



# ENVIRONMENTAL ENRICHMENT IN ZOO ANIMALS

O. TALLO-PARRA, X. MANTECA

Environmental enrichment is a goal-directed and pre-established strategy to enhance animal welfare by promoting positive physical and emotional states through stimulating natural rewarding behaviours, and through covering both generic (choice, control, variety and complexity) and specific needs. Environmental enrichment, as a husbandry practice, is as important and necessary as nutrition or veterinary care to ensure optimal animal welfare. At designing and evaluating environmental enrichment, the attention should not be paid to what is being done by the human, what it is, or what it looks like; but to what it generates, induces, promotes, or allows in the animal.

## ENVIRONMENTAL ENRICHMENT

The environmental enrichment, also known as behavioural enrichment or simply referred as enrichment, is a husbandry principle that seeks to enhance the welfare of animals in captivity by improving animal's mental well-being and/or physical fitness. Although the concept of environmental enrichment has usually been associated with objects animals can "play" with, environmental enrichment goes far beyond the random addition of items into a facility. It is a goal-directed and pre-established strategy to enhance animal welfare by promoting positive emotional and/or physical states. These states are achieved through stimulating natural rewarding behaviours, and through covering other needs that could not be fully fulfilled under animals' specific structural living conditions (management routines, facility design, social context, etc.).

The strategies of environmental enrichment can include, among others, the following objectives:

- To create dynamic and stimulating environments providing a certain degree of novelty and changes to the life of target individuals.
- To induce natural rewarding species-typical behaviours by providing specific contexts, opportunities and competences to perform it.
- To provide cognitive challenges and social opportunities.
- To allow behavioural choices and stimulate individual animal's control over its environment and life expectancies.
- To achieve optimal physical fitness and natural activity budgets.

In contrast to other husbandry practices also important for ensuring optimal welfare, such as veterinary care or nutrition, environmental enrichment practices do not modify directly the physiology of the animals. Instead, it creates environmental context and opportunities animals can use or benefit for covering specific needs, and thrive physically, psychologically and socially. Thus, although environmental enrichment as a husbandry practice has been developed more recently than others and has received less attention, it is as important and necessary as nutrition or veterinary care to ensure

optimal welfare in animals under human care.

The beneficial effects of environmental enrichment for animal welfare are several and have been extensively reported. The use of enrichment has been associated to lower concentrations of stress-related hormones, decrease or elimination of repetitive behaviours, and overweight reduction. Also, captive animals under successful environmental enrichment programmes are healthier and fitter, display greater behavioural diversity and "desirable" behaviour patterns, and show activity budgets similar to their free-ranging conspecifics. Interestingly, studies using cognitive bias have demonstrated in several species that animals under enrichment are more optimistic (an indicator associated with positive welfare states) than those without enrichment.

In several species, therapeutic impacts of environmental enrichment against several pathologies have been demonstrated, and its neurobiological effects are being studied. Interestingly, some recent studies also revealed that environmental enrichment, through both the maternal and paternal line, can have intergenerational effects on offspring and transgenerational effects on subsequent generations, via epigenetic mechanisms. Moreover, positive effects of enrichment on reproduction through changes on animal's physiology, reproductive behaviours and social stability are also well known. All this knowledge, thus, highlights the importance of environmental enrichment and optimal welfare in future conservation success and biodiversity protection.

Although depending on the context surrounding the individuals, it is important to keep in mind that the environmental enrichment could be potentially necessary and should be applied in all species, including those with less cognitive capabilities or simpler behavioural repertoires. Moreover, the enrichment needs or priorities may vary not only between species but also between individuals according to many factors such as their temperament, age, sex, physiological state, hierarchy or past experiences. Animal facilities, management, and other contexts can also condition the environmental enrichment needed. This is because some enclosure design, social dynamics, animal management, training or research can meet totally or partially some animal needs and induce positive emotional experiences as well. In zoological institutions (including zoo, aquaria and other institutions in care of wild animals), people in charge of environmental enrichment should identify what are the needs of the target individuals, the characteristics of their living conditions,

and design environmental enrichment plans accordingly, covering those missing aspects required for optimal welfare levels.

