

RESEARCH ARTICLE

Thirty Years Later: Enrichment Practices for Captive Mammals

Julia M. Hoy,* Peter J. Murray, and Andrew Tribe

School of Animal Studies, The University of Queensland, Gatton Campus, Queensland, Australia

Environmental enrichment of captive mammals has been steadily evolving over the past thirty years. For this process to continue, it is first necessary to define current enrichment practices and then identify the factors that limit enhancing the quality and quantity of enrichment, as well as the evaluation of its effectiveness. With the objective of obtaining this information, an international multi-institutional questionnaire survey was conducted with individuals working with zoo-housed mammals. Results of the survey showed that regardless of how important different types of enrichment were perceived to be, if providing them was particularly time-consuming, they were not made available to captive mammals as frequently as those requiring less staff time and effort. The groups of mammals provided with enrichment most frequently received it on average fewer than four times per day, resulting in less than two hours per day spent by each animal care staff member on tasks related to enrichment. The time required for staff to complete other husbandry tasks was the factor most limiting the implementation and evaluation of enrichment. The majority of survey respondents agreed that they would provide more enrichment and carry out more evaluation of enrichment if it was manageable to do so. The results of this study support the need for greater quantity, variety, frequency, and evaluation of enrichment provided to captive mammals housed in zoos without impinging on available staff time. *Zoo Biol* 29:303–316, 2010. © 2009 Wiley-Liss, Inc.

Keywords: captive mammals; environmental enrichment; evaluation; survey; questionnaire

*Correspondence to: Julia M. Hoy, School of Animal Studies, The University of Queensland, Gatton Campus, Queensland 4343, Australia. E-mail: j.hoy@uq.edu.au

Received 25 July 2008; Accepted 20 March 2009

DOI 10.1002/zoo.20254

Published online 11 May 2009 in Wiley InterScience (www.interscience.wiley.com).

INTRODUCTION

Captive animal management has improved dramatically since the first quantitative enrichment study was published [Yanofsky and Markowitz, 1978] thirty years ago [Shyne, 2006]. In recent years there has been exponential growth in the publication of articles about enrichment, which indicates that it is a growing field [de Azevedo et al., 2007]. Nonetheless, for zoos to be able to contribute to conservation means that in the future they will need to be “extraordinary” in terms of challenging themselves and their current practices [Hutchins, 2003; WAZA, 2005]. To date, enrichment has only had partial success [Mason et al., 2007] and in order to significantly improve current enrichment practices, and consequently the welfare of captive animals, it is necessary to quantify current practices.

Enrichment involves the addition of stimuli or the provision of choices [de Azevedo et al., 2007], designed to stimulate any one or more of the senses and can originate from animal keepers, zoo visitors, and the surrounding environment. Bloomsmith et al. [1991] described the five broad categories of enrichment as social, physical, occupational, sensory, and nutritional. It can be difficult to decide which types of enrichment should be provided to a specific group of animals at any given time, yet the goal of an enrichment program should be to provide mammals with enrichment from every category [Bloomsmith et al., 1991].

Another aim of enrichment is to increase the complexity of the captive environment both physically and temporally [Carlstead and Shepherdson, 2000], as such it is necessary to consider periods outside the normal working hours of animal care staff as this can be a relatively large proportion of the day. The practice of unchaining elephants overnight has been shown to be an effective form of enrichment [Brockett et al., 1999; Wilson et al., 2006], otherwise little published research exists on the specific provision of enrichment outside staff working hours.

It is imperative that the effectiveness of enrichment provided to every captive animal is accurately evaluated, as some enrichment can inadvertently have a negative impact on animals [Bloomsmith et al., 1991; Shyne, 2006]. In addition, responses to enrichment can vary considerably between institutions [Bloomsmith et al., 1991] and individual captive mammals [Shepherdson et al., 2004]. There is also the potential for unintended consequences of enrichment as animals discover unique ways of using it [e.g. Bayne, 2005; Markowitz, 1982]. Furthermore, a lack of available time and money within many institutions affirms the need to ensure that enrichment is efficacious. The importance of evaluating the effectiveness of enrichment has been recognized by many institutions housing captive animals, although the magnitude and precision of the evaluation varies [Roberts, 2005]. To confirm enrichment actually occurred, evaluation is required to determine whether the well-being of the animals improved and thus whether the strategy was actually effective enrichment. For the purpose of this study, the term enrichment was defined as any husbandry activity that has the specific *aim* of improving an animals wellbeing [Swaigood and Shepherdson, 2005].

