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JZAR Research article

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Research article

Investigating the effect of social grouping on the behaviour of captive leopards

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Keywords: activity budget, Electivity index, felid, *Panthera pardus,* sociality

Article history:
Received: 12 Jun 2020
Accepted: 23 Apr 2021
Published online: 30 Apr 2021

Abstract

Big cats are both popular and well represented in zoological collections worldwide, and there is considerable interest in evidence-based studies to develop best practice husbandry guidelines. The majority of big cat species, including the leopard *Panthera pardus* are typically solitary in the wild, whereas in zoos they are sometimes maintained as pairs or larger groups. This study investigates the behaviour of six leopards housed as a trio, a pair, and singleton in the Parco Faunistico Valcorba, Italy. Behavioural data were collected using instantaneous focal sampling at one-minute intervals with continuous recording for events, and Electivity Index was used to assess the use of each enclosure zone by individual leopards. Poisson regressions were used to determine whether individual leopard, weather and decibel levels were predictors of behaviour change. Overall, the Poisson regressions were significant for all behaviours except allogrooming. Both affiliative and aggressive behaviours were observed most frequently in the recently mixed trio, and these were often initiated by the male. By contrast, the pair of leopards rarely interacted with one another.

Irrespective of condition, leopards tended to overutilize a few key zones in their exhibits and did not use their enclosures evenly. However, there were differences in zone overlap: the pair housed leopards appeared to use different zones to one another, whilst the trio of leopards appeared to use similar zones. These data suggest that group housing may be a viable housing strategy for leopards, provided that the animals are given the opportunity to avoid each other should they choose to do so. However, personality and compatibility of leopards is likely to be a confounding factor that must be considered when developing group-housing husbandry strategies. Further studies with a focus on group housing of other felid species would be valuable to evidence-base their captive husbandry.

Introduction

Billions of animals are maintained under captive or semi-captive conditions, and the Felidae family are particularly well represented, both as pets and in zoological collections globally (Mason 2010; Kroshko et al. 2016). Big cats feature prominently in the marketing and collection plans of many zoos, and four of the public's top 10 most charismatic animals were big cats (Courchamp et al. 2018). The majority of species in the *Panthera* Genus are well studied, particularly with regards to behaviour and the impact of enrichment (Lyons et al. 1997; Miller and Kuhar 2008). However, some felid species and some topics, notably sociality, would benefit from further research.

With the exception of lions Panthera leo, big cats are generally described as being solitary in the wild (Dunston et al. 2017). In order to maintain a sustainable food source, individuals must defend a territory (Breton and Barrot 2014). However, territory size is associated with prey density: locations with high prey density may support a higher concentration of big cats, each occupying a smaller-than-average territory (Mosser and Packer 2009). Conversely, some big cats, such as the Amur tiger *Panthera tigris tigris*, are found in regions where prey is widely

Table 1. Study subjects.

Housing	Name	Gender	Date moved into collection	Colour
Trio	Arturo	Male	Jun 2013	Spotted
	Katie	Female	Jan 2016	Spotted
	Noemi	Female	Jan 2016	Spotted
Pair	Sharon	Female	Jan 2014	Spotted
	Ulap	Female	Jan 2014	Spotted
Single	Pasquale	Male	Jan 2016	Melanistic

distributed, necessitating extensive territory sizes (De Rouck et al. 2005). Thus, the development of a largely asocial lifestyle may be related to the availability of prey.

Stander at al. (1997) studied wild leopards *Panthera pardus* in Namibia and identified that there was considerable overlap in home ranges. On average, the overlap in home ranges between males was 46%, and for females was 35%. This may suggest that opportunities for interaction between individuals may occur more frequently in the wild than previously assumed. Pirie et al. (2014) also observed positive social interaction occurring between adult male leopards and related individuals in the wild. This may suggest that captive big cats have a greater capacity for social behaviour than previously assumed.

