

BEHAVIOURAL ASPECTS OF THE SWIFT FOX (*Vulpes velox*) REINTRODUCTION PROGRAM. Weagle, K.¹ and C. Smeeton², Cochrane Ecological Institute, PO Box 484, Cochrane, Alberta, Canada T0L 0W0

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Swift Fox Reintroduction

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ABSTRACT

The Swift fox reintroduction program began in Canada in 1983, prior to this date a captive breeding colony of Swift fox was established at the Cochrane Ecological Institute. Captive bred animals have contributed 646 young to the releases vs 64 wild caught Swift fox trans-located from the United States. Because the Swift fox is extirpated in Canada and has substantially reduced numbers in the USA little is known of their social behaviour. It was postulated that their behaviour (living in social groups rather than independently) could significantly affect the reintroduction program. Observations were made on three groups of animals at the captive breeding colony, three sibling pairs in a 9 hectare enclosure, five aged animals in a 0.6 hectare enclosure and 22 breeding pairs in small enclosures. It was found that the Swift fox appeared to prefer live in groups, that rearing animals in larger enclosures resulted in more successful hunting habits, and that vocalisation played an important part in Swift fox breeding and survival. These findings have resulted in a change in the release strategy of the Swift fox to the wild, with new efforts being concentrated on building or adding to colonies in areas of suitable habitat rather than releasing smaller groups over wide areas of prairie.

KEY WORDS - extirpated species, *Vulpes velox hebes*, prairie, Alberta, Saskatchewan, Canada

Introduction:

The Swift fox (*Vulpes velox*) is unique to the Great Plains of North America. Historically the range of the Swift fox included most or all of the 12 great plains States in the U.S. and the prairie regions of four Canadian Provinces (Hall and Kelson, 1959; Egoscue, 1979; U.S. Fish & Wildlife Service, 1995). Despite the species' unobtrusiveness the Swift fox was considered common or abundant in its original range until the late 1800's (U.S. FISH & Wildlife Service, 1995, FaunaWest ,1991)

The Swift fox is the smallest of North American canids, adult animals weigh an average of 2 kg. and measure 30-32cm at the shoulder and are 77 - 79 cm in length. The species is largely nocturnal and spends up to 16 hours out of 24 underground. The historic range of the Swift fox in Canada and the U.S. included prairie, steppe (short grass) and savannah (Banfield, 1974). One third of the total historic range of the Swift fox is north of the 49th latitude. The northernmost records of Swift fox are from 7,750 year old Swift fox bones excavated from the hearths and fire pits of the Plano peoples in the parkland country of central Alberta, a transitional area between grasslands and forest which changed its boundaries with the changing climate (Doll, 1982).

The Swift fox, like the blackfooted ferret (*Mustela nigripes*), burrowing owl (*Athene cunicularia*), and ornate box turtle (*Terrapene ornata*), was also commonly found in association with one of the three species of great plains prairie dog (*Cynomys sp.*). Before this association could be studied the Swift fox had been extirpated over much of its historic range (Smeeton, 1994). The taxonomic status of the Swift fox (*Vulpes velox*), and its possible subspecies, the Northern Swift fox (*Vulpes velox hebes*) is still under discussion.

The North American prairies are one of the world's most radically and rapidly altered biomes. It is speculated that the transformation of the land in less than 200 years from native prairie to cropland combined with the wholesale slaughter of the Plains bison had a significantly detrimental effect on the indigenous species of the Great Plains (Webb, 1931; Roe, 1970; Smeeton, 1993). An intense poisoning and trapping programme designed to eradicate the Plains wolf and grizzly and the reduction of once enormous prairie dog towns were a contributing cause of the complete disappearance of the Swift fox in Canada and from over 3/4ths of its known range in the U.S. (Carlington, 1980). The Swift fox is classed as extirpated in Canada (C.O.S.E.W.I.C. 1978) and as occupying an estimated 10% of its historic range in the U.S. (U.S. Fish & Wildlife Service, 1995). At the time of writing the Swift fox is Listed by the U.S. Department of the Interior as endangered (U.S. FISH & Wildlife Service, 1994), and the Petition to include the protection of the Swift fox under U.S. Endangered Species Protection Act (1974) has just completed its 12 month finding to conclude that protection of the species is warranted but precluded (U.S. Fish & Wildlife Service, 1995).

The Swift fox is a secretive, largely nocturnal species, of little commercial value. These

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factors have meant that little is known of the species' behaviour, existing wild population numbers (in the U.S.), or habitat requirements.

Apart from the effects of the transformation wrought by man on its habitat, and continued trapping and poisoning in the U.S., the Swift fox also falls prey to a wide variety of prairie species including Buteo's, hawks, owls, red fox (*Vulpes vulpes*), coyote (*Canis latrans*), and bobcat (*Lynx rufus*). It is thought that avian and mammalian predation on the Swift fox might also have increased as a consequence of changing and shrinking habitat (U.S. FISH & Wildlife Service, 1995)

CAPTIVE BREEDING and REINTRODUCTION PROGRAMME: World-wide, 64 adult Swift fox are held in eight institutions (ISIS, 1994), of the animals held, a total of 20 at 7 institutions are on display. With the exception of Kamloops Wild Animal Park (Kamloops, British Columbia, Canada) the zoos which exhibit Swift fox in Canada hold them in small enclosures, designed for easy and efficient management by Zoo personnel.

The attempt to re-introduce the Swift fox to Canada began in 1972, initiated by Miles & Beryl Smeeton at the Wildlife Reserve of Western Canada (now the Cochrane Ecological Institute), six years before the species was declared extinct in Canada. The founder foxes for the programme came from wild stock in U.S. The Cochrane Ecological Institute (CEI) now has 54 Swift fox (84% of the total captive animals world wide). The animals at CEI are bred specifically for re-introduction and release and are not on display. For this reason the CEI management practices for Swift fox differ markedly from those of the other facilities holding this species.

Over the past 12 years, 646 captive bred Swift fox have been provided for release to the re-introduction programme (Table 1). Over the same period the provincial & Federal Governments have captured and translocated 64 Swift fox from the U.S. for release in Canada. These 64 translocated animals were trapped on the Colorado/New Mexico border, the Pawnee National Grasslands, South Dakota, Colorado, and Wyoming .