The majority of literature regarding enrichment describes practices employed by staff within a zoo with the intent of increasing wellbeing for a specific group of animals with no discussion of the enrichment practices for all mammals within that zoo. Given this shortage of published information, this survey was designed to determine: (1) the variety of enrichment provided to zoo-housed mammals; (2) the

quantity of enrichment provided to zoo-housed mammals; (3) the methods used to evaluate the effectiveness of the enrichment provided; (4) the factors limiting the provision and evaluation of enrichment; and (5) whether respondents believe there is a need to improve current enrichment practices.

MATERIALS AND METHODS

Questionnaire

The questionnaire comprised 13 sections, with a total of 52 questions, in two response formats. The majority of the survey consisted of “scaled-response” questions, allowing the measurement of the respondents’ opinion toward each statement [Frazer and Lawley, 2000]. Several “close-ended” questions [Frazer and Lawley, 2000] were also included to provide further information in a structured manner. For questions regarding the specific work practices of animal care staff, participants who were not directly working with animals were given the option of indicating that they “were unaware of this information” or alternatively to state what they believed to be the situation. Approval to conduct the survey was granted by “The University of Queensland’s Behavioural and Social Sciences Ethical Review Committee” (Clearance number 2005000455).

Although enrichment is provided to other animals, this survey was limited exclusively to mammals which are the taxonomic group most commonly enriched [de Azevedo et al., 2007].

Definition of Terms

Prior to participants completing the questionnaire, the terms in Table 1 were defined and explained.

TABLE 1. Definition of the eight categories of enrichment used in the questionnaire

Enrichment category ^a	Definition	Examples
Feeding enrichment	Manipulation of food or method of providing food	Scattered food, hidden food, whole food, live food, puzzle feeders
Tactile enrichment	Provision of novel objects	Bags, balls, other toys
Structural enrichment	Alteration of the physical space of the enclosure	Using ground coverings, addition of natural or artificial structures
Auditory enrichment	Addition of natural or artificial sounds	Animal vocalizations, music
Olfactory enrichment	Addition of natural or artificial odors	Animal scents, perfumes
Visual enrichment	Addition of visual stimuli	Mirrors, televisions, reflectors
Social enrichment	Whereby the composition of a group is altered	Addition or removal of animals from an enclosure
Human-animal interactions	Organized interactions between animals and keepers or visitors	Positive reinforcement training

^aAs enrichment can involve more than one defined category, survey respondents were requested to classify enrichment based on what category they believed was most prominent.

Participants

Individuals working with captive mammals in husbandry, research, and management roles completed the survey. A total of 25 zoos across Australia, New Zealand, Singapore, and The United Kingdom were visited and their staff members were invited to complete the questionnaire. The questionnaire was also distributed to delegates at the seventh International Conference of Environmental Enrichment (ICEE) in New York, USA and at the eighth ICEE in Vienna, Austria, in addition to being posted on the Shape of Enrichment website (www.enrichment.org). A total of 238 questionnaires were completed, representing 60 zoos in 13 countries.

Statistical Analysis

The objectives of this study were to survey current enrichment practices, factors that limit enrichment, and evaluation of its effectiveness. As such, descriptive statistics were appropriate and sufficient for fulfilling the objectives. Although rare in scientific literature, reporting only descriptive statistics is preferable to applying complex statistical analysis in inappropriate circumstances [Kuhar, 2006; Plowman, 2008].

Although 238 respondents participated in the survey, various questions were not attempted by some participants because of a lack of direct knowledge in that area. No section within the survey was dependent on the previous responses of participants, so incomplete questionnaires were suitable for inclusion. As such, the number of respondents (n) varies with each question.

RESULTS

Importance of Different Varieties of Enrichment Provided to Captive Mammals

The survey respondents identified clear differences in the level of importance for each of the categories of enrichment (Table 2). Feeding enrichment was identified as the most important category of enrichment for captive mammals, followed by tactile enrichment and structural enrichment with visual enrichment rated as the least important (Table 2).

TABLE 2. Importance of the different categories of enrichment for captive mammals^a

	Percentage of responses ($n = 238$)			
	Very important	Important	Slightly important	Not important
Feeding enrichment	88.7	9.2	2.1	0.0
Tactile enrichment	70.2	26.1	3.4	0.4
Structural enrichment	67.2	31.1	1.7	0.0
Olfactory enrichment	42.9	41.6	13.4	2.1
Human-animal interactions	41.2	39.5	15.5	3.8
Social enrichment	34.0	36.6	25.1	4.3
Auditory enrichment	16.4	39.9	37.0	6.7
Visual enrichment	12.7	27.8	43.5	16.0

^aThe importance of different categories of enrichment would be likely to vary for different groups of mammals, so respondents were asked to provide a generalized opinion for all mammals.

