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Dipartimento Biomedicina Comparata e Alimentazione
Department of Comparative Biomedicine and Food Science

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Assessing Brown Bear Adaptation in Captive Conditions: Developing a Working Ethogram and Analyzing Behavioral Responses to Habitat Dynamics and Environmental Influences

Supervisor
Prof. Simona Rosaria Carla Normando

Co-Supervisors
Dott.ssa Elena Stagni,
Dott.ssa Irene Redtenbacher

Submitted by Camilla Carrer
Student n. 2003471

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ABSTRACT

This thesis presents an analysis of brown bear (*Ursus arctos*) behavior within the context of sanctuary-captive conditions, focusing on two pairs of brown bears cohabitating with siblings. Thanks to the development and usage of a working ethogram, the study documents bear behavioral patterns, emphasizing their response to environmental stimuli.

The observations were conducted over 140 continuous 15-minute sessions for each of the four bears, providing a comprehensive time budget of their behaviors.

The study took place at BEAR SANCTUARY Müritz, involving two sibling pairs of brown bears observed in two different sanctuary enclosures, allowing for data collection on how they behave in different environments.

One pair of bears was moved between two enclosures at BEAR SANCTUARY Müritz, while the second pair was translocated from another FOUR PAWS bear sanctuary. This research contributes to the understanding of the complex interplay between behavior and environmental factors, offering significant implications for improving wild animal welfare and management within sanctuary settings.

INTRODUCTION

General information on brown bear (*Ursus arctos*)

The brown bear (*Ursus arctos*), one of the most widely distributed large carnivores, inhabits a variety of environments across North America, Europe, and Asia. They thrive in diverse habitats including forests, mountain regions, tundras, and coastal areas. Their home ranges can be quite extensive, with males averaging between 73 to 2,600 square kilometers, significantly larger than those of females (*Anita J. Norman, et al., 2013*).

Seasonal movements of brown bear have been observed, with individuals sometimes traveling hundreds of kilometers during the autumn to reach areas of favorable food supplies (*Wilson, D., S. Ruff, 1999*).

Home ranges in brown bears often overlap, particularly among related females. Males, however, have significantly larger home ranges, which can overlap with those of several females. Despite this overlap, there is no evidence of territorial defense. Although generally solitary animals, bears do exhibit social bonds, primarily seen in females with their cubs (*Wilson, D., S. Ruff, 1999*).

However, occasionally, even adult male bears may congregate in large numbers in areas with abundant food sources, such as salmon streams and areas of high berry production (*Wilson, D., S. Ruff, 1999*). In this context they may form foraging groups with more than one age class of young, and this occasion provides unique opportunities to observe social interactions among these animals (*Mauricio Cantor, Damien R Farine, 2018)*.

Under these conditions, dominance hierarchies are usually formed and maintained with aggression. Highest-ranking individuals are large adult males, although the most aggressive bears are females with young. Least aggressive and lowest ranking are adolescents. However, the only lasting social bonds are formed between females and the young. (*Wilson, D., S. Ruff, 1999*)

Given their omnivorous nature, brown bears consume many kinds of foods, exhibiting a mix of foraging and predatory behaviors, which vary according to seasonal availability (*Van Daele, et al., 2010*): in addition to a variety of plant resources including berries, nuts, and roots, they also

occasionally eat larger creatures like deer and moose as well as insects, fish, and small mammals. In coastal areas, salmon makes up a significant amount of the diet during spawning seasons (*Jennifer K. Fortin, et al., 2016*; *Wilson and Ruff, 1999*). When salmon swim upstream, dozens of bears may gather to feast on the fish, craving fats that will sustain them through the long winter ahead. In fall a brown bear may eat as much as 90 pounds of food each day, and it may weigh twice as much before hibernation as it will in spring (*Folk et al., 1972*).

Although brown bear populations in North America show a wide range in size, researchers found no significant difference in body mass between the two European populations using a new analytical approach. This method incorporated modeled age-standardized body masses in linear models, correcting for sex and season. The greater variation in North America may be due primarily to the presence of large bears that feed on salmon (*Oncorhynchus spp.*), which does not occur in Europe. (*Jon E. Swenson* et al*., 2007*).

Ursus arctos individuals may be active at any time of the day, but generally forage in the morning and evening and rest in dense cover by day, where it may excavate shallow depressions in which to lie (*Wilson, D., S. Ruff, 1999*).

Despite their size, brown bears are extremely fast, capable of reaching speeds of 30 miles per hour. (*Craighead and Mitchell, 1982; Storer and Tevis, 1955*). This speed is facilitated by their powerful muscular structure. Particularly distinctive is the shoulder hump, which is a large muscle that not only aids in digging and turning over rocks but also contributes to their overall strength and agility, allowing them to accelerate quickly and navigate through their diverse habitats (*Herrero, S., 1972*).

Their fur color ranges from light brown to almost black, providing camouflage in various environments. Additionally, their long, curved claws are adapted for digging and tearing apart logs to find insects, roots and other food sources (*Penteriani V. et al., 2020*).

These physical characteristics, coupled with their speed and dexterity, enable brown bears to forage efficiently and defend themselves against potential predators and competitors (*Schwartz et al., 2003*).

In the wild

In the wild, brown bears complex behavioral patterns are influenced by ecological and social factors. These behaviors include foraging strategies, seasonal denning, and reproductive activities (*Penteriani V. et al., 2020*).

For example, Hibernation is an important life history activity that coincides with winter in seasonal environments and represents an adaptation for coping with harsh environmental conditions, generally associated with low temperatures and food scarcity (*Geiser, 2013; Ruf & Geiser, 2015*). For brown bears, hibernation is critical: pregnant females give birth and lactate while in dens, so during hibernation, energy savings can be substantial and, furthermore, premature emergence can negatively impact energy conservation and cub survival (*Friebe, Swenson et al., 2001; Geiser, 2004*) (*Pigeon, Stenhouse, & Côté, 2016*). Moreover, to highlighting the importance of this period, it's important to take in consideration that bears may spend as much as half of their life in winter dens, and hibernation demands a preceding phase (hyperphagia) involving the intense search for food in order to store energy for their survival and reproductive success (*Friebe et al., 2001*). Thus, the conservation and management of brown bears requires knowledge regarding the denning ecology of different populations as well as their foraging behaviors, reproductive cycles, and responses to environmental changes. This is essential for both wild animal management as well as for those individuals that are kept under captive conditions to ensure their long-term survival and well-being (*Jennifer K. Fortin, et al., 2016*).

In captive environments

Brown bears in captivity often exhibit different behaviors compared to those in the wild due to their complex needs and large home ranges, making them difficult to manage even in sanctuaries (*J. Pierce, M. Bekoff, 2018*). While the captive environment provides protection from threats like hunting and habitat loss, there are still challenges to face like limited space and human interaction (*McLennan et al., 2012*).

Understanding how these conditions affect bear behavior is vital for enhancing animal welfare and management practices in such settings. Achieving the best layout of enclosures in zoological parks is not a recent goal and applies to all animal species (*Hediger, 1955*). However, this can be motivated by very different expectations (*Robinson, 1998*). The purpose may be to increase activity of the animals or to make them more visible to the public (*Little and Sommer, 2002; Bashaw et al., 2003*), to prevent the animals from performing stereotypies, to promote natural behaviors or to increase reproductive success. The way to achieve these goals is generally called 'enrichment' and often consists in new feeding methods (*Carlstead et al., 1991; Forthman et al., 1992; Wiedenmayer, 1998; Fischbacher and Schmid, 1999; Mc Phee, 2002; Morimura, 2003*) or in new facilities (*Renner et al., 2000; Renner and Plebani Lussier, 2002*). Moving the animal in new enclosures (*Kristen E. Lukas, et al., 2003*) is also considered an 'occupational therapy' (*Seidensticker and Doherty, 1996*), together with positive reinforcement training to suppress boredom and reduce stereotypic behaviors in captive animals (*Laule and Desmond, 1998*).

Zoo exhibits for bears are usually small and often poorly furnished. Bears kept in such barren environments, particularly from an early age, tend to perform stereotypies (*Forthman et al., 1992*). For this reason, the decrease in the amount of stereotypies is often considered a good indication of an improvement in wellbeing. However, the barren environments are not the unique explanation for stereotypies (*S. Montaudouin, G. Le Pape, 2005*). Rearing and husbandry procedures as well as genetic factors have been implicated in the etiology of stereotyped behaviors (*Mason, 1993; Liu et al., 2003*), together with visitors and keepers' presence (*S. Montaudouin, G. Le Pape, 2005*).

Sanctuaries are protected areas where the animals are maintained and sheltered for prolonged periods: they offer accommodation or treatment of sick or wounded animals, the rejected young that are still not able to survive in nature and animals seized from the owner because of being illegally kept in captivity, illegal trade, export, import and other reasons as determined by the law (*UNMIK Regulation No. 2001/09, May 15, 2001*).

Unlike zoos, where animals are often confined to smaller enclosures designed primarily for public viewing, true sanctuaries focus on the welfare and rehabilitation of animals. Although the animals are still kept in enclosed areas, these spaces are usually larger and more tailored to meet their physical and psychological needs. However, sanctuaries must also consider the individual histories of the animals they shelter. Prior experiences, such as trauma from illegal captivity or neglect, can influence their behaviors and overall well-being (*Jignesh Rot et al., 2023*).

This study took place in one of the FOUR PAWS' bear sanctuaries: FOUR PAWS is an international animal welfare organization focused on protecting animals under human care. It works to expose animal suffering, rescue those in need, and safeguard their well-being. The organization leads various campaigns, including efforts to end the dog meat trade, fur farming, animal abuse in the fashion industry, and illegal wildlife trafficking. Additionally, it rescues a range of animals, such as big cats, local wildlife, foxes, and bears (*FOUR PAWS*).

Since 1998, FOUR PAWS has been committed to ending the improper keeping of brown bears in Europe by advocating for legislative changes and rescuing bears. These bears, often rescued from neglect, abuse, or inadequate conditions, come from environments like circuses, private ownership, zoos and situations where they were exploited as dancing bears or used as bait for hunting dog training (*FOUR PAWS*).

To date, FOUR PAWS has rescued over 130 bears across Europe and played a key role in ending the keeping of dancing bears in Bulgaria and Serbia, stopping the illegal keeping of restaurant bears in Kosovo and Albania, and putting an end to private bear ownership in Poland. The organization ensures that rescued bears are provided with the best possible care at their sanctuaries, where their physical and psychological needs are met (*FOUR PAWS*).

These species-appropriate environments, provided by the sanctuary, include a terrain rich in variety and structures, natural vegetation (trees, bushes, open grasslands), human-made or natural water resources to give the possibility to bath and swim, but also hidden areas, resting places in the outside enclosure as well as indoor shelters that can be accessed by bears any

time. The bears have the possibility of building dens for hibernating and interacting with human-made naturalistic structures, according to their individual characteristics and needs. As much as possible of the overall area of the enclosure has to consist of natural ground but never less than 80% (*FOUR PAWS - Global Animal Protection Organization (fourpawsusa.org)*).

AIM

The purpose of this study is to analyze the behavioral patterns of two sibling pairs of brown bears currently living in BEAR SANCTUARY Müritz, Germany.

The research employs a detailed working ethogram that includes a wide range of behaviors, with a particular focus on key behaviors such as resting, eating, locomotion, bathing and grooming, stereotypies, affiliative behaviors, and the use of the den and out-of-sight areas.

