

It's a sign: Animal welfare and zoo type are predictors of animal identification signage usage and quality at zoo exhibits

Anna Fourage¹ | Chris R. Shepherd² | Marco Campera^{1,3} | K. A. I. Nekaris^{1,3} | Vincent Nijman¹

¹Oxford Wildlife Trade Research Group, School of Social Sciences, Oxford Brookes University, Oxford, UK

²Monitor, Big Lake Ranch, British Columbia, Canada

³Little Fire Face Project, Cipaganti, Indonesia

Correspondence

Anna Fourage, Oxford Wildlife Trade Research Group, School of Social Sciences, Oxford Brookes University, Gypsy Ln, Oxford OX3 0BP, UK.

Email: 19140142@brookes.ac.uk

Abstract

Conservation education programs are listed as priority actions for almost every threatened species on the International Union for Conservation of Nature Red List. Zoos play an important role in delivering such programs, yet evidence of zoo education in many non-western countries is limited. Here, we evaluate animal identification signage prevalence and quality at zoo exhibits and investigate whether animal welfare, zoo type (accredited, government, and private), admission fee, zoo size, and proximity to urban centers are influencing factors. We used hornbills (Bucerotidae) as a model taxon, surveyed hornbill signage, and conducted welfare assessments of hornbill exhibits. We developed scoring frameworks and applied content analysis to analyze signage quality. Our results show that out of 18 zoos that displayed hornbills, 15 had hornbill signage. However, of the 106 hornbill exhibits in these zoos, 33% had no signage. We also found that signage presence or absence at individual zoos and signage quality is strongly correlated with animal welfare quality. Zoo type is a key factor in predicting signage and welfare quality, with accredited zoos scoring highest for both signage and welfare, followed by government and private zoos. Private zoos charged higher admission than other zoo types, and zoo size and proximity to urban centers did not influence signage or welfare scores. Overall, we conclude that in our study, signage usage and quality are inadequate, highlighting the importance of compliance with robust zoo standards to improve education and welfare within zoos to support global conservation goals.

KEYWORDS

conservation education, hornbills, Southeast Asia, zoo welfare

1 | INTRODUCTION

With increased rates of species extinction, educating the general public about the dangers of biodiversity loss has become a high priority for conservation organizations (Arumugam & Annavi, 2019;

Ehrlich & Pringle, 2008; Kolbert, 2014; Moss et al., 2015; Navarro-perez & Tidball, 2012). Most zoos are active conservation stakeholders, and many are non-profit organizations whose primary aim is to contribute to global wildlife conservation (Gusset & Dick, 2011). As venues housing captive wildlife for public display, zoos are

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2022 The Authors. *Zoo Biology* published by Wiley Periodicals LLC.

well-placed to further contribute to biodiversity conservation through the provision of visitor education (Ballantyne et al., 2007; Dierking & Falk, 1994; Patrick et al., 2007).

Modern zoos increasingly emphasize education in their mission statements (Mellish et al., 2019; Patrick et al., 2007). In fact, many zoos claim to place education as their highest institutional priority (Moss & Esson, 2013; Roe et al., 2014). Many authors consider modern zoos to have five connected goals: conservation, research, entertainment, provision of good animal welfare, and education of the public (Carr & Cohen, 2011; Godinez & Fernandez, 2019; Hosey et al., 2013; Reade & Waran, 1996). To provide comprehensive education, zoos may employ different tools to communicate with a wide variety of visitors (Roe et al., 2015). These include immersive exhibits, keeper talks, feeding demonstrations, interactive technologies such as digital guides and touch screens, and animal identification signs (hereafter referred to as "signs" or "signage") (Luebke et al., 2016; Perdue et al., 2012).

As the most basic form of messaging, signs are the predominant form of zoo visitor education, with 97% of 176 surveyed zoos worldwide using such signs at animal exhibits to convey important information about the species on display (Roe et al., 2015). At a minimum, signs should include the species' name, distribution, habitat, diet, behavior, and conservation status (Ballantyne & Packer, 2016; Fraser et al., 2009). Graphics are also an important element of signs as attractive displays with bright colors are thought to capture visitors' attention, with Fogelberg (2014) suggesting that signs that use photographs instead of illustrations are preferable. Moreover, signs should communicate, inspire, and promote empathy toward the exhibited animals (Fogelberg, 2014; Packer & Ballantyne, 2010; Serrell, 1996).

The literature shows that visitor perceptions of the zoo experience and environment influence visitor behavior, including learning and concern for conservation (Clayton et al., 2009; Godinez & Fernandez, 2019; Hosey, 2005; Howell et al., 2019; Miller et al., 2018). Animal exhibits are a fundamental component of the zoo environment, yet, exhibits with poor animal welfare can negate the effects of education communication, as animals housed in insufficiently small and barren enclosures rarely display natural behaviors. Consequently, visitors spend less time at these exhibits (Bitgood et al., 1988; Fernandez et al., 2009). On the other hand, naturalistic exhibit design enhances animal welfare and promotes natural behavior, which increases visitor learning (Altman, 1998; Reade & Waran, 1996; Routman et al., 2010; Smith & Broad, 2008). Hence, even if signage is of a good standard, poor animal welfare can override any messaging delivered by the sign.

While many developed countries legislate welfare standards, some countries, such as Thailand, have minimal zoo regulation or zoo welfare standards (Agoramoorthy & Harrison, 2002; Bansiddhi et al., 2020). Additionally, in Thailand, zoo licensing standards do not stipulate educational requirements. Therefore, as noted by Puan and Zakaria (2007) and Roe et al. (2014), it is the decision of individual zoos whether or not to prioritize education, which depends upon management objectives and vision.

Understanding the educational contribution of zoos and wildlife tourist attractions in Southeast Asia has been approached from various angles. For example, Puan and Zakaria (2007) surveyed how zoo visitors in Malaysia perceive the role of zoos and their motivations and expectations of their visit. They found that visitors expected zoos to focus more on providing education and conservation than entertainment, despite visitors primarily visiting zoos for recreation. Their study also assessed which information visitors believed should be included on signage, but the authors did not assess the signage itself to see if it matched visitor expectations, nor did it assess how many zoos included signage. Another study by Schmidt-Burbach et al. (2015) found that 71% of 117 assessed wildlife entertainment venues in Thailand did not include any form of education. It is unclear whether signage was an educational component in the 29% of facilities that did provide some educational material. Thus, to the best of our knowledge, there are no studies that provide a more comprehensive analysis of zoo education in Thailand.

We defined three broad categories of zoos in Thailand that have different organizational objectives and priorities (1) accredited member zoos of the World Association of Zoos and Aquariums and the Southeast Asian Zoos Association; (2) Government-subsidized zoos, including wildlife rescue centers and open zoos that receive rescue or confiscated wildlife and are open to the public, which are run by the Department of National Parks, Wildlife, Plants and Conservation (only one of which is accredited), and provincial zoos located in small towns operated by the local government or military; and (3) private zoos that are not accredited members of zoo organizations and are for-profit businesses that frequently provide captive wildlife entertainment including shows, demonstrations, and other human-animal-interactions.

Of these three zoo classifications, welfare issues have been reported at government zoos due to under-funding and housing large numbers of confiscated wildlife (Fuller, 2013; Wonruang, 2018); substandard welfare in private zoos (Agoramoorthy & Hsu, 2005; Cohen, 2009; Schmidt-Burbach et al., 2015); and issues reported by Agoramoorthy and Harrison (2002) in evaluated member zoos in the Southeast Asian Zoos Association (referred to as accredited zoos in this study). Agoramoorthy (2004) subsequently published conditions had improved in these zoos after being brought to the attention of zoo management.

There are other factors that may also be correlated with the use and quality of signs. The cost of admission is one variable worthy of investigation, as income generated from ticket prices can facilitate the fulfillment of conservation and education objectives (Godinez & Fernandez, 2019). Whether this finding applies to accredited zoos and other zoo types in Thailand is unknown. Another factor that may be associated with the quality of education is the size of the zoo, as larger facilities will likely have more resources and dedicated education departments compared to smaller zoos (Crudge et al., 2016).

