

The effects of the enclosure and management on the behaviour of captive wolves (*Canis lupus*).

BSc Dissertation report, abbreviated

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Abstract

In order to further investigate the findings of Frézard and Le Pape (2003) and of Kreeger *et al.* (1996) among others, an investigation was conducted into the effects of certain factors of the physical and social environments on the behaviour of captive grey wolves (*Canis lupus*). Information was gathered concerning the environments and histories of wolves at six facilities in the UK. Behavioural data was collected from these wolves in the form of scan samples, continuous observations and map plots. This data was used to determine potential relationships between environmental factors and behavioural tendencies. It was found that more alert resting behaviour was observed more in higher density enclosures ($p=0.0007$). Wandering, or exploratory behaviour, tended to be observed more in enclosures with a more varied layout ($p=0.0025$). Resting and resting alert behaviours were both observed more in hand reared, more socialised wolves ($p=0.0108$ and $p=0.0129$ respectively) and trotting was observed more in pack reared, less socialised wolves ($p<0.0000$). Resting behaviour was observed more in packs housed at facilities with lower human visitor activity levels ($p=0.0050$) and trotting was observed to occur more in packs in facilities with higher human activity levels ($p<0.0000$). Pack cohesion, measured as mean distances between individual wolves, was found to be higher (i.e. mean distance decreased) in mixed-sex packs compared to single-sex packs ($p=0.018$). These results were found to concur with some previously published information and disagree with other information, due to the conflicting nature of published material on wolves, their behaviour in captivity, and welfare and its behavioural measurement (Mech & Boitani, 2003; Packard, 2003, Hosey *et al.*, 2009; Morgan & Tromborg, 2007). This study suggested that further investigation into the relationship between socialisation and visitor-related stress levels in captive wolves may provide valuable information regarding this species and its captive welfare.

Introduction

Busch (2007) asserted that a wolf pack will not function normally in a small enclosure. The inability of lower ranked wolves to escape the aggression of other pack members was used as an example of abnormal social stressors, negatively affecting the wolves involved. Reduced retreat space was considered an environmental challenge; an inability to overcome an environmental challenge, due to lack of resources, internal (e.g. cognitive coping mechanisms) or external (e.g. tools) can result in elevated stress levels in captive animals. Welfare can be reduced, especially if the heightened stress levels are chronic (Hosey *et al.*, 2009). Frézard and Le Pape (2003), as well as Kreeger *et al.* (1996), found that enclosure size had little effect on the proportion of the amount of time spent resting compared to the amount of time spent in activity by the wolves; dubbed the rest-activity balance by Frézard and Le Pape (2003). Frézard and Le Pape also found that pack structure showed a stronger effect on behaviour than did enclosure size.

Wolf welfare, and even more so the perception of wolf welfare, in captivity has the potential to vary widely. Wolves are known to breed easily in captivity (Busch, 2007; Mech & Boitani, 2008), and the existence of the domestic dog (*Canis lupus familiaris*) shows that the wolf is capable of adapting almost completely to life in very close proximity to humans, albeit over generations of domestication. There are likely to still be factors of living in close proximity to humans that can cause some disturbance or stress to wolves. Noise disturbance by zoo visitors and construction work has been found to have increased aggression displays in silver-back gorillas (*Gorilla gorilla*) and corticoid levels in faecal samples from Hawaiian honeycreepers (*Vestiaria coccinea*) respectively. Stress does not necessarily result from all potentially stressful factors, however; there appears to be much variation according to species, individual and other environmental and health factors (Hosey *et al.*, 2009).

Wolves that have been hand reared by humans appear to show reduced fear responses to regular procedures and are less likely to display aggression or fear towards unfamiliar humans (Klinghammer & Goodmann, 1987). This may suggest that wolves held in captive situations may benefit from lowered stress levels as a result of being more familiar with humans. Conversely, a lack of human socialisation may be beneficial if the wolves are expected to be moved away from the humans that reared them, as the removal of a social companion or companions may add to the stress of the move (Klinghammer & Goodmann, 1987).

This study was conducted in order to further investigate these issues of the social and physical environment.

