



**Male-Female Interaction and How this changes  
throughout the year in Captive Wolves (*Canis lupus*)**

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## **Abstract**

In the wild, the dominant pair of wolves will interact differently throughout the year, this is due to them being the only pair to breed in the pack and following the reproductive cycle. Autumn is when proestrus begins in females, bringing hormonal scents that gain the attention of the male, causing both wolves to interact more with each other. Estrus and copulation happen in the winter months, making this the season that most interactive behaviours are displayed. Females carry the pups for 61 to 62 days resulting in the pups being born in spring, with the female going into the anestrus phase of the cycle, having no sexual activity until the proestrus phase begins again in late autumn. The metestrus phase of the reproductive cycle consists of pregnancy and pup care, this lasts throughout spring and summer, the female will feed the pups on only her milk for between 5 to 9 weeks, not leaving the den or allowing any of the other wolves in, including her mate. Once weaned both parents will teach the pups to survive, with them learning how to hunt and forage so they do not starve once they leave the pack, also learning how to fight by play fight with all members of the pack. Due to the female interacting more with the pups during these months, she interacts less with the male.

This study was to determine if this is how captive wolves behave. Three pairs of captive wolves were observed at two locations; The UK Wolf Conservation Trust (UKWCT) and Howletts Wildlife Park. 96 hours of observations, 32 hours for each pair of wolves, made with 11,520 lines of data collected, 240 lines for each pair on each day.

The results suggest that dominant captive wolves do interact differently throughout the year, with "Follow" being the behaviour observed the most. However, due to captive wolves not having to hunt or patrol their territory, their activity levels are low, spending most of the days resting.

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## **Introduction**

Wolves (*Canis lupus*) are very social animals, the strength of the social bonds that wolves share among pack members are second only to those social bonds shared by primates (Busch, 1995). In wild wolves only the dominant pair will mate and produce offspring, a pack of wolves will usually only have a single litter every year of one to six pups (Miklósi, 2007). The bond between the dominant pair is extremely strong (Busch, 1995). Wild wolves live in packs of between 2 to 42 individuals (Miklósi, 2007), wolf pack size will depend on season, where the wolves live and size of prey, the bigger the prey, the bigger the pack size needs to be able to kill the prey, during the spring and summer there will be lots of offspring from other animals, having these smaller animals to hunt means the pack does not have to be as big. As it gets colder during autumn and winter the prey offspring has grown into larger animals, needing a bigger pack of wolves to kill them (Miklósi, 2007). The pack is made up of the dominant pair, their current offspring and perhaps other young who have yet to leave, there may also be a few subordinate adult wolves in the pack, these subordinate adults are usually the brothers and sisters of the dominant pair (Busch, 1995). Subordinate wolves are not allowed to breed, the dominant pair make sure this does not happen with physical and mental aggression, the dominant female is also able to suppress the hormones of the other females (Mech and Boitani, 2003). Occasionally a wolf pack will have lone wolves join it temporarily, this will usually be within the colder months as they will need the size of the wolf pack to kill the large prey. Every pup born to a wild pack of wolves will eventually disperse (Mech and Boitani, 2003), this is to avoid inbreeding, the juvenile wolves will leave at around 3 years of age (Miklósi, 2007) to either start their own packs or join another pack, they must travel great distances to leave the territory of their parental pack (Miklósi, 2007), this does not happen in captive wolves. Dominant pairs of captive wolves will be kept as just a pair, this is due lack of space in the enclosures, young have nowhere to disperse to, so if a pair of wolves produce offspring, they will be removed from the dominant pair before any bond is made and hand raised, they will either be kept

as a group of siblings, each one having been sterilised so there can be no incest, or they will be separated and paired up with a non related wolf, they will remain within this pair for life, this is with the hope that they will breed and improve numbers. Hand rearing wolves changes the behaviours slightly from wild wolves, hand reared wolves are usually more docile, allowing humans (*Homo sapiens*) to touch them, they are not as scared of humans as wild wolves are, who will avoid them (Miklósi, 2007). These changes in behaviour are also due to captive wolves not having to hunt for their food, as it is handed to them on a daily basis by their keepers, and them not needing to patrol their territory (Sillero-Zubiri and Macdonald, 1998) since their territory is already predetermined by a man made fence.

During the mating season, the pair will double scent mark, the female will urinate, the male will then urinate either near or over the females urination. This double scent mark is thought to help bond the pair through hormonal secretions contained in the urine (Busch, 1995). Urination scent marking is done all year round, this conveys the same information as a wedding ring would in humans (Rothman and Mech, 1979).

Throughout the year the dominant pair of wild wolves' behaviour towards each other changes. Seasonal peaks in the wolf's reproductive behaviour is correlated with seasonal changes in the reproductive hormones (Seal et al 1979). In autumn, testosterone in the males and estrogen in the females begin to rise, priming the reproductive organs for the different phases of reproduction in the female; proestrus; when the ovarian follicles mature to accept an egg, this is when a bloody vaginal discharge appears, estrus; when the female is in "heat" and is more receptive to the males sexual advances and will copulate with him, metestrus; occurs after ovulation, the corpus luteum develops and progesterone secretion increases, while estrogen secretion decreases, the female wolf will become pregnant, and anestrus; sexual inactivity (Packard et al, 1983) there are no sexual hormone secretions, this takes place during pup care, which can last up to six months, usually between the months of June and December (Seal et al, 1987). With these hormonal changes come changes in the

behaviour, during proestrus the male will become attentive to the odours in the females urine. The female has been known to body-rub, paw, nuzzle, place her chin on the males back and even to present her rear to his nose (Schenkel, 1948). Female wolves have been known to express unreciprocated sexual interest before the bloody vaginal discharge of proestrus, this is know as pre-proestrus (Seal et al, 1987) this is due to the rising hormones and development of incomplete ovarian follicles (Packard et al, 1989). During estrus the female will avert their tail to one side, exposing her swollen vulva to the male, if the male is unresponsive the female will paw, body rub, straddle and sometimes even mount him (Mech and Boitani 2003), once the male is interested the pair will copulate, with the male mounting the female. However, if the female is the one that is not receptive she will growl and bite at the male repelling him(Busch, 1995). Little is known about about how long the estrus period lasts in wild wolves (Mech and Boitani, 2003) as the length of time may differ to that of captive wolves for various reasons. However studies have been done on captive wolves and they have shown that estrus lasts between fifteen days and about a month (Mech and Boitani, 2003) and this usually takes place between the months of January and April (Miklósi, 2007), with such a short time for copulation male wolves have less incentive than other male dogs do to abandon their pregnant females in search of another estrus female (Mech and Boitani,2003), without the opportunity to inseminate any other females, the male has no reason not to stay with the female and help care for the pups (Mech and Boitani, 2003), this could possibly be why the dominant pair form such long lasting relationships, they do not however mate for life, if one of the pair dies the other will eventually find another mate and produce more offspring (Busch, 1995). Metestrus females do not always become pregnant, but instead can become "pseudo pregnant" (Johnston, 1986), where they are not pregnant, but will still show the signs and behaviours of a pregnant female, sometimes even lactating, though the fluid has no nutritional value (Packard et al, 1983). Once in the metestrus phase the whole pack will begin preparing the den, with the dominant pair making sure it is to the females liking. During pup care the female will put all her attention into

bringing up her pups, the male will still follow closely and also provide care for the pups, this includes bringing food, teaching and playing. During pup care the anestrus phase of the females reproductive cycle will begin, this will continue until the pups are old enough to hunt for themselves and no longer need the females complete care or attention, this changes with each litter, usually lasting from June to December (Seal et al, 1987). Once the pups are old enough the cycle will begin again.

Pups need to be born after the harshness of winter, usually between late March and early May (Busch, 1995), this is to allow them to grow and learn to hunt before the winter comes back round again (Van Ballenberghe and Mech, 1975). Gestation is usually 61 to 64 days, so the dominant pair will therefore copulate in winter (Mech, 1970). Prior to giving birth and for a few days after, the female will not allow the male into the den, instead he will stand guard, either fighting or drawing away any potential threats (Busch, 1995). While nursing the female will not leave the den, it is up to the male to bring her food (Busch, 1995). Pups are usually weaned at 5 to 9 weeks, living only on their mothers milk, which is high in protein and low in fat (Packard et al, 1992) until then. Pups will reach adult size by their first winter, making the pack look like it has more adults, this is helpful for hunting but also when it comes to an invading attack, possibly by another wolf pack, they will not attack a pack of wolves full of adults (Mech and Boitani, 2003).