The maintenance of big cats in captivity has not always been informed by their social behaviour. For example, early menageries and zoos often maintained big cats in pairs, with the assumption that this would encourage breeding. For some species, notably the cheetah *Acinonyx jubatus,* this may have actually prevented breeding, owing to the natural history of the species (Marker and O'Brien 1989). Modern zoos now use a more ethologically informed approach to big cat management by keeping these animals in groups that roughly match their wild social groupings (Breton and Barrot 2014). However, due to limitations in enclosure space or due to breeding success, big cats may sometimes be maintained in unnatural social groupings (Mallapur and Chellam 2002; Mallapur et al. 2002). For example, groups of adolescent big cats may be maintained together while arrangements are made for them to be sent to other collections. Similarly, zoos may need to house single-sex groups of big cats in order to prevent breeding. These groupings may affect the behaviour of big cats, particularly if individuals are trying to establish territories within their exhibits (Metz et al. 2017).

The leopard is well represented in zoos: a search of the Zoological Information Management System (ZIMS) (Species360 2021) revealed a minimum population of 940 individuals globally. Wild leopards are described as asocial (Stander et al. 1997), though some social behaviour has been documented in the wild. While many zoos maintain leopards in solitary conditions, some collections house two or more individuals in a shared exhibit, and some social groupings appear to be successful (Mallapur et al. 2002). For example, research by Miller and Kuher (2008) suggest that another solitary big cat, the tiger, was able to adapt to a single-sex group-housing situation. Given their prevalence in captivity and the queries surrounding their sociality, both in the wild in captivity, *P. pardus* presents an interesting subject for behaviour studies. An opportunity arose to study zoo-housed leopards under three different housing conditions in the same zoological collection, allowing empirical data to be collected on effects of social housing on behaviour.

Methods

Subjects

Before data collection took place, the project was ethically reviewed and accepted by the University of Milan Ethics committee. The study group consisted of six (2.4) adults leopards housed at Parco Faunistico Valcorba in Italy (Table 1). Two females (Ulap and Sharon), though originally confiscated from a private collection, were longer-term residents of the park, and were housed in a shared exhibit. A single melanistic male (Arturo) was also housed singly in an exhibit. In January 2016, a further three leopards became available following confiscation from a private collection (Katie, Noemi and Pasquale). The male, Pasquale, was maintained in a single exhibit, and the females were mixed with Arturo. Leopards were locked into the indoor exhibits during the night from 06.00 until 18.00, and were given access to all parts of the enclosure except the house during visitor open hours (from 09.30 until 17.00).

Table 2. Ethogram of state behaviours for the leopards observed in the study. Ethogram was adapted from Stanton et al. (2015).

Behaviour	Description
Inactive	Leopard is stationary. Eyes may or may not be closed.
Locomotion	Leopard is moving around the enclosure. Behaviour may include running, walking, climbing or pacing.
Feeding	Leopard used paws, tongue and teeth to insert food into mouth and chew.
Grooming	The leopard licks its own fur.
Allogrooming	The leopard licks the fur of a conspecific.
Vigilance	The leopard is stationary, with eyes open and surveys its enclosure, visitors or conspecifics.
Out of sight	The leopard is not visible to the observer or camera.

Behavioural observations

Behavioural observations were undertaken by one of the authors (EC), and took place from 28 July to 3 November 2016. Behaviour was observed between 10.00 and 19.30. Observations were undertaken on all six leopards and consisted of instantaneous focal samples at 60-sec intervals for 1-hr observation periods (Martin and Bateson 2007). The choice of leopard for observation was determined using a random number generator (1–6), with each individual being removed from selection once observations had taken place, to ensure all individuals were observed equally. Each leopard was observed for 30 hr overall.

Weather conditions were also recorded (as identified on World Weather Online 2021). Noise (from visitors or vehicles) was recorded using a Meterk 30-130dB(A) LCD Noise Meter. An ethogram was developed using Stanton et al.'s (2015) and Quintavalle Pastorino et al.'s (2017b) ethograms. State behaviours were later condensed into six generic categories, and Out of Sight (see Table 2). Continuous sampling for event behaviours focussing on aggressive and affiliative social behaviours was also conducted during observations (Table 3).

During behavioural observations, proximity data were also collected for the socially housed leopards. Data were collected at 60-sec intervals for 1-hr observations; the leopards were either classified as being in body contact, being within one, two or three body lengths of one another, or not being within close proximity. Body lengths were chosen as the measure of proximity because they could be more accurately assessed in the field.

