CAPTIVE SWIFT FOX BEHAVIOUR DURING THE SUMMER MONTHS

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Abstract

Captive swift fox summer behaviour was observed over eight twenty-four hour time periods. Eight different 'family' groups were examined for differences in behaviour with and without kits. There was no temporal difference in behaviour pattern between wild and captive swift fox. Captive swift fox exhibited diel activity patterns peaking at 0230h, 0800h and 2100h. Kits partook in more investigatory and play behaviours than adult swift fox. Females were significantly affected by the presence of kits. Wild born adult fox did not behave differently to captive born adults. The performance of particular behaviours were weakly correlated to temperature and windspeed..

Key words: *animal welfare, captive, parental behaviour, reintroduction, swift fox, wild*

Introduction

Swift fox (*Vulpes velox*) are currently extinct in Canada and seeking protection under the US Endangered Species Protection Act (1973). The animal is currently a "Candidate 1" species "Warranted" but "Precluded" (US Federal Register, Vol. 60. No. 166). They are extirpated from Canada and only occupy 10 per cent of their historic home range in the United States (Sharps, unpublished). They are the smallest North American canid: weighing on average 2 kg and being similar in size to a domestic cat (Egoscue 1979; Cabryn *et al* 1986; Cabryn *et al* 1994; Sharps unpublished, Weagle & Smeeton 1995; see Appendix 1, Figures c-p). They are believed to be mainly nocturnal and monogamous (Weagle & Smeeton 1995). Their mating season occurs during February and April. Kits are born 50 to 52 days after mating (Weagle & Smeeton 1995).

This swift fox reintroduction programme began in Canada in 1972 and was initiated by Beryl Smeeton, the founder of the Cochrane Ecological Institute, (C.E.I.). Today C.E.I. holds the only captive breeding colony of swift fox in the world (C.E.I. 1996).

The behaviour of captive endangered populations meant for reintroduction has received much attention and criticisms in recent years (Box 1991; Kleiman *et al* 1994

Shepherdson 1994; Wallace 1994; Synder *et al* 1996). Captive-bred animals may lose culturally transmitted and learned behaviours while in captivity (Stewart & Hutchings 1996). Successful reintroductions depend on pre-release conditioning and procedures (Bright & Morris 1994). Survival of many released species has been enhanced by pre-release training. Miller and colleagues (1990) enhanced predator avoidance in Siberian polecats (*Mustela eversmanni*) using mild aversive stimuli. Not all species require the same amount and type of training (Box 1991). Not all behaviours are learnt some are innate, and not so easily lost during captive breeding programmes (Stewart & Hutchings 1996). Not all captive breeding facilities are equally lacking in environmental design. Hence the degree of behavioural loss (if any) must first be assessed before initiating a training procedure.

Swift fox are believed to require extensive 'anti-predator' and 'foraging' training (Pruss 1994). This statement is presumptive, as swift fox captive behaviour has not previously been studied (Smeeton, pers comm). Little is known about the biology of this canid (Herrero *et al* 1986; Userk & Sharp 1986; Cabryn 1989; Pruss 1994; Smeeton 1993, 1994). The full array of behaviours exhibited by captive swift fox is unknown. Only by examining the behaviour of swift fox in captivity can the degree of behavioural lacking (if any) be assessed.

This paper quantitatively examines and describes: summer, captive swift fox behaviour. The behaviour of foxes with and without cubs is assessed. This description is used to compare temporal behaviour patterns. Behaviour of wild born and captive born swift fox are compared. Behaviour differences due to gender are analysed. A comprehensive description of captive swift fox behaviour over a full twenty-four hour time period is portrayed.

Methods

Site description

The Cochrane Ecological Institute is situated in the foothills of the Rocky Mountains, Alberta, Canada. The reserve consists of 160 acres of native mixed grass prairie (50%), wetland (10%) and mixed woodland (40%). Many large ungulates: moose (*Alces alces*), white tailed deer (*Odocoileus virginians)* and mule deer (*Odocoileus heminous*), roam the land. Coyotes (*Canis latrans*) and a varying population of waterfowl, passerines and raptors inhabit the reserve (Weagle & Smeeton 1995).

