Comments and revisions submitted to:

Clio Smeeton
Cochrane Ecological Institute
P.O. Box 484
Cochrane, Alberta
Canada T0L 0W0
Phone (403) 932-5632
FAX (403) 932-6303
E Mail cei@cadvision.com

Running Header: **Breeding biology of a captive Swift fox population**

Captive breeding of the Swift fox at the Cochrane Ecological Institute, Cochrane, Alberta, Canada. Clio Smeeton, Kenneth Weagle

Clio Smeeton
Cochrane Ecological Institute
P.O. Box 484
Cochrane, Alberta
Canada T0L 0W0

Ken Weagle
Gwich'in Land and Water Board
PO Box 2018
Inuvik, NT
Canada X0E 0T0

ABSTRACT: An analysis of the Swift fox captive-breeding program at Cochrane Ecological Institute, Cochrane, AB Canada from 1972 to 1997 is presented. During that period captive-bred swift fox provided 841 animals to the Canadian Swift fox reintroduction program in southern Alberta and Saskatchewan. Reintroduced swift foxes were the progeny of 189 foxes, 34 of which came directly from wild U.S. stock. The 272 litters produced averaged 3.6 ± 0.45 kits per litter with a range of 1 to 7 kits. Year 1 females had a significantly lower fecundity than all other years, with the highest fecundity in females being in year 5. Year 1 males also had a significantly lower fecundity than other ages. In wild males the fecundity was significantly lower than all age groups except year 1. The maximum number of kits produced by a female was 33, and for a male, 46. Most litters (71%) were born between April 16 and May 10 with some whelping as late as June 26. Nineteen percent of yearling females and 18% of yearling males produced litters when paired with at an older animal, of pairs where both male and female were yearlings, 11% produced litters. Females did not produce litters after 8 years of age, but males continued to produce litters to the age of 14 years. A blueprint for the management of a swift fox breeding colony is presented, as well as protocols for feeding, housing, animal handling and immunisation of a captive–breeding Swift fox colony.

Introduction:

Captive breeding of the Swift fox (Vulpes velox) began in Canada in 1972 at the Wildlife Reserve of Western Canada (now the Cochrane Ecological Institute, CEI), six years before the species was declared extinct in Canada (Committee On the Status of Endangered Wildlife In Canada, (C.O.S.E.W.I.C) 1978). The founder foxes for the programme came from wild stock taken in Colorado, Wyoming, and South Dakota, U.S.A. By 1997 the CEI held 64 Swift foxes bred specifically for maximum genetic heterozygosity and reintroduction into protected areas of their historic range. The swift fox colony at the CEI was not designed for the exhibition of the animals to the public, nor were the animals kept for trade or other financial gain.

At one stage, exclusive of the Cochrane Ecological Institute, three additional institutions were also active in the captive-breeding program. These facilities contributed information to the CEI studbook and were the Moose Jaw Wild Animal Park, Calgary Zoo and Edmonton Valley Zoo. Since 1994 Moose Jaw Wild Animal Park and Calgary Zoo have discontinued captive breeding. Edmonton Valley Zoo had one swift fox as of 1997.

Although the captive breeding of swift fox has been don for over 25 years little has been published on the methods or the results of the program. Schroeder (1987) summarised some of the findings to date and fixed the gestation period at 51-52 days. His observations were conducted at the CEI and the small colony at the Calgary Zoo. Weagle and Smeeton (1995) summarised some of the behavioural characteristics of the colony at CEI. Teeling (1996) reported detailed observations on captive breeding behaviour at CEI and Bremner (1997) developed environmental enhancement procedures for captive breeding enclosures at CEI.

This paper examines the breeding biology of the Swift fox in a captive breeding facility. The data was obtained from the Studbook for Swift fox from Cochrane Ecological Institute and from daily observations of the colony at feeding times. The paper also presents, in an Appendix, the feeding; housing and health care protocols developed over the 22 years of breeding.