"Soft" release methods (pens built in the release sites, where the foxes were fed, and from which they were later released) were used initially by Government authorities. Later the decision was made to change to the less expensive in equipment and manpower "hard" release method (kennelled foxes turned out into the release sites) (Brechtel, et al, 1993).

Prior to 1993 the CEI was not involved with release procedures or researching release sites. In 1993 the CEI developed a release protocol which used Portable Protective Shelters and initial 24 hour monitoring of captive bred Swift fox released in the newly established Grassland's National Park (Smeeton, 1994).

METHODS

CEI is situated in the foothills of the Rocky Mountains and within the historic range of the Swift fox. The facility consists of 160 acres of 50% native mixed grass prairie, 10% wetland, and 40% mixed woodland. At present, the large ungulates using the CEI are Moose (*Alces alces*) and Whitetail deer (*Odocoileus virginians*). There is a varying population of coyote (*Canis latrans*), and a fluctuating population of waterfowl, passerines, and raptors.

Life Histories and Behavioural Observations: A studbook and observations on the life histories and behaviour of the Swift fox have been made at Cochrane Ecological Institute since its creation in 1972. Detailed observations have been made since 1993. Three types of housing for the captive bred Swift fox have been observed:

1. Single Pair Enclosures - CEI has a total of 23 single pair enclosures. These enclosures average 18 m. X 12 m. in size, and are made of 2.5 m. X 3 m. chainlink panels with a 0.6 m. overhang and 0.6 m. groundwire piled with rocks. The floor of the enclosures consists of native prairie and 5% of them included aspen trees (*Populus tremuloides*). Each enclosure contains two artificial den boxes. The den boxes consist of three connected chambers and are covered with an insulated "A"- frame.

The single pair enclosures contained two breeding age Swift fox. These animals varied in age from juveniles (less than one year) to 14 years. From 1993 to 1995 the total number of breeding pairs has varied from 19 to 25.

2. 9 Hectare Enclosure - A group of six, five month old, Swift fox from three litters (three males, three females) were introduced into a 9 hectare native prairie enclosure in November 1993. The enclosure consists of 40% open prairie, 10% bog, 50% mixed aspen and spruce groves. The enclosure is surrounded by a 2.5 meter high fence with a 0.6 m. over hang and a 0.6 m. ground wire. Seven widely spaced artificial den boxes and one artificial "mound" (expanded polystyrene on wire over a three chambered box) are contained within the 9 hectares. Of the eight artificial shelters, two were in the woodland, and the remaining six in the open country (Figure 1).
3. 0.7 Hectare Pen - A group of five aged, unrelated adult Swift fox (1 male 4 females) which had spent their entire lives in single pair breeding pens, were introduced into a 0.7 hectare enclosure in October 1994. The enclosure is natural prairie with mixed aspen and spruce trees, there is no understorey in the enclosure and no open country. Six artificial den boxes were widely spaced within the pen.

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Food Habits: During the summer of 1994 scat samples from the 9 hectare enclosure were analysed to determine the food habits and hunting success of the Swift fox in that enclosure. During the period the six Swift fox were fed a diet of dead, day old, chicks and raw meat (either horse or road killed mule or Whitetail deer, or moose). The daily ration of food over the year averages four chicks per fox and approximately 110 g. of meat per fox. In the spring of 1994 one of the pairs of Swift foxes produced three kits, therefore during the experiment the population in the large pen was nine individuals (six adults and three kits).

A total of 97 Swift fox scat were collected from the large pen from July 27 to September 6, 1994. To increase the efficiency of scat collection a series of 10 flat rocks (approximately .25 m. by .25 m.) were placed along the collection route in the enclosure.

These rocks acted as "landmarks" where the Swift fox regularly defecated. The daily route also visited the den sites (both artificial and natural) that were known to be active during the study. The daily collection occurred at approximately 5:00 PM each day. The Swift fox population in the large pen was fed a weighed amount of food at approximately 8:30 PM each day.

For analysis the scat was soaked in water for 30 minutes. While still in the water the contents were pulled apart using two pairs of dissecting tweezers. The water was then sifted through a series of sieves down to a mesh size of 0.5 mm. The sifted contents were identified and stored in 70% alcohol or formaldehyde. Identification of hair and fine matter was done with a 10X hand lens of an American Optical dissecting scope (X10 ocular and X4, X10, X40 and X100 exocular). The species identification of the material whether mammalian or insect was done by comparison with the reference collection.

Swift Fox Vocalisation: From February to April 1995 a detailed study was initiated on the vocalisation of the Swift fox. The study included the recording of over 400 individual lubricious bays from the captive population. Calls were recorded using a *SONY WM-D6C* Professional Walkman and a *SONY ECM-Z157* Electret Condenser Microphone. It was endeavoured to make the recordings from as close to the fox as possible, first to enhance the quality of the recording, and second to ensure that the fox which was calling could be correctly identified. Most calls were recorded from a distance of 10 m. Recorded calls were transferred to the computer using *Creative Wave Studio v.2* for *Windows*, in conjunction with the *CREATIVE SoundBlaster AWE32* sound card.

Observations on the lubricious bay frequencies were made on three days for a 24 hour period (2- 3 March, 4 -5 March and 6 - 7 March, 1995). Calls were noted for every 15 minutes during the period.

Five tapes were made of the lubricious bays recorded from the captive colony. The frequency of calls on the tapes and the number of foxes were: Tape 1 - single fox, 1 call per minute; Tape 2 - single fox, 2 calls per minute; Tape 3 - single fox, 4 calls per minute; Tape 4 - single fox, 12 calls per minute; and Tape 5 - 4 foxes, four individual

calls every 20 seconds for a total of 12 calls per minute. The tepees were used to elicit responses from captive population. To test the responses to the tapes each tape was played for a 30 minute period and the responses noted before (30 minutes), during (30 minutes) and after (60 minutes) the tape was played.

In addition to the lubricious bays observations have been made on the warning barks and incidental vocalisation made during greeting and rearing.

RESULTS

Life History: The life history of the Swift fox in the captive breeding facility is summarised in Figure 2. Sexual maturity occurs in the winter of the first year (approximately 10 months) for both males and females. The breeding success of various combinations of adults and juveniles is summarised in Table 2.

The mating season begins in late February and continues until March. The Swift fox gestation period is 50 to 52 days. The actual mating dates were determined from the date of whelping which ranged from mid April to early June. During the mating season the Swift Fox, both male and female, attracted mates using a lubricious bay. The call was composed of a series of short barks and was distinctive for each individual. Established pairs mated earlier in the season than couples containing younger individuals and after mating the calling stops. It is possible that vixens past breeding age cease to call during the breeding season.