Captive wolves are usually sexually active at about 22 months old (Busch, 1995), however it has been known for them to breed as early as 10 months (Medjo and Mech 1976), many wild wolves do not start breeding until 4 or 5 years of age (Mech, 1995b) if at all, many wolves in the wild do not usually live longer than 4 or 5 years of age (Mech and Boitani, 2003), this is due to injury and possible starvation, during the winter if a wolf is not in a pack it can be difficult for them to hunt for food (Mech and Boitani, 2003). There have been cases of captive wolves living as long as 20 years. Pups are produced every year in the wild (Mech and Boitani, 2003), little is known about the age that wolves no longer produce offspring, there have been females in captivity that have produced

offspring at 14 years, and a male that has sired at 15 years (Mech and Boitani, 2003), the oldest known wolf in the wild was a female aged 14 years (Mech 1988) and the oldest male was slightly younger at age 11 (Mech, 1995a), however from the age of 9 the litters begin to get smaller (Mech, 1988).

Even though the more significant behavioural changes happen in autumn and winter, wolf pairs stay together all year round, other than scent marking they display friendly behaviours towards each other; nuzzling, licking, following closely and sleeping at different distances to each other throughout the year. Wild wolves also enjoy play and it is not just the pups, adults play an ambush type of game where they will leap or crash into another, unsuspecting wolf, they also play chase and play fight (Busch, 1995).

Wolves in the wild will spend spring and summer raising and teaching the young to hunt and forage, thus interacting more with each other. The dominant male will mate with whichever female comes into season first, to prevent incest the dominant female will produce hormones that suppress the hormones of the younger females, once the pups become old enough to breed they will disperse from the pack to either start their own pack or join another, this also prevents incest. This however does not happen in captive wolves, the pups will be taken off the parents straight away to be hand reared and live in a separate enclosure. With the lack of raising young and even having to hunt captive paired wolves rarely spend much time noticing each other until hormones flare up in autumn.

The social structure of wolf packs has been one of the most intensive areas of study for wolf researchers (Busch, 1995), as has the reproductive cycle of captive wolves. Studying wolves either in the wild or in captivity is made increasingly difficult by the wolves not wanting to be seen, wild populations of wolves will avoid humans (Miklósi, 2007). The majority of behaviours reported have been observed in captive wolves and then used to help observers identify these behaviours in wild wolves (Mech and Boitani, 2003), however there is a lack of studies and literature based solely on

the behaviours of the dominant pair of captive wolves as this all gets represented in the wild wolf literature, also there is a lack of studies on the behaviour throughout the year, with the majority only studying mating behaviours.

My aim is to determine whether captive dominant wolves' behaviour towards each changes throughout the year like in wild wolves, my hypothesis is that it does. I hypothesise the interactive behaviours I will witness are greet, lick, sniff, nuzzle, bite, growl, follow, paw, mount, groom, play fight, chase, play, body rub, nibble and genital investigation, the majority of which will be in autumn and winter.

## Wolves:

Motomo (male) and Mai (female).



Mai on the left, Motomo on the right.

The first pair of wolves at the UK Wolf Conservation Trust (UKWCT), Motomo is a Grey Wolf (*Canis lupus*), born on 19th May 2008. Mai is a Canadian Timber Wolf (*Canis lupus occidentalis*), born on 27th April 2006. They have been together since December 2010. Mai was hand reared from a pup, whereas Motomo has not been, this makes it more dangerous for the keepers to be in the enclosure with him as there is a possibility he will attack them. Within their first year together they unexpectedly had three pups, who were taken away to be hand reared, since then, due to lack of space Mai has been sterilised so she can no longer have offspring, however she will still produce the hormones and go through the reproductive cycle, meaning Motomo will still mate with her. At the

beginning of this study Mai went through a pseudo pregnancy, where her body went through the physical signs of the pregnancy cycle, such as swelling of the stomach, even though she was not carrying offspring, for a few months after she would treat small sand bags like her own pups, bringing them in and out of the den and carrying them around with her.

Both wolves get fed six days out of seven, Mai would receive 1 to 1.2kg of meat, being hand reared she is able to be fed right through the fence. Motomo will be fed 1.4kg of meat, however not being hand reared, this food will be thrown over the fence for him to eat. The meat consists of beef, chicken, rabbit and deer. Feeding time is between 12 and 1 o'clock.

Occasionally on Saturdays Mai will get taken for a walk in the nearby fields, Motomo will howl to find out where she is, sometimes this will make Mai stop until she is returned to Motomo.

Every Wednesday the Trust is open to the public, this changes the wolves behaviour, the keepers will call the wolves over to the fence to allow the public to see them. During these days Motomo will usually stay out of sight, with Mai coming over to the fence when called.

Torak (male) and Mosi (female).



Torak on the left, Mosi on the right.

The second pair of wolves at UKWCT. Torak is a Grey Wolf born on 22nd April 2006, Mosi is a Canadian Timber Wolf born on 27th April 2006 (like her sister Mai). They have been together since they were pups. Torak was originally Mai's mate, however one year Mosi came into season first, so Torak mated with her, leading Mosi and Mai to fight and the sisters having to be separated, Torak and Mosi have been together since. This pair have never produced offspring. Torak has been sterilised, he still responds to Mosi when she comes into season and tries to mate with her, however he produces no sperm.

Both wolves have been hand reared making it possible to feed them both through the fence. Mosi will receive 1 to 1.2kg of meat whereas Torak will receive 1.4kg of meat. This food is made up of beef, chicken, rabbit and deer.

During the Wednesday open days Torak will keep out of sight, whereas Mosi seems to really enjoy

the attention and will be up by the fence seeing the visitors.

Kago (Male) and Nushka (Female).



Nushka on the left, Kago on the right.

This is the only pair at Howletts Wild Animal Park, run by The Aspinall Foundation. Both are Grey Wolves, Kago was born on 27th April 2015. Nushka was born on 14th May 2015. They have been together since the 31st July 2015. Neither wolf has been sterilised, The Aspinall Foundation are hoping they will mate and produce offspring, due to being so young this may not happen until spring 2018. Due to their youth they enjoy playing, they will chase the children outside the enclosure and will play fight with each other as pups in the wild would do, they also enjoy chasing birds and attacking trees.

Both wolves have been hand reared making it safe for the keepers to go in the enclosure, when this

happens the wolves will follow the keeper around, if the keeper tries to approach the wolves, Kago will begin growling a warning, not wanting anyone to go near Nushka, he is very protective of her.

Instead of being fed through the fence like at UKWCT, this pair are given an animal carcass to share, Kago will usually take more than his fair share, sometimes walking away with the whole thing.

When the enclosure was first made up, the keepers put in two man made dens for the wolves to make their own, however they did not seem to like these as the wolves decided to make their own.

## **Site description**

Even though there are three pairs of wolves, there were only two locations visited; the UK Wolf Conservation Trust home to Motomo and Mai, and Torak and Mosi. This is a wolf sanctuary, housing four packs of wolves all in separate enclosures, the Trust does have other animals, but none interfere with the wolves, it is a quiet, peaceful area, with low amounts of people, except on Wednesday, when they allow the public in to be educated about the wolves.

Howletts Wildlife Park is home to Kago and Nushka, this is a zoo atmosphere, with lots going on outside the enclosure, with a vast number of patrons visiting each day and all the other animals within the park, this is a busy, loud environment.



**Motomo and Mai**

The enclosure is 3716m<sup>2</sup>. The den is a large, grassy mound near the front and to the left of the enclosure, being able to see the entrance from the fence. To the left of this is man made wooden table (seen in the picture) for the wolves to jump onto, this was put there part way through this study. To the right of the den is a large woodland area, going all the way up to the right hand side

fence. In amongst this woodland area is a table, that does not get used by the wolves. Behind this is some open space and then further back is more woodland area. During the spring and summer with the trees in full bloom it is difficult to see through the foliage, creating lots of areas for the wolves to hide away from the public eye, also creating lots of shade for when the temperature is too high. In autumn and winter even though there is less foliage, the amount of woodland still makes it easy for the wolves to hide.

There is a trough at the front of the enclosure full of water for the wolves to drink from, it is big enough for the wolves to get into if they need to cool off.



### Torak and Mosi

The enclosure is 8951m<sup>2</sup>. The den is a large, grassy mound, with a small unused waterfall built into the front of it, towards the front of the enclosure, but still some distance from the fence (seen in the picture). To the left of the den is a large woodland area that expands towards the back of the enclosure. To the right of the den is a small number of trees, behind these trees and the den is an open space, with another woodland area beyond this to the right. With such a large den and so much woodland it is difficult to see behind, especially during spring and summer. To the right and near the front of the enclosure is a man made wooden table, put in part way through the study, this is due to the old one, behind the first set of trees on the right of the den, was going unused.