The study compares the behavior of one sibling pair across two different enclosures within the sanctuary, and documents the behavioral changes observed in a second sibling pair upon their arrival from another FOUR PAWS Bear Sanctuary, as well as after 15 days in their new enclosure. Additionally, scan sampling was utilized to track the bears' enclosure usage and provide insight into their spatial preferences.

By examining these behaviors in different contexts, the research aims to highlight the impact of environmental changes on brown bear’s behavior. The findings are intended to improve the welfare of wild animals under human care and enhance management practices in animal sanctuaries, ultimately improving the living conditions for bears in captivity.

MATERIALS AND METHODS

Animal descriptions

The study focused on two pairs of sibling brown bears: Sylvia and Pavle from April to June 2023, and Dasha and Lelya from June to the end of July 2023.

The first pair observed, Sylvia and Pavle, were confiscated by authorities from Serbian Circus Corona in October 2016. Environmental inspectors from the Provincial Secretariat for Urbanism and Environmental Protection, in cooperation with the Ministry of Agriculture and Environmental Protection of Serbia, seized the bears. Their cage was dirty with food leftovers and garbage, unprotected from rain, cold, or heat, and so small that the bears could not stand up or turn properly. Sylvia and her brother Pavle endured neglect and inadequate nutrition, they were fed only scraps and leftovers. These poor conditions led to severe health issues.

PAVLE: A castrated male brown bear born in 2003, arrived at the BEAR SANCTUARY Müritz in November 2017 with his sister Sylvia. He weighs between 160-190 kg and exhibits stereotypic behaviors mainly observed in presence of loud noises and of visitors.

SYLVIA: Born in 2003, Sylvia shares a similar history with her brother, with whom she is still housed with. She has a severe deformation of her left front limb, likely due to traumatic luxation of the humeroantebrachial joints and injury to the epiphyseal growth plates at a younger age resulting in retarded growth of all bones distal to the humerus with either missing or reduced digits. Her carpal joints show osteoarthritic changes, and joint rigidity is probably due to chronic shortening of the flexor tendons and complete structural disruption of the elbow and carpal joints.

The loss of digits and fur on large areas of the affected limb is likely caused by a severe cut or laceration that healed by second intention. Tooth wear is attributed to her previous nutrition and living conditions. Her inability to bear weight on the left front limb is probably mechanical rather than pain-related, as she generally behaves normally and is in good health. In April 2022, she underwent an ovariectomy following the suggestions of the veterinarians to reduce the

excessive frustration exhibited during the mating season. Sylvia is not compatible with any other bear, male or female, except for her brother Pavle, with whom she shares a unique bond.

The second pair observed are two Ukrainian female brown bears, rescued by FOUR PAWS in October 2019. Before they arrived in BEAR SANCTUARY Domazhyr (Ukraine), Dasha and Lelya were living in a small barren concrete enclosure as a tourist attraction at a hotel and restaurant in Skole. The owner settled up a private mini zoo for entertainment purposes and for attracting more guests. Later on, as the owner become older, the family could not carry on the business and maintain the zoo, therefore it closed its activity and thanks to the Ukrainian Authorities, FOUR PAWS was asked to take care of them.

Due to Lelya's health conditions, she was moved to BEAR SANCTUARY Müritz in 2023, to take advantage of its beneficial proximity to the Leibniz Institute for Zoo and Wildlife Research in Berlin. To not forcibly separate them, it was decided that Dasha was to join her sister on her journey to Germany.

DASHA: An intact female brown bear born in 2005, weighing approximately 140 kg, she is agile and in good health.

LELYA: An intact female brown bear born in 2005, weighing approximately 140 kg, she showed particular health problems visible on the skin, where its coat grows unevenly. Since it was not possible to treat her optimally in Ukraine, due to the political situation, it was needed to move the bear to another country, with easily accessible veterinary care.

Daily husbandry routine

The daily care routine for the bears at the sanctuary is designed to match their natural rhythms, especially taking into consideration the period right after they wake up from hibernation. At first, the bears are given their time to adjust, but later on, more activities such as enrichment and training are introduced.

Their diet also changes accordingly. Initially, they are given mainly vegetables and fruits, with a single feeding round that includes items like carrots, cucumbers, tomatoes, celery, and apples, which are given daily over the fence. When keepers enter the enclosures, the food is spread and hidden to encourage foraging behavior. Later on, as the activity levels of the bears increased, the routine and diet were adjusted to include more animal products such as eggs and meat, with a second feeding round added, followed by a third one in the late summer.

Every morning the bears which need it, receive a piece of bread with honey, which is used to administer necessary medications. For example, in this study, only joint supplements like glucosamine were administered to Sylvia.

The cleaning and management of the enclosures do not follow a strict schedule but is done based on the daily requirements, ensuring that the bears' needs are met flexibly.

Enclosure use

For the study purposes, the enclosures of the bears observed in this study were conceptually divided into areas. This segmentation allowed a more precise localization of the bears during observations (Figure 1).

By utilizing scan sampling every two minutes, it was possible to systematically record the position of each bear within these defined areas at regular intervals.

This method provided an accurate and consistent data collection, facilitating a detailed analysis of the bears' spatial distribution and movement patterns. It also proved useful in determining the frequency of utilization and the preferences of the bears within different sections of the enclosure, since they were determined also taking into account the different structure and items of each area. For example, the separation enclosure (E) with a bear house (B), the proximity of a tourist attraction (C for Circus-Wagen) or street (S), the presence of a pond (P) or lake (L) or river (R).

Map Legend:

Green shaded areas	Enclosures
Blue shaded areas	Lakes and Ponds
Blue lines	Water streams
Yellow circles	Enrichment Spots
Brown Squares	Bearhouses
Red semicircles	Artificial dens
Brown lines	Touristic Path
Black sections with labels	Study area subdivisions

Figure 1.

Bear Sanctuary Müritz map with subdivision of the enclosure in smaller areas.

Data collection

Before the official start of the project, trial days were conducted to observe baseline behaviors and refine the working ethogram. During these preliminary observations, several behaviors emerged as significant; therefore, adjustments were made to adapt the working ethogram.

Subsequently, the data were collected in 560 behavioral observations in continuous recording for 15 minutes each, totaling 8400 minutes (140 hours) over a period of three months, from April 25th, 2023, to July 23rd, 2023.

During each observation, the key letters of a working ethogram were collected manually, together with general information like the weather, presence of visitors (0; <5; <10; <20; <30; >30) and other environmental stimuli, mainly noises, that supposedly triggered stereotypies, flights or other related behaviors. The recorded variables were: K (Keepers); D (Dog); B (Baggy, which is the vehicle used by the caretakers to feed the animals); L (Loud visitors); N (Loud Noises as machinery, saw, hammer); A (Another Bear, that is not part of the study, interacting with the subject); E (Enrichments). During the data collection, concurrently with the continuous recording, a scan sampling was conducted every two minutes to mark the subject's occupation zone.

The table below (Table 1.) shows a sample of data collected during a single day of scan sampling.

Date	Time (h)	Duration (min)	Name	Bear	Weather	Max Visitors	Variables	Start	02:00	04:00	06:00	08:00	10:00	12:00	14:00	End
25-Apr	08:30	15	Pavle 1.1	Pavle	Cloud	0	/	U	U	U	U	U	U	U	U	U
25-Apr	09:00	15	Sylvia 1.2	Sylvia	Cloud	0	/	T	T	T	T	T	T	T	T	T
25-Apr	10:30	15	Pavle 2.1	Pavle	Cloud	5	/	P	P	P	P	P	P	P	P	P
25-Apr	11:00	15	Sylvia 2.2	Sylvia	Cloud	10	/	P	P	P	P	P	P	P	R	R
25-Apr	12:00	15	Pavle 3.1	Pavle	Cloud	10	/	U	U	U	U	U	U	U	U	U
25-Apr	12:30	15	Sylvia 3.2	Sylvia	Cloud	10	/	D	D	D	D	D	D	D	D	D
25-Apr	14:30	15	Pavle 4.1	Pavle	Sun	5	X	P	P	P	P	P	P	P	P	P
25-Apr	15:00	15	Sylvia 4.2	Sylvia	Sun	5	X	F	F	F	F	F	F	F	F	F
25-Apr	16:30	15	Pavle 5.1	Pavle	Sun	5	X	D	D	D	D	D	D	D	D	D
25-Apr	17:00	15	Sylvia 5.2	Sylvia	Sun	5	X	P	P	P	P	P	P	P	P	P

Table 1. – Location Scan Sampling

Priority was given to video recording to capture any behaviors, even when the subject moved around the enclosure. During the observation period, the subject was followed throughout the enclosure. If the subject was out of sight, it was marked as such, and the observer continued to move around to regain visibility whenever possible.

Within the 30min timespan of the following table (Table 2.) are considered 15min for the actual observation time and 15 minutes used for searching the bear and finding the optimal position for the camera.

Day A			**Day B**	
Bear 1	8:30-9:00	**Before visitor's arrivals**	Bear 2	8:30-9:00
Bear 2	9:00-9:30		Bear 1	9:00-9:30
Bear 1	10:30-11:00	**Busy hours**	Bear 2	10:30-11:00
Bear 2	11:00-11:30		Bear 1	11:00-11:30
Bear 1	12:00-12:30	**Busy hours**	Bear 2	12:00-12:30
Bear 2	12:30-13:00		Bear 1	12:30-13:00
Bear 1	14:30-15:00	**Busy hours**	Bear 2	14:30-15:00
Bear 2	15:00-15:30		Bear 1	15:00-15:30
Bear 1	16:30-17:00	**Low frequency of visitors**	Bear 2	16:30-17:00
Bear 2	17:00- 17:30		Bear 1	17:00- 17:30

Table 2. – Daily Observation Schedule

Day B: consider same timetable of day A but inverting the order of the bears to be observed.

Ethogram

The working ethogram used in this study is an adaptation of a pre-existing, yet unpublished ethogram developed as part of the BearWell project. An overview of the project was presented in a poster at the EAZA Animal Welfare Forum 2024 (*Stagni et al., 2024*). The poster, titled *"BearWell and CatWell: species-specific welfare assessment protocols for brown bears (Ursus arctos), lions (Panthera leo), and tigers (Panthera tigris) in sanctuaries"*, was presented at Parco Natura Viva, Italy, from 19-22 March.

Several behavior descriptions were retained from the original ethogram, such as bathing, flight, agonistic interactions without contact, agonistic interactions with contact, aggression toward objects, aggression toward humans, and self-directed behaviors.

However, some behavior descriptions had to be modified or expanded to align properly with the scope of this study. Most changes resulted from the fact that the observed bears were housed in pairs, meaning each subject always cohabitated with another conspecific. This led to the inclusion of behaviors that reflect social dynamics, such as allogrooming, self-grooming, and play. As a result, behaviors like affiliative social interaction were adjusted to exclude these specific activities.

Other behaviors were added to reflect some bear-specific characteristics. For instance, behaviors like digging and climbing were included to track environmental interactions, which varied depending on the individual and the context. For example, Dasha frequently exhibited climbing behaviors, whereas Sylvia and Lelya were more prone to digging.

Additionally, the behavior "standing still" was incorporated due to its frequent occurrence during trial days.

