additional Wellbeing aim, the evolution of Recreation into Engagement helps demonstrate the need for the zoo to promote animal welfare and planetary health as part of a visitor's general day out [8]. Although the four original aims are not always mutually exclusive [9], they do describe the organisational values of the zoo and the reasons for the maintenance of its living collection of plants and animals. As such, we define the modern zoo as an organisation whose activities strive to meet these aims, and these aims are embedded into all aspects of its work and operations. The concept of "the modern zoo" with these established aims appears commonly understood wherever zoos occur globally [10–12] and therefore we have evaluated the relevance of these aims to how zoos could, wherever they are, use them as the basis for activities that add further value.

For clarity, we define the four established aims of the modern zoo as follows. Conservation: the management of populations for ex situ breeding and support for field-based recovery programmes. Education: formalised learning sessions and the explanation and interpretation of biodiversity and ecological messages. Research: output from basic and applied science pertaining to the zoo's core mission and objectives. Recreation: providing an engaging and stimulating experience for visitors in a recreational capacity. In some parts of the world, these aims were first prescribed when zoological collections began to be licenced and inspected [13], and when zoo membership organisations first formed [14], as a way of promoting the existence of the zoo in a post-War world, to give added value and credence to the species in each zoo's collection, and to provide a means of evaluating the zoo's objectives, conservation mission and wider focus [15]. Adding to these aims to include Wellbeing (the provision for good animal welfare and consideration of human wellbeing and planetary health) can provide further opportunities to develop activities that positively impact on human communities [8]. Their further development and evolution provide zoos with a more secure and sustainable foundation on which to base their mission statements, activities, and wider impacts [16].

The value of zoos to nature conservation and applied animal science is vast and well understood, with numerous papers documenting the conservation advances of the zoo community [17], the impacts provided to pure and applied science by zoo research [18] and the animal welfare advancements achieved [19]. The role of zoos to human society, human wellbeing benefits and positive socioeconomic impacts (for example) is less well documented. For many human populations, particularly those in high density urban environments, a visit to the zoo maybe the only way to feel connected to nature [1]. Their importance as a bridge between an all-encompassing anthropogenic environment and green spaces or naturalistic settings supporting other living organisms is clear. The aim of this commentary is to review the work undertaken by modern zoos in how they attempt to fulfil their key aims to highlight the "added value" that is generated from this work (both from the existence of the zoo as a public organisation and from the opportunities offered to its visitors during their time in the zoo). The positive role of the zoo to society also extends to its online presence, the publications it generates, and the activities that it supports away from its home location. We suggest areas for future study and investigation to further understand the zoo's societal contributions and consider the need for more integration of the relevance of the animal collection and its needs, with the needs, wants and ideals of human stakeholders (works, visitors, students, local residents, and a global audience touched by the zoo's work).

## 2. Conservation Aims and Society

Conservation, the management of populations for ex situ breeding and support for field-based recovery programmes, is a core component of the modern zoos' profile [15] and it can provide a wealth of societal benefits outside of the primary aims of species survival and biodiversity protection [12,20]. Zoos represent significant financiers of conservation projects encompassing thousands of projects across hundreds of different countries [21].

As such, they can generate beneficial societal impacts far beyond their key role of species conservation. Projects such as the in situ Mbeli Bai lowland gorilla study (Republic of Congo) are heavily financed by zoological collections [22] and ultimately have developed educational programmes to benefit local people living in the same area as the gorillas [23]. Such educational initiatives are aimed at improving the knowledge of local school children on the benefits of protecting biodiversity, as well as enhancing and increasing the conservation capacity building by employing Congolese nationals in conservation-focused roles, such as research assistants. These strong links between zoo funding and an integrated conservation approach, well beyond the zoo's boundary, highlights the global impact of their conservation aims. In situ staff, local to the gorillas, receive training in scientific, academic and language skills to enable their pursuit of higher education qualifications [23,24]. This engagement of local stakeholders in conservation efforts is a key factor towards the successful recovery of threatened species' populations.

Similarly, Zoos Victoria has trialled an in situ conservation project with the goal of balancing species protection alongside of community needs with the novel approach of encouraging football matches amongst key demographics [25]—i.e., those that are crucial to the long-term success of conservation action [26]. This football-focused project hoped to not only reduce human–wildlife conflict but also inter-tribal disputes that may reduce the efficacy of integrated conservation strategies [26]. This has been achieved by encouraging young men from the Rendille culture, who inhabit the Melako Conservancy in Kenya, that are of age to become warriors to partake in sport rather than activities that may result in conflict or harm [25]. Reducing human–wildlife conflict improves the livelihoods for local people and promotes positive outcomes for wildlife and society. As some zoo conservation projects focus on this mitigation [27], there are clear, wider societal benefits to the zoo's involvements in conservation activities.