At the front of the enclosure is a trough (seen in the picture) filled with water for the wolves to drink from.



Kago and Nushka

This enclosure is 2610m<sup>2</sup>. The den a large, grassy mound is towards the back of the enclosure, surrounded by trees, the mound can be seen from the front of the enclosure, but not the entrance.

There are two wooden man made dens towards the front of the enclosure, with a newly built table with a ramp in front of them, this was put in part way through the study. Right at the front and to the left of the enclosure is a pond, where the wolves drink from.

The back, left corner is a small holding enclosure, used for holding the wolves if in need of separation.

There is a woodland area towards the back of the enclosure, with the den in the middle, this gives plenty of places for the wolves to hide and for shade during the hotter months.

## Method

There were only two locations visited, The UK Wolf Conservation Trust (UKWCT), home to Torak and Mosi, and Motomo and Mai, and Howletts Wildlife Park, home to Kago and Nushka.

These were visited for four days within each season, dates were as follows:

	<b>Spring</b>	<b>Summer</b>	<b>Autumn</b>	<b>Winter</b>
<b>UKWCT</b>	26th May 2016 2nd June 2016 3rd June 2016 7th June 2016	22nd August 2016 23rd August 2016 24th August 2016 25th August 2016	14th November 2016 16th November 2016 17th November 2016 21st November 2016	17th February 2016 20th February 2016 22nd February 2016 23rd February 2016
<b>Howletts</b>	27th May 2016 6th June 2016 9th June 2016 14th June 2016	15th August 2016 17th August 2016 18th August 2016 19th August 2016	19th November 2016 20th November 2016 23rd November 2016 24th November 2016	18th February 2016 19th February 2016 25th February 2016 26th February 2016

Calculating at 96 hours in total, 32 hours for each pair of wolves.

Before any data were collected, one day was spent with each pair of wolves to see how they interacted with each other.

## Ethogram

### Behaviours observed between the wolves:

Greet, Lick, Sniff, Nuzzle, Bite, Growl, Follow, Mount (Mech and Boitani, 2003), Play Fight, Chase and Play - when one wolf runs and body slams the other. (Busch, 1995).

### Individual behaviours observed:

Out of Sight, Resting, Standing, Walking, Scratching, Howl, Eating, Stretching, Running, Trotting, Laying and Laying on Side.

All individual behaviours were behaviours witnessed while doing the study.

The wolves were then observed for four days in each season, for two hours each day, one in the morning and one in the afternoon, data were collected in 15 minute sections, with an interval of 10

minutes between each section.

During each minute the behaviours of each pair towards each other was recorded. After each minute the individual behaviour was recorded.

Once all the data were collected, the IBM SPSS Statistical software (SPSS) was used to plot the data in to graphs, comparing the difference in frequency between Location, Season, Sex and the time of day, with a Kruskal-Wallis ANOVA test being performed on each one to determine the significance.

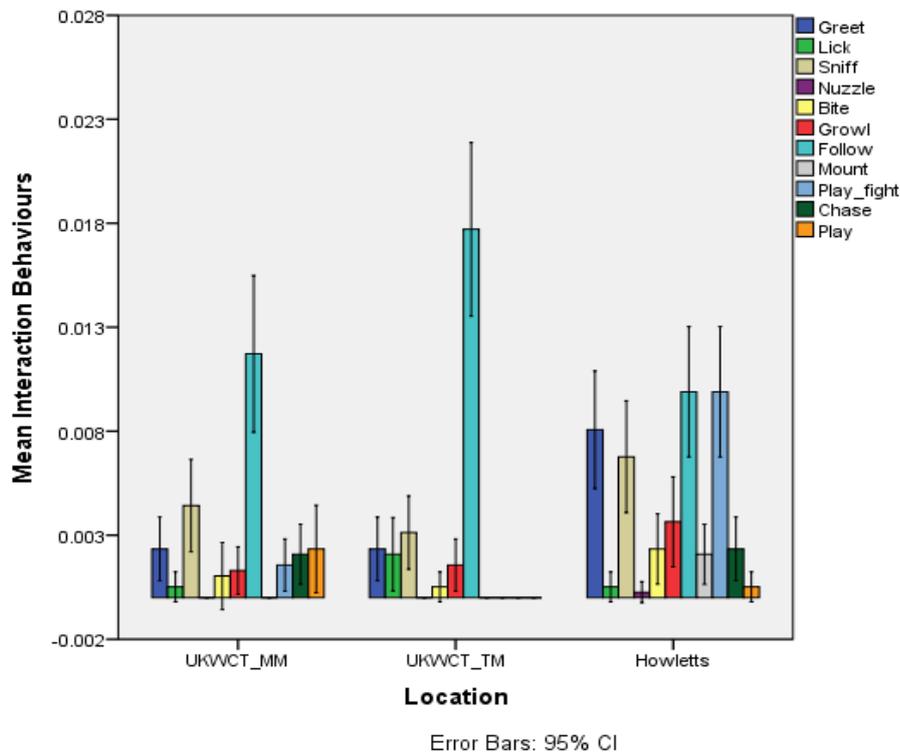
## **Results**

The data set comprised of 11 observed interactions between the wolves and 12 observed individual behaviours. Obtaining 11,520 lines of data from these, being 240 lines of data per visit.

Graph Index: Location: UKWCT\_MM = Motomo and Mai

UKWCT\_TM = Torak and Mosi

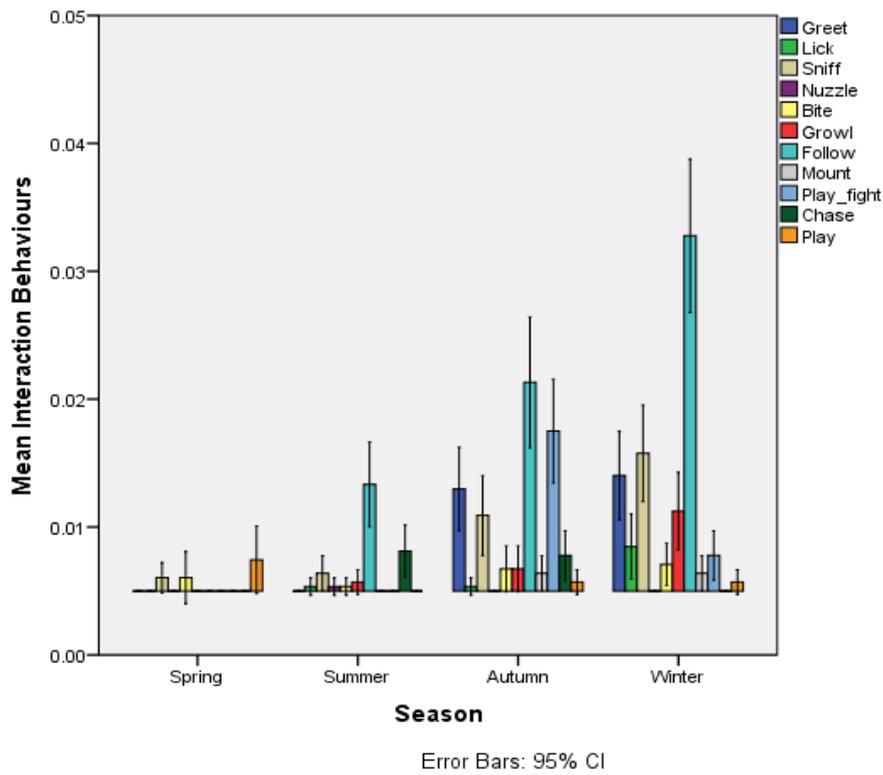
Howletts = Kago and Nushka



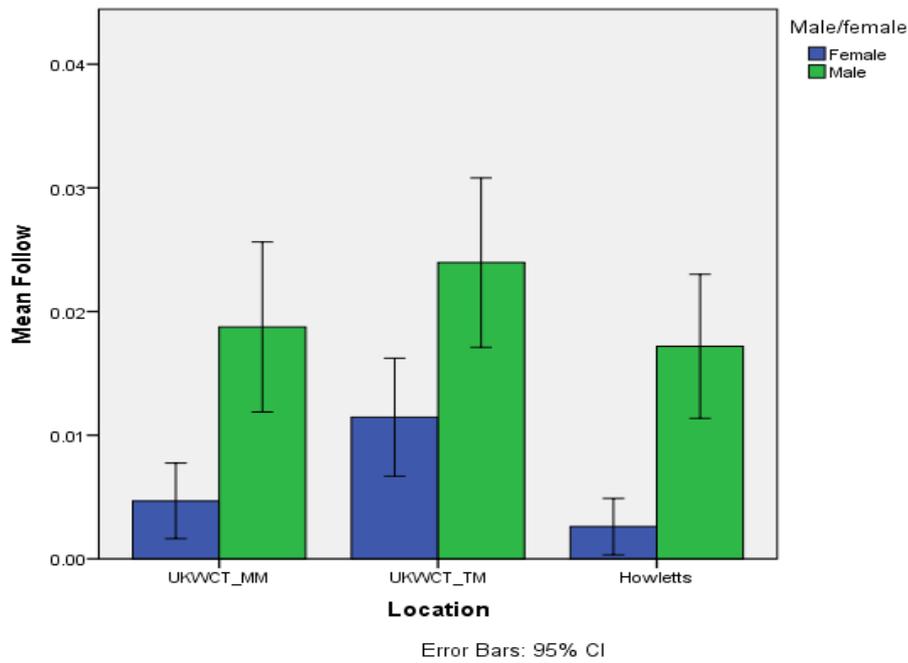
Graph 1. The mean frequencies of interactive behaviours at each location.

