HUSBANDRY GUIDELINES
Eurasian lynx (*Lynx lynx* sspp.)

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Preface

The report has been written as a result of my three months traineeship at the European Association of Zoos and Aquaria. This traineeship forms a part of the training Animal Management at the Van Hall Institute in Leeuwarden, The Netherlands.

In the first place, I want to thank Ing. Lars Versteege for his support, cooperation and evaluations.

Also, I want to thank the National Foundation for Research in Zoological Gardens (NFRZG) for making available their enormous amount of information and their office supplies. Furthermore, I want to thank the employees and trainees of the NFRZG for the valuable experience and three pleasant months.

In addition, I want to thank Pascal Baudet and Margot Lebesque for their support and their contributions to the report.

Celesta Krelekamp
Amsterdam, 2 January 2004

Abstract

Husbandry guidelines are developed in order to increase the knowledge of the people keeping Eurasian lynxes in captivity. By increasing the knowledge, the conditions for the well-being and reproduction of all animals in the European StudBook (ESB) population can be optimised which will benefit the possible establishment of a sustainable population.

Data were collected through a literature study, a husbandry questionnaire and through personal knowledge of the European StudBook keeper, Ing. Lars Versteege. In the first section, the *in situ* situation of the Eurasian lynx is described. The second section describes the recommendations for management in captivity.

The Eurasian lynx is a medium sized felid that is currently found in Europe, the Russian Federation and Asia, thus living in ambient temperatures ranging from -25°C to +25°C. The brownish-yellow felid is terrestrial and primarily associated with forested, mountainous areas. Their home range size depends on habitat type and type and density of prey. They are strictly carnivorous and primarily hunt on small ungulates. These solitary animals are active at dawn and dusk (crepuscular). Mating is seasonal, between February and April. The total population size is estimated at below 50.000 mature breeding individuals. Although as a species the animal is not threatened yet, they may not survive unless active measures are taken to conserve it.

Most captive lynxes are contained by wire mesh, glass and concrete. Recommended minimum space is 4 x 2 x 2,5 metres per cat (l x w x h). More important than an enclosure's size is its complexity and usability. Each lynx must have access to its own den box. Established pairs and groups can be kept together continuously (for enrichment), although incidents may occur. In the case of established pairs and groups, removal of other animals prior to a birth is not required, although risks can be inherent to this situation. Hand-rearing should only be done when the health of the cub or dam is in peril. The methods of choice for permanent contraception are for females ovariohysterectomy and for males castration. Lynxes, in most cases, are fed once a day and fasted once or twice a week. A combination of diets is recommended, also providing opportunities to exhibit species-appropriate behaviours. Fresh water should always be available. Daily handling should only consist of a visual examination by the staff. Interactions between lynxes and humans should take place in a protected contact situation. Each zoo should have written standard operating guidelines that address the safety of the keepers and the public. An animal due to be transported should be healthy, contained safely in an appropriate crate (according to IATA guidelines) and subjected to a minimum of stress (light and noise levels kept low and acclimated to the crate before transport). For precise individual identification animals are implanted with chips. All newly arrived lynxes should be quarantined for at least 30 days. The diseases and parasites commonly associated with Eurasian lynxes are: FIE, FVR, FCV, FIP, rabies, salmonellosis, tuberculosis, FIA, anthrax, roundworms, ear mites, fleas and toxoplasmosis. In captivity, they can reach an age up to 24 years. Problems concerning the management of the captive population are the unknown origin of a large percentage of the population and the disagreement on the validation and determination of the different subspecies.

The report finishes with a description of the husbandry questionnaire that was carried out and recommendations for additional research.

Contents

Introduction

This report consists of the husbandry guidelines for the Eurasian lynx (*Lynx lynx*). Husbandry guidelines should be developed in order to increase the knowledge of the staff of zoos and other people involved in breeding with Eurasian lynxes (the target group). By increasing the knowledge, the conditions for well-being and reproduction of all animals in the European StudBook (ESB) population can be optimised. Optimised reproduction in this case does not indicate maximum reproduction, but rather the build up of a sustainable population that can also (in the future) be used for reintroductions.

The husbandry guidelines consist of 2 sections:

- section 1: Biology and field data;
- section 2: Management in captivity.

Section 1 consists of the description of the biology and field data of the Eurasian lynx. Section 2 consists of recommendations for management in captivity. This section deals with the following topics: enclosure, feeding, social structure, behavioural enrichment, breeding, population management, handling and legislation. The report finishes with recommendations for additional research and references.

This report was compiled after a literature study using several books, articles and mostly internet. Internet was used as main source material because of its extreme amount of information. Data was also collected through a husbandry questionnaire and through personal knowledge of the European StudBook keeper, Ing. Lars Versteege.

Neonate will be defined in this text as an animal in the first three weeks of life. When mentioning sex ratios the following form is used: male.female.unknown.

Section 1 Biology and field data

1 Biology

This chapter covers basic biological information relevant to *in situ* and *ex situ* Eurasian lynxes. Successively, taxonomy, morphology, physiology and longevity are discussed.

1.1 Taxonomy

In table 1, the taxonomy of the Eurasian lynx (*Lynx lynx*) is described, including all known living species and subspecies.

Taxonomy	**Latin name**	**English name**
Class	Mammalia	Mammals
Order	Carnivora	Carnivores
Family	Felidae	Cats
Genus	Lynx	Lynx / Los
Species	*Lynx lynx*	Eurasian lynx
	Lynx canadensis	Canadian lynx
	Lynx pardinus	Iberian lynx
	Lynx rufus	Bobcat
Subspecies of the Eurasian lynx	*Lynx lynx lynx*	Northern lynx
	Lynx lynx kozlovi	Irkutsk lynx
	Lynx lynx wrangeli	Siberian lynx
	Lynx lynx carpathicus	Carpathian lynx

Table 1: Taxonomy of the Eurasian lynx (Nowak, 1999 and Versteege, 2003)

There is still an ongoing debate among felid taxonomists on the validation and determination of the different subspecies. The subspecies mentioned in table 1 are thought to be different subspecies (Versteege, 2003).

The most often used common names of the Eurasian lynx are:
- English: Eurasian lynx;
- Dutch: Europese lynx;
- German: Luchs;
- French: Lynx;
- Spanish: Lince (Anonymous, 2003a).

1.2 Morphology

Measurements
The measurements of these medium-sized cats are shown in table 2. In this table the measurements of adults are shown. The weight of newborn cubs is displayed as well. The ear tufts of the Eurasian lynx can be up to 4 centimetres long (Anonymous, 2003b).

Measurements	Adult males	Adult females	Newborns
Head and body lengths (cm)	80 – 130		
Weight (kg)	21,6	18,1	0,25 - 0,36
Height at shoulder (cm)	60 – 75		
Tail length (cm)	11 – 35		

Table 2: Measurements of Eurasian lynxes (Anonymous, 1999a, Anonymous, 2000)

Colouration

The ground colour of the fur of the Eurasian lynx is brownish-yellow, but can vary to rusty or reddish brown (Anonymous, 2000). Greyish colours dominate in the wintercoat (Tomkins, 1962). There are three main coat patterns: predominantly spotted, predominantly striped and un-patterned (Anonymous, 2003a). The spotting is dominate in the summer and is almost barely visible in the winter phase (Anonymous, 2000). Pelt colours also vary within and between the species range (see under 'Description'). The colouration of the coat serves as a perfect camouflage in wooded areas (Anonymous, 2003b). Their underbelly and face are of a lighter cream colour (Anonymous, 2003c). The ears have tufts of dark hair and the backsides are black towards the tip, showing light central spots (Anonymous, 2000). Their white whiskers frame their muzzle (Hernandez, 2002). The irises are yellow brown to a light yellowish green colour. Eurasian lynxes have a black tipped tail (Anonymous, 2000). See figure 1.

Figure 1: The Eurasian lynx

Description

The Eurasian lynx has a stout body with a thick and soft pelt (Hernandez, 2002). This pelt even protects it from the cold Siberian winter nights (Anonymous, 2003b). The summer coat is shorter than the winter coat (Nowell and Jackson, 1996). The Eurasian lynx has, as all small cats, a complete ossified t-bone (Fowler, 1986). It also possesses a small heart (Honders and Kuipers, 1992). Furthermore, it has relatively long legs with the rear limbs longer than the front legs, giving the body a tilted forward appearance (Anonymous, 2000). The front feet have five toes while the hind feet only have four (Breitenmoser, 2000). The lack of a clavicle permits more freedom of movement of the forelimb. The ulna is well developed (Fowler, 1986).
The claws are sharp, strong and retractile, especially those on the front feet used to seize prey (Breitenmoser, 2000).

The claws are covered by an epithelial envelope when retracted (Fowler, 1986). Eurasian lynxes have large, wide-spreading feet which are covered in fur (Anonymous, 2003d). In winter, the fur is very densely at the bottom of the feet (Anonymous, 2003a). The area load is then about 40 grams per square centimetre. This prevents them from sinking into the snow. The snowshoe effect makes it possible for, the cats to walk easily on the surface of deep snow (Anonymous, 2003b). The thick fur also keeps their feet warm as they walk on the cold ground (Anonymous, 2003c). The head of the Eurasian lynx is rounded (Breitenmoser, 2000). The animal has flared large ruffs of long hair around its neck and under its chin. It also has whiskers (Hernandez, 2002) and long tufts of hair on the tips of its large pointed ears (Anonymous, 2003c). The ear tufts aid excellent hearing (Anonymous, 2003b). Eurasian lynxes do not have a premolar, but they do have two sharp eye-teeth to kill prey with. They also have six incisors, to cut off pieces of meat (Honders and Kuipers, 1992). The species has anal glands and males have an os penis (baculum) (Fowler, 1986). Eurasian lynxes have a short, stubby tail (Anonymous, 2003c).

Rather than smelling their prey, lynxes depend on their extraordinary sense of hearing along with their sight (Hernandez, 2002). It can hear a mouse 65 meters away and can spot roe deer at a distance of 500 meters (Anonymous, 2003b). The sense of touch is also very well developed (Petstra, 1997).

Pelt colour varies within and between different parts of the species' range (Breitenmoser, 2000). The spotted-striped types, controlled by the "tabby" gene, predominate in present reintroduced European lynx populations (originating mainly from the Carpathian mountains further east) (Anonymous, 2003a). Overall, northern animals tend to be greyer and less spotted than southern animals (Anonymous, 2000) which mainly have a reddish tint and profused spotting (Anonymous, 2003a).

Individuals from the species' northern and eastern geographical range are larger than those from southern and western areas (Breitenmoser, 2000). The lynxes of eastern Siberia reach the largest size (Anonymous, 2003a).

The main differences between male and female lynxes are size and the (non-) visibility of reproductive organs. Male lynxes are generally bigger than females. This difference in size probably originates from sexual competition in which only the large and powerful males survived (Hernandez, 2002). However, a large female in an older age class can be confused with a small male in a young age class. In addition, significant geographic variation exists among the different populations (Bookhout, 1994). Male lynxes can also be recognised by the visibility of testicles (pers. comm.).

Cubs look the same as their parents when they are born. They already have tufts on both their ears and the collar of long hair around their necks and under their chins (Mellen and Wildt, 2003).

Because the Eurasian lynx has a complete ossified t-bone, it can not roar. However, it can hum or purr by breathing in and out (Fowler, 1986). The otherwise very quiet male lynxes, can be heard meowing in the mating season (Anonymous, 2003b). Mating usually takes place at night and during late afternoon (Fowler, 1986), and at those times the males are especially vocal (Anonymous, 2000). Intromission is

signalled by a “copulatory cry” given by the female; this vocalization is typically a low, barely audible growl (Mellen, 2003).

1.3 Physiology

Information such as heart rate, respiratory rate and body temperature of an adult lynx are shown in table 3.

Physiology	Adult lynx
Body temperature	37,8 to 39,9ºC
Heart rate	40 to 50 beats per minute
Respiratory rate	10 per minute

Table 3: Physiology of the adult Eurasian lynx (Fowler, 1986)

Eurasian lynx cubs have a lower body temperature in the first weeks after birth, as they are not able to regulate their body temperature yet. In the first few weeks their body temperature can range from about 36 to 38ºC (Fowler, 1986).

1.4 Longevity

In the wild, the Eurasian lynx has no natural enemies. Only sporadic cases of lynxes killed by wolves, wolverines and tigers have been reported. However, a lynx can be fatally injured by large prey during hunting. They can also suffer from various parasites and diseases, such as rabies or feline panleucopaenia. The mortality among juvenile lynxes is high; at least half of them do not reach adult age. Currently, traffic accidents and hunting are the main causes of mortality (Breitenmoser, 2000). In the wild the Eurasian lynx can live up to 10 to 12 (Hernandez, 2002) or even 17 years. In captivity, the Eurasian lynx can reach an age of up to 24 years (Anonymous, 2003a).

2 Field data

This chapter relates specifically to Eurasian lynxes in the wild. It includes information on zoogeography and ecology, diet and feeding behaviour, reproduction and behaviour.

2.1 Zoogeography and ecology

Distribution

Current distribution
Currently, the Eurasian lynx is found in Europe, the Russian Federation and Asia (Anonymous, 2003a). See figure 2.

