

Communication

Improving Animal Wellbeing Using Behavior-Based Methodologies: A Discussion on Enrichment and Bears under Human Care

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Abstract: This communication discusses the Bear Care Group's "behavior-based" enrichment philosophy, focusing on the importance of enrichment programs built on the knowledge of species' natural histories, living strategies, and observed daily and seasonal routines. Methods for program development are discussed, detailing the benefits to animal wellbeing, including the reduction of chronic stress and frustration that lead to abnormal or stereotypical behaviors. The concepts are illustrated through a discussion of bear natural history and living strategies, but these methods are applicable to a wide range of taxa. The Bear Care Group encourages facilities to consider behavior-based enrichment programs to promote positive welfare for their animals.

Keywords: behavior-based enrichment; behavior-based husbandry; enrichment; goal-based enrichment; living strategies; bear enrichment; animal welfare; bears



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1. Introduction

Environmental enrichment has become an essential part of modern husbandry for animals under human care. Although the concept of enrichment dates back to the 1920s [1], the field of environmental enrichment grew significantly in the early 1980s when zoologists began to study and publish the effects of different environments, feeding methods, and husbandry methods on zoo animals [2–7]. A handful of enrichment frameworks and guidelines have been developed over the years [8–13], with traditional enrichment planning involving a handful of enrichment categories (i.e., social, cognitive, physical habitat, sensory, and food), with individual items then presented to the animals from each category. These categories and the presentation of enrichment were meaningful from a human perspective, but not necessarily from the perspective of the animals, who might weigh the importance of each of these categories differently based on their natural histories.

More recently, there has been a shift towards behavior-based husbandry methods built on the knowledge of the species' natural history. Through behavioral research conducted on zoo animals exhibiting abnormal repetitive behaviors, a documented concern for animals under human care [14–18], scientists have reported that fewer abnormal and/or repetitive behaviors are exhibited when the environment and husbandry routine more closely mimic the wild environment and daily schedule of the species [19–23]. Additionally, research has shown evidence that behavioral diversity may be positively correlated with positive welfare and negatively correlated with physiological measures of stress (fecal glucocorticoid metabolites, cortisol:dehydroepiandrosterone (DHEA) metabolite ratio) [24,25]. Furthermore, as science has delved into the study of animal "happiness" and measures of positive welfare rather than the absence of negative welfare, many scientists have suggested correlations between goal-directed or environmentally focused behaviors (such as exploration and

food acquisition), choice and opportunity, and animal-to-animal interactions or affiliative behaviors (such as bonding, maternal care, play, and sexual activity) with positive affective states and positive affective engagement [26–28]. As defined by Mellor [26] (p. 6), “*the experience animals may have when they actively respond to motivations to engage in rewarding behaviours, and it includes all associated appetitive and consummatory affects that are positive*”.

The Bear Care Group (BCG) began teaching behavior-based bear husbandry in 2009, which Else Poulsen (founder of the BCG) later defined as “*the deliberate provision of species-specific, internal and external care of animals befitting their genetic and circumstantial expectations to reduce stressors inherent in captive living*”. Behavior-based husbandry is focused on the animals’ agenda, including: enclosure design and furniture; diet presentation and nutrition; care and maintenance routines; caregiver and animal relationship building; communication (e.g., operant conditioning); ambient parameters (e.g., photoperiod, temperature, sound); and veterinary care [29]. In other words, care is provided for the physical, psychological, and emotional needs of the animal, incorporating all of these inputs. The concept of behavior-based husbandry had previously been presented by James Bousquet in an American Association of Zookeepers Animal Keepers’ Forum article [30] and has since been referenced numerous times over the years [23,31–33]. Holistic approaches to environmental enrichment have also been presented by other recognized industry experts. Jill Mellen and Marty Sevenich MacPhee of Disney’s Animal Kingdom [34] proposed planning enrichment programs based on species-specific goals identified through research into species’ natural histories and wild activity budgets, as well as incorporating knowledge of individual histories and current exhibit parameters. The Bear Care Group has built upon this philosophy, changing how enrichment is planned and implemented in zoological facilities, leading to improved wellbeing for animals under human care. In this article, we will discuss the benefits of behavior-based enrichment, including program design based on an animal’s natural living strategies and creating opportunities for positive affective engagement [35]. While we use bears throughout the article as examples, these methods can be applied to a wide range of taxa.

2. Behavior-Based Husbandry

As mentioned above, behavior-based husbandry is the species-specific internal and external care of animals befitting of their genetic and circumstantial expectations to reduce stressors inherent while living under human care [29]. The focus of behavior-based husbandry is on the animal’s agenda as opposed to the human agenda. Animals are sentient beings with needs and wants that motivate their behavior. An animal’s “agenda” is motivated by survival (needs): survival in the habitat they are genetically predisposed to exist in, with specific behaviors relating to finding sustenance and seeking mates for reproduction to pass on their genes. An animal’s agenda is also motivated by positive outcomes (rewards) or experiences that result in pleasure (wants) and promote biological functioning [36,37].

Animals have evolved to live in complex environments; consequently, it is vitally important to recreate this complexity under human care. (We should note, however, that the focus should be on recreating experiences and opportunities that are linked to positive emotions and not negative emotions. For example, we do not aim to recreate the experience of fleeing from a predator or fighting a conspecific during rutting season [38]. Animals are born with genetically encoded survival techniques (known as ‘living strategies’ [39]), which have evolved for the environment in which they would naturally live. The way an animal finds and processes food resources generally matches up with the food resources that are available in their natural habitat. For example, the sloth bear is a specialized insect eater who tears into termite mounds with long, curved claws, then blows away the dirt and debris with their elongated snout and curved upper palate, then sucks the termites into their mouth with their incredible suction power and missing two front teeth. These behaviors and physical adaptations match the sloth bear’s natural environment, the scrub jungle of India, where termite mounds are plentiful [40].