Overall, environmental enrichment should be adapted to the biological, social and contextual realities of target individuals. Because these realities are constantly changing, and because time and repeated exposure can affect the effectiveness of enrichment (for instance, enrichment actions can lose its “novelty” effect or stop being cognitive challenging as animals get used to it), environmental enrichment strategies have to be under constant revision, modifications and redesign, in an endless process that ensures its effectiveness over time. Applying successful environmental enrichment programs is necessary but challenging. Because of that, the use of the scientific methodology, and reliable sources and updated knowledge is of major importance. Likewise, providing the zoo staff with up-to-date training courses about environmental enrichment practices is also crucial.

#### HOW TO APPLY ENVIRONMENTAL ENRICHMENT (SEE ANNEX)

Although there are different strategies and guidelines to apply environmental enrichment successfully, all of them agree on:

- The need for a deep knowledge of biology, life expectancies and natural habitat of the target species, as well as the characteristics of target individuals or groups and its management and context.
- The importance of a well-established design of the environmental enrichment plan, including the welfare goals, and the enrichment strategies, actions and tools used to achieve it.
- The critical need to evaluate whether the enrichment strategy or plan is effective and thus, the welfare of target individuals improves.
- The endless cycle of Detect-Design-Apply-Evaluate processes.

Some studies have classified environmental enrichment in five not mutually exclusive categories (food-related, social, sensory, physical habitat, and cognitive). Environmental enrichment should be preferably considered according to their effects on the animal, which can be several but also differ between species and individuals as mentioned previously. Because of that, instead of thinking about how an enrichment tool or action looks like (how it is physically or prepared), enrichment strategies should be designed and evaluated according to the mental and/or physical states that these actions are meant to induce in the animal.

Environmental enrichment can vary from simple actions or objects to very complex strategies or tools. For instance, changing feeding time routines or food location to make it more unpredictable is a simple strategy that has been shown to be a successful environmental enrichment in several species. On the other hand, improved animal welfare has also been reported in animals participating in complex research projects as those activities were perceived as stimulating and pleasant cognitive enrichment by some individuals. Similarly, very simple to very complex facility designs can enrich animals' life and improve welfare. Adding slatted tops to giraffes' feeders is a relatively low-cost modification that has been proved to encourage more naturalistic foraging behaviour and reduce oral stereotypy. On the other side, building and managing a complex and wide animal trail network in a zoo provided plenty opportunities for enrichment and improved significantly the welfare of individuals using it.

Although not necessarily in contradiction, the ultimate goal of environmental enrichment is to enhance the welfare of a target individuals and not to simulate natural environments or improve visitors' experience. Some very successful enrichment strategies can

use elements not present in the natural habitat of the target species, or involve very non-aesthetic, unnatural objects or actions. For instance, the addition of non-natural odours has been proven as successful as natural odours when used as sensory enrichment for some species, stimulating exploratory behaviours, inducing group cohesion and providing unexpected novelty in the enclosure. As another interesting example, captive chimpanzees (*Pan troglodytes*) using cognitive challenging computer games to obtain food rewards presented a similar activity budget to free-ranging conspecifics. Although the use of a computer is very far from being natural for chimpanzees, it was hypothesized that the computer game presented a similar cognitive challenge for obtaining food than free-ranging chimpanzees face in the wild when eating fruits from plants with spines. Computer games also provided an opportunity to solve problems and control some aspects of the environment. Although there are mixed results at studying the impact of unnaturalistic-looking environmental enrichment in visitors' experience, it is each institution's responsibility to fit all necessary environmental enrichment strategies with visitors' expectations and education goals. Fortunately, some studies reported an increase in visitor satisfaction when observing animals under environmental enrichment as general activity and behaviour diversity usually increases. Sensitizing the general public about environmental enrichment and establishing a good communication programme may be an interesting option to fit all the institution's goals.