Graph 1 shows the mean frequencies of all 11 behaviours the wolves showed towards each other throughout the year at each location. Showing that Kago and Nushka displayed each of the different behaviours, whereas Motomo and Mai displayed all behaviours except for "Nuzzle" and "Mount," and Torak and Mosi displayed only six out of eleven behaviours these being; "Greet," "Lick," "Sniff," "Bite," "Growl" and "Follow." All locations show that "Follow" was the behaviour observed the most.

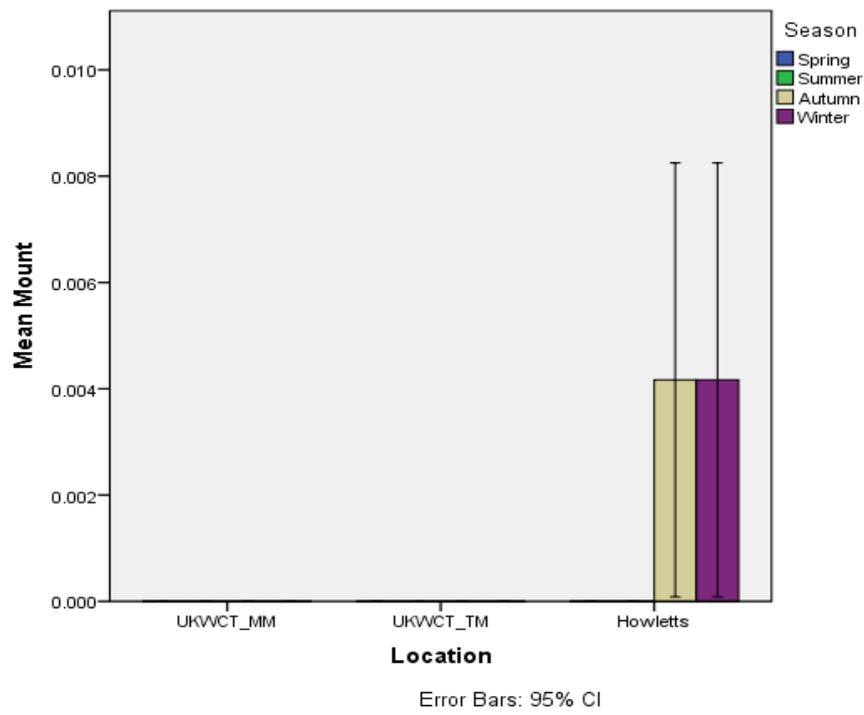
Graph 2 shows the mean frequencies of all 11 behaviours the wolves showed towards each other during each season. Showing that during "Autumn" and "Winter" was when the majority of the behaviours were displayed, with "Autumn" displaying one more behaviour than "Winter," all season apart from "Spring" have a large display of the behaviour "Follow."



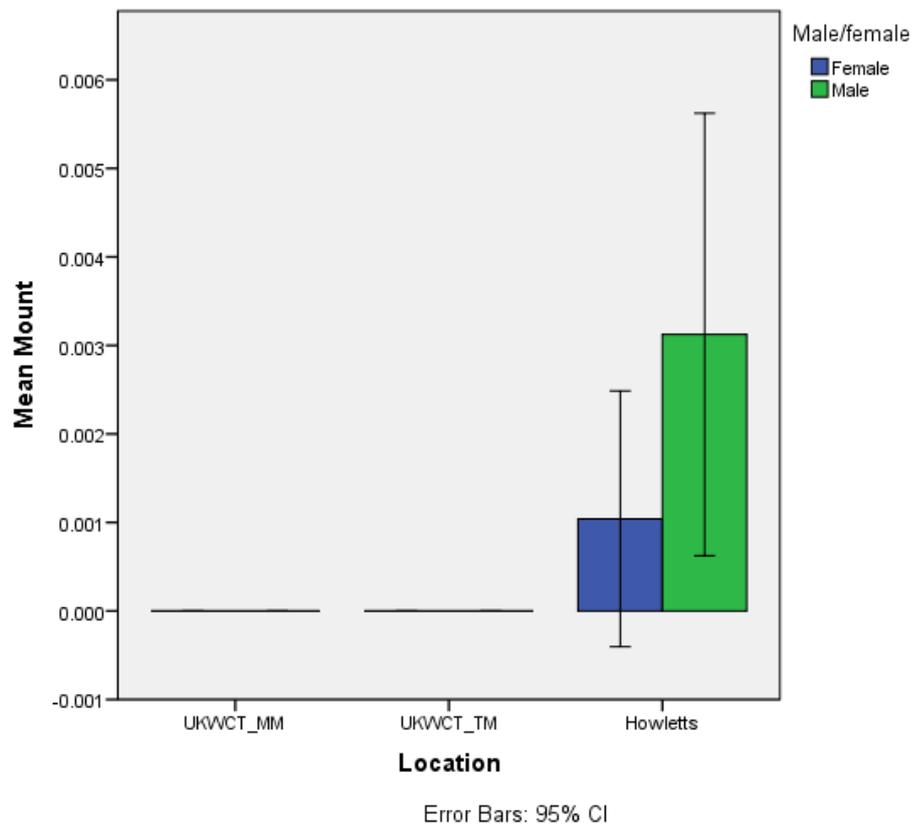
Graph 2. The mean frequencies of interactive behaviours during each season.



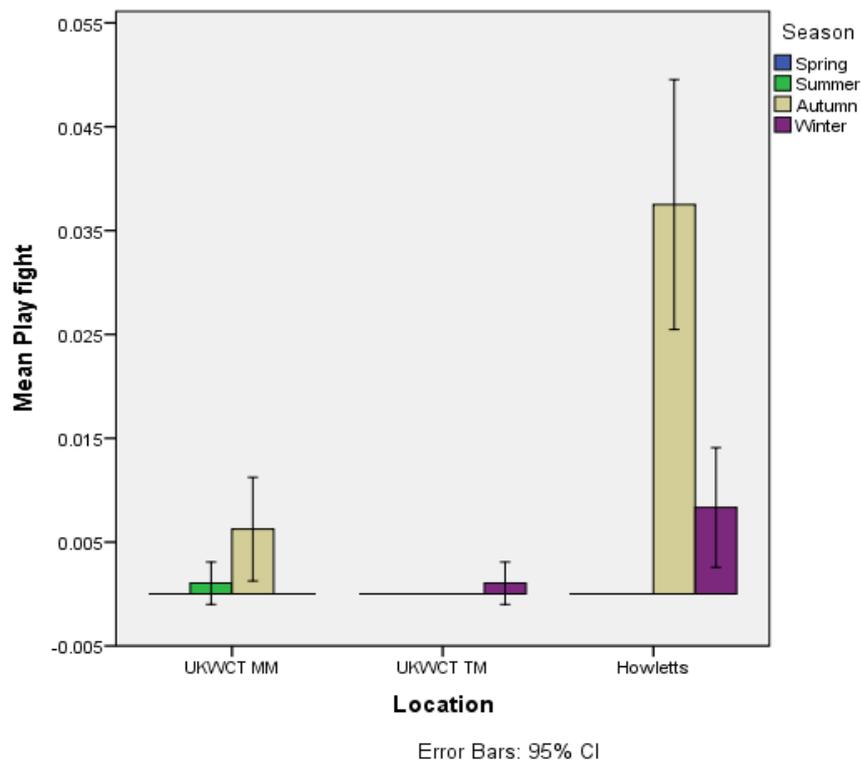
Graph 3. The mean frequency of Follow divided by sex at each location.