Provision of Each Variety of Enrichment to Captive Mammals

When asked as to how many times each type of enrichment was actually provided to mammals during a typical week, it was shown that feeding enrichment was provided most frequently (Table 3). Visual enrichment was provided the least often, with only 1.8% of respondents making visual enrichment available to captive mammals several times daily, and over 75% of respondents never providing this form of enrichment (Table 3).

TABLE 3. Frequency with which each type of enrichment was provided to captive mammals over a one-week period^a

	Percentage of responses (<i>n</i> = 219)				
	Several times daily	Once a day	Several times a week	Once a week	Not at all
Feeding enrichment	53.0	26.9	15.5	3.7	0.9
Human-animal interactions	42.0	19.6	16.4	5.5	16.4
Tactile enrichment	21.9	38.8	29.2	6.8	3.2
Structural enrichment	5.0	10.5	21.0	35.2	28.3
Social enrichment	5.5	5.5	5.9	7.3	75.8
Olfactory enrichment	3.2	10.5	26.5	27.4	32.4
Auditory enrichment	3.2	6.4	8.7	7.8	74.0
Visual enrichment	1.8	3.7	8.2	11.0	75.3

^aEnrichment is not always able to be delivered or provided as it is often a process rather than a discrete event that can be accurately counted. Enrichment is also available inadvertently as a result of the surrounding environment, which also cannot be accurately quantified. Thus, this survey referred only to the staff effort to provide enrichment.

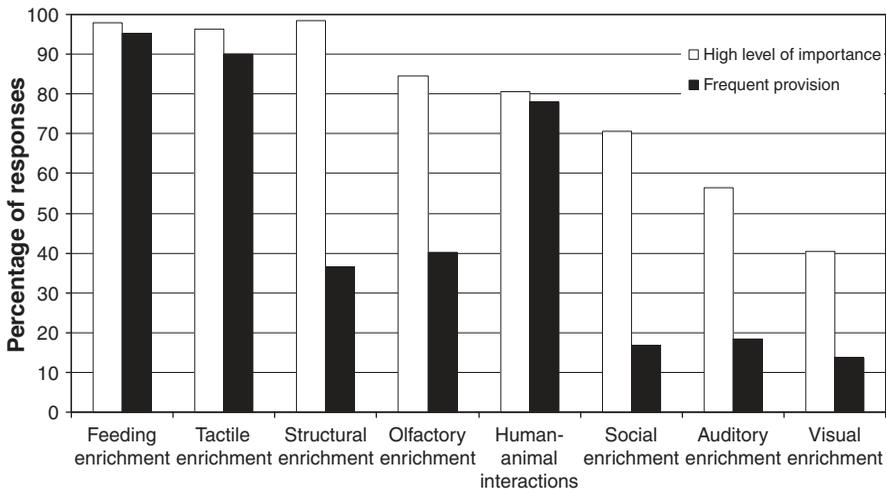


Fig. 1. Comparison between the perceived importance and actual frequency of provision of the different types of enrichment. A “high level of importance” is the total percentage of responses of “very important” and “important” (Table 2). “Frequent provision” is the total percentage of responses where enrichment was provided more than once during the week (Table 3).

The relatively unprocessed data in Tables 2 and 3 is open to interpretation, but for the purposes of this paper, “High level of importance” and “Frequent provision” were defined and graphed (Fig. 1) to illustrate the extent to which the perceived importance and actual provision of each type of enrichment differed. There was very little difference in the importance and frequency of feeding enrichment, tactile enrichment and to a slightly lesser extent, human–animal interactions (Fig. 1). The greatest difference between the importance and actual provision of the enrichment was observed with structural enrichment where it was considered to be as important as feeding and tactile enrichment, yet was undertaken relatively infrequently (Fig. 1). Olfactory enrichment was recognized as a relatively important form of enrichment in the survey and was provided more often than the other two forms of sensory enrichment (auditory and visual enrichment) (Fig. 1).

