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First Cycle Degree (B.Sc.) in
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Development and Application of an Ethogram for a Socialization Project on a Pair of captive Brown Bears (*Ursus arctos*): Design, Implementation and Behavioural Analysis in a Sanctuary Setting

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1. ABSTRACT

This thesis presents a study in the field of brown bear socialization, with the aim of developing and testing the efficacy of a working ethogram for future socialization studies.

The study focused on a pair of brown bears, a male and a female, housed in adjacent enclosures within a sanctuary context. By enabling controlled interactions through a gate mechanism, it was firstly possible to evaluate the social compatibility. Subsequently, a brief period of cohabitation was introduced to observe social behaviours and dynamics

Logistical constraints and resource limitations lead to an abbreviated socialization timeframe, which resulted in not reaching the desired outcome. A more accurate resource management could help to achieve a successful socialization, even though wanted outcomes are not always guaranteed even with sufficient resources.

Despite that, the study provided valuable insights. The developed ethogram demonstrated efficacy in documenting bear behaviours, allowing for potential applicability in similar contexts.

Overall, the study emphasizes the significance of continued research in brown bear ethology, considering methodological refinements and resource allocation to achieve the desired outcomes in wildlife management.

2. INTRODUCTION

2.1 Brown bear distribution and biology

The brown bear (*ursus arctos*) is the largest predator found in Europe where around 17,000 individuals are present. The rest of the brown bears population, amounting to 180,000 to 200,000 individuals, can be found roaming in the vast forest regions of Alaska, Canada and Russia, preferring to inhabit areas where the human presence is less predominant. (Kaczensky, P., Chapron, G., von Arx, M., Huber, D., Andrén, H., and Linnell, J. 2013.).

It is one of the six members of the genus *Ursus* (Schwartz et al. 2003b) and the most widespread species of Ursidae (Pasitschniak-Arts 1993, Schwartz et al. 2003b.), being currently listed globally as a species of least concern (Swenson et al.2000).

Brown bears are sexually dimorphic with males being 1.2–2.2 times larger than females (Lefranc et al. 1987, Jakubiec 1993, Schwartz et al. 2003b, Swenson et al. 2007).

The U. arctos is recognizable by a layer of dense inner fur and long outer guard hair, which, although is predominantly brown, can range from almost black to near-white.

Its aspect varies according to the season: the bear shed its fur going from a thicker and darker winter coating to a thinner and lighter shade in summer (Murie, 1985; Obbard, 1987).

Despite their weight, ranging between 100 and 320 kg, this large plantigrade can reach a speed of 50km/h. The fore and hind feet are provided with heavy pads made of fibrous connective tissue, and powerful non retractile claws that can measure up to 10 cm in length. (LeFranc et al).

Bears have a highly developed sense of smell aiding them in their continuous search for food, activity that take up 2/3 of their day. For this purpose, they roam extensive areas, covering stretches of up to 40 kilometers. (Craighead and Mitchell, 1982; Storer and Tevis, 1955).

2.2 Brown bear diet

Being omnivorous their diet is very wide: 80% of it consist of numerous species of grasses, herbs, shoots, flowers and roots, as well as tubers and a large variety of berries, acorns and nuts. They love sugary foods like fruits and honey, which they take from beehives after opening them with their skilful paws; this provides them with a healthy treat that strengthens their immune system (Bunnel and Hamilton, 1983; Craighead et al., 1982).

The rest of their diet is made up of eggs, insects and meat, mostly coming from small rodents, birds, frogs, snakes and fish. Larger preys such as ungulates are rarely killed, as bears tend to prey only on the ones weakened by severe winters, disease, malnutrition, old age, or injuries, but they feed on

carrion of winter killed big game like moose, caribou, elk, bison and deer. (LeFranc et al., 1987; Nowak and Paradiso, 1983).

In preparation for winter, bears enter a phase called hyperphagia in the fall, where they significantly increase their food intake, consuming fruits rich in fats and sugars such as nuts, seeds, and berries. This feeding behavior enables them to build up a fat layer crucial for insulation and as an energy source during their hibernation. (Lentfer et al., 1972; Reynolds et al., 1976; Schoen et al., 1987).

2.3 Hibernation

Brown bears exhibit a fascinating adaptation to seasonal changes known as hibernation. During this period, typically spanning several months in winter, brown bears enter a state of reduced metabolic activity, allowing them to conserve energy when food resources are scarce (Folk et al., 1972).

What they perform is not a true hibernation: they are dormant rather than torpid.
The difference lies in the deepness of the reduction of the metabolic rate; while in torpidity is highly accentuated, with drastic slowing of heart rate and breathing, in the case of dormancy everything is way more moderate. Therefore, although the frequency of their heartbeat and breathing slows down, the bears are easily woken and are able to defend themselves in the case it is needed (F Geiser, T Ruf, 1995).

Their dormancy is continuous for 3-7 months, a period that they spend in dens which they dig themselves and that can be used for consecutive years. Natural caves or rock fissures sometimes also serve as retreats (Craighead and Craighead, 1972).
Throughout this period, as long as they are in the den, bears do not eat, drink, urinate, or defecate, and they will lose one third of their body weight: they will rely entirely on the reserves accumulated beforehand (Craighead and Craighead, 1972; Folk et al., 1972).

Bears will emerge from the dens in spring entering the stage 2 called "walking hibernation"; they will look underweight and will start first to graze, gradually going back to their normal diet. (Nelson et al., 1983).

2.4 Brown bear social organization
Brown bears are solitary animals meeting other individuals only during the breeding season. The territories of the females may overlap, while males have larger territories and tend to avoid each other. The female stays with the offspring until she comes into heat, after which she chases the

youngs away, generally when they are around 2-2.5 years old. Siblings may stay together, playing, and feeding for as long as 4.5 years (Murie, 1985).

As bears rely primary on their sense of smell, olfactory cues are widely used by rubbing on trees, biting, clawing, and striping tree bark. Marked trees demark territory, advertise sexual condition, or serve as grooming stakes. On the ground, trails are left by rolling, urinating, and defecating (LeFranc et al., 1987).

Bears mostly use vocalization in response to a threat (Craighead, 1979; Stonorov and Stokes, 1972). Distress calls can be heard by a hurt animal, both adult and juvenile, the latter performing the vocalization also in case of hunger, cold or separation from siblings.
The offensive actions are accompanied by growling and roaring (Schaller et al., 1985), while chuffing is a friendly call used as a greeting, coaxing, appeasement or during courtship and mating as well as between a female and its offspring. This vocalization consists of a series of brief low-intensity sounds caused by a forceful exhalatory sound combined with a popping noise produced by movement of lips and cheeks. (Peters, 1984; Peters and Wozencraft, 1989).

2.5 Brown bears in captivity

The complexity of the bear behaviour, its extended home range and high intelligence makes them incredibly hard to be provided with an optimal welfare captive setting. Bear species are extremely prone to develop stereotypic behaviours which are repetitive behaviours, invariant in form, and which have no apparent functional consequences (Mason, 1991b). Some of the most common include: pacing, head rolling, excessive grooming, and self-directed behaviours, all of which are a result of the stress caused by the artificial and confined environment (Kleiman, D.G.; Thompson, K.V.; Baer; 2010).

Although bears are solitary animals in the wild, in captivity sometimes subjects are grouped in order to improve their welfare, reducing the boredom and providing a social enrichment (Fagen R and Fagen JM). In fact, it has been proved that even though solitary species spent the majority of their time alone, they still seek social interactions with individuals in neighbouring enclosures (Yoerg, 1999). As stated by *Montaudouin S and Le Pape G* in *Comparison between 28 zoological parks: stereotypic and social behaviours of captive brown bears (Ursus arctos) "*the social relationships will be more playfull and less agonistic if not more than two bears are housed together, even in the case of a male with females."

The establishment of social bonds happens mainly through social play, and is largely dependent on age. It has been observed in zoos that young bears can develop strong bonds through play, while it appears to be almost impossible to achieve the same result with older individuals of the same sex. During the mating season is not rare to see aggression between males in the wild as well as captive, non-bonded individuals. (Colemenares and Rivero, 1983).

2.6 Rescue and FOUR PAWS

An increasing number of bears find themselves in captivity, often as a result of being rescued from harsh or unsuitable living conditions. Many organizations are dedicated to the rescue and rehabilitation of these animals, with FOUR PAWS being one prominent example.
"FOUR PAWS is the global animal welfare organisation for animals under direct human influence, which reveals suffering, rescues animals in need and protects them" quoting the website (https://www.four-paws.org/).

The organisation is actively involved in numerous campaigns including fighting to end the dog meat trade, the fur farming, the animal abuse involved with the fashion industry and the illegal wildlife trade as well as rescuing of different species such as big cats, local wildlife, foxes and bears.

Since 1998, FOUR PAWS has been working tirelessly to end the inappropriate keeping of brown bears in Europe, by acting both through a legislative change and through rescue and housing of bears in our FOUR PAWS bear sanctuaries and partner projects.

Different species of bears that have been subjected to neglect, abuse, or inadequate living get a second chance in life, after being rescued from various captive settings: from circuses to private keeping, zoos and bile farms, exploited for entertainment as dancing bears or used as baits to train hunting dogs.

The organisation has so far rescued over 130 bears in Europe, and amongst others, succeeded in putting an end to the keeping of dancing bears in Bulgaria and Serbia, the illegal keeping of restaurant bears in Kosovo and Albania, and the illegal private keeping of bears in Poland.

FOUR PAWS is dedicated to provide to the bears brought to the sanctuaries the best possible care, ensuring they are placed in environments where their physical and psychological needs are met.

In the heart of Müritz national park in Germany it is possible to find the Western Europe's largest bear sanctuary: the BEAR SANCTUARY Müritz (Latitude: 53° 15' 32" N; Longitude: 12° 45' 43" E).

A place that covers an area of 16 hectares, currently home to 11 brown bears, rescued from neglect and mistreatment, and that now find a lifelong safe home in a semi-natural habitat.

The animals are offered the opportunity to revert to their natural instincts, by providing them with a natural habitat in which they can fulfil their urge to wander, withdraw into their own space, dig out dens, bathe in the pond and go into a state of hibernation. These animals that have lived in captivity cannot be reintroduced to the wild as they are too dependent on humans and would not survive; moreover they would not keep a distance to human settlements, posing a threat to humans and hence themselves by risking of being shot.

It is here that the study took place: a socialization project with the aim of socializing a pair of Brown bears, a male and a female.

3. AIM OF THE STUDY

Develop a working ethogram to be used in socialization studies, applying it to a pair of brown bears kept under captive conditions. In order to socialize the animals as safely as possible it was necessary to observe them to assess their compatibility.

The main reason why FOUR PAWS carry on these socialization projects is to increase the welfare of both the animals. It is not a matter of making the management easier or creating space by freeing an enclosure: if the experience is not enriching for the animals they will not be housed together.