Class	Type	*Key*	*Code*	*Description of Behavior*	*Modifier*
ACTIVITY	State	l	**Locomotion**	Bears move forward or in any direction, with no repetitive pattern. They might walk or run while sniffing and investigating the environment at the same time. The action of foraging is included.	
	State	e	**Eating**	Bears chew and ingest food items, provided by the caretakers or found in the enclosure. They grab the food directly with the mouth or they bring the food to the mouth with the front paws. Body position is irrelevant (e.g. they can stand, sit or lie) and they can move some steps while grazing. Bears might be eating Alone (L) or in company of other bears (B), the latter is considered if the distance between the bears is within three body length.	L/B
	State	p	**Play Alone**	Bears interact with objects present in the enclosure, they may manipulate, snap or throw objects around. Includes pulling, pushing, nosing, batting, mouthing, rubbing, shaking, pawing, holding or biting a movable object or permanent surfaces such as ledges or rockwork. The object used to play could be an enrichment item, another object or there is no object involved. If there is no object involved, bears may play with their own paws. They might paddle and splash in the water, run, jump and/or roll.	
	State	b	**Bathing**	"Bears sit, walk, or swim in the water of a pool or pond. They can show maintenance behaviors (e.g. self-grooming) and explorative behaviors."	
	State	l	**Climbing**	Bears perform an ascending locomotion, grabbing on a tree, bars or semi-vertical structure.	

	State	i	**Digging**	Bear moves repetitively the front paws forward and backward, moving the soil and removing plants roots. It might use its claws or mouth. The action of burrowing to build a den is included. Specify the position and orientation of the animal by using (E) if the animal is digging in proximity and direction of a gate or fence, or (D) if the animal is digging under the roots of a tree or in a comfortable and safe place where it might rest.	E/D
	Point	f	**Flight**	"They run away from something or from someone (human, conspecific or other species). The conspecific has not shown any sign of aggression or threat (otherwise would be R of an agonistic social interaction)."	
	State	t	**Other**	Bears perform any other behavior not included in this working ethogram.	
INACTIVITY	State	r	**Resting**	Bears lie down (lateral or sternal) or sit. The eyes might be open or closed and they may be sniffing the air and observing the surrounding environment. They might be resting alone or in company of other bears.	
	State	a	**Standing still**	Bears remain on their paws neither moving forward nor backwards. They may be sniffing the air and observing the surrounding environment.	
	State	d	**In the Den**	Bears are inside the den that could be either a bear house or any shelter both artificial or natural. You can either see or hear them at a distance, and they can be performing other behaviors.	
	State	o	**Out of sight**	Bears cannot be seen or they can be seen only partially, hindering behavior recognition. They might become out of the visual during the 15 min observation or they cannot be seen from the beginning.	

MAINTENANCE	State	g	**Self-Grooming**	Bears use their tongue, jaws and teeth to scratch and bite at their fur, removing any dirt, debris, or parasites that may have accumulated. They may also use their claws to comb through their fur and remove any tangles or mats.	
	State	u	**Rubbing**	Bears may rub any part of the body against an object, usually repeated. This may be a sign of territory marking or an act of self-grooming. Transient contact while in locomotion is excluded.	
AFFILIATIVE SOCIAL INTERACTIONS	State	P	**Play Together**	Bears perform tactile interaction with each other, by wrestling, pawing, biting and chasing each other in a manner that is considered playful, not harmful and with no other agonistic intent. Vocalization if they happen, are soft.	
	State	G	**Allo-grooming**	One animal uses its paws, mouth, or other part of its body to touch the other animal; the mechanical motion of allo-grooming resembles scratching, picking, stroking, rubbing, licking or nibbling.	
	State	c	**Affiliative Interactions with Contact**	Bears perform any other affiliative social interaction with a conspecific, that is not included in this working ethogram. Bears interact in a positive manner through contact with a conspecific. They might paw, mouth or rub and they might rest their head on the back of the conspecific. It might be avoided or reciprocated by the conspecific. Specify if the observed bear is the agent (A) or recipient (R) of this behavior.	A/R/X
	State	n	**Mounting**	One bear position itself on top of another bear, typically placing its forelegs over the shoulders or back of the other bear. This action may involve pressing down or straddling the other bear's body. Mounting behavior may be accompanied by vocalizations, such as growling or vocal displays, as well as physical gestures such as pawing or nuzzling.	
	State	m	**Arousal**	Bears perform behaviors which may include increased respiration and vocalization like repetitive grunts, huffing and tongue click.	

AGONISTIC INTERACTIONS	Point	W	**Agonistic Interactions Without Contact**	"Bears interact and/or communicate in an agonistic and unfriendly manner with a conspecific, without physical contact between the bears. They physically or vocally threat a conspecific with mock charges, growls, jawing or loud snorts. The legs are stiff. In case one of the subjects is actively showing aggressive behaviors and the other shows avoidance and/or submissive behaviors, then the first individual should be identified as A (agent) and the second as R (recipient). (A subordinate bear backs up, walks or runs away. Rarely lies down and approaches a dominant like a fawning dog. He/she might drop the head and face away). X if none of them can be clearly identified as agent or recipient of the action."	A/R/X
	Point	C	**Agonistic Interactions With Contact**	"Bears interact in an agonistic and unfriendly manner with a conspecific, there is physical contact between the bears. The agent charges a conspecific and it ends in a fight or in a flight of the recipient. In case one of the subjects is the initiator of the agonistic interaction, by doing the charge or starting the fight, then it should be identified as A (agent) and the other bear R (recipient). X if none of them can be clearly identified as agent or recipient of the action."	A/R/X
	Point	v	**Vocalization**	Bear may growl and roar when approached by another bear as a warning. Bears may perform visual display as well, such as standing on their hind legs or fluffing up their fur, to intimidate other bears and assert their dominance.	
	Point	j	**Aggression towards object**	"Bears have a sudden and violent reaction directed to an item inside the enclosure. They charge and strike the object and growl loudly."	
	Point	H	**Aggression towards human**	"Bears have a sudden and violent reaction directed to a human (staff or visitor) or an heterospecific (e.g. a visitor's dog). They show threatening behaviors like mock charge, jawing or snorting. Define if staff (S), visitor (v)" or heterospecific (H)	S/V/H

ABNORMAL BEHAVIOURS	State	S	**Stereotypies**	Bears perform the same behavior in a repetitive manner, without apparent reason. Behaviors shown can be pacing (incl. circling), weaving, tongue playing, head swaying, head tossing, bars biting or licking.
	State	s	**Self-Directed Behaviors**	“Bears bite, suck or lick part of their bodies (usually the same spot) repetitively, without any obvious purpose of self-maintenance. It might be accompanied by a "humming" vocalization.”
	State	R	**Re-directed behavior**	Bears might redirect their frustration towards another target, which could be a conspecific or an object present within the enclosure. The animal might bite, suck or lick part of a conspecific’s body (usually the same spot) repetitively, without any obvious purpose of grooming. It might be accompanied by a "humming" vocalization.

Table 3. - Working Ethogram

Data analysis

After the field data collection, the observations were recorded using BORIS (Behavioral Observation Research Interactive Software) (https://www.boris.unito.it/). BORIS facilitated the coding process of live observations and video-analysis, allowing the data to be exported into a Microsoft Excel 2010 spreadsheet.

By extracting the time budget calculated by the software, the total duration of each behavior was determined and then transformed into a percentage. The formula used for this process is:

$$x = \frac{\text{total duration of each behavior (s)}}{tot.number\ of\ observation\ of\ each\ bear\ (140)\ x\ duration\ single\ observation\ (900s)}$$

This formula helps to understand the proportion of time each bear spent on different behaviors during the observation period.

The time budget of the state events, which indicates the percentage of time each bear allocated to different behavioral categories, is illustrated using pie charts. These charts provide a visual representation of how the bears distribute their time across various activities.

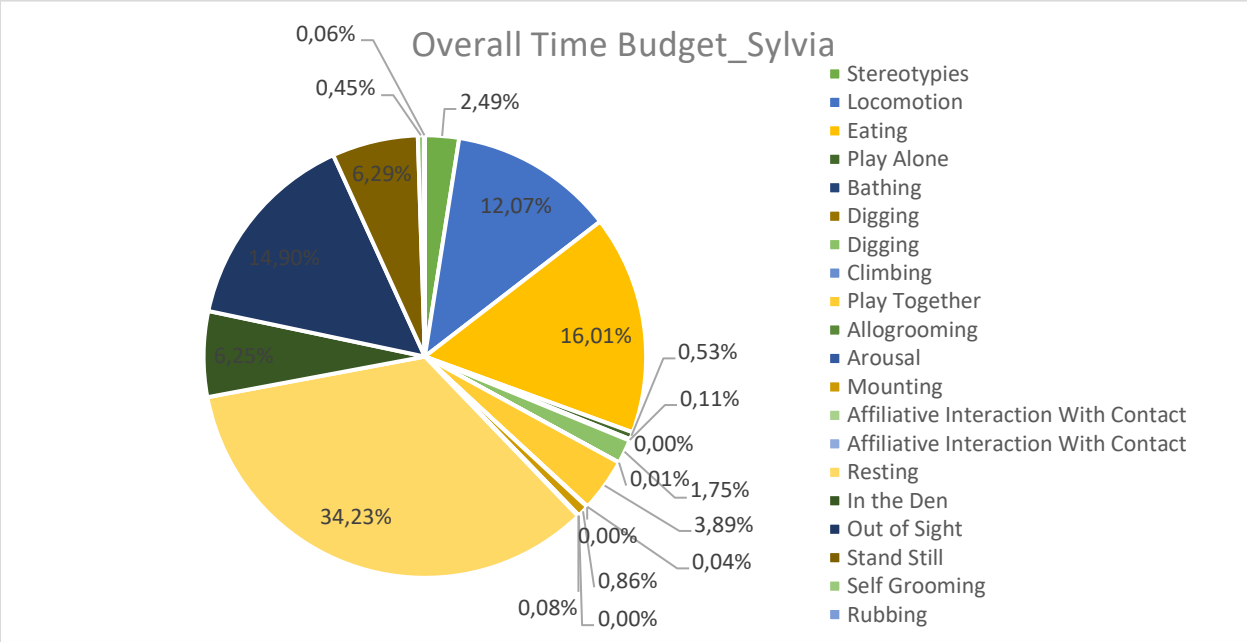
The study presents a quantitative description of the collected information through descriptive statistics. This includes summarizing the data to provide an overview of the observed behaviors through overall time budgets of each of the four subjects (Pie chart 1.; Pie Chart 2.; Pie Chart 3.; Pie Chart 4.;). Subsequently, further examination were made to compare the first two subjects in the first enclosure (Sylvia and Pavle Phase I.) with the data collected with the same subjects in the second enclosure (Sylvia and Pavle Phase II.)

In this study only descriptive statistics will be carried out, further analysis are still ongoing and inferential statistics may be applied in the future.

