BAIT HUNTING MAY CHANGE THE AGE AND SEX COMPOSITION OF A LOCAL RED FOX POPULATION.

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Summary

Even if the red fox (Vulpes vulpes) is a key species in the fauna of the northern forests, extensive studies of this animal is still lacking. Due to its negative effect on other important game, the red fox has traditionally been intensively hunted. However, the species has a high reproducing potential, and may sustain a high hunting mortality. The effect of hunting also depends on which foxes that get shot and the hunting methods applied.

In this study, I investigated the relationship between hunting methods and sex and age composition of the bag, in addition to the effect of heavy hunting on a local fox population.

A total of 225 foxes were collected during the hunting seasons 2004/05 and 2005/06 in two regions, Interior area, I.A (Hedmark), and Coastal area, C.A (Oslo, Akershus and Østfold). Most of the foxes shot in C.A were shot at bait. All the foxes trapped in box traps were trapped in C.A. Most of the foxes shot in I.A were shot by the use of dogs.

More males than females were shot at bait, except in March, when the sex ratio was equal. Heavy hunting one year in a restricted area changed the sex and age composition among foxes shot in the same area the next year. The main difference was an increase in the proportion of young males in the bag. There were also strong indications of fewer breeding females the next year. There were differences in the mean body mass and the frequency of foxes with mange (*Sarcoptes scabiei*) between the hunting methods. There was no significant difference in reproduction between females in age group 0+, and females in age group >0+. Sex determined foetuses showed near 50:50 (16/15) ratio of males/females.

Introduction

The red fox (*Vulpes vulpes*), also just called fox, is a key species in the fauna of the northern forests. Several studies show that the red fox is a limiting factor for economic important game like roe deer (*Capreolus capreolus*), hare (*Lepus timidus*), black grouse (*Tetrao tetrix*), capercaillie (*Tetrao urogallus*) and willow ptarmigan (*Lagopus lagopus*), as well small predators like the pine marten (*Martes martes*) and goshawk (*Accipiter gentilis*) (Marcström et al. 1988, Lindström et al. 1994, Lindström et al. 1995, Aanes et al. 1996, Selås 1998, Smedshaug et al. 1999, Kauhala et al. 2002, Saniga 2002, Baines et al. 2004, Kauhala 2004,

Jarnemo et al. 2004, Kjellander et al. 2004). Further more; the red fox is in some areas an important predator on lambs of free-ranging sheep (*Ovis aries*) (Saunders et al. 1995, Warren et al. 2001, Moberly et al 2004). Possibly, the red fox is also a main reason for the decreasing population of arctic fox (*Alopex lagopus*) (Tannerfeldt et al. 2002).

Still, although interactions with other species is obvious and numerous, the red fox is one of the least studied species of the northern forests.

Due to the red fox's predation on important game species and livestock, there have been several attempts to reduce the number of foxes, in both Norway, and other parts of the world were the species is present. The annual bag of red fox in Norway and Britain is 17.000 -20.000 and more than 190.000 respectively (Heydon et al. 2000, Statistics Norway 2005). However, the effect of hunting on red fox density is uncertain. Though, man induced mortality (hunting/traffic) may accounts for a high proportion of the yearly mortality of the red fox (Storm et al. 1976, Lindström unpublished, Allen et al. 1993, Heydon et al. 2000).The red fox has a high reproduction potential, and may sustain a high hunting pressure (Saunders et al. 1995).

The effect of hunting on the red fox population should be expected to depend not only on the actual number of foxes shot, but also on the sex and age composition of the shot foxes, and at what time of the year the hunting takes place. A population of red fox usually consists of resident adults that, to a varying degree, defend their territories against other foxes, and of young "floaters", without a territory (White et al. 1994, Meia et al 1995, Cavallini 1996, Tsukada 1997, Frafjord 2004). The proportion of adult foxes in the yearly bag is not well documented. If mostly young"floaters" are shot, the effect of the hunting is probably low. On the contrary, removal of adult, resident foxes, especially females in late winter, should be expected to have a higher influence on the population.