Enclosure use

During each observation, the location of each leopard was recorded using focal sampling at 1-min intervals. Each leopard enclosure was divided into 10 zones of unequal sizes (see Figures 1 and 2, and Table 4) based on their substrates and distance from visitor viewing areas. The size of each zone was assessed by mapping the exhibit using an aerial view from Google Earth Pro™ 2019 (see Table 4). For analysis, the use of each zone was analysed

Table 3. Ethogram of event behaviours for the leopards observed in the study. Ethogram was adapted from Stanton et al. (2015).

Behaviour	Category	Description
Bare teeth	Aggressive	Animal opens its mouth and pulls the lips back, exposing its teeth
Bite	Aggressive	Snap teeth in response to another leopard. The individual makes contact with the other leopard using its mouth.
Chase	Aggressive	Runs after conspecific or other individual or object.
Fight	Aggressive	Individual uses claws and teeth to aggressively attack another individual. Fight may also be accompanied by growling or hissing.
Hiss	Aggressive	A drawn-out, low-intensity hissing sound produced by rapid expulsion of air from the cat's mouth, usually during exhalation.
Growl	Aggressive	A low-pitched, throaty, rumbling noise produced while the mouth is closed.
Play with conspecific	Affiliative	Initiates interaction with conspecific in a non-aggressive manner. Behaviour may include rolling and wrestling.
Prusten	Affiliative	Cat expels jets of air through the nose creating a low-intensity, soft, pulsed sound, described as being similar to the snorting of a horse.
Roar	Aggressive	Long, throaty, high intensity call.
Rub head	Affiliative	Makes contact with the head or body of another leopard or an enclosure object using the muzzle.
Spray	Other	Stands with tail raised vertically and releases a jet of urine backwards against a vertical surface or object.
Yawn	Other	The mouth is opened widely, the head tips back, lips are pulled back so that the teeth are exposed.

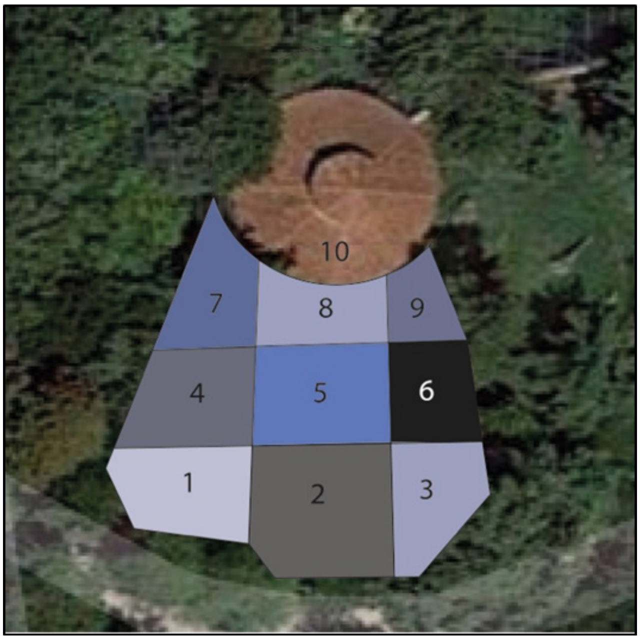

Figure 1. Map of enclosure for the trio of leopards. Image developed using Google Earth Pro™ 2019.

Figure 2. Map of enclosure for the pair of leopards. Image developed using Google Earth Pro™ 2019.

https://doi.org/10.19227/jzar.v9i2.548

Table 4. Enclosure zones and their sizes. Information on the left pertains to the exhibit for the leopard trio, and information on the right is for the pair. The leopards were not given access to the house during zoo opening hours, so this section was excluded from the Electivity index analysis.