Graph 4. The mean frequency of Mount at each location during each season.



Graph 5. The mean frequency of Mount divided by sex at each location.



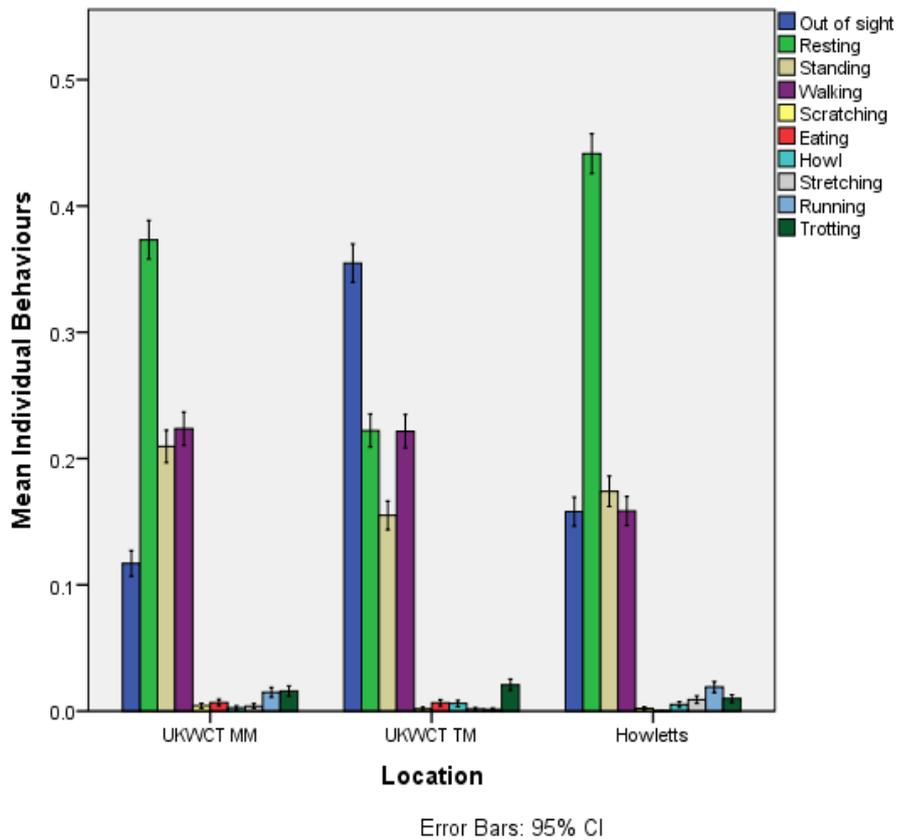
Graph 6. The mean frequency of Play Fight at each location during each season.

Graph 3 shows the mean frequency for the behaviour "Follow" divided by sex at each location. Showing that it was mainly the male wolves following the females at each of the locations. A Kruskal-Wallis test showed this to be significant difference,  $H(1) = 38.776$ ,  $p = 0.000$ .

Graph 4 shows the mean frequency for the behaviour "Mount" divided by season at each location. Showing that only the wolves at Howletts displayed the Mount behaviour, only during "Autumn" and "Winter," this is a significant difference,  $H(3) = 8.005$ ,  $p = 0.046$ .

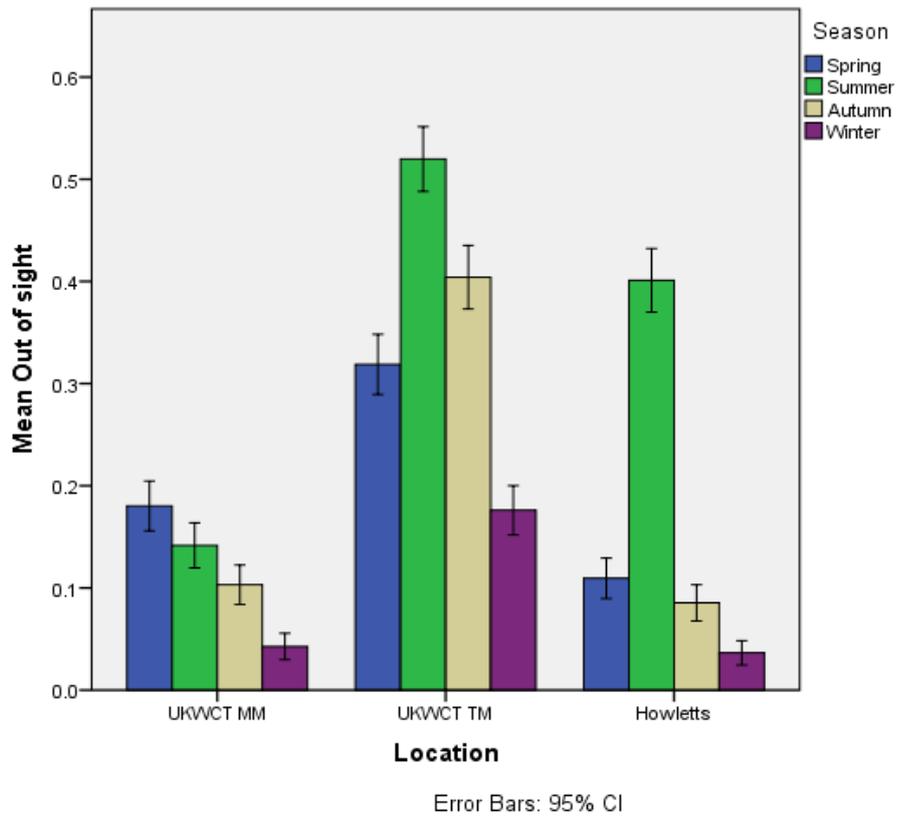
Graph 5 shows the mean frequency for the behaviour "Mount" divided by sex at each location. Showing that it was mainly Kago displaying this behaviour, however Nushka was seen to also display this behaviour. However this is not a significant difference,  $H(1) = 2.001$ ,  $p = 0.157$ .

Graph 6 shows the mean frequency for the behaviour "Play Fight" at each location during each season. Showing that the behaviour "Play Fight" was mainly displayed by the wolves at Howletts, with the majority of this in the "Autumn," this is a significant difference,  $H(3) = 79.935$ ,  $p = 0.000$ .

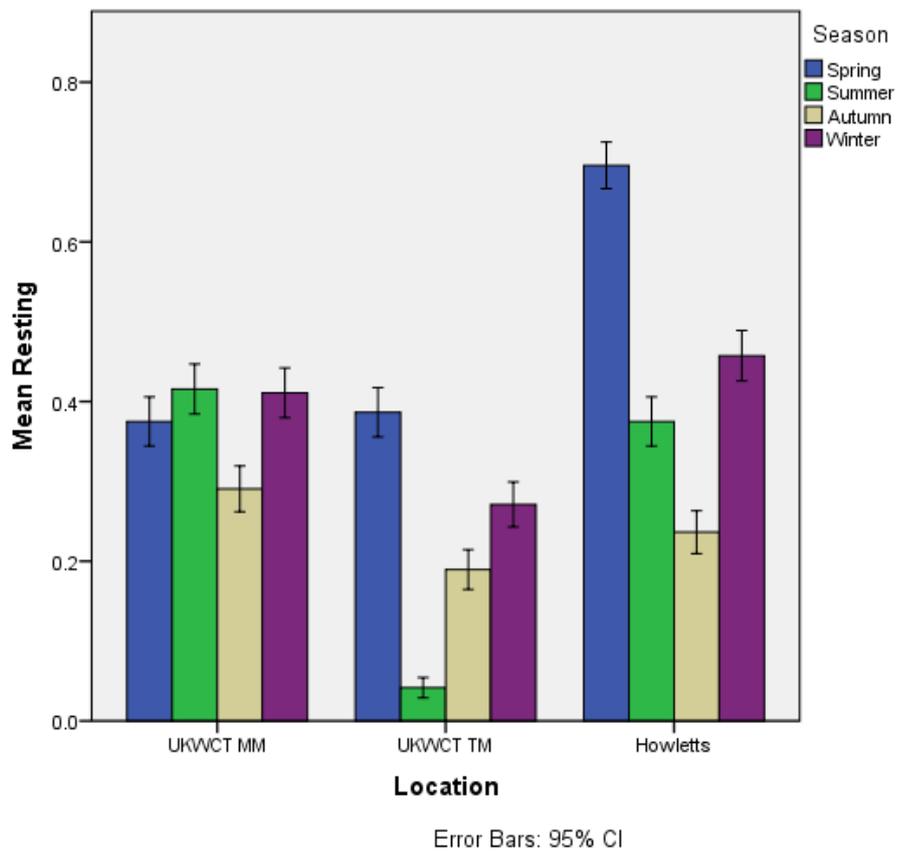


Graph 7. The mean frequencies of individual behaviours at each location.