The hunting method used may influence the sex and age composition of shot foxes (Jensen et al. 1968, Storm et al. 1976, Lindström unpublished, Takeuchi et al. 1994, Bubela et al. 1998). This may vary trough the year, due to changes in behaviour pattern, dispersal, mating and pregnancy (Storm et al. 1976, Lindström unpublished, Takeuchi et al. 1994, Cavallini 1998, Robertson et al. 2000). Social behaviour may vary within different fox populations, depending on food availability and possibly other factors (White et al. 1994, Meia et al. 1995, Cavallini

1996, Baker et al. 2004, Frafjord 2004). A varying proportion of females may stay in their mother's territory as non breeding "helpers", but to what extent this occurs in Norwegian fox populations is to a large extent unknown.

In summary, several factors should be expected to influence the vulnerability of foxes to various hunting methods. In this study, I have analysed age- and sex composition, in addition to reproductive status of red foxes, shot during two hunting seasons in eastern Norway. I have compared the sex- and age composition of foxes shot in two interior valleys, to foxes shot in a coastal, agricultural area, and compared different hunting methods.

The main focus of the study is to compare:

1) Sex and age composition of animals shot in relation to different hunting methods, and time of the year.

2) The quality (body mass of first year old males, frequency of foxes with mange) of foxes in relation to hunting methods.

3) The relationship between the age of females and their potential to reproduce.

4) The effect of heavy hunting in a restricted area.

Methods and study area

Study area

Foxes collected in this study were shot and trapped during the hunting seasons 2004/05 and 2005/06. The area where the foxes were collected was divided into two areas; Coastal area and Interior area. Coastal area (later called C.A), is represented by the counties of Oslo, Akershus and Østfold, a region of high productivity and mild winters. Interior area (Later called I.A) is represented by Alvdal and Engerdal, two municipalities north in Hedmark County, and is a region of lower productivity and colder winters than C.A.

Within the C.A, the hunting was particularly intense within a restricted area of about 400 ha. This area located in the municipality of Vestby, later called V.N, is a typically agricultural area of Southeast Norway, dominated by fields, fragmented forests, and scattered farms. The fields are mainly used for cereal production, and the forests are intensively logged. There has "always" been hunted fox in the area, but hunting pressure was increased during the seasons 2004/05 and 2005/06. New bait sites were established, and new box traps were made, as a part of this study.

Material

The hunting season of red fox in Norway is from the 15.of July, to the 15.of April. Most of the foxes collected in this study were shot between November and March during the seasons of 2004/05 and 2005/06.

Foxes were collected from 16 hunters in I.A, and 15 hunters in C.A. Some hunters were more active than others, and they also used different hunting methods. The hunting methods were divided into shooting at bait, box traps and "other methods".

• Shooting at bait at night is one of the most common ways to hunt red fox in Scandinavia. Most of the foxes shot in C.A were shot at bait. Food waste, dead animals (game or livestock), entrails from slaughtered livestock or big game, and fish is commonly used as bait. The bait is located in an open area were the fox use to travel at night. The hunter hides in a house, barn or a specially built shelter. Weapon used for fox hunting at night are either rifle or shotgun. Hunting during the dark hours of the night requires snow-covered ground or artificial light for good visibility (Kraabøl 2003).

• Box traps are a common method to trap foxes. The fox is trapped alive, and is shot inside the box trap. All of the foxes trapped in box trap were trapped in C.A.

• "Other methods" are all other hunting methods than shooting at bait and box traps. Foxes shot in I.A were mostly shot by "other methods", mainly hunted with chasing dogs, or shot at dens. The foxes shot by "other methods" in C.A were mostly shot by use of a flute that imitates a prey (calling), shot by coincidence and shot during roe deer hunting.

For each fox shot, the following data were recorded: Name of hunter, date, area, habitat, hunting method, sex, weight, and if the fox suffered from sarcoptic mange (*Sarcoptes scabiei*). Uterus from most of the females shot in March and April was dissected and number of foetuses counted. If possible, the foetus' sex were determined and registered. Big wounds from bullets witch could influence the weight were recorded if possible. The fox's lower jaw were removed and kept frozen, for later age determination.