Methods:

Location: 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 surrounded by a 2.5 m Game fence with 0.6 m wire mesh overhang and a 0.6 m chain link strip along its base. The property consists of 50% native mixed grass prairie, 10% wetland, and 40% mixed woodland. The site is also used by large ungulates (Moose, *Alces alces*, Whitetail deer, *Odocoileus virginians*, and Mule deer *Odocoileus hemionus*. There is a varying population of coyote (*Canis latrans*), and a fluctuating population of indigenous waterfowl, passerines, and raptors.

Facilities: The CEI includes a purpose built Animal Health building with kennels for the treatment ill or injured foxes, as well as separate food preparation and storage facilities. The swift fox at CEI were housed in three types of enclosures:

Single Pair Enclosures - CEI has a total of 23 single pair enclosures, averaging 18 m. X 12 m. in size, and are made of 2.5 m. X 3 m. chainlink panels with a 0.6 m. wire mesh overhang along the top of the fence, and at the bottom, a 0.6 m. wide strip of chainlink fencing lain flat on the ground and filed with rocks. All enclosures consist of fenced native prairie, 5% of them also include aspen trees (*Populus tremuloides*). Each enclosure contained 2 artificial den boxes. The den boxes consist of three connected chambers and are covered with an insulated "A"- frame. Two breeding age Swift fox are housed in each enclosure. These animals varied in age from juveniles to 14 years.

9 Hectare Enclosure – The enclosure consists of 40% open prairie, 10% bog, and 50% mixed aspen and spruce groves. A 2.5 m high fence surrounded the enclosure with a 0.6 m. wire mesh overhang and a 0.6 m. ground wire (chain link mesh fence plus rocks). Seven widely spaced artificial den boxes and one artificial "mound" (expanded polystyrene on wire over a three chambered box) were contained within the 9 hectares. Of the eight artificial shelters, two were in the woodland, and the remaining six in the open country.

1 Hectare Enclosure – The enclosure consists of aspen groves surrounded by a 2.5m fence, 0.6 wire mesh overhang and 0.6 chain link along its base. The enclosure contains 6 artificial shelters. The enclosure is used to house a fluctuating number of aged non-breeding swift fox, mainly females.

Breeding Records: The data on the breeding biology was obtained from the Studbook maintained at CEI since breeding began in 1972. The Swift Fox Studbook was maintained on ISIS software and yearly records were provided to the Brookfield Zoo, Chicago to supplement the international stud book for endangered species breeding. The data from the ISIS software was exported to EXCEL software for detailed analysis.

Animals were paired to maintain maximum genetic heterozygosity in the breeding colony and after release. New breeding pairs where chosen so that the inbreeding coefficient was less than 0.05. This coefficient was calculated using the program in the ISIS software used to keep the studbook. The genetic background of animals intended for release was taken into account by CEI when identifying proposed release sites to ensure that animals carrying the same bloodlines are not repeatedly introduced into the same area.

Data collection: Daily observations of swift fox behaviour recorded during feeding (at dusk, 5:00PM to 10:00PM depending on the season). Each animal was observed and his or her activity recorded. If an individual was not seen it was noted.

The above observations were used to determine dates of birth. Without entering the enclosures, we noted any sign of hair plucked from the abdomen of the female exposing the teats or the flush of pink in the teats which indicates the presence of milk. We also looked for changes in behavioural patterns as an indication that birth had occurred. We assumed that if competitive feeding behaviour between adults stopped, if females ceased to appear for feeding, and if males began to collect feed and carries it into the den, it could be assumed the vixen had whelped. We report observations of the vixen's aggression toward kits attempting to suckle as an estimate of the age of weaning and note the behaviour changes in the kits as they age.

Data Analysis: To analysis the data contained in the ISIS software the contents of the Swift fox stud book were converted to an EXCEL spreadsheet data base. Numbers of litters, average litter size, and the number of individuals (males and females) used in the breeding program were calculated from tables extracted from the data base. The birth date of litters and the age of the sires and dams at the birth of the litters were also obtained from this data base.

The student t tests used to examine differences of litter size with age were performed using the statistical software package SPSS v7.1.

Results and Discussion:

Breeding Population.