During the mating season (February/ April) the foxes in the 9 hectare enclosure exhibited signs of dominance and subservience among each other at feeding time. The mated pair in this enclosure withdrew from sharing the communal artificial dens and constructed a den of their own. They would not permit the other unmated animals to come within 3 m. of the natal den. Once the kits were hunting (approximately three months), the communal dens were utilised again by all adults and by the kits in varying numbers.

Whelping generally occurred in the artificial den boxes or in some cases in underground dens constructed by the pair within the enclosure. The date of whelping was determined by a marked change in behaviour on the part of the dog fox. The vixen did not appear at feeding time, instead, the dog fox collected as much food in his mouth as possible and delivered it to the den. The dog fox did not eat until the vixen had been fed. The vixen rarely left the kits for the first two weeks and the feeding activity was the sole responsibility of the male. During this two week period the male tended to spent more time outside the den. The kits eyes opened at between 12 and 14 days. After that period the pair alternated in the time spent with the kits. When the dogfox was collecting food for the vixen and kits in the single pair enclosures he would not take the food directly to the den mouth but would travel in an elaborate pattern all over the enclosure

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before going to the den mouth. This behaviour has not been observed in the 9 hectare enclosure.

The kits emerged from the den at approximately three to four weeks. Their first forays were usually short and tightly controlled by the parents. Both males and females uttered warning barks during this period and these barks were strictly heeded by the kits.

By two months the kits were much bolder and forays were much more extended. By this time the kits showed a considerable degree of independence and were less likely to respect the parents warning barks. The adult foxes, both dog fox and vixen, still collected food and took it to the den for the kits, but they were often mobbed by the kits before getting to the den and stripped of their offerings. The dog fox also continued to feed the vixen. The kits obtained food from adults by putting their noses to the corner of the adult's mouth. The vixen obtained food from her mate by a preliminary flattening of her ears and a distinctive "chuckle", then she would take hold of a projecting bit of meat from the dogfoxes mouth, and he would relinquish it to her. If the food carrying adults reach the den without the kits emerging, the adults called the kits out of the den using the same "chuckle" for feeding. During this adolescent period there was rarely any aggression shown by the parents towards the kits.

When the vixen was weaning the kits she would utter a high pitched hum, and move away from the importunate kit. She would continue to collect, or hunt, food and provide that food to the kits. The kits were weaned by six weeks. After the kits were weaned the dogfox was less likely to carry food to the kits, but instead encouraged the kits to go to the food source. During this period the dogfox rebuffed importunate kits by baring his teeth or growling.

While weaning the kits, the parent Swift foxes spent a greater time in den boxes other the those occupied by the kits, although the attention paid by the adults to the kits did not lessen.

A critical period in the captive breeding cycle was August. By this time the kits have entered full adolescence and were ready to disperse. Vocal aggression, high pitched hums and chittering between the kits was more common. Digging in the single pair enclosures was pronounced. Injuries were more common as a result of increased digging along the wired perimeter fencing.

In a wild environment this was a period of range expansion when feed (grasshoppers) were readily available and the kits began to disperse from the family unit. In the captive breeding situation, this was the time when the kits were best released to the wild. Since 1992 all the captive raised Swift Fox released to the wild have been released during September.

Once the kits have been removed from the parents, the adult animal's activity pattern

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reverted to the schedule followed prior to the birth of the kits. Less time was spent above ground. In the group enclosures it was noted that the Swift foxes all reverted to the use of one den, sometimes enlarging it significantly. They also used the other dens provided, but no territorial defence behaviour was observed.

New pairings were made in September /October of each year. Existing pairs that produce kits were not broken up but in cases where mates had been lost, or females were past breeding age, new pairings were made. Pairs were selected using the ISIS software "GENE" to determine inbreeding coefficients of less than 0.5.

Male Swift fox, within the captive colony continued to breed successfully for a greater period of time than do females. The oldest producing male Swift Fox at CEI died at 15 years of age, having fathered 5 kits in his final year, while female Swift fox cease breeding at eight years of age. In the release sites, the oldest known Swift fox (from radio collar information) was a translocated male who died at 8 years of age, a captive raised released female Swift fox was recollared in 1991, aged 6 years, and has not yet been recovered dead.

Observations showed that when the animals reach the age of eight they were inclined to become deaf.

The collected data provided by the captive breeding programme over the last 20 years indicates that pair selection is important for Swift fox. The observed majority of Swift fox appear to mate for life. Incompatible pairs coexisted in a single pair enclosure without fighting, but did not breed. Established pairs, separated and repaired with different individuals, in general did not breed. It was possible that as long as both members of an established, but separated, pair of breeding age can hear each other's lubricious bays they will disregard the other fox in the enclosure with them. Separated, established pairs, if reunited, bred again. Established pairs who had lost a mate and were re-matched bred but the breeding success of such new pairings cannot be guaranteed.

Some Swift fox bred in their first year, but the majority did not. The keys for the successful breeding of Swift fox in captivity appeared to be age and compatibility. There were marked temperament differences between individuals and the likelihood of a successful pairing depended upon that compatibility.

Successfully bred pairs have lost their kits for a variety of reasons. The most common cause of death in kits was parental stress. The stressed animal continually carries the kits around the enclosure until they die. Parental stress can be caused by habitat change, enclosure layout, and insufficient food.

Habitat change - The disturbance of den boxes within the enclosures occupied by mated pairs can result in kit carrying behaviour. Transferring mated pairs from a familiar to an

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unfamiliar enclosure will have the same result. The noise and vibration produced by heavy equipment working in the vicinity also causes kit carrying behaviour.

Enclosure layout - This was not applicable to large (0.7 hectare and over) enclosures, where the mated pair has some control over the site selection of the natal den. In small enclosures (18m X 12m or less) the overall enclosure layout was particularly important. It was essential that the enclosure was designed in such a way as to offer maximum seclusion for the paired Swift fox. Swift fox demonstrate increased anxiety if observed from above. Kit carrying behaviour also occurred if Swift fox, or other carnivores, are within sight of the mated pair. Pens were constructed so as to be visually isolated from each other.

Insufficient food - If the amount of feed provided was insufficient, pairs increased digging and exhibited increased aggression towards Swift foxes which do not form part of the family unit.