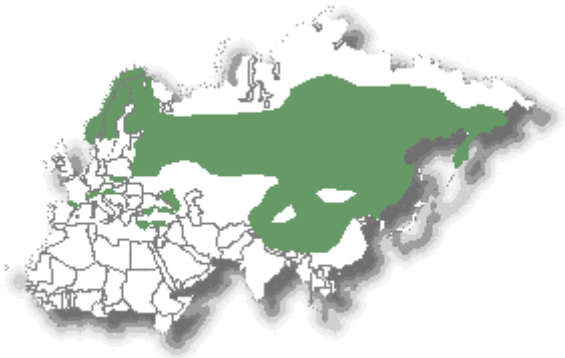

Figure 2: Distribution of the Eurasian lynx (Garman, 2000)

Throughout this range different subpopulations exist, though not all of them have been recognised (see chapter 1.1). The Northern lynx (*Lynx lynx lynx*) can be found in Norway, Sweden, Finland, Estonia, Latvia, Lithuania, Poland, Belarus, Ukraine and the Western Russian Federation. The Carpathian lynx (*Lynx lynx carpathicus*) has its range in the Carpathian Mountains (Slovakia, Poland, Romania, Ukraine) and in the Czech Republic, Hungary, Slovenia, Croatia, Bosnia-Herzegovina, Serbia and Montenegro, Albania, Macedonia and Greece. The Irkutsk lynx (*Lynx lynx kozlovi*) can be found in Central Siberia (Central Russian Federation) and the Siberian lynx (*Lynx lynx wrangeli*) in Eastern Siberia (Eastern Russian Federation) (Anonymous, 2003a, Anonymous, 2003e, Nowell and Jackson, 1996). Eurasian lynxes are also found throughout the northern slopes of the Himalayas, the mountains of the Central Asian desert region and the entire Tibetan plateau. They also live in the Caucasus (Russian Federation, Georgia, Azerbaijan, Armenia, Iran and Turkey). Animals from this last region are sometimes recognized as the subspecies *Lynx lynx dinniki* (Caucasian lynx). The reintroduced Eurasian lynxes live in the Alps and Jura Mountains (France, Switzerland, Italy and Austria). The Carpathian lynx population has been the source of this reintroduction (Anonymous, 2003a).

Historical
The Eurasian lynx once flourished (Hernandez, 2002) in the forested areas throughout most of Europe, the Middle East, Central Asia and Russia (Garman, 2000, Breitenmoser, 2000). It was probably absent from some of the larger islands such as Ireland and Sicily and from countries with few forests. It was also absent from the Iberian Peninsula, where the smaller, Iberian lynx occurs (Breitenmoser, 2000).

The species was actually eradicated from most of the European sub-region within the past 150 years, surviving only in the north and the east. In these regions, numbers fell in the early 1900s, but recovered concurrently with increases in small ungulate populations (Anonymous, 2003a). In Western Europe, all Eurasian lynxes were exterminated. In Central Europe, they survived only in the Carpathian Mountains and a small area of the south Dinaric Mountains in Greece, Macedonia and Albania. Human activities reduced the population to its minimum numbers in the 1950s (Breitenmoser, 2000). Their numbers were drastically reduced as a result of hunting and trapping for fur and for sport (Hernandez, 2002). Its natural prey became increasingly rare and consequently the large feline preyed on badly protected livestock (Anonymous, 2003b). Because of this last fact, they were hunted even more. Their habitats (forested areas) were also slowly being destroyed (Hernandez, 2002) by deforestation, expansion of agriculture and an increase in human population (Breitenmoser, 2000). In the 1970s, great concern for the future of the lynx lead to taking lynxes from areas where they were abundant in Europe and releasing them in to the forested mountains of Switzerland, Austria, Germany, (Hernandez, 2002) Czech Republic, France, Slovenia, Croatia (Breitenmoser, 2000) and Slovakia (Anonymous, 2003b). Reintroductions have been moderately successful (Hernandez, 2002). In general, lynxes adapt well to settled and cultivated areas. In Switzerland the reintroduced population has now stopped expanding and is threatened by an imbalanced sex ratio. Because of unusually high losses of male cubs, special attention is given to possible congenital problems (Anonymous, 2003a). Since the fall of the Iron Curtain, the animals have been observed to migrate into Central Europe (Anonymous, 2003b). In Sweden, excessive hunting and the feline panleucopaenia resulted in a severe drop in the population. The species is now protected in Sweden. In Finland, where the population grew from virtually zero in the 1950's to over 500 lynxes thirty years later, special hunting licenses are issued (Anonymous, 2000).

Reports on lynx distribution show that in Russia a major population increase and range expansion (including the colonisation of the entire Kamchatka peninsula) took place in the 1930s and 1940s. Areas where they had previously been extirpated were re-colonised, mainly due to a sharp decline in commercial hunting during this period of social upheaval. Harvest levels now range between 2.000 and 5.800 annually. The maximum harvest reported (1956: 5.800) is similar to harvests reported for 1985 and 1986, which could indicate that the lynx population has remained relatively stable. In 1993, Russia announced export quotas for lynx fur: 2.800 per year. Export of lynx fur is currently low, below 1.000 annually (Anonymous, 2003a).

China also announced in 1993 the setting of export quotas for lynx furs: 1.000 per year. Exports of lynx fur is currently low, below 1,000 annually (Anonymous, 2003a). No information is available on the historical developments of the Eurasian lynx in the Asian region.

The lynx may have occurred in Palestine before that area was largely deforested (Nowak, 1999).

Habitat

The Eurasian lynx is a terrestrial animal. They occur in temperate regions (Mellen, 2003) with sufficient ungulate populations and far from dense human populations (Hernandez, 2002).

Throughout Europe and Siberia, lynxes are primarily associated with forested, mountainous areas. They prefer deciduous forest or old growth taiga and mixed woodlands, with plenty of undergrowth for cover (Anonymous, 2000). In Central Asia, lynxes occur in more open, thinly wooded areas (Anonymous, 2003a). These lynxes are found to inhabit rocky, barren areas above the mountain tree lines, semi-deserts and in northern latitudes. They can even survive taiga, alpine tundra (Anonymous, 2003d, Breitenmoser, 2000).

The climate in these regions varies greatly, with temperatures ranging from -25 C to +25°C (Anonymous, 2003f).

In snowy periods, the animals use paths, roads and human traces for moving around (Anonymous, 2003a). During this period, they resort to hiding behind rocks for hunting. Only during extremely bad weather the Eurasian lynx takes shelter in caves, hollow logs, and trees (Hernandez, 2002).

Population

Based on estimates of density and geographic range, total population size for lynxes is estimated at below 50.000 mature breeding individuals (Anonymous, 2003e).

The European population is estimated at around 7.000 (Breitenmoser, 2000), and is dispersed into many separate subpopulations (Anonymous, 2003a), as can be seen in table 4.

Population	**Land**	**Size of the area (km²)**	**Size of the population**
Northern population	Norway, Sweden, Finland	873.000	2500
Baltic population	Latvia, Estonia, Lithuania, Poland, Ukraine, Belarus	60.000	2000
Carpathian population	Czech republic, Slovakia, Poland, Hungary, Ukraine, Romania, FR Yugoslavia	104.000	2200
Bohemian-Bavarian population	Czech republic, Germany, Austria	6.000	100
Balkan population	FR Yugoslavia, Albania, FYR Macedonia, Greece	1.600	50
Dinaric population	Slovenia, Croatia, Bosnia-Herzegovina	10.000	200
Alps population	France, Switzerland, Italy, Austria, Slovenia, Liechtenstein, Germany	40.000	150
Jura population	France, Switzerland	11.000	100
Vosges population	France	2.800	Unknown
Pyrenean population	France	Unknown	Extinct

Table 4: Populations of the Eurasian lynx (Breitenmoser, 2000)

Apart from the Northern population, the Baltic, the Carpathian and the European populations are not large enough and too isolated to survive (Anonymous, 2003a, pers. comm.). Populations will only have a chance if they are properly managed (Anonymous, 1999a, pers. comm.).
In the Russian Federation, the Eurasian lynx is thought to be doing well, with an estimated Siberian population of 36.000 to 40.000 (Anonymous, 2000).

In the Caucasus, the animal is now quite rare.

Little information is available on the remainder of the Asian population (Anonymous, 2003a).

Conservation status
Although the Eurasian lynx is not endangered, threats such as habitat loss, harvesting and changes in native species dynamics (prey base) induce an ongoing population decline (Anonymous, 2003e, Anonymous, 2003a, Anonymous, 2003c). In some parts of its range it has already become extremely rare and may not survive unless active measures are taken to conserve it (Anonymous, 1999a). Studies have shown that lynxes are quick to rebound if hunting pressures are lessened and protected areas are set aside (Anonymous, 2000). Furthermore, it must be taken into consideration that wolf conservation impairs lynx density, as wolves and lynxes are competing species (for prey, habitat, etcetera) (Mitchell-Jones, et al., 1999).

The recognised conservation classification codes for the Eurasian lynx are given below.

Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)
Listed under Appendix III (Anonymous, 1999b). This obligates contracting parties to take appropriate and necessary legislative and administrative measures to ensure the protection of the Eurasian lynx, regulate any exploitation in order to keep the populations out of danger, and take measures including closed seasons and / or other procedures regulating the exploitation, temporary or local prohibition of exploitation in order to restore satisfactory population levels and regulation of sale, keeping for sale, transport for sale or offering for sale of live and dead wild animals (Anonymous, 2001a).

EU Habitat Directives
The lynx is listed in Appendix II. This appendix includes animal and plant species of community interest whose conservation requires the designation of special areas of conservation (with exception of the Finish population). It is not listed as a priority species. It is also listed in Appendix IV. This appendix includes animal and plant species of community interest which are in need of strict protection (Breitenmoser, 2000).

IUCN Red List
The species is listed in the category Nearly Threatened (NT) (Anonymous, 2003e). This means the Eurasian lynx does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for, or is likely to qualify for, a threatened

category in the near future (Anonymous, 2003g).

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
Lynx lynx is listed under Appendix II (Anonymous, 2003h), which contains species that are not necessarily threatened with extinction but may become so if trade is not controlled. It also contains species that look so similar to endangered species that they are difficult to distinguish (Anonymous, 2003i).

European Union Regulation (EC)
The Eurasian lynx is listed under Annex A of this regulation on the protection of species of wild fauna and flora by regulating trade (Wallström, 2000).

Legal status in European countries
The legal status of the Eurasian lynx in European countries is summarised on attachment I. On attachment II, an Action Plan can be found. This includes actions to protect the Eurasian lynx that have to be taken by countries harbouring them. On attachment III, the actions undertaken by several countries can be found.

Legal status in non-European countries
Hunting is prohibited in the following countries: Georgia, India, Iran, Kazakhstan, Kyrgyzstan, Nepal, Pakistan, Tajikistan, Turkmenistan and Uzbekistan. Hunting is regulated in: China, Mongolia, Russia and Turkey. In Bhutan and Myanmar hunting is prohibited in protected areas only. No information was available on: Afghanistan, Armenia, Azerbaijan, Iraq, North Korea and Syria (Anonymous, 2003e).

2.2 Diet and feeding behaviour

The Eurasian lynx is strictly carnivorous and hunts for its prey (Hernandez, 2002). The main prey items are small ungulates, particularly roe deer (*Capreolus* spp.), musk deer (*Moschus moschiferus*) and chamois (*Rupicapra* spp.). The prey animals are mostly female, young, weak, old or ill animals. When these prey animals are scarce they will also hunt pikas (*Ochotona* spp.) (Anonymous, 2003a), rodents, hares (*Lepus* spp.), foxes (*Vulpes vulpes*), wild boar (*Sus scrofa*) (Anonymous, 2003b), ground-dwelling birds (Hernandez, 2002) and domestic animals such as sheep (*Ovis aries*) (Anonymous, 2000). In general, throughout Europe and Siberia, the Eurasian lynx primarily hunts ungulates. The lynxes of the Central Asian deserts and high mountains appear to prey mainly on rodents, hares and pikas. In some parts of their range, lynxes prey mainly on large ungulate species, including red deer (*Cervus elaphus*), caribou / reindeer (*Rangifer tarandus*), argali (*Ovis ammon*) (Anonymous, 2003a) and moose / elk (*Alces alces*) (Breitenmoser, 2000). Overall, female lynxes seem to hunt for less deer than males (Garman, 2000).

Lynx prey can be recognised by the way the prey is eaten. The lynx starts with the fleshy parts. Seldom does it break the bones. It leaves the innards and the stomach behind for other predators. When it has finished eating the prey, the carcass is still intact with head and feet. (Honders and Kuipers, 1992).

The lynx hunts mostly at dusk and at night (Hernandez, 2002, Anonymous, 2003b). They hunt mostly by sight and hearing.

As they can only run fast for short distances (Hernandez, 2002), because of their small heart (Honders and Kuipers, 1992), they must surprise their prey (Hernandez, 2002). First, they follow their prey for up to several days (Nowak, 1999), keeping low to the ground. When circumstances are favourable, they attack the unsuspecting animals at close range**,** from the ground. (Contrary to popular belief, Eurasian lynxes do not climb trees for hunting and pounce on their prey, but merely to escape danger.) Once the animal is caught, the prey is killed by a bite in the neck, cutting the spinal cord. If the animal is too large, they merely hold the throat of the animal until it suffocates (Hernandez, 2002). Lynxes are capable of killing prey three to four times their own size. The prey is usually dragged several hundred metres before being consumed (Nowak, 1999). With their razor-sharp teeth, lynxes cut through flesh efficiently. Portions of the prey that are not immediately consumed are cached and retrieved later (Hernandez, 2002). Lynxes do not travel further than one to two kilometres for the first two days after leaving the carcass (Böer et al., 1995). According to a Swedish research project, the chance of a successful hunt is about 75% when the prey is at a distance of 20 metres. The chance decreases to 50% at a 50 metres distance and to 30% at a 200 metres distance (Honders and Kuipers, 1992).

Naturally, the Eurasian lynx is very dependant on the density of their prey (pers. comm.). Their territories range enormously in size according to density of prey (Breitenmoser, 2000) and the diminishing prey base in Western Europe has led to a severe reduction in the lynx population (Anonymous, 2000). The territory of the Eurasian lynx also ranges according to the type of prey (Breitenmoser, 2000). The most thorough estimates of resident adult density (per 100 km^2), derived from radio telemetry studies, are available from Switzerland: 0,94 (Jura Mountains); 1,2 (northern Alps); 1,43 (central Alps). Based on snow tracking, an estimated 0,34 to 0,74 individuals per 100 km^2 live in Sweden. Where ungulate prey is abundant, density estimates are high: 10 to 19 lynxes per 100 km^2 in the Bialowieza Forest in Poland and Byelorus. Where hares are the major prey, density estimates from Russia are of the order of less than four lynxes per 100 km^2. In the northern parts of Siberia, arctic hares and lynxes fluctuate cyclically. In Finland, lynxes tend to be in better condition in the south-west (where there is an introduced population of white-tailed deer from North America) than in the rest of the country, where ungulates are very rare and hares are the main available prey (Anonymous, 2003a).