4. MATHERIALS AND METHODS

4.1 Animals involved in the study

ROCCO – male brown bear

- Age – 13 years old
- Weight – 160kg
- Castrated

He was rescued on June 2019 from a private keeping in Albania, where he was kept in a backyard, as his owner got him when he was only a cub.

His keeping conditions were poor: confined to a small and rusty cage with a concrete floor with no access to water to bathe and no protection against wind, sun or rain. Luckily, after eight years, the owner wanted to get rid of the bear as he was getting too expensive, and that is when FOUR PAWS could finally rescue Rocco and bring him to BEAR SANCTUARY Müritz.

Upon his arrival at the sanctuary he was kept in his box for a night, and after that acclimatization period he could be released in his new enclosure an explore the surroundings.

His isolated keeping conditions in Albania made him a very sensitive bear, as he gets easily stressed and uncomfortable when surrounded by too many people and does not cope well with strong noises. His response to these stimuli is a self-directed behaviour: he gently grabs his paws with the mouth and shakes it, while he vocalizes loudly, but fortunately he does not bite on it and does not injure himself. Of course, the team does his best to avoid him reaching that threshold, by trying to identify the triggers and keeping him content as much as possible.

Despite that he is a very active bear that loves enrichments and all the new things he experienced here for the first time, like swimming, climbing and even the snow, as well as interacting with the caretakers during medical training.

During winter of 2022 something very special happened for Rocco and the whole team at the BEAR SANCTUARY Müritz. For the first time in his life, Rocco followed his natural instincts and withdrew into hibernation. Thanks to the efforts of the whole caretaker team, which provided several denning opportunities, a species appropriate diet and optimal care, the bear could choose his straw-filled tunnel, where he retreated for 2 months.

Rocco has been subjected already to a socialization project in 2021 with bear Luna, but the two unfortunately didn't get along in the long-term.
Although at the beginning they were doing fine by playing with each other a lot, after a while some quarrels started to arise and became more and more frequent especially during feeding time.

Rocco would try to eat Luna's portion of food as well, but of course Luna would get defensive; as a solution the animal caretakers fed them far away from each other for several weeks.

After a long discussion the decision was to separate the pair as long-lasting conflicts with other bears are cause of stress, which of course is something the caretaker try to avoid as much as possible in order to provide the optimal care.

DUSHI – female brown bear

- Age – 15 years old
- Weight – 100kg
- Not spayed

She comes from Albania as well, as she was kept in the zoo Safari Park Fier also known as "Europe's worst zoo", and rescued in 2019.

The bear had to suffer for many years under terrible keeping conditions: not too differently from Rocco she was also kept in a small and dirty cage with concrete flooring. After the rescue, before moving to BEAR SANCTUARY Müritz. She made a stop at the zoo Tirana so that she could gather enough strength for the long journey to Germany.

Dushi is missing the left front leg, but the reason is unknown; after she was checked by the wildlife veterinarian a sad truth emerged: bullet fragments were found in both of her front leg, hinting that somebody shot her in the cage and that Dushi lost her leg due to that. The wound wasn't properly treated, but healed somehow on its own.

She is a very curious yet cautious bear, often seen standing on her hind legs to better check her surroundings; as the caretakers get to know her more and more they figured that Dushi is very picky about the food she eats: Grapes, apples and carrots are her favourite treats, along with everything sweet, but cucumbers, Zucchini or tomatoes are absolutely not appreciated.

Sadly, the years spent at the zoo have taken a toll on Dushi's behaviour: she shows stereotypic behaviours such as pacing and head swinging, especially in front of gates, same pattern that could be seen during her time before the rescue.

These behaviors, are common in animals kept in environments that do not meet their physical or psychological needs. Different studies suggest that providing animals with more complex and stimulating environments can potentially reduce the frequency of these behaviours although some become permanent part of the behaviour repertoire of the individual. This can be done through environmental enrichment or changes in housing conditions, that will help promoting natural and species-specific behaviours (GJ Mason, 2023).

The caretaker team work hard on keeping Dushi as busy as possible by providing lots of enrichment and engaging with her with medical training.

Despite that Dushi shows a strong character and appears to be less insecure than Rocco's previous mate, Luna.
In addition to that, when she was housed in an enclosure adjacent to Rocco, the two could be seen often at the gate showing positive interactions and interest towards each other.
Those were the reason why the team of BEAR SANCTUARY Müritz decided to give it a go and start a socialization project between the two bears.

4.2 Enclosure description and arrangement

The sanctuary comprises a total of seven enclosures, each with a respective smaller area to momentarily enclose the animals if needed, called separation enclosure. Six of the enclosures are provided with an inside sleeping den, or bearhouse, which the bears can use to rest or even for hibernation. Moreover, it is useful to carry out medical training sessions or temporary trap the bear when needed.

All the enclosures are connected with each other by a system of tunnels and sliding doors making it possible to exchange bears at will. The perimeter is made of two electric fences, a lower internal one and a higher external one with return on top for safety.

On the right (figure 1), it is possible to see the map of the sanctuary with highlighted the enclosure where Rocco and Dushi were housed, and the enclosure chosen for the socialization.

Dushi's enclosure consist in:

- Separation enclosure 1.2
- Separation enclosure 2.2 a
- Separation enclosure 2.2b

The first and the second areas are connected through a tunnel.
She has no bearhouse, but she is provided with an artificial den where she can retreat into, as well as two small ponds.

Rocco's enclosure is the adjacent 2.2, which also has another small separation enclosure with a bearhouse on the opposite side. A small natural canal cuts through the enclosure offering him a bathing opportunity.

Rocco's enclosure
Dushi's Enclosure
Socialization's enclosure

Figure 1. Map of the sanctuary

The whole area that will be used for the socialization included:

- Separation enclosure 2.2 a and b
- Enclosure 2.3
- Separation enclosure 2.3 a and b
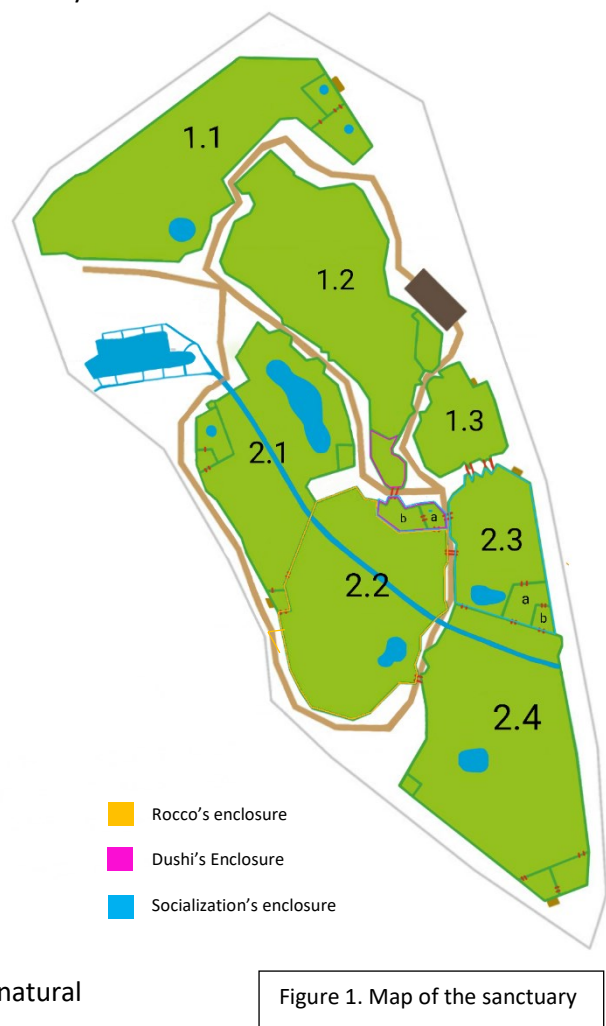
4.3 Daily husbandry routine

During the socialisation period the bears were subjected to the normal husbandry routine.
The cleaning of the enclosures was performed a couple of times a week without fixed schedule.
The bears are provided with fresh water thanks to drinkers with an auto-refill mechanism. They are not closed anywhere for the night, having therefore always access to their whole enclosure with the possibility to graze ad libitum.

The routine included two feedings per day consisting of vegetables and fruits such as, carrots, cucumbers, tomatoes, celery, potatoes, apples, as well as eggs and occasionally meat and fish.
The food would be thrown over the fence and occasionally spread and hidden inside the enclosure to encourage the foraging behaviour, especially when paired up with the cleaning.
Some cooperative feeding sessions were carried out from time to time; cooperative feeding consist in providing the food to the bears in proximity to each other, in this case in front of the sliding door separating the bears. This was attempted first with low value food, like vegetables, and then also with high value food such as dry dog food, nuts and fruits.

As long as the animals were in the pre-socialization phase, enrichment were also often provided, in various size and complexity, according to individual needs: from simple jute bags and cardboard boxes, to hanging toys and balls built by the caretakers.

4.4 Working ethogram

A working ethogram (Table 1) was created in collaboration with Four Paws' Animal Behaviour and Welfare Specialist Elena Stagni. For this study the behaviours selected were the ones relevant for the socialization.

The same ethogram was also applied on another study happening at the same time, always in the sanctuary, having as subject another pair of brown bears.

Table 1. Working ethogram

BEHAVIOR TYPE	BEHAVIOR CODE	DESCRIPTION	BEHAVIORAL CATEGORY	MODIFIERS
State event	Bathing	Bears sit, walk, or swim in the water of a pool or pond. They can show maintenance behaviours (e.g. self-grooming) and explorative behaviours. (Including beahviours such as Play Alone/Afiliative and Agonisitc Behaviour)	Activity	
State event	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 and locomotion is irrelevant (e.g. they can move, sit or lie down). Bears might be eating alone or in company of other bears, the latter is considered if the distance between the bears is (0) in contact, (2) within 2 body leghts of distance, (4) within 4 body leghts, (6) within 6 body leghts and (8) within 8 body leghts of distance.	Activity	0 / 2 / 4 / 6 / 8
State event	Locomotion	Bears move forward or in any direction, with no repetitive pattern and not running. They might sniff and investigate	Activity	

		the environment at the same time, including foraging.		
State event	Running	Bears move in any direction at a speed faster than a walk. This behaviour is not caused by fear of any stimulus, and might be performed towards humans, heterospecific or conspecific.	Activity	
State event	Other	Bears perform any other behaviour not included in this working ethogram.	Activity	
State event	Play Alone	Bears interact with objects present in the enclosure, they may manipulate, snap or throw objects around (including enrichments). 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 or with the surrounding environment, such as digging. They might paddle and splash in the water, run, climb, jump and/or roll.	Activity	
State event	Digging	Bears break up or move earth, dirt or other substrate/surfaces with their paws and claws.	Activity	
State event	Resting	Bears lie or sit down. The eyes might be open or closed and they may be sniffing the air and observing the surrounding environment. Bears might be resting alone or in company of other bears, the latter is considered if the distance	Inactivity	0 / 2 / 4 / 6 / 8

		between the bears is (0) in contact, (2) within 2 body leghts of distance, (4) within 4 body leghts, (6) within 6 body leghts and (8) within 8 body leghts of distance.		
State event	Standing Still	Bears remain on their four paws, niether moving forward nor backwards.	Inactivity	
State event	Self-Grooming	Bears use their powerful 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 tongue to lick themeselves or their claws to comb through their fur and remove any tangles or mats.	Maintenance	
State event	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.	Maintenance	
State event	Allo-grooming	Bears use their paws, mouth, or other part of their body to touch the other animal; the mechanical motion of allo-grooming resembles scratching, picking, stroking, rubbing, licking or nibbling directed towards the other bear. This type of behaviour can also happen through the gate.	Affiliative Social Interactions	
State event	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. This could happen also through the gate. Vocalization if they happen, are soft.	Affiliative Social Interactions	