From 1972 to 1997 CEI used 97 vixens and 92 dog fox in their breeding program. The initial two pairs came from an Animal Rehabilitation Centre in Golden, Colorado, subsequently sources of founder Swift fox can be found in Table 1.

As a result of the captive breeding programme, from 1983 to 1997, 841 swift fox were provided for release to the Canadian reintroduction programme. Over the same period, the Federal Canadian Wildlife Service, as lead agency for the provincial governments of Alberta and Saskatchewan, captured and translocated 91 Swift fox from the U.S. for release in Canada. These 91 translocated animals were trapped on the Colorado/New Mexico border, the Pawnee National Grasslands in Colorado, South Dakota, and Wyoming.

The features of the Swift fox life history are summarised in Figure 1.

In 1986 the initial Swift Fox Recovery Team set a protocol for pairing, and set an age requirement for release of swift fox. This policy called for an inbreeding coefficient of less than 0.05, and that all captive bred foxes aged 4 years should

be released. Swift fox that were over 4 years old, at the time of this decision, were to be retained. The aim was to get a breeding colony of an even age and wide genetic heterozygosity. Swift fox paired on a genetic basis will not necessarily breed; other factors (age, compatibility) also have been shown to effect pair breeding success. The result of this policy was the colony then consisted of young newly paired animals, older newly paired animals and aged animals, with fewer established reproductive pairs, resulting in a period of kit production decline in the captive colony after 1991 (Fig 3).

Limited observations were available on Swift fox life cycles in wild populations in Canada. What data is available indicated that both wild and captive-bred populations showed similar behavioural characteristics (Pruss, 1993). One striking 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 14 years. In the wild death is seldom the result of old age, in contrast, within the captive colony death as result of old age is the norm. 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. Observations in the captive colony of Swift fox becoming deaf after 8 years has significant implications for survival in the wild.

The (189) breeding Swift fox, at CEI, produced 991 individuals in 272 litters from 1972 to 1997. The average size of the litters was 3.6 ± 0.45 kits, and numbered from 1 to 7 kits. The females that had the highest fecundity produced on the average more litters over their breeding life. They generally had one mate and no apparent pattern could be seen in their parents.

Only three vixens, #288, #289 and #360 of the 14 with ALS>4, were from the same parents but different litters (Table 2). It is suspected that some Swift fox lines have higher fecundity than others do. In addition to these three females at the CEI, a sibling of #288 and #289, transferred to the Moose Jaw Wild Animal Park, where records show that she also had an average fecundity of over 4 kits/litter.

It was also noted that six of the 14 vixens with over 4 kits per litter were from wild parents. Because of the lack of information on the litter size in wild populations comparisons can not be made between the captive bred and wild litters.

Table 3 summarises the relationship between age and fecundity for females. Using the student t test to compare the means for the fecundity of the females at different ages, year 1 individuals had a significantly lower (student t, $\alpha = 0.05$) fecundity than all other groups except wild females. Year 5 females had a significantly higher (student t, $\alpha = 0.05$) fecundity than all other groups. Wild females had a significantly lower (student t, $\alpha = 0.05$) fecundity than years 4 to 8.

Table 4 makes a similar comparison of fecundity for the males. Males, year 1, individuals had a significantly lower fecundity than most other year classes (student t, $\alpha = 0.05$). The fecundity of wild males was significantly lower than all other years except year 1 and year 11 (student t, $\alpha = 0.05$).

In both the above comparisons the wild males and females in the captive breeding program were separated from the captive born individuals because we did not know their age. The fact that the fecundity of the wild individuals in both males and females was generally lower than captive raised may be related to their ability to adjust to a captive environment. Once the program began the captive animals were added to the program to maintain the genetic diversity, the analysis showed that they were less able to contribute to the production of animals for the reintroduction program than the captive born Swift fox.

Table 3 showed that females never produced past the age of eight years, while males produced until they died of old age (Table 4). The vixen producing the maximum number of kits, Stud # -273, who produced 33 kits in eight years with an average litter size of 4.13 kits/litter. The maximum production for a male was 46 kits with an average size per litter of 4.18 kits/litter, Stud # 277.