Zone	Zone name	Size (m^2)	Within 10m of visitor viewing	Zone	Zone name	Size (m^2)	Within 10m of visitor viewing
1	Water pool	316	No	A	Water pool	189	No
2	Visitor viewing window	653	Yes	B	Visitor viewing window	279	Yes
3	Visitor viewing window	549	Yes	C	Visitor viewing window	208	Yes
4	Middle left zone	278	No	D	Middle left zone	192	No
5	Centre of exhibit	422	No	E	Centre of exhibit with trees	384	No
6	Elevated branches	362	No	F	Elevated branches	252	No
7	Upper left zone	102	No	G	Upper left zone	61	No
8	Central zone near house	387	No	H	Central zone near house	40	No
9	Wooded zone near house	228	Yes	I	Wooded zone near house	270	Yes
10	House	37	No	J	House	37	No
Total		3,354		Total		1,913	

per leopard using Electivity Index (Brereton 2020). Electivity Index is assessed using the following formula:

$$E^* = (Wi - (1 / n))/(Wi + (1 /n))$$

$$Wi = (ri / pi)/(\sum(ri / pi)$$

For this formula, *ri* refers to the observed use of a resource or zone, and *pi* refers to the expected use of a given resource. The letter n denotes the total number of zones or resources available to the study species. Electivity Index values may be used to compare the utilisation of different zones in an exhibit, accounting for differences in their size. Electivity Index generates a value for each zone varying between -1, suggesting underutilisation, or +1 (overutilisation of a resource) (Brereton 2020).

Sociogram

A sociogram was constructed showing the strength of relationships between individuals using time spent in proximity of another leopard (i.e., at body-length or nearer). This was completed by calculating Association Index (AI) values for each relationship, as used by Stander et al. (1997). Possible AI values range from 0 (never seen in proximity) to 1 (always seen in proximity).

$$\text{Association index} = 2N/ (n1 + n2)$$

Where N is the number of times leopards 1 and 2 were seen together (including when around the third leopard), $n1$ is the total number of times leopard 1 was seen (whether alone or with other leopards) and $n2$ is the total number of times leopard 2 was seen (whether alone or with other leopards).

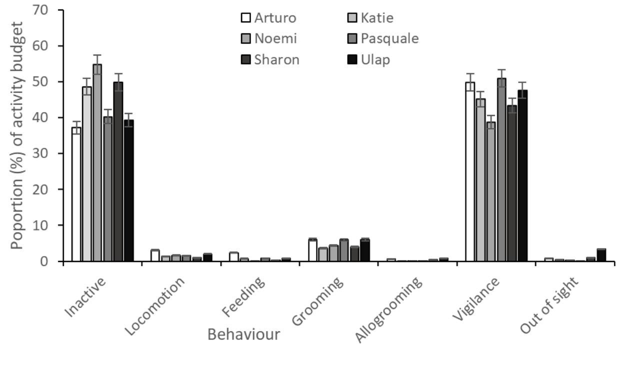

Figure 3. Activity budget, as broken down by individual leopard (+/- standard error).

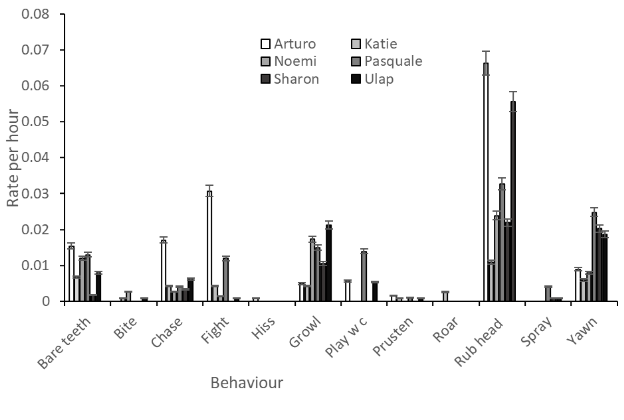

Figure 4. Average number of events per hour observed for each leopard (+/- standard error).

Table 5. Output of Poisson regressions on leopard state behaviour.