Other conservation activities that zoos are involved in can be more creative and original. One strategy for cotton-top tamarin (*Saguinus oedipus*) conservation supplied indigenous communities with locally made clay stoves, thereby reducing the firewood demand by up to 66% [28]. This initiative not only reduced both deforestation and flooding but also caused an additional benefit to humans by reducing eye and lung irritation caused by the previously used open fires. Habitat protection yields greater biodiversity gains; ZooH! Zurich, via its Masoala rainforest exhibit, has funded projects in sustainable agroforestry and use of forest products, in addition to improving access to safe drinking water through well construction, and developing educational programmes for local schools near Masoala National Park in Madagascar [29]. Zurich zoo also aims to boost ecotourism in Madagascar [30], an activity that can yield multiple and far-reaching benefits [31] by adding further value to wildlife and income generation that can be fed back into conservation action plans. However, local stakeholder concerns and running or maintenance issues must be taken into account, as to omit or side-line local stakeholder involvement is likely to lead to failure or raise concerns over the intentions of the project [32,33]. The expertise that zoos offer in personnel management, public relations and human resources can be of benefit to the planning of conservation action, as well as to the creation and sustainment of dialogue between all invested parties.

Zoos also offer the potential for the training of environmental custodians [34]. The Durrell Training Academy, for example, has trained hundreds of international conservationists who live and work in their homeland [35]. These graduates are part of the local society, contributing financially, imparting skills, and promoting biodiversity protection to their family, friends, and other members of the community. Attendees of such courses report higher levels in confidence and competencies, and stronger ties to a network of like-minded practitioners [35]. Similarly, expertise or technical support from ex situ activities can be applied in the field by visiting zoo staff and taught to local teams to continue the activity in the native range states of threatened species or ecosystems [27,36]. Many zoos engage in similar activities, supporting conservation capacity of local communities [37]. We have illustrated that this dissemination of zoo-derived technologies or methodologies has the

power for greater potential conservation autonomy in areas where focal species reside, thereby having meaningful impact on local communities.

As such, zoos are in a unique position to offer a global perspective through the species managed within the living collection, linking larger, global societal impacts to those of its home country and its own locale. As an example, charismatic, crowd-pleasing species in the zoo that occur in currently threatened wild habitats (and that would benefit from in situ conservation action) can illustrate impactful (and direct) conservation actions to visitors. Orangutans (*Pongo* sp.) and other Asiatic species in collections can highlight the impacts of unregulated palm oil industries, habitat degradation and workers' rights in their countries of origin, which may be several thousand kilometres away from the zoo itself. These messages can be emphasised in zoo services, such as advertising the removal of products that may contain palm oil in restaurants and giftshops, online via zoo social media accounts and displays/presentations near species-specific enclosures [38]. Sustainable consumer practices can have wide-ranging societal benefits, and zoos and aquaria can lead in these changes. An example from Monterey Bay Aquarium promotes sustainable seafood consumption via the Aquarium's "Seafood Watch" program, and actively evaluates its success through strategic planning [39]. However, while charismatic animals (such as orangutans) act as the flagship to promote wider conservation action and inspire zoo visitors to positively act for a specific species, such concern does not always result in increased care towards general biodiversity issues [40]. Therefore, wider evaluation is required to determine how zoos portray conservation advocacy as well as how zoo visitors (and others) engage with its most successfully.

Zoos evidently have the potential to illustrate the benefits of biodiversity and species conservation to humanity, addressing such messages to different societies across the globe. Perhaps using an anthropocentric perspective may encourage behavioural change in zoo visitors who are not swayed by the plight of species loss; for example, by illustrating ecosystem services and how they impact on human society (alongside impacts to non-human animals too). Further engagement with all communities and increasing the zoo's reach into less represented visitor groups (i.e., outside of the traditional family day out) may not only connect more people with the importance of conservation action, but also expand the zoo's scope with more communities who will be more likely to see its value to their own lives. Such engagement work provides further support for Wellbeing to be more widely established as the fifth aim of the modern zoo [8].