Similarly, the methods an animal employs to build nests or protect itself from the elements match the nesting materials and shelter types available in its natural habitat. For example, the Andean bear is known to climb trees and bend back branches to create a platform for both feeding and resting. These bears will gather leaf litter or other leafy branches, which they will place on top of this platform to create a nest [41]. When seeking shelter, Andean bears have been observed searching for rocky overhangs or caves. These behaviors correlate with the Andean bears' natural environment, namely tropical forests and high-altitude mountainous forests and grasslands [42].

When animals under human care inhabit environments with a decreased level of complexity or range of opportunities for natural behavioral diversity, they often experience chronic stress. As discussed in Bracke and Hopster's [36] paper regarding the importance of natural behavior, it is important to provide opportunities that are "expected" by the animal, as their welfare is reflected by the state of their cognitive-emotional motivation systems. In the Istwerte-Sollwerte model that Bracke and Hopster [36] present (modified after Wiepkema's model [43]), a mismatch between what an animal perceives to be (Istwerte) and what an animal "wants" (Sollwerte) leads to stress and frustration. Conversely, a match between *what is* and *what is wanted* results in satisfaction and positive emotion. The importance of this has long been appreciated; Miller et al. [24], Mellor [26], and Lawrence et al. [27] have all described the resulting positive affect in animals who are provided with opportunities to successfully carry out their natural behaviors. While it is desirable to minimize chronic stress levels and resulting abnormal and/or stereotypical behaviors [22,23,44], it is also equally important to increase positive emotional states and feelings of pleasure to ensure a state of positive welfare [27,35–37]. This is where enrichment becomes an essential component of behavior-based husbandry; it is through behavior-based enrichment opportunities that animals can successfully carry out goal-directed behaviors, make choices that control aspects of their wellbeing, and experience positive affective states such as pleasure or satisfaction.

2.1. Behavior-Based Enrichment

Behavior-based enrichment focuses on providing opportunities for animals to engage in their species-specific living strategies, including feeding strategies, nesting and denning strategies, social strategies, grooming strategies, and strategies for seasonal adaptation. The goal is specifically to encourage the expression of positive species-specific behaviors, so it is important for caregivers to have a clear understanding of both their animal's morphology and natural history in order to provide successful, engaging experiences. While the zoo or sanctuary environment may look different than the wild, similar opportunities can be provided by caregivers so that animals can express natural behaviors, even if they do so in slightly different ways (e.g., building a nest of hay on top of a climbing platform instead of a nest of leafy branches at the top of a tree). Behavior-based enrichment considers the individual history of each animal and tailors program goals to meet individual needs. For example, an Andean bear who is disabled and cannot climb high into a tree to build a nest should be provided opportunities to engage in nest-building behaviors lower to the ground. Animals housed in groups should be provided multiple enrichment opportunities for each living strategy to avoid creating unwelcome competition for resources.

Behavior-based enrichment should be an expected component of the daily husbandry routine and not an "extra" duty or only when it is convenient. Program goals should mimic the natural daily and seasonal schedules of the animals. Animals under human care are subject to the daily routines created by their caregivers. These schedules involve caregivers cleaning the habitats and enclosures, providing food, and enriching the environment. Caregivers should establish appropriate routines that are based on the animal's agenda and the daily 24-h schedule that they are genetically predisposed to expect from their native habitat, versus human schedules, which are based on normal staffing hours for cleaning, feeding, enriching, and training.

2.2. Living Strategies

Living strategies are species-specific ways in which animals use the structures and events in their environment to ensure their survival [39]. Permanent structures (such as boulders, trees, or rivers), ephemeral structures or events (such as streams, food resources, changes in photoperiod or season), and constantly changing events (such as the availability of and access to food resources) in an animal's environment all play a role in how that species finds food, mates, and shelter. Research into the natural history and genetic predispositions of a species will provide insight into the type of habitat, temperature range, and natural daily schedule that they have evolved to expect and react to. These factors affect a myriad of species-typical behaviors, including social strategies (social grouping, reproductive behaviors, communication, food sharing behavior); feeding strategies (food seeking, preparation, and consumption behaviors); nesting strategies (day beds, maternal dens, shelter, nest building behavior); grooming behaviors (bathing, dry cleaning); and adapting to seasonal changes (hyperphagia, torpor, hibernation). Animals naturally adjust their daily and seasonal routines based on these living strategies; it is critical for caregivers to understand these "expectations" in order to provide similar opportunities while under human care.

2.3. Bear Living Strategies

Feeding strategies encompass food seeking, food preparation, and food consumption behaviors.

Bear species exhibit a wide range of feeding strategies based on their genetic predispositions and evolutions in their native habitats. Some bears have a specialized dietary niche, such as the bamboo-eating giant panda; others are more generalized and opportunistic in their diet and foraging behaviors, such as the brown bear, which eats a range of foods from insects and berries to large ungulates [45,46]. Examples of bear feeding strategies include berry picking, tree climbing to reach fruits, ground digging to unearth insect larvae, tearing apart rotting logs to extract insects, opportunistic predation on or scavenging of ungulates, or seasonal fishing for salmon. In a bear's agenda, sustenance (food) is important all of the time, both for survival and for the pleasurable rewards it provides. Therefore, feeding behaviors play a large role in behavior-based bear enrichment since they comprise a significant time investment in a bear's daily and seasonal routines.

When considering these different food sources and feeding strategies, caregivers should consider the sequence of behaviors involved in searching for and subsequently preparing food sources for consumption. For example, an Andean bear feeding on bromeliads involves a complex sequence of behaviors. First, the bear must locate a tree with enough bromeliads to make it worth climbing and possibly building a feeding platform in. Then the bear uses its sharp claws and strong limbs to climb the tree, seeking an optimal position on a sturdy branch for balance while reaching out to grasp a bromeliad. The bear may decide to build a feeding platform to bring collected bromeliads for processing. Processing the bromeliads triggers a separate sequence of behaviors since the bear wants to remove the tough outer leaves and expose the meristematic tissue or succulent stems to feed on. This involves dexterous manipulation using both paws and lips to remove specific leaves in order to consume the preferred parts of the plant.