Age determination

The foxes' age were determined by counting the cementum layers on the roots of canines, or preferably molars (Harris 1978). The jaws were boiled 30 to 45 minutes, to facilitate the extraction of the teeth, without damaging the cementum layers. The teeth were then decalcified in 5% HNO₃ for about 24 hours. After decalcification, the teeth were submerged in running water for 24 hours, to wash out the acid. After washing, the teeth were cut in thin sections (thickness of 30 μ) with the use of a freezing microtome, following another 2 hours of washing in running water. The washed sections were stained, using Mayer's Haemalun as stain. The sections were stained between 10 to 15 minutes, and then washed in running water for about 1 hour. After the final washing, the sections were mounted on microscope slides with liquid glycerol-gelatine, and were then ready for microscopic counting of cementum layers. The microscopic counting of each section was done by two persons, for greater accuracy (Jensen et al. 1968, Geiger et al. 1977, Harris 1978).

The first cementum layer usually becomes visible during the fox's second summer (Harris 1978). If microscopic counting revealed no cementum layers, the fox's age was set at 0+ (age group 0+). This meant that the fox was born last spring, and still in its first year. If one cementum layer could be detected, the fox was in its second year, and its age was set at 1+ (age group 1+). The precision of the age determination method used is estimated to be between 90 and 100 % (Harris 1978).

There were few foxes of 2 years and older in the material. These were collected into one age group >1+, in the later statistical analysis.

Statistical analysis

The statistical program used in this study was Sigma Stat. Statistical tests used were simple T-test and Chi-square test.

Animals collected

During this study, 225 foxes were collected. Hundred and sixty four were shot and trapped in box traps in C.A, and 61 were shot in I.A. Some hunters contributed only a single fox, while the most active hunter in C.A contributed 94 foxes during the two years.

Results

1) Sex and age composition of animals shot in relation to different hunting methods and time of the year.

Sex- and age composition

Foxes shot at bait in C.A (n = 131), had a male/female ratio of 86/45, when foxes from all age groups and both years were pooled. There was a high and almost significant male bias among foxes of age group 0+ (χ^2 = 3.36, df =1, P = 0.07). In age group 1+, there were significantly more males than females (χ^2 = 4.41, df =1, P = 0.04) (Fig 1).

The number of foxes trapped in box traps in C.A was low (n = 19), especially compared to the number of foxes shot at bait in the same area. All foxes except one were in age group 0+ or 1+. The only animal in age group >1+ trapped in box trap was a 3 year old female, who suffered from a serious infection in her mouth, and was probably heavily affected by this. Foxes in age group 0+ trapped in box traps had a higher male/female ratio than foxes in age group 1+ (Fig 3), but the n for both age groups were too small for statistical treatment.

Only 14 of the foxes shot in C.A were shot by "other methods". The male/female ratio among those was 10/4 (Fig 4). The n in the sample was to low for statistical treatment.

The number of foxes shot at bait in I.A was small (n = 17). The male/female ratio was 11/6 (Fig 2). Foxes shot by "other methods" in I.A (n = 44) had a male/female ratio at 21/23 (Fig 5). The differences in the sex- and age composition between foxes shot at bait and foxes shot by "other methods" in I.A were not statistically tested, due to low n among foxes shot at bait in I.A. No foxes were trapped in box traps in I.A.



Fig 1. Sex and age of foxes shot at bait in Coastal area.



Fig 2. Sex and age of foxes shot at bait in Interior area.



Fig 3. Sex and age of foxes trapped in box traps in Coastal area.



Fig 4. Sex and age of foxes shot by "other methods" in Coastal area.



Fig 5. Sex and age of foxes shot by "other methods" in Interior area.

Male/female ratio among foxes shot at bait in March.

While there was an excess of males among foxes shot at bait during October through February and in April, this was not the case in March. The male/female ratio among foxes shot at bait in March 2005 and March 2006 were 7/11 and 6/7 respectively, which did not differ from a 50:50 ratio (χ^2 = 0.113, df =1, P = 0.74) and (χ^2 = 0.0434, df =1, P = 0.84). During the rest of the hunting seasons of 2004/05 and 2005/06, the male/female ratio were 27/13 (χ^2 = 1.86, df =1, P = 0.17) and 39/13 (χ^2 = 5.91, df =1, P = 0.02) respectively (Fig 6 and 7). There was not enough data from I.A to evaluate the variation in sex through the year.