Methods

29 wolves of both sexes and various ages were observed at six different facilities in the UK. Information about their physical and social environments was collected by talking with their keepers and by observation of the enclosure and pack. The information collected can be found in table 1. The enclosures were mapped and their area was estimated using observation, information from the facility and Google Earth version 5.1. Some environmental factors were scored using a novel scoring system inspired by Frézard and Le Pape (2003). See appendix A for the scoring system used.

Table 1: Summary of the physical and social environments of the wolves studied.

Facility	A	B	C	D	E	F
Encl Size	958	2,000	2,550	27,188	600	6,391
Encl Density (m ² /wolf)	192	500	1275	2091	300	2130
Enclosure Layout	13	13	12	15	14	13
Human Activity	2	3	3	3	3	2
Number in Pack	5	4	2	13	2	3
Sex; M:F	Mixed; 2:3	Single; 0:4	Mixed; 1:1	Mixed; 11:2	Single; 0:2	Mixed; 1:2
Rearing	Human	Pack	Pack	Pack	Human	Human
Socialisation	5	2	1	2	4	5
Pack Structure	Extended Family	Adult Litter	Breeding Pair	Complex Family	Adult Half-Sisters	Extended Family

Behavioural data was collected over the course of three to five days at each facility. A scan sample was conducted for one hour, three times per day with observation points every five minutes. Continuous observation notes were taken for the rest of the day and the approximate positions of the wolves within the enclosure were plotted hourly. The ethogram used for the behavioural observations was the 'International Wolf Center Ethogram', adapted from Goodmann *et al.* (2002). The behavioural data collected from the scan samples was turned into percentage observations of each behaviour to make the data comparable between facilities. The most common behaviours were compared across facilities using the Kruskal-Wallis test. The facilities were then split according to some of the environmental factors that information was collected for and the percentage observations of the common behaviours were compared using Mann-Whitney *U* tests. The map plots were measured to give estimated mean distances between individual wolves and these were compared across facilities using Kruskal-Wallis. The facilities were then split according to pack sex (mixed or single-sex) and the estimated mean distances were compared between these two groups using a Mann-Whitney *U* test. The statistical packages used for these comparisons were Minitab 15.1 and SPSS 14.0 for Windows.

Results

The five most common behaviours observed during scan samples were rest, rest-alert, stand, trot and wander. Table 2 shows the descriptive statistics for the percentage observations of these five behaviours.

Table 2: Descriptive statistics for the percentage occurrences of the six most commonly observed behaviours during scan samples.

Beh	N	Min	Max	Range	Mean	SE Mean	SD	Med	Q1	Q3	IQR
R	82	0.00	92.31	92.31	29.53	3.27	29.65	22.18	3.85	50.58	46.73
R-A	82	0.00	66.67	66.67	17.89	1.59	14.40	17.66	5.25	26.92	21.68
ST-T	82	0.00	100.00	100.00	16.96	1.89	17.08	12.49	5.19	21.56	16.37
TT	82	0.00	94.44	94.44	13.50	2.05	18.58	5.81	0.00	19.83	19.83
WN	82	0.00	61.54	61.54	12.00	1.38	12.50	7.69	1.44	19.65	18.21

Each behaviour was then compared across facilities; each behaviour was found to differ significantly between facilities (see table 3).

Table 3: Significance of differences in the percentage observations of the five common behaviours across the six different facilities.

Beh	H value	d.f.	p value
R	29.08	5	p<0.001
R-A	16.56	5	p=0.005
ST-T	15.62	5	p=0.008
TT	34.55	5	p<0.001
WN	17.05	5	p=0.004

The facilities were then split according to environmental factors and the common behaviours compared for significant differences using Mann-Whitney *U* tests. For the enclosure density tests the enclosures were grouped as more than (N=29) or less than (N=53) 1000 m²/wolf. The enclosure layout tests were grouped as enclosures with a score of 12 or 13 (N=58), or a score of 14 or 15 (N=24). For the rearing and socialisation tests the enclosures were grouped according to whether the wolves were hand-reared and socialised (socialisation scores of 4 or 5) or pack-reared and unsocialised (socialisation scores of 1 or 2); N=37 and N=45 respectively. For the human activity tests the facilities were grouped according to whether the human activity score was 2 or 3 (N=28 and N=54, respectively). For scoring system see appendix A.