### 3. Education Aims and Society

Reaching a wider demographic than would be perceived as the traditional zoo visitor should become a key objective of the modern zoo's engagement and educational outputs moving forwards. A school, college or university trip, or family and friends visit to the zoo, to learn more about the natural world, is probably one of the most identifiable and laudable reasons for the existence of modern zoological collections. As stated previously, the audience that zoos attract provides them with enormous global potential as the promoters of positive human behavioural change. Although it has been debated that visitors to zoos are mainly those with children [41], zoos can appeal to a wider demographic [42], offering opportunities for both formal (educational sessions delivered as part of a specific programme) and free choice learning (review of zoo interpretation and consideration of its content and messaging) [43,44]. Free choice learning opportunities, such as viewing zoo animal behaviour, educational signage or interactive displays, or animal demonstrations, can provide visitors with the chance to learn about biodiversity [45–49]. However, certain educational activities in zoos can fail to result in a long-term enhancement of conservation knowledge or awareness of biodiversity education [50] and therefore evaluation and scrutiny of educational messaging is required across demographics. Therefore, zoos hold the potential for the establishment of collective knowledge on the importance of biodiversity to societal and planetary health and wellbeing if educational programmes and messaging

are appropriately conceived and consistently evaluated and re-worked to maximise the impact [45,46,51].

If zoos are effective in their conservation education objectives, the potential for a sustainability-themed behaviour change in their visitors is considerable [52]. Measuring the efficacy of such conservation education, however, is key, and the evaluation of useful and relevant messaging needs to be undertaken and then built into future educational activities [53]. Research across 48 countries has demonstrated that zoos do use feedback to develop their educational techniques, though satisfaction ratings are sometimes weighted more strongly than educational outcomes [54], and therefore reflection on the best practice is a goal of zoo educational programmes.

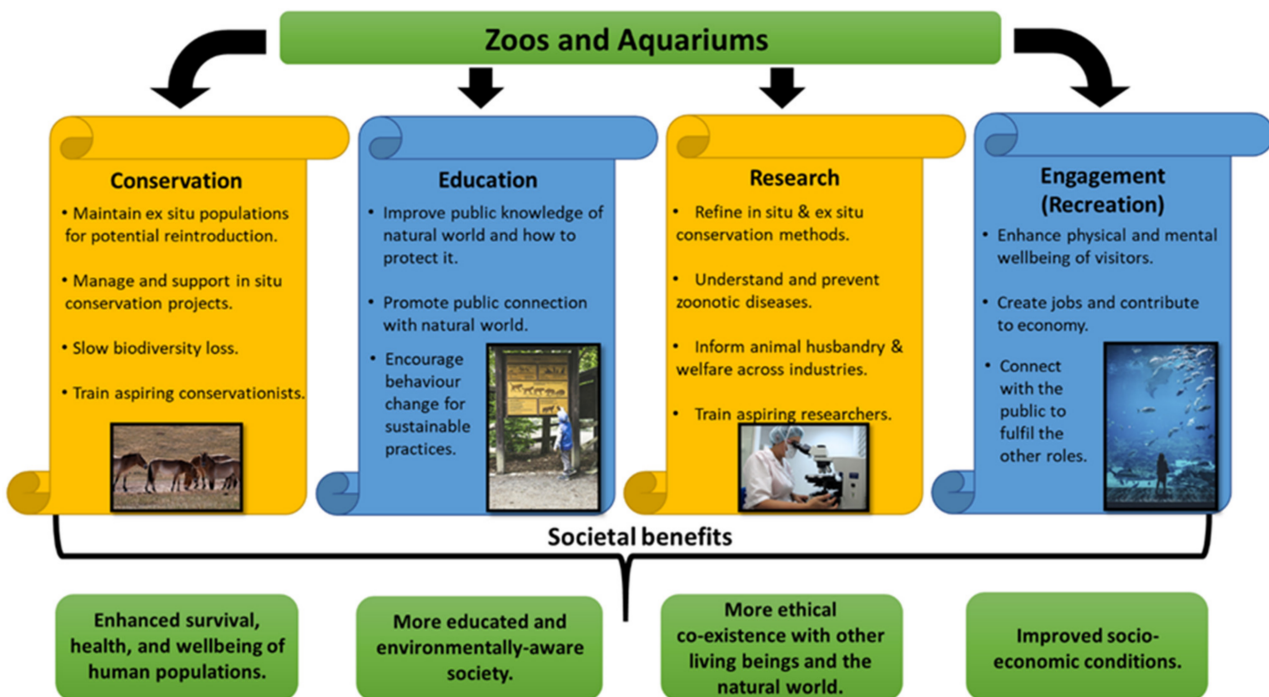
Zoos may be more effective in their educational aims than comparable organisations (such as museums) because they contain living animals. Considered to be relevant ambassadors for free-living counterparts [47], captive wild animals may help engage zoo visitors with wider biodiversity and planetary health messages and promote a sense of empathy for the natural world [44,55–57]. These authors illustrate that the social context of the zoo and associated opportunities for connection with live animals can promote the development of caring for nature, which in turn may influence behaviour. Many visitors are also motivated to further view and interact with animals and plants in a positive way [47], and this affinity can be considered biophilic [58]. Evidence suggests that visitors who recently viewed zoo animals alongside a planned conservation education exercise gained higher scores for (i) biodiversity understanding and (ii) knowledge of actions that could be used to protect biodiversity than when prior to visiting the zoo [46]. Similarly, this greater understanding of biodiversity has been demonstrated in other studies of visitors following a zoo or botanical garden visit [59], and may be in part because visitors have opportunities to engage in active learning. Visitors appear to be inherently interested in specific taxa [60], so strategically placed educational materials can improve visitor awareness of conservation. For example, interpretation could be placed in front of exhibits with high footfall (such as those that contain charismatic species), so that exposure to beneficial or instructional messaging is maximised.