Fig 6. Male/female ratio among foxes shot at bait in C.A the season 2004/05.



Fig 7. Male/female ratio among foxes shot at bait in C.A the season 2005/06.

2) The quality of foxes in relation to hunting methods in C.A and I.A.

Body mass

The mean body mass for males in age group 0+ collected in the coastal area was 6.84, 6.03, and 6.58 kg for foxes shot at bait, trapped in box traps and shot by "other methods" respectively. Mean body mass for males in age group 0+ shot at bait was significantly higher than for those caught in box traps (t = 2.57, df = 56, P = 0.01). The difference in body mass between males 0+ shot at bait and shot by "other methods" was not significant (t = 0.652, df = 53, P = 0.52).

Males in age group 0+ shot at bait in I.A had a mean body mass at 6.97 kilo. Males in age group 0+ shot by "other methods" in I.A had a mean body mass at 5.32 kilo. The difference was not tested statistical, due to low n.

Frequency of mange

The frequency of foxes with mange in C.A was 6.9, 15.8 and 21.4 % for foxes shot at bait, caught in box traps and shot by "other methods" respectively. Foxes shot at bait in C.A had a significantly lower frequency of mange than both foxes caught in box traps (χ^2 = 17.4, df =1, P = < 0.0001), and foxes shot by "other methods" (χ^2 = 38.7, df =1, P = < 0.0001). The frequency of foxes with mange among foxes shot in I.A was 20* and 5.1 % for foxes shot at bait and shot by "other methods" respectively. The difference was not statistical tested, due to low n.

3) Reproduction

Nineteen female foxes shot in C.A, and 3 female foxes shot in I.A in March and April was dissected. In C.A, 2 of the females collected late in March and early April showed sign of already having given birth before they were shot, and was excluded from further analysis. Of the 17 remaining females, 10 were in age group 0+, and 7 were in age group >0+. The frequency of barren females was 20 % in age group 0+ and 14.3 % in age group >0+. Mean

^{*} Only data on mange/free from mange from 5 foxes shot at bait in I.A.

number of embryos/foetuses was 3.80 and 4.29 for females in age group 0+ and >0+ respectively, but the difference was not significant (t = -0.419, df = 15, P = 0.68). Including only females with foetuses present in uterus, mean number of foetuses in uterus of females in age group 0+ and age group >0+ were 4.75 and 5.00 respectively. The difference was not significant (t = -0.318, df = 12.0, P = 0.76). Of the 31 foetuses old enough for sex determination, the male/female ratio was very close to 50:50. 16 were males, and 15 were females. The females shot in I.A were in age group 0+ and 4+. The female in age group 4+ had 4, and the 2 females in age group 0+ had 4 and 5 foetuses in uterus. Foetuses collected from I.A were too young for sex determination.

4) Variation in sex- and age composition of animals shot at V.N between the two years.

Following the heavy hunting during the season 2004/05 in V.N, the male bias increased in the bag from the season of 2005/06. Foxes shot in V.N the season 2004/05 showed a bias towards males in age group 0+, and especially in age group 1+ (Fig. 8). When foxes of age group >1+ were pooled with age group 0+ and 1+, the male/female ratio was 24/12, but this was not significant (χ^2 = 1.43, df =1, P = 0.23). Among foxes shot in V.N during the season 2005/06, the male/female ratio was 27/5, and the male bias was highly significant (χ^2 = 7.09, df =1, P = 0.008). Almost every fox shot in V.N in 2005/06 were in age group 0+ and 1+ (Fig. 9).



Fig 8. Sex and age of foxes shot in V.N the season 2004/05



Fig 9. Sex and age of foxes shot V.N the season 2005/06.

Four female foxes were shot in V.N in March 2005. All of them were pregnant. Only 1 female fox was shot in V.N in March 2006. The uterus of the female shot in V.N in March 2006 was not opened because of damages from the bullet.

Mean body mass for males in age group 0+ shot in V.N the season 2004/05 was 6. 09 kilo (n = 10), while mean body mass for males in age group 0+ in the same area the season 2005/06 was 6.5 kilo (n = 20). The difference was not significant (t = -1.12, df = 28.0, P = 0.27).