State event	Arousal	Bears perform behaviours which may include increased respiration and vocalization like repetitve grunts, huffing and tongue clicking towards other bears.	Affiliative Social Interactions	
State event	Mounting	One bear positions 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. One bear should be identified as A (agent) and the other bear R (recipient)	Affiliative Social Interactions	
State event	Interactions	Bears display positive interest towards conspecific, also through the fence, indulging in interactions which are not expressively described in this working ethogram. For Example, one bear might show interest in another bear by looking at them, sniffing the air at a distance, stretching the neck or head towards the conspecific direction. They can also briefly touch or smell each other.	Affiliative Social Interactions	
State event	Caretakers Interaction	Bears interact with the caretakers, displaying positive interest towards them, in response, for example, to a feeding or training session.	Affiliative Social Interactions	
Point event	Flight	Bears suddenly run away from something or from someone (human, conspecific or other species). In the case of a conspecific, the latter has not shown	Agonistic Interactions Without Contact	

		any sign of aggression or threat (otherwise would be R of an agonistic social interaction).		
Point event	Avoidance	Bears avoid interactions in response to social behaviours, both agonistic and affiliative, of other bears.	Agonistic Interactions Without Contact	
State event	Away From	Bears prevent closeness with other bears, by changing direction of their path, backing slowly away or turning their head away.	Agonistic Interactions Without Contact	S/V/H
Point event	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 behaviours like mock charge, jawing or snorting. Define if staff (S), visitor (V) or heterospecific (H).	Agonistic Interactions Without Contact	A/R
Point event	Aggression towards object	Bears have a sudden and violent reaction directed to an item inside the enclosure. They shake, charge and strike the object and growl loudly. The subject of this reaction could also be the gate or ther bars of the enclosure.	Agonistic Interactions Without Contact	
Point event	Mock Charge	Bears start the action of charging but stop after few steps without getting close to 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).	Agonistic Interactions Without Contact	
State event	Tension	Bears display general tensing of muscles, especially of front. Bears might be	Agonistic Interactions	

		walking or staying still. Ears might be laying back or near head with the openings not conspicuous from the front. Vocalizations like growling or roaring may be performed.	Without Contact	
Point event	Vocalizations	Bear may produce sounds of huffing, growls, low or high roars and teeth clacking as a warning when approached by another bear or when approaching another bear.	Agonistic Interactions Without Contact	
Point event	Jawing	Bears open and close the jaws, repetitively, rapidly and loudly. Body positions is stiff.	Agonistic Interactions Without Contact	
Point event	Pawing	Bears might try to reach another bear with their paws and/or claws. This could also happen through the gate. In case one of the subjects is the initiator of the agonistic interaction, then it should be identified as A (agent) and the other bear R (recipient).	Agonistic Interactions With Contact	A/R
Point event	Charge	Bears do a short run, violently and rapidly against a conspecific, usually with vocalisation. 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).	Agonistic Interactions With Contact	A/R
Point event	Fight	Bears have aggressive contact, characterised by loud growls, biting, swiping and striking. 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	Agonistic Interactions With Contact	A/R/X

		identified as A (agent) and the other bear R (recipient). Put X if none of them can be clearly identified as agent or recipient of the action.		
State event	Stereotypies	Bears perform the same behaviour in a repetitive, constant, exhagerated and often unvarying manner, without apparent purpose or obvious goal. Behaviours shown can be pacing (incl. circling), weaving, tongue playing, head swaying, head tossing, bars biting or licking.	Abnormal Behaviours	
State event	Self-Directed	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" vocalisation.	Abnormal Behaviours	
State event	Re-Directed	Bears might redirect their frustration towards another target, which could be a conspecific or an object present within the enclosure. Bears bite, suck or lick part of a conspecific´s body (usually the same spot) repetitively, without any obvious purpose of grooming. Might be accompanied by a "humming" vocalisation.	Abnormal Behaviours	
State event	Out of Sight	Bears cannot be seen or they can be seen only partially, hindering behaviour recognition. They might become out of the visual during the 15 min observation or they cannot be seen from the beginning at any of the predefined observation points.		

The colour coding has the purpose of distinguishing the different behavioural categories:

- ☐ Activity
- ☐ Inactivity
- ☐ Maintenance
- ☐ Affiliative Social Interactions
- ☐ Agonistic interactions without contact
- ☐ Agonistic interactions with contact
- ☐ Abnormal behaviours

In the table 2. The different modifiers and their meaning are explained:

Eating, Resting	Aggression towards human	Mock charge, Pawing, Charge	Fight
Shows the distance between the bears defined in Body lengths. 0 = in contact 2 = within 2 body lengths 4 = within 4 body lengths 6 = within 6 body lengths 8 = within 8 body lengths	Defines the recipient of the action. S = Staff V = Visitor H = Heterospecific	A = Agent R = Recipient	A = Agent R = Recipient X = if none of the subjects can be clearly identified as agent or recipient of the action.

Table 2. Modifier meaning

4.5 Data collection

Behavioural sampling

- Live observation, with data collected on paper. Some video recordings were taken of the most relevant behaviours such as social affiliative or agonistic interactions, eating and resting in proximity, abnormal behaviours.

- **Camera type**: Canon EOS 4000D

- **Observation method**: continuous focal.

- **Observation length**: 15 minutes

- **Number of observations per day**: 12, 6 per each bear

  The subjects were alternated: the first bear was observed at 8:30, the second bear was observed at 9, to then start again with the first subject at 10: 00 and so on for the whole day.

  The bear observed as first in the day was then the one observed as second the following day.

- **Timespan**:

  1. 8:30 – 8:45
  2. 9:00 – 9:45
  3. 10:00 – 10.15
  4. 10:30 – 10:45
  5. 11:30 – 11:45
  6. 12:00 – 12:15
  7. 13:30 – 13:45
  8. 14:00 – 14:15
  9. 15:00 – 15:15
  10. 15:30 – 15:45
  11. 16:30 – 16:45
  12. 17:00 – 17:15

  Each observation had as a focus a single individual, the behaviour of the other subject where not reported in the same moment.

- **Starting date**: 25th of April – It corresponds to the first day in which Dushi was officially considered out of hibernation.

  The bears were observed for three months, from the 25th of April to the 22nd of July.

  The observations were 6 per week and in addition to that there are days in which observations were not performed. Altogether the days in which the animals were not observed were:

  03/05; 15/05; 17/05; 24/05; 26/05; 07/06; 11/06, 12/06; 15/06; 20/06; 21/06; 22/06; 26/06; 27/06; 28/06; 29/06; 31/06; 09/07; 15/07.

  In this whole time frame a total of 820 observations were performed (410 Rocco, 410 Dushi), amounting to a total time of 205 hours of observations.

Location recording

Together with the behaviour recording, a scan sampling of the location was also carried out, as well as the recording of the distance between subjects.

The enclosures were split into areas, each named with a different letter: during the pre-socialization period it could be useful to use it, in case we want to detect if one subject preferred to spend time in the area adjacent to the other individual's enclosure or not.
During the socialization it can help to determine whether both bears are using the whole enclosure and if they are spending more time in a particular area.

The enclosures were divided into distinct areas, each labeled with a different letter.

During phase 1, Rocco's 'R1' area was deliberately kept small, covering the perimeter around Dushi's enclosure. This ensured that if he was found in that area, he was at a meaningful distance from Dushi. In the pre-socialization period, this division helps to observe if one bear prefers to stay near the other's enclosure.
During socialization, it assists in determining whether both bears are utilizing the entire enclosure or spending more time in specific areas, reason why the zones were more numerous.

Every two minutes the location would be noted down (Figure 2.) (Figure 3.).

The distance between the animals was calculated in body lengths, according to the following system:
- 0 = in contact
- 1 = ≤ 2 body length
- 2 = ≤ 4 body length
- 3 = ≥ 6 body length

Dushi's Areas
- D2
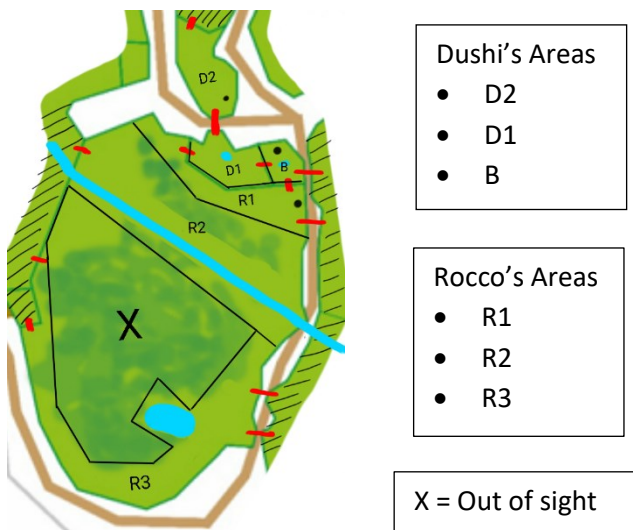- D1
- B

Rocco's Areas
- R1
- R2
- R3

X = Out of sight

Figure 2. Map of Rocco's and Dushi's enclosures with areas partition
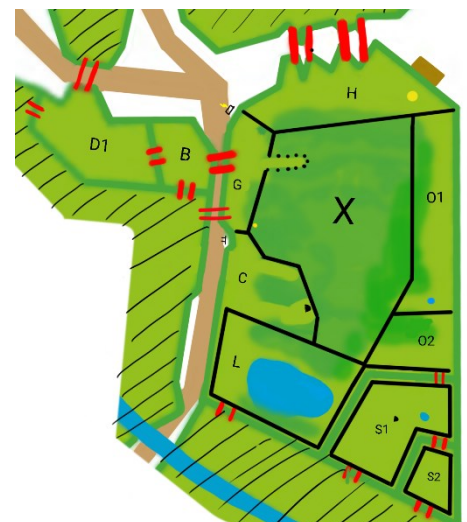

Figure 3. Map of socialization's enclosures with areas partition

All events

In addition to that some behaviors were selected and recorded as "all events", meaning that whenever they would happen, even outside of the observation time, they were noted down. Those behaviours were selected as they are crucial to be noted during a socialization project.