Subjects

Eight adult female, eight adult male and nineteen kits (cubs), swift fox served as subjects. They were pair housed in eight pens. A male and female of reproductive age and their offspring (if present), were contained in each pen. These rectangular enclosures averaged 14m x 7m in size and were made of 2.5m x 3m chain link panels with a 0.6m overhang and 0.6m of ground wire (Weagle & Smeeton 1995). Two artificial den boxes consisting of three wooden chambers covered by an insulating "A"-frame were contained in each enclosure. The base of each enclosure consisted of the surrounding native prairie flora (Weagle & Smeeton 1995; see Appendix 1, Figures a-b). The thirty-five observed animals consisted of eight 'family' groups: (1) Four male and female pairs with no kits; (2) Three pairs with five kits and; (3) One pair with four kits.

Three adult males were wild born the other five were captive born. Two females were wild caught while the rest were captive born. The age of the adult foxes ranged from 1 to 10 years. The age of the wild born foxes could not be determined.

Each fox was fed three, dead day old chicks and a portion of raw meat (either road kill or horse meat). All foxes were fed the above once a day at 2000h. All 'families' with kits received supplementary feeding of three chicks per kit each day, at 1000h. Water was changed each day.

Research design and procedure

One hundred and ninety-six hours of observational data were collected from 1st July 1996 to the 14th August 1996. Each of the eight pens were instantaneously time-sampled for a full twenty-four hour period using methods described by Martin & Bateson (1993). Daylight hours lasted from 0500h to 2230h for most of the observation period. These daylight hours were divided into: six two-hour samples, one three-hour sample (0500h-0800h) and one, two and half hour sample (2000h-2230h). Behaviours were recorded at minute intervals for each sample period. Three or four samples were recorded each day. No pen was observed more than once per day.

Three hides were made, consisting of wire and cloth to limit observer effect on the foxes as particular animals failed to habituate to the observer.

Night observations consisted of eight six and a half hour (2230h-0500h) sample periods. Behaviours were recorded every two-minutes using the same method of scanning as described above.

A Moonlight NV-100 night scope was used to allow observation at night. An infra-red Cam Light was used to illuminate check-sheets. Each time interval was signalled by a Sarabe C Pocket Vibrating timer worn on the wrist. 'Beepers' could not be used as they would disturb the foxes too much. Nixon 8x21 CF binoculars enhanced viewing whenever necessary.

The adults could be identified due to differing facial components and behaviours. Individual cubs could not be identified. Table 1 describes all behaviours recorded (see Appendix 1, Figures c-p, for pictures of particular behaviours).

Table 1 Ethogram of behaviours examined.

Behavioural category	**Definition**
Resting alert	All cases of sitting, lying or standing while not asleep.
Sleeping	Curled in a ball or lying stretched out with eyes closed.
Investigating	Walking, running or standing while sniffing at enclosure.
Walking and running	Obvious.
Cache	Digging a hole , placing a food item and covering the item with debris using movements of the nose.

Table 1 Continued.

Behavioural category	**Definition**
Eat	All masticatory behaviours associated with food ingestion.
Food Gather	Collecting and carrying of food in the mouth.
Food Beg	Positioning of mouth and nose close to mouth and nose of conspecific while wagging the tail.
Self Groom, Groom kit, Groom adult	Biting, nibbling or scratching of own body, kit's body or adult's body.
Play chase	Running, chasing alone or with one or more conspecific.
Play fight	Wrestling, tumbling biting and jumping with one or more conspecific.