A further factor concerns how zoos are traditionally located near urban areas and usually hold distinctive positions in the community

(Patrick & Tunnicliffe, 2012). The proximity of a zoo to an urban center may influence education provision as zoos in these locales generally have higher visitor numbers (Nekolný & Fialová, 2018). Despite the absence of legislative requirements, visitors could reasonably expect quality education in accordance with established zoo roles. To the best of our knowledge, these variables are unassessed for their effect on educational signage quality.

The overall aim of this study was to evaluate animal identification signage usage and quality in Thai zoos. We predicted that the use and quality of signs are related to animal welfare, zoo type, admission fee, zoo size, and proximity to the urban centers. Specifically, we expected (1) a positive relationship between the quality of signs and animal welfare; (2) the type of zoo would influence signage score, with accredited zoos scoring better than private zoos; (3) zoos with higher admission fees would have higher signage scores; and (4) larger zoos located closer to urban centers have higher signage scores. To the best of our knowledge, this study is the first to investigate the relationship between signage and animal welfare and is important as zoos are increasingly recognized to hold an important role in educating the general public on biodiversity awareness, of which a vital aspect is proper signage and good animal welfare.

2 | MATERIALS AND METHODS

2.1 | Study zoos

We visited 55 zoos located throughout Thailand between July and September 2020. All institutions were visited during public opening hours by the same research team. To compare signage between institutions, we decided to focus on hornbills (Bucerotidae). Hornbills are large (up to 130 cm in length), often colorful birds, with a unique breeding system (females are sealed into their nest cavities before egg-laying) (Kinnaird & O'Brien, 2007), and they are commonly held by Thai zoos. Thirteen species of hornbills are native to Thailand (Trisurat et al., 2013); nine are threatened according to the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (hereafter the Red List). All these species are protected under Thai law (Phassaraudomsak et al., 2019). Hornbills play a unique role in the ecosystem as seed dispersers; populations have declined in Thailand largely due to habitat destruction (Poonswad et al., 2013; Trisurat et al., 2013) and the wildlife trade (Beastall et al., 2016; Phassaraudomsak et al., 2019).

2.2 | Signage

We photographed all hornbill signs at exhibits and when required translated signs into English using a professional translator. We used a directed approach to content analysis (Hsieh & Shannon, 2005) to assess signage content using the key attributes of signs (species name, distribution, habitat, diet and conservation status) as identified from the literature (Fraser et al., 2009). We observed more exhibits than signs, so if one exhibit had more than one sign, we averaged the signage score for

that exhibit. We referred to Kinnaird and O'Brien (2007) and Robson (2008) to assess the accuracy of the content. For this study, we evaluated sign quality based on the inclusion of the aforementioned attributes, the accuracy of content, language(s) of sign, and the physical condition of the sign, that is, if the sign is old and/or faded.

We developed a scoring system and framework to ensure that we scored the signs systematically and recorded the following information from signs: species name as listed (scientific name, common name in Thai and English); type of sign (static or interactive); the language of the sign (including accuracy of translation); inclusion of photographs, illustration or graphic; inclusion of Red List status; legal status under Thai law which indicates whether the species is protected or not; distribution; habitat; information on behavior and biology; use of interactive materials and the physical condition of the sign. We assigned each attribute a score between one and three, with attributes weighted for importance (Table 1). If signage was missing from an exhibit, we assigned an overall score of zero for that exhibit.

2.3 | Animal welfare

We conducted simple welfare assessments of all on-display hornbill exhibits. While a comprehensive welfare audit is preferable, we could not evaluate back of house conditions or obtain information from zoos regarding the individual histories of the birds. Many private zoos are reluctant to permit requests to assess their welfare conditions due partly to public criticism of the poor standards within such zoos (Cohen, 2013; Daly, 2019; World Animal Protection, 2018). Instead, we focused on primarily evaluating resource-based parameters (husbandry conditions) as these could be readily observed by members of the public yet still allow us to make inferences about welfare conditions. Moreover, many Thai zoos exhibit birds in enclosures without back of house areas (A. Fourage pers. observ.); therefore, we feel that the exhibits are fair representations of the actual conditions.

We based the assessment on the Five Domains (Mellor, 2017), which recognize the importance of nutrition, environment, physical health, behavior, and mental health on animal welfare. We developed the welfare assessment by consulting the European Association of Zoos and Aquariums' Hornbill Husbandry Management Guidelines (Galama et al., 2002). We assessed 13 criteria (provision of water, species-appropriate diet, enclosure size, shade and light, provision of nest boxes and perches, the type of substrate, provision of vegetation, appropriate social grouping, cleanliness of the enclosure, environmental noise, provision of enrichment, and the ability to perform natural behaviors). We scored the variables as zero (inadequate welfare), one (welfare needs improvement), and two (good welfare), with a maximum of 26 points available.

2.4 | Other variables

We recorded the zoo admission fees in Thai Baht and converted them into US dollars (using rates on March 22, 2021 from www.xe.com).

TABLE 1 Signage scoring attributes with their weighting in parentheses

Attribute and weighted score	Score (0)	Score (1)	Score (2)	Score (3)
Name of species (3)	No name	Incorrect common Thai/English name	Inaccurate scientific name	Correct Thai name, English name, Scientific name
Language of sign (3)	One language - Thai or English only	Sign is bilingual or trilingual but has many translation mistakes	Sign is bilingual or trilingual and has a few translation mistakes	Sign is bilingual or trilingual with no translation mistakes
Photo/illustration (1)	No photograph or illustration	Includes accurate photograph and/or illustration	n/a	n/a
IUCN Red List Status (2)	No Red List status provided	Includes Red List status, but this is outdated (e.g., lists Vulnerable status but is now Endangered)	An up-to-date Red List status is provided	n/a
Thai legal status (2)	No status is provided	n/a	Includes an accurate status	n/a
Distribution (3)	No information or information has major mistakes (e.g., wrong continent)	Mainly inaccurate or vague (e.g., lists range countries)	Information is accurate but misses out some range countries	Information is thorough and accurate
Habitat (2)	No information is provided	Includes some information but includes at least one inaccuracy (e.g., lowland plains instead of the rainforest)	Information is comprehensive and accurate	n/a
Behavior and biology (3)	No information	Includes information but contains at least one inaccuracy	Information is all accurate but limited to two facts (e.g., size and reproduction habits)	Information is comprehensive and accurate
Use of interactive materials (1)	No use of interactive elements such as QR codes	Inclusion of interactive elements such as a QR code	n/a	n/a
Condition of sign (3)	Sign cannot be read as it is so damaged, faded, or dirty	Sign is damaged, faded, or dirty in parts, and some information cannot be read	Sign is in reasonable condition, but shows wear and tear	Sign is made from durable material and is in very good condition and is clear and easy to read

Note: The maximum possible score is 23. N/a denotes where no score is available due to weighting.

When zoos charged different admission fees for foreigners, as is a relatively common practice in tourist attractions in Thailand, we used the ticket price for an adult foreigner. We used Google Maps to calculate the distance from zoos to urban centers. If the zoo size was not available online, we calculated the size in hectares using CalcMaps (2015) (www.calcmaps.com). We did not calculate zoo size by the number of species and specimens or visitor numbers because in many cases, we could not obtain such information from some of the zoos included in this study.

2.5 | Data analysis

To investigate whether the signage and welfare scores were influenced by the type of zoo (governmental, accredited, and private), size of the zoo, proximity to urban centers, and admission fee, we ran generalized linear mixed models via the “glmmTMB” command in the package “glmmTMB” (Brooks et al., 2017). We fit the raw data to distributions for zero-inflated count data. We tested the different distributions present in the package “glmmTMB” and selected the one with the lowest dispersion. We used the zoo name as a random effect to take into account the fact that some signs were from the same zoo. We checked for multicollinearity of the predictors via the “vif” function in the package “car” (Fox et al., 2012) and excluded admission fee from the analysis as it was collinear with the type of zoos. We tested the model diagnostics for model selection via the package “DHARMa” (Hartig, 2021). We selected the model based on QQ plot residuals and residual vs predicted plot. To check pairwise comparisons between the type of zoos, we ran a post hoc test with Bonferroni Holmes (BH) correction of the p-value using the package “emmeans” (Lenth, 2021). We also ran logistic regressions to determine whether the different categories used to assess the signage score differed between zoo types. We coded as zero when the sign received the lowest score in that category and as one when the sign received other scores. We only included the exhibits with signs for this analysis. We ran the analysis via R software v 4.0.4.