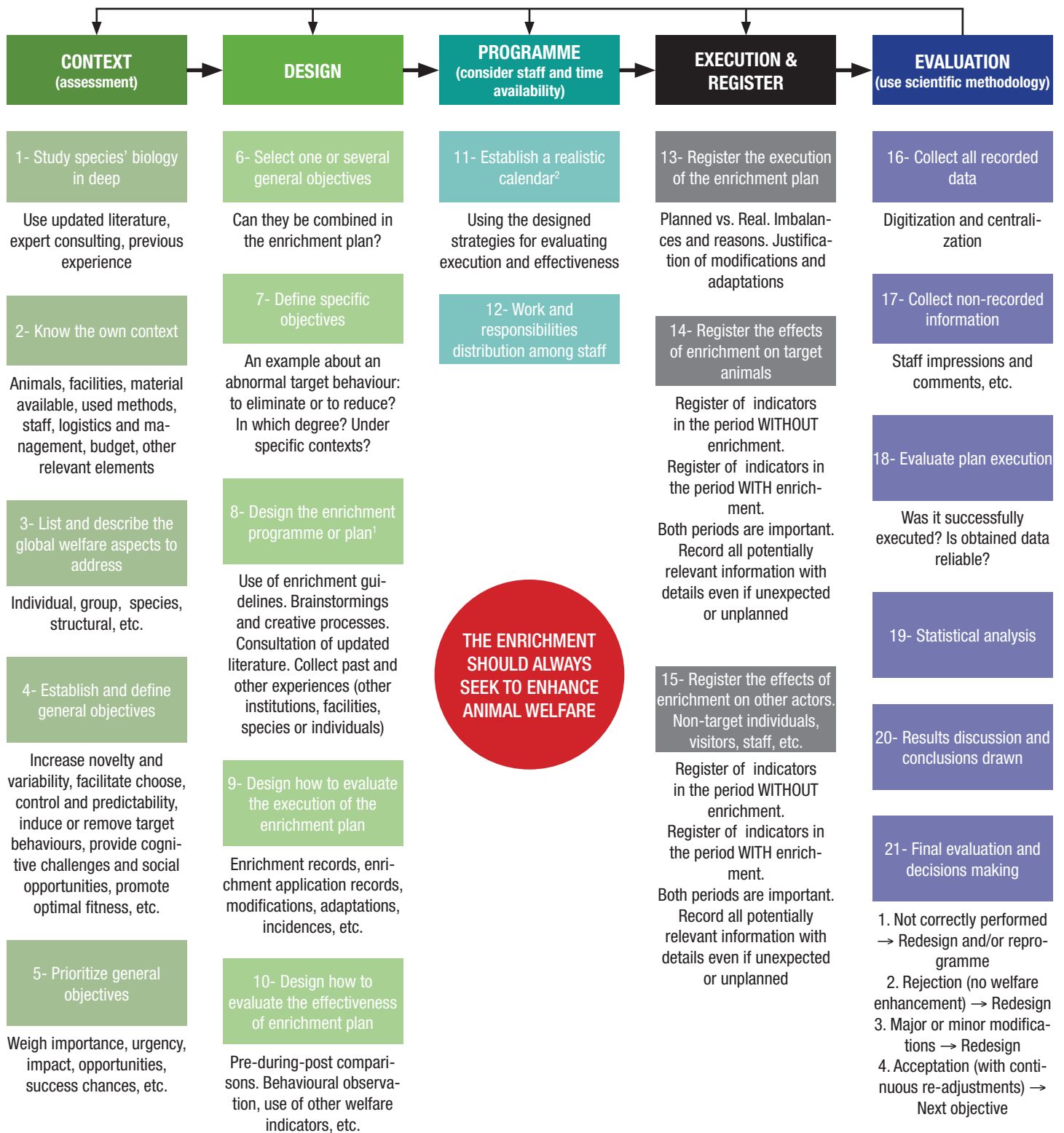
Modern zoological institutions should integrate environmental enrichment into their daily animal management and give it proper importance and consideration. Thus, when animal welfare is a priority, time, human and economic resources should be invested in the environmental enrichment programmes.