The sequences of behaviors that a bear performs to seek, prepare, and consume its food should be the fully realized goal that caregivers plan to provide, allowing the animal the complete opportunity to express the appropriate range of species-typical behaviors. It is not as straightforward as simply providing a bear with the succulent stem of a bromeliad plant! Andean bears under human care must be provided opportunities to climb, balance, reach, build a platform, gather foods, and process them to eat using dexterous manipulation with their paws and lips. These are all genetically encoded bear behaviors. If these opportunities do not exist, frustration and chronic stress from an inability to engage in species-typical behaviors can develop, potentially resulting in abnormal behaviors.

Social strategies include social grouping, reproductive behaviors, communication, food sharing, and privacy.

Bears are generally considered solitary animals, in that they are typically found living alone. Bears do possess well-developed social skills; though they may often live alone, they can be highly social in their interactions with other bears in their habitat [47]. Females are often found living with cubs, and after cubs leave their mothers, they can often be found living in small social groups (subadult coalitions) for a year or two until they disperse on their own. During mating season, male and female pairs often come together to court and breed for a period of days or even weeks. This may involve engaging in daily living activities together, such as feeding and grooming. Most bear species have been observed in larger groups, sharing food when resources are plentiful. Examples include brown bears during the salmon run [48], Andean bears during a fruiting event [49], or polar bears feeding on a beached whale carcass [50]. Social skills are critical when navigating group interactions; these skills should be considered when human caregivers are creating social living strategy goals.

Bear species exhibit a wide variety of reproductive behaviors. Some species are obligately seasonal in their estrus and breeding behavior, while other species experience a seasonal estrus cycles [51]. Courtship and breeding involve an entire repertoire of behaviors, from scent marking and urine testing to affiliative displays and vocalizations. Vulnerable bear species housed in accredited facilities are often managed through species survival programs. Where the institutional or management program goal is to manage and provide breeding opportunities, understanding the range of social behaviors that bears engage in is important for a successful breeding program. Bear species of “least concern” on the IUCN red list [52] or bears that have been rescued or are undergoing rehabilitation for release may not be appropriate to place in breeding situations. An animal’s individual history and experience may preclude caregivers from providing opportunities for social interactions with other bears. Consideration should still be given to how caregivers can provide these bears with opportunities to use their social skills in other situations.

Communication strategies are exhibited by all bear species. These include more than vocalizations and physical demonstrations (i.e., stomping and jaw clacking), considering that bears typically live by themselves. Bears use a highly evolved olfactory system, which assists in communication over long distances and periods of time [53–55]. Scent marking is one of the most important communication strategies a bear uses. Bears will use their claws to scratch, teeth to bite, or bodies to rub on trees, marking them to show other bears how big they are (by how high the marks are on the tree) and who they are (through the scent glands on their paw pads that leave behind their individual scent mark). Bears will also use urine and feces to communicate, dripping urine as they walk over low shrubs and bushes, pedemaking in the soil as they drip urine and slide their feet back and forth over the ground, or leaving a pile of feces at the edge of their territory [56–58]. The pheromones contained in urine, feces, sweat glands, and genital secretions provide a plethora of information to other bears about the age, sex, and reproductive status of the bear who left the message. It is important to provide bears living under human care with behavioral opportunities to communicate. Habitats need to have “information trees” (upright trees or trunks) for bears to leave their scent on. Daily surface cleaning and disinfection routines may remove or interfere with communication “messages”, so caregivers should carefully consider how to manage cleaning agents and schedules in order to minimize unintended social impact.

Bears also need privacy. While they possess well-developed social skills, they also need the option to choose to enjoy time alone. Depending on a bear’s circumstance (a pregnant denning female, for example, or a bear with a traumatic past), at times they may feel a greater need for the opportunity to avoid other bears, humans around their environment, or other stimuli. Bears should always be provided opportunities to choose privacy and security when they want to be alone and undisturbed by other bears or humans. Bear habitats need multiple areas where socially housed animals can avoid one another, including both physical and visual access. Environmental levels of visual and acoustic

stimuli should be assessed for bear habitats, reducing the potential for sensory “flooding” as much as possible.

Nesting and denning strategies encompass the creation and use of day beds, night nests, maternal dens, hibernation dens, and shelters from weather.

Bear species exhibit a wide range of nesting strategies, depending on their natural habitat and climate. Most species build nests with branches, grasses, or leaf litter. Brown and black bears may dig ground dens or hollow out holes in fallen logs or tree trunks; sun bears and Andean bears make tree nests by bending branches back overlapping each other; sloth bears find shelter in cool caves away from the scorching hot midday sun. Bears under human care should be provided with multiple resting areas of varying heights so they can choose the best place to rest or sleep. Their choices will vary based on temperature, precipitation, privacy, social access to others, time of day (day bed vs. night nest), or season (hibernation den, maternal den).

Large amounts of varying types of nesting materials should always be available, allowing bears to choose where and how to make their nests, as well as the option to replace soiled bedding. Some bear species spend *significant* amounts of time carefully preparing their nests or creating their dens. Allowing the animals to engage in these species-typical behaviors is necessary while under human care to promote positive affective engagement and reduce frustrations that can lead to abnormal behavior.

Grooming strategies include bathing in water, dry cleaning of fur with soft substrates (grasses, leaf litter), combing of fur on hard substrates or structures (rocks, trees), coating fur in mud to keep insects away (Langen, Angelika, 2021, Northern Lights Wildlife Society, e-mail message to author, 30 June), and cleaning of cubs.

To encourage different grooming behaviors while under human care, bears should be provided with access to a variety of environmental “furniture” and substrates. Habitats need to have a water source large enough for bears to submerge and bathe in, if they choose. Habitats should have natural substrates such as grass, soil, mulch, or leaf litter that bears can roll in for dry cleaning. Upright trees and large boulders can be used for scratching and combing fur. Mud, snow, and varied water depths or flows will provide bears with additional opportunities for grooming.

Adaptation to seasonal changes involves an animal’s survival techniques for dealing with seasonal environmental change.