Factors Influencing the Schedule with which Enrichment was Provided

The most significant factor influencing the schedule for provision of different types of enrichment to specific animals was the time taken by animal care staff to complete other husbandry tasks with only 3.4% of respondents selecting this is never a limitation (Table 4). Over half of the respondents indicated that enrichment schedules were determined either by an individual staff member, or through the use of a formal calendar, or as a result of the availability of volunteers at least some of the time (Table 4). Identification of abnormal behavior of mammals also commonly influenced the enrichment schedule “some of the time” as there were only 16.0% of responses that this was never a factor in determining when enrichment was provided (Table 4).

Processes Used to Develop Ideas for Enrichment

The process most often used in developing new enrichment ideas was a formal approval process, with 46.8% of respondents often using this method (Table 5). Conversely, 45.1% of respondents often implemented some type of enrichment without any formal approval (Table 5). The use of published literature listing approved items for enrichment was a method regularly used “some of the time” to determine ideas as only 15.7% of respondents were not using this medium (Table 5).

TABLE 4. Factors influencing the schedule determining when enrichment is provided

	Percentage of responses (<i>n</i> = 235)		
	Often	Some of the time	Never
Time taken by animal care staff to complete other tasks	70.8	25.8	3.4
Responsibility of individual staff members	46.0	37.9	16.1
Formal enrichment calendar or schedule	30.5	33.7	35.7
Identification of abnormal behavior	23.0	60.9	16.0
Availability of volunteers	12.0	40.2	47.8

TABLE 5. Methods used in the development of ideas for enrichment

	Percentage of responses (<i>n</i> = 235)		
	Often	Some of the time	Never
Formal approval process	46.8	35.7	17.4
Devised and implemented by staff without formal approval	45.1	34.9	20.0
Responsibility of specific staff member/s	21.3	28.2	50.6
Literature listing approved enrichment items	13.6	70.6	15.7

TABLE 6. The number of times most and least frequently during a typical day that enrichment was provided to a single enclosure of animals

	Animals most often provided with enrichment (<i>n</i> = 190)		Animals least often provided with enrichment (<i>n</i> = 148)	
	Frequency (%)	Cumulative %	Frequency (%)	Cumulative %
Not at all	0	0	47.3	47.3
Once	12.1	12.1	33.8	81.1
Twice	24.2	36.3	16.2	97.3
Three times	27.4	63.7	2.7	100.0
Four times	20.5	84.2	0	0
Five times	6.3	90.5	0	0
Six times	5.3	95.8	0	0
Seven times	1.0	96.8	0	0
Eight times	3.2	100.0	0	0

Frequency of Provision of Daily Enrichment

Participants were asked to provide examples of specific enclosures of mammals that were provided with enrichment the greatest, or the least number of times in a day.

For the example where enrichment was provided most frequently, 84.2% of respondents provided enrichment four times or less to a single enclosure (Table 6). The average number of times enrichment was provided to these animals was 3.2 (± 0.12) times per day. With regards to the animals provided with enrichment least frequently, 81.1% of respondents supplied them with enrichment once or less (Table 6). A total of 47.3% of respondents reported that they did not provide any enrichment at all in a day to the groups of mammals identified as being provided with enrichment least frequently (Table 6). The average frequency of provision of enrichment for these animals was 0.74 (± 0.07) times per day.

Time Spent by Animal Care Staff on Tasks Related to Enrichment

Close to a third of respondents (27.7%) stated that they spent less than an hour on tasks related to enrichment during a typical day (*n* = 213). 39.5% of respondents spent 1 hour on enrichment, 21.6% spent two hours, and 5.6% spent three hours. Only 5.6% of respondents spent four hours or more on tasks related to enrichment,

with a maximum response from two respondents of six hours spent on tasks relating to enrichment per day. The majority of respondents (88.8%) spent two hours or less on tasks related to enrichment each day with the average calculated to be 1.4 (± 0.08) hours per day.

Taxonomic Groups Provided with the Most Enrichment

Respondents identified the groups of animals that received the greatest quantity of enrichment in a day to be Primates (50.6%; $n = 182$), followed by Carnivora (26.4%), Artiodactyla (14.8%), Rodentia (3.8%), Proboscidea (2.7%), and 1.7% of responses covered animals in other mammalian orders.

After-Hours Enrichment

Participants were asked to specify how much enrichment was provided to mammals outside the normal working hours of animal care staff as compared with during working hours. Over two-thirds of respondents reported that less enrichment was made available outside normal working hours, with only 11.1% of respondents providing more enrichment than during working hours (Table 7). With regard to how much enrichment the survey participants thought should actually be made available after-hours, only 18.7% of respondents selected less, thus 81.3% of respondents had the opinion that the same or more enrichment should be made available to captive mammals outside the working hours of staff (Table 7).