The included behaviours were:

- Agonistic interactions without contact – Avoidance, Away From, Agression towards human, Mock Charge, Tension, Vocalizations
- Agonistic interactions with contact – Jawing, Pawing, Charge, Fight

4.6 Socialization process

The socialization was done by following a plan that would allow the bears to gradually know each other and be as safe as possible throughout the whole process:

- In phase 1 the bears are separated, could touch each other through the bars of the sliding door.
- In phase 2 the bears were given access to the same enclosure, gradually increasing the time they spent together. Eventually they would have been let together overnight.

Phase 1

From the 25th of April to the 3rd of July the bears were in two adjacent enclosures and could interact, by seeing, smelling and touching each other, in two points, which consisted in the sliding doors separating the 2.2 main and separation enclosures. They were subjected to a lot of moving on weekly basis due to routine husbandry practices, but they were almost always able to interact with each other, when not, the separation didn't last longer than a day.

For example, Dushi would occasionally be temporary enclosed in the 1.2 separation enclosure, ad Rocco moved to the two small areas where normally Dushi stays, making it possible for the bears to interact only through the tunnel, which present sliding doors on both sides. When that was the case Dushi would always be the one having access to it.

Phase 2

The next step was to let the bears in the same enclosure together.

Before letting them together, as a routine, they were fed separately and an increased amount (compared to their daily ration) of low-value food (only vegetables, no dog food or nuts), was placed in the enclosure chosen for the socialization.

Caretakers were placed in different points along the fence and communicating with each other in order to keep a constant eye on the pair and to be ready to act if necessary: if a fight would erupt, they would try to separate the bears by using either water, food or loud noise.

When it was time to let the bears meet each other, Rocco was trapped in 2.3 separation enclosure and Dushi in 2.2 separation enclosure. The latter had access to enclosure 2.3 first and as she started roaming around the slide for Rocco was opened as well so they could meet.

The following table (Table 3.) represents the days and the time that the bears spent in the same enclosure and the areas that they had available throughout the day. In green the moments in which the bears were sharing the same space.

| Table 3. time and enclosure areas shared during socialization. |

		SUBJECT	LOCATION	NOTES
04.07.2023		ROCCO	2.3 separation enclosure A and B **2.3 enclosure (11:00 – 12:30)** **2.2 separation enclosure A and B (11:00 – 12:30)**	**The bears were together from 11:00 to 12:30**
		DUSHI	2.2 separation enclosure A and B 2.3 enclosure **2.3 separation enclosure A and B (11:00 – 12:30)**	
05.07.2023		ROCCO	2.3 separation enclosure A and B **2.3 enclosure (11:00 – 15:00)** **2.2 separation enclosure A and B (11:00 – 15:00)**	**The bears were together from 11:00 to 15:00**
		DUSHI	2.2 separation enclosure A and B 2.3 enclosure **2.3 separation enclosure A and B (11:00 – 15:00)**	
06.07.2023		ROCCO	2.3 separation enclosure A and B **2.3 enclosure (12:00 – 16:20)** **2.2 separation enclosure A and B (12:00 – 16:20)**	**The bears were together from 12:00 to 16:20**

	DUSHI	2.2 separation enclosure A and B 2.3 enclosure **2.3 separation enclosure A and B (12:00 – 16:20)**	
07.07.2023	ROCCO	2.3 separation enclosure A and B **2.3 enclosure (13:00 – 15:00)** **2.2 separation enclosure A and B (13:00 – 15:00)**	**The bears were together from 13:00 to 15:00**
	DUSHI	2.2 separation enclosure A and B 2.3 enclosure **2.3 separation enclosure A and B (13:00 – 15:00)**	
12.07.2023	ROCCO	2.3 separation enclosure A and B **2.3 enclosure (10:00 – 11:45)** **2.2 separation enclosure A and B (10:00 – 11:45)**	**The bears were put together from 10:00 to 11:45**
	DUSHI	2.2 separation enclosure A and B **2.3 enclosure** **2.3 separation enclosure A and B (10:00 – 11:45)**	
18.07.2023	ROCCO	2.3 enclosure 2.3 separation enclosure A and B (8:00 – 14:00) **2.2 separation enclosure A and B (13:00 – 17:00)**	**The bears were put together from 13:00 to 17:00**
	DUSHI	2.2 separation enclosure A and B (8:00 – 13:00) **2.3 enclosure (13:00 – 14:00)** **2.3 separation enclosure A and B (13:00 – 17:00)**	

4.7 Data analysis

The collected data were analysed on the software BORIS (Behavioral Observation Research Interactive Software)

BORIS is an event logging software for video/audio coding and live observations. It is possible to upload the ethogram and start an observation, inserting the desired behaviour by pressing the assigned key on the keyboard.

From the software it is possible to extract a time budget that expresses the total duration in seconds of each behaviour. By select the desired observation different analysis can be carried out.

For this study different time budgets were extracted in order to create various graphs.

To do so it was necessary to obtain the percentage of the duration of each behaviour, which is possible by applying the following formula:

$$\frac{Total\ duration\ of\ the\ behaviour\ (s)}{Duration\ of\ one\ observation\ (s)\ \times\ Total\ number\ of\ observations}$$

- The *Total duration of the behaviour* is a number that is extracted from BORIS
- The *Duration of one observation* was always 900 seconds
- The *Total number of observations* varies according to the selected observations that we want to include in the graph

☐ **Time budget of the bears separated** – *Pie chart showing the percentage of time allocated by the bear for each state event behaviour considering all the observations in which the bears were in two different enclosures.*
Two charts were created, one for each bear
Total number of observations: 401 per subject
The number of occurrences of the point events were also reported in a separate table

☐ **Time budget during socialization** – *Pie chart showing the percentage of time allocated by the bear for each state event behaviour considering all the observations in which the bears were socialized.*
Two charts were created, one for each bear
Total number of observations: 9 per subject
The number of occurrences of the point events were also reported in a separate table

☐ **Comparison among the eating behaviour's modifiers** – *Pie chart showing the comparison among the eating behaviour's modifiers considering all the observations up until the day the bears were put together for the first time.*
The modifiers for the behaviour "eating" were summed between the subjects, in order to analyse the amount of time in which the bears decided to eat in close proximity in contrast with eating on their own
Total number of observations: 623

- **Comparison among the resting behaviour's modifiers** – *Pie chart showing the comparison among the resting behaviour's modifiers considering all the observations up until the day the bears were put together for the first time.*

  The modifiers for the behaviour "resting" were summed between the subjects, in order to analyse the amount of time in which the bears decided to rest in close proximity in contrast with resting on their own.

  Total number of observations: 623

- **All state behaviours' comparison between two timeframes** – *Histogram showing the comparison between the behaviours performed by the bear during the first 15 days of observation and the last 15 days before the bears were put together for the first time.*

  Two graphs were created, one for each bear

  This comparison can be useful to highlight any eventual change in the time allocated for each behaviour between the very beginning, where the bears start to get used to each other, and the last days before actually socializing them.

- **Eating and resting behaviours' modifiers comparison between two timeframes** – *Histogram showing the comparison between the eating behaviour's modifiers during the first 15 days of observation and the last 15 days before the bears were put together for the first time.*

  Two graphs were created, one for each behaviour.

- **Overall time budget** – *Pie chart showing the percentage of time allocated by the bear for each state event behaviour throughout the whole observation period.*

  Two charts were created, one for each bear.

  Total number of observations: 410 per subject

  The data used were collected not considering the partition between socialization phases.

  For the behaviours "eating" and "resting" the modifiers were summed in order to have the total amount of time allocated for eating, independently on the distance.
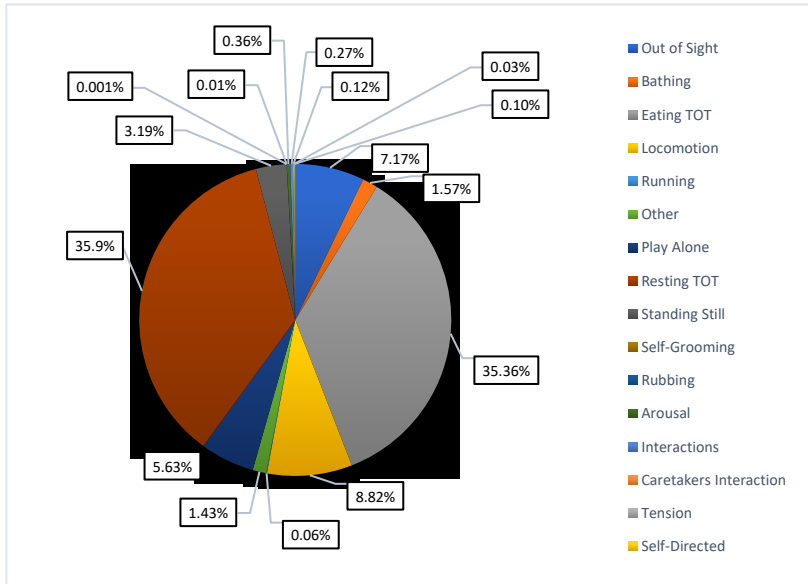
  The number of occurrences of the point events were also reported in a separate table

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

5. RESULTS

5.1 Time budget of the bears separated

Rocco

Figure 4. Time budget of the bears separated – Rocco. Pie chart showing the percentage of time allocated by Rocco for each state event behaviour considering all the observations in which the bears were in two different enclosures.

Most of the time (52.86%) was spent in activity behaviours. (eating 35.36%; locomotion 8.82%; play alone 5.63% bathing 1,568%; other 1.43%; running 0.06%).

Inactivity covered the 39.09% of the time (resting 35.90%; standing still 3.19%).

Affiliative social interactions follow with a 0.75%. Arousal (0.36%), interaction (0.27%), caretaker interaction (0.12%).

The self-directed behaviour was performed for 0.10% of the time and tension for 0.03%; as depicted in the previous chart (figure 4) they are the only behaviours performed by the bears in the respective categories. Maintenance behaviours amount to a total of 0.01%, with rubbing (0.01%) and self-grooming (0.001%).