All bear species experience seasonal changes in their environment. Temperate bear species generally experience the largest environmental variation in temperature, weather, and overall availability of food resources. This creates a highly evolved physiological need for torpor or hibernation (called “walking hibernation” in the case of polar bears). In preparation for this period of hibernation, bears drastically increase their caloric intake to increase their weight. These increased fat stores sustain them through periods of eating little to nothing for a number of months, resulting from seasonal weather changes or giving birth to and nursing young. Hyperphagia and hibernation are how temperate bears adapt to the vast seasonal changes in their environment; the opportunities to engage in and express these seasonal behaviors are critical to overall health and wellbeing.

Tropical bears also experience seasonal changes, such as precipitation levels and the availability of specific food resources. While tropical bears do not hibernate due to year-round food availability, they do need to move between habitats based on resource levels. Some species switch their diet based on the specific food sources available at different times of the year, taking advantage of occurrences such as masting events and salmon runs. Resting patterns and shelter use may also vary with seasonal precipitation changes. For example, tropical bears may spend more time in caves during the monsoons and more time in trees during the fruiting season.

Bear species that live in a wider geographical range may experience more variation in one habitat than another. Black bears, for example, are known to hibernate for longer periods in the northern parts of their range but only for a short time in the southern parts of their range. This environmental adaptability is also observed in bears under human

care. When planning seasonal husbandry changes, consider the environment and region the bear is currently living in. Research and model their seasonal schedule to mimic that of wild bears in the same or similar environment. For example, in more northern climates, bears may experience hyperphagia and hibernation much earlier, then remain dormant in their dens much longer than bears in more southern climates. Bears that have recently been moved to a different climate may need an adjustment period in order for their behaviors to mirror those of their wild counterparts in the region. If caregivers pay close attention, bears under human care will communicate what they need and when they need it, which will closely match the needs of wild bears living in the same climate.

There are often differences between the geophysical parameters of a bear’s natural environment and the habitat they occupy under human care. These differences can be overcome by assessing how a bear might be adapted to deal with those parameters in the wild. For example, Andean bears do not usually experience freezing temperatures, with the exception of those who periodically move through higher elevations in the Andean mountains. In zoos and sanctuaries situated in climates with cold winters, keeping indoor dens/enclosures heated so bears are comfortable often results in elevated activity levels throughout the winter. Some bears may choose to spend more time in outdoor habitats because they have the ability to retreat indoors and warm up when they get cold [32].

3. Behavior-Based Enrichment Planning

Instead of simply offering enrichment objects from a handful of categories, behavior-based enrichment provides opportunities to carry out species-specific living strategies. Daily enrichment goals should include opportunities for species-typical feeding, social, grooming, and nesting/denning strategies. Seasonal enrichment goals should provide opportunities for carrying out species-typical adaptations to seasonal changes. Laying out your natural history research in terms of living strategies is useful for organizing enrichment ideas to encourage a wide range of species-typical behaviors.

To illustrate with an example, if we were to create a behavior-based enrichment program for a sloth bear, a tropical insect- and fruit-eating bear from India, it might resemble the plan below in Table 1:

Table 1. Examples of behavior-based daily sloth bear enrichment.

Living Strategy	Goal (Wild Behavior)	Daily Enrichment Examples Providing This Behavioral Opportunity	Examples of Habitat/ Structures Providing This Opportunity
Feeding	Ground digging in the pursuit of insects	<ul style="list-style-type: none"> • Bury small foods in digging pits: <ul style="list-style-type: none"> ○ insects ○ nuts ○ dried fruits ○ diced coconut meat ○ small fruits (grapes, berries, etc.) • Mix insects or small foods into substrate beds 	<ul style="list-style-type: none"> • Digging pits <ul style="list-style-type: none"> ○ mulch ○ soil ○ bark chips • Substrate beds <ul style="list-style-type: none"> ○ leaf litter ○ wood shavings ○ shredded paper ○ hay ○ straw ○ bark chips ○ wood wool/excelsior

Table 1. Cont.

Living Strategy	Goal (Wild Behavior)	Daily Enrichment Examples Providing This Behavioral Opportunity	Examples of Habitat/ Structures Providing This Opportunity
	Tearing open termite mounds and rotting logs, or ripping bark off trees in pursuit of insects	<ul style="list-style-type: none"> • Wrap food in layers of cloth or paper • Hide food inside boxes, cardboard tubes, and bags <ul style="list-style-type: none"> ○ layer boxes and bags for more complexity • Provide rotting logs full of insects <ul style="list-style-type: none"> ○ create insect logs by leaving them outside/in the woods to rot and accumulate insects • Hide food inside tree cavities 	<ul style="list-style-type: none"> • Deadfall • Rotting logs • Large hollow logs and root balls • Holes drilled into deadfall to hide food
Sucking up insects and blowing away dirt/debris		<ul style="list-style-type: none"> • Smear foods inside bamboo or plastic tubes to be sucked out <ul style="list-style-type: none"> ○ avocado ○ peanut butter ○ jelly/jam ○ applesauce ○ cooked sweet potato/squash • Place food inside small log holes or rock crevices • Mix small food items into substrates that the bear must blow away to suck up food items • Provide rotting logs full of insects • Place small food items inside puzzle feeders for the bear to suck out <ul style="list-style-type: none"> ○ bamboo feeder tubes (closed) ○ ends and holes drilled in the middle) ○ plastic pipes (capped ends and holes drilled in the middle of the pipe) ○ hard plastic balls (with holes drilled in them) • Provide insect-infested browse <ul style="list-style-type: none"> ○ create by bundling leafy branches and sprinkling insects over them 	<ul style="list-style-type: none"> • Holes drilled into deadfall and climbing structures to hide food in • Substrate beds • Digging pits • Rotting logs • Natural substrate floors • Rock piles

Table 1. Cont.