3 | RESULTS

We observed 172 hornbills of nine species (seven native and two non-native) on display in 106 exhibits in 18 zoos. We recorded 82 signs in 15 zoos; three private zoos did not have signs relating to hornbills. Over a third of exhibits had no signs (33.02%). Most hornbill exhibits at private zoos had no signs (ratio signs/exhibit = 0.34) compared with 1.08 for accredited zoos and 0.84 for government zoos. There was a wide variation in admission fees, zoo size, and distance to urban centers (Table 2).

3.1 | Relationship between signage, welfare, and other variables

Signage score and welfare score were positively correlated (two-tailed Spearman correlation: $\rho = 0.816$, $p < .001$) (Figure 1). The signage score

TABLE 2 Summary of investigated variables per zoo type with standard error (SE)

Type and number of zoos	No. of zoos with signage	No. of species	No. of hornbill	No. of hornbills	No. of exhibits	No. of signs	Mean signage score	Mean welfare score	Mean admission fee (USD)	Mean size of zoo (hectares)	Mean proximity to urban center (km)
Accredited (5)	5	8	7	75	49	53	15.58 SE 0.98	19.35 SE 0.52	4.86 SE 1.06	262.75 SE 138.18	24.42 SE 7.30
Private (7)	4	7	61	61	38	13	5.74 SE 2.32	10.99 SE 1.47	16.43 SE 3.42	20.07 SE 10.81	26.60 SE 11.75
Government (6)	6	7	36	36	19	16	12.09 SE 0.30	13.90 SE 0.76	4.92 SE 4.21	27.08 SE 21.08	36.80 SE 19.07
Total: 18	15	9	172	172	106	82	9.63 SE 0.79	15.37 SE 0.47	6.63 SE 0.87	111.98 SE 17.52	29.69 SE 2.40

Note: The mean signage score is per exhibit, as some exhibits had more than one sign. Maximum signage score = 23 and maximum welfare score = 26. Signage and welfare score mean for 106 exhibits.

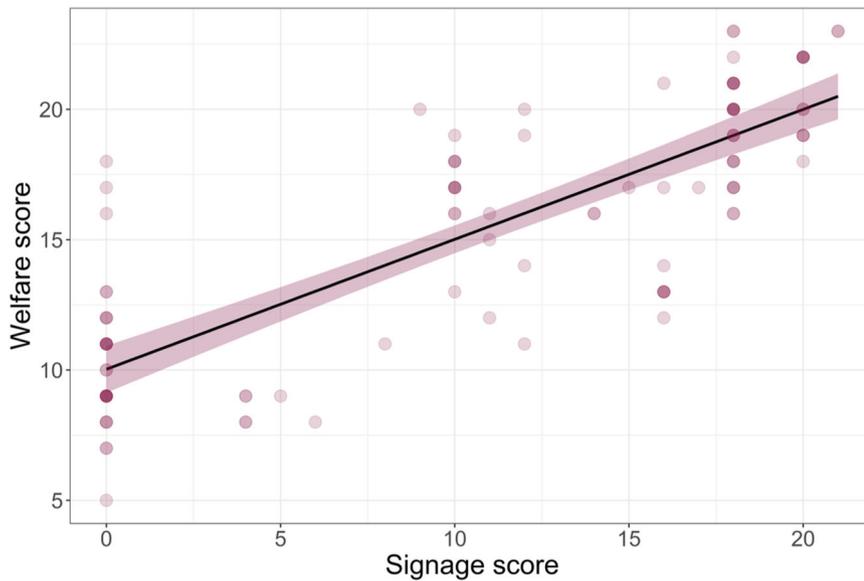


FIGURE 1 Positive correlation between signage score and welfare score of 106 exhibits in 18 zoos in Thailand. The line represents a linear trendline at a 95% confidence interval.

TABLE 3 Results of the generalized linear mixed models to predict the signage and welfare scores of 106 exhibits in 18 zoos in Thailand

Response	Predictor	Estimate	St. error	t-value	p-value
Signage score ^a	Intercept	3.022	0.636	4.749	<.001
	Proximity to urban centers	-0.009	0.008	-1.178	.238
	Size of zoo	0.001	0.002	0.308	.758
	Type of zoo: Government	-0.172	0.693	-0.249	.803
	Type of zoo: Private	-2.336	0.732	-3.188*	.001
Welfare score ^b	Intercept	2.935	0.095	30.973	<.001
	Proximity to urban centers	-0.001	0.001	-0.311	.758
	Size of zoo	0.8 E ⁻⁴	2.3 E ⁻⁴	0.331	.741
	Type of zoo: Government	-0.270	0.112	-2.420*	.016
	Type of zoo: Private	-0.547	0.107	-5.089	<.001

Note: Type of zoo: Accredited zoo was set as the reference category. "a" family fit: Poisson; "b" family fit: genpois; * $p < .05$.

was significantly lower in private zoos than in governmental (BH post hoc odds ratio government/private: $8.701 \pm SE 5.410$, $t = 3.478$, $p = .002$) and in accredited zoos (BH post hoc odds ratio accredited/private: $10.340 \pm SE 7.571$, $t = 3.188$, $p = .003$) (Table 3; Figure 2). We found a higher welfare score in accredited zoos than in private zoos (BH post hoc odds ratio accredited/private: $1.732 \pm SE 0.186$, $t = 5.089$, $p < .001$), in governmental zoos than in private zoos (BH post hoc odds ratio government/private: $1.320 \pm SE 0.129$, $t = 2.835$, $p = .008$) and in accredited zoos than in governmental zoos (BH post hoc odds ratio government/accredited: $1.314 \pm SE 0.146$, $t = 2.420$, $p = .017$). Of the three zoos without any hornbill signage, all three were private zoos, and all scored below average on welfare, with one zoo having the lowest welfare score in this study. The signage and welfare scores were not influenced by the size of the zoo and its proximity to urban centers (Table 3).

3.2 | Signage content, accuracy, and quality

The overall mean signage score for all 106 exhibits was 9.93 (SE 0.79), and the mean score for the 82 signs observed was 15.10 (SE 0.58) across all zoos out of a maximum score of 23. We found the signs to vary considerably in accuracy and quality (Table 4). The highest scoring attribute was Species Name, with most signs ($n = 78$) including the common Thai, English, and Scientific names. The lowest scoring attribute was the Thai legal status, where most signs did not include this information. Only a third of signs included an accurate IUCN Red List conservation status. The primary issues concerned distribution, where some range countries were either missing or vague, for example, "Asia." A third of the signs had overly simplistic information about habitat, such as only stating "rainforest," without including details such as elevation. We found inaccurate information on biology and behavior, which mainly

FIGURE 2 Significant results of the generalized linear mixed models to predict the signage and welfare scores of 106 exhibits in 18 zoos in Thailand. Plotted data are predicted model values (a) box plots embedded in violin plots representing the signage score (predicted model values based on proportions over the maximum value 23) in relation to the type of zoo; (b) box plots embedded in violin plots representing the welfare score (predicted model values based on proportions over the maximum value 26) in relation to the type of zoo.