RESULTS

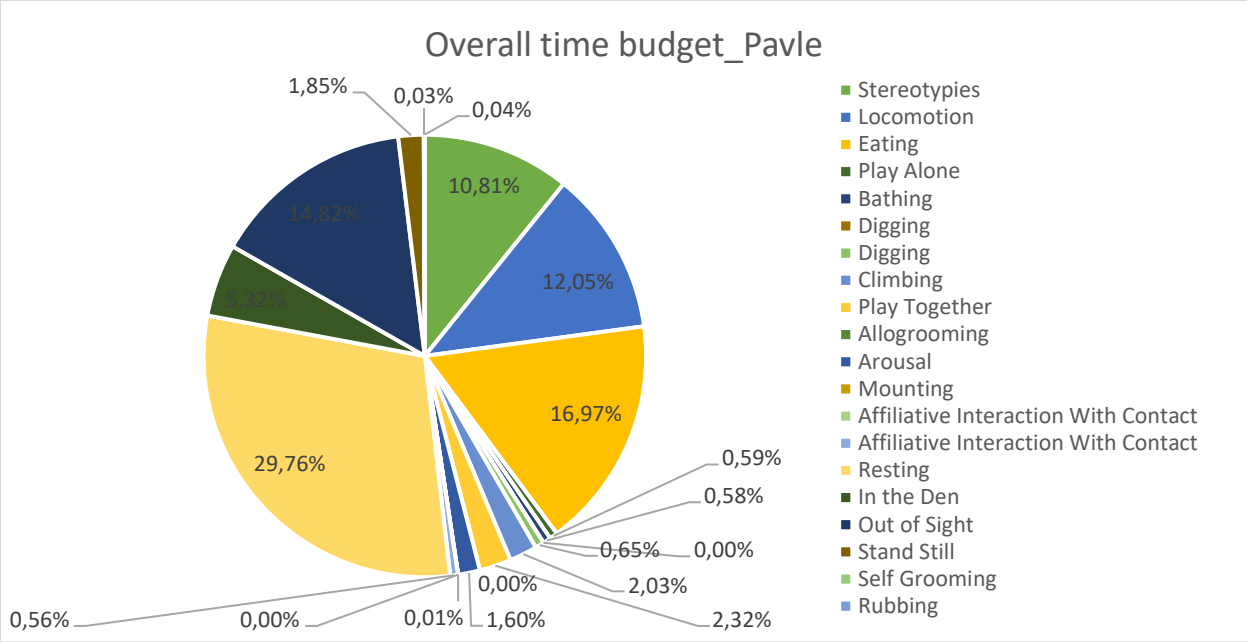
Overall behavior observed for each subject

The following graphs show the percentage of behaviors observed for each subject over the entire observation period for that subject: 140 observations for each bear, 126000 seconds.
The pie chart illustrates the proportion of time each bear allocated to various behaviors during the observation period. Each segment of the pie chart represents a different behavior, with the size of the segment corresponding to the percentage of time spent on that behavior.



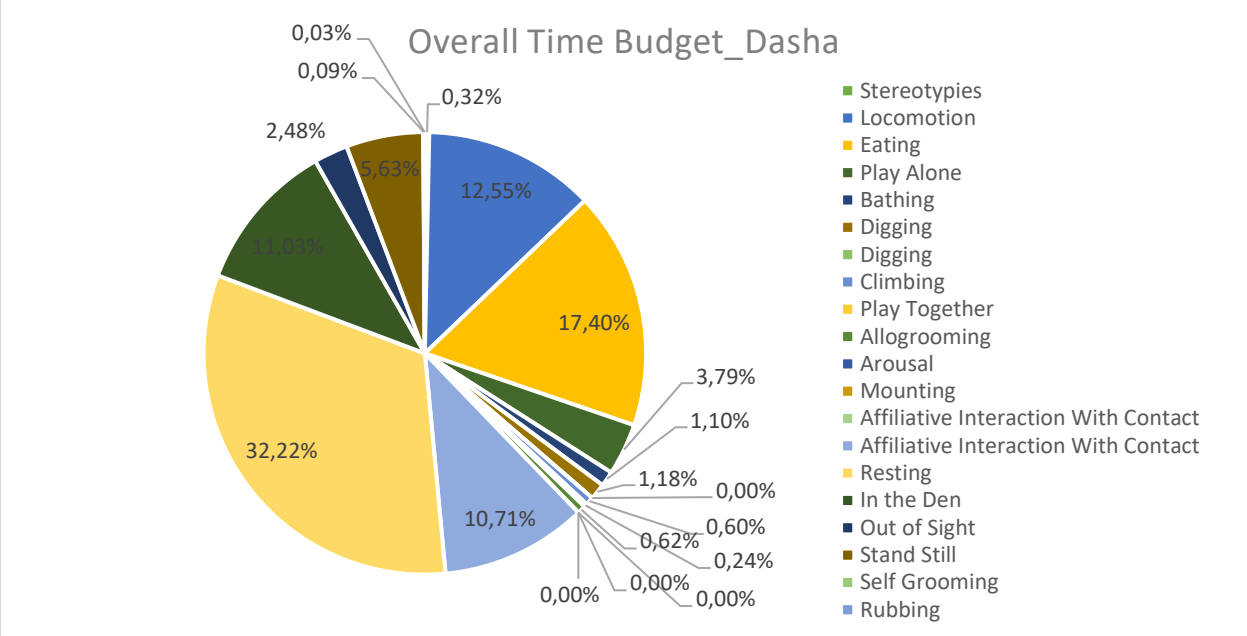
Pie Chart 1. - Overall behaviors observed in Sylvia during the study.

Proportion of time Sylvia allocated to the represented behaviors during the observation period.



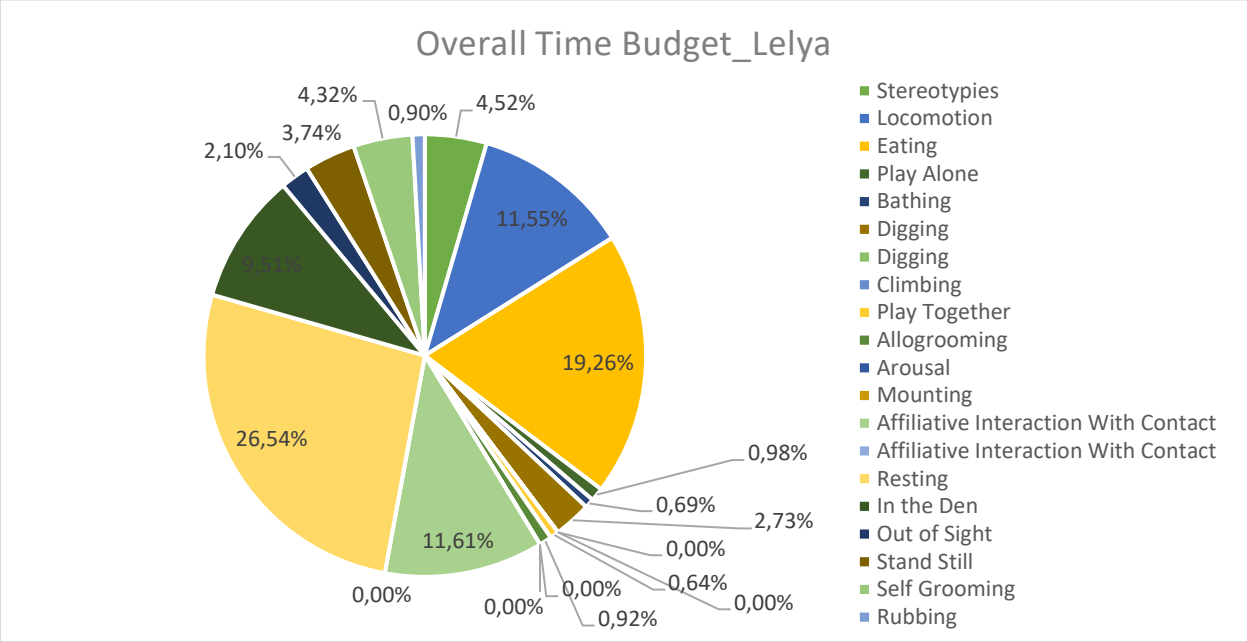
Pie Chart 2. - Overall behaviors observed in Pavle during the study.

Proportion of time Pavle allocated to the represented behaviors during the observation period.



Pie Chart 3. - Overall behaviors observed in Dasha during the study.

Proportion of time Dasha allocated to the represented behaviors during the observation period.



Pie Chart 4. - Overall behaviors observed in Lelya during the study.

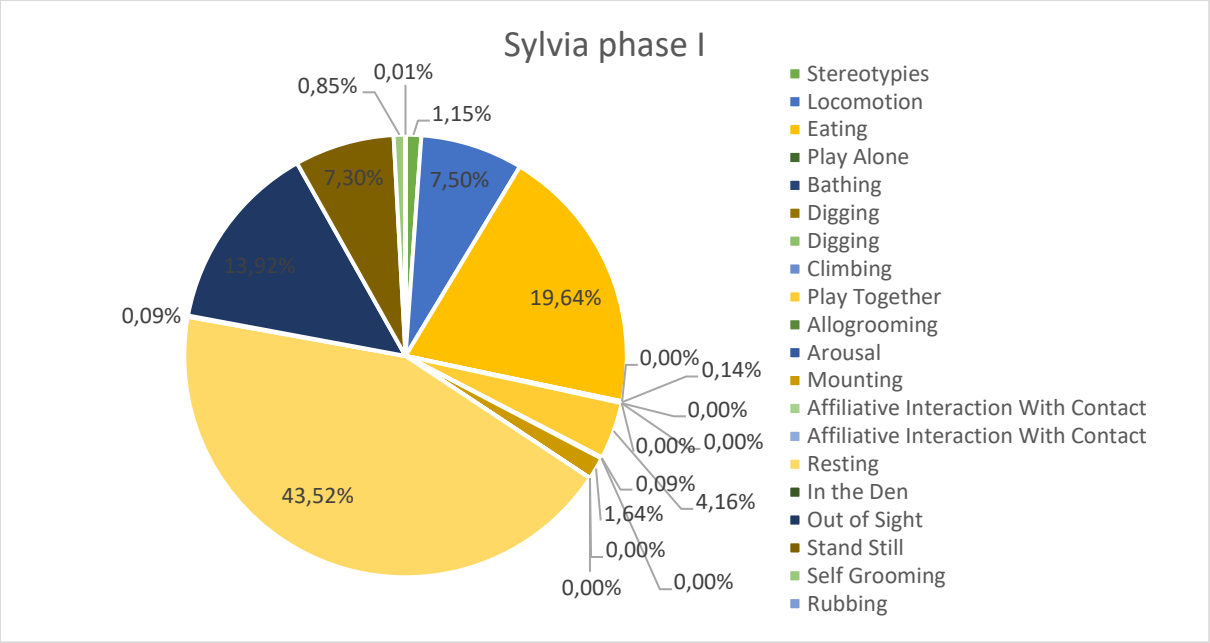
Proportion of time Lelya allocated to the represented behaviors during the observation period.

From a general quantitative description, given by the shown charts, the behaviors exhibited by the bears for a higher amount of time and their respective percentages were:

- Resting: The related segment is the largest, indicating that the bears spent most of their time resting. Sylvia, Pavle, Dasha, Lelya spent respectively 34,23% (Pie chart 1.), 29,76% (Pie chart 2.), 32,22% (Pie chart 3.) and 26,54% (Pie chart 4.) of the total observation period performing this behavior.
- Eating: The graphs show that Sylvia dedicated 16,01% of the time observed eating (Pie chart 1.), while Pavle the 16,97% (Pie chart 2.), Dasha 17,40% (Pie chart 3.) and Lelya manifested this behavior for 19,26% of the time she was observed.
- Locomotion: Sylvia spent 12,07% (Pie chart 1.), Pavle 12,05% (Pie chart 2.), Dasha 12,55% (Pie chart 3.) and Lelya 11,55% (Pie chart 4.) of the total observation time in locomotion.