Zoos also provide numerous opportunities for formal education. Whilst the traditional demographic associated with formal zoo education is school-age students, there are opportunities for adults too. For adults, this may appear in the form of live animal demonstrations, or through free-choice learning [49]. Many zoos employ specialist educators, and in the United Kingdom, the zoos are legally obliged to provide a written educational policy [61]. For young students, formal zoo education may take the form of in-zoo lessons, tours or workshops [62]. Zoos often link these sessions to the prescribed educational curriculum [63]. From a national perspective, this helps to mainstream primary school education of concepts such as biodiversity, sustainability and ecosystem function [43]. Learning outside of the classroom may also encourage students to engage more with these complex ideas; the naturalistic environment of the zoo can promote greater respect for animals from school pupils, particularly when the zoo visit includes a practical educational activity [64]. Guided visits can increase conservation-focussed learning when compared to the recall of knowledge after an unguided visit that relied on student engagement with the interpretative messaging located around the zoo [65]. As such, zoos should build on the positive experiences of students being able to learn in a novel way outside of the classroom by maximising the investment in education provision by ensuring sufficient education staffing is present to broaden opportunities for engagement with key conservation messages for all learners. Recall of biodiversity knowledge two years post-zoo visit has been documented [52], demonstrating the potential for impactful human behaviour change (based on in-zoo experiences and learning) that an original zoo visit can catalyse.

Ultimately, the underpinning conservation principle for education quality in zoos globally is to *“to influence behaviour change for conservation in society”* [66]. The zoo’s influence extends beyond its footprint, in the form of remote educational sessions, virtual tours, livestream webcams, and the promotion of research for scientists and students [67]. With

many of these tools being developed during the COVID-19 pandemic [67], zoos have improved their ability to provide education, and also engagement, to a wide range of audiences in society. By diversifying the medium of their outreach, i.e., linking in-person activities to online platforms such as YouTube® [68], zoos can further enhance the education of demographic groups that may not visit the zoo [69] and encourage engagement with entertaining but educational content relevant to the promotion of the zoo’s aims as well as the wider importance of biodiversity conservation.

Bridging between conservation and education, many of the examples discussed here and in Section 2 show that the zoo’s aims are almost never mutually exclusive. Educational initiatives have conservation benefits, and conservation action plans build in educational outcomes to ensure the long-term success of species and habitat survival programmes. The features of a zoo’s education department, as well as the “soft touch” educational activities designed for visitors, highlight the wide range of skills and knowledge available in the sector, which can (and should) be applied to conservation activities too (Figure 1).



**Figure 1.** Wider integration of the zoo’s aims helps to expand the societal impact they have both over visitors directly and human populations further afield.

#### 4. Research Aims and Society

Zoos have long been associated with scientific research, and indeed the advent of the modern zoo by the Zoological Society of London was based on scientific aims and ideals [3,4]. Scientific research conducted by or at zoos has significantly advanced our understanding of the natural world [70]. Zoos provide researchers with a closer proximity and easier access to a wide range of taxa, creating unique opportunities for research that could be otherwise difficult to conduct [71]. Such research is often applied [72] and undertaken with the aim of directly benefiting zoos and their mission (i.e., in situ and ex situ conservation, animal welfare and visitor education), or can instead be conducted purely for the advancement of science [18] and therefore can be impactful across different academic fields.

Even though zoo research primarily benefits the main stakeholders within that industry (e.g., animals and wildlife, visitors, zoo managers/practitioners), wider human society also accrues positive gains from such research activities. Biodiversity loss threatens ecosystem services, which human societies rely on for long term survival and overall

wellness [73]. Aligning with the conservation aims of the modern zoo, integrated in situ and ex situ conservation efforts are a fundamental tool in preventing species extinctions, thus slowing biodiversity loss [74]. Zoos conduct and support research aimed at refining methodologies and technologies used in conservation efforts, both in the wild (e.g., developing a device for portable genetic analysis and species identification in the field) [75] and in captivity (e.g., discovering how to support the pregnancy and successful captive breeding of Sumatran rhinos, *Dicerorhinus sumatrensis*) [76].