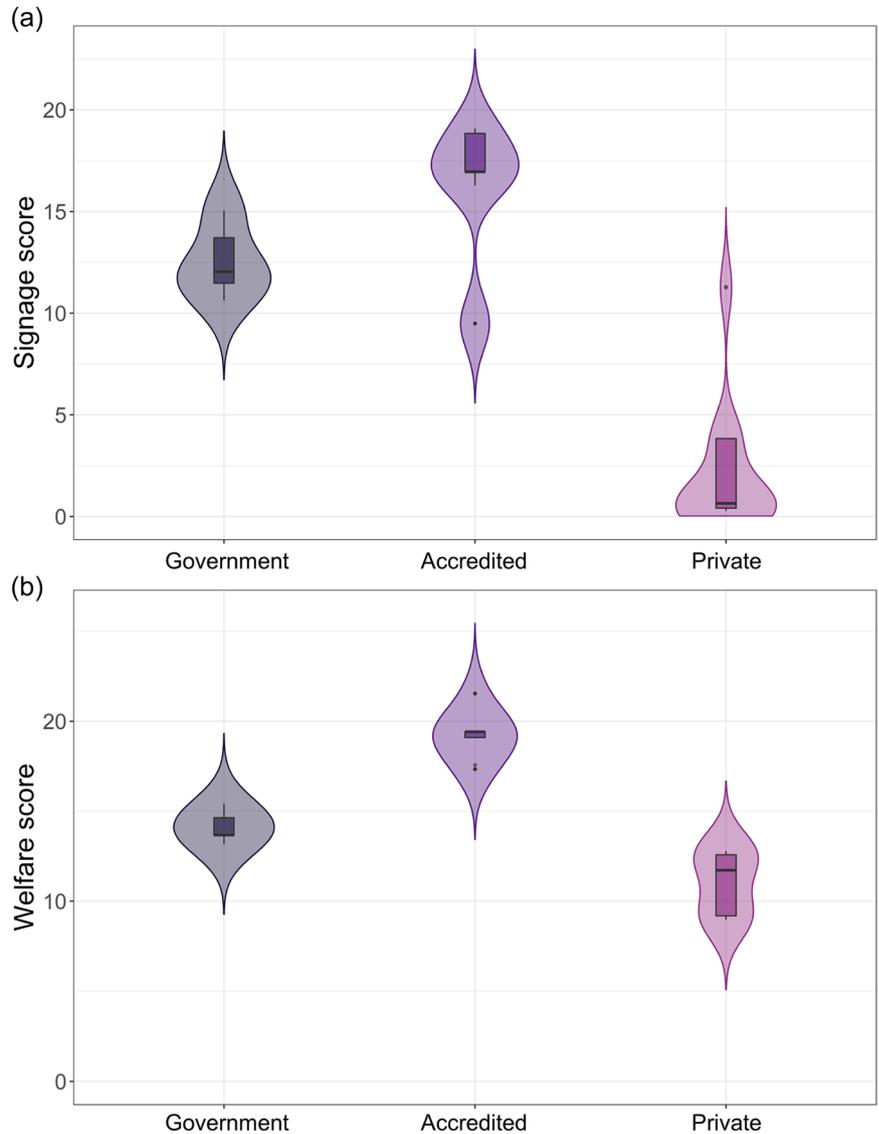


TABLE 4 Breakdown of 82 signs scoring in rank order of the highest score per attribute frequency

Score Signage attribute	Frequency (n and %) of attribute score							
	0		1		2		3	
	n	%	n	%	n	%	n	%
Name of species	2	2.44	0	0	2	2.44	78	95.12
Inclusion of photo or illustration	8	9.76	74	90.44	n/a	n/a	n/a	n/a
Information on behavior and biology	10	12.19	7	8.54	8	9.76	57	69.51
Condition of sign	2	2.44	11	13.41	12	14.63	57	69.51
Language of sign; quality of language	33	40.24	1	1.22	2	2.44	46	56.08
Distribution	15	18.29	3	3.66	22	26.83	42	51.22
IUCN Red List status	35	42.68	23	28.05	24	29.27	n/a	n/a
Habitat	21	25.61	39	47.56	22	26.83	n/a	n/a
Interactive material	62	75.61	20	24.39	n/a	n/a	n/a	n/a
Thai legal status	64	78.05	n/a	n/a	18	21.95	n/a	n/a

Note: n/a denotes where no score was possible due to the weighting of scores.

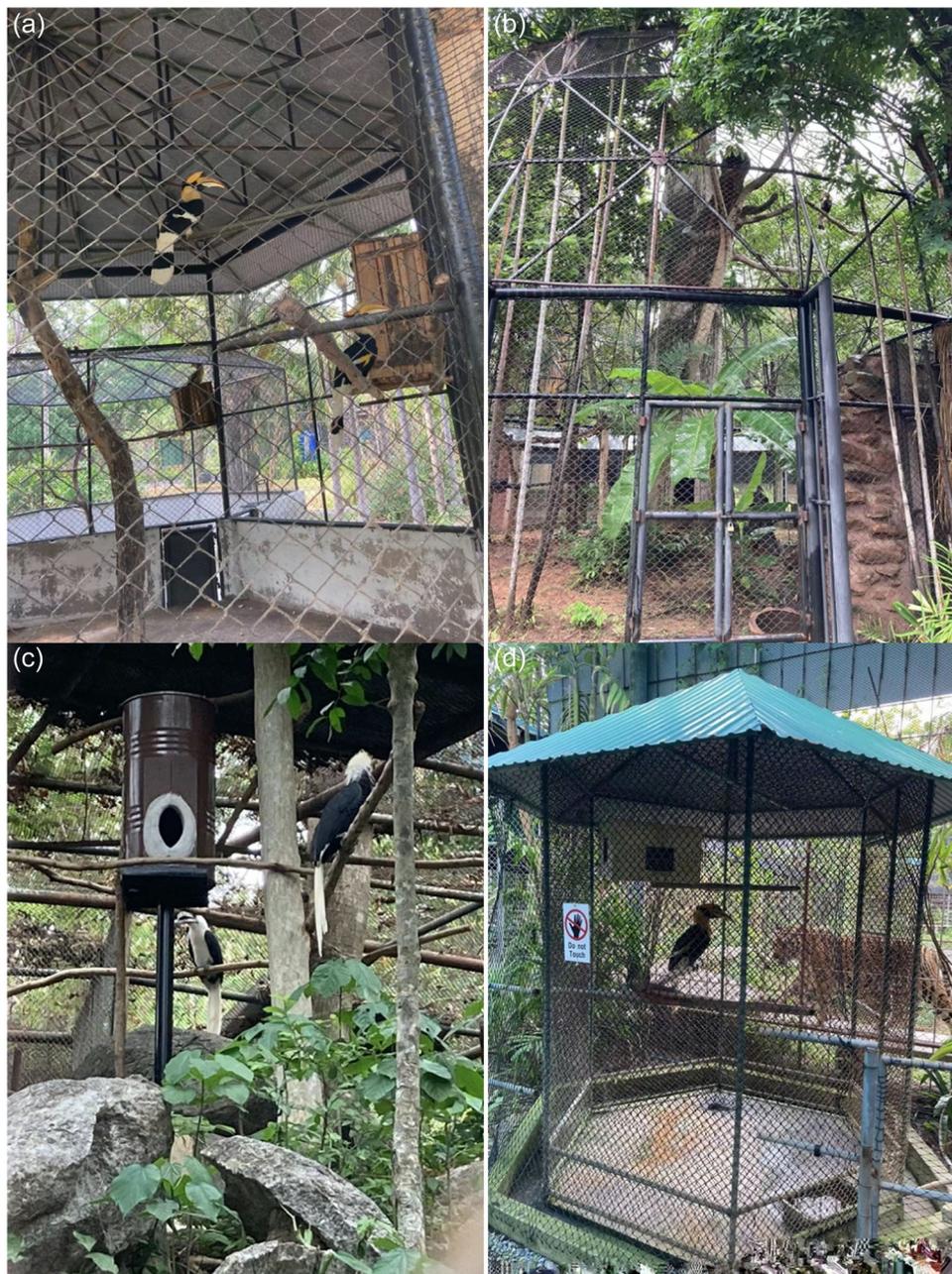


FIGURE 3 Hornbill exhibits at zoos in Thailand and their welfare scores in parentheses (out of a maximum of 26): (a) Great Hornbill exhibit at a government zoo (12); (b) Hornbill exhibit at an accredited zoo (23); (c) White Crowned Hornbill exhibit at an accredited zoo (20); (d) Great Hornbill exhibit at a private zoo (7).

concerned reproductive behavior or physical characteristics. In terms of signage condition, a minority ($n = 13$) were in a poor state, that is, faded, broken, or so dirty that signs were difficult to read. We found a range of different styles and quality signs (Figure 3); most were of durable quality made from PVC or aluminum, but some were made of paper.