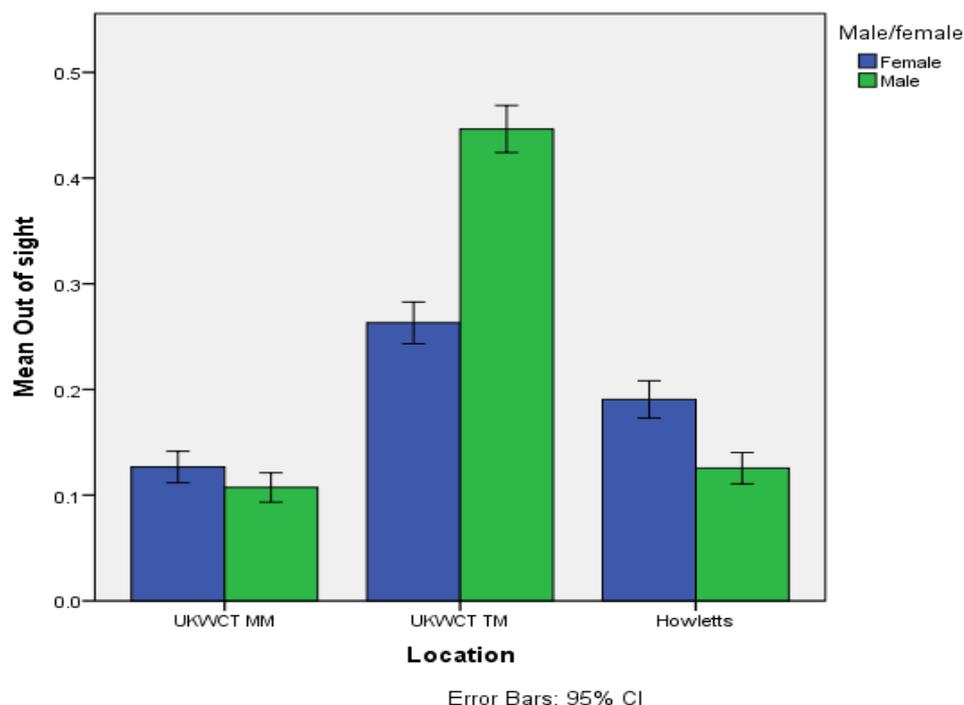
Graph 7 shows the mean frequencies of 10 individual behaviours at each location. Showing that "Resting" and "Out of Sight" were the most behaviours displayed by each individual, with the wolves at Howletts "Resting" the most, and Torak and Mosi "Out of Sight" the most.



Graph 8. The mean frequency of Out of Sight at each location during each season.



Graph 9. The mean frequency of Resting at each location during each season.



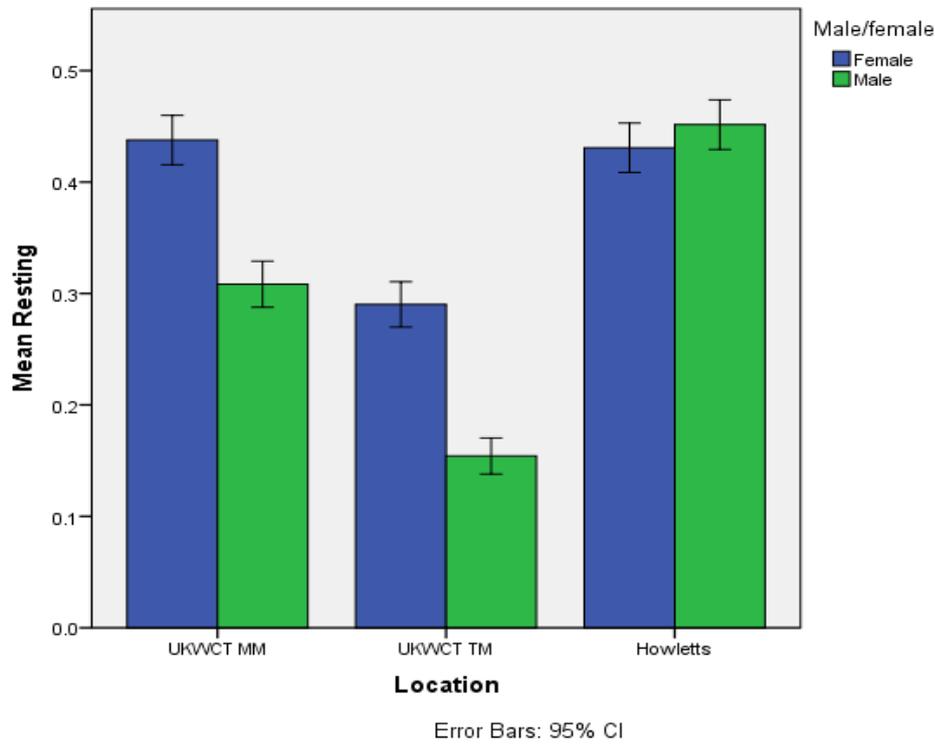
**Graph 10.** The mean frequency of Out of Sight divided by sex at each location.

Graph 8 shows the mean frequency for the behaviour "Out of Sight" at each location during each season. Showing that the wolves were "Out of Sight" the most during the "Summer," except for Motomo and Mai, this is a significant difference,  $H(3) = 635.518$ ,  $p = 0.000$ . Whilst Graph 9 shows the mean frequency of "Resting" at each location during each season. Showing Kago and Nushka "Resting" the most, especially during "Spring," this is also a significant difference,  $H(3) = 469.277$ ,  $p = 0.000$ .

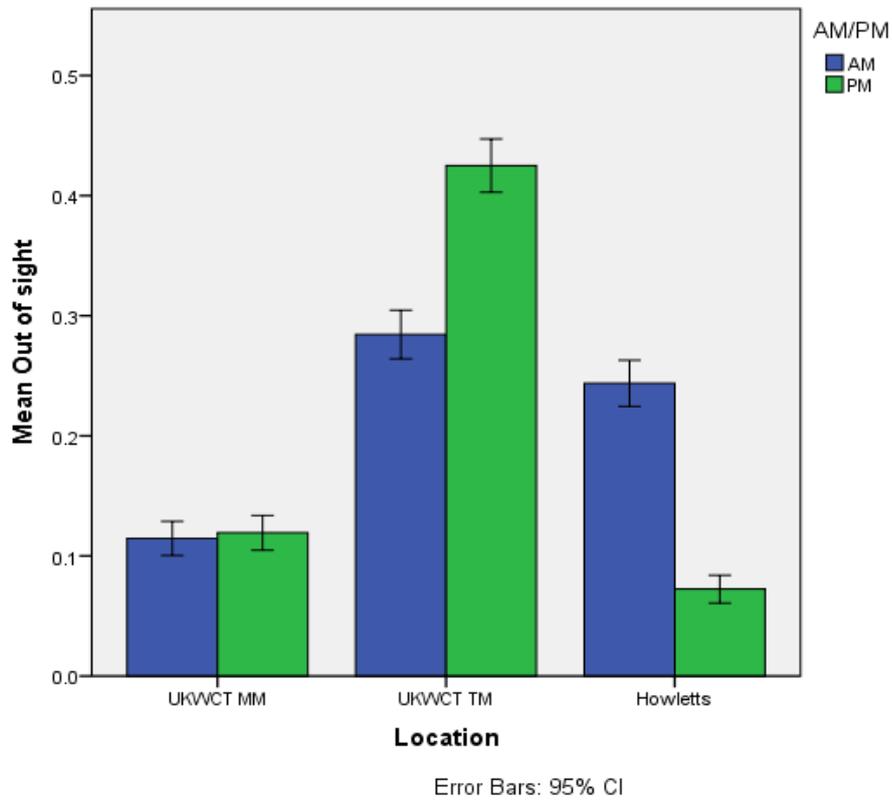
Graph 10 shows the mean frequency of "Out of Sight" divided by sex at each location. Showing that Torak is more "Out of Sight" than any other wolf, this is a significant difference,  $H(1) = 18.894$ ,  $p = 0.000$ .