Fecundity in the captive pairs was effected by several factors. The use of heavy equipment within 2 Km of breeding enclosures resulted in the loss of 2 litters. The lack of a visual barrier between enclosures effected some vixens adversely and resulted in carrying their cubs until the cubs died. Cub carrying, for these animals, ceased if a visual barrier was put into place. Other vixens were not effected in this way, and vixens in the 9Ha enclosure also were not disturbed by the proximity of other swift foxes. Any injury of animals in the breeding season will result in disturbance of the pair. Either when the animal is removed for examination and treatment, or if one animal has to be removed for a prolonged period of veterinary care. Removal of swift fox for veterinary treatment can result in reabsorption of kits in a pregnant vixen, or in failure to breed. Unless noted and treated immediately, Mastitis, as a result of injury to the teats of nursing females, will result in death and can mean the loss of kits.

Established pairs mated earlier in the season than newly paired couples, and after successful mating the lubricious bay calling stops. Vixens past breeding age cease to call during the breeding season (Weagle and Smeeton, 1995).

At CEI whelping generally occurred in the artificial den boxes or, in some cases, in underground dens dug by the pair within the enclosure. For approximately two weeks after whelping the dog fox provided the vixen, which rarely leaves the den, with food. The daily records indicate when the females are no longer observed at feeding. Once whelping has occurred the males also tend to spend more time out of the den and can be observed collecting and carrying food into the den for the female. When this series of behaviours have been observed, the date of

whelping is estimated. These dates were checked by back calculations of when the kits were first observed to have emerged from the dens. At CEI the adults and kits were never handled during the first month and a half unless there was an injury that required immediate attention.

Figure 2 shows the distribution of birth dates for litters for the captive-breeding programme. Seventy-one per cent of the litters produced at CEI were born between April 16 and May 10. This indicates that the peak of the breeding extended from February 24 to March 20. Litters were born as early as April 11 and as late as June 26. These observations agree with the period of lubricious bay calling from the first week of February until the first weeks of April (Weagle and Smeeton, 1995) within the captive-breeding colony. We have observed that breeding may be affected by weather patterns, with more activity during warmer post, but the present data is too limited to confirm these conclusions.

We found that when new pairs of Swift fox were put together in the colony there were differences in the breeding success depending on the age of the pairs. In new pairs with a yearling female and experienced males 19% of the pairings resulted in kits in the first year. In pairings with yearling males and experienced females 18% resulted in kits; and when both of the pair were yearlings 11% of the pairings resulted in kits in the first year.

When we examine the average number of litters per year for the entire period of the program (Figure 3), it can be seen that the maximum production per year for the colony was 18 litters in 1991; and that there was a substantial increase in the number of litters from 1986 to 1992. This increase came with the setting at the target number of breeding pairs at 25 in 1987. The data showed that it is very unlikely to have a litter from all breeding pairs. This was related to several factors as follows:

1. Age of the breeding pair (lower success if yearling comprised one or both pair members, pairs composed of yearlings, no litters from> 8 year old females)
2. Injury during breeding season
3. Abortion of litter or destruction of kits because of disturbance
4. Lack of visual isolation of breeding pairs from other pairs
5. Incompatibility between new pairs

Feeding Protocol: Using a food and feeding protocol developed from 1972 to 1997 the captive colony was fed the following per adult fox ration – 4-day-old chicks, 150 gm of horse meat or wild ungulate meat. After the kits emerged from the dens, this diet was supplemented with mice (*Mus musculus)* and 150 gm per day per kit of moist Iames Puppy Chow.

Corresponding with the period of increased activity for the Swift fox, both in the wild and in captivity (Pruss, 1994 and Teeling, 1996), feeding took place at dusk. The food was thrown into the pens over the perimeter wire, eliminating the need

for handler entry into the pens. No attempts were made to ensure that each of the swift fox pairs in the pen got an equal share of the food, and no problems with over or under-consumption by one of the pair was observed over the years.