Winter brings both problems and advantages. Lynxes can be easily seen against the snow in wintertime because of the lack of grass for hiding. Moving through snow is relatively easy for these cats because of their large, fur-covered feet that prevent them from sinking into the snow (Hernandez, 2002). Large ungulate prey is favoured in winter because of their vulnerability in deep snow. For example, Scandinavian lynxes have been reported to switch from predation on small game in autumn to large game in winter (Anonymous, 2003a). In the summer months the intake of rabbits increases (Garman, 2000).

The intestinal tract of the Eurasian lynx is short, adapted to rapid digestion and assimilation of meat (Fowler, 1999).

2.3 Reproduction

This subchapter details the physiological aspects of the reproductive cycle of the Eurasian lynx.

Sexual maturity
Sexual maturity in Eurasian lynx females is reached between 21 and 27 months, while males take 30 to 36 months (Anonymous, 2000, Anonymous, 2003d). Females remain fecund until the age of 14, males until they are 16 to 17 years old (Nowak, 1999).

Seasonality
Mating is seasonal. The mating season is in the early spring, between February and April (Anonymous, 2003a). A second breeding period, possibly for females that did not conceive during the primary period, has been observed in May (Fowler, 1986). The receptive period can last from one to ten days (Anonymous, 2000). The interbirth interval is generally one year, but with occasional breaks (for example three years with litters, one without) (Anonymous, 2003a).

Gestation
The gestation period lasts 67 to 74 days (Breitenmoser, 2000). Before giving birth, the female makes a den in a cave, in a hollow log, at the base of trees or in dense vegetation (Hernandez, 2002, Anonymous, 2000).
In years of low prey availability, females may not conceive at all or may spontaneously abort in response to the body's poor nutritional condition (Anonymous, 2000).

Birth
Female lynxes give birth to a litter of between one and four cubs, with the average being two (Breitenmoser, 2000). They are mostly born in May or June (Anonymous, 2003a). Cubs are born with their eyes closed, nearly deaf, immobile and are unable to regulate their own body temperature yet (Fowler, 1986). They weigh on average 250 to 360 grams (Anonymous, 2000).

Development
Between 10 and 17 days their eyes open (Anonymous, 2000) and they are able to keep themselves warm without the help of their mother (Hernandez, 2002). They begin to walk between 24 and 30 days. The female nurses her young for three to five months and they begin to eat some solid food at one month of age (Anonymous, 2000). At six weeks old, the cubs follow the mother on short trips (Hernandez, 2002). The cubs are weaned when they are between three and five months old, and are usually independent of their mothers at ten months (Anonymous, 2003c). The young remain with the adult female until the following mating season, by which time they weigh between 9 and 14 kilograms (Breitenmoser, 2000). At the age of one year, the cubs leave their mother (Hernandez, 2002). Young lynxes may remain together for some weeks or months after separating from their mother, travelling and hunting co-operatively (Anonymous, 2000). By the time they reach two years they are fully grown (Anonymous, 2003b). Males do not participate in parental care (Hernandez, 2002).

The mortality rate in cubs is high. In the first year around 50% of the cubs die (Breitenmoser, 2000). The mortality is the highest at three to four months after birth, just after the cubs fully emerge from the lair for longer periods. Survival seems to be correlated with the covering and soil humidity of the lair. More covering means dryer lair and greater survival of the cubs (Boutros, 2001).

2.4 Behaviour

Activity

Eurasian lynxes are active at dawn and dusk (crepuscular) (Anonymous, 2003j). The length of daily motion depends on food resources (Anonymous, 2003b). It ranges from two to five, up to 25 kilometres (Böer et al., 1995). They rest mainly around mid-day and midnight (Anonymous, 2003a), except during the rutting period (Breitenmoser, 2000). They rest under a ledge, the roots of a fallen tree or a low branch. The animals stay active during winter. Only during extremely bad weather do they take shelter in caves, hollow logs and trees (Hernandez, 2002).

Eurasian lynxes spend time grooming themselves in order to keep clean and scratch on hard surfaces (for example logs and trees) in order to keep their claws sharp (Hernandez, 2002).

Social behaviour

The Eurasian lynx is a solitary animal. The only social units are a mother with dependent offspring, male and female during breeding season, siblings hunting together before separating (Anonymous, 2003d), and females have been seen hunting together when having cubs (Anonymous, 2003c).

The home range size of the Eurasian lynx depends on habitat type, and composition and density of prey (Breitenmoser, 2000). Excluding outliers, average home ranges reported for males are 264 ± 23 km^2; for females home ranges of 168 ± 64 km^2 are reported. Within these home ranges, core areas average 185 ± 58 km^2 for males, and 72 ± 27 km^2 for females. From this it can be concluded that females tend to use the central part of their home ranges more intensively, whereas males regularly visit the periphery of their home ranges. Male core areas show some overlap, while those of females are exclusive. With the exception of the overlap zones, one male and one female share the same area. On average, 86% of a female's home range is covered by a male's home range. Studies from Sweden and Russia have also concluded that males generally share their ranges with just one female and cubs. However, males seem to avoid female core areas, and thus appear to control a zone around females and their cubs, avoiding competition for prey and excluding other male competitors (Anonymous, 2003a).

Lynxes mark their boundaries by urinating on rocks, trees and stumps (Hernandez, 2002). They also mark through cheek, chin, head and neck rubbing on an inanimate object, by scraping the ground with their hind feet and by sharpening their claws (Mellen, 2003).

When the young are born, they are completely dependent on their mother for warmth, food and protection. This is why the female stays with her cubs constantly until driven to leave by hunger, and even then she is only away for very short periods of time.

During the development, females hunt with their young in order to teach them proper techniques. The young learn this through observation and practice. Eurasian lynx cubs are active, curious and skilled at climbing trees, using their sharp claws (Hernandez, 2002). When the cubs leave their mother, siblings may travel and hunt together for several months (Anonymous, 2003d). When hunting together, one animal chases the prey into the direction of the other (Nowak, 1999). After that period together, the siblings separate. Male lynxes travel longer distances than females, who generally stay close to their mother (Hernandez, 2002).

As described before, Eurasian lynxes have one large white spot in the middle of the back of each ear. This signals the mood of the cat to other felines; the spots are clearly visible when the ears are laid back which may signal aggression (Anonymous, 2003c). Tail, eyes and whiskers are also indicators of escalating aggression (Mellen, 2003).

Sexual behaviour

During mating season of the Eurasian lynx, the males move widely, marking actively their territories and going out from their home ranges (Anonymous, 2003a). Urinating on rocks, trees and stumps help the male locate potential females (Hernandez, 2002). During this time, lynx males can be heard meowing (Anonymous, 2003b). Most probably those males manifest their desire to find a female (Anonymous, 2003a).

A male follows a female in a three to five day course. Sometimes more males are following one female (Anonymous, 2003a). When a female and male meet for the first time, they greet each other by sniffing and rubbing their cheeks against each other. After this, they sniff the genital region of each other (Mellen, 2003). During the first two days of contact, male and female spend all their time together and sleep side by side. During this period they chase each other, hunt together and sniff and lick each other (Hernandez, 2002). The female is receptive during a period of 24 to 48 hours within this time frame (Mellen, 2003).

Mating usually takes place at night and during the late afternoon (Fowler, 1986). The male approaches the female, grasps her by the nape and mounts by straddling the female: first with the front feet and then with the hind feet. The female responds to the nape bite by adopting a lordosis posture (front quarters lowered, rear quarters elevated, and tail moved to one side). The female sometimes also treads with her hind feet. At this point, the male occasionally begins stepping with his hind feet, often simultaneously rubbing against the female's flanks. The rubbing by the male may induce the female to adjust or to exaggerate her lordosis posture. The male then begins pelvic thrusting. Mounts typically last one to five minutes before intromission occurs. In most instances, the male maintains a firm grasp on the female's nape throughout the mount. Intromission is readily apparent and is signalled by a 'copulatory cry' given by the female; this vocalization is typically a low, barely audible growl. Five to ten seconds after the female emits this vocalization, she throws the male off her back, often threatening him and then she begins to roll vigorously on her back. Rolling on the back typically lasts 5 to 30 seconds. Then the male and female groom their own anogenital regions (Mellen, 2003).
They usually mate many times before the male leaves to find another mate. Females only have one mate each season while males usually have many (Hernandez, 2002).

Section 2 Management in captivity

1 Enclosure

This chapter provides a general guide to what has been used and found to be appropriate boundary, substrate, furnishings and maintenance, environment, and dimensions for Eurasian lynx enclosures.

1.1 Boundary

Most lynxes are contained by wire mesh, glass and gunite (sprayed concrete). If wire mesh is used, the fencing material should be imbedded into a concrete base (footings) that prevents the animals from digging itself out. Gauge of wire mesh should be fine enough so that a cat cannot reach through and snag a keeper or reach into an adjacent enclosure (Mellen, 2003). The climbing skills of Eurasian lynxes should be taken into account; enclosures must therefore be covered or the barriers must be made high enough to prevent the lynxes from jumping out. The top-part of a non-covered barrier should be an inclined plane, sloping in the direction of the enclosure. Electric fencing should be attached on the inside at the top (pers. comm.). See figure 3.

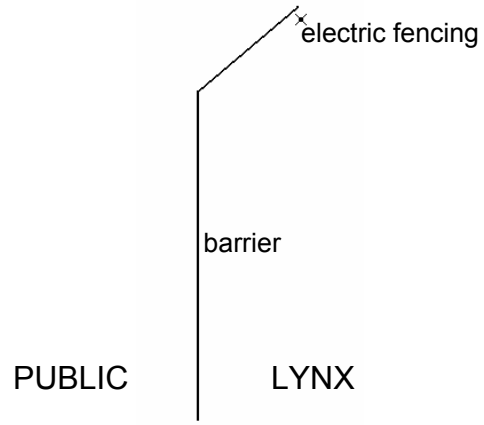

Figure 3: Barrier of a non-covered enclosure of the Eurasian lynx (pers. comm.)

In an optimal situation, the enclosure of the Eurasian lynx is organised in such way that the lynx is not openly displayed. In order to accomplish this, the barriers must be almost fully covered, leaving only a few peepholes open for the public to look through (pers. comm.). For covering trees, climbing-plants (ivy) or bamboo can be used. Straw matting, placed on the outside of the mesh walls can also serve as effective visual barriers (Mellen, 2003). In a non-covered enclosure, trees and plants must be placed in such way that the lynx cannot use it to climb out (pers. comm.). Any space between adjacent enclosures should always be masked (Mellen, 2003).

Enclosures should have a shift or secondary holding area in order to safely move animals from their primary enclosure for cleaning, feeding and medical procedures. Doors between these areas should be remotely operated shift doors (sliding or guillotine types are preferred) (Mellen, 2003). It is also possible to have a primary enclosure which has the ability to be divided into separate compartments (pers. comm.). It must always be possible to give each cat its own separate area (Mellen, 2003).

Because Eurasian lynxes are originally solitary animals, it is recommended that each cat has access to its own den box and a minimum of seven visual barriers in the enclosure. Each visual barrier should be large enough for one cat to be out of view of another cat in the enclosure. Many exhibits have water features (running water) to create white noise. The effects of white noise on behaviour or well-being of lynxes have not been systematically studied (Mellen, 2003).

Ideally, the public must be kept at a distance of 1,5 meters from the enclosure (pers. comm.). Obviously, gauge of wire mesh should be fine enough so that a cat cannot reach through and snag visitors (Mellen, 2003).

1.2 Substrate

The floors in indoor enclosures are preferably made of cement or concrete, because these materials are easily cleaned (pers. comm.). Providing a layer of straw, wood shavings or sand on the floor of the enclosure (10 to 15 centimetres deep) is recommended (Mellen, 2003).

Bedding materials for dens include straw, wood shavings or wood wool are also recommended. However, presence of bedding material sometimes induces felids to urinate or defecate in the nest box. If individuals persist in using a den box for a latrine, a second den box should be provided (lynxes will typically use one box as a latrine and the second one as a den) (Mellen, 2003).

1.3 Furnishings and maintenance

Furnishing

The complexity and usability of an enclosure is very important. There is a negative relationship between time spent pacing and enclosure complexity. In other words, lynxes that are housed in a complex enclosure spend less time pacing than those housed in enclosures that are more sparsely furnished. Enclosure complexity is among others defined by the number of physical barriers which one cat could use to hide from another. In enclosures with seven or more barriers, pacing was reduced or non-existent (Mellen, 2003).

It is recommended that each lynx has access to at least one den box. Animals housed continuously outdoors should each be provided with a den designed to protect them from the weather elements and temperature extremes. However, it must be taken into account that shelter from sunlight does not necessarily constitute shade (Mellen, 2003).

Care should be taken to allow lynxes to utilize the vertical component of an enclosure by providing aerial pathways. Aerial pathways (i.e. logs) can be suspended by chains and thereby the pathways can be changed by repositioning the logs (Mellen, 2003).

Lynxes seem to prefer perching platforms at or near the top of their enclosure a place from which they can hide and peer out. Durable plastic materials as well as wood make good platforms or shelves. The location of the elevated platforms should provide the cats with a good view of the horizon (Mellen, 2003).

Heat pads can be provided, although this is not a necessity for lynxes (pers. comm.). However, appropriate placement of heat pads and shade can encourage them to stay in public view (Mellen, 2003).

Live plants can survive in lynx enclosures. When plants are placed in the enclosure, most are protected with artificial materials, but a few are left unprotected. These few 'sacrificial plants' will be destroyed while the 'hosed-off' plants remain relatively untouched by the cats (Mellen, 2003).

Eurasian lynxes also require logs upon which they can sharpen their claws. Rotting logs stimulate clawing activity (Mellen, 2003).