#### REFERENCES

- Alligood, C.A., Dorey, N.R., Mehrkam, L.R., & Leighty, K.A. (2017). Applying behavior-analytic methodology to the science and practice of environmental enrichment in zoos and aquariums. *Zoo Biology*, 36(3), 175–185. <https://doi.org/10.1002/zoo.21368>
- Alligood, C.A., & Leighty, K.A. (2015). Putting the “E” in SPIDER: Evolving Trends in the Evaluation of Environmental Enrichment Efficacy in Zoological Settings. *Animal Behavior and Cognition*, 2(3), 200–217. <https://doi.org/10.12966/abc.08.01.2015>
- Burghardt, G.M. (2013). Environmental enrichment and cognitive complexity in reptiles and amphibians: Concepts, review, and implications for captive populations. *Applied Animal Behaviour Science*, 147(3–4), 286–298. <https://doi.org/10.1016/j.applanim.2013.04.013>
- Carlstead, K., & Shepherdson, D. (1994). Effects of Environmental Enrichment on Reproduction, 13, 447–458.
- Clark, F.E. (2017). Cognitive enrichment and welfare: Current approaches and future directions. *Animal Behavior and Cognition*, 4(1), 52–71. <https://doi.org/10.12966/abc.05.02.2017>
- Clark, F.E. (2013). Marine mammal cognition and captive care :A proposal for cognitive enrichment in zoos and aquariums. *Journal of Zoo and Aquarium Research*, 1(1981), 1–6. <https://doi.org/https://doi.org/10.19227/jzar.v1i1.19>
- Coe, J. (2017). Embedding Environmental Enrichment into Zoo Animal Facility Design. In *Zoo Design Conference* (Vol. 2, pp. 1–21).
- Coelho, C. M., de Azevedo, C. S., Guimarães, M. A. D. B. V., & Young, R. J. (2016). Environmental Enrichment Effect on Fecal Glucocorticoid Metabolites and Captive Maned Wolf (*Chrysocyon brachyurus*) Behavior. *Journal of Applied Animal Welfare Science*, 8705(April), 1–10. <https://doi.org/10.1080/10888705.2016.1161512>
- Collins, C., Quirke, T., Overy, L., Flannery, K., & Riordan, R. O. (2016). The effect of the zoo setting on the behavioural diversity of captive gentoo penguins and the implications for their educational potential. *Journal of Zoo and Aquarium Research*, 4(2), 85–90.