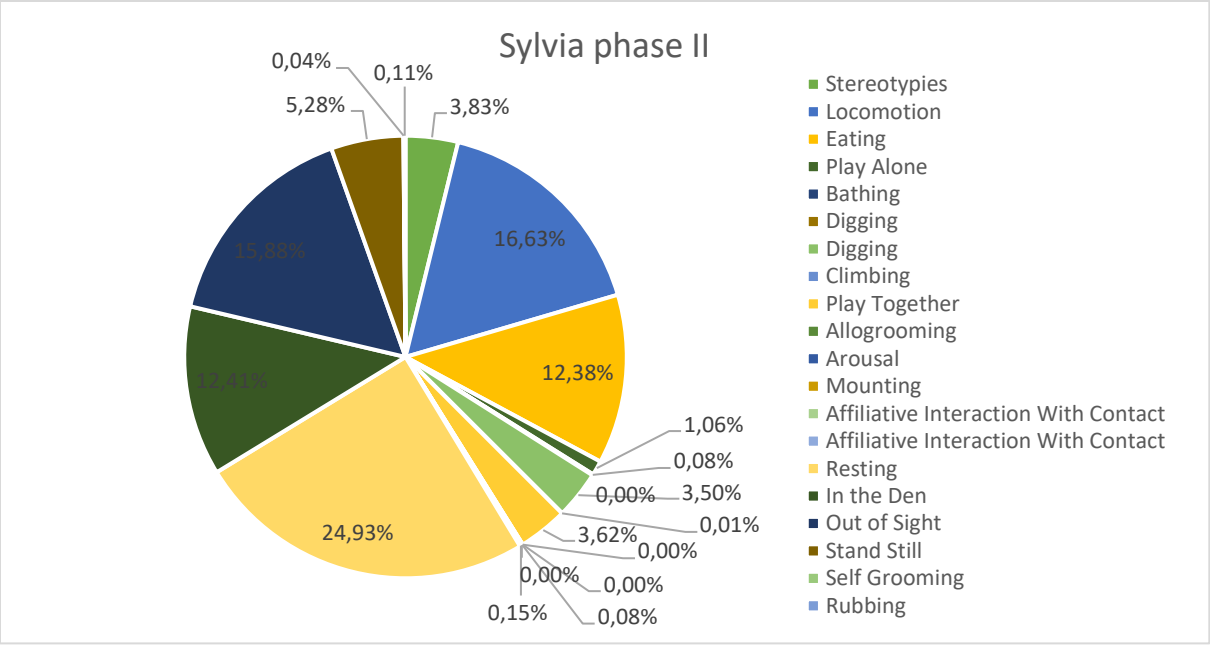
- Bathing and Self-grooming: A minor percentage of time was dedicated by Sylvia, Pavle and Dasha to these behaviors, with the corresponding summed percentage: 0,56% (Pie chart 1.), 0,61% (Pie chart 2.), 1,19% (Pie chart 3.). In the case of Lelya is slightly higher, reaching a sum of 5,01% (Pie chart 4).
- Stereotypies: Sylvia (Pie chart 1.) and Dasha (Pie chart 3.), with respective values 2,49% and 0,32%, seem to have less inclination to display stereotypic behaviors than Pavle with 10,81% (Pie chart 2.) and Lelya 4,52% (Pie chart 4.)
- Affiliative behavior like affiliative interaction with contact, allogrooming, play together and mounting can be summed together resulting in these percentages for each subject: Sylvia 4,87% (Pie chart 1.) Pavle 2,89% (Pie chart 2.), Dasha 11,57% (Pie chart 3.) and Lelya 13,17% (Pie chart 4.).
- In the den: Sylvia spent 6,25% (Pie chart 1.), Pavle 5,32% (Pie chart 2.), Dasha 11,03% (Pie chart 3.) and Lelya 9,51% (Pie chart 4.) of the total observation time in the den.

Comparison of behaviors observed between two different enclosures



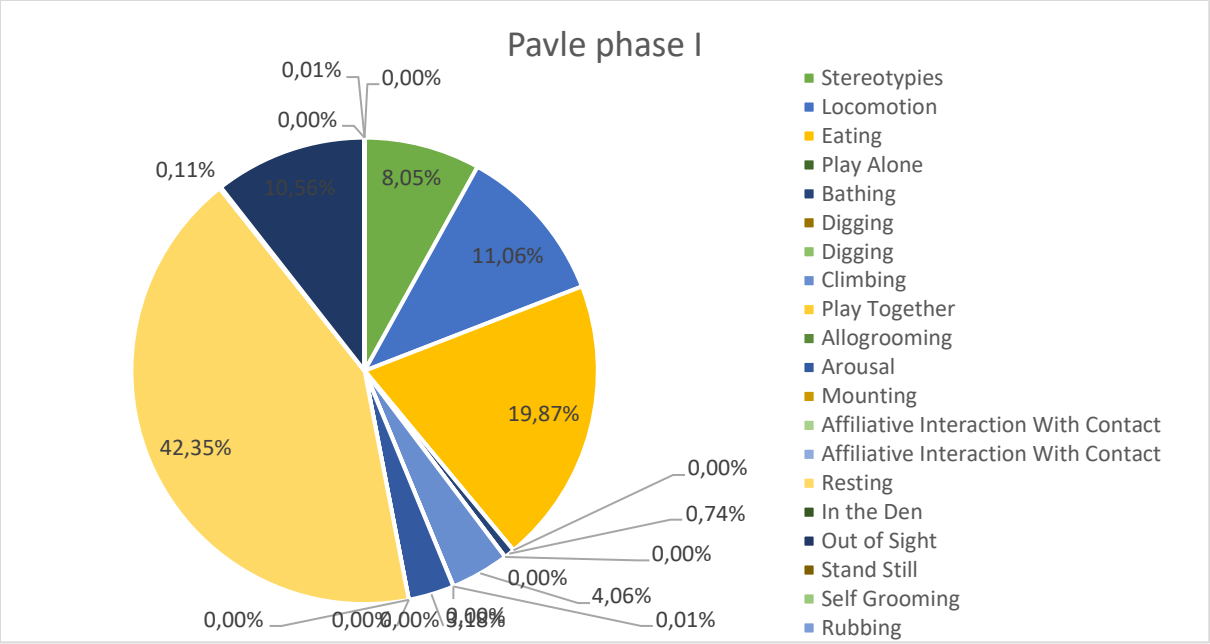
Pie Chart 5. – Sylvia phase I.

Behaviors observed in Sylvia during phase I, in the first enclosure.



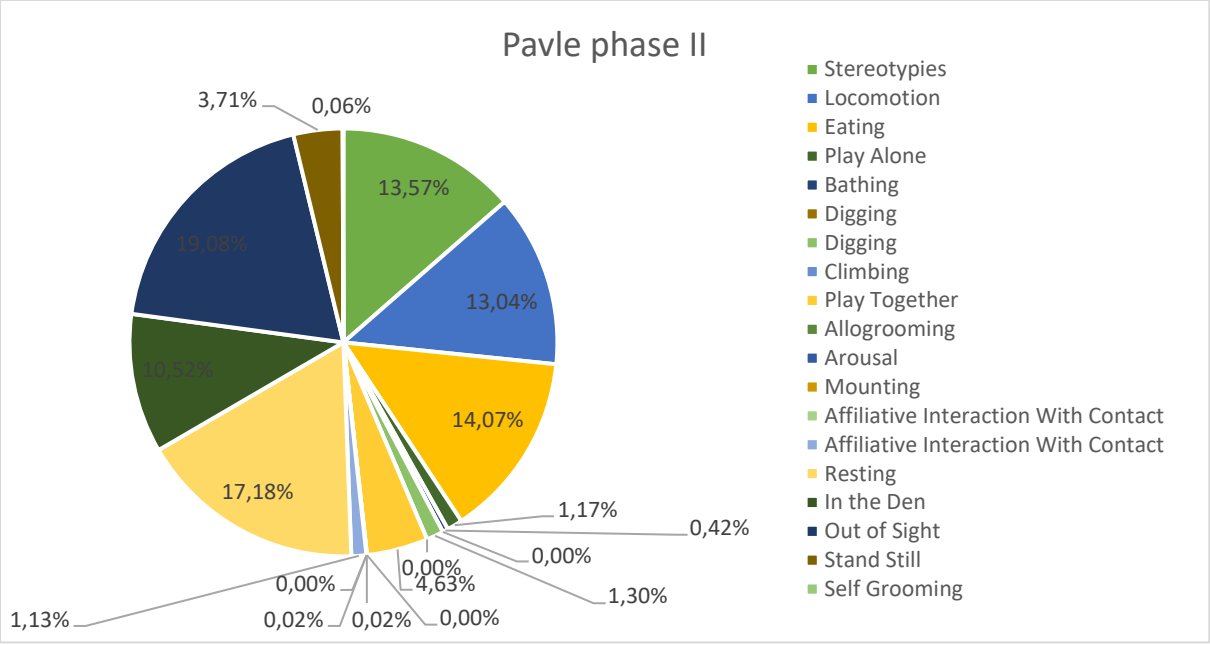
Pie Chart 6. – Sylvia phase II.

Behaviors observed in Sylvia during phase II, in the second enclosure.



Pie Chart 7. – Pavle phase I

Behaviors observed in Pavle during phase I, in the first enclosure.



Pie Chart 8. – Pavle phase II

Behaviors observed in Pavle during phase II, in the second enclosure.

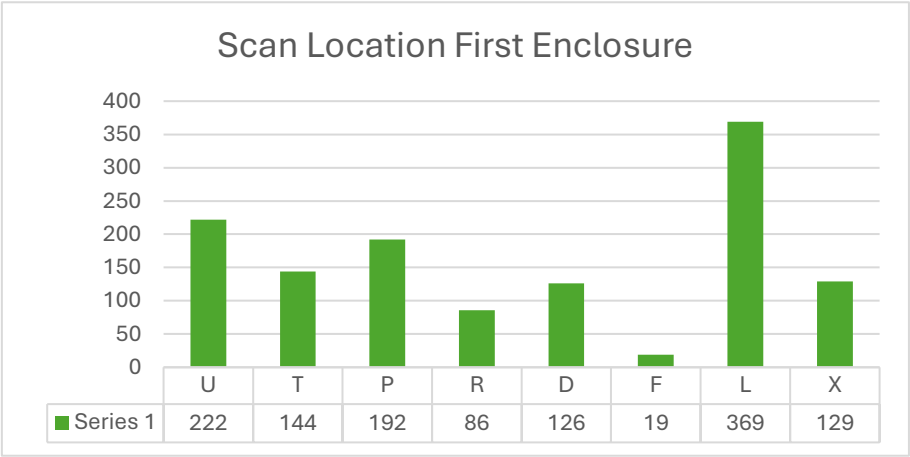
As shown in the pie chart the difference in behaviors between the two different enclosure is quite clear.

- Resting: The most evident behavior exhibited by Sylvia in phase I (Pie chart 5) is resting, accounting for 43,52% of her observed time. However, in Phase II (Pie chart 6), her resting time decreases to 24,93%. Similarly, Pavle shows a significant amount of time spent resting in the first enclosure, with a value of 42,35%, while in the second enclosure, his resting time drops to 17,18%.
- Eating: A decrease in eating behavior is also observed for Sylvia, dropping from 19,64% in Phase I (Pie chart 5) to 12,38% in Phase II (Pie chart 6). A similar pattern is seen with Pavle, whose eating behavior declines from 19,87% in Phase I (Pie chart 7) to 14,07% in Phase II (Pie chart 8).
- Locomotion: Sylvia spent 7,50% of her time in locomotion during Phase I (Pie chart 5), which increased to 16,63% in Phase II (Pie chart 6). A similar pattern is observed with Pavle, whose locomotion rose from 11,06% in Phase I (Pie chart 7) to 13,04% in Phase II (Pie chart 8).
- Stereotypies: Sylvia engaged in stereotypic behaviors for 1,15% of her time in Phase I (Pie chart 5), which increased to 3,83% in Phase II (Pie chart 6). Pavle also exhibited a similar rise, with his stereotypies increasing from 8,05% in Phase I (Pie chart 7) to 13,57% in Phase II (Pie chart 8).
- Affiliative behaviors: Sylvia displayed no affiliative interactions with contact in Phase I, but this slightly increased to 0,15% in Phase II. Her allogrooming behavior was 0,09% in Phase I, dropping to 0% in Phase II. She engaged in playing together 4,16% of the time in Phase I, which decreased to 3,62% in Phase II, while her mounting behavior dropped from 1,64% in Phase I to 0,08% in Phase II. Pavle, on the other hand, showed affiliative interactions with contact at 3,18% in Phase I, which declined to 1,13% in Phase II. His allogrooming remained at 0% in both phases. His play together behavior, however, increased from 0,01% in Phase I to 4,63% in Phase II, while mounting behavior slightly rose from 0% in Phase I to 0,02% in Phase II.