Zoo research into animal health and welfare also benefits human societies by encouraging ethical coexistence with other living beings while also protecting human health. As highlighted by the COVID-19 pandemic and recent monkeypox outbreaks, a growing and increasingly crowded human population is threatened by the emergence of novel diseases. At the time of writing, the world's population has passed 8 billion people [77] and therefore the role of zoos in helping implement evidence for a sustainable future is even more important. By researching zoonotic diseases, which zoos are in a privileged position to do [78], we can more efficiently understand and prevent human–animal disease transmission. Human health is also affected by food safety, which is in turn impacted by the welfare of the farm animals involved in food production [79]. Zoo methods (e.g., environmental enrichment), research tools and the ways in which zoos respond to policy and advocacy for enhanced welfare environments can all help inform ways to improve husbandry and welfare in farm animals. For example, zoo research that evaluates the individual measure of animal welfare, such as via Qualitative Behavioural Assessment [80] or from individual quality of life plans [81,82], can show the value of such individual-centred welfare assessments that may help improve the quality of care (and therefore productivity and economics) of livestock husbandry, where a herd- or group-level approach to animal welfare is commonplace.

In this manner, the cross-disciplinary usage of zoo research techniques and outputs can have an indirect but positive impact on human health and wellbeing. The application and effectiveness of enrichment to zoo animal welfare has been cited in research that has aimed to assess the relevance of, and further encourage the use of, enrichment for farm animals [83,84]. Historically, it has mainly been zoo animals that have benefitted from farm animal research [85]. There is, however, great potential for further cross-disciplinary studies and the development of mutually beneficial scientific collaborations between these animal-based institutions, which will facilitate education and knowledge transfer for the improvement of global animal welfare [86]. Such large-scale enhancements to animal welfare contribute to the advancement of compassionate approaches in human society and therefore support the sustainable utilisation of living organisms.

As visitors are a key stakeholder, the zoo must ensure that it provides an educational and relevant recreational experience for a wide-ranging demographic. To meet this outcome, zoos will undertake social science research to further understand and ultimately improve visitor engagement and education. A key goal of social science is provide an explanation for human social activities [87], and because going to the zoo (for a large number of people) is social, relevant social science methodologies that provide understanding of how zoo visitors respond to environmental messaging or conservation and sustainability further support the societal value of the zoo, as they enable constructive and accessible engagement with said visitors [56]. For example, the outcomes of social science research have been used to inform conservation education practices in zoos and beyond [88].

Finally, another important contribution of zoos to society is their role as research training centres, helping to shape future generations of scientists [89,90]. Many zoos offer research placements on a wide range of topics, and/or have collaborations with universities to provide their students with an opportunity to put into practice what they learned in the classroom. There, they can develop laboratory- and field-based research skills in data collection, analysis and research planning [91], while improving their confidence in the scientific method [92]. Consequently, zoo research outputs (both in terms of the scientific

publications generated and the knowledge exchange between staff and students) have added value to communities local and far from the actual site of scientific activity.

### 5. Engaging Visitors and Societal Benefits

Recreation refers to a zoo's ability to provide an entertaining and stimulating experience for visitors. It is undoubtedly the most controversial of the modern zoo's aims and raises questions about individual animal rights, dominance of humans over the natural world and brings into question the scientific and moral worth of the zoo [93]. When the modern zoo was defined, it is plausible to suggest that the role of Recreation was reconceptualized from 'entertainment'. Historically, the role of the zoo for entertainment has been prioritised at the expense of animal welfare and conservation practice. As the ethical grounds for maintaining any species of animal in captivity solely for human entertainment are hard to justify, zoos and zoo research have, in the modern zoo era, downplayed the role of entertainment and the historical connotations this maintains. Carr and Cohen [11] warned against the promotion of the entertainment focus on zoo websites. Zoos avoid the use of the word 'entertainment', typically describing 'attractions', 'encounters' and a 'fun zoo' on their websites. Carr and Cohen [11] consider that the global zoo image should firstly present detailed accounts of the conservation action and impact, and secondly should ensure that the entertainment messaging does not "*adversely affect transmission of the conservation or education [messaging]*".