Methods Used to Evaluate the Effectiveness of Enrichment for Captive Mammals

The most commonly used method to evaluate the effectiveness of enrichment provided to captive mammals was through animal care staff making observations when time permitted, with 63.1% of respondents using this method often, and only 4.7% never using it as an evaluation method (Table 8). Almost half of the respondents indicated that evaluation was never carried out by a specific designated staff member, formally recorded and analyzed, or documented by volunteers (Table 8).

Factors Limiting the Provision of Enrichment

Participants selected up to three factors most limiting how much enrichment could be provided to captive mammals. The limiting factor most influencing how much enrichment was made available to mammals was the time taken by animal care

TABLE 7. Quantity of enrichment available to mammals outside the normal working hours of animal care staff

	Enrichment made available		Enrichment that should be available	
	Percentage of responses ($n = 225$)	Cumulative frequency (%)	Percentage of responses ($n = 219$)	Cumulative frequency (%)
None	14.2	14.2	5.5	5.5
Less	55.1	69.3	13.2	18.7
Same	19.6	88.9	32.4	51.1
Slightly more	8.9	97.8	27.4	78.5
Much more	2.2	100.0	21.5	100.0

TABLE 8. Methods used to evaluate the effectiveness of enrichment provided to captive mammals

	Percentage of responses ($n = 233$)		
	Often	Some of the time	Never
Observations made by animal care staff when time permits	63.1	32.2	4.7
Regular documentation by animal care staff	44.6	38.2	17.2
The responsibility of a specific staff member	18.0	33.0	48.9
Formal recording of data followed by statistical analysis	7.7	43.3	48.9
Regular documentation by volunteers	6.9	39.5	53.6

TABLE 9. Factors limiting evaluation of the effectiveness of enrichment

	Percentage of responses ($n = 233$)		
	Often	Some of the time	Never
A lack of time available for staff to evaluate	74.2	24.0	1.7
A lack of appropriate equipment	46.4	41.6	12.0
A lack of education in methods of quantitative evaluation	36.1	39.1	24.9
The availability of students or volunteers to evaluate	27.5	45.9	26.6

staff to complete other tasks, comprising 26.2% of all responses ($n = 660$). The next two most limiting factors were the time required for preparing enrichment (22.0%) and the time needed to distribute the enrichment to each enclosure (20.3%). The cost of producing enrichment was also considered a limiting factor by respondents (13.2%). The need to evaluate new enrichment was less of a limiting factor, comprising 8.5% of responses. The two least significantly limiting factors were the time required for cleaning and maintenance of enrichment items and enclosures (6.2%), and the availability of volunteers to prepare enrichment (3.6%).

Factors Limiting Evaluation of the Effectiveness of Enrichment

The factor most limiting the quantity and quality of evaluation of enrichment was the lack of staff time available to do so with 74.2% of respondents selecting this as often being a limitation, and only 1.7% reporting it as never a limitation (Table 9). A lack of suitable equipment was the next most limiting factor, with only 12.0% of respondents not reporting this to be a limitation (Table 9).

Would More Enrichment be Provided if it was Manageable?

When requested to indicate their level of agreement with the statement: "More enrichment would be provided to mammals if it was manageable", 42.1% of respondents ($n = 233$) "Strongly agreed", 42.1% "Agreed", 13.3% were "Neutral", and 2.6% "Disagreed".

Would More Evaluation be Carried out if it was Manageable?

When requested to indicate their level of agreement with the statement: "More evaluation of enrichment would be carried out if it was manageable", 38.0% of respondents ($n = 234$) "Strongly agreed", 47.0% "Agreed", 12.8% were "Neutral", and 2.1% "Disagreed" with the statement.

DISCUSSION

Current Enrichment Practices

The observed differences in the level of importance, and the frequency of provision of each of the different categories of enrichment to captive mammals (Tables 2 and 3) has also been reported in the literature where different types of enrichment are not represented equally in published enrichment studies [de Azevedo et al., 2007].

The level of importance and the frequency of provision were similar and relatively high for feeding enrichment, tactile enrichment, and human–animal interactions (Fig. 1). There were disparities in the importance and provision of the other categories of enrichment with the frequency of provision lower than the importance (Fig. 1). These disparities may reflect difficulties involved with providing those categories of enrichment as compared with feeding enrichment, tactile enrichment, and human–animal interactions.