- In the den: Sylvia spent 0,09% of her time in the den during Phase I (Pie chart 5), rising significantly to 12,41% in Phase II (Pie chart 6). Similarly, Pavle's time in the den increased from 0,11% in Phase I (Pie chart 7) to 10,52% in Phase II (Pie chart 8).
- Out of sight: Sylvia was not visible for 13,92% of the observation time in Phase I (Pie chart 5), and this increased to 15,88% in Phase II (Pie chart 6). Pavle showed a similar trend, with his out-of-sight time rising from 10,56% in Phase I (Pie chart 7) to 19,08% in Phase II (Pie chart 8).

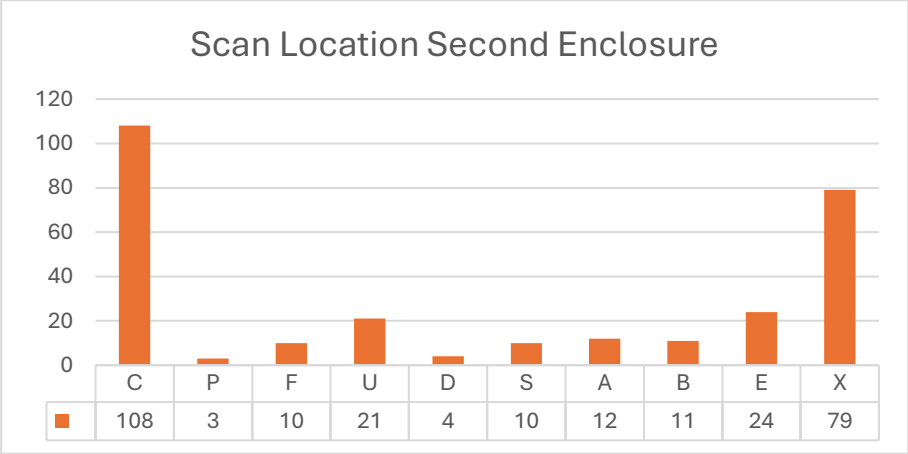
It is important to specify that inferential statistics will be needed to assess whether the described differences are significant.

The next graph shows the results of scan sampling for the two different enclosures where Sylvia and Pavle were observed during this study.



- Histogram 1. – Sylvia and Pavle scan sampling phase I

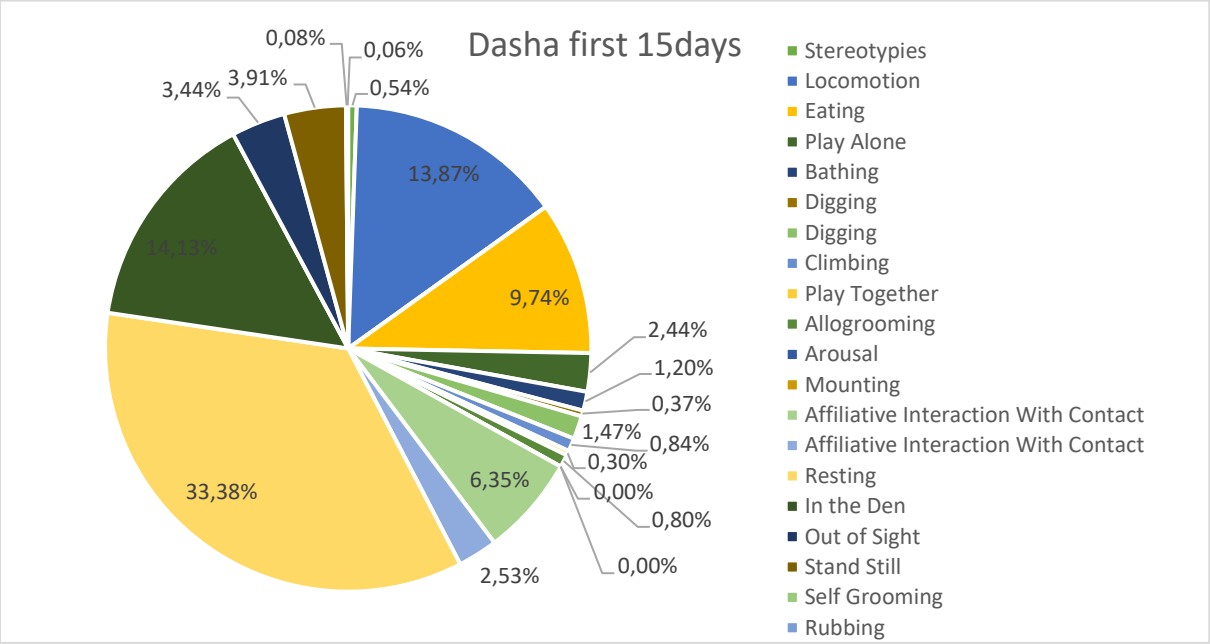
Scan sampling data for the first enclosure, where Sylvia and Pavle were observed during this study.



- Histogram 2. – Sylvia and Pavle scan sampling phase II

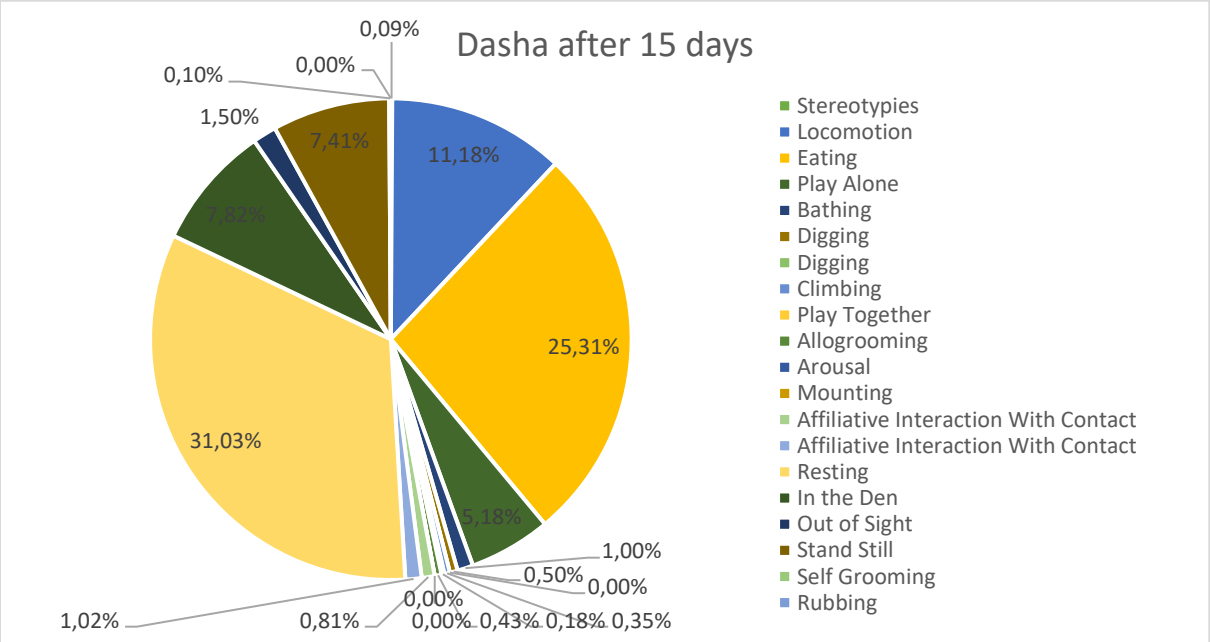
Scan sampling data for the second enclosure, where Sylvia and Pavle were observed during this study.

Comparison of behaviors observed at arrival in a new enclosure and after 15 days.



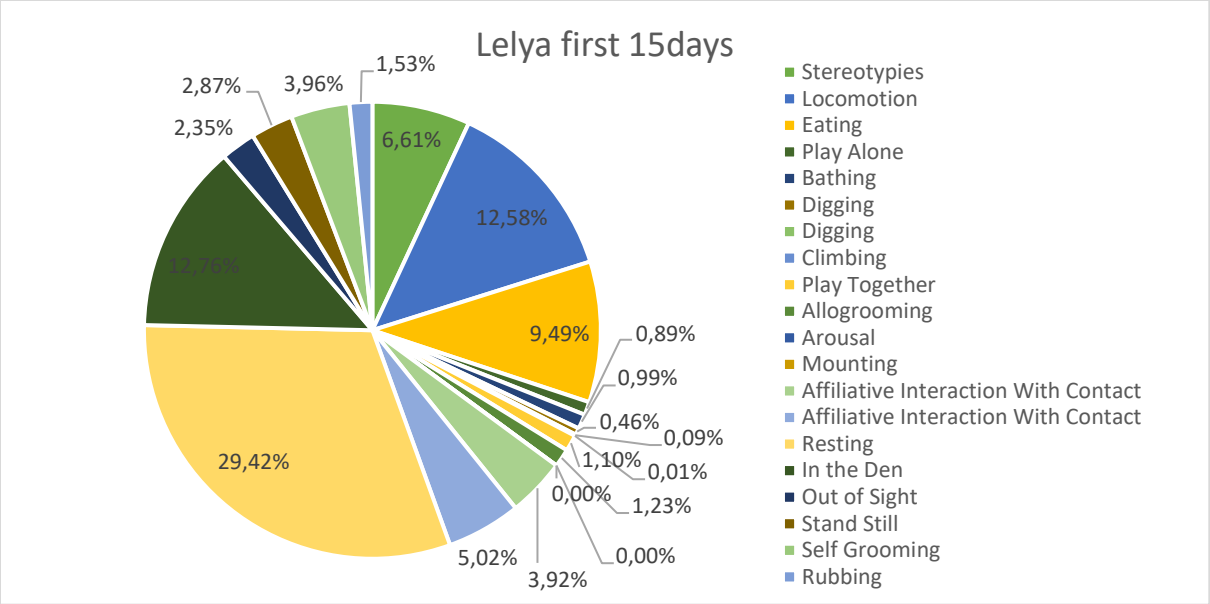
Pie Chart 9. – Dasha first 15 days

Behaviors observed in Dasha during the first 15 days in the new enclosure.