The bear was out of sight for 7.17%. of the time (Figure 4)

Number of occurrences of points events – Rocco

| Behaviour	Nº of occurrences
Aggression towards object	35
Flight	1
Avoidance	0
Aggression towards human	0
Mock Charge – Agent	3
Mock Charge – Recipient	0
Vocalizations	0
Jawing	0
Pawing – Agent	2
Pawing – Recipient	0
Charge	0
Fight	0

It is possible to notice that the number of occurrences of the point event behaviours performed by Rocco in this phase, corresponds exactly to the ones recorded when taking into account the whole observation period. (Table 7)

From this we can infer that none of these behaviors was performed during the socialization time. (Table 4)

Table 4. Number of occurrences of point events – Rocco. Table containing the number of occurrences of the point event behaviours performed by Rocco considering all the observations in which the bears were in two different

Dushi
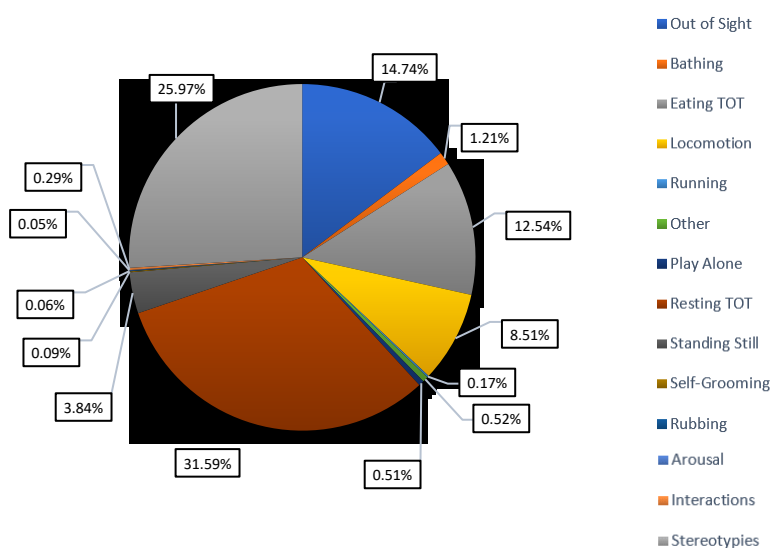
Figure 5. Time budget of the bears separated – Dushi. Pie chart showing the percentage of time allocated by Dushi for each state event behaviour considering all the observations in which the bears were in two different enclosures.

Most of the time (35.43%) was spent in inactivity behaviors. (resting 31.59%; standing still 3.84%). The stereotypic behaviour takes up the 25.97% of the time.

Activity covered the 23.45% of the time (eating 12.54%; locomotion 8.51%; play alone 0.51% bathing 1.21%; other 0.52%; running 0.17%)

Affiliative social interactions follow with a 0.26%., arousal (0.05%), interaction (0.29%).

Maintenance behaviours amount to a total of 0.15%, with rubbing (0.06%) and self-grooming (0.09%)

No agonistic interactions, both with and without contact, were recorded. (Figure 5)

Dushi was out of sight the 14.74% of the time.

Number of occurrences of points events – Dushi

Behaviour	Nº of occurrences
Aggression towards object	6
Flight	1
Avoidance	0
Aggression towards human	0
Mock Charge – Agent	2
Mock Charge – Recipient	0
Vocalizations	4
Jawing	0
Pawing – Agent	6
Pawing – Recipient	1
Charge	0
Fight	0

All the behaviours except of "avoidance" present the same number of occurrences observed when the whole study period was taken into consideration. (Table 5 and Table 8)
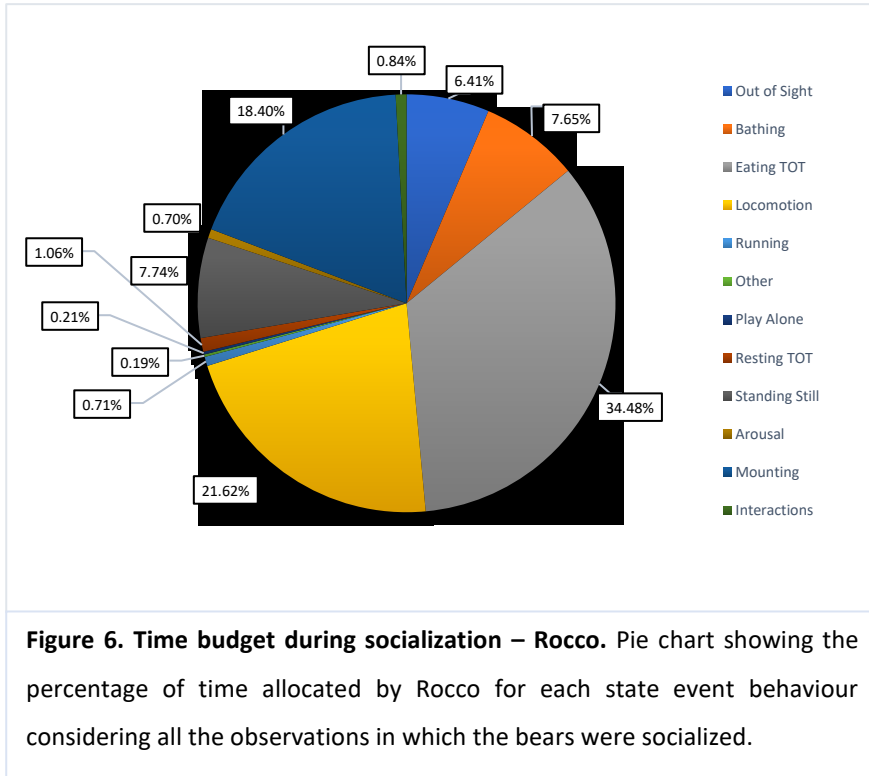
Table 5. Number of occurrences of points events – Dushi. Table containing the number of occurrences of the point event behaviours performed by Dushi considering all the observations in which the bears were in two different enclosures.

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5.2 Time budget during socialization

Rocco

Figure 6. Time budget during socialization – Rocco. Pie chart showing the percentage of time allocated by Rocco for each state event behaviour considering all the observations in which the bears were socialized.
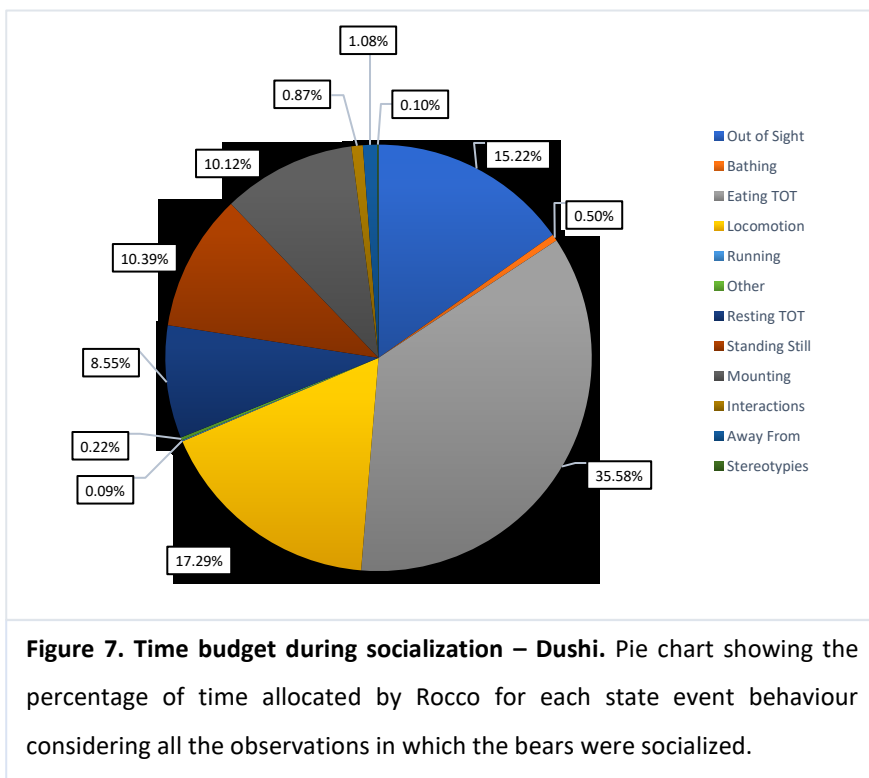
Activity behaviours (64.86%) (eating 34.48%; locomotion 21.62%; play alone 0.21% bathing 7.65%; other 0.19%; running 0.71%)

Among the affiliative social interaction (19.93%) the majority is represented by mounting (18.40%), with a small percentage of interactions (0.84%) and arousal (0.70%).

Inactivity behaviours (8.8%) included standing still (7.74%) and resting (1.06%). Out of sight (6.41%) (Figure 6)

Dushi

Figure 7. Time budget during socialization – Dushi. Pie chart showing the percentage of time allocated by Rocco for each state event behaviour considering all the observations in which the bears were socialized.

Activity behaviours (53.68%) (eating 35.58%; locomotion 17.29%; bathing 0.50%; other 0.22%; running 0,09%)

Among the affiliative social interaction (10.98%) the majority is represented by mounting (10.12%), with a small percentage of interactions (0.87%).

Inactivity behaviours (18.94%) standing still (10.39%), and resting (8.55%). Out of sight (15.22%). (Figure 7)

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Number of occurrences of points events – Rocco and Dushi

| Behaviour	Nº of occurrences	
	Rocco	Dushi
Aggression towards object	0	0
Flight	0	0
Avoidance	0	8
Aggression towards human	0	0
Mock Charge – Agent	0	0
Mock Charge – Recipient	0	0
Vocalizations	0	0
Jawing	0	0
Pawing – Agent	0	0
Pawing – Recipient	0	0
Charge	0	0
Fight	0	0

The number of occurrences of the point events reflects what was stated in the previous table.

No events were recorded with the sole exception of 8 avoidance behaviors from Dushi. (Table 6)

Table 6. Number of occurrences of point events – Rocco and Dushi. Table containing the number of occurrences of the point event behaviours performed by Rocco (left) and Dushi (right) considering all the observations in which the
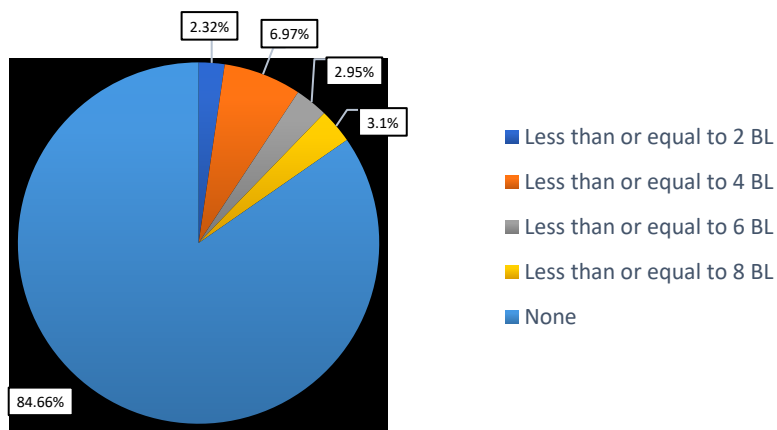
5.3 Comparison among the eating behaviour's modifiers
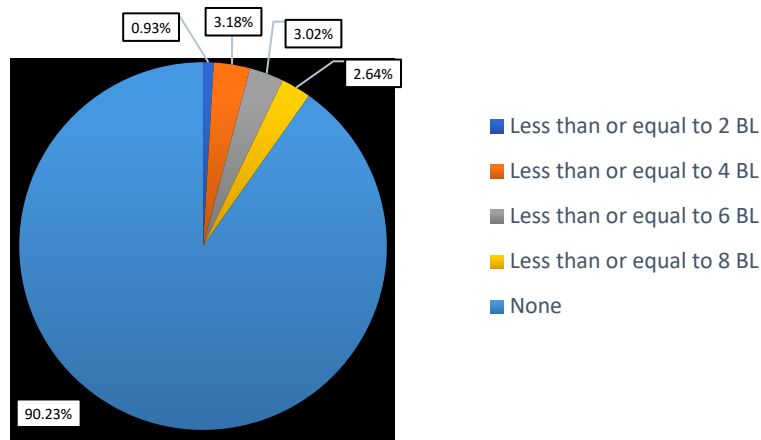
Figure 8. Comparison among the eating behaviour's modifiers. Pie chart showing the comparison among the eating behaviour's modifiers considering all the observations up until the day the bears were put together for the first time.