Living Strategy	Goal (Wild Behavior)	Daily Enrichment Examples Providing This Behavioral Opportunity	Examples of Habitat/ Structures Providing This Opportunity
	Climbing trees to pick fruit/nuts	<ul style="list-style-type: none"> ● Place whole fruits up high in trees or climbing structures <ul style="list-style-type: none"> ○ Wrap unshelled/unhusked nuts and fruits with paper, cloth, or cardboard boxes so bear has to process the food to eat it ● Hang foods from tree branches/climbing structures with cloth or string so bears have to “pick” them 	<ul style="list-style-type: none"> ● Live trees ● Climbing structures ● Upright tree trunks/telephone poles <ul style="list-style-type: none"> ○ cemented into ground or secured to wall
	Climbing trees in pursuit of insects, larvae, and honey	<ul style="list-style-type: none"> ● Drill holes in upright tree trunks or climbing structures and wedge sticks or large dowels into the holes to create “branches”. Secure foods or enrichment devices (puzzle feeders) to branches using cloth so bears must break into the “packaging” to get the food while hanging in the tree. ● Wrap foods in paper, cloth, or cardboard boxes and hang them from the branches using string or cloth so the bear has to hang from the tree and unwrap, tear open, and remove the food from the packaging ● Build “beehive” from a log with holes drilled in it to hold honey or insect larvae and hang it from tree branches or climbing structures <ul style="list-style-type: none"> ○ Place an eye hook on top of the log for hanging ● Hang honeycombs wrapped in layers of paper or cardboard boxes from tree branches or a climbing structure 	<ul style="list-style-type: none"> ● Live trees ● Upright tree trunks or telephone poles ● Climbing structures
	Scavenging the ground and low bushes for fruit	<ul style="list-style-type: none"> ● Hide food in substrate piles so bears must move substrate around to find food ● “Scatter feeds”—scatter food around enclosure so bear must search for it 	<ul style="list-style-type: none"> ● Live berry bushes and vines ● Natural substrate floors
	Picking berries	<ul style="list-style-type: none"> ● Provide a field of puzzle feeders made from bamboo or plastic pipe (with capped ends) with holes cut in them so they require a lot of dexterous manipulation to get small food items out, mimicking the work a bear does at a berry patch 	<ul style="list-style-type: none"> ● Live berry bushes and vines

Table 1. Cont.

Living Strategy	Goal (Wild Behavior)	Daily Enrichment Examples Providing This Behavioral Opportunity	Examples of Habitat/ Structures Providing This Opportunity
	<p>Additional cognitive challenges (Sloth bears occasionally go after the unknown and difficult to attain)</p>	<ul style="list-style-type: none"> • Firehose food puzzle <ul style="list-style-type: none"> ○ place food inside and tie the firehose in a loose knot • Puzzle feeders with food placed inside so bear must manipulate feeder and figure out how to remove the food <ul style="list-style-type: none"> ○ bamboo feeder tubes (closed ends and holes drilled in middle) ○ plastic pipes (capped ends and holes drilled in middle of pipe) ○ hard plastic balls or other containers (with holes drilled in them) • Line puzzle feeder tubes (bamboo or plastic pipe) with paper (you can roll up the paper for multiple layers) and place small foods inside so the bear must use claws to poke holes through the paper in order to get the food out • Attach the puzzle feeder to the outside of the enclosure so the bear must manipulate it with claws and suck out the food through the enclosure mesh 	
Social	Communication	<ul style="list-style-type: none"> • Provide visual access to bears not physically housed together • Set up mirrors in the hallway for bears to see each other 	<ul style="list-style-type: none"> • Live trees to rub on (“information trees”) • Upright tree trunks or deadfall <ul style="list-style-type: none"> ○ Cemented into the ground or secured to a wall

Table 1. Cont.

Living Strategy	Goal (Wild Behavior)	Daily Enrichment Examples Providing This Behavioral Opportunity	Examples of Habitat/Structures Providing This Opportunity
Privacy		<ul style="list-style-type: none"> ● Provide visual barriers for bears that are physically housed together 	<ul style="list-style-type: none"> ● Dens <ul style="list-style-type: none"> ○ concrete culverts ○ rock/cement structures ● Hollowed-out tree trunks or root balls ● Live trees, bushes, bamboo patches
Denning and Nesting		<ul style="list-style-type: none"> ● Provide fresh substrates <ul style="list-style-type: none"> ○ Mulch ○ Soil ○ Leaf litter ○ Wood shavings ○ Grass ● Provide fresh nesting material <ul style="list-style-type: none"> ○ Hay ○ Straw ○ Wood wool ○ Sheets ○ Towels ○ Blankets ○ Duvet/comforter 	<ul style="list-style-type: none"> ● Climbing structures with platforms large enough for bears to lay/rest on ● Low-to-ground platforms ● Hammocks <ul style="list-style-type: none"> ○ fire hose ○ bamboo ○ hang from frame if on the ground ○ hang from trees, climbing structures, or eye hooks in the ceiling/walls ● Dens <ul style="list-style-type: none"> ○ concrete culverts ○ rock/cement structures ● Hollowed-out tree trunks or root balls ● Live grasses
	Bathing in water	<ul style="list-style-type: none"> ● Provide large plastic or metal tubs filled with water ● Set up a mister/shower head 	<ul style="list-style-type: none"> ● Pools ● Waterfalls
Grooming	Dry cleaning of fur	<ul style="list-style-type: none"> ● Provide fresh substrates to roll in ● Attach heavy-duty natural-bristle scrub brushes to the enclosure wall/mesh to rub against 	<ul style="list-style-type: none"> ● Natural substrate floors ● Live grass ● Rock piles ● Trees ● Substrate beds

3.1. Daily Routines

Wild animals generally develop daily routines based on their natural histories, living strategies, and personal agendas. Under human care, animals are naturally subjected to the daily routines created by their caregivers (human agendas), which do not always reflect the species' natural routines. It is important to develop appropriate plans/goals based on the animals' expressed behaviors rather than human schedules. It is possible and critical to create an environment that allows the animals to engage in their choice of behaviors while working around the constraints of staff hours for cleaning, feeding, enriching, and training. By prioritizing enrichment provisions amidst normal cleaning/feeding routines, staff can provide the animals with varying options and choices throughout the day as it fits the animals' natural schedules and their behaviors indicate the need. The following plan (see Table 2) illustrates what a sloth bear's daily schedule might look like, including how enrichment would be incorporated into the caregiver's schedule to provide numerous opportunities to express species-typical behaviors and experience positive affect throughout a 24-h period. Ensure that the plan incorporates the variation between species, individual animals, and times of year. Reinforcing caregiver-animal relationships will provide useful

knowledge to assist in tailoring enrichment to individual animal preferences, increasing opportunities for the animal to pursue activities that result in positive affective states. Animals may be diurnal, nocturnal, or crepuscular in their activities and may even change this schedule seasonally. It is important to research each species’ natural history and understand what their schedule would typically look like in the wild at different times of the year to better manage husbandry goals (cleaning, feeding, and enriching).