During and after weaning, supplementary feeding took place in the morning between 9:00 and 11:00AM. Mice and chicks were thrown into the enclosures (1 mouse/1 chick per kit) and Iames puppy chow placed in a covered bowl inside the gate.

When there was no snow on the ground, approximately one litter of water was supplied on a daily basis. Watering was done from 8:00 to 10:00AM. Water bowls were placed in permanent structures within the enclosure so that they could be filled from outside the enclosure.

From 1994/97 straw insulated lengths of grain filled 1inch plastic pipe were placed with one end 6 to 8 ft. inside the enclosure and the other end 2 to 3 feet outside the enclosure. The aim was to form a conduit, which would entice small indigenous mammals into the enclosures. In 1997 this method was supplanted by the use of woodpiles (Bremner,1997). In both cases the intention was to increase availability of prey for the foxes to hunt.

Housing Protocol: Over the years many attempts were made to provide safe and efficient housing for the colony. The final design was developed in the early 1990's and consisted of an insulated two part structure designed to provide maximum shelter from wind and heat, thus approximating the underground den used in the wild. The Den box was constructed to have three interconnected chambers this was covered by an insulated A-Frame, with ground level entrances opposing the positions of the entrances in the Den Box. During the winter months straw bails were also piled around the A-Frames to increase the insulation and reduce windage. Two structures were placed in each single pair enclosure.

Approximately 80% of the captive pairs inhabited the A-Frames. The remaining pairs dug dens where they would live and rear their kits. During the gestation period, and after whelping, pairs were not discouraged from digging. After the kits were separated from their parents in August, a regular maintenance program filled in all holes with cobble sized rocks. The main reason for this was to lessen the chance of escape by burrowing and to provide for easier capturing of individuals when necessary.

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 were more common. Digging in the single pair enclosures was increased markedly. Injuries were more common as a result of active digging along the wired perimeter fencing. In a wild environment this was a period of range expansion when feed (grasshoppers)

was 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 (Weagle and Smeeton, 1995). Juvenile Swift foxes, in captive breeding facilities, mature in their first year and can breed at less than one year old.

Summary and suggestions for a Blueprint for Captive Breeding of Swift fox:

This program has been developed in order to provide a method for the captive breeding of swift fox for reintroduction into their historic range, and to illuminate those aspects of captive breeding that would apply to other endangered species bred for re-introduction.

1. Both males and females can reproduce in their first year. Vixens can reproduce until their eighth year and males for their entire life.

2. As swift fox are monogamous in general, the pair bond should be respected and reproducing pairs should not be separated.

3. To maximise kit production at the breeding facilities, swift foxes should be released that have not established a pair bond, and have not reproduced by their third season together.

4. The average litter size was 3.6 $\pm$0.45 kits. Some vixens consistently produced larger litters. Vixens consistently producing larger litters should be retained within the breeding colony until the end of their potential breeding years (for females' 8 years).

5. Handling of individuals and disturbance of breeding enclosures, between February and June should be kept to a minimum.

7. Extraction of nursing swift fox kits between birth and 20 days should never be undertaken.

8. As observation has shown that some, but not all, swift fox individuals will undertake excessive cub carrying behaviour if within sight of other pairs, single pair breeding enclosures should be visually isolated from each other.

9. Housing should be designed to allow for efficient capture to reduce handling stress and obviate the use of traps or the noose.

10. Breeding enclosures should have natural floors (grass pasture) permitting the animals to dig and hunt prey species entering the enclosures.

11. Environmental enhancement structures should be present to encourage the presence of small prey in the enclosures, thus providing hunting opportunities for the adult swift fox and kits.

12. Nutritional requirements are provided by a diet of 4 day-old chicks and 150 gm of horse/game meat a day per fox for the months September- March and from March to September this diet should be supplemented with mice (*Mus musculus*) one per animal, and Iames puppy chow.

13. An immunisation program for adults and kits prevents canid disease and parasites in the colony.

14. Animals being brought into the existing colony should be health checked, immunised, and quarantined for a minimum of 60 days. Each quarantined animal should be kept separately. Quarantine facilities should be isolated, and each animal should be provided with an insulated den box and visually barred from seeing any other foxes.