Discussion

1) Sex and age composition of animals shot in relation to different hunting methods, and different time of the year.

Sex and age composition

Foxes shot at bait shoved a bias towards males. As the male/female ratio for sexed foetuses was equal in C.A, a male bias among foxes shot could not be explained by a male bias among foxes born. The difference in sex composition among foxes shot at bait and by "other methods" in I.A could indicate that there may be a male bias among foxes shot at bait, even if the sex composition in the population is even. Possible reasons for this male bias could be; 1) Higher frequency of natal dispersal among males, leading to younger and less experienced

males in the population, 2) High male activity during mating season, 3) Different behaviour/shyness between the sexes.

1). Males are usually the most dispersing sex, and probably over represented among the immigrants in an area (Storm et al. 1976, Saunders et al. 1995, Robertson et al. 2000, Kamler et al. 2004). It is well documented that young animals that disperse, suffer higher mortality than resident animals (Storm et al. 1976, Lindström unpublished, Heydon et al. 2000, Ferreras et al. 2004, Kamler et al. 2004). A fox in a new and unknown area do not have the advantages that a resident fox has. The immigrant fox is not as able to recognise changes and signs in the area that could mean danger as the resident foxes. Being in an unfamiliar area, the immigrant foxes do not know where the best hunting areas are. This could make the immigrant juvenile males more disposed to visit baits.

2) The mating season for red fox in Europe is January- March (Storm et al. 1976, Cavallini 1996, Cavallini 1998, Weber et al. 1999). Studies have showen an increased male activity during this period (Storm et al. 1976, Cavallini 1996, Cavallini 1998). This may cause the males to visit baits more frequently than females.

3) It is a common opinion among fox hunters that male foxes are less shy than females (Kraabøl 2003). An example of different behaviour between sexes may be the foxes shot by "other methods" in I.A, compared to the foxes shot at bait in C.A. Disregarding other possible differences between I.A and C.A, foxes shot by "other methods" in I.A showed a equal sex ratio, while foxes shot at bait in C.A showed a strong and in some cases a significant male bias. Foxes shot by "other methods" in I.A were mostly shot by use of chasing dogs, or shot at dens. When the fox get chased by a dog above ground, or get confronted with a terrier or a dachshund inside a den, shyness will probably not affect the possibility to get shot in the same degree than in a situation where the fox approaches bait sites.

There is probably a combination of the 3 reasons that gives the male bias among foxes shot at bait.

Few foxes were trapped in box traps during this study. The box trap is unfamiliar in the environment, and the fox probably find it suspicious. Foxes trapped in box traps are probably less careful than other foxes. Lindström shoved in a study in Sweden, that foxes caught in box traps in the beginning of hunting season were usually 0+ foxes, especially males (Lindström

unpublished). Foxes trapped during this study had significantly lower body mass and higher frequency of mange than foxes shot at bait in the same area.

Foxes shot by "other methods" in I.A showed different frequency of sex than foxes shot by "other methods" in C.A. However, the number of foxes shot by "other methods" in C.A was low. The male/female ratio in I.A was quite equal, with actually more females than males, while it was male biased in C.A. The number of foxes shot by "other methods" in C.A was to low to compare age among those shot in I.A. Foxes shot by "other methods" in I.A were mostly hunted by chasing dogs, or shot at dens. In C.A, most of the foxes shot by "other methods" were shot by coincidence, for instance during roe deer hunting, or by calling. Even if the mentioned hunting methods are collected under "other methods", they are quite different, and could lead to differences among foxes shot. It is also possible that the reason for the differences in foxes shot in the two areas is just differences in the structure of the populations, due to different male hunting mortality, or non anthropogenic reasons.

Sex composition in March compared to rest of the hunting season

The male/female ratio of foxes shot in March showed a different and actually opposite trend to the foxes shot the rest of the season. The most reasonable explanation for this difference is that females, although being shyer than males and less dispersing, get nutritionally stressed during this month due to pregnancy. As pregnant female foxes do not increase their home range (Henry et al. 2005), they probably use food sources, including baits more intensive during this period. Lindström showed in his study that the frequency of adult females trapped in box traps increased during the period when the females were pregnant or lactating (Lindström unpublished). One other possible explanation to the change in sex ratio in March could be that the male/female ratio in the population has changed, because of high male mortality in the previous months. But the sudden shift from high male bias in January and February, to the equal or female biased sex ratio in March, indicating that this is less likely.