In accredited and governmental zoos, signs were significantly better based on logistic regressions (Table 5) than in private zoos in terms of inclusion of pictures, information on habitat, behavior, and biology. Accredited zoos were significantly better than private zoos in including information on distribution, conservation status, and having signage in Thai and English (Table 5). One accredited zoo had one

trilingual sign (Thai, English, and Mandarin). No signs from private zoos included a Red List or Thai legal status. In general, all zoo types had low scores related to the inclusion of information on the Thai legal status and interactive elements such as QR codes (Figure 4).

4 | DISCUSSION

In our evaluation of the prevalence and quality of animal identification signs at hornbill exhibits in Thai zoos and factors that influence this, we found that signage score is strongly correlated with animal

TABLE 5 Estimated model means based on logistic regressions with each category included in the signage score as a response variable (0: minimum score, 1: other scores) in relation to the type of the zoo.

	Government (G)	Accredited (A)	Private (P)	Sig. differences
Language	0.31 (0.12)	0.81 (0.05)	0.08 (0.07)	A > G,P
Species name	1.00 (0.00)	1.00 (0.00)	0.85 (0.10)	
Photo or illustration	1.00 (0.00)	1.00 (0.00)	0.38 (0.13)	P < G,A
ICUN Red List status	0.31 (0.12)	0.79 (0.06)	0.00 (0.00)	A > G > P
Thai legal status	0.31 (0.12)	0.25 (0.06)	0.00 (0.00)	
Distribution	0.69 (0.12)	0.94 (0.03)	0.46 (0.14)	A > G,P
Habitat	0.63 (0.12)	0.91 (0.04)	0.23 (0.12)	P < G,A
Behavior & biology	0.88 (0.08)	1.00 (0.00)	0.38 (0.13)	P < G,A
Interactive	0.38 (0.11)	0.26 (0.06)	0.00 (0.00)	
Condition of sign	1.00 (0.00)	1.00 (0.00)	0.85 (0.10)	

Note: The exhibits without signs were not included in the analysis.

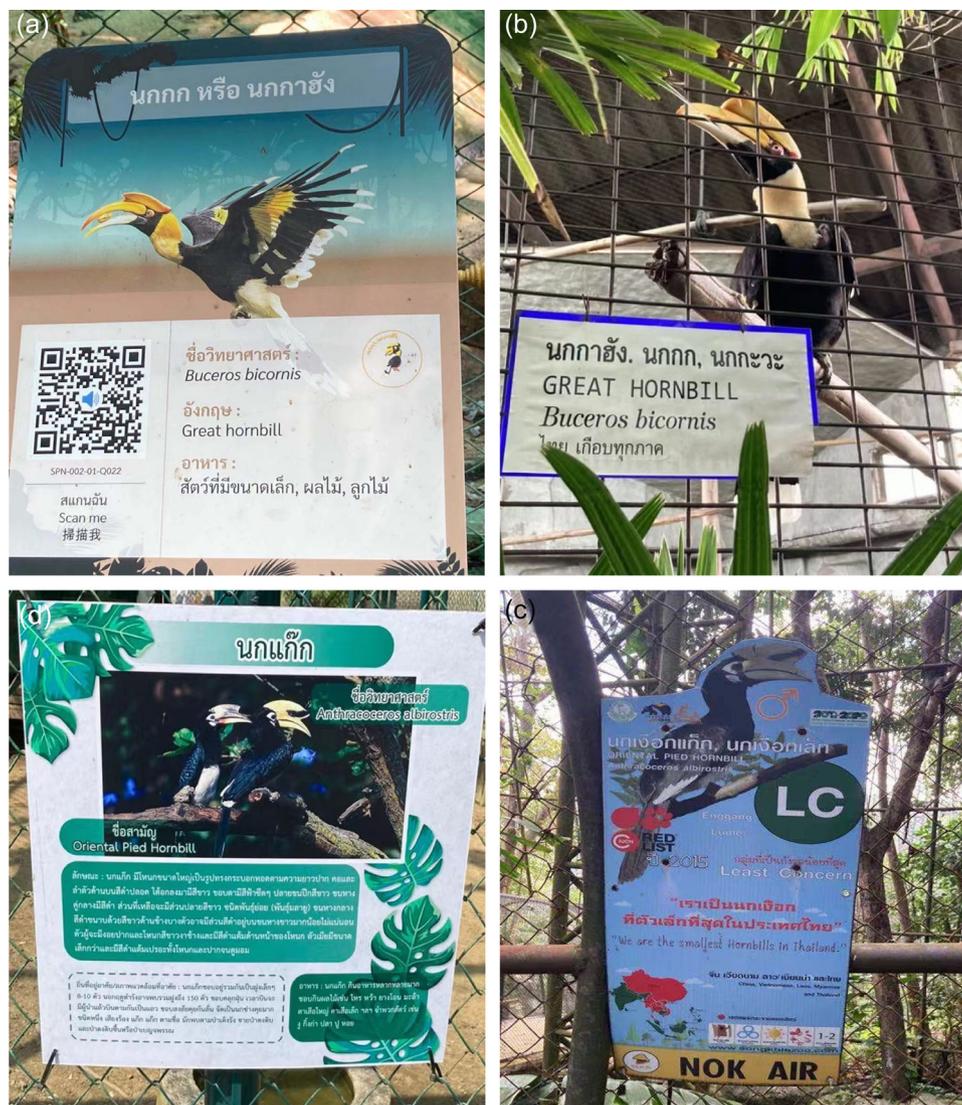


FIGURE 4 Hornbill signs observed at zoos in Thailand and their scores in parentheses (out of a maximum 23): (a) sign at a government zoo with QR code (10); (b) sign listing species name only at a private zoo (4); (c) sign in Thai at a government zoo (11); (d) sign at an accredited zoo (19).

welfare score and zoo type. In particular, accredited zoos scored higher on both signage and animal welfare than government and private zoos. Additionally, accredited zoos had a higher ratio of signs per exhibit than other zoo types.

The provision of animal identification signs at zoo exhibits is considered a basic component of zoo-based learning for visitors (Fogelberg, 2014). Therefore, the overall poor prevalence of signage usage, with one-third of the total exhibits missing signage, is a concern because it deprives visitors of learning opportunities and conservation awareness. Previous research by Roe et al. (2015) showed that 97% of zoos surveyed worldwide used animal identification signs at exhibits. In Thailand, Schmidt-Burbach et al. (2015) found that only 29% of facilities included any educational content (the type of content is unknown); in contrast, we found that 83% of zoos had signage. The differences in these findings may be due to all of the zoos included in Roe et al.'s (2015) study being accredited, compared to 33% in ours. Schmidt-Burbach et al. (2015) only assessed private facilities that predominantly held single species used for tourist entertainment, whereas we also included accredited and government zoos.

We also showed how the quality of signage attributes is affected by zoo type. The most significant of these is that accredited and government zoos scored higher for the inclusion of pictures, information on habitats, behavior and biology, and conservation status, whereas private zoos contained less specific information, particularly for distribution and habitat. For example, some signs used one word "forest" for a description of habitat, or instead of listing the individual countries of distribution, simply stated "Asia." The total exclusion of the Thai legal status and the Red List status, both the lowest scoring attributes in this study, from signs at private zoos suggests that private zoos are not motivated to provide such information to their visitors or do not employ specialized zoo educators.