Although the around the 90% of the time was spent eating far from each other (no modifier), it is possible to see that the second largest percentage is the modifier "less than or equal to 4BL" (3.18%). (Figure 8)

The % of 6BL and 4 BL are very close.

5.4 Comparison among the resting behaviour's modifiers

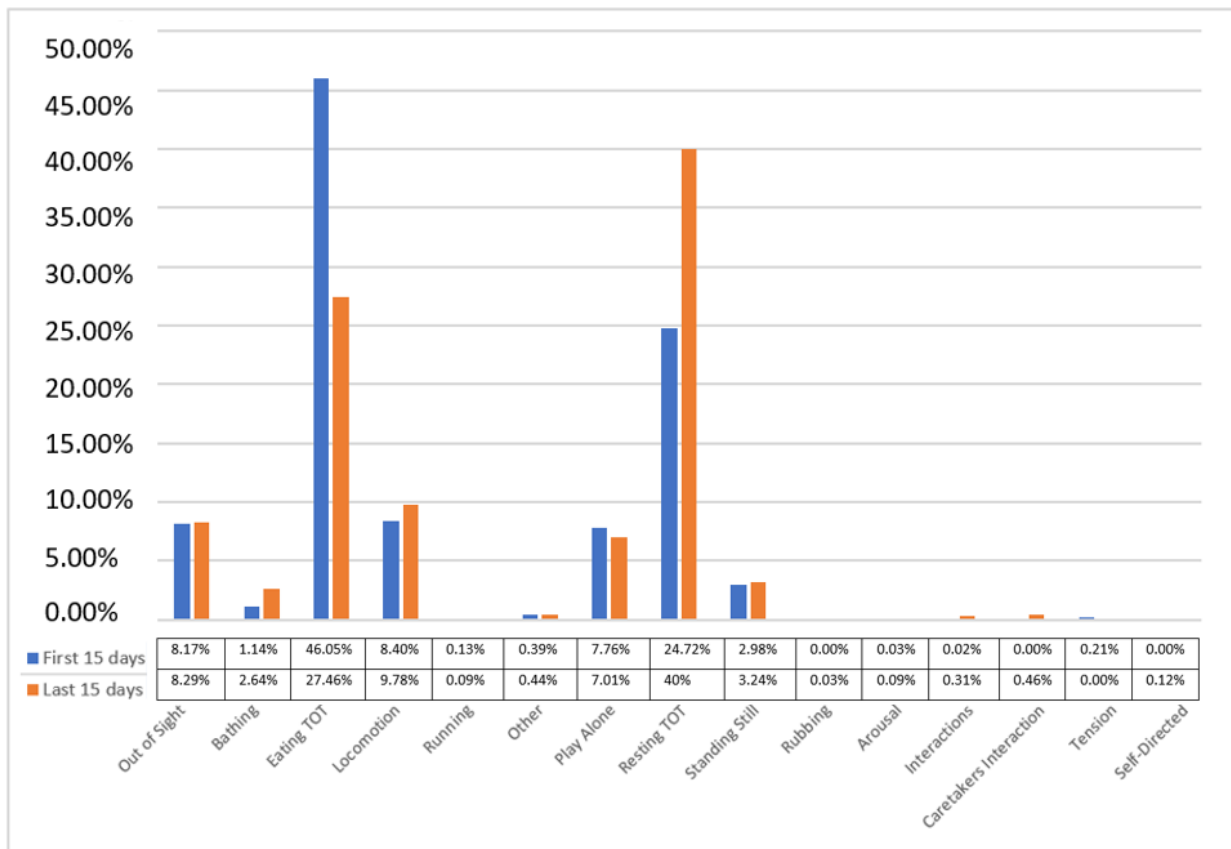**Figure 9. Comparison among the resting behaviour's modifiers**. Pie chart showing the comparison among the resting behaviour's modifiers considering all the observations up until the day the bears were put together for the first time.

Also for the resting behaviour the largest amount of time is spent resting far from each other (84.66%), but the next bigger percentage belongs to the "less than or equal 4 BL" (6.97%). (Figure 9)

5.5 All behaviours comparison between two timeframes

Rocco

	Out of Sight	Bathing	Eating TOT	Locomotion	Running	Other	Play Alone	Resting TOT	Standing Still	Rubbing	Arousal	Interactions	Caretakers Interaction	Tension	Self-Directed
First 15 days	8.17%	1.14%	46.05%	8.40%	0.13%	0.39%	7.76%	24.72%	2.98%	0.00%	0.03%	0.02%	0.00%	0.21%	0.00%
Last 15 days	8.29%	2.64%	27.46%	9.78%	0.09%	0.44%	7.01%	40%	3.24%	0.03%	0.09%	0.31%	0.46%	0.00%	0.12%

Figure 10. All behaviour comparison between the two time frames – Rocco. Histogram showing the comparison between the behaviours performed by Rocco during the first 15 days of observation and the last 15 days before the bears were put together for the first time.
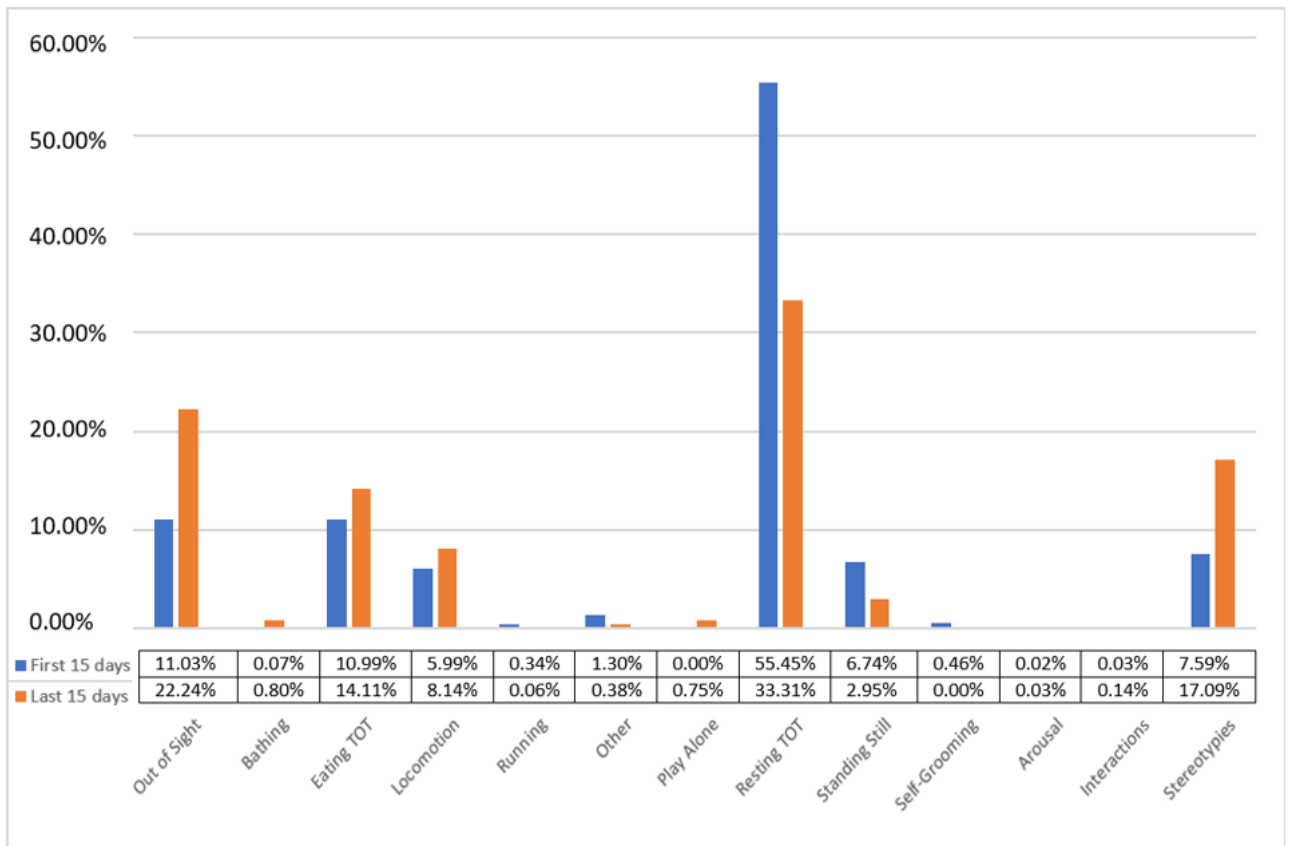
Some of the behaviours appear to increase from the first to the last 15 days: it is the case for out of sight, bathing, locomotion, other, resting, standing still, rubbing, caretakers interaction and self directed. It is interesting to notice how both the behaviours from the "affiliative social interactions" are higher in the last 15 days. Arousal went from 0.03% to 0.09%; interactions went from 0.02% to 0.31%.

On the other hand, some behaviours appear to be less predominant in the last 15 days, this is the case for eating, running and play alone.

Moreover, from the agonistic interaction without contact, the tension behaviour, that is initially present the 0.21% of the time, went down to 0%. (Figure 10)

We cannot state that the difference between the two time frames is statistically significant because of the lack of inferential statistics.