2) The quality of foxes in relation to hunting methods.

Male foxes in age group 0+ shot at bait in C.A were heavier than males in age group 0+ trapped in box traps and shot by "other methods" in the same area. A red fox must probably

be highly nutritionally stressed before it enters a box trap. Being a natural scavenger, the threshold to visit baits is apparently much lower.

The frequency of foxes with mange varied with the hunting methods in C.A. It was significantly more foxes with mange among foxes shot by "other methods" and foxes trapped in box traps, than among foxes shot at bait. The high frequency of mange among foxes caught in box traps was no surprise. Foxes with mange loose much of their natural shyness, and get easier to trap. I expected a lower frequency of mange among foxes shot by "other methods", than the actual result. Foxes shot by "other methods" should in the theory not be shot because of their incautiousness or scavenging behaviour, as foxes shot at bait or caught in box traps. But most foxes collected, which were shot by "other methods" in C.A were shot by coincidence, during roe deer hunting and by calling. Foxes which have lost their shyness due to mange infection are more exposed to hunting mortality, and will of course be highly represented among the foxes shot. The result must though be treated cautiously, due to the low number of foxes shot by "other methods" in C.A.

There was a lower frequency of foxes with mange in I.A, than in C.A. The difference was not statistically tested due to low number of foxes shot at bait in I.A, and shot by "other methods" in C.A. The frequency of mange at 20 % among foxes shot at bait in I.A must be treated cautiously, because mange/no mange were only reported in 5 foxes. Hunters in I.A reported that there were very few foxes with mange in their hunting areas. Among foxes shot by "other methods" in I.A, the frequency of foxes with mange were 5.1 %. The difference in the frequency of mange among foxes shot by "other methods" in I.A and C.A could be explained by differences in hunting methods. It is also possible that the frequency of mange in the populations differs. A lower frequency of mange should probably be expected in I.A. The population density is probably lower in the colder and less productive region, and the colder winters should make infected foxes decreases the mange's possibility to spread.

A source of error in the frequency of mange among foxes shot in both C.A and I.A, is that hunters often did not reported shot foxes with mange. Hunters are often unwilling to handle mangy foxes, due to the possibility of being infected by the mite that causes mange. Some hunters also believed that foxes with mange were not interesting for the study.

3) Reproduction

There were evidently great differences in ovulation time among females in C.A (see picture). Some foetuses were old enough for sex determination early in March, while others were too small for sex determination two weeks later. Farmed foxes may differ a month from first litter born to the last, and this is probably also true in wild populations (Halstvedt pers comm.). None of the foetuses found in females shot in I.A at the end of March and beginning of April were old enough for sex determination, which may indicate later breeding in I.A.



(Photo: Arnstein Staverløkk).

Foetuses found in two females shot at the same bait the 18.of March 2006, in C.A

The frequency of barren females were higher, and the mean number of foetuses lower in the females in age group 0+ compared to the females in age group >0+, but the differences were not significant. However, this may be due to small sample size. Significant differences were found in a larger material collected in a study in Sweden (Englund 1970).

The mean number of foetuses found in dissected uterus during this study was close to 4, and this is similar to findings from Sweden, USA, Switzerland and Australia (Englund 1970, Storm 1976, Saunders et al. 1995, Weber et al. 1999). But even if the mean number of foetuses per female is about 4, it does not mean that 4 cubs per female are still alive in late summer. Cubs suffer high mortality in their first weeks. A study from Sweden showed that the summer mortality of cubs varied between 70, to just a few %, due to variation in the density of rodents (Englund 1970). It is also likely that some of the foetuses counted in this study,

would have been stillborn or would have died short time after birth. At least one of the counted foetuses in this study was less developed than its siblings, and would probably never have been a part of the area's winter population. But nevertheless, the reproduction potential is strong.

4) The effect of hunting on the fox population in V.N.