Behaviour	r^2	Predictor	DF	X^2	P
Inactive	4.85%	Model	10	158.29	<0.001
		Individual	5	82.77	<0.001
		Weather	4	68.80	0.001
		Max dB	1	10.69	<0.001
Locomotion	5.04%	Model	10	71.19	<0.001
		Individual	5	15.91	0.007
		Weather	4	52.69	<0.001
		Max dB	1	4.33	0.037
Feeding	19.35%	Model	10	101.42	<0.001
		Individual	5	63.68	<0.001
		Weather	4	46.53	<0.001
		Max dB	1	0.05	0.815
Grooming	9.46%	Model	10	218.11	<0.001
		Individual	5	187.73	<0.001
		Weather	4	26.45	<0.001
		Max dB	1	0.5	0.478
Allogrooming	12.83%	Model	10	5.81	0.831
		Individual	5	2.11	0.833
		Weather	4	3.10	0.541
		Max dB	1	0.26	0.607
Vigilance	0.7%	Model	10	38.43	<0.001
		Individual	5	16.8	0.005
		Weather	4	18.20	<0.001
		Max dB	1	2.15	0.142

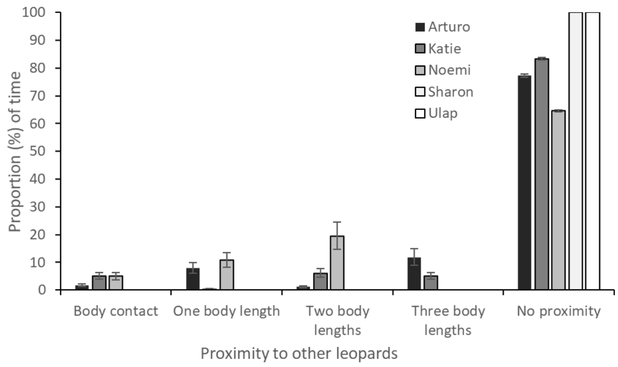

Figure 5. Proximity data for the trio and pair housed leopards (+/- standard error). The trio consisted of Arturo, Katie and Noemi, and the pair were Sharon and Ulap. The term 'Body contact' indicates that the leopard was touching at least one other leopard during the observation.

Data analysis

Data were collated using Microsoft Excel 2013™, and were analysed using Minitab, version 18. State behavioural data were converted into activity budgets for each leopard, and the average number of occurrences per behaviour were generated for events.

Using the raw data, Poisson regressions were run on the counts of state and event behaviours per hour. The weather condition (as per World Weather Online 2021) and individual leopard were included as categorical predictors, and the max decibel level recorded per hour was included as a continuous predictor. The social grouping (trio, pair or singleton) was not included due to its multicollinearity with individual leopard.

For enclosure use, Electivity Index values per zone per animal were generated and were tested for normality. The expected values for each zone were generated by taking the size of each zone, dividing these by the total size of the exhibit and then multiplying by the number of observations conducted for a specified animal. These were compared, using Chi squared test for independence, against the observed number of uses of each zone for each animal.

Results

Behaviour

In order to compare the activity budgets of the trio, pair and single conditions, the means for behaviours were generated for the trio and pair of leopards, respectively. A comparative activity budget was developed to demonstrate how activity patterns differed between the three conditions (Figure 3).

The Poisson regressions were significant for all state behaviours except for allogrooming (Table 5). However, the models, explained only a limited amount of variance in behaviour, with most models explaining between 0.7 and 12.83% of behaviour. The exception was the Poisson regression for feeding, which explained 19.35% of variance in behaviour.

A comparative graph was also developed to illustrate differences in the frequency of event behaviours that were observed between the three conditions (Figure 4). The frequencies were calculated by omitting the out of sight category; the frequency of events was calculated as an average frequency per leopard per hour.

For statistical analysis, all affiliative and aggressive behaviours were pooled, and the Poisson regressions were run on the pooled results. The models for both aggression and affiliative behaviour were significant, with the regression for aggression and affiliation explaining 11.03 and 5.49% of behavioural variance, respectively (Table 6).

Table 6. Output of Poisson regressions on leopard event behaviour.