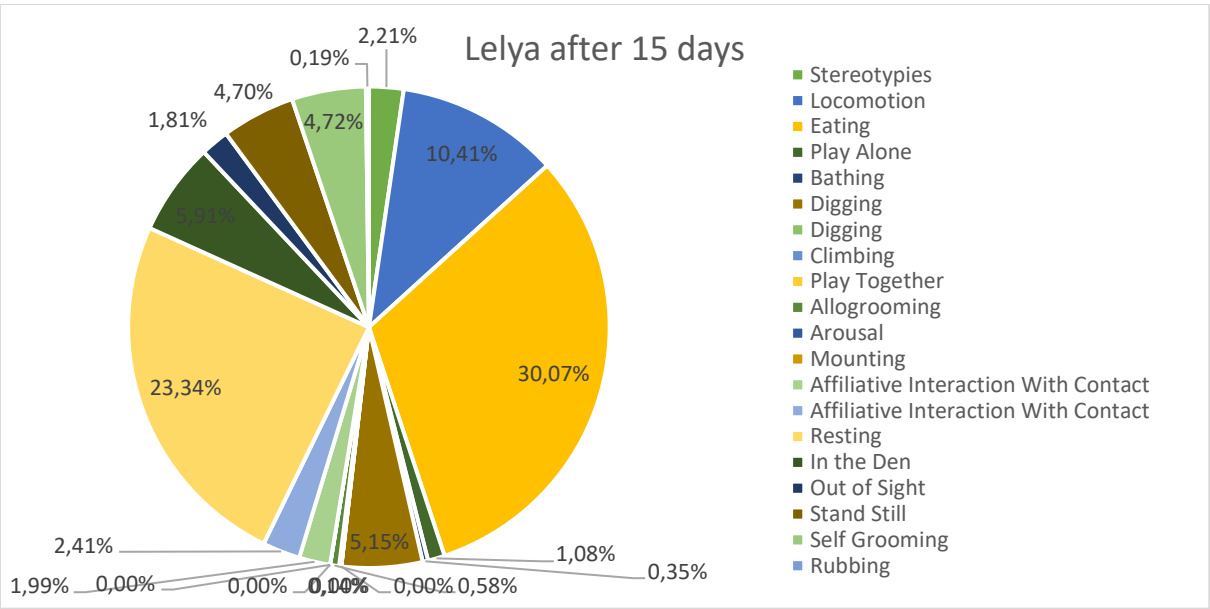
Pie Chart 10. – Dasha after 15 days

Behaviors observed in Dasha after 15 days in the new enclosure.



Pie Chart 11. – Lelya first 15 days

Behaviors observed in Lelya during the first 15 days in the new enclosure.



Pie Chart 12. – Lelya after 15 days

Behaviors observed in Lelya after 15 days in the new enclosure.

As represented in the pie chart the difference in behaviors between the first 15 days in the new enclosure and after 15 days is quite distinct; however, further inferential statistical analysis is needed to confirm this.

- Resting: Dasha's resting behavior decreased slightly from 33,38% in the first 15 days (Pie chart 9) to 31,03% after 15 days (Pie chart 10). Similarly, Lelya's resting time dropped from 29,42% in the first 15 days (Pie chart 11) to 23,34% after 15 days (Pie chart 12).
- Eating: Dasha exhibited a significant increase in eating behavior, rising from 9,74% in the first 15 days (Pie chart 9) to 25,31% after 15 days (Pie chart 10). Lelya showed a similar trend, with her eating time increasing from 9,49% in the first 15 days (Pie chart 11) to 30,07% after 15 days (Pie chart 12).
- Locomotion: Dasha’s locomotion decreased from 13,38% in the first 15 days (Pie chart 9) to 11,18% after 15 days (Pie chart 10). Lelya also showed a reduction in locomotion, going from 12,58% (Pie chart 11) to 10,41% (Pie chart 12) in the same time periods.
- Stereotypic Behavior: Dasha's stereotypic behaviors dropped from 0,54% in the first 15 days (Pie chart 9) to 0,09% after 15 days (Pie chart 10). Similarly, Lelya’s stereotypic behavior decreased significantly from 6,61% (Pie chart 11) to 2,21% (Pie chart 12).
- Affiliative behaviors: Dasha showed a decline in affiliative interactions with contact, from 6,35% (Pie chart 9) to 0,81% (Pie chart 10). Her allogrooming decreased from 0,80% (Pie chart 9) to 0,43% (Pie chart 10) and the play together dropped from 0,30% (Pie chart 9) to 0,18% (Pie chart 10). Lelya experienced a similar pattern, with affiliative interactions with contact falling from 5,02% (Pie chart 11) to 2,41% after 15 days (Pie chart 12). Her allogrooming dropped from 1,23% (Pie chart 11) to 0,58% (Pie chart 12) and play together reduced from 1,10% (Pie chart 11) to 0,14% (Pie chart 12).
- In the Den: Dasha spent 14,13% of her time in the den in the first 15 days (Pie chart 9), which decreased to 7,82% after 15 days (Pie chart 10). Similarly, Lelya’s time in the den dropped from 12,76% (Pie chart 11) to 5,91% (Pie chart 12) in the same period.
- Out of Sight: Dasha was out of sight for 3,44% of the time in the first 15 days (Pie chart 9), which decreased to 1,50% after 15 days (Pie chart 10). Lelya’s out-of-sight time also decreased, from 2,35% (Pie chart 11) to 1,81% after 15 days (Pie chart 12).

DISCUSSION

Overall behavior observed for each subject

The observed time budget provides insights into the behavioral patterns and welfare of the bears. The high percentage of time spent resting suggests that the bears have sufficient access to resources and are not experiencing significant stressors that might increase their activity levels (*Katherine A. Zeller, et al., 2019*). In a 2023 study by Kelly Bruno, Cassidy Hubbard, and Emily Lynch, the authors report that in zoo settings, bears with access to enriched environments, such as multiple habitats, show fewer stress-related behaviors like pacing and spend more time engaging in natural behaviors like foraging and resting (*N. Wielebnowski, 2003*).

A substantial amount of time dedicated to eating is a typical behavior in brown bears, as foraging is central to their daily activities. This aligns with findings from several scientific studies. For example, in a study on brown bear behavior, researchers found that bears spend a significant amount of their active time foraging to meet the energy demands (*Fortin et al., 2013; Zeller et al., 2019*). Another study noted that during the summer and fall, brown bears devote around 60-70% of their time to foraging, reflecting the importance of food intake for survival (*Rode et al., 2006*). Furthermore, research in Sweden indicated that bears prioritize foraging during seasons of higher food availability, particularly in areas with abundant resources like berries and fish (*Ashlee J. Mikkelsen et al., 2023*).

Locomotion is considered in several scientific studies as one of the main activities of brown bears, together with eating, and this study confirms a major percentage dedicated to this behavior (*Bjørn Dahle, Jon E. Swenson, 2003*). Furthermore, it is also possible to notice some differences according to the season. The time spent on locomotion increases gradually starting after the hibernation (graphs: Pavle phase I and Sylvia phase I) until the late spring (Pavle phase II and Sylvia phase II), while comparing this pair with the second observed, is possible to see that this behavior's percentage starts from a similar value (Dasha first 15 days and Lelya first 15

days) and slightly decrease in the middle of the summer (Dasha after 15 days and Lelya after 15 days).

Additional insights are offered by other behaviors like bathing or grooming. These are considered positive indicators of health and comfort, as serves both thermoregulation and stress reduction purposes (*Babitz et al., 2022*). Research suggests that providing access to water and opportunities for grooming can significantly enhance the psychological well-being of captive bears, reducing the occurrence of stereotypic behaviors and promoting natural activities (*Pastorino et al., 2007***)**.

In the case of Lelya, she seems to exceed the normal average performance, according to literature, of self-grooming together with rubbing, probably due to the health condition of the subject (*Wielebnowshi, 2003*).

On the contrary stereotypic behaviors, such as pacing or head swaying, are often indicative of stress or an inadequate environment, particularly when the animals lack sufficient environmental enrichment. (*Garner, 2005*). In the case of Lelya it's possible to notice a decrease in the frequency of this behavior between the first fifteen days and the next period observed; it might be a sign of her adaptation in the new environment, since it's also accompanied by an increased percentage of foraging and a decrease in hiding behavior (decreased amount of time spent in the den).

Social interactions such as affiliative interactions with contact, play together or mounting, although a smaller percentage of the time budget, are crucial for understanding social dynamics within the bears. The presence of social behaviors indicates opportunities for social enrichment and the formation of social bonds, which are vital for the bears' mental and emotional health (*Støen, O.-G. et al., 2005*). In this study the two pairs observed behaved differently mainly according to the different subjects, the sex and the seasonality, but in both cases was possible to record affiliative interactions.

Comparison Between Phase I and Phase II for Sylvia and Pavle

The behavioral patterns of Sylvia and Pavle showed marked differences between Phase I and Phase II, indicating, if the finding is confirmed by inferential statistics, that the change in enclosure had a significant impact on their activities. The overall decrease in resting and eating behaviors, paired with an increase in locomotion and stereotypies, suggests that the second enclosure may have provided different stimuli or challenges, leading to more active but potentially stress-related behaviors. Such behavioral shifts after environmental changes are consistent with previous studies, where animals in captivity often react to novel stimuli or spatial arrangements with increased exploration and occasional stress-related behaviors (*Clubb, Mason, 2003; Mallapur et al., 2005*).

In Phase I, both bears spent a substantial portion of their time resting and eating, behaviors often linked to comfort and environmental familiarity. However, in Phase II, these behaviors dropped significantly, replaced by increased locomotion and stereotypic activities. This shift suggests that while the second enclosure might have encouraged exploration, it may have also introduced factors leading to more stress, as indicated by the increase in stereotypies.

The scan sampling results reinforce this observation. In Phase I, the most frequently used areas (U and L) provided comfort, food, or shelter, leading to their frequent use. In contrast, Phase II saw an increased usage of area C, close to a touristic attraction, which might have increased the loudness of the area, and area X, indicating the bears were out of sight. This could reflect either exploration of a new space or avoidance behavior linked to environmental changes or stress (*Maple and Perdue, 2013*). According to other scientific studies, bears tend to explore new environments actively, but when stressed, their usage patterns might reflect attempts to avoid discomforting stimuli (*Krebs and Davies, 2009*).

Comparison of the First 15 Days and After 15 Days for Dasha and Lelya.

The behavioral patterns of Dasha and Lelya during their first 15 days in the new enclosure and after 15 days, if confirmed by inferential statistics, also reflect adaptation processes. During the initial phase, higher levels of resting and affiliative behaviors were observed, while their locomotion and eating were relatively low. This is consistent with other studies where animals, when introduced to new environments, tend to rest more and engage in social behaviors as part of their coping mechanisms (*Tetley and O'Hara, 2012*).

After 15 days, both bears showed a decrease in resting and affiliative behaviors, with a substantial increase in eating, indicating that they had adapted to their new environment. Reduced locomotion also supports this, as it suggests that after exploring the new space, the bears became familiar with it and resumed normal activities. This pattern is similar to findings where animals settle into a new routine after initial exploration, once environmental stability is perceived (*Vickery and Mason, 2005*).

Importantly, stereotypic behaviors decreased after the first 15 days, which is a positive indicator of reduced stress over time. Such reductions in stereotypies can reflect improved welfare as animals adjust to more stable or enriched environments (*Mason and Rushen, 2006*). The decline in these behaviors, along with more frequent normal activities like eating, suggests a positive acclimatization to the new enclosure for both Dasha and Lelya.

Limitations of the study

This study has several limitations that should be considered when interpreting the results.

Firstly, it was not possible to conduct a Phase I observation of Dasha and Lelya in their previous enclosure before their relocation to BEAR SANCTUARY Müritz. This limits the ability to compare their behaviors before and after the move, thereby affecting the understanding of the impact of the new environment on their behavior.

Secondly, the bears were observed in three different enclosures. Although these enclosures were similar and contained comparable items such as ponds, trees, open land, and bear houses, they were not identical. Little changes in the predisposition of the enclosures, could introduce inconsistencies in the behavior of the bears, affecting the reliability of the results: the differences in environmental features could influence the bears' interactions with their surroundings and with each other.

Furthermore, the study had to take into account numerous variables, including external factors and the diverse backgrounds and behaviors of the individual bears. Each bear's unique history and prior experiences can impact their behavior in captivity, adding complexity to the analysis. The variability among subjects can obscure clear patterns and make it challenging to generalize the findings.