Behavioural Observations - Breeding: Single pair enclosures: Established pairs in the breeding pens increased the level of digging in February, March. They scent marked the gate, and at the four corners of the pens. They began to share one of the two provided artificial dens. Vocalisation, other than the Lubricious bay, between animals sharply increased.

9 hectare enclosure: In 1994, juvenile pairs in the 9 hectare pen sharply increased the level of digging, unrelated to the artificial dens provided. They scent marked where trails crossed and on prominent features of the landscape. Calling did not start until April and continued on in May after all the adult animals had ceased calling.

0.7 hectare enclosure: The group of Swift fox placed in this enclosure consisted of 4 females and one male that had been retired from the breeding program. It was assumed that because none of the animals had produced litters for several years they would not breed. The male began calling during the mating season when other adult males in the breeding colony were calling. Scenting was limited in the enclosure and digging was not increased. All females in the 0.7 hectare enclosure were aged 9 years and over, which was over the breeding age for vixens.

Temporal Activity Patterns: Observation of the behaviour patterns of the captive Swift fox colony at the CEI has shown that the schedule of activity was primarily nocturnal. The animals emerged from the den sites in the evening approximately one hour before sun down. In the latitude of CEI this varied from 20:00 in summer to 16:00 in winter. In the morning the captive animals were rarely observed out of their den after 9:00.

During the cooler months of the year (September to April) the captive Swift fox can

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sometimes be caught "sun bathing" during mid-day. This activity involved sleeping, usually on straw bails, which were placed around the dens in winter for insulation. This activity only occurred on sunny days when the wind speeds were low (less than 5 km/hr) or there was no wind.

Aggression: 9 hectare enclosure: The Swift fox kits introduced into the 9 hectare enclosure in November 1993 showed no signs of aggression. Within 48 hours of being released to the enclosure all animals were sharing the artificial dens. At times all kits would be observed to use one den, but all dens were utilised by varying numbers of animals at various times.

Single pair Enclosures: Vocal aggression in new pairs occurred in the first week after the pair was put together. No aggressive behaviour was observed other than vocal. In order to reduce the likelihood of aggressive behaviour, when a new pair was put together, both animals to be paired were put into an unfamiliar enclosure containing two den boxes. On occasions when a new animal has been introduced into a single pair pen which already contained an established single fox, the level of aggression observed reflected individual temperament differences, rather than territorial aggression.

0.7 hectare enclosure: The Swift fox adults introduced into the 0.7 hectare enclosure in October 1994 showed no signs of aggression. All shelters were utilised from the time the animals were introduced to the enclosure, though never more than two animals were noted to use one shelter at one time.

Food Habits: A summary of the scat content from the 9 hectare pen and from a small sample from Grasslands National Park are found in Table 3 and Table 4.

Single Pair Enclosures:

Swift fox within the single pair enclosures hunt and kill insects, small birds, voles, and mice which entered the pens. The foxes in the single pair pens also killed Richardson's ground squirrels (*Spermophilus richardsonii*) introduced into the pens after the kits were weaned and prior to their release. There was a marked difference in hunting ability between individual Swift fox in the captive colony, and some evidence of individual animals specialising in killing certain species.

Magpies (*Pica pica*) were killed by Swift fox, but the slightly larger and heavier American crow (*Corvus brachyrhynchos*) which also lands in the enclosures was left alone.

VOCALIZATION: Swift fox are a vocal species. Research has shown that Swift fox will respond to call playback tapes of the Swift fox lubricious bay. Warning barks uttered by one Swift fox on sighting a predator will be echoed by other Swift fox out of sight of the threat.

Lubricious bays

9 hectare enclosure: 1994: The six juvenile Swift fox in the 9 hectare enclosure did not start uttering the lubricious bays until late March 1994. They continued to utter the lubricious bays into April, long after the established adult pairs in the single pair pens had ceased calling.

1995: The five (one was killed by a raptor) Swift fox in the 9 hectare enclosure were now adults. Lubricious bays were first heard in the last week of February, 1995. This was slightly later than the adult Swift fox in the single pair enclosures began to call.

Single pair enclosures: 1994: All pairs occupying the single pair pens were either established pairs (15) or new pairings comprising adult X juvenile (7). There were no juvenile X juvenile pairs in the single pair pens. Lubricious bays were uttered by the established and adult X juvenile new pairs in the single pair enclosures from the first week of February 1994 through to the third week of March. There did not appear to be any difference in timing of lubricious bays from either type of pairings.

1995: Of 22 pairs in the single pair enclosures contained seven juvenile X juvenile pairs, four adult X juvenile pairs, and eleven adult X adult pairs. Lubricious bays were heard from the 1st week of February to 2nd week of March from the adult X adult and adult X juvenile pairs. Lubricious bays were heard from the Juvenile X juvenile pairs in the single pair pens from March to April. During the 1995 mating season, one female was heard calling well into June. On an examination of the enclosure it was found that her mate had died. It is not known whether such late calling indicated that the female was still receptive but it is known that some of the yearling females whelp in June indicating that they were still receptive in April.

0.7 hectare enclosure: The male in the 0.7 hectare enclosure was observed to be calling during the peak of the lubricious bay for adult X adult pairs. All females in that enclosure are beyond breeding age.

Figure 3 presents the frequency of lubricious bays from the captive colony during three 24 hour periods (2 -3 March, 1995; 4 -5 March, 1995; 5 -6 March, 1995). During each 24 hour session, the majority of calling came between 17:30 and 07:00. The average call rate between these times was over 23 calls per 15 minutes in each case, compared to 0.5 and 0.38 calls per 15 minutes for 07:00 to 17:15 in the first two sessions and 3.5 calls per 15 minutes in the third session. Only in the third session did call rates between 07:00 and 17:15 rise above 10 calls in 15 minutes; this occurred three times - between 13:15 and 13:30, between 9:15 and 9:45, and between 10:45 and 11:15; during the second of these peaks, the call rate rose as high as 50 calls in 15 minutes.

Figure 4 shows the response of the Swift fox colony to the five combinations of the lubricious bays played to them. Using a T-test to compare the responses before, during and after the playing of the calls it was found that tapes four (single fox, 12 calls per minute) and five (4 foxes, four individual calls every 20 seconds for a total of 12 calls per minute) produced a significantly higher response.