Playing with object	Biting, tossing and jumping on an object.
Stalking	Observing an object or animal in a crouched position, with ears laid back with the intention of attack.
Dig	Using front paws to claw at substrate.
Out of sight	Animals are not seen in the enclosure.
Eliminating	Obvious.
Rolling	Rubbing face and flank on the ground or on object.
Aggression	Any antagonistic behaviour directed to conspecific.
Stretching	Elongating of limbs usually accompanied by a bout of yawning.

Temperature and windspeed were constantly recorded by the on sight weather station monitor.

Data analysis

The total number of occurrences of each behaviour type per adult fox per hour was calculated. The percentage occurrence of overall cub behaviour per hour per pen was assessed. Statistical analysis was performed on these data using the statistical package Minitab for Windows version 9.2. Non-parametric Mann-Whitney statistical tests were used to analyse differences in: kit/adult behaviour; male/female behaviour; behaviour of females with kits/females without kits; behaviour of males with kits/males without kits; parental behaviour of males and females. Kruskal-Wallis non-parametric statistical tests were used to assess differences in behaviour due to: time of day, windspeed and temperature. Behaviours were correlated to windspeed and temperature using Rank-Spearman correlations.

Results

Daily time budget for swift fox

The mean time spent above ground per hour was assessed. Swift fox were least active between 1100h and 1700h (Figure 1). Three main peaks of activity occurred at 0230h, 0800h and 2100h.

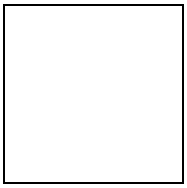

Figure 1 Mean time spent above ground per hour for captive swift fox.
Indicates hours of darkness.

All behaviour types apart from play-fighting, aggression and eliminating were affected by time (see Table 2). The pattern of occurrence of different behaviour types are shown in Figures 2-4.

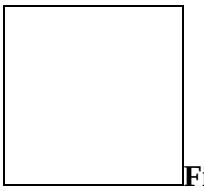

Figure 2 Shows the mean occurrence of resting alert, sleeping and investigating per hour over a twenty-four hour time period.
Indicates hours of darkness.

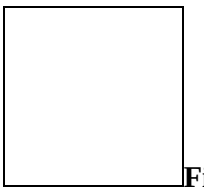

Figure 3 Shows the mean occurrence of eating, caching and grooming per hour over a twenty-four hour time period.
Indicates hours of darkness.

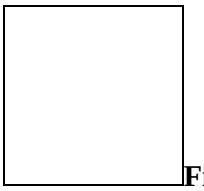

Figure 4 Shows the mean occurrence of playing and stalking per hour.
Indicates hours of darkness.

Table 2 Behaviours affected by time.

Behaviour	***H* value**	***P* value**
Rest alert	92.79	< 0.001
Sleep	37.86	< 0.03
Investigate	98.32	< 0.03
Walk	37.80	< 0.001
Cache	62.45	< 0.001
Run	77.24	< 0.001
Self-groom	47.40	< 0.003
Groom-kit	41.64	< 0.03
Groom-adult	46.47	< 0.005
Play-chase	40.46	< 0.03
Dig	53.17	< 0.001
Food-gather	63.96	< 0.001
Stalk	48.61	< 0.003
Out-of-sight	94.48	< 0.001

All *df* =23

The effect of temperature on behaviour

Certain behaviours were shown to be affected by temperature (see Table 3.1). Resting alert, investigating, running, play-chasing and digging were negatively correlated to temperature. Out-of-sight was positively correlated to temperature. All of the correlations were weak correlations (see Table 3.2).

Table 3.1 Behaviours affected by temperature.

Behaviour	***H* value**	***P* value**
Resting alert	29.07	< 0.001
Investigating	30.31	< 0.001
Run	34.90	< 0.001
Play-chase	19.76	< 0.005
Dig	16.00	< 0.03
Out-of-sight	38.38	< 0.001

All *df* = 6

Table 3.2 Correlation of behaviours to temperature.