The reconceptualization of entertainment as Recreation distances modern zoos from the menagerie of the past and allows zoos to prioritise their other roles in their marketing and practice. However, zoos are well-established and important 'urban attractions' [94] and to achieve economic sustainability, zoos need visitors. They are reliant on the money visitors generate to stay open, promote animal welfare and continue vital conservation and education work, as well as continuing to contribute significantly to local and national economies (e.g., by maintaining vast numbers of people in employment, for example) [95]. Roe et al. [96] found zoos rated educational roles as their highest priority but 'a place for people to relax and socialise' and 'a place to see animals from another country' were also given high or very high priority ratings by most zoos. Zoo visitors conversely rated 'a place for people to socialize and relax' less of a high priority, perhaps reflecting society's changing perception of animal ethics and nature governance generally. Visitors also prioritised learning at the zoo, but before learning can occur people must first be enticed to visit the zoo. Modern zoos therefore find themselves in a challenging position striving to maintain wild animals in captivity for conservation and education purposes, promoting respect for animals, while minimizing the exploitation of animals so people can be entertained [97].

Zoos are more than recreational experiences [1]. Yet being engaging by encouraging recreational activities that focus on nature is a clear reason for their existence, with many zoos reliant on gate entry and ticket sales for their continued operations. This does not mean to suggest that recreation cannot be built on; to harness the interest that people have in coming to the zoo for an enjoyable experience and then creating something more meaningful from it. An important development to the recreational aim of the zoo is to consider opportunities for engagement with the wider activities with which zoos are involved [8]. Therefore, whilst a visit to the zoo is still fun and enjoyable, rephrasing from being purely recreational adds more credibility to the zoo's mission. The simple reason for visiting the zoo to see animals is, in itself, a reason to be celebrated [98], as this demonstrates a deep-seated and inherent interest in the natural world that provides a hook for engagement with deeper, conservation or sustainability focused themes and ideas. Fostering this initial interest means zoos can promote free-choice learning, framing interest in learning more with a positive social experience that further provides a learning opportunity [44]. Therefore, it would be advantageous to consider the education opportunities offered by zoos when developing both the external education policy and internal zoo policy to maximise the educational offering and impact.



From an anthropological approach, an evaluation of the cages, enclosures and exhibits created within a zoo can provide an insight into a society's beliefs and opinions, at that time, towards the natural world and how the natural world was valued [99]. This cultural history is accessible to all and is a useful and relevant living museum of societal attitudes that can be studied and analysed to shape appropriate future decision making and perspectives. The relevance of the zoo to human recreational purposes, yet in a setting which benefits nature, is made clear when concepts of landscape ecology are applied to the zoo [100]. Landscape ecology is a discipline that investigates the ecological effects of the spatial patterning of ecosystems across broad scales [101]. Zoos can garner added relevance by modelling and developing more sustainable landscapes that enhance human health and wellbeing, promote connectivity with nature and ensure sanctuary to native species that are further useful to human society.

A second suggested reconceptualization evidenced in Rose and Riley [8] may further modernise the recreation role of the zoo, which actively promotes good practice in the other roles. 'Engagement' helps focus discussion on the benefits of having an enjoyable and relaxing time at the zoo, and how this has positive implications for zoo research, education, and conservation goals. Recreation may seem to trivialise the wider work of zoos but engagement with the conservation, education and research outputs of the zoo can occur more readily in a relaxed and comfortable atmosphere, as has been demonstrated in other areas of learning [102]. Enhancing a wider connection with the natural world allows the wellbeing of zoo visitors and zoo animals to be mutually considered and prioritised.

Green prescribing aims to promote mental and physical human health via immersive experiences in nature. A recent trip to green (e.g., parks, woodland, and forest) or blue (e.g., wetlands and the coast) space is positively correlated with positive wellbeing and negatively correlated with mental distress [103]. Thus, being immersed in nature, even for a short time, promotes mental wellbeing. Given that many zoos are also botanical gardens [104] and/or are situated in areas of forest or woodland or natural greenery, they provide an automatic connection with nature, with added wellbeing benefits [8]. Zoos are in an enviable position of providing nature connections, while also directly providing animal interaction. Coolman et al. [105] investigated the effects of walking through an immersive zoo exhibit and found that participants demonstrated significant reductions in blood pressure and salivary cortisol, reported feelings of greater happiness, and were less tense. Zoos, therefore, allow rare opportunities for improvements in human wellbeing and in turn this reinforces all other aims of the modern zoo. As green and blue prescribing become entrenched in health policy, the engagement role of modern zoos will be further realised as zoos become increasingly recognised as accessible green and blue spaces offering access to nature, with diverse landscapes and wildlife.

Connecting an engagement or recreational aim of the modern zoo with its other principles appears to be the key to fostering long-term positive relationships within society. Holzer et al. [106] found that children who were regular zoo visitors would be the strongest advocates for their existence when adult—visiting regularly, visiting more zoological collections, and promoting the educational relevance of the zoo. Recreation, or the more appropriate Engagement, is a vital role for modern zoos that should promote both human and non-human animal wellbeing and bolster the wider aims of the zoo [107]. Archaic views that seek to exploit animals for human pleasure have no place in the modern zoo, but society must engage with zoos first before zoos can meet and successfully fulfil any of their other aims.