Water features such as pools, re-circulating streams, built-in water features for drinking, aesthetics and eventual bathing are recommended. However pools should be filled from a source of potable water. Unless the pool has a mud bottom, it should be dumped, scrubbed and disinfected at least weekly. If animals routinely defecate in the pools, auxiliary sources of water should be provided. Pools should slightly slope and should contain deep (more than 30 centimetres) and shallow areas (Mellen, 2003).

Maintenance

Since scent marking behaviours (cheek, chin, head and neck rubbing on an inanimate object, urine spraying, scraping the ground with hind feet, and sharpening claws) seem important to lynxes, cleaning (especially with disinfectants) should be done sparingly. Dirt substrates in outdoor planted exhibits should be raked and spot-cleaned daily (faeces picked up) and standing pools of urine should be hosed off with water. Urine-stained cement surfaces should be disinfected weekly. Food containers, and water bowls should be cleaned and disinfected daily. Food and animal waste should be disposed of carefully. Phenol disinfectants should not be used. Perches and shelves where animals climb, sit and rest should also be kept free of faeces and urine but it is not necessary to clean them daily. When a layer of straw, wood shavings or sand is present on the floor of the enclosure, this must be changed approximately every two months (Mellen, 2003), depending on the situation (to what extend it is used, etcetera) (pers. comm.).

Footbaths should be used prior to entering and exiting all enclosures or areas containing enclosures. Each footbath should be filled with a disinfectant and its use strictly adhered to by all personnel.

Appropriate controls for vermin infestation should be maintained. Rodent control can be accomplished by using snap traps or live traps. Bait stations should contain poison which provide a very low chance of secondary poisoning. Insect control can include fly or pest strips, natural or synthetic pyrethrins and growth inhibitors. All chemicals should be approved by the institutional veterinarian prior to use. Application should be performed by a licensed pest control technician. The technician should be accompanied by staff members to assure the safety of the animals and staff (Mellen, 2003).

1.4 Environment

Heating
The Eurasian lynx can tolerate a wide range of temperatures, *in situ* temperatures range from -25°C to +25°C (Anonymous, 2003f). The animal can not endure high temperatures. Because of this, lynxes that are kept outdoors should have sufficient shade. In case of extreme weather conditions, shelter (in the form of a den) should be provided that has sufficient clean bedding materials or other means to protect the cat from the weather elements (rain, snow and wind) and temperature extremes. When enclosures are made with gunite, the hollow structure absorbs and reflects both heat and cold, subjecting animals to extremes above and below ambient temperatures (Mellen, 2003).

Lighting
Sufficient lighting (1100 lux at 3 meters) should exist in indoor enclosures to permit routine cleaning, but more subdued light levels (200 to 300 lux) are recommended for exhibition purposes (Mellen, 2003).

Ventilation
Indoor housing should be well ventilated in order to minimize drafts, odours, dust and moisture condensation. There should be eight to ten complete changes of non-recirculated air per hour and a 15 to 40% intake of fresh air. If possible, separate circulating systems for each indoor cat enclosure should be available to reduce the risk of disease. Auxiliary ventilation, such as exhaust fans and vents or air conditioning should be provided when the ambient temperature is 29°C or higher (Mellen, 2003).

More research needs to be done to establish optimal humidity levels for the Eurasian lynx. In general a humidity of 55% ± 10% for indoor enclosures is recommended (Mellen, 2003).

1.5 Dimensions

The substantial size of the home ranges that wild lynxes occupy is difficult to recreate in a captive environment. Recommended minimum space per cat is as follows: 4 x 2 x 2,5 metres per cat (l x w x h). The spatial density is one animal per 20 m^3. Floor space should be increased by 50% for each additional cat. The Eurasian lynx is a terrestrial species and they should have more floor space allocated than arboreal species. However, complexity and usability of the enclosure is more important than size as mentioned earlier. The cats' exhibit should also be sufficiently deep so visitors do not encroach on the cats' flight distance (Mellen, 2003).

Cats should have access to at least 75% of the enclosure's vertical space. Researchers found that the greater the height of the enclosure, the lower the levels of faecal corticoids (hormone which' production is induced by stress) (Mellen, 2003).

A separate space should be available for each lynx. This can be reached by using a shift or secondary holding area (Mellen, 2003) or a primary enclosure which can be divided it into separate compartments (pers. comm.). When using shift or secondary holding areas, they should be at least 1 m^3 (Mellen, 2003).

2 Feeding

As well as outlining a basic diet, including supplementary requirements, this chapter considers non-nutritional aspects of feeding, such as special dietary requirements, methods of feeding and information concerning water supply.

2.1 Basic diet

Lynxes are obligate carnivores that kill other animals for food. It is rarely possible to provide natural prey species and therefore a good understanding of the nutritional requirements of cats is necessary when formulating artificial diets. Because cats lack much of the metabolic flexibility of facultative carnivores or omnivores, they have therefore far more specific and demanding nutritional requirements than canids or ursids for example. This has many implications for the formulation of a correct diet. In general, non-domestic cats share the same nutritional requirements as their domestic counterpart (Blomqvist et al., 1999).

There are three different sorts of diets which can be fed to captive lynxes. The first one is a dry extruded diet. If only the nutritional aspects of diets are considered, dry extruded diets are recommended for small felids as they can be made nutritionally complete. A few commercial extruded diets with high palatability are available. The second diet is a high-moisture, ground diet. A formula for a nutritionally supplemented ground meat diet, designed to be complete for all life stages (see attachment IV) (Mellen, 2003). It is also possible to feed a variety of whole animals (for example rabbits, rats or guinea pigs), gutted carcasses (for example chickens or rabbits) and carcass parts (for example beef) as the major part of the diet. Birds reared on zoo premises or culled from free-range flocks are preferred to reduce the risks of hormone and antibiotic residues sometimes present in broiler and battery chickens. Day-old chicks are easy and convenient to use for food, but they are generally too rich in vitamin A. Once a chick has absorbed its yolk sac, it becomes a more suitable food item. Where facilities permit it, it is useful to rear day-old chicks on the premises and cull them at different stages of growth. Rabbits, rats and guinea pigs should be commercially bred. The feeding of wild birds and animals such as rabbits and pigeons is not advised. Wild animals can carry a variety of transmissible diseases and it is rarely possible to submit the carcasses to adequate inspection prior to feeding (Blomqvist et al., 1999, husbandry questionnaire).

<u>Nutritional content</u>
Nutrient requirements of domestic cats have been used as the basis for formulating the diet for the Eurasian lynx in the absence of more specific information. Attachment V contains nutrient requirements for adult maintenance as estimated by AAFCO. AAFCO practical nutrient profiles are appropriate for diets containing conventional foodstuffs with complex matrices and low digestibility (Blomqvist et al., 1999). Below follows a general description of nutrient requirements for captive lynxes.

Protein
Lynxes require high levels of animal protein containing a wide range of essential amino acids and have a limited ability to conserve nitrogen when dietary levels are low.

Adult lynxes require 25% of protein of the dry weight of the diet (Blomqvist et al., 1999).

Many essential amino acids are required preformed in a cat's diet, as they cannot be synthesised in sufficient quantities by conversion of other amino acids. For example, lynxes require relatively high levels of dietary methionine, partly due to a need for precursors for the synthesis of another amino acid, taurine. However, they also require a dietary source of taurine, as they are unable to synthesise sufficient. Lynxes are also particularly sensitive to arginine deficiency (Blomqvist et al., 1999).

Lynxes do utilise soluble carbohydrates from other sources, but they derive most of their blood glucose from amino acid metabolism. Muscle meat is a good source of protein (Blomqvist et al., 1999).

Fat
Fats supply a large percentage of the lynxes' energy requirements. Due to a limited ability to desaturate fatty acids unlike most other mammals, lynxes cannot meet their essential fatty acid (EFA) requirements solely from linoleic and / or linolenic acids. For example, they have a limited capacity to synthesise arachidonic acids, which is therefore effectively an EFA for these animals. Arachidonic acid is only present in animal fat. Deficiencies of fats of animal origin result in poor coat condition and reproductive failures (Blomqvist et al., 1999).

Vitamins
Lynx' requirement for water-soluble vitamins of the B group is provided by whole animal prey items, although some are synthesised by the intestinal bacterial flora. Consequently, B vitamin deficiencies are rare in captive lynxes. However, due to the overcooking of food, deficiencies of thiamine (vitamin B1) can occur. Lynxes can synthesise vitamin C (Blomqvist et al., 1999).

Lynxes are unable to synthesise vitamin A from the plant-derived precursor, beta-carotene. Therefore they rely on preformed vitamin A from animal tissue in the diet. This vitamin occurs predominantly in the viscera of prey, particularly the liver. Deficiencies may occur in cats fed unsupplemented meat diets. Vitamin A deficiency produces general ill thrift, anorexia, alopecia and neurological problems in some species. Conversely, excessive amounts of dietary vitamin A can lead to the development of painful bone abnormalities in the spine and limbs (Blomqvist et al., 1999).

Vitamin D requirements of lynxes are poorly understood. Dietary supplementation with D3 could be desirable in captive lynxes. However, excessive dietary vitamin D is dangerous and can promote the mineralization of soft tissues throughout the body (Blomqvist et al., 1999).

Vitamin E requirements are high, the level depending on other dietary constituents. A deficiency may occur in cats fed a not supplemented diet high in polyunsaturated fats or cod liver oil (Blomqvist et al., 1999).

Vitamins B are found in muscle meat, but that is very low in fat-soluble vitamins such as A, D or E (Blomqvist et al., 1999).

Minerals
Carcasses of terrestrial vertebrates contain adequate amounts of the necessary minerals. However, where only meat is fed, inadequate amounts of calcium and possibly manganese will be provided. Therefore such diets must be supplemented, particularly with calcium. When adding calcium separately, calcium carbonate is the most appropriate source. Unsupplemented diets will result in nutritional bone disease in which bones are poorly mineralised and subject to deformity and fracture. Excessive amounts of dietary calcium are not absorbed, but may inhibit the absorption of manganese and zinc (Blomqvist et al., 1999).

Quantity
Many lynxes in zoos are obese. The amount to feed depends on the season (Blomqvist et al., 1999), the fat content of the diet, the activity level of the animal and the physiological state (lactating, growing, etcetera). Amounts can range from 4% of the body weight (dry matter basis) to 10% (Mellen, 2003) and should be determined by experience and individual observation (Blomqvist et al., 1999). On average, captive lynxes should be fed 1,3 kilograms per day per animal (husbandry questionnaire). The condition of the animal and body mass changes should be assessed on a regular basis. Adjustments to the amount offered should be made to maintain target condition and weight (Mellen, 2003).

Choice of diet
Dry extruded diets can be made nutritionally complete, but many animals will not accept them, presumably due to palatability issues. Acceptance is most likely if the dry diet is introduced to young at weaning, without exposure to high-moisture alternatives. However, acceptance is not guaranteed. Furthermore, lynxes are unlikely to demonstrate the stalk-rush-kill sequence when fed this diet (Mellen, 2003).

The high-moisture, ground diets are well-fortified with other micronutrients, so additional vitamins and minerals should not be supplemented. However, these products have several inherent problems. Firstly, vitamin A is present in exceptionally high concentrations. Secondly, the fat content in these products usually is in excess of 35% DM. Obesity in zoo-maintained lynxes may be due in part to excessive dietary intake of fat, combined with insufficient physical activity. Thirdly, these foods are typically soft when thawed. Soft diet consistency may contribute to poor oral health. However, this can be reduced by offering bones twice a week (Mellen, 2003) or feeding small, whole vertebrate prey (Blomqvist et al., 1999).

When lynxes are solely fed muscle or organ meats, bone disease is common. Also, diets of exclusively non-supplemented all-meat or all chicken neck diets directly and negatively impact sperm production in male lynxes. However, only when fed diets that consist of whole animals, gutted carcasses and / or carcass parts, species-appropriate behaviour is seen (Mellen, 2003). In addition, when whole prey are fed, skin, hair and feathers act as roughage to aid the passage of food through the gut (Blomqvist et al., 1999).

It is therefore suggested to offer a cross-section of diets (a combination of ground meat diet; dry extruded diet; bones; and whole animals, gutted carcasses and carcass parts) on weekly basis rather than an exactly balanced diet each day. The goal is to provide a nutritionally complete diet while giving the animals opportunities

to exhibit species-appropriate behaviours (Mellen, 2003).

2.2 Special dietary requirements

Attachment V contains nutrient requirements for lynxes during growth as estimated by the NRC and practical nutrient profiles in diets during growth and reproduction as estimated by AAFCO. NRC nutrient requirements are based on use of purified dietary ingredients with high digestibility. AAFCO practical nutrient profiles may be more appropriate for diets containing conventional foodstuffs with more complex matrices and typically lower digestibility (Mellen, 2003). In general, pregnant and nursing females should have their rations increased and supplemented with vitamins and minerals, especially calcium (Blomqvist et al., 1999). Lactation is usually the most demanding period, especially with large litters (Mellen, 2003). Caution should be taken that not too many supplements are added (pers. comm.). Growing lynxes, at the point of weaning, require 33% of protein of the dry weight of the diet, while adults only need 25% (Blomqvist et al., 1999). It may be necessary to provide a soft diet for geriatric animals, but this could also exacerbate existing dental problems (Mellen, 2003).

Furthermore, lynxes which are kept outdoors throughout the year should need more food during winter and less in summer months (Blomqvist et al., 1999).

Special attention must be paid to the diet for animals that have been recently moved or captured. It is necessary to bear in mind that these cats may refuse to eat due to the many changes in their living conditions including different food, and that they may be under significant stress. Nutritional inadequacies may become apparent under these circumstances. It is good practice to introduce a new diet gradually to any animal and if specialised diets have been fed previously, it may be necessary to obtain a supply of this food to ease the change in diet. Only in cases where severe problems become inevitable, the cats in question should get freshly killed, whole animals with the abdominal cavity opened. These can provide an effective feeding stimulus (Blomqvist et al., 1999). However, special attention should be given to the risks that are involved when feeding such freshly killed animals (see chapter 2.3).