The behaviours that showed significant differences were then tested against one-tailed hypotheses (see table 4).

Table 4: The significant statistical results of the Mann-Whitney *U* comparisons between environmental factors of the five most commonly observed behaviours.

Environmental factor	Enclosure density	Enclosure layout	Rearing & socialisation	Human Activity
Behaviour				
Rest	-	-	W=1781.5, p=0.0108	W=1425.0, p=0.0050
Rest-alert	W=1920.0, p=0.0007	-	W=1775.0, p=0.0129	-
Stand	-	-	-	-
Trot	-	-	W=972.5, p≤0.0001	W=728.0, p≤0.0001
Wander	-	W=2133.5, p=0.0025	-	-

Rest-alert was found to have been observed more frequently in higher density enclosures and wander more frequently in enclosures with higher layout scores (higher variability). Rest and rest-alert were observed more frequently in hand-reared, more socialised packs and trotting was observed more frequently in pack-reared, unsocialised packs. Resting was also observed more frequently in facilities with lower human activity levels and trotting in those with higher activity levels.

The mean estimated distances between wolves at the different facilities (see table 5) suggested that there may be difference between facilities, this was tested for significance using a Kruskal-Wallis test; $H=139.047$, $d.f.= 5$, $p\leq 0.001$, a significant difference was found.

Table 5: Estimated mean distances (m) between wolves at all facilities.

Facility	A	B	C	D	E	F
Mean distance (m)	31.79	67.14	40.35	22.01	5.35	10.88

The facilities were then divided according to the sex-structure of the packs; the estimated mean distances between individuals in mixed sex packs (N=143) were compared with the estimated mean distances between individuals in single sex packs (N=71) using a Mann-Whitney *U* test. It was found that there may have been a significant relationship between the make up of the pack and the mean distance between pack members, the mixed sex packs apparently positioning themselves closer together overall ($W=14478$, $p=0.018$).

Conclusions

Resting behaviour was observed proportionally more in hand reared, more socialised wolves and less in wolves in enclosures with higher human activity levels. Resting alert was observed proportionally more in higher density enclosures and in hand reared, more socialised wolves. Trotting was found to have occurred more in pack reared, less socialised wolves and in enclosures with higher human activity levels. These findings may relate to previous findings suggesting that prior experience of humans could affect the wolves' responses to humans (Fritts *et al.* 2003; Mech, 1997; Wooply and Ginsburg, 1967). Wandering (exploratory behaviour) was found to have been observed proportionally more in enclosures with higher layout scores, or increased variability, suggesting that Carlstead *et al.*'s (1993) findings in leopard cats (*Felis bengalensis*) may also apply to grey wolves. The significant difference between enclosures found in the proportion of the standing/vigilance behaviour was not accounted for by any of the environmental factors investigated. Pack cohesion was found to have been significantly related to the sex of the pack; individuals from mixed sex packs tended to locate themselves nearer to their pack members than did individuals from single sex packs, which may relate to Frézard and Le Pape's (2003) finding that single sex packs tended to behave abnormally.

This study was focussed on a relatively small sample size and, while it provided detailed information regarding these wolves during the sample period, it may not be representative of captive wolves overall. It has, however, highlighted some areas that may benefit from further study. Further investigation into some of the issues discussed in this report may include a look into the effects of pack structure over a wider sample population. Another area that may benefit from a more in depth study would be the effects of human presence on the behaviour, health and overall welfare of captive wolves; of particular interest would be an analysis of the effects of hand rearing and socialisation on visitor-related stress levels. The information provided by these wolves may be added to what is already known about this species and be used to focus further investigation into the species as a whole and its needs in captive environments.

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UK Wolf Conservation Trust, Berkshire, England

References

Busch, R.H. (2007) *The Wolf Almanac*, The Lyons Press, Guilford.

Carlstead, K., Brown, J.L. and Seidensticker, J. (1993) Behavioural and adrenocortical responses to environmental changes in leopard cats (*Felis bengalensis*), *Zoo Biology*, vol. 12, part 4, pp. 321-331.

Frézard, A. and Le Pape, G. (2003) Contribution to the welfare of captive wolves (*Canis lupus lupus*): A behavioral comparison of six wolf packs, *Zoo Biology*, vol. 22, part 1, pp. 33-44.