Behaviour	***RS* value**	***P* value**	
Resting alert	- 0.194	< 0.05	
Investigating	- 0.200	< 0.05	
Run	-0.246	< 0.05	
Play-chase	-0.171	< 0.05	
Dig	-0.15	< 0.05	
Out-of-sight	0.232	< 0.05	

The effect of windspeed on behaviour

Certain behaviours were affected by windspeed (see Table 4.1). Resting alert, investigating, eating, caching, running and digging are negatively correlated to windspeed. Out-of-sight is positively correlated. However, again all of these correlations are weak (see Table 4.2).

Table 4.1 Behaviours affected by windspeed.

Behaviour	***H* value**	***P* value**
Resting alert	31.27	< 0.001
Investigating	25.53	< 0.001
Eat	9.19	< 0.03
Cache	12.41	< 0.01
Run	17.55	< 0.003
Dig	12.88	<0.01
Out-of-sight	41.12	< 0.001

All *df* =6

Table 4.2 Correlation of behaviours to windspeed.

Behaviour	***RS* value**	***P* value**
Resting alert	- 0.191	< 0.05
Investigating	-0.229	< 0.05
Eat	-0.138	< 0.05
Cache	-0.160	< 0.05

Run	-0.191	< 0.05
Dig	-0.164	< 0.05
Out-of-sight	0.288	< 0.05

Difference in behaviour of wild born versus captive born adults

There was no statistical difference in the performance of twenty out of twenty-two behaviours assessed. Wild born swift fox 'play-chase' less than captive born swift fox (W=54543.0, P< 0.03). Wild born swift fox 'play fight' less than captive born swift fox (W=54918.5, P<0.03).

Difference in male adult behaviour versus female adult behaviour

Female swift fox 'groom-kits' significantly more than male swift fox (W=35233.5, P<0.01). There was no significant difference in the performance of any other behaviour due to gender.

Difference in behaviour of adults versus kits

Kit, swift fox differed in behaviour to adult swift fox. There was no difference in the amount of time spent: resting alert, running, food-gathering, rolling or out-of-sight. Adults spent less time: investigating, eating, caching, self-grooming, grooming-kits, grooming-adults, stretching, play-fighting, play-chasing, playing with object, digging, food-begging, eliminating, and stalking than kits (see Table 5). Adults spent more time sleeping than kits (W=94535.0, P<0.003).

Table 5 Behaviours performed more significantly by kits.

Behaviour type	***W* value**	***P* value**
Investigating	87356.0	< 0.001
Eating	88410.5	< 0.001
Cache	89975.5	< 0.003
Self-groom	89956.5	< 0.005

Groom-kit	88642.5	< 0.001
Groom-adult	91280.0	< 0.03
Stretch	91439.0	< 0.05
Play-chase	84073.0	< 0.001
Play-fight	86806.5	< 0.001
Play-object	85638.5	< 0.001
Dig	85615.0	< 0.001
Food-beg	91059.5	< 0.001
Eliminate	90369.0	< 0.001

Behaviour of males with kits versus males without.

There was very little difference in behaviour of males with and without kits. Males with kits rested alert more (W=10195.5, P= 0.005) and slept more (W= 98854.0, P < 0.01) than males without kits. Males with kits cached less (W=8875.0, P< 0.03), ran less (W=8568.5, P< 0.01) and spent less time out-of-sight (W=8478.5, P<0.03). Males with kits were never observed playing with objects.

Behaviour of females with kits versus females without

There is no difference in the performance of sleeping, adult-grooming, digging and stalking. Females without kits never play-fought. Females with kits were never observed playing with objects. Females spent less time out-of-sight if they had kits (W=7387.0, P<0.001). Females with kits spent more time resting alert, investigating, walking, eating, caching, running, self-grooming, play-chasing and food-gathering than females without (see Table 6).

Table 6 Behaviours performed more often by females with kits than females without.