Table 2. An example of how enrichment may be provided throughout the daily routine of a sloth bear.

Time	Bear Behavior	Husbandry Note	Enrichment to Be Provided
Sunrise	Bears wake Bears check on cage mates		Enrichment goal: provide opportunities for social communication <ul style="list-style-type: none"> • Opportunities may be set up the night before or already exist in the habitat/enclosure
Shortly after Sunrise	Bears groom		Enrichment goal: provide opportunities for bathing/grooming <ul style="list-style-type: none"> • Opportunities may be set up the night before or already exist in the habitat/enclosure
Early Morning	Bears search for food	This is a critical time for a bear; if it is hungry in the morning before caregivers arrive, it will begin to express abnormal behaviors such as pacing	Enrichment goal: provide opportunities for species-typical feeding strategies <ul style="list-style-type: none"> • The caregiver must feed the bears at sunrise or leave the bears with enrichment objects full of foods the night before so the bear can investigate for leftovers in the morning
Early morning to Mid-morning	Bears continue their search for food	Caregiver cleaning indoor/outdoor areas and placing morning diet/enrichment	Enrichment goal: provide opportunities for species-typical feeding strategies
Mid-morning to Early afternoon	Bears rest in daybeds	<i>Opportunities for these enrichment goals can be provided during the previous time slot</i>	Enrichment goal: provide locations/structures for nesting Enrichment goal: provide opportunities for nest building
Early Afternoon to Mid-afternoon	Bears may get up to search for food Bears may continue to rest in daybeds	Caregiver offering midday feeding/enrichment	Enrichment goal: provide opportunities for species-typical feeding strategies Enrichment goal: provide locations/structures for nesting, privacy, quiet, and shade Enrichment goal: provide opportunities for nest building
Mid-Afternoon to Evening	Bears active—search for food Bears are willing to work harder for enrichment since they have already been satiated earlier in the day	Caregiver placing evening diet/enrichment Enrichment options should offer a mental challenge (such as puzzle feeders) and physical exercise	Enrichment goal: provide opportunities for species-typical feeding strategies <ul style="list-style-type: none"> • Be sure plenty of puzzle feeders and other enrichment are given so that food is left overnight for the early risers who want to eat before care staff arrive.

Table 2. Cont.

Time	Bear Behavior	Husbandry Note	Enrichment to Be Provided
Evening to Night	Bears begin to show an interest in bedding down	<i>Opportunities for these enrichment goals can be provided during the previous time slot</i>	Enrichment goal: provide a choice of locations/structures for bedding down for the night that include privacy Enrichment goal: provide opportunities for nest building

3.2. Seasonal Routines

While researching species' daily routines and living strategies to develop daily enrichment ideas and a daily enrichment schedule, it is equally important to understand how they react and adapt to seasonal environmental changes in their natural environments. When researching these strategies, look at populations of animals experiencing similar climates to where your facility is located. For example, polar bears are highly adapted to extreme environments, occupying niches in the Arctic Circle. However, several subpopulations live in the southern Hudson's Bay area that experience seasonality similar to what many polar bears living under human care will experience. The behavior of bears within these populations provides information about how polar bears might be successfully housed in more temperate climates. Polar bears generally experience an annual metabolic cycle opposite that of brown bears; they gain weight in the winter months and lose weight over the summer. They experience a 'walking hibernation' while waiting for the bay to freeze in the fall in order to migrate to their hunting grounds on the pack ice [59,60]. Some polar bears are omnivorous feeders in the summer, while others fast through the season [61]. Mimicking seasonal resource availability and the presentation of daily dietary needs through enrichment programming allows the bears to appropriately manage their own weight loss and gain as their genetics predicate, improving opportunities for polar bears to thrive year-round in more temperate climates.

While temperate species naturally come to mind when thinking about seasonal husbandry adaptations, tropical animals also experience seasonal changes in their habitats and food resources. Resting patterns and diets may change seasonally for tropical bears based on annual precipitation or fruiting cycles. These changes can be mimicked for bears under human care by observing populations of bears living in similar climates. For example, sloth bear populations living in northern India experience greater variations in temperature than those in southern India. These bears exhibit seasonal changes in activity levels similar to what we naturally observe in bears in temperate climate zones (Seshamani, Geeta, 2014, Wildlife SOS, New Delhi, India, Personal communication). For a highly adaptable, facultatively seasonal species such as the sloth bear [51], we can even compare the behaviors of wild black bears living in similar habitats to understand the changes expected during different seasons. Table 3 demonstrates seasonal enrichment changes for sloth bears living in a four-season temperate zone climate.

In cases of mixed-species exhibits or enclosures housing animals from different climates, consideration must be given to providing multiple microclimates within their habitats. Temperature gradients can be created by having both outdoor and climate-controlled indoor habitats, including areas with a variety of dry substrates and water features. Additionally, providing multiple structures and shelters at different levels where animals can choose to be in the elements (sun, wind, and rain), protected from the elements, and experience differing temperatures will assist with the cohabitation of species with differing seasonal adaptations. Seasonal routines may also need to be modified for different individuals of the same species living in a socially housed group. For example, not all bears will be ready to den at the same time. By providing animals with multiple choices and control over their environment (for example, the choice to rest in a quiet den or forage in the

larger outdoor habitat), the needs of all animals can still be met when careful consideration is given.

Table 3. Examples of behavior-based seasonal sloth bear enrichment.