2.3 Method of feeding

It is recommended to feed lynxes once a day and fast them once or twice a week (husbandry questionnaire). A portion of their diet may be used for training, for example to shift into secondary holding areas (see chapter 7.1). Lynxes should be separated before feeding to prevent fighting and to allow accurate measurement of food consumption (Mellen, 2003).

Food can be offered on clean cement cage floors, metal feeders attached to cage walls or in aluminium or stainless steel pans. Surfaces where perishable foods are prepared should be cleaned and disinfected daily (Mellen, 2003).
When feeding whole or partial prey items, they should be deep frozen to kill any parasites prior to presentation. Thawing under refrigeration in a clean area and delivery in insulated containers should help reduce the exposure risk from potentially harmful microbes (Mellen, 2003). It is important to ensure that carcasses are not fed whilst the inside is still frozen as this may lead to gastric upset. Once thawed, whole

carcasses should be offered at or around the ambient temperature. It is suggested that the intestines are removed from chicken carcasses to lessen the risk of salmonella infection (Blomqvist et al., 1999).

2.4 Water

Fresh, clean, potable water should be available at all times. Water should be provided in containers that cannot easily be overturned or emptied. Water bowls should be cleaned and disinfected daily. Felids are known to routinely defecate in water bowls. This behaviour is difficult to discourage. Elevating water bowls at 15 to 30 cm above the ground sometimes discourages this behaviour. Automatic watering devices may be used for lynxes. However, some animals will not use these lix-it type waters. An animal which has not used a lix-it previously, should be monitored closely to assure proper water consumption (Mellen, 2003).

3 Social structure

This chapter outlines a suitable social structure and details concerning any changes in the group structure. The chapter also includes information on the possibility of sharing the enclosure with other species.

3.1 Basic social structure

Lynxes are solitary animals (see section 1, chapter 2.4). However, they can still be housed together in captivity. In fact, being placed in a situation where they are not competing for food and territory, significantly alters their behaviour towards each other. They build strong social bonds when in captivity (Mellen and Wildt, 2003). Established pairs and groups can be kept together continuously. Eurasian lynx pairs and groups can consist most commonly of one male and one female, multiple females with or without a male, or a mother with cubs. It is not advised to house males together as there is too high a risk of fighting. When lynxes do not get on, they must also be housed individually (pers. comm., husbandry questionnaire).

When housing lynxes together, one must consider that incidents may occur. Data shows that even, long time, seemingly well established pairs or groups, can suddenly provoke a maiming or death (pers. comm.).

3.2 Changing group structure

Introduction or reintroduction of animals

Since the potential of fatalities is always a possibility, introductions should proceed slowly. Perhaps the three most necessary ingredients to long term success are adequate space, knowing the animals and staff preparedness (Mellen, 2003).

Space

Ideally, the space should be designed in such a way that each animal can be individually rotated without physical contact with its conspecific. This encourages the cats to perceive the enclosure as a shared space. Initial contact should be through a small mesh fabric, providing visual, olfactory, auditory, but not physical contact. If the approach of shared space is not possible, howdy cages or alternating between cages with only a small see-through partition is recommended. If one cat is noticeably more timid than the other, it is recommended that the timid cat's cage should be used for the physical introduction, thereby allowing it the advantage of being in familiar territory. Putting a male into a female's cage, rather than vice versa, is also an effective strategy, as is putting both cats in an enclosure that is unfamiliar to both of them (Mellen, 2003).

Know your animals

The decision to move from visual contact to physical contact should be made carefully. Things to consider during the initial physical introduction include making each cat fully aware of the other's presence. If startled, lynxes sometimes respond with a life-threatening attack. Caretakers should observe tail, ears, eyes and whiskers as indicators of escalating aggression: the tail twitches in mild to thrashing motions, ears go back and are flattened, eyes narrow, and whiskers are thrust forward. The cat's head will likely move up and down, both cats will side-step, arch their backs and

circle around one another. They usually maintain a certain pre-determined, mutually agreed upon safety zone or distance between themselves, as they continue to posture and vocalize with hisses and / or growls. A key point is that during this initial stage, their eyes are never averted. If one breaks and runs, a chase usually ensues. This is where the caretaker must be doubly alert to possible serious aggression. Depending on the cat, a certain amount of yowling, scratching and jumping on each other with fur flying can be expected. It becomes a judgement call as to whether to separate them until the next day's meeting or to try to distract and re-direct them. It is important to be able to distinguish between dangerous fighting and simple testing. It is best to err on the side of safety. Gradually, the cats will begin to look more relaxed. Newly introduced cats should be allowed daily contact as even one day apart can set the process back to the beginning. Furthermore, no matter how compatible a pair may seem in the first meetings, the cats should be separated at night until they show consistently positive behaviour in full-day encounters and appear totally at ease with each other and their surroundings (Mellen, 2003).

Staff preparedness
During an introduction, staff should prepare for the worst-case scenario, planning strategies ahead of time. Planning should include knowing the availability of the veterinarian, location of transport carriers and an exact plan of action with roles clearly defined. If a fight does escalate to a life-threatening level, hoses and / or poles are often used to separate lynxes. Loud noises (for example, noise from a CO_2 fire extinguisher) and shouting can often provide the needed surprise effect for distracting a cat (Mellen, 2003).

Removal of animals from a social group
The removal of an animal may be necessary for example because of a transfer, veterinary consult or pregnancy. In case of a well established pair, the male does not need to be removed prior to the birth (pers. comm., husbandry questionnaire). However, possible risks may be involved with this. For more information see chapter 5.1. When the male is removed, adequate exhibit space should be available for him (Mellen, 2003).

The removal of an animal can be accomplished through using a crate (see chapter 7.1), restraining an animal or animals (see chapter 7.2), using the secondary areas, or through dividing the enclosure into separate compartments (see chapter 1.1).

3.3 Sharing enclosure with other species

In the majority of the cases, the Eurasian lynx does not share its enclosure with another species. However, in Salzburg Zoo Eurasian lynxes share their enclosure with wolverine (*Gulo Gulo*) and European brown bears (*Ursus arctos*) (husbandry questionnaire).

4 Behavioural enrichment

This chapter provides an overview of a number of possible methods to induce behavioural enrichment in captive Eurasian lynxes. However, the response to the methods used for enrichment varies from individual to individual. Thus, the methods in this chapter are not a guarantee for success.

4.1 Animals

Lynxes, if compatible, can be maintained in pairs or groups (see chapter 3.1). As mentioned before, personal experience has determined consistently strong social bonding between Eurasian lynxes. Lynxes seem to enjoy the comfort, interaction and added stimulation that established pair or group bonding offers (Mellen and Wildt, 2003).

Another option is to rotate the animals on exhibit daily (for example place one lynx on exhibit while the other one is in a holding area, then at midday, bring the first one in and allow the other one access to the exhibit). This way, both individuals may actively move through the exhibit, examining the scent marks left behind by the previous inhabitant and marking over those with its own, in a manner similar to the ranging activities of their wild counterparts (Mellen, 2003).

Although it is not common, the Eurasian lynx can share its enclosure with for example wolverines (*Gulo Gulo*), as now is being done in Salzburg Zoo. According to the Salzburg staff, keeping the animals together seems to be enriching for both (husbandry questionnaire).

4.2 Food

Behavioural enrichment can also be induced by opportunities for animals to procure food in ways similar to their wild counterparts. However, their traditional stalk-rush-kill sequence is difficult to replicate in captivity because of the constraints around the feeding of live prey. In fact, feeding live mammal or bird prey is not typically desirable, feasible, or, in some countries, legal. Other techniques must be employed to provide appetitive or hunting opportunities for captive lynxes. Fortunately there are numerous methods to achieve this (Mellen, 2003).

One method is feeding slaughtered animals, gutted carcasses or carcass parts. Many cats exhibit all or part of the stalk-rush-kill sequence with these items (Mellen, 2003).

Food can also be scattered around the cats' enclosure, for them to find. This technique is particularly useful for lynxes housed in well-planted exhibits. Through this method lynxes are kept both active and visible throughout a long period of the day (Field, 1998). A log or brush pile in the exhibit where bits of food are hidden in, can also stimulate hunting behaviour (Mellen, 2003).

By suspending a chunk of muscle meat from the top of the enclosure, hunting as well as spectacular leaping behaviour is stimulated.

Suspending fresh horse- or oxtails from a bungee cord attached to a tree branch is also a good option (Mellen, 2003).

Another option for enrichment through food items is a recipe for blood balls (blood that has drained from thawed meat). The blood is mixed with water (1:3) and put in latex balloons. Once the blood mixture is frozen, the balloon is removed and the blood ball is offered to the cats (Mellen, 2003).

4.3 Other

Captive lynxes often exhibit hunting behaviour towards novel objects, even if they are not associated with food. Stalking and pouncing behaviour can be induced with Boomer Ball© or other large plastic objects. To encourage exploratory behaviour, Boomer Balls can also be partially cut open and large bones wedged inside. Pumpkins placed in an enclosure may be stalked and attacked. Burlap bags stuffed with straw also stimulate hunting sequences. Rotting logs exposed to the elements stimulate clawing activity. Animal skins (for example cow hides) (Mellen, 2003), but also skins of sheep, rabbis or goat (husbandry questionnaire) seem particularly attractive to lynxes and maintain their interest longer than plastic objects. Lynxes also have shown interest in skins shed by snakes (Mellen, 2003) and wool of sheep (husbandry questionnaire). Scents such as perfume (for example Avon Angel Fire© and Calvin Klein Obsession©), fresh catnip and spices (for example cumin, allspice and cinnamon) elicit investigation and scent marking behaviour (Mellen, 2003).

Behavioural enrichment can also be accomplished by change and variation in the environment. It has already been made clear that complexity and usability of the enclosure is more important than size (see chapter 1.3). Furthermore, care should be taken in to account to allow lynxes to utilize the vertical component of an enclosure by providing aerial pathways. Lynxes seem to prefer perching platforms at or near the top of their enclosure, a place from which they can hide and peer out. The location of the elevated platforms should provide the cats with a good view of the horizon. Providing a layer of straw, wood shavings or sand on the enclosure floor (10 to 15 centimetres deep) can also provide variety. Furthermore, live plants can be used in lynx enclosures (see chapter 1.3)

Finally, husbandry training can also be construed as a form of enrichment (see chapter 7.1).

4.4 Implementation

Development of enrichment ideas should be goal-oriented; proactive; based upon the animal's natural history, individual history and exhibit constraints; and should be integrated into all aspects of their captive management. A protocol for reviewing and approving enrichment items should be established. A written schedule for presentation of enrichment items should be maintained. This is effectively accomplished by using a calendar to schedule delivery. Keepers place their initials next to the enrichment item on the calendar to document that that item was delivered. Over time, keepers will be able to determine how often the items can be presented to elicit optimal response (and avoid habituation to items) (Mellen, 2003).

5 Breeding

This chapter outlines appropriate breeding techniques, including details on mating, the gestation period, birth, development and care of young and procedures involving hand-rearing. Contraception is also described.

5.1 Mating

Introduction and segregation

When males and females are housed separately, due to incompatibility, they have to be introduced periodically for breeding. For procedures concerning introductions see chapter 3.2. Ideally, the male should be left with the female until copulations have been observed and the length of time for one oestrous cycle has passed without any observed copulations (that is the female is presumed pregnant and not cycling) (Mellen, 2003). However, when severe aggression is observed, the male should be removed sooner (pers. comm.).

Logically, lynxes held in (compatible) pairs (1.1) do not have to be introduced before mating. In this case removing the male prior to a birth is not required either (pers. comm., husbandry questionnaire). A large number of litters have been successfully raised in the presence of males. Nonetheless, there is always the risk involved. The Eurasian lynx is still a solitary animal and the male's presence may be deleterious to successful rearing of offspring (Mellen, 2003). It also depends on the size of the enclosure. If the enclosure is very large, the lynxes have enough space to hide from each other and thus the risk of a catastrophe is smaller. Other females that are housed with pregnant ones, do not have to be removed before the birth, but this may differ per situation (pers. comm.).

During the period of oestrus and breeding, most incidents (provoke a maiming or death) seem to occur. Sexually mature pairs that have shown no breeding success or activity over a reasonable period should be re-evaluated, with serious thought given to introducing them to new partners. This is particularly appropriate in situations where females have been observed to repeatedly rebuff advances by the male, often a precursor to his becoming fatally aggressive towards her. (Mellen and Wildt, 2003).

Enclosure

If animals are housed separately, a pair must have a common enclosure wall (mesh screen) or the male must be rotated into the female's enclosure (while the female is in a holding area) so that behavioural responses that indicate oestrus (included below) can be observed (Mellen, 2003).

Male.female ratio

The appropriate male.female ratio is 1.1. However, when the enclosure is very large, a male can also be housed together with multiple females (pers. comm.). This originates from the *in situ* situation, where male lynxes usually have many mates per season (see section 1, chapter 2.4). It is not advised to house multiple males together. Such a group entails too high a risk of fighting (pers. comm.).

Courtship and copulation

The onset of oestrus in lynxes is indicated by an increase in a combination of several behaviours including cheek rubbing (both male and female), flehmen (male), male following female, male approaching female, male watching female, urine marking (both male and female), male sniffing anogenital region of female, and vocalization (meowing by male). Oestrus is also indicated by significant increases in faecal estradiol concentrations. Oestrus typically lasts two to five days (Mellen, 2003).