Behaviour type	***W* value**	***P* value**
Rest alert	11134.0	< 0.001

Investigating	10721.0	< 0.001
Walk	10069.5	< 0.003
Eat	9661.0	< 0.05
Cache	9690.5	<0.01
Run	10133.5	<0.003
Self-groom	10012.5	<0.01
Play-chase	9889.5	<0.003
Food-gather	9849.0	<0.001

Difference in Male and Female behaviour with kits

There was no difference in amount of resting alert, sleeping, rolling, grooming of adults, play chasing, play fighting, digging, food-gathering, aggression, and stretching. Males spend more time out-of-sight than females (*W*= 10212.0, P< 0.01). Females with kits spend more time investigating, walking, eating, caching, running, self-grooming and stalking than males without kits.

Table 7 Behaviours performed more often by females with kits than males with kits.

Behaviour type	***W* value**	***P* value**
Investigating	8038.5	< 0.001
Walking	8465.5	< 0.003
Eat	8829.0	< 0.03
Cache	8921.5	< 0.03
Run	8349.5	< 0.01
Self-groom	8446.0	< 0.003
Stalk	8929.0	<0.01

Discussion

Captive swift fox have been shown to be active over extended periods during the day and night. Three peaks of activity have been observed: 0830h (three hours after dawn) and 2100h (an hour and a half before dusk) and 0230h (see Figure 1).This temporal activity pattern is almost identical to that described by Pruss (1994) for wild swift fox during the whelping/rearing period: "… the highest percentage of each hour spent above ground in the morning occurred several hours after dawn (i.e., 0830h)… the evening peak…occurs around 2000h which is up to two hours prior to dusk, although this pattern was variable among weeks." The 0230h peak exhibited by captive swift fox was not shown in wild swift fox. Pruss (1994) was not able to comment on activity levels at 0230h or through the night due to insufficient data.

Swift foxes were the least active between the hours of 1100h and 1700h (Figures 1-4). This was the hottest time of the day. Behaviour is affected by temperature, yet weakly correlated. Pruss (1994) and Weagle and Smeeton (1995) suggest that high temperature levels force swift fox underground (or into den boxes). This may be the reason for the decreased activity pattern mid-day. However, it does not explain the 0830h morning peak. If it was merely temperature constraints forcing the foxes underground the activity peak should be higher in the early hours of the morning, before dawn when it is cooler. These two peaks may be correlated with the presence of preferred prey such as prairie dogs (*Cynomys ludovicianus*; Sharps, unpublished). Captive swift fox are not solely crepuscular or nocturnal but exhibit diel activity during the summer months.

The patterns of occurrence of particular behaviour types were analysed to find what behaviours were occurring during peak activity hours. Three peaks of resting alert occurred throughout the twenty-four hour period: 0300h, 0830h and 2000h (Figure 2). This mirrors the overall above ground pattern (Figure 1). This is not surprising, as resting alert was the most frequently performed behaviour type. Two peaks of sleeping were observed. Although captive swift fox are above ground from 0600h they sleep around their den boxes until 0800h when they become more active (Figure 2). Investigatory behaviours occur mostly in the evening, through the night until dawn. Pruss (1994) describes investigating as an integral part of hunting behaviour. At night the foxes may be hunting small prey such as mice and insects. They could be heard eating however, what they were eating could not be identified.

Playing and grooming showed three similar peaks during the twenty-four hour time period 0230h, 0800h, 1300h. Both of these behaviours were performed more often by kits (Table 5). Playing peaked at 1900h and decreased at 2000h, presumably because the foxes were fed. Feeding behaviour usually overrides play behaviour (Grier & Burk 1992). Grooming peaked at 2200h. This was after the foxes were satiated and had eaten.

Eating and caching were closely associated behaviours (Figure 3). Two peaks of eating occurred at 2030h and at 1000h. This corresponds to the feeding time. Caching occurred most after the night time feed and not the morning feed (Figure 3). Perhaps the foxes were more hungry during the morning. Males with kits were shown to cache less than males without, yet the females cached more. Perhaps foxes with kits cached less as there was less excess food to store.