Season	Event ¹	Behavior	Examples of Seasonal Enrichment and Habitat Elements
Autumn	Hyperphagia <i>August–October</i>	Sloth bears in climates that experience seasonal changes may follow a similar pattern as temperate bear species and be voracious eaters at this time of year, as they put on weight to get them through seasonal lethargy or “denning” in the coming winter. Sloth bears will spend more time searching for food, travel further distances, and work harder to get food. They are less tolerant of sharing food at this time.	<ul style="list-style-type: none"> • Increase overall amount of enrichment • Increase the number of enrichment items/activities/feeding stations • Increase complexity of enrichment • Provide more food and more enrichment than is needed by the number of bears in the enclosure
	Metabolic Depression <i>October–November</i>	Sloth bears in climates that experience seasonal changes may follow a similar pattern as temperate bear species and start to slow down both in appetite and activity at the end of this season. They may start seeking out denning sites for the winter. They may prefer to be alone rather than with a companion.	<ul style="list-style-type: none"> • Access to dens • Provide substantial amounts of fresh nesting material • Separate bears who wish to be alone <ul style="list-style-type: none"> ○ leave with visual access if tolerated
Winter	Metabolic Depression <i>also called Seasonal Lethargy or “Denning”</i> <i>October–March</i>	Sloth bears do not hibernate, but in cooler climates they will slow down during the winter, both in appetite and activity level. ²	<ul style="list-style-type: none"> • Reduce overall amount of enrichment if the bears have slowed down • Reduce the complexity of enrichment if bears are not putting as much energy into working for their food • Provide substantial amounts of fresh nesting material • Allow bears to sleep or stay in their den if they wish (do not disturb) • Use food trough/food door to drop food/enrichment into enclosure if bear chooses not to shift out for cleaning or food/enrichment placement

Table 3. Cont.

Season	Event ¹	Behavior	Examples of Seasonal Enrichment and Habitat Elements
Spring	Coming out of metabolic depression/seasonal lethargy <i>March–May</i>	Sloth bears in cooler climates that slowed down during the winter will start coming out of their metabolic depression/seasonal lethargy and becoming more active.	<ul style="list-style-type: none"> • Slowly increase the overall amount of enrichment according to the bears’ needs • Slowly increase the number of enrichment items/activities/feeding stations once the bears are more active • Start doing intros if bears had been separated over the winter
Summer	Active, social, breeding season <i>May–July</i>	Bears are rising with the sun and looking for food as soon as they get up.	<ul style="list-style-type: none"> • Provide food enrichment at sunrise • Leave bears with puzzle feeders the night before so that the bear can investigate for leftovers early in the morning • Increase overall amount of enrichment • Increase complexity of enrichment • House social bears together
	Early Hyperphagia <i>July</i>	Hyperphagia comes early for some bears—typically right after breeding. Sloth bears will spend more time searching for food, travel further distances, and work harder to get food. They are less tolerant of sharing food at this time.	<ul style="list-style-type: none"> • Increase overall amount of enrichment • Increase the number of enrichment items/activities/feeding stations • Increase complexity of enrichment • Provide more food and more enrichment than is needed by the number of bears in the enclosure

¹ The date range is only a guideline. The increase or decrease in diet and enrichment must be responsive to the bears’ appetite and behavior changes. For example, during hyperphagia, if the bears eat all of the foods offered, continue to increase the daily ration by significant amounts. The only way to gauge if bears are satiated is if there is food left over. During the onset of metabolic depression, when the bears slow down, the daily ration should only decrease according to their decreased appetites. There must always be foods leftover in both scenarios. ² Kuhrt, Trudy. 2011; Toledo Zoo, Toledo, OH, USA; Sodaro, Carol. 2011; Brookfield Zoo, Brookfield, IL, USA; Bayrakci, Rana. 2011; Woodland Park Zoo, Seattle, WA, USA; Thompson, Debbie. 2011; Little Rock Zoo, Little Rock, AR, USA; Seshamani, Geeta. 2014. Wildlife SOS, New Delhi, India; Sha, Arun. 2015. Wildlife SOS, New Delhi, India. Personal communications.

3.3. Other Considerations—Individual History and Current Circumstance

Behavior-based enrichment considers an animal’s individual history as well as current circumstances. Enrichment routines should be personalized based on each animal’s sex, age, rearing, previous environment, medical conditions, life cycle stage, current habitat condition, and social circumstances. These individualized changes might apply to any or all aspects of the daily and seasonal routine, potentially impacting the amount or availability and timing of enrichment opportunities needed to create the same species-specific opportunities for each animal. While this paper does not compare/contrast different husbandry and enrichment strategies for animals housed in zoos or conservation breeding programs versus sanctuaries or rehab/release facilities, consider how an animal’s needs may vary depending on individual history, environment, and current circumstances.

When considering an animal's rearing history and/or previous environment, it is important to understand if they experienced any sort of trauma (i.e., premature maternal separation, being forced to perform in a circus, being kept in inadequate enclosures with poor welfare, etc.). Prior trauma can make animals more fearful of new experiences, including large natural habitats and enrichment. Animals that have experienced trauma or have exhibited fearful or wary behaviors should be allowed to adapt gradually to new habitats. They should be introduced at a slower rate to larger or new spaces, as well as to novel enrichment, proceeding at their own pace based on their level of comfort. A well-adjusted animal that was mother-reared and grew up in a natural enclosure with behavior-based husbandry will likely adjust to new enrichment and new experiences more quickly and confidently. Always monitor behavior, as animals will clearly provide behavioral indicators of their comfort levels, and introduction schedules for novel stimuli should be adjusted accordingly.

Similarly, age and medical conditions may play a role in planning daily enrichment routines. Young, healthy bears are full of energy and require enrichment and habitat structures that provide more opportunities for physical and mental exercise. These bears will want to climb more, travel further, work harder on puzzle feeders, etc. Conversely, an older bear who has slowed down or a bear with arthritis or missing limbs from prior injuries (i.e., a rescued wild bear that was hit by a car) will need a habitat and enrichment tailored to their physical limitations. Examples may include building climbing structures lower to the ground or adding extra steps and ramps to climbing structures and pools. Aiding access to resources or spaces for differently-abled and/or geriatric animals allows them to express a wider range of behaviors, despite any reduced physical capabilities.