Fritts, S.H., Stephenson, R. O., Hayes, R. D. and Boitani, L. (2003) Chapter 12: Wolves and Humans. In Mech, L. D. and Boitani, L. (2003) *Wolves: Behaviour, Ecology and Conservation*, The University of Chicago Press, Chicago.

Goodmann, P.A., Klinghammer, E. and Willard, J. (2002) Wolf Ethogram, *Ethology Series No. 3*. Eckhard H. Hess Institute of Ethology, Wolf Park, Battle Ground, Indiana. International Wolf Center Ethogram: personal communication.

Hosey, G., Melfi, V. and Pankhurst, S. (2009) *Zoo Animals: behaviour, management, and welfare*, Oxford University Press, Oxford.

Klinghammer, E. and Goodmann, P.A. (1987) Chapter 2: Socialization and management of wolves in captivity. In Frank, H. (1987) *Man and Wolf; Advances, Issues and Problems in Captive Wolf Research*, Dr. W. Junk Publishers, Dordrecht.

Kreeger, T. J., Pereira, D. L., Callahan, M. and Beckel, M. (1996) Activity patterns of gray wolves housed in small vs. large enclosures, *Zoo Biology*, vol. 15, part 4, pp. 395-401.

Mech, L.D. (1997) *The Arctic Wolf: Ten years with the pack*, Voyageur Press, Stillwater.

Mech, L. D. and Boitani, L. (2003) *Wolves: Behaviour, Ecology and Conservation*, The University of Chicago Press, Chicago.

Mech, L.D. and Boitani, L. (2008) *Canis lupus*. In: IUCN 2010. IUCN Red List of Threatened Species, Version 2010.1 (Internet). Available from: <http://www.iucnredlist.org> [Accessed: 06 Apr 2010].

Morgan, K.N. and Tromborg, C.T. (2007) Sources of stress in captivity, *Applied Animal Behaviour Science*, vol. 102, pp. 262-302.

Packard, J.M. (2003) Chapter 2: Wolf Behavior: Reproductive, Social and Intelligent. In Mech, L. D. and Boitani, L. (2003) *Wolves: Behaviour, Ecology and Conservation*, The University of Chicago Press, Chicago.

Woolpy, J.H. and Ginsburg, B.E. (1967) Wolf Socialization: A Study of Temperament in a Wild Social Species, *American Zoologist*, vol. 7, part 2, pp.357-363.

Appendix A: Scoring system used to assess the physical and social environmental factors of the wolf packs.

Factor	Score	Description
Enclosure	1	full concrete
Ground type	2	partial concrete-partial earth
	3	partial concrete-partial grass
	4	full earth
	5	partial earth-partial grass
	6	full grass
	Percentage of exposed features or sheltering features <i>estimated</i>	1
2		15-30
3		30-45
4		45-60
5		60-75
6		75-100
Availability of water deepest part recorded for multi-depth pools	1	drinking water only
	2	small amount (children's paddling-pool size) of shallow water (paw to hock-height) available
	3	moderate amount (2-4 children's paddling-pool size) of shallow water available
	4	small amount of belly-depth water available
	5	moderate amount of belly-depth water available
	6	enough water to swim in OR large amount (5+ paddling pools) of belly-depth water available
Socialisation		
Un-socialised	1	no conscious human contact, non-contact feeding, dart-sedated for veterinary treatment
Partially socialised	2	occasional keeper contact, food brought by humans, may sedate for veterinary treatment
Regularly socialised	3	regular keeper contact, incl. physical contact, food & veterinary as with 2
Frequently socialised	4	frequent keeper contact, as with 3 + may hand-feed
Fully socialised	5	as with 4 + occasional-frequent contact with non-keeper/unfamiliar humans
Human activity	1	minimal activity levels near enclosure (private enclosure)
	2	occasional moderate activity near enclosure (private enclosure, arranged visits)
	3	intermittent moderate activity levels near enclosure (medium-large non-city zoo)
	4	continuous moderate activity levels near enclosure (medium city zoo)
	5	intermittent high activity levels near enclosure (medium-large non-city zoo)
	6	continuous high activity levels near enclosure (large city zoo)