Behaviour	r^2	Predictor	DF	X^2	P
Aggressive	11.03%	Model	10	394.02	<0.001
		Individual	5	190.4	<0.001
		Weather	4	198.27	<0.001
		Max dB	1	45.51	<0.001
Affiliative	5.49%	Model	10	81.33	<0.001
		Individual	5	69.44	<0.001
		Weather	4	11.13	0.025
		Max dB	1	0.1	0.747

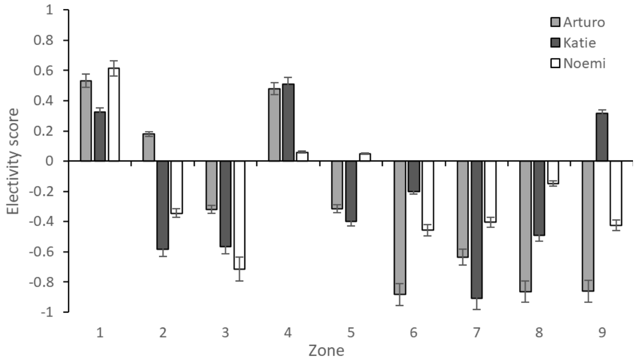

Figure 6. Electivity index graph for the leopard trio enclosure utilisation. A value of 1 indicates overutilization of a zone, and -1 indicates underutilisation of a zone.

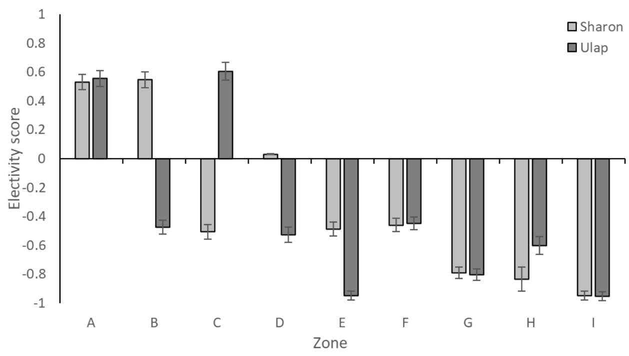

Figure 7. Electivity index graph for the leopard pair's enclosure usage. A value of 1 indicates overutilization of a zone, and -1 indicates underutilisation of a zone.

Enclosure use

Social proximity graphs were developed to show how commonly leopards spent time close together (Figure 5). Electivity Index values were also calculated for both the trio and pair of leopards to demonstrate the proportional use of each zone for each animal (Figures 6 and 7). Chi squared tests for independence were run on the total number of observed uses of each zone per leopard (ri) versus the expected use of each zone based on their size (pi). The trio of leopards all showed significant deviance from expected enclosure use, with Arturo ($X^2(8)=1.74$, $P<0.001$), Katie ($X^2(8)=6.56$, $P<0.001$) and Noemi ($X^2(8)=1.64$, $P<0.001$), showing significant scores. The trio appeared to overutilise similar resources, while some zones, notably 6, 7 and 8, appeared to be underutilised by all individuals.

A Chi squared test for independence was also run on the pair of leopards. Both individuals showed significant deviation from expected values (Sharon ($X^2(8)=1.90$, $P<0.001$) and Ulap ($X^2(8)=2.63$, $P<0.001$) respectively). While both individuals appeared to underutilise some zones including E, F, G, H and I, several zones including B and D appeared to be overutilised by one leopard and underutilised by the other.

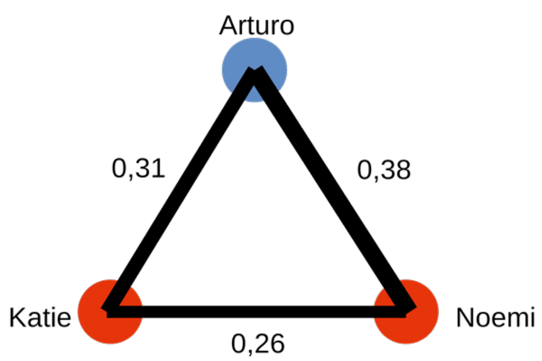

Figure 8. Sociogram showing the association index values for the relationship between leopards housed as a trio.

Sociality

Although sociograms are generally used for larger groups of animals, one is provided here for leopards hosted in a trio to allow visualisation of AI values and the strength of leopard relationships (Figure 8). Higher values indicate a stronger association between two individuals. Relationships between Arturo and the two females were much stronger than the relationship between the females.