	Out of Sight	Bathing	Eating TOT	Locomotion	Running	Other	Play Alone	Resting TOT	Standing Still	Self-Grooming	Arousal	Interactions	Stereotypies
■ First 15 days	11.03%	0.07%	10.99%	5.99%	0.34%	1.30%	0.00%	55.45%	6.74%	0.46%	0.02%	0.03%	7.59%
■ Last 15 days	22.24%	0.80%	14.11%	8.14%	0.06%	0.38%	0.75%	33.31%	2.95%	0.00%	0.03%	0.14%	17.09%

Figure 11. All behaviour comparison between the two time frames – Dushi. Histogram showing the comparison between the behaviours performed by Dushi during the first 15 days of observation and the last 15 days before the

In this case it is possible to observe a different set of behaviours increasing in the last 15 days: out of sight, bathing, eating, locomotion, play alone and stereotypies.
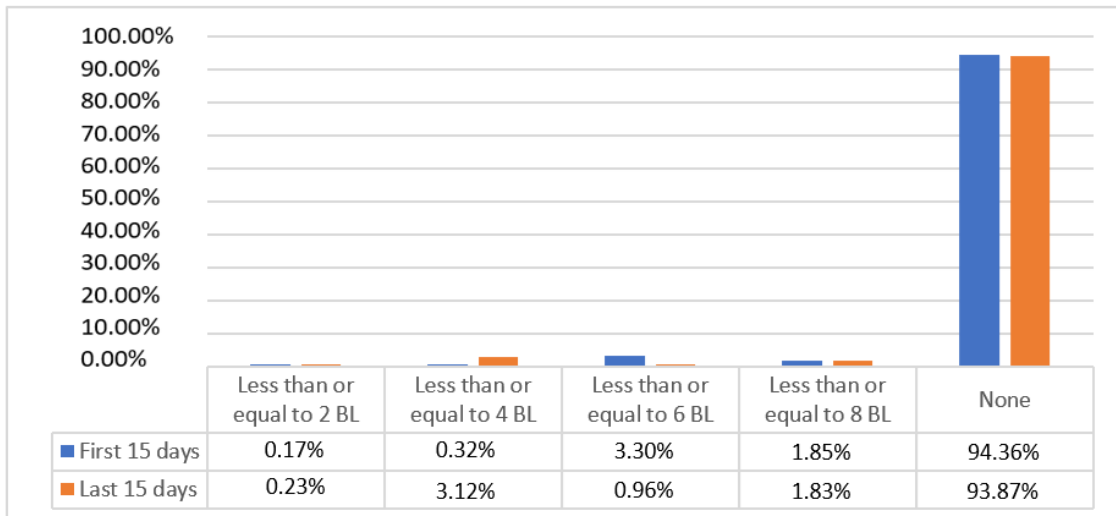
Among the "affiliative social behaviours", arousal slightly increases from 0.02% to 0.03%; Interaction starts from 0.03% and goes up to 0.14%.

interesting is the increase of stereotypies from 7.59% to 17.09% and decrease of resting from 55.45% to 33.31%.

Behaviours that instead were performed less in the last 15 days are: running, other, resting, standing still, self-grooming. (Figure 11)

We cannot state that the difference between the two time frames is statistically significant because of the lack of inferential statistics.

5.6 Eating and resting behaviours' modifiers comparison between two timeframes

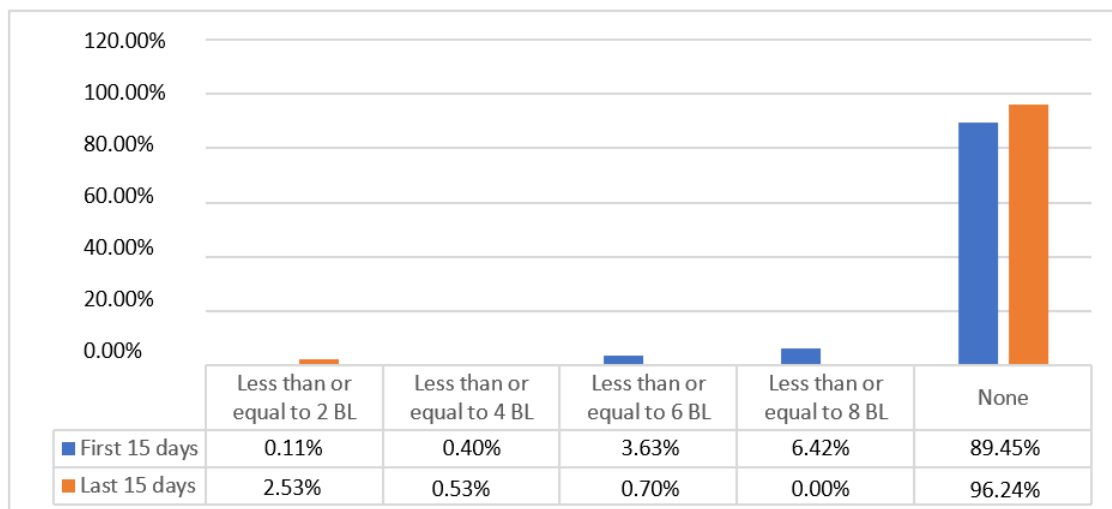|	Less than or equal to 2 BL	Less than or equal to 4 BL	Less than or equal to 6 BL	Less than or equal to 8 BL	None
First 15 days	0.17%	0.32%	3.30%	1.85%	94.36%
Last 15 days	0.23%	3.12%	0.96%	1.83%	93.87%

Figure 12. Eating behaviours' modifiers comparison between two timeframes. Histogram showing the comparison between the eating behaviour's modifiers during the first 15 days of observation and the last 15 days before the bears were put together for the first time.

It is interesting to notice how the modifiers expressing a higher proximity between the animals, got higher in the last 15 days. modifier 2 went from 0.17% to 0.23% and modifier 4 went from 0.32% to 3.12% in the case of eating (figure 12); for the resting modifier 2 went from 0.11% to 2.53% and modifier 4 went from 0.40% to 0.53%. (figure 13)

The amount of time spent by the bears apart from each other reduced slightly, from 94.36% to 93.87% in the case of eating. (Figure 12) It appears to be the opposite for resting, with an increase in the time spent apart (from 89.45% to 96.24%) (Figure 13)
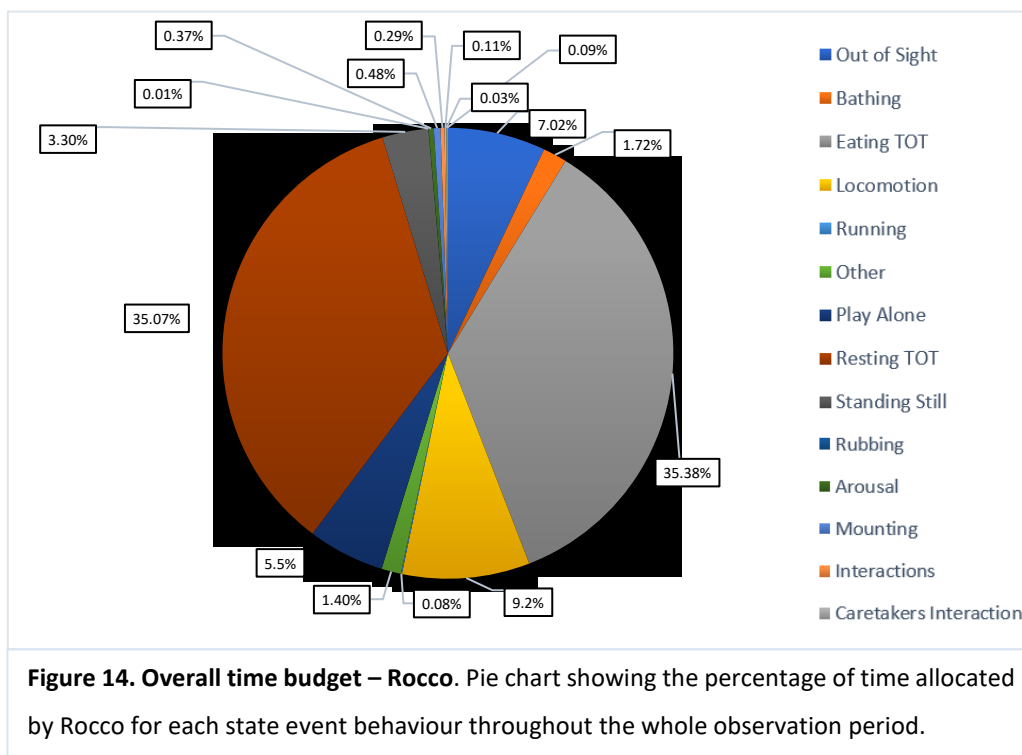
We cannot state that the difference between the two time frames is statistically significant because of the lack of inferential statistics.

	Less than or equal to 2 BL	Less than or equal to 4 BL	Less than or equal to 6 BL	Less than or equal to 8 BL	None
First 15 days	0.11%	0.40%	3.63%	6.42%	89.45%
Last 15 days	2.53%	0.53%	0.70%	0.00%	96.24%

Figure 13. Resting behaviours' modifiers comparison between two timeframe Histogram showing the comparison between the resting behaviour's modifiers during the first 15 days of observation and the last 15 days before the bears were put together for the first time.

5.7 Overall time budget

Rocco

Figure 14. Overall time budget – Rocco. Pie chart showing the percentage of time allocated by Rocco for each state event behaviour throughout the whole observation period.

Rocco allocated the vast majority of time (53.23%) to behaviour under the "activity" category which includes locomotion (9.15%), play alone (5.50%), bathing (1.72%), other (1.40%), running (0.08%), and eating, the latter having the highest percentage (35.38%).

Digging is also part of this category, but was not observed at all.

The second more abundant portion of time (38.37%) was spent performing inactivity behaviours such as standing still (3.30%) and resting which is the more predominant, with 35.07% being almost equal to the time spent eating.

The affiliative social interactions, mounting (0.48%), arousal (0.37%), interaction (0.29%), caretaker interaction (0.11%) covered a 1.25% of the time; from this category the "play together" and "allo-grooming" behaviours were not observed.
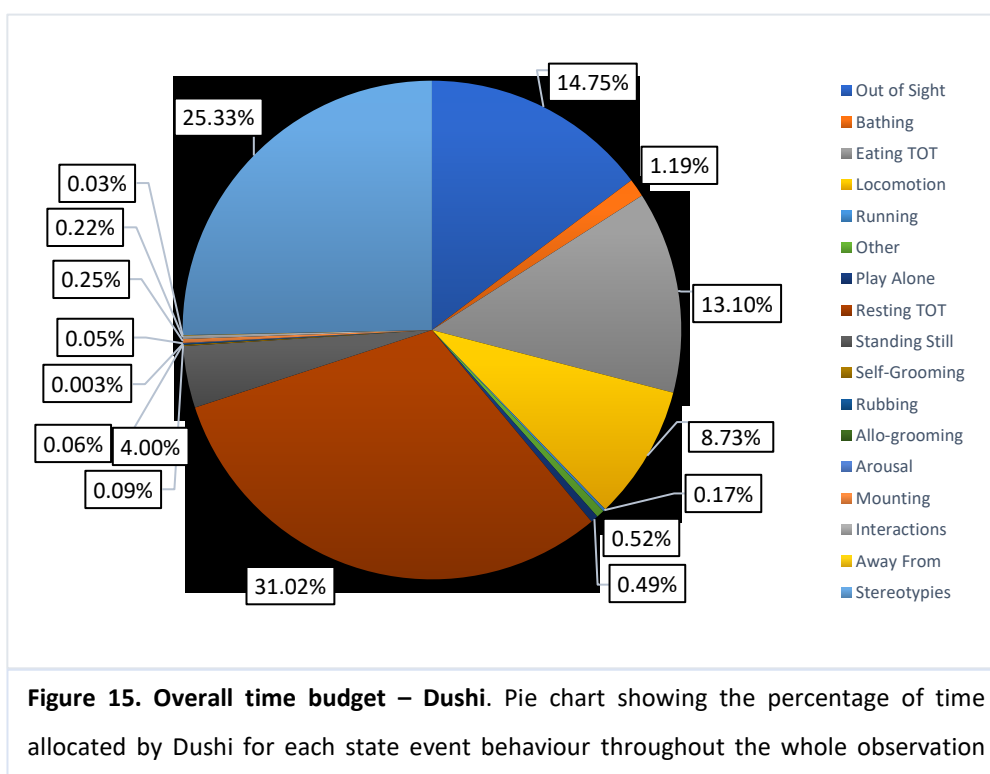
The self-directed behaviour, the only one recorded among the abnormal behaviours, occupied the 0.09% of the time.