When working with socially housed animals, caregivers should recognize that they need multiple access points to hammocks, platforms, climbing structures, and other habitat features, thus providing the option to not engage if challenged by a companion. Habitats and furniture must be designed so animals do not become cornered or trapped if social tension arises; alternate avoidance routes should always exist. Socially housed animals need to be provided with multiple sources for each enrichment item or activity, with the intention of minimizing unnecessary competition for resources that may result in aggression between individuals.

Routines may also change based on which stage an animal is experiencing in its life cycle. Breeding bears need enrichment routines that allow for successful introductions and reproductive behaviors. During introductions, extra enrichment and food provisions are necessary so bears feel they have more than enough resources to allow another bear into their territory [62]. In addition, consideration must be given to the habitat(s) where the animals will be introduced. There must be enough resources for nesting and denning, bathing and grooming, and all other living strategies that the animals would want to engage in. A habitat that only meets the needs of one bear will not suffice when putting bears together for breeding; alterations may be required to increase the habitat furniture and behavioral opportunities to meet the needs of both bears.

While the normal daily routine for a bear may involve at least three feedings/enrichment provisions per day, this will change when a female dens up to give birth. Routines may need to be adjusted for individual bears as, while a pregnant female bear is denning, there may be males or subadults who remain active. Routines must be adaptable, and caregivers should reassess daily and seasonal routines on a regular basis to ensure the needs of the animals are met at that moment in time. If bears choose to sleep more or den up in the winter, they should be allowed to do so; daily enrichment routines should adjust to meet that need. Likewise, if bears choose to spend more time awake or switch their waking hours from diurnal to nocturnal, the enrichment routine should accommodate the bear's changing needs.

4. Assessment

Welfare is a subjective phenomenon and consequently difficult to quantify. Routine assessment of animal welfare is an essential component of any husbandry program as it provides the opportunity to gauge the success of care parameters such as enrichment. Wellbeing exists on a continuum, so assessment questions should reflect both “inputs” and “outputs” that provide insight into where an animal exists on this scale. Originally, welfare assessments centered around the concept of mitigating negative welfare [63–65]. Scientific research into animal sentience and emotion emphasizes measures of positive welfare, including motivational states, positive emotions, and positive affective engagement [24,37,66]. Various approaches to measuring positive welfare have been proposed [24,66] and some species-specific tools have recently been developed [67,68] but more research is required to validate behavioral measures of positive welfare [24,66]. While future articles are planned to discuss welfare assessment, currently The Bear Care Group recommends a tool developed by Maher et al. [67] for assessing welfare for hibernatory bear species (brown, American black, and Asiatic black bears). This tool uses not only traditional management-based and resource-based measures (such as provision of food, enrichment, and space) to assess welfare risks to the animal but also includes animal-based measures (such as expression of species-typical behaviors) that are potential indicators of positive welfare. This tool has been tested for inter- and intra-rater reliability as well as item reliability for each indicator in the assessment. Results showed good to excellent levels of all reliability measures, indicating potential utility as an assessment tool for caregivers of temperate bear species. Routine assessments should incorporate seasonal changes and life events. Assessment results should be factored into the modification of programs to increase positive welfare.

5. Discussion

This article discussed the importance of researching a species’ natural history to identify their living strategies, including natural daily and seasonal routines, in order to appropriately create and implement enrichment goals into daily care routines. Living strategies for many species will often overlap, streamlining the planning process for facilities caring for multiple species or individuals. While we used bears as examples to illustrate key points, the concepts discussed are applicable to behavior-based enrichment programs for any species. Examples include:

- Food-related enrichment goals should mimic species-typical feeding strategies, allowing for natural, environment-focused exploration and food acquisition;
- Animals should be managed in appropriate social groups, with environmental and enrichment options minimizing the risks of aggression or adverse social interaction and optimizing opportunities for affiliative behavior. These considerations should include not only interactions between socially housed animals but also those with caregivers;
- Animals should be provided with opportunities to engage in various bathing and grooming behaviors;
- Multiple resting and denning locations should be provided, incorporating a variety of environmental choices ranging from sun to shade, social to private, noisy to quiet, with appropriate options to evade weather and ambient conditions/stimuli when desired;
- A variety of substrates for nesting/bedding should be offered to animals who build or rest in nests, line dens, burrows, etc.;
- Enrichment goals should include and encompass a range of species-specific behaviors that encourage physical exercise, mental stimulation, emotional fulfillment, and opportunities to pursue and successfully attain both *wants* and *needs*.

Understanding and applying this information may appear simple, but many facilities experience behavioral issues with the species under their care. Caregivers confronted with behavioral concerns should revisit each species’ natural history and living strategies, comparing the animal’s habitat, daily and seasonal routines, and enrichment program goals to the genetic predispositions and documented behaviors of individuals that live in

natural conditions. Identifying missed behavioral opportunities or habitat elements, or significant differences in daily and seasonal routines, can help prioritize programmatic adjustments. Identifying daily routines or habitat features that create obstacles to behavioral goals may help us understand possible causes of atypical behaviors exhibited by the animals. Developing goals or methods intended to overcome environmental and behavioral obstacles in order to elicit species-typical behaviors (or redirect atypical behaviors) will help focus enrichment program modifications. It is important to create and regularly review action plans and goals to assess your enrichment program and determine what modifications or adjustments would be beneficial. Any enrichment program, behavior-based or otherwise, should constantly be assessed, adjusted, and improved. Providing opportunities for multiple living strategies can be a challenge for caregivers, but it is vital to remember that the further an animal's environment diverges from its natural habitat and routine, the likelihood of developing abnormal and/or stereotypical behaviors increases [21–23,29]. Conversely, when an animal's environment more closely matches their natural history expectations and provides a greater diversity of behavioral opportunities, the likelihood that animals will engage in behaviors that elicit positive emotions increases, as does their overall welfare [24,27,36]. It is the caregiver's responsibility to provide as many 'good life opportunities' [69] as possible for animals to exert choice and control over their lives. Monitoring behavior, developing species-appropriate management programs, and responding to each animal's *wants* and *needs* create a foundation for excellent stewardship, care, and wellbeing. As Else Poulsen often wrote or taught, approach every interaction with an animal with the mindset of "Who are you, and what can I do for you?".

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