Warning Barks: Warning barks were uttered by both sexes and adult and juvenile swift fox. Warning barks will be given on sighting any predator avian or terrestrial. The frequency of warning barks is increased once the kits are weaned. As soon as a warning bark is heard all kits, whether or not they are part of the family of the Swift fox uttering the bark, will run into the den.

The warning bark uttered by the Swift fox on sighting a predator will be taken up by Swift fox out of sight of the predator. When a manned bird of prey was walked near the single pair enclosures (approximately 25 m.) a warning bark was immediately issued from the nearest animal. This bark was instantly passed on throughout the colony. It has also been observed that warning barks will be given when a fox views the domestic dog that resides at CEI. This later behaviour was more prominent when the kits have left the dens in early summer. Warning barks were not observed to be given when moose, white tailed deer or otters were sighted near the pens.

Other Sounds: The chuckle sound was uttered by mated pairs prior to the arrival of kits. The chuckle was also used by the parent animal to call the kits out of the den and by the vixen to elicit food from the dog fox.

Hums, chitters and snarls were sounds used to indicate aggression between individuals.

DISCUSSION

Life History: In Canada, little information on the life history of the Swift fox has been collected from wild populations. In the United States more studies have been conducted. Schroeder (1987) established the average gestation period for the Swift fox in the captive colony at the Wildlife Reserve of Western Canada (now the Cochrane Ecological Institute) and Calgary Zoo as 51 days. This was confirmed by the present observations. The firm establishment of the gestation period is hindered by the birth of the kits in dens and the sensitivity of the vixens to disturbance. Schroeder's observations on copulation dates (5 February to 5 April) confirm an fairly extended breeding season, but did not mention whether juvenile pairs bred later in the season, than established adult pairs as noted in this work. No observations could be found on the breeding season or gestation period for Swift fox in the wild.

Pruss (1994) has made observations on the activity patterns of reintroduced Swift fox in southern Alberta. She assumed that the cubs were all born on May 1 and that they first

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emerged from the den at four weeks. In the captive colony the kits emerged for the first time at approximately three weeks. It was assumed that this one week difference was related to Pruss's assumed birth date rather than actual differences in the wild and captive population. In her study it was found that the adults spend more time above ground during daylight hours once the kits emerged from the den. This activity pattern was also observed in the captive population.

Pruss noted that the females weaned the pups at approximately eight weeks which corresponded with the present observations in the captive colony.

Hunting behaviour in the reintroduced wild population was closely followed by the captive population in the 9 hectare enclosure. Pruss noted that kits first took small mammals at week seven and ground squirrels at week twelve. Kits in the 9 hectare enclosure were observed to be successfully hunting in July. One of the problems with captive breeding was the ability to expose kits to prey and the hunting experience. At CEI live trapped ground squirrel were regularly put in the single pair enclosures with the parents and kits, but other native prey were limited because of the size of the pen.

In 1983 when captive born kits were first introduced to the 9 hectare enclosure they were observed hunting almost immediately. This indicated that kits born and reared in the single pen enclosures quickly developed hunting skills. Subsequent studies on the food habits of the Swift fox in the 9 hectare enclosure showed that they appeared to hunt in preference to the food provided and that prey species made up over 50% of their diet.

Limited observations were available on Swift fox life cycles in the wild populations. What is available indicated that the wild population and captive breeding colony showed similar characteristics. The difference between the captive colony and the wild populations appeared to be in the age of the animals, in the captive breeding facility males have produced progeny up to the age of 15 years. Death was the result of old age and not predation as in the wild. Females in the captive colony appeared to stop breeding at the age of eight. Unpublished data on the age of Swift fox in the wild (Swift fox Stud Book, maintained by CEI) indicated that the oldest known male in the wild was 8 years, the oldest known female in the wild was aged 6 years. The observation in the captive colony of Swift fox becoming deaf after 8 years has significant implications for survival in the wild. Death from predation would ensue at the slightest impairment of hearing. It was therefore postulated that 8 years would be a maximum age for Swift fox in the wild.

Swift Fox Communities: From the observations made at CEI there was evidence to suggest that the Swift fox lives in loosely formed communities. Swift fox are a gregarious, highly social species (J. Sharpes, personal communication, 1992, Rongstad et al, 1989, U.S. Fish & Wildlife Service, 1995). Swift fox vocalisations link individual animals; calls will be repeated by all Swift fox within earshot and the response to those

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calls will be the same. The ripple effect of repeated warning barks reduces the chances of success for predators on this small, vulnerable canid. The repetition of the lubricious bay increases the likelihood of matching unpaired Swift fox, a particularly important point as they are very fastidious in mate selection, thus Swift fox living within hearing of each other have a greater protection from predators and a greater chance of pairing.

Historically Swift fox were reported to be found within close proximity of each other. Wright (1913) reflecting on his pioneer days said that there were "millions of Prairie dogs" and "next in numbers was the little Swift fox". At this time of writing, remnant populations of Swift fox were found only in pockets, or "hotspots" over what appeared to be a much larger range of similar habitat in the U.S. (Dr. L. Carbyn, Canadian Wildlife Service, Edmonton, personal communication).

When Swift fox were introduced to large enclosures, either 9 hectare or 0.7 hectare enclosures, with a number of animals per enclosure, association patterns between individuals included sharing of artificial dens, and a reduction in aggressive behaviour. In the larger enclosure the Swift fox appeared to share a multiplicity of different dens, unless the den is occupied by a vixen with unweaned kits.

An examination of the relative success of the reintroduction of the Swift fox to areas of Alberta and Saskatchewan in Canada, indicated the Alberta program was more successful. In Alberta the 328 released animals have been concentrated in a smaller area (2070 sq. km.) as compared to Saskatchewan where 369 animals have been released (3728 sq. km.). If the Swift fox tended to live in communal groups rather than individually, the higher density of the released animals in Alberta (0.16 animals per km²) may be related to the apparent success over the releases to date in Saskatchewan (0.10 animals per km²). Efforts to reintroduce the Swift fox in the U.S. had a greater level of success when family groups were released, rather than single animals or siblings (Sharps, 1993; U.S. Fish & Wildlife Service, 1995).

Food Habits: The high occurrence of prey in the scat of animals from the 9 hectare enclosure, even with a supplemental diet of approximately 238 g. of day-old chicks and horse meat per day, indicates that the captive raised Swift fox, when exposed to wild prey, utilised it on a consistent basis. The nature of the study did not allow for the association of the scat with an individual Swift fox, because of this it was not possible to examine the development of hunting skills by the three kits that were born and lived in the large pen over the study period. Seeing that such a high percentage of the scats examined contained wild prey it was assumed that the kits were successfully hunting.