A small percentage (0.03%) of the "agonistic interaction without contact" category was recorded, represented solely by the "tension" behaviour.

The maintenance behaviours occupy a very short amount of time, only a 0.01% of rubbing.

Out of sight (7.02%) (Figure 14)

Dushi

Figure 15. Overall time budget – Dushi. Pie chart showing the percentage of time allocated by Dushi for each state event behaviour throughout the whole observation

The greatest amount of time spent by Dushi was on inactivity behaviours (35.02%), with resting being the most present (31.02%), followed by and standing still (4.00%).

Following inactivity, a 25.33% of the time was occupied by stereotypies, only behaviour performed by Dushi under the category of the abnormal behaviours.

Almost the same percentage can be observed for the activity category (24.20%), including all of them except for digging: eating (13.11%), locomotion (8.73%), bathing (1.19%), other (0.52%), play alone (0.49%) and running (0.17%).

The affiliative social interaction represents the 0.52%, including mounting (0.25%), interactions (0.22%), arousal (0.05%) and a very small percentage of allo-grooming (0,003%). "Play together" and "Caretaker interaction" were not recorded.

Dushi performed both self-grooming (0.09%) and rubbing (0.06%) as part of the maintenance behaviours (0.15%).

The "agonistic interaction without contact" is the less abundant category (0.03%), among the two possible behaviours, no "tension" was recorded, but "away from" was performed.

Out of sight (14.75%). (Figure 15)

Number of occurrences of point events – Rocco

Behaviour	Nº of occurrences
Aggression towards object	35
Flight	1
Avoidance	0
Aggression towards human	0
Mock Charge – Agent	3
Mock Charge – Recipient	0
Vocalizations	0
Jawing	0
Pawing – Agent	2
Pawing – Recipient	0
Charge	0
Fight	0

Many of the point event behaviours were not performed at all, and for the few that were recorded the amount is extremely low with 3 mock charges as agent, 2 pawing as agent and only one flight.

A predominance can be seen in the "aggression towards object" behaviour, with 35 occurrences. (Table 7)

This behaviour was almost entirely represented by the bear shaking the sliding door.

Table 7. Number of occurrences of point events – Rocco
Table containing the number of occurrences of the point event behaviours performed by Rocco throughout the whole observation period

Number of occurrences of point events – Dushi

Behaviour	Nº of occurrences
Aggression towards object	6
Flight	1
Avoidance	8
Aggression towards human	0
Mock Charge – Agent	2
Mock Charge – Recipient	0
Vocalizations	4
Jawing	0
Pawing – Agent	6
Pawing – Recipient	1
Charge	0
Fight	0

Dushi performed a various range of point event behaviours, which belong mostly to the "agonistic interactions without contact" category.

The most abundant behaviour is avoidance, but its presence is not much superior of the one of the other behaviours. (Table 8)

Table 8. Number of occurrences of point events – Dushi.
Table containing the number of occurrences of the point event behaviours performed by Dushi throughout the whole observation period

5.8 All events

During the whole observation period, only one behaviour was recorded outside of the standard observation timeframe, as part of the category "agonistic interactions with contact".
A quick fight erupted having Rocco as an agent; it occurred on the 6th of July at 16:22. The bears separated on their own and none of them got injured

6. DISCUSSION

In this study it was possible to apply a working ethogram and verify its efficacy in evaluating the compatibility between two individuals.
Through the observations it was possible to notice that affiliative social interactions were happening between the individuals, and that they were present in a higher percentage compared to the agonistic behaviours.

The choice of assigning modifiers to the behaviours "eating" and "resting" revealed itself very useful in recording the proximity of the bears while performing such behaviours, as they are important to test the animal's compatibility (Giovanni quintavalle pastorino, 2017).

The modifier "agent" and "receiver" on the agonistic interactions was crucial to be able to record them as many times as possible: without modifier "receiver" if the bear observed received, for example, a pawing, it would have not been possible to note it down, and the occurrence would have been lost.

All the agonistic behaviours performed or received by a bear not involved in the study were noted unter "other", not to distort the data.

Some of the behaviours, such as play together, jawing and charge were not recorded at all during the whole study period, but they must be included anyway as they are relevant in a socialization study.

The data collected on location were not analysed in this study, but they could be useful to determine the amount of time spent by the bears in proximity, rather than far from each other.

It is important to distinguish though, the moments in which the bears were close or far from each other reasons, such as husbandry practices. Therefore, those data are valuable only in case the animals had an actual choice to stay close to/far from the other individual.

Overall, the distribution of time spent in each behavior category aligns with findings from other studies. There is a noticeable predominance of both active and inactive behaviors, a relatively low percentage of time dedicated to maintenance behaviors, and a significant presence of stereotypic behaviors (S. Montaudouin, G. Le Pape, 2005).

The time allocated by the animals to eat and rest in close proximity to each other increased as time passed, as well as an increase in affiliative interaction and a reduction in agonistic ones, showing a gradual acclimatization of the animals to each other.

Comparing the tables present in sections 5.1 and 5.2 regarding the occurrences of point events it is possible to observe that during the pre-socialization period no avoidance was performed by Dushi, behaviour instead observed as the bears were socialized.
On the other hand, "pawing" was performed only through the gate, in phase 1.

In section 5.3, the comparison between eating behaviour's modifiers, it is interesting to observe that the second largest percentage is the modifier "less than or equal to 4 BL" (3.18%), showing that the bears were comfortable in eating in proximity to each other.

Due to the enclosure design it was unavoidable to provide visual, olfactory, and limited tactile contact at the same time, although it would be desirable to add the tactile contact only in a second phase (David M. Powell, 2010). Other studies were performed in which the process was the same: to introduce male maned wolves, *Chrysocyon brachyurus*, to their pups, the males and pups were given visual, olfactory, and limited tactile contact simultaneously. No aggression from the males was seen during this stage, and all the females remained calm (Bestelmeyer 1999).

Dushi was given time to explore the enclosure and she was the one occupying it when the socialization started. This was optimal as it is better that when introducing submissive individuals to a new conspecific, it is preferable for the introduction to take place in the non-dominant animal's enclosure rather than the reverse. For example, among felids, it has been observed that males thend to be aggressor during an introduction, rather than females; thus, some zoo biologists suggest that physical introductions take place in the female's cage, giving her some advantage (Andrews 1998).

During the socialization period the time spent by the bears together was gradually increased, as initial full- contact introductions should be short in duration, and it would be ideal to end the session in a positive way

Subsequent sessions can be longer based on the responses of the animals, but introduction sessions should happen consistently, as even short delays can set the process back.

Animals should not be housed together overnight until there is consistently positive interaction between them during multiple all-day encounters, and both animals seem comfortable with one another and the environment. All individuals should be eating and resting normally before they are housed together overnight (Andrews 1998).

The bears were fed prior the socialization and even more low-value food was spread in the enclosure to let the bears engage in foraging and gradually test their compatibility around food. Moreover, being satiated during an introduction may decrease the likelihood of aggression (David M. Powell, 2010).

On the third day of socialization, as the animals were comfortable around each other, there was the decision to make a step further in the process and feed the bears, together with their normal ration, also some high value food. This led to a conflict between the two bears: a quick fight erupted, it lasted a couple of seconds, and the bears separated by themselves. There were no visible injuries reported on the bears, but the choice was to end the socialization for the day.

Although the animals seemed comfortable with one another, it is important to progress very slowly to lower the risk of setbacks (David M. Powell, 2010).

After the fight the bears were socialized the following day, but for a shorter amount of time and no high-value food was involved.

Because of the behaviours observed in the animals, a particularly intense monitoring and management was needed. Because there was to some extent, an unforeseen lack of human resources at that time, the decision was taken that it'd be too risky to leave them together without an intense monitoring and management and the project was stopped for the year.

In the days the bears were socialized the most predominant affiliative behaviour was mating, and no "play together" was performed at all. This is coherent with the fact that brown bears are solitary animals that meet only during the mating season (Murie, 1985).

Due to different complications, the socialization project got delayed and the mating season was over, this factor could have accentuated the incompatibility of the pair.

7. LIMITATION OF THE STUDY

The study was performed in a real setting not in laboratory; therefore, a lot of variables must be taken into considerations.

Some unexpected events occurred: during the period of the study, the natural canal that cuts through the sanctuary got infected by an algae. For safety some of the animals were moved from their enclosures and for a short amount of time Rocco and Dushi could not interact.
A similar situation presents anytime an enclosure cleaning takes place as the bears are moved and forced apart, making it impossible to record behaviours valuable in the context of socialization, such as eating and resting in proximity to each other.
The water incident overall delayed the socialization process, resulting in the wrong timing, as the mating season was ending.

The amount of out of sight can be justified by the extensive dimension of the enclosures, as well as their designs.
The lack of personnel was a major issue as it was not possible to have caretakers fully dedicated to the socialization, since it would have not been possible otherwise to carry out the routine husbandry practices.

8. CONCLUSION

Independently of the socialization outcome, this study aimed to apply the working ethogram and test its efficacy.

The experience gained during this study was very important for planning future socialization studies, giving valuable information about suitable timing, amount of resources, amount of personnel and amount of structured planning needed.

Nonetheless, the working ethogram applied, proved itself useful to analyse the duration of time spent on each behaviour as well as the presence of affiliative or agonistic interactions and relevant occurrences, like the proximity of the bears while eating or resting.

The efficacy of the ethogram may vary according to the setting, but it proved to be a reliable tool that can be applied for future socialization studies in captive conditions.
In fact, thanks to the data gathered during the observations time it was possible to monitor and record agonistic behaviours as well as the affiliative ones, in both of the phases of the socialization.

This was crucial in phase 1, as it allowed to test the animals' compatibility and take the decision to socialize the bears safely, reducing as much as possible negative outcomes.

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