The female is actually receptive to the male (will allow him to mount and copulate) during a period of 24 to 48 hours within the oestrus period. Mating usually takes place at night and during the late afternoon (Fowler, 1986). The male approaches the female, grasps her by the nape and mounts by straddling the female: first with the front feet and then with the hind feet. The female responds to the nape bite by adopting a lordosis posture (front quarters lowered, rear quarters elevated and tail moved to one side); the female sometimes also treads with her hind feet. At this point, the male occasionally begins stepping with his hind feet, often simultaneously rubbing against the female's flanks. The rubbing by the male may induce the female to adjust or to exaggerate her lordosis posture. The male then begins pelvic thrusting. Mounts typically last one to five minutes before intromission occurs. In most instances, the male maintains a firm grasp on the female's nape throughout the mount. Intromission is readily apparent and is signalled by a 'copulatory cry' given by the female; this vocalization is typically a low, barely audible growl. Five to ten seconds after the female emits this vocalization, she throws the male off her back, often threatening him and then she begins to roll vigorously on her back. Rolling on the back typically lasts 5 to 30 seconds. Both the male and female usually then groom their own anogenital regions (Mellen, 2003). They usually mate many times (Hernandez, 2002).

Seasonality

Mating is seasonal, occurring between February and April (Anonymous, 2003a). In the wild there is a second breeding period in May, perhaps for females that did not conceive during the primary period (Fowler, 1986). This may also occur in captivity (pers. comm.).

5.2 Gestation period

The gestation period lasts 67 to 74 days (Breitenmoser, 2000). In the wild, females sometimes do not conceive at all or may spontaneously abort in years of low prey availability (Anonymous, 2000). This implies that captive female lynxes with reproduction problems, may be responding to their body's poor nutritional condition. In such cases, the diet of the female must be re-evaluated and possibly changed (pers. comm.).

An indicator of gestation in lynxes is of course the absence of behaviours that indicate oestrus (see chapter 5.1). Pregnant lynxes have been observed to show noticeable abdominal distension at about a month after conception (Fowler, 1986). Elevated progestagen levels are also an indicator of pregnancy (Mellen, 2003).

Before parturition, it must be assured that the female has current vaccinations so that she has high levels of antibodies to pass to her offspring through the placenta and

colostrum. The female should be checked for intestinal parasites and treated as needed (Fowler, 1986).

Pregnant females should be provided with at least one den box, preferably two. See figure 4. The den box must allow the female to stand up and turn around in the back half of the den box. The box should have a sliding door in the front of the box to provide easy access. The hinged lid must have a 20 centimetres overhang at the front and 10 centimetres at the sides to prevent water getting into the box during cleaning or inclement weather. The box should contain a partition that limits light and draughts, providing additional seclusion for the female and cubs. Wood shavings can be provided as a substrate. The den box should be placed on the floor of the enclosure with legs that raise the box 10 centimetres of the ground. Den boxes can be made of wood or plastic (Mellen, 2003).

Figure 4: Sample den box that could be used to den pregnant female Eurasian lynxes (Mellen, 2003)

The installation of cameras used to monitor mother and cubs must be carried out well in advance to avoid disturbance at critical times. The cameras can be installed in many locations, including inside dens (Mellen, 2003, Fowler, 1986).

The female will use an area outside the den box as a toilet and keep the box remarkably clean. Food and water should be provided outside the box. Details concerning an appropriate diet during gestation are discussed in chapter 2.2. Cleaning should be suspended in the immediate area a week prior to the earliest possible date of birth. The female will stay in the den for one or two days prior to giving birth (Blomqvist et al., 1999).

<u>Artificial reproductive techniques</u>
Artificial reproductive techniques such as artificial insemination (AI), in vitro fertilisation (IVF) and embryo transfer (ET) should allow the breeding of genetically compatible but socially or sexually incompatible individuals and those with physical or mental handicaps that preclude natural breeding (Blomqvist et al., 1999).

5.3 Birth

Female Eurasian lynxes give birth to a litter of between one and four cubs, with an average of two (Breitenmoser, 2000). At birth the cubs weigh on average 250 to 360 grams (Anonymous, 2000). The young are born with their eyes closed, nearly deaf, immobile and are unable to regulate their own body temperature yet (Fowler, 1986). This makes them dependent on their mother for warmth and food (Hernandez, 2002). In almost every case, the birth of Eurasian lynx cubs proceeds without any problems and thus without the need of assistance by humans (pers. comm.).

The female will not come out of the den to feed until a couple of days after the birth. Even then her excursions for food and water will only be when no one is about. Females will deal with weak or dead cubs by removing them from the den or eating them. Hand-rearing should be a last resort and only when the health of the cub or dam is in peril (Blomqvist et al., 1999). For more detailed information see chapter 5.5.

Extraneous noise and activity should be limited; only animal care staff familiar to the female should be in the immediate vicinity of a female with young cubs (Mellen, 2003). Cleaning should be limited until the cubs are at least five to six weeks old (Blomqvist et al., 1999). Low-light closed circuit video cameras can be used to monitor females with young (Mellen, 2003).

5.4 Development and care of young

Table 5 shows how much a cub normally grows in its first six weeks.

Weight of healthy captive Eurasian lynx cubs	
Age	**Weight (g)**
At birth	250 to 360
Week 1	638
Week 2	747
Week 3	1021
Week 4	1323
Week 5	1625

Table 5: Weight of healthy captive Eurasian lynx cubs in the first six weeks (Anonymous, 2000, Mellen, 2003)

They begin to walk between 24 and 30 days. The female nurses her young for three to five months, but they begin to eat some solid food at one month of age (Anonymous, 2000). At six weeks old, the cubs follow the mother on short trips. Eurasian lynx cubs are active, curious and skilled at climbing using their sharp claws (Hernandez, 2002). The cubs are weaned when they are between three and five months old (Anonymous, 2003c). Young should remain with their mother until they are one year old or until aggression is observed (mother – cub or cub – cub) (pers. comm., Mellen, 2003). During rearing, mother and cubs can stay with the male and other females if they were compatible before. When aggression is observed, the male and / or other females must be removed.

If the other lynxes were removed from the compatible group for safety reasons and keepers want to be on the safe side, the other lynxes should only be introduced after the young have been removed from the mother. Of course, non-compatible animals should not be introduced when cubs are involved (pers. comm., husbandry questionnaire).

If the mother is calm, she may be briefly separated from her cubs weekly so that they can be weighed. Weighing should be done on the same day and time each week. During handling of the young, sterile gloves should be worn to reduce unfamiliar scents left on the neonates and to reduce transmission of diseases (Fowler, 1986). During the rest of the week, the neonates should be checked visually from a distance by staff (pers. comm.).

The most common causes of death in neonates are maternal neglect or exposure, maternal or cage mate trauma, pneumonia and congenital defects (Fowler, 1986).

5.5 Hand-rearing

Cubs should be mother-reared of possible (Blomqvist et al., 1999). However, when maternal neglect, cannibalism of littermates, inadequate milk supply or illness are present, hand-rearing is needed (Mellen, 2003). Maternal neglected neonates will soon be dehydrated, hypothermic and hypoglycaemic and will rapidly become moribund (Fowler, 1986). It becomes incumbent upon caregivers to be prepared to pull and hand-rear, rather than to forfeit young repeatedly to habitual maternal neglect and / or cannibalism. The ultimate goal in these situations is to learn to hand-rear effectively in a way that will best enable these cubs to be integrated successfully with conspecifics and develop adequate social skills as adults (Mellen, 2003).

If the necessity of hand-rearing is anticipated, sera can be collected and used subcutaneously and orally in hand-reared neonates to assist in passive transfer of antibodies. Equipment for hand-rearing includes: isolette / incubator (set at 29°C), sheepskins / synthetic fleece pads, heating pad (set on low with a double thickness of bedding placed over half the pad enabling neonates to move if they become too warm), bottles / nipples (for example Pet Nurser©), milk replacements (for example Pet-Ag's KMR© [kitten milk replacer], Cimicat, ZooLogic © Milk Matrix Components or Esbilac© [puppy milk replacer]), electrolytes (used in stead of water for first few feedings or if diarrhoea develops), infant data chart (see attachment VI) and scale (to measure weights) (Mellen, 2003, Blomqvist et al., 1999).

Immediately after removal from their mother the young should be weighed and their sex determined, they should undergo a complete physical examination, the rectal temperature should be taken and the umbilicus disinfected. Congenital defects such as cleft palate will be detected at this stage. The degree of dehydration must be assessed at this stage by a veterinary surgeon and if possible a blood sample taken for haematology and serum biochemistry. Prophylactic antibiotics may be given (Blomqvist et al., 1999).

The cubs should initially be kept in an incubator or box heated to 25 to 30ºC (Blomqvist et al., 1999) with a relative humidity of 50% to 60%. The housing temperature is gradually reduced over the first three weeks until the animals are

thermally stable at room temperature (21,1 to 23,0ºC). An ambient temperature that is too high can cause hair loss (Fowler, 1986).

For the first 12 hours only 10% dextrose or oral rehydration fluids should be given to pulled cubs. After this milk replacements mentioned above are given. With these products the carer only has to add water, although it may be necessary to vary the formula strength. Rehydration fluids and milk should be fed at body temperature and all bottles, teats and other equipment used should be sterilised after each feed. Before and after each feed urination and defecation should be stimulated with a clean, warm and damp cloth. Care should be taken to avoid abrasion. The cubs should be fed every few hours from early morning to mid-evening (Blomqvist et al., 1999). Table 6 shows how much and how often the cubs need to be fed a day, at each age.

Age	**Frequency**		**Notes**
Week 1	6 x daily	Every 3 hours	4 to 6 hours at night
Week 2	5 x daily	Every 4 hours	8 hours nightly
Week 3	5 x daily	Every 4 hours	8 hours nightly
Week 4	4 x daily	Every 4 to 5 hours	Add baby food
5 weeks to weaning (10 to 12 weeks)	4 x daily	Every 5 hours	-
Weaning (10 to 12 weeks) to 6 months	3 x daily	-	-
6 months to a year	2 x daily	-	-

Table 6: Hand-rearing feeding schedule (Mellen and Wildt, 2003)

Each animal should be treated as an individual; some will take more milk, some less. A rough estimate of the required fluid quantity is 10 to 15% of the bodyweight per day (Blomqvist et al., 1999). Increases in volume and concentration and the addition of supplements are based on the response of the neonate. Some individual animals may have an intolerance either to the quantity of a formula that is given or to some of its ingredients. If a neonate develops diarrhoea, poor hair coat and / or poor weight gain that cannot be related to other causes, switching from one milk replacer to another should be considered (Fowler, 1986). In such case, the milk should be replaced with oral rehydration fluids for 24 hours and the formula reintroduced or replaced gradually thereafter. Made up solutions should not be stored longer than 12 hours. The correct posture for a lynx when being bottle fed is prone with the head raised slightly and supported (Blomqvist et al., 1999). Never feed a neonate on its back. Formula should never be forced into the neonate's mouth by squeezing the bottle. A young lynx that is very weak or has poor suckling reflexes may inhale some of the fluid (Fowler, 1986). Solid food can be introduced at four weeks of age, with complete weaning usually possible by 10 to 12 weeks. Throughout the whole hand-raising period, accurate daily notes must be kept on feeding, urination, defecation and weight (see attachment VI) (Blomqvist et al., 1999).

If caregivers have problems or concerns, a veterinarian should be consulted immediately. There is very little margin for error and there is no substitute for knowledge and experience in addressing the issues quickly and effectively. Mortality is the highest during the first few days of life (Mellen, 2003) and early vaccination of

hand reared lynxes is recommended (Blomqvist et al., 1999), because they are at a higher risk of infection through their frequent interaction with humans (pers. comm.).

Caretakers should attempt to strike a balance between providing food and comfort to a hand-raised cub, but not become a part of the cubs' social structure. With hand-rearing, the risk exists that the cubs will imprint on their human caretaker and fail to learn the appropriate social skills necessary to achieve social and reproductive competencies as adults. It is recommended that human caretakers never engage in any social play behaviour with hand-raised felids (Mellen, 2003).

When hand rearing a litter, it is advised to house them separately for the first two or three weeks as injuries may result from suckling by siblings (Fowler, 1986). In the event of a single cub having to be pulled, it is important to socialize it with conspecifics. Four weeks is a good age to introduce a domestic kitten or cub of its own or another species. The introduced kitten or cub should be from a healthy female with current vaccinations and be seronegative for FIV and FeLV. A medical examination should be performed on the hand-reared as well as on the introduced kitten or cub, prior to any contact. The companionship between the two will provide valuable play experience necessary to acquire socialization and developmental skills. Another very viable solution for a singleton or even a litter, is to make use of a domestic female as a surrogate mother that is healthy, appropriately vaccinated and seronegative for FIV and FeLV (Mellen, 2003). Several institutions have had success using domestic dogs, cats or even goats. Psychologically, having a surrogate dam may have major benefits for the neonate (Fowler, 1986).

In terms of reintroducing cubs back to females, attempts to do so should be assessed on a case-by-case basis. In short, females should be monitored intensively for signs of aggression towards reintroduced cubs. Transfer of soiled bedding to the female during the separation may facilitate successful reintroduction (Mellen, 2003).

5.6 Control of reproduction

Space for lynxes in captive collections will always be limited and must be managed very carefully. Contraceptive techniques have therefore become an important part of the veterinary care. Selective reduction in breeding can be achieved simply by separating females and males at the appropriate point in their reproductive cycles, but all too often the pressures of restricted space, need to exhibit animals and a desire to encourage normal social behaviour patterns limit this option. Furthermore, non-breeding, intact females are at a greater risk to reproductive tract cancers and other uterine diseases than their breeding counterparts as a result of exposure to endogenous steroids. Consequently, artificial methods of contraception are often relied upon. These methods can be divided into permanent (or irreversible) and temporary (or reversible) techniques. Permanent contraceptive techniques have the advantage of being 100% effective, but the disadvantage of removing animals from the potential captive gene pool.
Temporary techniques have the advantage of reversibility, but long-term use is associated with an increased incidence of uterine diseases and reproductive tract tumours (Blomqvist et al., 1999).

Permanent contraceptive techniques for females

Ovariohysterectomy
This technique consists of the removal of the ovaries and uterus. It is the best technique for the long-term health of an animal. This operation removes the source of endogenous steroids that can promote mammary cancer and endometrial hyperplasia in non-breeding females and removes the uterus that is otherwise susceptible to infection during contraceptive progestagen treatment. For the sterilisation of surplus females, ovariohysterectomy is the method of choice. Although surgically straightforward, the procedure does involve entering the abdominal cavity which carries the risk of post-surgical complications (Blomqvist et al., 1999).