The limited number of scats that were collected from Grasslands National Park showed that newly released Swift fox quickly begin to hunt. Of the 19 Swift Fox released in Grasslands National Park three were the juveniles born and raised in the 9 hectare enclosure. Two of the 21 scat analysed in the study were collected in the area of their release site. The analysis of these scat did not show differences from the other 19 samples. The sample size was too small to make any deductions on the impact of the

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rearing in larger pens on the hunting success in the wild. The day-old chick that was found in one scat from Grasslands National Park was from food provided to the newly released Swift fox on the first night of the release.

In comparing the literature on Swift fox scat and stomach content wide variations were found (Table 5). These variations show that the Swift fox was an opportunistic feeder and will take most any prey available to them. Table 5 showed a consistent presence of insect in the Swift fox diet. In the present study insects were present in 86% of the scat analysed. The identification of the insects in the scat from both the 9 hectare enclosure and Grasslands National Park was difficult because of the extensive maceration of the food. Generally the remains of the insect were limited to fragments of chitin and in rare cases parts of legs or thorax.

No literature was found on the vocalisation of the Swift fox. The preliminary results of the analysis of the digitised lubricious bays have indicated that individual Swift fox can be identified by their calls. Further research is under way to fully characterise the digitised calls and develop a practical method of analysing the calls.

The concentration of the calling during the period of dusk to dawn for lubricious bays masked the activity pattern of the species during this period of the year. The variation in the calling rates over the period was considered to be random and not causal. Weather records (temperature, and wind speed) were taken at CEI during the period of the vocalisation experiments and no correlation was found with either.

The response of the captive colony to the played back lubricious bays indicated that calling can be initiated artificially. More experimentation will be necessary to determine the optimum play back frequency to elicit responses.

Behaviour and Reintroduction: Several of the behavioural observations reported have contributed to the improvement of the reintroduction program.

Time of Release - Observations of the kits in the captive population indicated that in August their level of activity and restlessness increased. Dispersion of the kits in the wild occurred during August. Initial studies of the release times have indicated that captive raised Swift fox released in the fall have a higher survival rate than those released in the spring (Brechtel, et al, 1993).

Southern Alberta and Saskatchewan, during August and September (until the first hard frost), supports an extensive, high density, grasshopper population. Scat analysis has shown that the grasshopper made up an important component of the Swift fox diet in both captive (9 hectare enclosure) and wild populations.

Both these observations have helped to support the CEI policy of fall releases (last week in August - first week of September). Concentrating the releases in late August and early September ensure that a secure food supply is available until the animals adjust to

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their new surroundings and acquire the additional hunting skills needed for survival in the wild. The natural tendency for the young to disperse at this time fits with their instinctive behaviour and meant that the juveniles were prepared to move away from the family group and establish their own dens. This natural instinct was felt to lessen the trauma of being released into a new, wild environment.

Portable Protective Shelters - Protective shelters set out into the previously researched release sites offer a secure haven for newly introduced foxes, increase their survival and reduce the likelihood that the animals will travel through unknown country immediately on release.

Age of release - Captive breeding for reintroduction can lead to the accumulation in the breeding colony of large numbers of animals. Animals can become non-releasable for a variety of reasons, age is one but the most common is injury. In order to minimise the overall age of the colony, when releasable animals reach the age of four years the parents and kits were released as a family group. All animals were released at the same location, and it is hoped that this will encourage a more natural assimilation of the kits into the wild environment.

Releasing the adults at age four meant that they have potential for reproduction in the wild. Releasing a mated pair with kits increases the likelihood of kit production in the breeding season following release because, as Swift fox are monogamous, there is no need for either animal to seek a mate.

Density of release - The observations that led to the hypothesis that the Swift fox may be a communal animal, and the examination of the differences in the density of the releases in Saskatchewan and Alberta have resulted in a change of policy on release locations. Since 1993 releases in Grasslands National Park was made on what was considered to be suitable habitat criteria. Preliminary population estimates have shown that the released animals have not only established in the park but have migrated into nearby pasture lands.

Breeding Swift fox to maximise kit production and to increase kit survival after release - The Swift fox vixen ceases to breed at age eight, while the dogfox was capable of reproducing until aged 14 or 15. Swift fox pairs occasionally reproduced in their first year. More often newly paired animals will take two, or even three, years before reproducing. Compatible, established pairs aged between 2 and 8 years will refuse to breed if broken up and repaired with other animals within the same facility. A breeding colony can expect to get five to six years of cub production out of each pair, with the possibility of a further four more years of cub production from the dog fox, if the 8 year old vixen is removed and the dogfox re-matched. Both maximum breeding age and compatibility have been considered when choosing pairs for the captive breeding colony. The compatibility can only be judged after a pair was placed together. After

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several years of non production, assuming the animals were of a breeding age consideration would be given to re-pairing the animals.

The survival of reintroduced Swift fox was essential for the success of the Swift Fox Reintroduction Programme. Based on the observations made over a 20 year period the following steps have been developed to increase survival in the wild:

- (1) breeding enclosures resembled, as closely as possible, Swift fox habitat in the wild
- (2) breeding enclosures were large enough to offer maximum security and privacy to the occupants
- (3) all Swift fox enclosures were grouped within calling range of other Swift fox
- (4) keepers were discouraged from "making pets" the Swift fox
- (5) enclosures provided enough space and habitat to encourage the hunting of voles, mice, insects, small birds, etc.
- (6) Swift fox should were fed wild game, mice, and Richardson's ground squirrels, particularly when the cubs were being weaned
- (7) enclosures had soil floors that were deep enough to permit digging, and
- (8) Swift fox were re-introduced into previously researched, suitable, protected habitat using Portable Protective Shelters for the first 10 days after release.

Observations of Swift fox bred at larger Zoos that had the animals for exhibit showed that single or paired, Swift fox used for exhibit purposes in small, easily cleaned and maintained enclosures, become remarkably tame, unwary, and dependent upon their keepers. It was hypothesised that the keepers, under those conditions, come to provide the social enrichment that the wild Swift fox community would otherwise provide. Swift fox transferred from an exhibit situation to the captive colony were observed to revert from the tame behaviour and keeper dependency within six months of transferral.