## 6. Society and the Future Zoo

Zoos, as scientific centres of conservation excellence, are constantly evolving and responding to both conservation needs and societal expectations [108]. Although the primary motivation of most zoo visitors may always be recreational, a huge global audience means zoos have an increasingly unparalleled opportunity to enhance public connectedness with the natural world through both on-site and virtual live animal experiences [1,2,109]. Being

recreational, yet creating opportunities for meaningful engagement, is a strength of the zoo's work [8]. Creating truly immersive naturalistic exhibits, with engaging and interactive interpretive elements, has been demonstrated to both enhance visitor engagement and increase conservation-based knowledge [16,110]. Although there are examples of such exhibits, such as the Bronx Zoo's "Congo Gorilla Forest" [111], further evaluative and reflective study is needed to now further develop such exhibits and to identify the most appropriate means by which to utilise them to enhance educational outcomes and encourage pro-environmental behaviours amongst zoo visitors [112,113].

Through their combinations of live animal displays and creative educational messaging programmes, zoos globally have the opportunity to influence their visitors, eliciting action and encouraging them to change their behaviour to help conserve wildlife [38,114]. Although the role of zoos in changing visitor behaviour is a relatively new idea, it comes with incredible conservation potential, and creates a huge range of new research possibilities and opportunities to integrate in situ and ex situ conservation efforts [115]. Importantly, this is unlikely to impact the recreation value of zoos, as visitors also report placing a high value on learning about the actions they can take to conserve biodiversity [96]. Similarly, large, charismatic species, which are often the most popular with visitors, and important for driving visitor numbers, can also be extremely powerful catalysts for such public engagement [57,116]. Further research is needed to develop and evaluate visitor behaviour change campaigns to ensure they can be as efficacious as possible, and to also assess the potential for traditionally non-charismatic species (e.g., amphibians, fish and invertebrates) to achieve meaningful conservation impact and pro-conservation behaviour promotion (in zoo visitors) when exhibited in the zoo.

There is an increasing body of knowledge demonstrating that visiting immersive, naturalistic exhibits in zoos can also improve human health and well-being, both physiologically and psychologically [105,117]. As mentioned previously, green prescribing is the prescription of nature-based health interventions, and this emerging health strategy provides the zoo with further opportunities to engage with human wellbeing research work. As little is known of its efficacy, constraints, and opportunities of green prescribing [118], those visiting the zoo could help add to our knowledge of the usefulness of such prescribed health plans. This almost completely ignored benefit of zoos is becoming more important as urban areas expand and people become increasingly disconnected from the natural world [119]. Further research is needed to determine the full extent of the human health and well-being benefits provided by zoos, and how zoos can build on these to benefit a larger, more diverse audience [105]. Zoos are well placed to collect data from participants of green prescribing programmes to add evidence to the efficacy and relevance of such health interventions.

Zoos have extensive cultural impact, and accordingly have an obligation to make conservation and conservation education accessible to all [120]. It is already known that zoos do not reach certain public demographics. More effort is necessary to identify opportunities to reach a broader audience [121]. One way to do this is to support diversity in zoo staffing and encourage the hiring of staff from traditionally marginalized areas. Other areas of science have been successful with these efforts and could provide good models for zoos to follow [122]. This support should also be extended to the field conservation projects which zoos engage with globally. Effective conservation actions result from engagement with people, and zoos should continue to strive to work within local communities living alongside wildlife in the field, ensuring sustainable human-wildlife coexistence can be achieved. Revisiting and reassessing conservation planning and implementation will provide further research questions and novel educational opportunities to demonstrate the societal value of modern zoos to those living alongside of animals in their range states.

Measuring and evaluating successes in each of these areas is a difficult task; however, Table 1 outlines various research avenues that can be used to interrogate and show progress in each area. For the zoo to continue to attract large crowds of visitors, and to be a meaningful way that humans can connect with nature, the zoo must remember to not

portray aspects of nature or to construct the natural world in a way that human society wishes to see it [123]; i.e., to not give a stylised or anthropomorphic illustration of how animals live and what they are as biological entities. As well as being ethically essential to zoo operations, maintaining excellent standards of animal welfare is a commercially important aspect of the modern zoo too [124], as perceptions of how well the animals are doing positively correlates with an enjoyable visitor experience at the zoo. Therefore, to enhance societal value (by encouraging communities to see zoos as relevant to the modern world and truthful in their aims to conserve and care for biodiversity), welfare needs more prominence. Such a relationship between visitor perceptions and animal welfare, further supports the need for Wellbeing to become the next established aim of the modern zoo [8].