Discussion

Overall, the study revealed significant differences in leopard behaviour between social grouping styles for all behaviours apart from allogrooming. For the majority of behaviours, the differences in behaviour were quite slight between individuals. Both aggressive and affiliative interactions occurred most frequently in the trio of leopards.

Behavioural observations

The models for five of the six state behaviours were significant: only the model for allogrooming was not significant overall (Figure 5). However, the effect sizes for behaviour differences were relatively small: while state behaviour was affected by individual, weather and noise, the overall impact was relatively small.

Inactive behaviour is commonly observed in leopards (Mallapur and Chellam 2002), and inactivity levels remained high in the current study. Whilst visitors may sometimes be concerned by inactivity in captive big cats, wild felids also spend long periods of time resting in order to conserve energy (Skokalski et al. 2013). The behaviour therefore does not suggest compromised welfare. Inactivity levels were lowest for the male, Arturo, who had been recently housed with the two confiscated females. His vigilance behaviour was also high.

Additionally, the levels of aggressive and affiliative interactions were highest in the trio of leopards. Head rubbing was frequently seen, as were aggressive behaviours such as chasing and fighting. The recent mixing of individuals may have resulted in the greater frequency of interactions between individuals, alongside lower inactivity levels. It is likely that the new trio were still establishing their interactions with one another, particularly as the females were now housed alongside a male. It should be noted that the male, Arturo, appeared to initiate much of the interaction, with both head rubbing and fighting being observed. By contrast, the pair of females appeared to spend little time interacting with one another. This research shows similarities with the findings of Miller and Kuhar's (2008) long-term study on a group of six cohabiting female tigers, where interactions were highest at the beginning of the 6-year study period. As the animals became more accustomed to sharing space, the behavioural interactions appeared to decrease in their frequency. It is possible that this long-term effect of cohabitation may explain why the level of social interaction between the pair of females appears to be lower. It is likely therefore that interactions may decrease and inactivity levels rise as the trio become more accustomed to one another. However, it does appear that at this early stage, group-housing may have resulted in more active individuals.

While there are several potential confounding factors to the study, including the gender and personality of each individual animal, these data do seem to match the findings of other studies. Research on another solitary felid, the snow leopard *Panthera uncia*, revealed greater activity levels when animals were housed in pairs or groups (Macri and Patterson-Kane 2011), While felids may not live in groups in the wild, group housing may have value for captive animals that no longer have to compete for food resources. Without the need to hunt for food or patrol a territory, extra time might be spent engaged in social interactions with conspecifics, provided they are compatible.

In terms of event behaviours, only growling occurred more frequently for the single-housed than the pair or trio of leopards. As a behaviour, growling is often associated with aggressive or fear-based interactions. In the current study, we did not differentiate between growling directed at keepers and conspecifics, and anecdotal information from keepers suggests that the male regularly growled at keepers. By contrast, growling appeared to occur much less regularly for both the pair and trio of leopards, despite the fact there were conspecifics available to direct this behaviour towards.

Irrespective of the housing type, all leopards appeared to spend relatively little time engaged in locomotor behaviours, with all leopards spending less than 5% on average of their activity budget engaged in walking, running or climbing. These findings show similarities to those of Mallapur et al. (2002), who found that activity levels remained below 8% for animals in enriched enclosures, and less for those in barren exhibits (Mallapur et al. 2002). Inactivity may be a natural behaviour for leopards, particularly during the day, as in many parts of their native range leopards are nocturnal or crepuscular hunters (Ngoprasert et al. 2007). To develop a more holistic overview of leopard activity patterns, behavioural observations at night would be required in addition to zoo opening hours.

Enclosure use and proximity

Electivity Index demonstrates the use of a resource or area in proportion to its overall size, helping researchers to identify zones that have greatest value to animals (Brereton 2020). In order for a zone to be classified as overutilised, it must be used by the animal more times than its size might suggest. The leopard trio overutilised just a few zones, namely zones 1 (water pool area) and 4 (middle left zone), mainly for the purpose of resting. The remaining zones were largely underutilised.