In contrast, government zoos scored highest for the inclusion of the Thai legal status, possibly because they often care for confiscated wildlife in their facilities. Similarly, the inclusion of the Red List status on 79% of signs in accredited zoos suggests a desire to educate the public on conservation status in line with the objectives of a modern zoo. However, it is worth noting that a study by Dove (2016) found that zoo visitors do not always understand the Red List classification system and the difference between a threatened or endangered status. Further research could be helpful in determining how to present information on conservation status in a clearer way. Additionally, it is important to note that the outdated status of some of these signs highlights the challenges of keeping static signage up to date. The use of electronic graphics for signage could help update content and keep information relevant (Kelling & Kelling, 2014; Swanagan, 2000).

Furthermore, the absence of both the protected legal status and the Red List status fails to highlight the threatened conservation standing of most Asian hornbill species – a disconcerting factor given the rapid decline of hornbill populations in Thailand (Trisurat et al., 2013) due to the increase in trade (Beastall et al., 2016;

Phassaraudomsak et al., 2019). Moreover, zoo visitors have shown a preference for including conservation information on signage (Ballantyne & Packer, 2016; Fraser et al., 2009; Puan & Zakaria, 2007). As such, a strong case remains that zoos must educate visitors on how they can contribute to the conservation of globally threatened species (Ballantyne et al., 2007; Smith & Broad, 2008).

Almost 40% of signage observed in this study was in Thai only. This result, particularly for private zoos, was unanticipated due to the 39.8 million international tourists who visited Thailand in 2019 (Statista, 2021), many of whom desired interactive experiences with captive animals. Tourists from China are the largest international visitor group, comprising 27.5% of 2019 foreign arrivals (10.99 million people) (Statista, 2021), yet we observed only one sign in the Chinese language. As China is a major market for hornbill products (Phassaraudomsak et al., 2019), providing signage in the Chinese language in zoos with many Chinese visitors is an opportunity to emphasize the important role of these species in ecosystems and highlight wildlife trade issues.

Despite the absence of technology such as touch screens and digital media in all zoos, just under a quarter of signs included a QR code with information available in Thai and English. Adding additional language options (such as Chinese) for QR codes could be helpful, especially as studies show technology can help to enhance the visitor experience, especially for the younger generation (Clay et al., 2011; Leask et al., 2014; Yocco et al., 2011). However, there may be challenges with the successful adoption of this media, including resistance to change from institutions and the reluctance of visitors to pay for additional data charges (Arita-Kikutani & Sakamoto, 2007). Therefore, further research is needed to investigate the feasibility of this educational tool in Southeast Asia.

Perhaps the most striking finding of this study is the strength of the positive correlation between the quality of animal welfare and signage. We expected that accredited zoos would score higher on welfare than government zoos and private zoos, consistent with how the literature describes welfare in these zoo types (Fuller, 2013; Schmidt-Burbach et al., 2015; Wonruang, 2018). Several possible factors explain this result, including insufficient budgets and personnel trained in animal welfare (Fuller, 2013; Wonruang, 2018), organizational goals and priorities, and finally, the impact of poor regulation and absent zoo standards (Schmidt-Burbach et al., 2015; Wild Welfare, 2019). Both animal welfare legislation and zoo licensing requirements in Thailand do not explicitly mandate welfare standards (Dorloh, 2017). The implications of this are exemplified in the zoo with the lowest welfare score in this study (which also had no signage). This zoo kept a wreathed hornbill (*Rhyticeros undulatus*), a bird with a wingspan measuring up to 75–85 cm (Kemp & Boesman, 2020), in a 100 cm × 70 cm × 100 cm unfurnished wooden cage. Guidelines by the European Association of Zoos and Aquariums stipulate a minimum cage size of three meters high and a width of four wingspans to allow flight. As legislation in Thailand does not define "shelter," substandard facilities can operate with little consequence as they are not breaking the law (Wild Welfare, 2019).

Therefore, our finding supports the assumption that the provision of good signs may indicate that management is more likely

to provide good welfare. This assumption is related to the organizational priorities of zoos, whereby accredited zoos should be obliged by their objectives to meet welfare and educational objectives, while the private zoos included in this study are not accredited and may simply prioritize profit. In zoos where the visitor experience is already negated due to poor welfare (see Miller et al., 2018; Smith & Broad, 2008), the lack of good signage could reinforce the notion that zoos are not valuable educational institutions. A note of caution is due here as the organizational priorities of many private zoos included in our study can neither be proved nor generalized.

Our results showed that private zoos have substantially higher admission fees than accredited and government zoos, which is likely due to two reasons. Firstly, accredited zoos and government zoos in Thailand are subsidized and, in most cases, obligated to maintain low ticket prices to ensure affordability to local people. Indeed, Cain and Meritt (1998) observed that some zoos in the USA maintain low admission fees to encourage visits from low-income families. This observation cannot be generalized as there is a wide variation of fees charged by zoos throughout the world. Secondly, visitors to private zoos (many of whom are international tourists) are willing to pay a premium for interactions with charismatic species, such as tigers (*Panthera tigris*) and Asian elephants (*Elephas maximus*) (World Animal Protection, 2018). The ability to charge higher admission clearly indicates high visitor demand despite a zoo's focus on entertainment rather than educational contribution. Consequently, zoos may view visitor education as unnecessary or fear that highlighting threats faced by species while showing these same wild animals for commercial purposes could be harmful to their business.

Lastly, the finding that there is no relationship between signage score, zoo size, and proximity to urban centers was surprising. One possible reason for this result is the small sample size of private zoos in this study (a minority of these zoos keep hornbills compared to the total number of private zoos that focus on other species). Further studies that include animal identification signs for other species would increase the number of zoos included in the analysis. We also acknowledge the limitations of measuring welfare at one point in time and solely from the public view, as it is possible that we did not observe activities that may have affected the overall welfare score (such as the provision of enrichment). Nevertheless, we remain confident that we obtained information sufficient for the purposes of the assessment.

5 | CONCLUSIONS

Although most zoos used animal identification signs, we conclude that the overall ratio of signs per exhibit was low. Our research showed a strong positive correlation between the prevalence and quality of signs and animal welfare and that the quality of signs varied significantly according to the zoo type. Accredited zoos had the highest quality signage and welfare, while private zoos had the lowest. Many signs either did not include a Red List status, or the

status was outdated, and many signs did not include the hornbill's protected status under Thai law, which is concerning given the threats facing these species. This study supports hornbill conservation by highlighting the inadequate use of signs and the inferior welfare standards of many hornbill exhibits. The organizational priorities of zoo types, one that incorporates education as an institutional priority and another as a for-profit business, most likely play a significant role in our findings. The inclusion of specific educational objectives as part of zoo licensing requirements is much needed, and the provision of guidelines and other resources can assist zoos lacking specialized personnel or education departments. Finally, current legislation should be amended to include measurable and international welfare standards (such as the Five Domain model of welfare) and zoo standards that explicitly outline species-specific welfare requirements that need to be implemented and enforced. With the implementation of these measures, zoo conservation education can better meet global conservation goals.