Lastly, the sample size was relatively small, with only a few bears being observed. A limited sample size reduces the statistical power of the study and limits the ability to generalize the results to a larger population. Observing more bears across different settings would provide a more robust dataset and improve the reliability of the conclusions drawn.

In addition, in case we want to compare the two pairs, another limitation could be that the observations were conducted at different times of the year for the two pairs of bears. The first pair was observed immediately after hibernation and throughout the mating season, while the second pair was observed later in the summer. These differing observation periods mean that

the bears were experiencing different seasonal needs and behaviors, which could influence the findings. Seasonal variations can significantly affect bear activity levels, mating behaviors, and food availability, (*Fernandez, et al., 2020; Evans et al., 2016*) leading to potential discrepancies in the data.

In summary, while this study provides valuable insights into the behavior and welfare of captive bears, the limitations related to timing, enclosure differences, variable factors, and sample size must be acknowledged. Future research should aim to address these limitations by incorporating larger sample sizes, consistent observation periods, and more standardized environments to enhance the validity and applicability of the findings.

CONCLUSION

This study aimed to offer valuable information on the change of behavior between two phases of adaptation to a new environment, emphasizing the importance of understanding how they allocate their time in captivity. By utilizing a working ethogram, this research not only documented the common behaviors of brown bears in captive conditions but also highlighted their interactions with the environment. This study can inform caretakers and researchers in developing targeted strategies to enhance the physical, mental, and emotional well-being of these animals.

The comparative analysis of Sylvia and Pavle's behaviors between Phase I and Phase II, alongside Dasha and Lelya's adaptation during their first 15 days and thereafter, if confirmed by inferential tests, demonstrates how environmental changes and acclimatization periods significantly influence bear behavior. In particular, the reduction in resting and affiliative behaviors, coupled with increases in locomotion and stereotypies in Phase II, underscores the impact of environmental conditions on exploration and stress-related behaviors. On the other hand, the reduction of stereotypies and the increase in normal activities after the initial adjustment period for Dasha and Lelya indicate a successful acclimatization to their new surroundings.

These findings underscore the critical role of enclosure design and management in promoting the welfare of captive bears by creating environments that support their behavioral needs. Ultimately, this research contributes to our understanding of bear behavior in captivity and offers practical recommendations for improving their living conditions.

BIBLIOGRAPHY

- A. L. Evans, N. J. Singh, A. Friebe, J. M. Arnemo, T. G. Laske, O. Fröbert, J. E. Swenson, S. Blanc. Frontiers in Zoology 13, 2016. *Divers of hibernation in the brown bear*
- Agnieszka Sergiel and Russell C. Van Horn. Encyclopedia of Animal Cognition and Behavior, 2019. *Bear Sensory Systems*.
- Anita J. Norman, Nathaniel R. Street, Göran Spong. National Library of Medicine,2013. *De novo SNP discovery in the Scandinavian brown bear (Ursus arctos).*
- Ashlee J. Mikkelsen, Keith A. Hobson, Agnieszka Sergiel, Anne G. Hertel, Nuria Selva, Andreas Zedrosser. Ecology, Volume 105, Issue 2, 2023. *Testing foraging optimization models in brown bears: Time for a paradigm shift in nutritional ecology?*
- Avanti Mallapur, Qamar Qureshi, Ravi Chellam. Journal of Applied Animal Welfare Science, 2002. *Enclosure design and space utilization by Indian leopards (Panthera pardus) in four zoos in Southern India*
- Cl Tetley, SJ O'Hara. Biology, Environmental Science, 2012.*Ratings of animal personality as a tool for improving the breeding, management and welfare of zoo mammals.* doi: 10.1002/ece3.4061. eCollection 2018 May.
- Eduardo J. Fernandez, Ellen Yoakum, Nathan Andrews. Journal of Zoological and Botanical Gardens, Volume 1, Issue 1, 2020. *Seasonal and Daily Activity of Two Zoo-Housed Grizzly Bears (Ursus arctos horribilis).*
- Enrique González-Bernardo, Luca Francesco Russo, Esther Valderrábano, Ángel Fernández, Vincenzo Penteriani. Published: May 25, 2020. *Denning in brown bears.*
- G. Mason, J. Rushen. Environmental Science, Biology, 2006. *Stereotypic Animal Behaviour: Fundamentals and Applications to Welfare.*
- Giovanni Quintavalle Pastorino, Yiannis Christodoulides, Giulio Curone, Paul Pearce-Kelly, Massimo Faustini, Mariangela Albertini, Richard Preziosi, Silvia Michela Mazzola, 2007**.** *Behavioural Profiles of Brown and Sloth Bears in Captivity***.**
- Herrero, S. 1972. *Aspects of evolution and adaptation in American black bears (Ursus americanus) and brown and grizzly bears (Ursus arctos),*

- Jennifer K. Fortin, Karyn D. Rode, Grant V. Hilderbrand, James Wilder, Sean Farley, Carole Jorgensen, Bruce G. Marcot. Published: January 5, 2016. *Impacts of Human Recreation on Brown Bears (Ursus arctos): A Review and New Management Tool*.
- Jessica Pierce, Marc Bekoff. National Library of Medicine,2018. *A Postzoo Future: Why Welfare Fails Animals in Zoos.*
- Jignesh Rot, Ashish Kumar Jangid, Chandra Prakash Singh, Nishith A. Dharaiya. Trees, Forests and People: Volume 13, September 2023. *Escaping Neobiota: Habitat use and avoidance by sloth bears in Jessore Sloth bear Sanctuary India.*
- John R. Krebs, Nicholas B. Davies, 2009. *Behavioural Ecology: An Evolutionary Approach, 4th Edition.*
- Joseph P. Garner, *ILAR Journal*, Volume 46, Issue 2, Pages 106–117, 2005. *Stereotypies and Other Abnormal Repetitive Behaviors: Potential Impact on Validity, Reliability, and Replicability of Scientific Outcomes.*
- Karolina Westlund. Applied Animal Behaviour Science: Volume 152, Pages 1-6. March 2014. *Training is enrichment—And beyond*.
- Karyn D. Rode, D. C. Douglas, T. C. Atwood, G. M. Durner, R. R. Wilson, A. M. Pagano. Global Ecology and Conservation, Volume 40, December 2022. *Observed and forecasted changes in land use by polar bears in the Beaufort and Chukchi Seas, 1985–2040*.
- Katherine A. Zeller, David W. Wattles, Laura Conlee, Stephen DeStefano. Movement Ecology 7, 19, 2019. *Black bears alter movements in response to anthropogenic features with time of day and season*.
- Kelly Bruno, Cassidy Hubbard, Emily Lynch. Journal of Zoological and Botanical Gardens,*4*(1), 87-98, 2023. *Access to Multiple Habitats Improves Welfare: A Case Study of Two Zoo-Housed Black Bears (Ursus americanus).*
- Kristen E., Lukas, Michael P. Hoff, Terry L. Maple. Applied Animal Behaviour Science: Volume *Gorilla behavior in response to systematic alternation between zoo enclosures*. 81, Issue 4, Pages 367-386. 21 May 2003.

- *LAW ON ANIMAL WELFARE.* Pursuant to UNMIK Regulation No. 2001/09 of May 15, 2001, on Constitutional Framework of Provisional Self Governance in Kosovo, Chapter 9.1.26 (a) and 5.1 (n)
- Luc Le Grand, Neri H. Thorsen, Boris Fuchs, Alina L. Evans, Timothy G. Laske, Jon M. Arnemo, Solve Sæbø, Ole-Gunnar Støen. Sec. Behavioral and Evolutionary Ecology. Volume 7 – 2019. Frontiers Ecology Evolution, 24 April 2019. *Behavioral and Physiological Responses of Scandinavian Brown Bears (Ursus arctos) to Dog Hunts and Human Encounters.*
- Mauricio Cantor, Damien R Farine. 2018 Apr 20;8(10):4978-4991. *Simple foraging rules in competitive environments can generate socially structured populations.*
- McLennan, M. R., & Plumptre, A. J. (2012). *Protected areas and wildlife conservation: a case study of Uganda's national parks.*
- Michael J. Renner, Jennifer Plebani Lussier. Pharmacology Biochemistry and Behavior: Volume 73, Issue 1, Pages 279-283. August 2002. *Environmental enrichment for the captive spectacled bear (Tremarctos ornatus)*.
- Mindy Babitz, Angela Gibson and Jason Pratte. Journal of Zoological and Botanical Gardens, Volume 4, Issue 1, 2022. *Improving Animal Wellbeing Using Behavior-Based Methodologies: A Discussion on Enrichment and Bears under Human Care.*
- Nadja Wielebnowshi. Animal Welfare Forum: The Welfare of Zoo Animals, 2003. *Stress and distress: evaluating their impact for the well-being of zoo animals*.
- Penteriani V, Melletti M, eds. Cambridge University Press; 2020. *Bears of the World: Ecology, Conservation and Management*.
- Ros Clubb and Georgia J. Mason. Nature 425, 473-474, 2003.*Animal Welfare: Captivity effects on wide-ranging carnivores.*
- S. Montaudouin, G. Le Pape. Applied Animal Behaviour Science: Volume 92, Issues 1–2, Pages 129-141. July 2005. *Comparison between 28 zoological parks: stereotypic and social behaviours of captive brown bears (Ursus arctos*).
- Schwartz, C.C., Miller, S.D., & Haroldson, M.A., eds. 2003. *"Grizzly bear" in Wild mammals of North America: biology, management, and conservation.*

- Sophie S. Vickery, Georgia J. Mason. Zoo Biology 23, 2004. *Stereotypic behavior in Asiatic black and Malayan sun bear.*
- Stagni E., Sequeira S., Kirchner K., Manteca X., Brscic M., Redtenbacher I., Hartmann S. 2024. *BearWell and CatWell: species-specific welfare assessment protocols for brown bears (Ursus arctos), lions (Panthera leo) and tigers (Panthera tigris) in sanctuaries*
- Swenson, J.E., Adamič, M., Huber, D. et al. Oecologia 153, 37–47, 2007. *Brown bear body mass and growth in northern and southern Europe.*
- Terry Maple, Bonnie M. Perdue, 2013. *Zoo Animal Welfare.*
- Thomas Quirke, Ruth M. O'Riordan, Alain Zuur. Applied Animal Behaviour Science: Volume 142, Issues 3–4, Pages 189-197. 31 December 2012.*Factors influencing the prevalence of stereotypical behaviour in captive cheetahs (Acinonyx jubatus).*
- Wilson, D., S. Ruff. Washington: Smithsonian Institution Press., 1999. *The Smithsonian Book of North American Mammals*.

SITOGRAPHY

- FOUR PAWS International. *BEAR SANCTUARY Müritz. A FOUR PAWS project in Germany since 2006. (2021) Available at:* *BEAR SANCTUARY Müritz - FOUR PAWS International - Animal Welfare Organisation (four-paws.org)* (Accessed 20/06/2024)
- FOUR PAWS International. *FAQs while visiting a bear sanctuary - Our bears can choose.* (2022) Available at: https://www.four-paws.org/about-us/faqs-collection/faqs-while-visiting-a-bear-sanctuary (Accessed 03/01/2024)
- FOUR PAWS International. HELP FOR BEARS (2019) Available at: Help for Bears - FOUR PAWS International - Animal Welfare Organisation (four-paws.org) (Accessed 17/10/2024)
- BORIS. ***B**ehavioral **O**bservation **R**esearch **I**nteractive **S**oftware. (20.08.2023)* Available at: https://www.boris.unito.it/ (Accessed 16/08/2022)

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