Graph 11 shows the mean frequency of "Resting" divided by sex at each location. Showing that

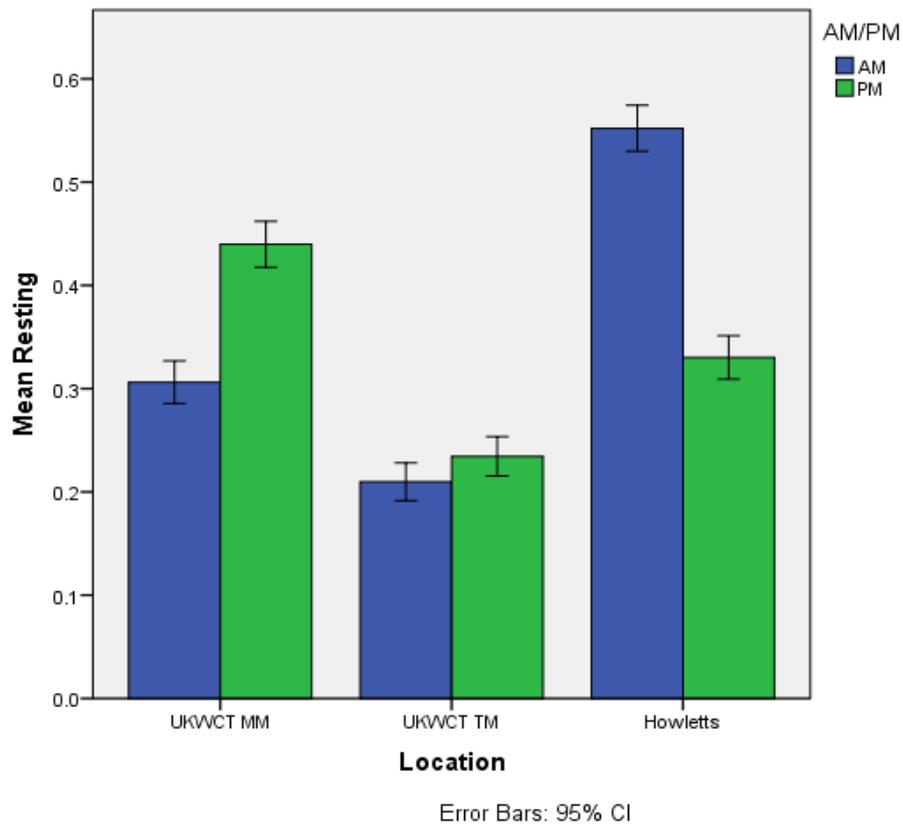
Kago and Nushka rested the most, closely followed by Mai, this is a significant difference,  $H(1) = 84.699$ ,  $p = 0.000$ .



Graph 11. The mean frequency of Resting divided by sex at each location.



Graph 12. The mean frequency of Out of Sight at each location divided into AM/PM.



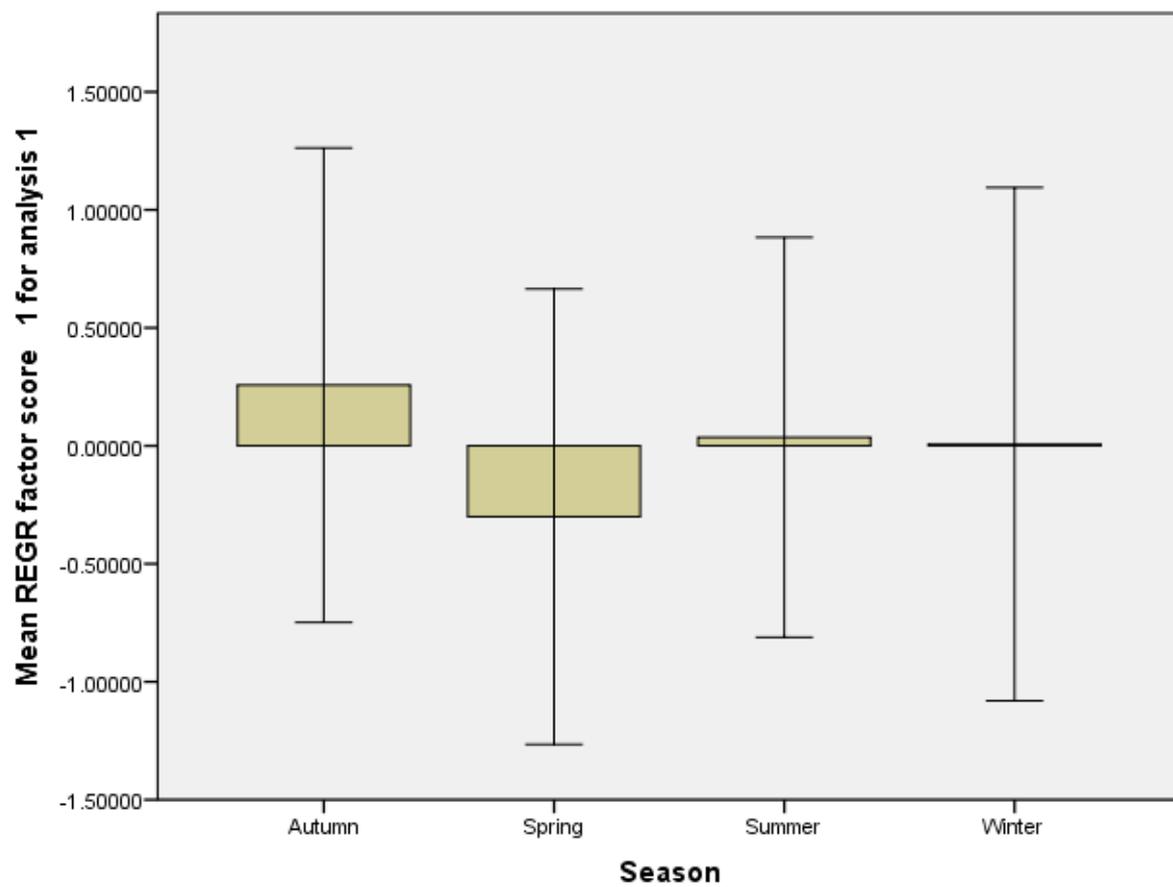
Graph 13. The mean frequency of Resting at each location divided into AM/PM.

Graph 12 shows the mean frequency of "Out of Sight" at each location divided into AM/PM.

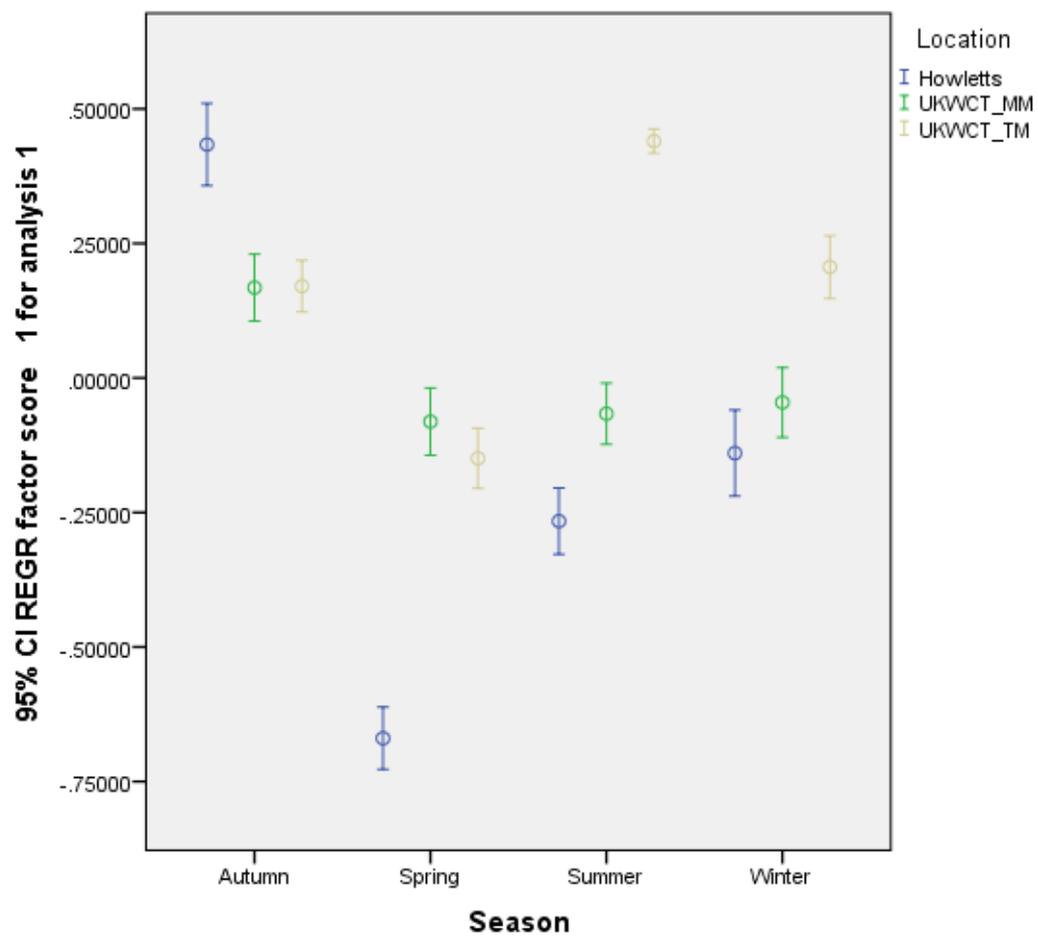
Showing that Torak and Mosi were "Out of Sight" more in the PM, with Kago and Nushka more in the AM and Motomo and Mai had little difference between AM and PM, however this is not a significant difference,  $H(1) = 1.308$ ,  $p = 0.253$ .