ACKNOWLEDGEMENTS

We thank our colleagues for reviewing this manuscript and for their helpful comments and support. We thank the reviewers for their valuable comments and suggestions, which have helped us improve the quality of our manuscript. We confirm that no specific funding was received for this study.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

- Agoramoorthy, G. (2004). Ethics and welfare in southeast asian zoos. *Journal of Applied Animal Welfare Science*, 7, 189–195. https://doi.org/10.1207/s15327604jaws0703_5
- Agoramoorthy, G., & Harrison, B. (2002). Ethics and animal welfare evaluations in south east asian zoos: A case study of Thailand. *Journal of Applied Animal Welfare Science*, 5, 1–13.
- Agoramoorthy, G., & Hsu, M. J. (2005). Use of nonhuman primates in entertainment in Southeast Asia. *Journal of Applied Animal Welfare Science*, 8, 141–149.
- Altman, J. D. (1998). Animal activity and visitor learning at the zoo. *Anthrozoos: A Multidisciplinary Journal of the Interactions of People & Animals*, 11, 12–21. <https://doi.org/10.2752/089279398787000869>
- Arita-Kikutani, H., & Sakamoto, K. (2007). Using a mobile phone tour to visit the Ueno zoological gardens and The National science museum in Tokyo, Japan. *Journal of Museum Education*, 32, 35–46.
- Arumugam, K. A., & Annavi, G. (2019). Captive breeding of threatened mammals native to Southeast Asia – A review on their ex-situ management, implication and reintroduction guidelines. *Annual Research & Review in Biology*, 30, 1–16. <https://doi.org/10.9734/ARRB/2018/45921>
- Ballantyne, R., & Packer, J. (2016). Visitors' perceptions of the conservation education role of zoos and aquariums: Implications for the provision of learning experiences. *Visitor Studies*, 19, 193–210. <https://doi.org/10.1080/10645578.2016.1220185>
- Ballantyne, R., Packer, J., Hughes, K., & Dierking, L. (2007). Conservation learning in wildlife tourism settings: Lessons from research in zoos and aquariums. *Environmental Education Research*, 13, 367–383. <https://doi.org/10.1080/13504620701430604>

- Bansiddhi, P., Brown, J. L., & Thitaram, C. (2020). Welfare assessment and activities of captive elephants in Thailand. *Animals: An Open Access Journal from MDPI*, 10, 919. <https://doi.org/10.3390/ani10060919>
- Beastall, C., Shepherd, C. R., Hadiprakarsa, Y., & Martyr, D. (2016). Trade in the helmeted hornbill *Rhinoplax vigil*: The 'ivory hornbill'. *Bird Conservation International*, 26, 137–146. <https://doi.org/10.1017/S0959270916000010>
- Bitgood, S., Patterson, D., & Benefield, A. (1988). Exhibit design and visitor behavior: Empirical relationships. *Environment and Behavior*, 20, 474–491. <https://doi.org/10.1177/0013916588204006>
- Brooks, M. E., Kristensen, K., van Benthem, K. J., Magnusson, A., Berg, C. W., Nielsen, A., Skaug, H. J., Maechler, M., & Bolker, B. M. (2017). glmmTMB balances speed and flexibility among packages for zero-inflated Generalized Linear Mixed Modeling, 9, 378–400.
- Cain, L. P., & Meritt, D. A. (1998). The growing commercialism of zoos and aquariums. *Journal of Policy Analysis and Management*, 17, 298–312. [https://doi.org/10.1002/\(SICI\)1520-6688\(199821\)17:2<298:AID-PAM10>3.0.CO;2-F](https://doi.org/10.1002/(SICI)1520-6688(199821)17:2<298:AID-PAM10>3.0.CO;2-F)
- Calcmaps. (2015). <https://www.calcmaps.com/map-area/>
- Carr, N., & Cohen, S. (2011). The public face of zoos: Images of entertainment, education and conservation. *Anthrozoos*, 24, 175–189. <https://doi.org/10.2752/175303711X12998632257620>
- Clay, A. W., Perdue, B. M., Gaalema, D. E., Dolins, F. L., & Bloomsmith, M. A. (2011). The use of technology to enhance zoological parks. *Zoo Biology*, 30(5), 487–497. <https://doi.org/10.1002/zoo.20353>
- Clayton, S., Fraser, J., & Saunders, C. D. (2009). Zoo experiences: Conversations, connections, and concern for animals. *Zoo Biology*, 28, 377–397. <https://doi.org/10.1002/zoo.20186>
- Cohen, E. (2009). The wild and the humanized: Animals in Thai tourism. *Anatolia*, 20, 100–118. <https://doi.org/10.1080/13032917.2009.10518898>
- Cohen, E. (2013). Buddhist compassion and animal abuse in Thailand's tiger temple. *Society and Animals*, 21, 266–283. <https://doi.org/10.1163/15685306-12341282>
- Crudge, B., O'Connor, D., Hunt, M., Davis, E. O., & Browne-Nuñez, C. (2016). Groundwork for effective conservation education: An example of in situ and ex situ collaboration in South East Asia. *International Zoo Yearbook*, 50, 34–48.
- Daly, N. (2019). Suffering unseen: The dark truth behind wildlife tourism. National Geographic. <https://www.nationalgeographic.co.uk/dark-truth-behind-wildlife-tourism>
- Dierking, L. D., & Falk, J. H. (1994). Family behaviour and learning in informal science settings: A review of the research. *Science Education*, 78, 57–72.
- Dorloh, S. (2017). The protection of animals in Thailand: An insight into animal protection legislation. *International Journal of Humanities and Cultural Studies*, 4, 58–63.
- Dove, T. (2016). Investigating factors which affect visitor understanding of the information displayed on species signs: A multi-method evaluation approach. *International Zoo Educators Association Journal*, 52, 39–42.
- Ehrlich, P. R., & Pringle, R. M. (2008). Where does biodiversity go from here? a grim business-as-usual forecast and a hopeful portfolio of partial solutions. *Proceedings of the National Academy of Sciences of the United States of America*, 105, 11579–11586. <https://doi.org/10.1073/pnas.0801911105>
- Fernandez, E. J., Tamborski, M. A., Pickens, S. R., & Timberlake, W. (2009). Animal-visitor interactions in the modern zoo: Conflicts and interventions. *Applied Animal Behaviour Science*, 120, 1–8. <https://doi.org/10.1016/j.applanim.2009.06.002>
- Fogelberg, K. (2014). Unsilencing voices: A study of zoo signs and their language of authority. *Cultural Studies of Science Education*, 9, 787–799. <https://doi.org/10.1007/s11422-013-9566-8>
- Fox, J., Weisberg, S., Adler, D., Bates, D., Baud-Bovy, G., Ellison, S., Firth, D., Friendly, M., Gorjanc, G., Graves, S., & Heiberger, R. (2012). Package 'car'. R Foundation for Statistical Computing.
- Fraser, J., Bicknell, J., Sickler, J., & Taylor, A. (2009). What information do zoo & aquarium visitors want on animal identification labels? *Journal of Interpretation Research*, 14, 7–18. <https://doi.org/10.1177/109258720901400202>
- Fuller, T. (2013). A burden of care over exotic wildlife in Thailand. *New York Times*, 4 February. <https://www.nytimes.com/2013/02/05/world/asia/thailand-faces-a-noahs-ark-size-burden-of-wildlife-care.html>
- Galama, W., King, C., & Koen, B. (2002). *EAZA hornbill management and husbandry guidelines*. EAZA Hornbill TAG.
- Godinez, A. M., & Fernandez, E. J. (2019). What is the zoo experience? How zoos impact a visitor's behaviors, perceptions, and conservation efforts. *Frontiers in Psychology*, 10, 1746–1747. <https://doi.org/10.3389/fpsyg.2019.01746>
- Gusset, M., & Dick, G. (2011). The global reach of zoos and aquariums in visitor numbers and conservation expenditures. *Zoo Biology*, 30, 566–569. <https://doi.org/10.1002/zoo.20369>
- Hartig, J. (2021). DHARMA: Residual diagnostics for hierarchical (multi-level/mixed) regression Models. <https://cran.r-project.org/web/packages/DHARMA>
- Hosey, G. R. (2005). How does the zoo environment affect the behaviour of captive primates? *Applied Animal Behaviour Science*, 90, 107–129. <https://doi.org/10.1016/j.applanim.2004.08.015>
- Hosey, G. R., Melfi, V., & Pankhurst, S. (2013). *Zoo animals: Behaviour, management and welfare* (2nd ed.). Oxford University Press.
- Howell, T. J., McLeod, E. M., & Coleman, G. J. (2019). When zoo visitors "connect" with a zoo animal, what does that mean? *Zoo Biology*, 38, 461–470. <https://doi.org/10.1002/zoo.21509>
- Hsieh, H. F., & Shannon, S. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, 15, 1277–1288.
- Kelling, N., & Kelling, A. (2014). Zooar zoo based augmented reality signage. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 58. <https://doi.org/10.1177/1541931214581230>
- Kemp, A. C., & Boesman, P. F. D. (2020). Wreathed Hornbill (*Rhyticeros undulatus*), version 1.0. In J. del Hoyo & A. Elliott (Eds.), *Birds of the World*. Cornell Lab of Ornithology. <https://doi.org/10.2173/bow.wrehor1.01>
- Kinnaird, M. F., & O'Brien, T. G. (2007). *The ecology and conservation of Asian hornbills: Farmers of the forest*. University of Chicago Press.
- Kolbert, E. (2014). *The sixth extinction: An unnatural history*. Henry Holt.
- Leask, A., Fyall, A., & Barron, P. (2014). Generation Y: An agenda for future visitor attraction research. *International Journal of Tourism Research*, 16, 462–471. <https://doi.org/10.1002/jtr.1940>
- Lenth, R. V. (2021). Emmeans: Estimated marginal means, Aka Least-Squares Means. R Package Version 1.6.1. <https://CRAN.R-project.org/package=emmeans>
- Luebke, J. F., Watters, J. V., Packer, J., Miller, L. J., & Powell, D. M. (2016). Zoo visitors' affective responses to observing animal behaviors. *Visitor Studies*, 19, 60–76. <https://doi.org/10.1080/10645578.2016.1144028>
- Mellish, S., Ryan, J. C., Pearson, E. L., & Tuckey, M. R. (2019). Research methods and reporting practices in zoo and aquarium conservation-education evaluation. *Conservation Biology*, 33, 40–52. <https://doi.org/10.1111/cobi.13177>
- Mellor, D. J. (2017). Operational details of the five domains model and its key applications to the assessment and management of animal welfare. *Animals: An Open Access Journal from MDPI*, 7, 8. <https://doi.org/10.3390/ani7080060>
- Miller, L. J., Luebke, J. F., & Matiassek, J. (2018). Viewing African and Asian elephants at accredited zoological institutions: conservation intent and perceptions of animal welfare. *Zoo Biology*, 37, 466–477. <https://doi.org/10.1002/zoo.21445>