For the trio, preferred zones contained areas for climbing including trees and elevated platforms. From the electivity index, it is not clear that there was a gender-based difference in the use of enclosure zones, as both the male and females appeared to use similar exhibit areas (Macdonald and Loveridge 2010). The overutilisation of similar zones suggests either that these zones contained particularly valuable resources, or that the leopards were choosing to spend time in shared areas.

The leopard trio also appeared to spend a proportion of time in close proximity to one another, spending on average 3.9% of their activity budget sharing body contact, and a further 6.4% of time within one body length of one another. While these proportions are not high, this is interesting to note for an animal that is considered to be solitary in its wild state (Macdonald and Loveridge 2010). Despite this conception of the leopard as solitary in the wild, there is a precedent for wild individuals spending time on proximity to one another. Pirie et al. (2014) observed wild adult leopards and cubs engaging in resting behaviour and interacting non-aggressively with one another. While leopards are often described as solitary, the data from this study suggests they have the capacity to develop associations with conspecifics, or as a minimum, toleration of other individuals in a captive setting (Stander et al. 1997).

By contrast, Electivity Index scores for the pair-housed leopards suggest that the two females actively avoided enclosure zones that were regularly used by the other animal. For example, zones B (visitor viewing area), C (window area) and D (middle left zone) all show overutilisation by one leopard, and underutilisation by the other. Additionally, proximity data for the pair shows that the two individuals were never observed during the day within three body length's proximity of one another. While the two females had shared an enclosure for several years, it is likely that they had adapted their use of the exhibit in order to avoid another; a theory that is supported by the comparatively few social behaviours shown between the two individuals. The segregation of the exhibit into zones used almost exclusively by one individual each is in stark contrast to the trio of leopards (Ngoprasert et al. 2007). In the wild, territory size is closely linked to the availability of food (Kroshko et al. 2016); it is interesting therefore that the two leopards appeared to avoid spending time in close proximity.

Previous research on the visitor effect has shown limited impacts of visitors on big cat behaviour (Skokalski et al. 2013). Studies on a lion, tiger and cheetahs showed that few behaviour changes occurred when behind-the-scenes tours took place. However, felids tended to distance themselves from the public during these periods. Therefore, avoidance of the public, or in this case conspecifics, might be used as a strategy to reduce conflict.

Individual differences

Studies by Baker and Pullen (2013), and Quintavalle Pastorino et al. (2017a,b) have investigated the effect of different carnivore temperaments on their husbandry routines and interactions with conspecifics. These studies, focussing on cheetahs, sloth bears *Melursus ursinus* and Asiatic lions *Panthera leo persica,* respectively, identified that big cat personality may play a key role in the suitability of social housing for individuals.

While personality was not the focus of this study, it is clear that individual temperaments may have affected the compatibility of the individuals in social housing conditions. Arturo, in the trio, initiated both aggressive and affiliative interactions with the two females and spent time in similar areas. By contrast, the two females avoided one another and did not appear to interact. While it appears that there were no major issues with compatibility with the subjects of this study, it is likely that incompatible personalities may scupper other attempts to mix leopards. Practitioners may therefore want to consider conducting personality assessments before attempting to house felids in pairs or larger groups (Baker and Pullen 2013).

Conclusion

In captivity, felids are kept in a range of social housing conditions, and while singletons and pairs, or mothers with cubs are the most common situations, group-housing conditions do also occur. This study revealed higher levels of aggressive and affiliative interactions in a recently mixed trio of leopards than in a longer-established female pair. Whilst the pair of females spent their time in different parts of their enclosures and tended not to interact with one another, the trio spent time in shared enclosure zones. While the study presents the findings of early interactions between the trio, it appears that social housing of compatible big cats may in some circumstances be feasible. Social housing of leopards, even in small groups of mixed sex, may have some value from an enrichment viewpoint if compatibility of animals is taken into account.

Acknowledgements

The authors are grateful to the staff at Parco Faunistico Valcorba for their help and expertise in developing the study. The authors would also like to thank C Colombari, Dr A Ferguson and staff at the Zoological Society of London for their support in both data analysis and proof reading an earlier version of the manuscript.

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