

Brando & Buchanan-Smith 2017 The 24/7 approach to promoting good welfare for captive wild animals [www.247animalwelfare.eu](http://www.247animalwelfare.eu)

### Examples of key features at different stages of an animal's life

The natural history of an animal, its biology, ecology and diet, sensory systems, natural habitat, social structure, major life history events, activity patterns, and human-animal interactions are among the many topics taken into account when developing species-specific animal welfare programs (see our website [www.247animalwelfare.eu](http://www.247animalwelfare.eu) for a worked example with common marmosets). Looking at the life cycle of a species, we find different life stages commonly divided into birth, baby, juvenile, adolescence, reproductive age, senescence and death. When we consider different life stages we can identify key features and considerations likely to be of importance to the welfare of the species. The table below provides examples highlighting these features across a wide range of species. To manage a species appropriately in captivity, it is important to find out about each of these key considerations and develop a management plan accordingly.

Table 1 Examples of key features at different stages of an animal's life.

<b>Life stage</b>	<b>Examples key features/ considerations in captivity</b>	<b>Example references</b>
<i>Birth</i>	Age of mother	In common marmosets dams first reproducing later in life (4 years and over) tend to live longer than those first reproducing at younger ages (Smucny et al., 2004).
	Mother and father experience, social group and infant experience (e.g. cooperative rearers; aunties)	Offspring of primiparous common marmosets have higher mortality than multiparous marmosets (Buchanan-Smith, 2010b). Maternal and paternal experience, together with number of helpers, influences infant survival in marmosets (Rothe et al., 1993; Buchanan-Smith, 2010b).
	Nutritional requirements of mother	Protein-calorie malnutrition during pregnancy in rhesus macaques led to compromised temperature control mechanism in infants (Kohrs et al., 1979). Exudate feeding is higher during the nutritionally sensitive periods of the reproductive cycle (i.e. terminal phase of gestation and lactation) in the Panamanian tamarin (Garber, 1984).
	Nutritional requirements of offspring	Nutritional requirements relate to seasons: maternal body condition, lactation, growth, and offspring behaviour is affected in north temperate deer (White, 1992).

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	Comfort (thermal and physical)	Increased infant mortality at higher environmental temperatures in red pandas, probably due to changes in maternal behaviour (Princée and Glatston, 2016).
	Seclusion of physical birth environment (e.g. nesting materials)	Secluded areas and access to dens improves snow leopard reproduction success (Freeman and Hutchins, 1978; O'Connor and Freeman, 1982).
	Human-animal interaction	Group size and composition (pairs more successful than group-housed) as well as positive human-animal interaction, such as keepers talking and interacting with the cats in their care, positively influences small captive felid behaviour reproductive success (Mellen, 1991).
	Infant mortality, including infanticide/cannibalism	Infant mortality in chimpanzees in zoos is likely to be negatively influenced by higher levels of inbreeding reducing perinatal survival. A sheltered life in a zoo environment and availability of veterinary care likely improves post-perinatal survival of infants (Courtenay, 1988). Stallions present at birth did not attempt to kill unrelated foals in Przewalski's horses but zoo-bred stallions that grew up in unnatural social groups attacked foals of mares that were pregnant during takeovers (Feh and Munkhtuya, 2008).
	Imprinting	If birds need to be hand-reared by a parental model, a bird puppet is believed to reduce sexual and filial imprinting on human caretakers. This was tested in the common raven. Puppet rearing did not affect social behaviour prior to release, dispersal from the release area, or integration with wild birds after release. Their increased vigilance, and fear of caretakers may improve survival chances after release (Valutis and Marzluff, 1999).
<i>Baby</i>	Mother's experience and dominance	Macaque mothers' preconception testosterone levels relate to high maternal dominance and to sex of offspring, with higher levels of dominance and testosterone resulting in more male births (Grant et al., 2011).
	Number of other relatives/allies/foes	Baby-transfer and other interactions between its mother and grandmother in a captive social group of lowland gorillas shows that the quality of infant care by the young adult daughter improves during first days after birth with the grandmother's encouragement (Nakamichi et al., 2004).
	Social group and members experience of infant care	Wild male maned wolves probably provide parental care through provision of food to their female and presumed offspring (De Melo et al., 2009).