Appendix:

Animal Handling Protocols: As swift fox bred at the CEI are destined for reintroduction not for trade or exhibit, CEI animal handling protocols have been developed with reintroduction in mind. The design of the A-Frame and Den Box enhanced efficient and humane capture methods.

Capture procedures were as follows:
Experience has shown that swift fox remain relaxed if kept in complete darkness, so the aim of the handling protocol is to keep the foxes in the dark as much as possible. As three handlers quietly enter the enclosure the foxes would retire to

the A-Frames. The openings to both the Den Boxes in the enclosure would then be stuffed with blanket material to prevent the foxes escape. The first A-Frame in the enclosure would then be removed, uncovering the den box beneath. The second A-frame/den box is left alone with entrances blocked until the first A-frame/den box is dealt with. A wool blanket, used to cover the animals in the chamber without exposing them to direct light, would be placed under the hinged top of the den box, over the three chambers and used to herd the enclosed animals into the centre chamber. Using bare hands handlers would feel under the blanket for the neck of an animal, grasp the fox by the scruff and lift it out, always ensuring that the animal's eyes remain covered.

After the work is completed in the enclosures, the entry holes to the A-frames/den boxes remain plugged for a minimum of 20 minutes before a single handler enters to remove the plugs. If foxes are to be transferred out of a live trap or into plastic cloud kennels, trap or kennels are also covered with blanket material to reduce stress. These methods proved to provide a minimum of stress on the animals and eliminated many of the injuries previously associated with live trapping, the noose, and other capture methods.

The captive animals are only captured three times during the year for pairs with kits and once for pairs without kits. During these capture periods animals would receive a vet check, an immunisation, and if they were kits would be tattooed for identification. The only other occasion for capture would be if the individual was in need of medical attention.

Immunisation Protocol: All swift fox at the CEI are inoculated against Canine Distemper – Adenovirus Type 2- Parainfluenza- Parvovirus vaccine (modified live virus) Leptospira Bacterin (Duramune DA2LP+P v), and Rabies (Imrab). The preventative worming programme uses Ivomec (ivomectin) injectable solution. The kits born in the captive breeding colony are inoculated using Duramune at 4 weeks, eight weeks , and just prior to release (five months). All kits are inoculated with Imrab at five months. Adult animals get one annual preventative booster each of both Imrab & Duramune. All newly arrived swift fox quarantined at the CEI go through the same preventative immunisation process.

All swift fox, both adults and kits, are treated annually for parasites using Ivomec injectable solution. Throughout the year swift fox scat is tested for the presence of parasites.

Quarantine Protocol: All newly arrived swift fox are quarantined for three months. Each animal is quarantined singly. The scat of all newly arrived animals quarantined at the CEI is tested for parasites on arrival and at the end of the quarantine period. All quarantined animals are treated with Ivomec injectable solution.

Literature Cited:

Brechtel, S.H., L.N. Carbyn, D. Hjertaas, and C. Mammo. 1993. CANADIAN SWIFT FOX REINTRODUCTION FEASIBILITY STUDY: 1989 TO 1992 - REPORT AND RECOMMENDATIONS OF THE NATIONAL RECOVERY TEAM. Unpublished Report, Edmonton, Alberta Environmental Protection

Bremner, S. 1997. DIET AND HUNTING BEHAVIOUR OF CAPTIVE-BRED SWIFT FOX (VULPES VELOX/ VULPES VELOX HEBES) INTENDED FOR RELEASE. Dissertation for M.Sc. Applied Animal Behaviour and Animal Welfare, University of Edinburgh, Edinburgh, Scotland.

Carbyn, L. N. and E. Klausz. 1995. LIVE TRAPPING SWIFT FOXES IN SOUTH EASTERN WYOMING, AUGUST 10 - 22, 1994 AND RELEASE IN OCTOBER 1994 IN SOUTHEASTERN ALBERTA. Report Submitted to the Canadian, Swift Fox Recovery Team, January 1995, Edmonton, Alberta.