Ovariectomy
This technique consists of the removal of the ovaries, but the uterus is left in place. Because the operation can be carried out through laparoscopy, the surgical procedure is simpler than with ovariohysterectomy and hence the potential for post-surgical complications is reduced. Although the source of endogenous steroids is removed, infections and even neoplasia of the uterus may still occur after recovery. However, the incidence of these conditions is likely to be less than in intact, non-breeding lynxes and far less than in lynxes receiving long-term progestagen contraception (Blomqvist et al., 1999).

Tubal ligation and salpingectomy
Tubal ligation involves tying the Fallopian tubes and salpingectomy removal of part of the Fallopian tubes, both procedures that can be carried out via a small incision around the umbilicus using laparoscopic techniques. Rather than being permanently tied off, the Fallopian tubes can be clamped with plastic clips, which are theoretically removable. However, patency of the tubes following clamp removal cannot be guaranteed. The risks of the animal developing reproductive tract cancer, endometrial hyperplasia and uterine infections is probably the same as for intact, non-breeding lynxes, but less than for lynxes receiving long-term progestagen contraception (Blomqvist et al., 1999).

Permanent contraceptive techniques for males

Castration
Castration, or removal of the testes, is a very simple operation in lynxes. Although castrated animals will tend to fight less, non-sexual aggression is unaffected. For sterilisation of surplus males, castration is the method of choice (Blomqvist et al., 1999).

Vasectomy
The removal of a section of the vas deferens, or vasectomy, is also a simple surgical procedure and it does not result in loss of libido or normal sexual behaviour. Lynxes may remain fertile for a limited period post-surgically. The surgically removed section of the vas should be fixed in formal saline for histological examination.
This is necessary to confirm that the procedure was carried out correctly. Ovulation, but not gestation, will be induced in females copulating with vasectomised males, thus the risk of reproductive tract diseases in non-breeding intact females in the

group or pair is not diminished. Other disadvantages of the technique include the risk of pseudo pregnancies and persistently cycling females (Blomqvist et al., 1999).

Temporary contraceptive techniques for females

Oral progestagens
Oral progestagens such as megestrol acetate (MA) and medroxyprogesterone acetate (MPA) can be given to lynxes. Although their use offers a more flexible approach to contraception than the long-acting injections and implants, the regular and long term administration of pills is easily overlooked by busy keeping staff. Furthermore, MA and MPA are known to cause an increase in appetite and hence weight gain in inactive captive lynxes. They also may be mildly diabetogenic (Blomqvist et al., 1999).

Injectable progestagens
Injectable preparations such as MPA and proligesterone (P) are probably easier to manage. Single injections produce two to six months contraception. In general, proligesterone produces fewer side effects (Blomqvist et al., 1999).

Depot progestagen implants
Depot progestagen implants are sealed tubes of medical silastic containing MPA, levonorgestrol or more commonly, melengestrol acetate (MGA). Placed subcutaneously by simple surgery, MGA implants provide a steady, continuous release of small quantities of the drug over two years. When resumption of breeding is required an implant can be removed and a return to cycling can be expected within weeks provided that fertility was normal before implantation. This is by far the simplest technique for medium term reversible contraception in females. However, the use of MGA also involves an increase in appetite and may also be mildly diabetogenic. MGA should not be used in genetically valuable felids for periods greater than two years. Implant sites should be monitored for abscess formation and implant rejection (Blomqvist et al., 1999).

Non-progestagens
The use of Porcine Zona Pellucida (PZP) immunocontraceptive injection is recommended only on surplus animals because reversibility has not been proved with lynxes yet (Mellen, 2003). Immunocontraception is a birth control method that uses the body's immune response to prevent pregnancy. In the past, two injections have been given in the initial year, followed by annual boosters. Recently, one-shot PZP injections that last at least a year have been tested successfully (Anonymous, 2003k).

Temporary contraceptive techniques for males

Reliable temporary artificial contraceptive techniques for males are currently not available (Blomqvist et al., 1999).

6 Population management

This chapter provides an overview of the captive population status, information on the species management programme and details on how to identify and sex captive Eurasian lynxes.

6.1 Population status

The total number of captive Eurasian lynxes maintained in EAZA institutions at 31-12-2002 was 318. The status of the Eurasian lynx by subspecies and regional breakdown is shown in table 7. The table shows that there is a large number of lynxes of unknown subspecies and / or origin: 58.54. Due to lack of (historical) information, it is very difficult to identify the origin of lynxes of unknown subspecies. The information used to comprise table 7 was gathered from historical data received from the EAZA institutions. Institutions which did not respond to the request for information have not been included. For this group, the information from the EAZA TAG Survey 10th series was used (Versteege, 2003).

L. l. ssp. / Region	Northern lynx	Irkutsk lynx	Siberian lynx	Carpathian lynx	Siberian lynx	Unknown ssp.	Hybrids
North Europe NO, SE, FI, EE, LV	54 (19.29.6)	-	-	-	-	7 (4.3)	-
West Europe NL, BE, GB, FR	3 (1.2)	-	36 (15.21)	2 (1.1)	-	34 (15.19)	9 (4.5)
Middle Europe DE, CH, AT	18 (7.11)	-	9 (3.6)	10 (5.5)	-	23 (12.11)	10 (6.4)
South Europe PT, ES, IT, SI	6 (3.3)	-	2 (0.2)	3 (1.2)	-	14 (6.8)	-
East Europe PL, CZ, SK	6 (3.3)	2 (1.1)	2 (1.1)	16 (9.7)	-	25 (16.9)	11 (7.4)
Ex-Russia RU, UA, KZ	2 (1.1)	-	1 (0.1)	-	3 (1.2)	9 (5.4)	1 (0.1)
Total	**89 (34.49.6)**	**2 (1.1)**	**50 (19.31)**	**31 (16.15)**	**3 (1.2)**	**112 (58.54)**	**31 (17.14)**

Table 7: The status of the captive Eurasian lynx spp. in EAZA institutions by region at 31-12-2002 (Versteege, 2003)

6.2 Species management programme

The European studbook coordinator is Ing. Lars Versteege. He works at the National Foundation for Research in Zoological Gardens (NFRZG) in Amsterdam, The Netherlands. Because of the problems with determination of the different subspecies, participants are encouraged to contact the studbook keeper for recommendations on proposed transfers and / or breedings. Contact can be made by telephone (00 31 20 52 00 750) or e-mail (Lars.Versteege@nvdzoos.nl) (Versteege, 2003).

Because of the unknown origin of a large percentage of the population and the disagreement on the validation and determination of the different subspecies, it is not yet possible or even useful to discuss breeding activity and success in captivity (numbers born, survival rates, population increase, population viability, founder representation, percentage wildcaught and captive born, etcetera). When a genetic study has been completed and agreement has been reached on the validation and determination of the different subspecies, the origin of all animals in the population can be determined (Versteege, 2003, pers. comm.).

6.3 Individual identification and sexing

For individual identification, the animal-care staff familiar with the lynxes can distinguish the individuals by differences in coat pattern, size, etc. Other staff can be informed about these differences. However, for other, more official occasions, more precise identification is needed. Especially for transport, it is very important that the animals concerned are accurately identified. For this purpose, more and more animals are implanted with chips (pers. comm.).

The main differences between male and female lynxes are size and the (non-) visibility of reproductive organs. Male lynxes are generally bigger than females. This difference in size probably originates from sexual competition in which only the large and powerful males survived to mate (Hernandez, 2002). However, a large female in an older age class can be confused with a small male in a young age class. In addition, significant geographic variation exists among the different populations (Bookhout, 1994). Male lynxes can also be recognised by the visibility of testicles (pers. comm.).

7 Handling

The difficulties associated with handling, capture, restraint and transportation are examined and ways to facilitate these procedures suggested.

7.1 General handling

Daily handling
Captive Eurasian lynxes are still wild animals and should be treated as such. Daily handling should only consist of a visual examination by staff (pers. comm.). Interactions between lynxes and humans should take place through a mesh screen or through fencing (protected contact situation) (Mellen, 2003). Direct (hands-on) contact must only take place when there is no other option (pers. comm.).

Training
The training of lynxes should be limited to acclimating them to their crate (prior to transportation) (Blomqvist et al., 1999) and training them to shift to other areas. Lynxes can be acclimated to their crate by given them prior access to the crate (at least 3 weeks) (Mellen, 2003). They can be trained to enter the crate voluntarily by feeding them inside the container during this time (Blomqvist et al., 1999). Lynxes can be trained to shift for example to secondary holding areas in the same way, by providing food in the area the animals should shift to (pers. comm.). Profound aversive stimuli such as squirting with hoses, loud noises, harsh words and long-term withholding of food (longer than 48 hours) are inappropriate to use for training. Lynxes respond to profound aversive stimuli with fear and / or aggression. It is best to keep keeper – lynx interactions positive and pleasant, in this way building a relationship of trust. Ideally, animals should not threaten a familiar caretaker when the caretaker approaches the mesh barrier (Mellen, 2003).

7.2 Catching and restraining

Physical
Traditionally, capture and restraint for small felids was accomplished by netting (Mellen, 2003). However, these techniques involve a danger of trauma for both animal and keeper because of the cat's trashing about (Fowler, 1986). More recently, training has successfully been used to facilitate capturing (Mellen, 2003). For more information on training, see above (chapter 7.1).

Chemical
Currently, ketamine hydrochloride is the drug of choice for chemical immobilization or anaesthesia. An initial dose of 5 to 10 milligrams per kilogram body weight, given intramuscularly, will allow the operator to grasp the lynx and, usually, to carry out short examination procedures. If additional sedation is required, subsequent doses should be administered intravenously. The recovery period will be prolonged unnecessarily if additional doses of the drug are given intramuscularly (Fowler, 1986).

Ketamine in combination with xylazine hydrochloride or diazepam is suitable for long-term anaesthesia (Fowler, 1986).

A well-known possible side effect of ketamine, used by itself, is convulsive seizures. Another side effect that sometimes occurs is mania in cubs. Instead of convulsing, the cub begins to vocalise, tries to climb the wall of the cage and throws itself on its back. This mania is not responsive to diazepam therapy. Total anaesthesia for an hour may be necessary to prevent self-trauma. More ketamine should not be given (Fowler, 1986).

All inhalant anaesthetics are suitable on lynxes (Fowler, 1986).

7.3 Transportation

Welfare is the prime consideration and this can only be assured if the animal that is due to be transported is healthy, contained safely in appropriately designed crates or boxes and subjected to a minimum of stress during the procedure (Blomqvist et al., 1999).

In advance

All relevant paperwork should be prepared well in advance. A clinical history, husbandry notes and biographical data should accompany the lynx (or be sent in advance), along with any veterinary health certification that is required by the receiving institution. Depending on the origin and destination, the movements of lynxes between countries may require export health certificates signed by a veterinarian acting on behalf of the appropriate government agency. The movement of Eurasian lynxes also requires CITES licences (see chapter 8.1) (Blomqvist et al., 1999).

Ideally, lynxes should be acclimated to their crate before relocation. Animal managers should make every effort to arrange this. For the procedures involved, see chapter 7.1 (Mellen, 2003).

Only healthy animals should be transported unless the movement is necessary to enable treatment. Prior to transport it is desirable that a veterinarian examines and evaluates the animal. The degree to which this is carried out will be determined by a number of factors. In the majority of cases examination will be limited to a visual check followed by discussion with the keeping staff and consideration of the animal's medical record. Ideally, more concrete evidence of the animal's health should be gained prior to transport from physical examination under anaesthesia and through blood samples. However, this is not always practical. Anyhow, it is very important that the animals concerned are accurately identified. If it has been necessary to anaesthetise an animal for crating, it must be allowed adequate time to recover fully before it is transported (Blomqvist et al., 1999).

During transport

For shipment purposes, all transport crates should meet International Air Transport Association (IATA) recommended guidelines (see chapter 8.1). Anyhow, the height of the container must allow the animal to stand in a natural position with its head held in its normal position. Further on, the width must permit it to easily turn around and lie down comfortably. Consideration should be given to the size of doorways that the crate is expected to pass through (Blomqvist et al., 1999). Crates should be made of wood, metal, weld mesh and / or wire mesh.

Design should include an access area for a pole syringe. The floor of the crate may be slatted or perforated, over a leak-proof droppings tray in such a manner that all faeces fall onto the tray. If a slatted or perforated floor is not required by the IATA, the floor must be leak-proof and covered by sufficient absorbent material to prevent excreta from escaping and provide comfort. Straw may be used for this, but care should be taken, if international shipments are involved, to insure that plant material is accepted by the receiving country (Mellen, 2003). The crate should be clearly labelled with the words “Live animal in transit” plus any other labels required by specific regulations (Blomqvist et al., 1999).

During transport the ambient temperature must be maintained within the appropriate range (-25°C and +25°C) (pers. comm., Anonymous, 2003f). Temperature extremes should be avoided. Excited lynxes overheat very easily in confined spaces. If cooling is necessary it should be achieved by using fans and not water. During delays when the ambient temperature is above 25°C, drinking-water should be provided (Blomqvist et al., 1999).

Ventilation during transport is crucial. There must be a free flow of air through the crate. This requires that air vents be provided on at least two sides (Blomqvist et al., 1999).

Light levels during shipment should be kept to a minimum. Ventilation openings on crates should be covered with a material such as burlap that filters light but does not impede air circulation (Mellen, 2003).

Lynxes tend to become aggressive and / or stressed by outside noises and activity. During transport, crates should be located away from people, loud equipment and other sources of potential stress. Qualified personnel should accompany the lynx(es) in order to reduce the risk of exposure to the above (Mellen, 2003).

Each animal should travel in a separate container, except for hand-reared young. They may be loaded in the same container as long as they are compatible and the space is sufficient for each animal to stand and lie down comfortably (Mellen, 2003). However, animals which are not weaned yet should not be transported unless absolutely necessary (Blomqvist et al., 1999). For safety reasons, animals should not be released from their transport containers under any circumstances (Mellen, 2003).