Stalking peaked once during the twenty-four hour period at 2000h. This behaviour seems to be associated with the presence or anticipation of food. The motivation to hunt may be highest at this time as the foxes may be hungry . It has been documented in many vertebrates that vigour and persistence of an act of predation increases with hunger (Curio 1976; Grier & Burk 1992). Caching and hunting are closely related to eating: these behaviours occurring mostly when the animals were fed. However, caching peaked for a second time at 0200h. Perhaps the foxes were storing live-caught prey.

Both temperature and windspeed affect the performance of behaviour. Certain behaviours are performed less when windspeed is high or temperature is high (Tables 3.2 and 4.2). Animals spend more time out-of-sight with extremes of temperature and windspeed. However, this effect may not be quite as strong as previously believed (Weagle & Smeeton 1995). The correlations are low and none above 0.29 (Martin & Bateson 1993). Perhaps, the temperatures and windspeeds examined were not as extreme as in other seasons. This may explain this contrasting result.

Captive born swift fox adults did not differ in behaviour to wild born swift fox. Although they played less, this result could be attributed to the presence of the kits. It has been shown that adult domestic cats play more in the presence of kittens (Martin 1984).

As to be expected, play and investigatory behaviours are performed more often by kits than by adults (Table 5). Digging, caching and grooming are also

performed more often by kits. Play has often been described as necessary in the natural development of juveniles (Martin 1984). Bateson (1981) refers to play as ‘scaffolding’ for building natural adult behaviour. Caching, digging and hunting and investigating are essential for swift fox survival upon release into the wild: hunting, allows the animal to forage and feed; digging allow the animals to construct shelters; caching allows the animal to store food; investigation allows an animal to navigate a complex terrain (Kleiman 1989). These behaviours, performed more by kits than by adults could be attributed to the fact that they are learning and perfecting necessary skills. Captive kits play in a similar manner to wild kits as described by Pruss (1994). Perhaps these behaviours are innate in swift fox or learned from their parents. Adult swift fox also exhibit behaviours described by Kleiman (1989) as necessary for survival. Also adult swift fox were observed to partake in teaching behaviours such as: anti-predator training (stalk and rush) and caching techniques. Pruss (1994) documents and describes the occurrence of these behaviours in the wild. The adult parent teaches the kits how to cache, catch prey and avoid predators. All of these training behaviours were observed to occur in captive swift fox.

There was no overall effect of gender on the performance of particular behaviours. However, female swift fox with kits behaved differently to females without kits. Also females with kits were more affected by the presence of kits. Again this result is as expected. Females usually contribute more to parental care than males. Foxes have been documented as halving the parental burden (Slukin & Herbert 1986).

Males were only slightly affected by the presence of kits. Males with kits spent less time out-of-sight than males with kits. However, they rested alert and slept more than males with kits. Perhaps they spent this time guarding the kits.

Females spent more time in behaviours involving kits (Table 6). They play-chased, food-gathered and investigated more. Pruss (1994) refers to ‘caching training behaviour’ performed by female parent swift fox. This could explain the increase in the amount of caching performed by these females. Male swift fox with kits cache less than males without. Perhaps the increase in caching by the females reduces the amount of caching performed by the male.

Females with kits eat and self-groom more than females without. These females may need to eat more to replenish lost body mass decreased by current or past lactation. Also they may be more active due to the presence of energy demanding kits.

Macdonald (1987) has described the negative effect of cubs on the condition of red fox *(Vulpes vulpes)* mothers. These swift fox mothers may be trying to restore coat condition and clean any wound inflicted by rough play.

Implications

Captive swift fox behaviour as measured by this study does not differ from wild swift fox behaviour, as much as has been suggested by Pruss (1994). However, further behavioural studies need to be undertaken in the wild to assess what wild swift fox actually do. This paper is by no means conclusive. It is merely a stepping stone and an insight into swift fox behaviour. Only when the cause of mortality in the wild is fully assessed can steps be taken to cure it in captivity, if it is a problem of captivity at all.

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