The result that feeding enrichment was considered the most important (Table 2) and provided most frequently (Table 3) may be because feeding enrichment is the most studied and published form of enrichment in zoos [de Azevedo et al., 2007; Swaisgood and Shepherdson, 2005]. This is perhaps due to the fact that feeding is essential and feeding enrichment can be relatively easy to implement and an immediate and recognizable effect can be observed. Furthermore, the most obvious difference between the lives of captive and wild mammals is the time and effort expended finding and processing food [Hosey, 2005]. Consequently, feeding captive mammals in a similar manner to the wild is a complex issue [Young, 1997].

The greatest difference between the importance and actual provision of enrichment was observed with structural enrichment where it was considered to be as important as feeding enrichment, yet was undertaken relatively infrequently (Fig. 1). Although structural enrichment is the most common form of enrichment provided for rodents in small enclosures within laboratories [de Azevedo et al., 2007], the larger and more substantial architecture of enclosures in zoos can make changing structures much more difficult than providing other forms of enrichment due to the increased labour and other costs required. Furthermore, the physical space available even in the largest of zoo enclosures is likely to be considerably less than most mammals would range over in the wild [Hosey, 2005]. As such, all mammals can benefit from appropriate, and changing enclosure structures as they can provide sources of novelty, variability, complexity, and stimulus change [Maple and Perkins, 1996].

In addition to the relative ease of providing olfactory enrichment, the result that it was considered the most important form of sensory enrichment (Fig. 1) may be due to the considerable recent research into the area of olfactory enrichment and publication of the positive effects that scents can have on the behavior of captive

mammals [Shyne, 2006; Swaisgood and Shepherdson, 2005]. The reduced level of importance and frequency of the other forms of sensory enrichment may reflect the complexity of sensory information, perception differences between species, and an inability to measure sensory information [de Azevedo et al., 2007].

Scheduling when different varieties of enrichment should be provided to specific animals and enclosures was most dependent on the time taken by staff to complete other husbandry tasks (Table 4). Thus, to maximize the time staff members have for enrichment, it is important that an enrichment program is efficacious, which requires a proactive, clearly defined plan [Mellen and Sevenich MacPhee, 2001]. When developing new ideas for enrichment, a formal approval process was commonly undertaken (Table 5). It has been suggested that formal approval using a committee or specified individual should explore the feasibility of different types of enrichment [Stewart, 2004] and should generate staff accountability, which can be key to the success of an enrichment program [Mellen and Sevenich MacPhee, 2001]. The proportion of respondents that used formal approval processes was similar to the proportion that implemented enrichment without formal approval (Table 5). This may reflect the suggestion that it is important to strike a balance between a strict approval process while also encouraging input from animal care staff as time delays while waiting for approval to be granted and a lack of control over the outcome can demotivate staff [Young, 2003].

New ideas for enrichment often depend on previously reported successes [Mason et al., 2007] and the results of this study show that it is a common practice to implement enrichment ideas provided and evaluated for a similar group of animals elsewhere, without any major modification (Table 5). Although possibly a good starting point for ideas, enrichment concepts originating from literature sources should still be evaluated in terms of their efficacy for the individual animals to which they are being provided, due to variations in animal responses in different situations [Bloomsmith et al., 1991; Hosey, 1997].

In terms of the quantity of enrichment provided, the addition of new enrichment into an enclosure less than four times per day (Table 6) is likely to result in considerably less stimuli than would occur for mammals in the wild. Nevertheless, spending two hours a day on tasks related to enrichment can be a relatively high proportion of a keeper's working day considering the multitude of other husbandry tasks requiring their attention. Fortunately, enrichment does not necessarily need to be time-consuming with some of the most effective methods involving very little effort on the part of the staff, while occupying a great deal of the animals' time and attention [Schapiro, 1997]. It is a common practice for staff to be responsible for various animals across a large variety and number of enclosures. As such, spending a total of an hour or two on enrichment is not likely to result in a large amount of time spent providing enrichment to animals in each enclosure. Furthermore, it is likely that this time spent on enrichment will be relatively predictable to the animals as it is most likely to fall into a few narrow periods where staff members are available during the day.

The groups of animals most often provided with enrichment were Primates and Carnivora, which are the two orders the majority of zoo enrichment studies also focus on [de Azevedo et al., 2007; Swaisgood and Shepherdson, 2005]. However, all captive mammals can benefit from enrichment and de Azevedo et al. [2007] suggest that there is a need to broaden the range of species enriched.