- Moss, A., & Esson, M. (2013). The educational claims of zoos: Where do we go from here? *Zoo Biology*, 32, 13–18. <https://doi.org/10.1002/zoo.21025>
- Moss, A., Jensen, E., & Gusset, M. (2015). Evaluating the contribution of zoos and aquariums to Aichi Biodiversity Target 1: Educational impacts of zoo visits. *Conservation Biology*, 29, 537–544. <https://doi.org/10.1111/cobi.12383>
- Navarro-perez, M., & Tidball, K. G. (2012). Challenges of biodiversity education: A review of education strategies for biodiversity education. *International Electronic Journal of Environmental Education*, 2, 13–30.
- Nekolný, L., & Fialová, D. (2018). Zoo tourism: What actually is a zoo? *Czech Journal of Tourism*, 7, 153–166. <https://doi.org/10.1515/cjot-2018-0008>
- Packer, J., & Ballantyne, R. (2010). The role of zoos and aquariums in education for a sustainable future. *New Directions for Adult and Continuing Education*, 127, 25–34.
- Patrick, P. G., Matthews, C. E., Ayers, D. F., & Tunnicliffe, S. D. (2007). Conservation and education: prominent themes in zoo mission statements. *The Journal of environmental education*, 38, 53–60. <https://doi.org/10.3200/JOEE.38.3.53-60>
- Patrick, P. G., & Tunnicliffe, S. D. (2012). Rationale for the existence of zoos. *Zoo Talk*, 19–35. https://doi.org/10.1007/978-94-007-4863-7_3
- Perdue, B. M., Maple, T. L., & Stoinski, T. S. (2012). Using technology to educate zoo visitors about conservation. *Visitor Studies*, 15, 16–27. <https://doi.org/10.1080/10645578.2012.660839>
- Phassaraudomsak, M., Krishnasamy, K., & Chng, S. C. L. (2019). *Trading faces: Online trade of helmeted and other hornbill species on Facebook in Thailand*. Malaysia: TRAFFIC.
- Poonswad, P., Chimchome, V., Mahannop, N., & Mudsri, S. (2013). Conservation of hornbills in Thailand. *Conservation Biology*, 19, 157–166. <https://doi.org/10.1002/9781118679838.ch19>
- Puan, C. L., & Zakaria, M. (2007). Perception of visitors towards the role of zoos: A Malaysian perspective. *International Zoo Yearbook*, 41, 226–232.
- Reade, L. S., & Waran, N. K. (1996). The modern zoo: how do people perceive zoo animals. *Applied Animal Behaviour Science*, 47, 109–118. [https://doi.org/10.1016/0168-1591\(95\)01014-9](https://doi.org/10.1016/0168-1591(95)01014-9)
- Robson, C. (2008). *Birds of Southeast Asia* (2nd ed.). Bloomsbury Publishing.
- Roe, K., McConney, A., & Mansfield, C. F. (2014). The role of zoos in modern society—A comparison of zoos' reported priorities and what visitors believe they should be. *Anthrozoos*, 27, 529–541. <https://doi.org/10.2752/089279314X14072268687808>
- Roe, K., McConney, A., & Mansfield, C. F. (2015). How do zoos 'talk' to their general visitors? do visitors 'listen'? A mixed method investigation of the communication between modern zoos and their general visitors. *Australian Journal of Environmental Education*, 30, 167–186. <https://doi.org/10.1017/ae.2015.1>
- Routman, E., Ogden, J., & Winsten, K. (2010). Visitors, conservation learning, and the design of zoo and aquarium experiences. In D. G. Kleiman, K. V. Thompson & C. K. Bear (Eds.), *Wild mammals in captivity - Principles & techniques for zoo management* (pp.137–150). University of Chicago Press.
- Schmidt-Burbach, J., Ronfot, D., & Srisangiam, R. (2015). Asian elephant (*Elephas maximus*), pigtailed macaque (*Macaca nemestrina*) and tiger (*Panthera Tigris*) populations at tourism venues in Thailand and aspects of their welfare. *PLoS ONE*, 10, e0139092.
- Serrell, B. (1996). *Exhibit labels: An interpretive approach*. AltaMira Press.
- Smith, L., & Broad, S. (2008). Do zoo visitors attend to conservation messages? A case study of an elephant exhibit. *Tourism Review International*, 11, 225–235.
- Statista. (2021). Number of international tourist arrivals in Thailand from 2015 to 2020. <https://www.statista.com/statistics/994693/thailand-number-international-tourist-arrivals/>
- Swanagan, J. S. (2000). Factors influencing zoo visitor's conservation attitudes and behavior. *Journal Environmental Education*, 31, 26–31.
- Trisurat, Y., Chimchome, V., Pattanavibool, A., Jinamoy, S., Thongaree, S., Kanchanasakha, B., Simcharoen, S., Sribuarod, K., Mahannop, N., & Poonswad, P. (2013). An assessment of the distribution and conservation status of hornbill species in Thailand. *Oryx*, 47, 441–450. <https://doi.org/10.1017/S0030605311001128>
- Wild welfare. (2019). Conditions in Samut Prakan Croc Farm & Zoo and Phuket Zoo. <https://wildwelfare.org/conditions-in-samutprakarn-croc-farm-zoo-and-phuket-zoo/>
- Wonruang, P. (2018). Special report: A refuge for impounded wildlife. The Nation Thailand. https://www.nationthailand.com/big_read/30355923
- World Animal Protection. (2018). <https://www.worldanimalprotection.org/news/captive-tiger-breeding-breeds-suffering-thailand-must-enforce-ban>
- Yocco, V., Danter, E. H., Heimlich, J. E., Dunckel, B. A., & Myers, C. (2011). Exploring use of new media in environmental education contexts: Introducing visitors' technology use in zoos model. *Environmental Education Research*, 17, 801–814. <https://doi.org/10.1080/13504622.2011.620700>

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Fourage, A., Shepherd, C. R., Campera, M., Nekaris, K. A. I., & Nijman, V. (2023). It's a sign: Animal welfare and zoo type are predictors of animal identification signage usage and quality at zoo exhibits. *Zoo Biology*, 42, 283–295. <https://doi.org/10.1002/zoo.21734>