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Table 1: Swift fox production from captive breeding and wild caught translocated animals which have been reintroduced to the Canadian prairie from 1983 to 1994.

RELEASE AREAS	CEI CAPTIVE BRED SWIFT FOX	OTHER FACILITY* CAPTIVE BRED SWIFT FOX	WILD CAUGHT SWIFT FOX	% TOTAL RELEASED SWIFT FOX FROM CWR
Alberta				
Lostriver	100	17	27	69%
Foremost	31	20	7	53%
McIntyre	46	17		73%
Jumping Pound	2			100%
Southern Alberta	38	12	11	62%
Total in Alberta	217	66	45	66%
Saskatchewan				
Cyprus Hills	9	19	2	30%
Wood Mountain	61	50	15	48%
Nashlyn	41	56	1	42%
Grasslands National Park	94	9	1	90%
South Saskatchewan		11		0%
Total in Saskatchewan	205	145	19	56%
To Breeding Colony at Calgary Zoo	6			100
To Breeding Colony at Edmonton Valley Zoo	2			100
To Breeding Colony at Moose Jaw Wild Animal Park	5			100
Total Swift Fox	435	211	64	61

* This includes the Edmonton Valley Zoo (18), Moose Jaw Wild Animal Park (125), and Calgary Zoo (68). Calgary Zoo, as of 1994, no longer have a captive breeding programme.

Table 2: A summary of breeding success for pairs containing yearlings for 1993 to 1995.

Combination	Litters in First Year	Sample Size	% Producing Litters
Both Yearlings	2	11	18%
Yearling X Adult	6	18	33%
Adult X Adult	25	38	65%

Table 3: Summary of the food item primary content and number of occurrences in the 75 scat from the large pen study.

Food Item	Primary Content () number of Scats	Occurrence () number of Scats
Horse Meat	43% (32)	53% (40)
Day-old Chicks	7% (5)	49% (37)
Vole	49% (37)	67% (50)
Unknown Bird	1% (1)	
Insects		24% (18)
Other		7% (5)

Table 4: Summary of the food item primary content and number of occurrences in the 21 scat collected in Grasslands National Park during the 1994 release.

Food Item	Primary Content () number of Scats	Occurrence () number of Scats
<i>Microtus spp.</i>	14% (3)	43% (9)
<i>Lagurus curtatus</i>	5% (1)	5% (1)
<i>Peromycus maniculatus</i>	10% (2)	29% (6)
Unknown Mammal	43% (9)	57% (12)
Day-old Chick	5% (1)	10% (2)
Insects	24% (5)	86% (18)

Table 5: A comparison of the scat analysis from Swift fox in Grasslands National Park with literature data.

Food Group	Uresk & Sharps, 1986	Hines & Case, 1991	Zumbaugh & Choate, 1985	Rongstad et al, 1989		Present Study
				Area 1	Area 3	
Mammals	49.00%	100.00%	65.2 % *	41.00%	74.00%	90.00%
Insects	27.00%	56.00%	7.7% *	14.00%	10.00%	86.00%
Birds	6.00%	40.00%	18.4% *	42.00%	12.00%	0.00%
Plants	13.00%	54.00%	1.8% *			
Other			6.8% *			10.00%
Location	S. Dakota	Nebraska	Kansas	Colorado		Sask.
Sampling Dates	May to Sept	?	November to January	Year Round		Sept

* Per cent of stomach content by volume

Figure 1: Habitat types contained in the 9 hectare enclosure (grid size was 33 m by 33 m).

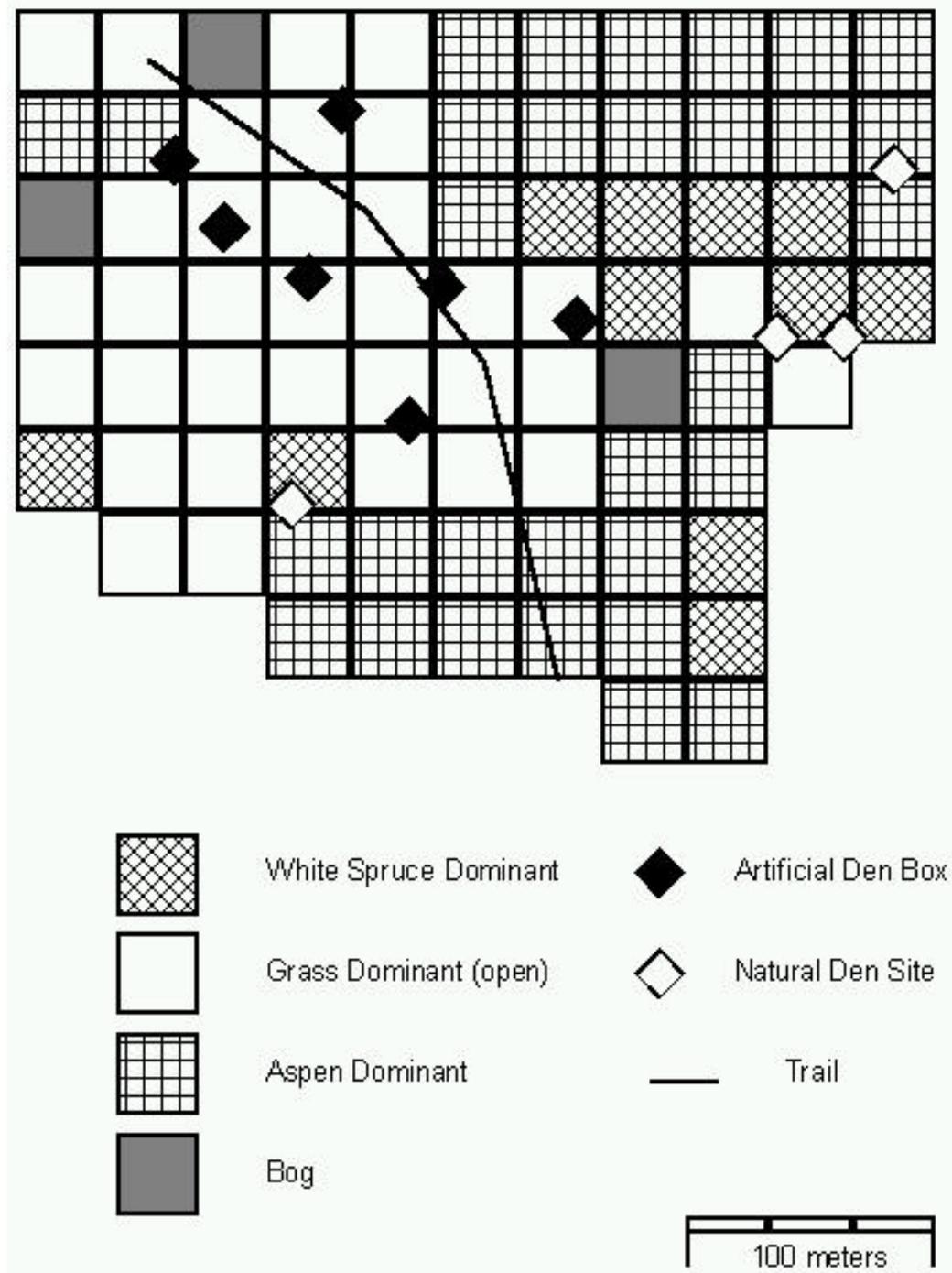
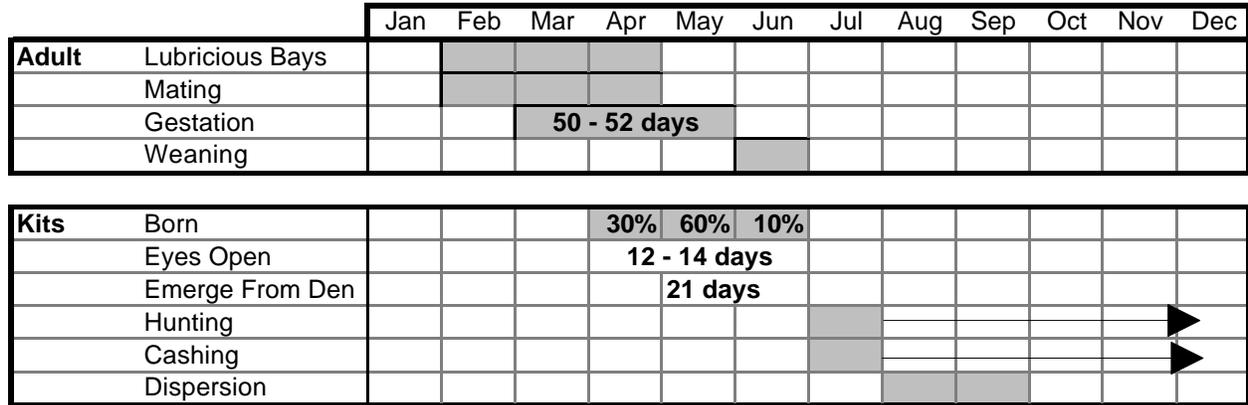