Neither the hunting effort nor the number of foxes shot in V.N differed substantially between the hunting seasons 2004/05 and 2005/06. However, the sex and age composition among the foxes shot differed between the two seasons. Compared to the season 2004/05, a higher frequency of foxes in age group 0+ was shot during the season 2005/06. This is in agreement with other similar studies. An increase in the proportion of young foxes seems to be a general trend in heavily hunted fox populations (Jensen et al. 1968, Storm et al. 1976, Hewson 1986, Gortàzar et al. 2003). The heavy hunting also changed the sex ratio in the population. This appears to be related to the male biased natal dispersal among foxes. Due to the reduction in the resident population in the season 2004/05, a high proportion of the foxes shot in 2005/06 were probably male immigrants from adjacent areas. The resident female population appeared affected by the hunting. Only one older female was shot during the season 2005/06 compared to 5 during the season 2004/05. A reduced number of females in age group 0+ was shot during the season 2005/06 compared to the season 2004/05. Assumed that the sex ratio among raised cubs is about 50:50, the low number of females in age group 0+ indicates that fewer litters were born in V.N and surrounding areas during the spring of 2005, as a consequence of the high hunting mortality. A possible reduced number of litters could not be explained by less available food the summer of 2005. Males in age group 0+ shot in V.N the season 2005/06 were about 0.4 kg heavier than the males in the same age group shot in the season 2004/05. The density of bank vole (Clethrionomys glareolus) was four times higher in a control area about 10 km from V.N the autumn 2005, than the autumn 2004 (Sonerud pers comm.). The increased density of bank vole was probably the reason for the increased body mass, and indicates that there was more available food in the area the summer of 2005 than in the summer of 2004.

The red fox is considered as a territory holding species. Mean territory size for both sexes in an agricultural area in Sweden is about 400 ha (Lindström 1982). Four hundred ha is the same size as the whole V.N hunting area. But there was shot 37 foxes in V.N the season 2004/05.

This means almost one fox per 10 ha. Four of the foxes were pregnant females shot in March. The large number of foxes, and especially pregnant female foxes shot the season 2004/05 indicates that territories are not strongly defended in the area. It has been shown that the red fox, and other species, do not defend territories when food is easily available and/or spatially concentrated (Tsukada 1997). This may be the case in V.N, being a highly productive area, supplemented by bait sites and human waste. V.N may function as an attractive "sink area". A red fox usually travel about 4 to 15 km per night (Goszczyński 1989, Meia et al. 1995, Tsukada 1997). Many of the foxes shot in V.N could have been resident and territory holding foxes from adjacent areas on excursion in search for food. The hunting in V.N has obviously affected the fox population in a larger area than the actually 400 ha hunted.

Conclusion

Foxes shot by different hunting methods differ in the composition of sex, age and quality.

Male foxes in age group 0+ shot at bait in C.A are significantly heavier than male foxes in age group 0+ trapped in box traps. Foxes shot at bait in C.A have a significant lower frequency of mange than foxes trapped in box traps.

Males are over represented among foxes shot at bait. The male/female ratio in foxes born can not explain the male bias among foxes shot at bait. Males are probably overrepresented among foxes shot at bait because of being over represented among immigrants, are more active during mating and because of males being less shy and cautious than females. It is also possible that heavily hunted populations are male biased because of the male biased natal dispersal.

Female foxes suffer higher hunting mortality in March, compared to the rest of the season, probably due to their higher food demand during pregnancy.

The age of female foxes in a population in a good quality habitat does not strongly influence the reproduction potential. If hunting mortality is high, for instance because of intense bait hunting in an area, a considerable portion of the resident females may be shot. Vacant territories may not be filled, due to female's lower frequency of natal dispersal, and the reproduction in the area could be reduced.

Acknowledgements

I want to thank all the hunters that have contributed with foxes to this study, especially Gunnar Andersen, who alone contributed 94 foxes during these two seasons. Without the help from the fox hunters in I.A and C.A, this study would have been impossible to accomplish. I want to thank my supervisor Olav Hjeljord for good advice and useful critics, John Gunnar Dokk for helping me with age determination at the laboratory, and all others who have helped me during this study. I also want to thank my girlfriend, family and friends, who have been forced to listen to my constant fox talk the last two years.

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