Graph 13 shows the mean frequency of "Resting" at each location divided into AM/PM. Showing that Kago and Nushka "Resting" the most during the AM, with Motomo and Mai more in the PM, Torak and Mosi had little difference between AM and PM. this is a significant difference,  $H(1) = 5.743$ ,  $p = 0.017$ .

This entire matrix was subject to a Principal Components Analysis (PCA) to derive a global overview of the 40 variables that comprise this data set (Shaw, 2003). The first principal axis (5.1% variance) was dominated by "active" activities, with the biggest positive loadings given to "Play Fight," "Walking" and "Standing," and negative loadings for resting, "Laying Down" and "Laying on Side." This first principal axis can therefore be seen as a surrogate for overall activity. It differed significantly between sites ( $\text{Chi-sq} = 168$ ,  $\text{df} = 2$ , \*\*\*) and seasons ( $\text{Chi-sq} = 418$ ,  $\text{df} = 3$ , \*\*\*), with the highest activities in "Winter" and the lowest in "Spring."



Error Bars:  $\pm 1$  SD



## Discussion

These results support the hypothesis that captive dominant wolves behaviour towards each other changes throughout the year, with the majority of interactions happening in "Winter." Even though there were more behaviours observed in "Autumn," the behaviours observed in "Winter" were more interactive in nature this can be seen in graph 2. These differences in behaviours correlate with the seasonal changes in the reproductive hormones in both male and female wolves suggested by Seal et al (1979).

The PCA shows over all the behaviours observed the majority of the "active" behaviours were observed during "Winter," with "Spring" being the least "active." This is confirmed by graphs 1 through 13. Out of the 16 interactive behaviours hypothesised to be witnessed 5 were not observed, these being; groom, paw, body rub, nibble and genital investigation. Possibilities for these behaviours not to have been may be due to the fact they happened when "Out of Sight" or on days when no observations were being recorded, there were also times when the wolves were in sight, but the behaviour was difficult to see due to the wolves facing the wrong way, or one of the pair standing in the way.

Of all the interactive behaviours "Follow" seems to be the one observed the most, although the wolves may not have actually been following each other, it is difficult to determine when they are following and when they are just walking in the same direction at the same time and therefore appear to be following. The pair to do this the most was Torak and Mosi, with Torak following Mosi more, this does happen in the wild, the male is always protective of the female, and as she starts coming into proestrus the male will start picking up this scent and become more attentive to her. Looking at graph 1 the main wolves to "Play" were Motomo and Mai, this would involve Motomo running full speed and then body slamming Mai, this is suggested by Busch (1995) as typical wolf behaviour, as this is what wolves have been observed doing in the wild and is thought by researchers to be a favourite game of theirs. It could be due to the two year age difference between

the pair, or the fact that Motomo was not hand reared. This was observed in Kago and Nushka once, but not in Torak and Mosi.

The results show that Kago and Nushka at Howletts would "Play Fight" during the "Autumn" and "Winter" months, more so in the "Autumn," as seen in graph 6, this may be due to their age, being the youngest pair being observed, having grown up together and not having mated before, it is more probable that they will play together. Older wolves have also been known to "Play Fight" this has been seen on numerous occasions in the wild (Busch, 1995) with Motomo and Mai being observed to "Play Fight" just not as often as Kago and Nushka, this behaviour was not observed in Torak and Mosi.

Graph 4 shows that only Kago and Nushka attempted to "Mount" each other, with graph 5 showing observations of Nushka also displaying the "Mount" behaviour, this was displayed in the "Autumn" which is what Mech and Boitani (2003) suggested a female wolf would do during proestrus. Kago would attempt to "Mount" Nushka during the "Winter," but during observations was unsuccessful, with Nushka responding with bites and growls. This may also be due to their age, wolves will begin mating at about 2 years of age, as both these wolves were only 1 at the beginning of the study, turning 2 during the study, it is unlikely they will produce pups this year. These results show that neither Motomo and Mai or Torak and Mosi at UKWCT mated during my observations, this could be due to observing them at the wrong time, even though wolves mate during January to December (Miklósi, 2007), data were collected at the end of February, as per the suggestions of the keeper, it was the last week in February and the weather had begun to warm up, there is no evidence on how the weather affects the mating behaviours, this could be a possibility for missing the mating behaviours.

The reason Torak and Mosi at UKWCT had the least amount of interactions was due to one or both of them being "Out of Sight" most of the time, as seen in graph 8, with "Summer" being the highest, this could be due to the foliage on the trees, with the enclosure being mostly a woodland area it is

difficult to see through the trees when they are in full bloom, during the "Summer" months. It would usually be Torak (graph 10) who would be "Out of Sight" and mainly in the afternoon (graph 12). During morning observations, both wolves will be waiting to be fed, staying out by the fence where they can see the kitchen, after eating Torak will usually walk away to a place that he was unable to be seen, even though this was determined not significant it was still observed and if this study were to be done again, camera equipment should be put out to avoid this.

The wolves being "Out of Sight" so much may also be because of their genes, since wild wolves will avoid humans (Miklósi, 2007), it is possible that in some captive wolves these genes and behaviours are still present and these could result in captive wolves displaying wild wolf behaviours.

Looking at the graphs show that all pairs of wolves were "Resting" a considerable amount, this means they were not very active at all. This is possibly due to the fact that as captive wolves they do not have to hunt for their food as it is handed to them or thrown over the fence, being captive wolves they also do not need to patrol the territory, in the wild these active behaviours could take up a lot of time. Observations showed Kago and Nushka at Howletts would be "Resting" during the morning, while Motomo and Mai, and Torak and Mosi at UKWCT would be "Resting" in the afternoon, as seen in graph 13. The reason for the pairs of wolves at the UK Wolf Conservation Trust would be more active in the morning is due to their feeding schedule, they would be fed between 12 and 1 o'clock, 6 out of 7 days, both pairs can see the kitchen from the front of their enclosures, resulting in them pacing at the fence and making them get excited when someone walked close to the kitchen door. Kago and Nushka were never observed being fed so there is no data collected as to the time this happened, however during observation in the afternoon, the zoo keepers would be more active around the enclosure, possibly making the wolves curious as to what is going on, also the animal in the next enclosure would get fed in the afternoon, making them excited, this suggests the possibility that they would be fed in the afternoon after data had been

collected. Being as young as they are they would chase children that would run up and down the fence, making the pair more active. With graph 13 showing they were "Resting" more in the morning this could possibly be due to not wanting to overheat during the heat of the day, which is usually between 11 and 1 o'clock. This inactivity seems to be "normal" behaviour in captive wolves, this may be due to not having to hunt or patrol their territory, like wild wolves do (Sillero-Zubiri and Macdonald, 1998).

In conclusion captive dominant wolves do indeed change their behaviour throughout the year, which coincides with the reproductive cycle, with spring and summer usually dedicated to pup care, hunting and territory patrolling in wild wolves, captive wolves, having to do none of these activities will spend most of the day resting. With autumn and winter dedicated to reproduction, captive wolves will show a little more activity, at least when it comes to behaviours towards each other, they do however still spend a lot of time resting, though not as much as during spring and summer, this is unlike wild wolves who will still have to patrol their territory and hunt, or else they will starve. If this study were to be done again it would be beneficial to collect data on wild wolves to compare with the captive wolf data and determine exactly what the difference in activity is. Also if this study were to be done again camera equipment should be set up so there would be no observations missed. Also collecting data for more days during each season and possibly for more hours during the day, getting to each place earlier and leaving later, would be beneficial to the study, to be able to observe more of these behaviours as well as behaviours not seen in this study.

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## **Disclaimer**

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