The majority of survey respondents provided captive mammals with the same amount or less enrichment after normal working hours than during the day, yet the majority of respondents believed that the same or more enrichment should be provided after hours (Table 7). Interestingly, Carnivores were a group often provided with the most enrichment, yet many species are nocturnal and would be most active at night while keepers were not present. In captivity, animals are exposed to the stimuli provided for them by their keepers, by visitors, and by their surroundings. During periods where staff are not working and visitors are not present, the sources of external stimuli are substantially reduced.

As the influence of enrichment varies from one animal to the next, it is important to assess how often the enrichment is used, the degree to which the enrichment is preferred by the animals, and how effective the enrichment is [Mason et al., 2007]. In this study, the most commonly used method to evaluate the efficacy of enrichment was the observations made by animal care staff, when time permitted (Table 8). The most common form of evaluation of enrichment published in the literature involves monitoring changes in animal behavior using a time budget [de Azevedo et al., 2007], which is time-consuming for staff and would be unachievable using only observations when time permitted. According to the results of this study, this type of formal evaluation is not undertaken often (Table 8). Furthermore, only 18% of respondents reported that evaluation of the effectiveness of enrichment was often carried out by a specific staff member, while almost half of the respondents indicated that it never occurred (Table 8). In contrast, Maple [2007] has suggested that zoos should recruit or collaborate with a doctoral-level animal behaviorist to systematically monitor animals in order to inform all aspects of zoo management.

Future Direction

The factors that respondents determined to most limit the provision and evaluation of enrichment involved a lack of time available for animal care staff. The fact that available time significantly limits an enrichment program is not a new problem and has been repeatedly noted in the literature [Bloomsmith et al., 1991; Mellen and Sevenich MacPhee, 2001; Newberry, 1995; Shepherdson, 1988; Young, 2003].

For an enrichment program to be effective in the long term, support is required from all levels of staff within an institution by providing sufficient resources to allow the most effective implementation and evaluation of enrichment [Mellen and Sevenich MacPhee, 2001].

The vast majority of survey respondents agreed that more enrichment would be provided, and more evaluation would be conducted if it was manageable. This further supports the findings that a lack of time was the greatest factor limiting what, when, where, and how much enrichment and evaluation was able to be implemented for captive mammals. These results show that there is a strong consensus from those working with captive mammals that current enrichment and evaluation practices should be improved.

CONCLUSIONS

As a lack of available staff time was identified as the greatest factor limiting the provision and evaluation of enrichment for captive mammals, there are essentially two possible solutions for improving current practices. These solutions are: (1) to

provide more staff or (2) to use methods to reduce the time taken to provide enrichment to captive mammals.

The evolution of enrichment over the past thirty years has been exponential, yet most survey respondents believed that current enrichment practices still need to be improved. This generates exciting possibilities for further development of captive animal management and enrichment practices over the next thirty years.

ACKNOWLEDGMENTS

The following institutions are acknowledged for willingly allowing J. Hoy to observe their enrichment practices and survey staff members: Adelaide Zoo, Alma Park Zoo, Auckland Zoo, Banham Zoo, Blackpool Zoo, Bristol Zoo, Chester Zoo, Colchester Zoo, Crocodylus Park, Edinburgh Zoo, Hamilton Zoo, London Zoo, Marwell Zoo, Melbourne Zoo, Orana Park, Paignton Zoo, Perth Zoo, Singapore Night Safari, Singapore Zoo, Suffolk Wildlife Park, Taronga Zoo, Twycross Zoo, Wellington Zoo, Welsh Mountain Zoo, and Whipsnade Wild Animal Park. Particular thanks are expressed to the individuals from each facility who enthusiastically orchestrated the processes involved with J. Hoy visiting and conducting the survey at their institution.

The organizing committees of both the seventh and eighth International Conference of Environmental Enrichment (ICEE) are acknowledged for providing J. Hoy with the opportunity to distribute the questionnaire to conference delegates. The Australasian Primate Society (APS) is acknowledged for awarding J. Hoy a scholarship toward attendance at the eighth ICEE.

Thanks are expressed to Professor W.L. Bryden for supporting this research and for encouraging the survey to be conducted in person.

The authors thank Mr. A. Lisle for statistical advice and Mr. E. Qualischeckski for assistance with the design of the questionnaire.