Figure 2: Schematic representation of the Swift fox life cycle in the captive breeding colony.



60% Time of Activity
 Per Centage of Activity in that period

Figure 3: The daily level of lubricious bays from the captive breeding colony of Swift fox observed over three 24 hour periods in March, 1995.

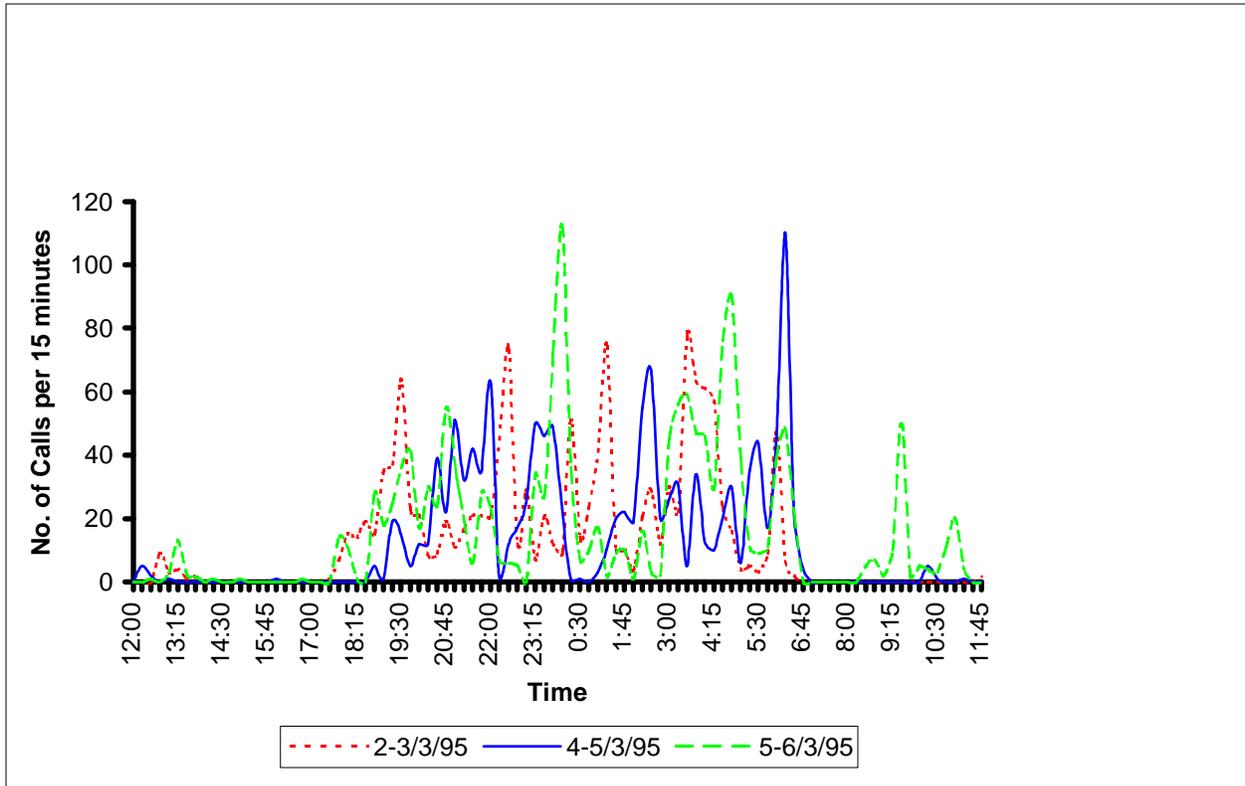


Figure 4: The response of the Swift fox captive breeding colony to five combinations of lubricious bays played to them over a thirty minute period (responses are the average of observations over five five minute intervals)