ISIS. 1994. ISIS MAMMAL ABSTRACT. Apple Valley, Minnesota. International Species Information System, 1994

Pruss, S.D. 1994. AN OBSERVATIONAL NATAL DEN STUDY OF WILD SWIFT FOX (VULPES VELOX) ON THE CANADIAN PRAIRIE. M.Sc. Thesis, University of Calgary, Calgary, AB, Canada

Schroeder, C. 1987. SWIFT FOX REPRODUCTIVE BIOLOGY IN CAPTIVITY. Manuscript report, University of Calgary, Calgary, Canada.

Teeling, E. 1996. WHAT DO THESE SWIFT FOX REALLY DO? CAPTIVE SWIFT FOX BEHAVIOUR DURING THE SUMMER MONTHS. Dissertation for M.Sc. Applied Animal Behaviour and Animal Welfare, University of Edinburgh, Edinburgh, Scotland.

Weagle, K. and C. Smeeton,1995. BEHAVIOURAL ASPECTS OF THE SWIFT FOX (*Vulpes velox*) REINTRODUCTION PROGRAM. THE Proceedings Of the 2nd International Conference on Environmental Enrichment, Copenhagen Aug 1995.

Figure 1: Schematic representation of the Swift fox life cycle in the captive-breeding colony.

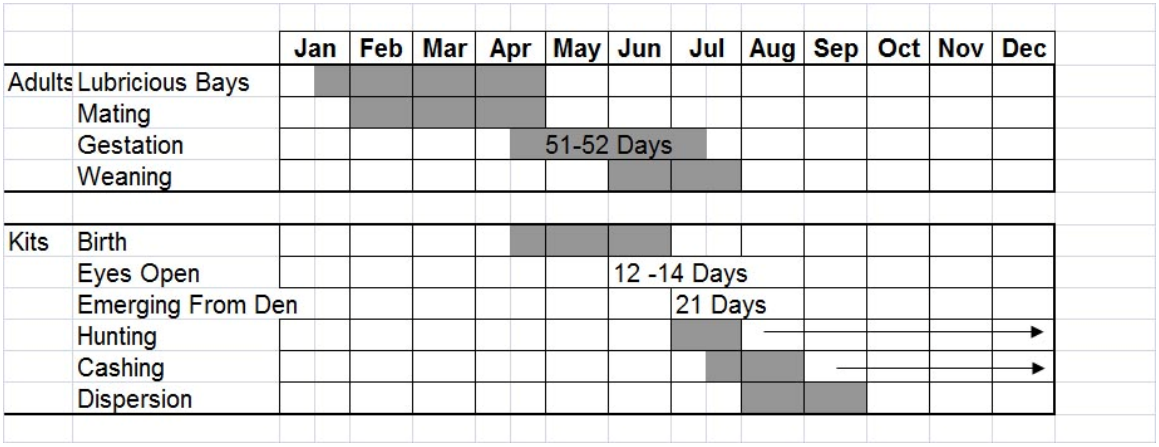

Table 1. Summary of the sources, numbers and dates imported for the Cochrane Ecological Institute founder Swift fox (locations from Carbyn and Klausz, 1995).

Source	Males	Females	Years
Golden, Colorado (first imports)	2	4	1972
Pierre, South Dakota	1	5	1978 – 1981
Pawnee National Grassland, Colorado	2	1	1980
Weld Co.,Colorado	1		1982
Lincoln Co., Colorado	2	2	1982 – 1985
Las Animas, Colorado	1		1987
Laramie Co., Wyoming	1		1990
Laramie Co., Wyoming	2	2	1990 – 1991
Laramie Co., Wyoming	5	3	1994
Total	17	17	

Table 2: Identity of parents, average litter size, number of litters and number of mates for the Swift fox females with average litter sizes greater thab 4 at Cochrane Ecological Institute from 1972 to 1997.