J. Hoy was supported by an Australian Postgraduate Award (APA) PhD Scholarship.

REFERENCES

- Bayne K. 2005. Potential for unintended consequences of environmental enrichment for laboratory animals and research results. *ILAR J* 46:129–139.
- Bloomsmith MA, Brent LY, Schapiro SJ. 1991. Guidelines for developing and managing an environmental enrichment program for nonhuman primates. *Lab Anim Sci* 41:372–377.
- Brockett RC, Stoinski TS, Black J, Markowitz T, Maple TL. 1999. Nocturnal behavior in a group of unchained female African elephants. 18:101–109.
- Carlstead K, Shepherdson D. 2000. Alleviating stress in zoo animals with environmental enrichment. In: Moberg GP, Mench JA, editors. *The biology of animal stress*. New York, NY: CABI Publishing. p 337–354.
- de Azevedo CS, Cipreste CF, Young RJ. 2007. Environmental enrichment: A GAP analysis. *Appl Anim Behav Sci* 102:329–343.
- Frazer L, Lawley M. 2000. *Questionnaire design and administration: a practical guide*. Milton, Queensland: John Wiley & Sons Australia. 119p.
- Hosey G. 2005. How does the zoo environment affect the behaviour of captive primates? *Appl Anim Behav Sci* 90:107–127.
- Hosey GR. 1997. Behavioural research in zoos: academic perspectives. *Appl Anim Behav Sci* 51:199–207.
- Hutchins M. 2003. Zoo and aquarium animal management and conservation: current trends and future challenges. *Int Zoo Yearb* 38:14–28.
- Kuhar CW. 2006. In the deep end: pooling data and other statistical challenges of zoo and aquarium research. *Zoo Biol* 25:339–352.
- Maple TL. 2007. Toward a science of welfare for animals in the zoo. *J Appl Anim Welf Sci* 10:63–70.
- Maple TL, Perkins LA. 1996. Enclosure furnishings and structural environmental enrichment.

- In: Kleiman DG, Allen ME, Thompson KV, Lumpkin S, editors. *Wild mammals in captivity*. Chicago: The University of Chicago Press. p 212–222.
- Markowitz H. 1982. Behavioral enrichment in the zoo. New York: Van Nostrand Reinhold Company. 210p.
- Mason G, Clubb R, Latham N, Vickery S. 2007. Why and how should we use environmental enrichment to tackle stereotypic behaviour? *Appl Anim Behav Sci* 102:163–188.
- Mellen J, Sevenich MacPhee M. 2001. Philosophy of environmental enrichment: past, present, and future. *Zoo Biol* 20:211–226.
- Newberry R. 1995. Environmental enrichment: increasing the biological relevance of captive environments. *Appl Anim Behav Sci* 44:229–243.
- Plowman AB. 2008. BIAZA statistics guidelines: toward a common application of statistical tests for zoo research. *Zoo Biol* 27:226–233.
- Roberts MK. 2005. A review of the evaluation of environmental enrichment in zoos. *Proc Seventh Int Conf Environ Enrich* 7:41–48.
- Schapiro SJ, Bloomsmith MA, Suarez SA, Porter LM. 1997. A comparison of the effects of simple versus complex environmental enrichment on the behaviour of group-housed, subadult rhesus macaques. *Anim Welf* 6:17–28.
- Shepherdson DJ. 1988. The application and evaluation of behavioural enrichment in zoos. *Primate Rep* 22:35–42.
- Shepherdson DJ, Carlstead KC, Wielebnowski N. 2004. Cross-institutional assessment of stress responses in zoo animals using longitudinal monitoring of faecal corticoids and behaviour. *Anim Welf* 13:S105–S113.
- Shyne A. 2006. Meta-analytic review of the effects of enrichment on stereotypic behavior in zoo mammals. *Zoo Biol* 25:317–337.
- Stewart KL. 2004. The environmental enrichment committee. *ALTA* 32:191–194.
- Swaisgood RR, Shepherdson DJ. 2005. Scientific approaches to enrichment and stereotypes in zoo animals: what's been done and where should we go next? *Zoo Biol* 24:499–518.
- WAZA. 2005. Building a future for wildlife—the World Zoo and Aquarium Conservation Strategy. Bern, Switzerland: WAZA Executive Office. 72p.
- Wilson ML, Bashaw MJ, Fountain K, Kieschnick S, Maple TL. 2006. Nocturnal behavior in a group of female African elephants 25:173–186.
- Yanofsky R, Markowitz H. 1978. Changes in general behavior of two mandrills (*Papio sphinx*) concomitant with behavioral testing in the zoo. *Psychol Rec* 28:369–373.
- Young RJ. 1997. The importance of food presentation for animal welfare and conservation. *Proc Nutr Soc* 56:1095–1104.
- Young RJ. 2003. Environmental enrichment for captive animals. Oxford, UK: Blackwell Science. 228p.