- Fernandez, L. T., Bashaw, M. J., Sartor, R. L., Bouwens, N. R., & Maki, T. S. (2008). Tongue twisters: feeding enrichment to reduce oral stereotypy in giraffe. *Zoo Biology*, 27(3), 200–212. <https://doi.org/10.1002/zoo.20180>
- Graham, C., von Keyserlingk, M. A. G., & Franks, B. (2018). Free-choice exploration increases affiliative behaviour in zebrafish. *Applied Animal Behaviour Science*, 203, 103–110. <https://doi.org/10.1016/j.applanim.2018.02.005>
- Greenway, E., Jones, K. S., & Cooke, G. M. (2016). Environmental enrichment in captive juvenile thornback rays, *Raja clavata* (Linnaeus 1758). *Applied Animal Behaviour Science*, 182, 86–93. <https://doi.org/10.1016/j.applanim.2016.06.008>
- Gusset, M., & Dick, G. (2015). WAZA magazine. Towards Positive Animal Welfare (Vol. 16)
- Kagan, R., Carter, S., & Allard, S. (2015). A Universal Animal Welfare Framework for Zoos. *Journal of Applied Animal Welfare Science*, 18. <https://doi.org/10.1080/10888705.2015.1075830>
- Kelly, Á., & Hannan, A. J. (2019). Therapeutic impacts of environmental enrichment: Neurobiological mechanisms informing molecular targets for enviromimetics. *Neuropharmacology*, 145(November 2018), 1–2. <https://doi.org/10.1016/j.neuropharm.2018.11.005>
- Maple, T. L., & Perdue, B. M. (2013). Zoo Animal Welfare. <https://doi.org/10.1007/978-3-642-35955-2>
- Mason, G., Clubb, R., Latham, N., & Vickery, S. (2007). Why and how should we use environmental enrichment to tackle stereotypic behaviour? *Applied Animal Behaviour Science*, 102(3–4), 163–188. <https://doi.org/10.1016/j.applanim.2006.05.041>
- Mellen, J., & Sevenich MacPhee, M. (2001). Philosophy of environmental enrichment: Past, present, and future. *Zoo Biology*, 20(3), 211–226. <https://doi.org/10.1002/zoo.1021>
- Mellor, D. J. (2016). Updating animal welfare thinking: Moving beyond the “five freedoms” towards “A lifeworth living.” *Animals*, 6(3), 21. <https://doi.org/10.3390/ani6030021>
- Mellor, D. J., Hunt, S., & Gusset, M. (2015). *Caring for Wildlife. The World Zoo and Aquarium Animal Welfare Strategy*. Gland, Switzerland: WAZA Executive Office.
- Makecha, R. N., & Highfill, L. E. (2018). Environmental Enrichment, Marine Mammals, and Animal Welfare: A Brief Review. *Aquatic Mammals*, 44(2), 221–230. <https://doi.org/10.1578/AM.44.2.2018.221>
- Näslund, J., & Johnsson, J. I. (2016). Environmental enrichment for fish in captive environments: effects of physical structures and substrates. *Fish and Fisheries*, 17(1), 1–30. <https://doi.org/10.1111/faf.12088>
- Ortiz, S., Maxwell, A., & Anderson Hansen, K. (2017). Research as an enrichment tool to improve welfare in captive animals. *Animal Husbandry, Dairy and Veterinary Science*, 1(4), 1–6. <https://doi.org/10.15761/AHDVS.1000124>
- Owen, M. A., Swaisgood, R. R., Czekala, N. M., & Lindburg, D. G. (2005). Enclosure choice and well-being in Giant Pandas: Is it all about control? *Zoo Biology*, 24(5), 475–481. <https://doi.org/10.1002/zoo.20064>
- Ross, S. R. (2006). Issues of choice and control in the behaviour of a pair of captive polar bears (*Ursus maritimus*). *Behavioural Processes*, 73(1), 117–120. <https://doi.org/10.1016/j.beproc.2006.04.003>
- Samuelson, M. M., Lauderdale, L. K., Pulis, K., Solangi, M., Hoffland, T., & Lyn, H. (2017). Olfactory Enrichment in California Sea Lions (*Zalophus californianus*): An Effective Tool for Captive Welfare? *Journal of Applied Animal Welfare Science*, 20(1), 75–85. <https://doi.org/10.1080/10888705.2016.1246362>
- Shepherdson, D. J. (2003). Environmental enrichment: past, present and future. *International Zoo Yearbook*, 38, 118–124.
- Shepherdson, D. J., Lewis, K. D., Carlstead, K., Bauman, J., & Perrin, N. (2013). Individual and environmental factors associated with stereotypic behavior and fecal glucocorticoid metabolite levels in zoo housed polar bears. *Applied Animal Behaviour Science*, 147(3–4), 268–277. <https://doi.org/10.1016/j.applanim.2013.01.001>
- Swaisgood, R. R., & Shepherdson, D. J. (2005). Scientific approaches to enrichment and stereotypies in zoo animals: what's been done and where should we go next? *Zoo Biology*, 24(6), 499–518. <https://doi.org/10.1002/zoo.20066>
- Ward, S. J., Sherwen, S., & Clark, F. E. (2018). Advances in Applied Zoo Animal Welfare Science. *Journal of Applied Animal Welfare Science*, 21(sup1), 23–33. <https://doi.org/10.1080/10888705.2018.1513842>
- Wells, D. L. (2009). Sensory stimulation as environmental enrichment for captive animals: A review. *Applied Animal Behaviour Science*, 118(1–2), 1–11. <https://doi.org/10.1016/j.applanim.2009.01.002>
- Yamanashi, Y., & Hayashi, M. (2011). Assessing the effects of cognitive experiments on the welfare of captive chimpanzees (*Pan troglodytes*) by direct comparison of activity budget between wild and captive chimpanzees. *American Journal of Primatology*, 73(12), 1231–1238. <https://doi.org/10.1002/ajp.20995>
- Young, R. J. (2003). *Environmental Enrichment for Captive Animals*. (R. J. Young, Ed.). Oxford, UK: Blackwell Science Ltd. <https://doi.org/10.1002/9780470751046>

# ANNEX I: ZAWEC GUIDELINES FOR PREPARING AND APPLYING AN ENVIRONMENTAL ENRICHMENT PLAN



<sup>1</sup> Planning (what, how, when, to who, etc.), Exposure/ Withdrawal criteria, Veterinary approval, Cleaning and disinfection, Other.

<sup>2</sup> Application dates, time and/or contexts— Periods for recording animals WITHOUT enrichment – Periods for recording animals WITH enrichment.