	Age of weaning and mother's nutritional requirements until weaning	Age-at-weaning effects growth and survival of clownfish; later weaning increases survival rates (Gordon et al., 2000).
<i>Juvenile</i>	Juvenile mortality	Environmental, health and social factors affect juvenile mortality in lesser kudu (Besselmann et al., 2008)
	Availability of same age play-mates	The frequency of infant play is affected both by age and by the number and ages of other infants in the troop in wild baboons. Juvenile and subadult play is affected by demographic and maturational factors, as well as kinship (Cheney, 1978).
	Space and time to play	Time of day, spare time, objects, and companions account for high rates of play in captive young tufted capuchins (Visalberghi and Guidi, 1998).
	Cognitive development opportunities	Changing environments may select for higher cognitive abilities. Similarly, changing conditions during ontogeny can cause plastic responses. Individual cichlid fish subjected to a change in food ration early in life (i.e., low to high or vice versa) outperform fish kept on constant rations in a learning task later in life. This result was independent of the direction of the implemented change, or the average amount of food each fish received, and the results in the juvenile stage did not change in adulthood. Environmental enrichment and training explain the findings and suggests that a single environmental change early in life might enhance cognitive abilities in animals (Kotrschal and Taborsky, 2010).
	Social learning	Early experience with and observations of zoo-housed adult copulatory behaviour by juvenile chimpanzees increases reproductive success (King and Mellen, 1994).
<i>Adolescence</i>	Mother's experience and dominance	Mother's dominance rank at son's conception predicts stress hormone levels in sub-adult male baboons, sons of lower ranking mothers had higher chronic faecal glucocorticoid than high-ranking mothers (Onyango et al., 2008).
	Friendships	Chimpanzee friendships are based on homophily in personality and relevant for socio-positive and cooperative behaviour (Massen and Koski, 2014).
	Social groupings (e.g. relatives/allies/foes)	Adolescent male chimpanzees may receive, but not inflict, more wounds than chimpanzees in other sex-age classes and management strategies (Ross et al., 2009).
<i>Reproductive age</i>	Social structure and possibilities	Housing females with companions known from adolescence, and careful management of

	to mate (e.g. social sexual suppression by dominants)	stress-sensitive females, might result in improved reproduction in white rhinoceros (Metrione and Harder, 2011).
	Bachelor groups	Factors such as forming all-male groups when the animals are still immature, providing visual barriers and refuges for subordinate animals, influence the formation and maintenance all-male gorilla groups in captivity (Stoinski et al., 2004).
	Inbreeding avoidance; protection of young (e.g. infanticide)	Infant mortality of inbred young is higher than non-inbred young in captive primates (Rails and Ballou, 1982). New male introductions to herd increases infanticide in captive plain zebras when the foal is less than 1 month of age (Pluháček and Bartoš, 2000).
<i>Senescence</i>	Social structure and behaviour	Similar affiliative social behaviour in old and younger adult chimpanzees implies continued need for social housing with advancing age (Baker, 2000).
	Physical decline (reduced mobility, pain)	Dental problems and osteo-spondyloarthroses are common in zoo animals and appear to increase with age in bears, big cats, great apes, barbirusas and pygmy hippos (Kitchener and MacDonald, 2004).
	Behaviour and physical aspects	Changes in behaviour and physical characteristics in octopus as indicators of senescence (Anderson et al., 2010).
	Aging rates and nutrition	Aging rate is higher under free-ranging conditions than in captivity. Differences in aging rates between captive and free-ranging ruminants increased as species were more specialized on grass diets (Lemaître et al., 2013).
	Cognitive decline (memory etc.)	Aging negatively affects performance in cognitive tests in rhesus monkeys (Herndon et al., 1997).
<i>Death</i>	Social aspects sickness and dying	The responses of a group of chimpanzees to a dying female included pre-death care, close inspection and testing for signs of life at the moment of death, all-night attendance by the deceased's adult daughter, cleaning the corpse, and later avoidance of the place where death occurred. In some cases it may be more humane if elderly apes are allowed to die naturally in a supported social setting than separating them for veterinary care or euthanasia (Anderson et al., 2010).
	Euthanasia	Post-mortem findings on correct end-of-life decisions can be validated by a scoring system to evaluate physical condition and quality of life in geriatric zoo mammals (Föllmi et al., 2007).

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