Female ID #	Parents' ID #	Average Litter size Kits/Litter	No. of Litters	No. of Sires
27	WxW	5.4	5	1
83	WxW	4.2	5	1
167	86x90	4.12	7	1
273	169x80	4.15	8	1
288	117x83	4.8	5	1
289	117X83	5.2	5	2
340	193x165	4.6	5	1
360	117x83	4.2	5	2
428	336x335	5.5	2	1
586	WxW	4.8	5	3
632	228x340	7	1	1
709	WxW	4.5	2	1
1024	WxW	4.3	3	1
1031	WxW	4.3	3	1

W - Wild Swift fox

Table 3: Average litter size by age class and sample size for captive females in the breeding program and for all wild females in the breeding program (age of wild females on introduction to the program was unknown).

Age of Vixen	Average Litter Size	Sample Size
1	3	35
2	3.4	41
3	3.5	43
4	4.0	35
5	4.8	23
6	3.8	18
7	3.8	18
8	4	9
Wild	3.1	50
	Total Litters	272

Table 4: Average litter size by age class and sample size for captive males in the breeding program and for all wild males in the breeding program (age of wild males on introduction to the program was unknown).

Age of Male	Average Litter	Sample Size
1	3.0	34
2	3.7	38
3	3.9	40
4	3.5	28
5	3.8	17
6	3.8	16
7	3.1	11
8	3.6	9
9	4.1	11
10	4.1	10
11	3.8	4
12	4	1
13	4	1
14	5	1
wild	2.9	51
	Total Litters	272

Figure 2: Distribution of birth dates for litters at CEI from 1976 to 1997 (Date from the International Stud Book).

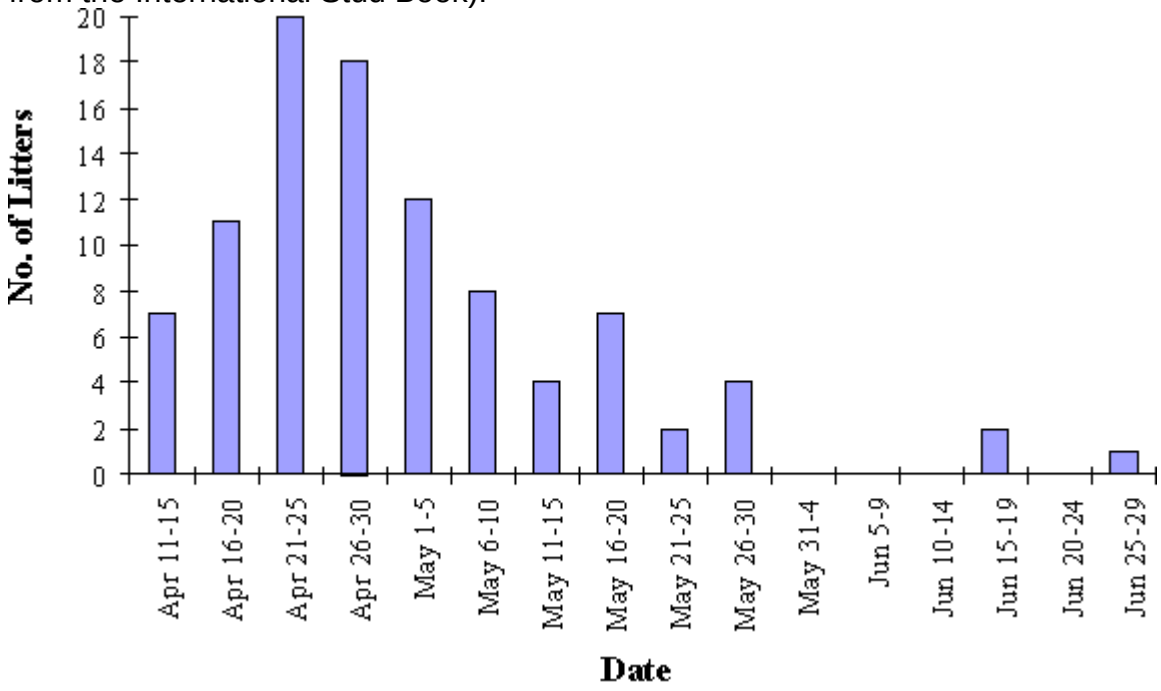

Figure 3: Numbers of litters per year born at CEI from 1976 to 1997 .