**Table 1.** Examples of measurements of social value and their outcome within the zoo, based around the different aims of the modern zoo. C.= Conservation; E.= Education; ER. = Engagement/Recreation; R. = Research.

Value	Outcome	C.	E.	ER.	R.
Recall of conservation messaging by school students following exposure to an education campaign	Students demonstrate improvement in their understanding of biodiversity and actions to protect it after a prolonged time period [46]	x	x		
Measuring engagement with a conservation initiative through social media post visit	Encourage more visitors to champion pro-conservation behaviour change, e.g., use of sustainable palm oil [38]	x	x		
Changes in self-reported conservation intention (purchase of sustainable palm oil) using on-site campaigns and social media	Conservation intentions and use of sustainable palm oil products can be higher following engagement with presentation over time [38]	x	x		
Developing research skills during an in-zoo research internship	Skills in research design, science communication and data management improve, and overall scientific quality is enhanced [91]		x		x
Testing and validating methods of on-site genetic analysis for species identification, using zoo animals	Conservation efforts are facilitated as the efficacy and real-world applications of the such methods for use in the field are confirmed [75]	x			x
Positive and planetary friendly visitor behaviour change	Longitudinal evaluation of visitor responses to zoo behaviour change campaigns to identify meaningful outcomes [114]	x	x	x	x
Green prescribing and associated benefits to human health and wellbeing	Evidence of long-term psychological benefits of being out in nature give new relevance to zoos in their communities [105]		x	x	x
Immersive, ecologically relevant exhibits	Assessing educational benefits of immersive, naturalistic zoo exhibits, (and their future development) to provide maximum impact on visitors [110]	x	x		x
Using ecologically-sound enrichment and species-relevant husbandry regimes	Assessing educational benefits of enrichment (and what it looks like in an enclosure) can define public responses to the zoo and its animals, and therefore improve how zoo animals convey important messages or stories [125]		x	x	x
Accessible and equitable conservation education	Assessing the current demographic reach of conservation education programmes and evaluating these initiatives accordingly improves them to enable widest engagement [53]	x	x		

## 7. Conclusions

Whilst the modern zoo's work with non-human animals is well known, well promoted and generally well understood, zoos can impact directly (both in a positive and negative manner) on the humans that visit them, live near to them and engage with their work and outputs. As organisations with strong welfare and conservation groundings, zoos can have a beneficial role to play in advancing how society thinks of, and cares about, the natural world, opening up educational avenues and inspiring the next generation to be mindful of anthropogenic effects on planetary health and the viability of biodiversity. Integrating zoos as a resource for human health and education, and for enabling pro-conservation behaviour change within wider social policy, will enhance the role of zoos further. Alongside of this, zoo animal husbandry needs continual improvement. The positive messaging of the zoo is reduced by identifiable indicators of poor welfare (e.g., abnormal repetitive behaviours) or inappropriate housing and enclosure design. Zoos must balance the need to continue with fundamental work on animal care alongside how they engage with their visitors and the society they are located within.

Ultimately, defining what the specific societal, economic, and public benefits of the existence of zoos to human populations is first needed. Then, methods of evaluating these benefits should follow. Such evidence gathering is required for these organisations to justify their aims, and how these aims are fulfilled. Consideration and measurement of how the presence of the zoo's living collection of animals and plants, and the access to its green spaces, enhances the quality of life of the people nearby (or who visit more broadly), and is required to develop and share positive approaches that benefit the widest demographic. Zoos and aquariums can be excellent places for the advancement of nature-based solutions to public health, e.g., through green and blue prescribing initiatives. Zoo audiences can be encouraged to further value nature and explore both current and potential connections to biodiversity due to the educational messaging and engagement activities of the zoo, their scientific outputs that provide the evidence for One Health/One World approaches, and the conservation activities that highlight how the quality of life is improved for human and non-human animals when biological diversity remains as diverse as possible. If the zoo's audiences are encouraged back as returning visitors, by actions, objectives, initiatives and activities that are deemed credible, relatable and relevant, so the zoo becomes sustainable; therefore, its place in society (as a provider of employment, income and a contributor to local and national economies) is more secure. This secure footing enables zoos to plan for the future, developing more ambitious conservation strategies that can bring the benefits of biodiversity conservation to more communities. The zoo's sustainability is key to their achievements of long-term, planetary friendly, human behaviour change and this will cement the role of the zoo in society as one that fundamentally benefits wildlife and people alike.

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