It is not necessary to provide food and water on short journeys. Water should be provided during transport where journey times are over 12 hours. Provided that an animal has been fed well before transport, food needs not be given for 48 to 72 hours. The provision of food and water during transport requires safe access to the food or water containers within the crates (Blomqvist et al., 1999). If feeding is required (for example due to an unforeseen delay), canned cat food must be provided but do not overfeed. Water containers must be positioned at the front of the crate and fixed off the floor to prevent soiling (Mellen, 2003). If animals are unaccompanied on long journeys, written instructions concerning feeding and watering should be attached to the outside of the crate in an obvious place (Blomqvist et al., 1999).

It is usually not necessary for a veterinarian to travel with a lynx unless it has been sedated or anaesthetised for the journey, which is rarely required. On the other hand, it is desirable that a familiar keeper accompanies any transport. This allows close monitoring and reassurance (Blomqvist et al., 1999). However, in most circumstances, this is cost-prohibitive (pers. comm.).

Arrival

Upon arrival, animal managers and veterinary staff should make a visual inspection of the animal as soon as it leaves the crate. Care should be taken to allow the lynx sufficient time to exit the crate under its own power. Each lynx should be released individually from its crate into its new holding area and allowed to acclimate before attempts are made to introduce it to conspecifics (Mellen, 2003). It is desirable that a familiar keeper accompanies a lynx during the first few days at a new institution. This allows close monitoring and reassurance during the settling-in period (Blomqvist et al., 1999).

7.4 Quarantine

All newly arrived lynxes should be quarantined for at least 30 days prior to entering the collection area. For lynxes originating from the wild or a range country source, the quarantine period should be extended (Mellen, 2003). Quarantine should be carried out in an independent facility located in an off-show area, which is physically isolated from all other areas that hold felids, has separate ventilation and waste disposal facilities and is staffed by personnel who have no contact with resident animals. If this is not possible, an area should be chosen that is as far away from the rest of the collection (felids) as possible and staff servicing the facility should always carry out their routine duties with resident animals before dealing with those in isolation. Strict hygiene precautions must be observed within the quarantine area (Blomqvist et al., 1999). Beyond basic tests (CBC, serum chemistry panel, serum banking and a physical exam), serology testing for feline immunodeficiency virus (FIV), feline infectious peritonitis (FIP), feline leukaemia virus (FeLV), toxoplasmosis and tuberculosis should be completed before the animal is mixed with other specimens. Three negative faecal checks should be completed and the animal should be treated for external parasites (fleas, ticks, ear mites, etcetera). During quarantine, lynxes should be provided with a nest box in which they can hide. Noise and proximity to large carnivores should be avoided (Mellen, 2003). When the various tests described above are negative and the veterinary surgeon is convinced that an animal is healthy, it should be vaccinated. Sufficient time must be allowed for a cat to develop a protective antibody response to the vaccines whilst still in quarantine (Blomqvist et al., 1999).

7.5 Safety

Each zoo should have written standard operating guidelines that address the safety of the keepers and the public (Mellen, 2003). In these guidelines procedures in case of an escape or attack must be included (pers. comm.).

As mentioned before, keepers should limit direct (hands-on) contact to the absolute minimum (pers. comm.). Keepers must even avoid entering the cat’s enclosure with its presence.

Interactions between lynxes and its keepers should take place through a mesh screen or through fencing (protected contact situation). If wire mesh is used, the fencing material should be imbedded into a concrete base (footings) that prevents the animals from digging out. The gauge of the wire mesh should be fine enough so that a cat cannot reach through and snag a keeper or visitors (Mellen, 2003). Ideally, the public must anyhow be kept at a distance of 1,5 meters from the enclosure. Furthermore the climbing skills of Eurasian lynxes must be taken into account; enclosures must be covered or the barriers must be made in such way that prevents the lynxes from jumping or climbing out (see chapter 1.1) (pers. comm.).

8 Legislation

This chapter deals with the legislation directly applicable to the management of the Eurasian lynx. It informs and advices about restrictions, but no liability can be accepted for any inaccurate information. It is strongly recommended that the original legislation or appropriate department be consulted prior to any action being taken.

8.1 Conservation

The national regulations designed to safeguard the survival of the Eurasian lynx by imposing restrictions on trade must be withdrawn from the specific national government. There are too many countries and thus regulations that also change too often to be mentioned here (pers. comm.).

International regulations regarding trade are stated in the Appendixes of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Anonymous, 2003l). The Eurasian lynx is listed under Appendix II (Anonymous, 2003h), which contains species that are not necessarily threatened with extinction but may become so if trade is not controlled. It also contains species that look so similar to endangered species that they are difficult to distinguish. International trade in specimens of Appendix II species may be authorized by the granting an export permit or re-export certificate; no import permit is necessary. Permits or certificates should only be granted when the relevant authorities are satisfied that certain conditions are met, above all that trade will not be detrimental to the survival of the species in the wild (Anonymous, 2003i).

8.2 Health and Welfare

The national regulations established to prevent the transmission of infectious diseases and to safeguard the health and welfare of individual animals must be withdrawn from any specific national government. In this case there are also too many countries and thus regulations that in addition change too often to be mentioned here (pers. comm.).

International regulations concerning welfare during air transportation are outlined by the International Air Transport Association (IATA). The current regulations can be withdrawn from the website of IATA: http://www.iata.org/cargo/liveanimals.htm (Anonymous, 2003m).

8.3 General

The Eurasian lynx is listed under Appendix III on the Appendixes of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) (Anonymous, 1999b).

This obligates contracting parties to take appropriate and necessary legislative and administrative measures to ensure the protection of the Eurasian lynx, regulate any exploitation in order to keep the populations out of danger, and take measures including closed seasons and / or other procedures regulating the exploitation, temporary or local prohibition of exploitation in order to restore satisfactory population levels and regulation of sale, keeping for sale, transport for sale or offering for sale of live and dead wild animals (Anonymous, 2001a).

The European Union Regulation (EC) includes a regulation on the protection of species of wild fauna and flora by regulating trade. The Eurasian lynx is listed in Annex A of this regulation (Wallström, 2000).

9 Specific Problems: Considerations for health and welfare

This chapter briefly outlines any physical conditions or complaints commonly associated with Eurasian lynxes. Also, the most common causes for adult mortality are reviewed. However, when dealing with actual diseases, a veterinarian must always be consulted prior to any action being taken.

9.1 Viral diseases

Feline infectious enteritis

Feline infectious enteritis (FIE) or feline panleucopaenia (FPL) is a highly infectious, fatal disease. The symptoms include marked depression, loss of appetite and vomiting. After several days, diarrhoea may develop also. Infection in pregnant females can result in young being born with brain damage which results in abnormal movement. The virus responsible is the parvovirus. It is very resistant and may survive in infected premises for several months. Domestic animals are probably the main source of infection. Further, recovered animals may continue to be infectious to other felids for long periods. Infection frequently occurs when animals are being transported for undoubtedly stress makes animals more susceptible (Mellen and Wildt, 2003). Only supportive therapy is available. Secondary infections can be treated with antibiotics (Fowler, 1986). Normal prevention includes annual vaccination (Blomqvist et al., 1999). Animals that are being transported or exposed to similar stress inflicting events should be vaccinated in advance (Mellen and Wildt, 2003). The use of inactivated vaccines is recommended, because modified live vaccines caused actual disease. Cubs should also be vaccinated with a killed vaccine (Blomqvist et al., 1999).

Feline respiratory infections

Feline respiratory infections include a number of viral and bacterial diseases that affect the upper airways, bronchi and lungs. Feline rhinotracheitis virus (FVR) is the most common disease, followed by feline calicivirus infection (FCV). The viruses responsible are herpesvirus (for FVR) and calicivirus (for FCV). Symptoms include sneezing, nasal discharge, conjunctivitis, mouth ulceration, a raised temperature, pneumonia and loss of appetite. In severe cases the loss of appetite or the pneumonia can eventually result in death (Fowler, 1986). Domestic cats are probably the main source of infection (Mellen and Wildt, 2003). The virus may persist in carrier cats that have recovered from an infection. Such individuals pose a threat to other felids in the collection. Broad-spectrum antibiotics are indicated to control secondary infection. The most crucial need is nourishment (Fowler, 1986). Adult felids should receive annual vaccinations against FVR and FCV (Mellen, 2003), because it only provides temporary protection (Fowler, 1986). A killed vaccine preparation should be used. Cubs should also be vaccinated with a killed vaccine (Mellen, 2003).

Feline infectious peritonitis

Feline infectious peritonitis (FIP) is caused by the coronavirus (Fowler, 1986). This disease is always fatal. The course can be chronic or acute (Blomqvist et al., 1999). The acute form presents itself through depression, anorexia, fever, weight loss and abdominal distention. The course may be prolonged over many weeks without abdominal distention. No specific treatment has been developed. Supportive care is indicated until a definitive diagnosis is made. Vaccines for FIP should not be used.

Little is known about this disease, so infected cats should be isolated and caution exercised to avoid carrying infectious agents to other felids (Fowler, 1986).

Feline leukaemia virus infection

Feline leukaemia (FeLV) is a multi-faceted, viral complex in the domestic cat. It is questionable whether or not the FeLV virus infects lynxes (Fowler, 1986). Vaccines for FeLV should not be used (Mellen, 2003).

Rabies

Rabies is caused by a virus that affects the central nervous system (Fowler, 1986). In the course of the disease three stages can be distinguished: the introduction, the rage and the paralysis. In the first stage the animal presents abnormal behaviour. In the second stage the animal comes into rage, including fighting and biting. The animal will try to break out of its enclosure. Sometimes the rage stage is of such short duration that it is not noticed. After the rage the feeling of pain disappears. The third and final stage includes the lower jaw hanging down and the voice changing. The animal usually dies within ten days from the first symptoms (Anonymous, 2001b). No treatment is available (Fowler, 1986). Adult felids should receive prophylaxis to prevent rabies. Only killed rabies vaccines should be used. Young animals should also be given rabies vaccines, if the risk of exposure is present (Mellen, 2003).

9.2 Bacterial diseases

Salmonellosis

Salmonellosis can be acquired from contaminated raw meat. The symptoms range from mild diarrhoea to severe gastroenteritis with generalised infection. Some infected animals appear unaffected. The disease can be transmitted to humans (Mellen and Wildt, 2003). The treatment consists of administrating broad-spectrum antibiotics (Fowler, 1986). To lessen the risk of salmonella infection, it is suggested that the intestines are removed from chicken carcasses before offering as food (Blomqvist et al., 1999).

Tuberculosis

Tuberculosis (TBC) is usually acquired from infected meat or via milk. Wild birds are a potential source of *Mycobacterium bovis*, the bacteria that causes TBC. The disease can take several months or even years to develop. This must be taken into account when importing animals from countries which are not TBC-free. Symptoms are usually marked weight loss. The disease can also be transmitted to humans (Mellen and Wildt, 2003). TBC is rarely treated (Fowler, 1986). Prevention consists of deep freezing whole or partial prey items prior to presentation (Mellen, 2003).

Feline infectious anaemia

Feline infectious anaemia (FIA) is caused by an organism called *Haemobartonella felis*, which is transmitted by blood sucking insects (cat fleas) (Blomqvist et al., 1999). Symptoms are usually preceded by stress (Mellen and Wildt, 2003). The symptoms include apathy. Treatment consists of blood transfusion and administering broad-spectrum antibiotics (Fowler, 1986). Since the methods of transmission of FIA are not fully understood, it is hard to advise on prevention of infection.

In view of the known risk factors which exist for FIA infection it is wise to take measures to prevent flea infestation and reduce inter-cat aggression. Infected cats should not be used as blood donors (Anonymous, 2003n).

Anthrax
Anthrax is caused by a bacterium called *Bacillus anthracis*. It forms spores and may remain dormant in soil for years (Fowler, 1986). The disease is usually associated with feeding contaminated carcasses (Blomqvist et al., 1999). Animals infected with the bacterium show signs of septicaemia, fever, depression and weakness. The disease can be treated with antibiotics. However, a diagnosis is rarely made in time for antibiotics to be effective (Fowler, 1986). Prevention consists of deep freezing whole or partial prey items prior to presentation (Mellen, 2003).

9.3 Parasitic diseases: Endoparasites

Faecal samples should be screened at least twice a year to make sure that the animals don't have parasites. When a specific problem is known to exist, faecal samples should be screened more frequently. Appropriate therapy should be instituted if parasites are present. If a persistent parasite problem exists, the animal as well as the environment should be considered when addressing the problem (Blomqvist et al., 1999).

Nematodes
The most common nematodes (roundworms) are *Toxascaris* and *Toxocara spp*. Most lynxes carry them with a direct life cycle. The eggs of *Toxascaris* and *Toxocara spp.* are very resistant and difficult to eliminate from the environment. Re-infection is easily accomplished by contamination of food with ova or by ingestion of secondary hosts (rodents). Heavy infestation can cause diarrhoea, vomiting, poor hair coat (Fowler, 1986) and, in severe cases, death due to intestinal obstruction. Young animals particularly should have regular parasitic egg counts carried out on faeces (Mellen and Wildt, 2003). Because elimination is essentially impossible once infection has occurred, periodic treatment with anthelminthics is necessary. A variety of effective compounds is available for administering in food (Fowler, 1986). It is good practice to vary the type of anthelmintic employed (Blomqvist et al., 1999).

9.4 Parasitic diseases: Ectoparasites

Otodectes
Ear mites can cause severe irritation and discomfort, and infestation may result in ruptured eardrums and chronic bacterial infection (Mellen and Wildt, 2003). The ear mites can be seen with the naked eye in the external ear (pers. comm.). Affected animals and those in contact with them should be treated regularly with an ear preparation to kill the mites (Mellen and Wildt, 2003). The best method of prevention is to eliminate exposure to affected cats. Further more, the ears of the animals must be regularly checked and cleaned when necessary (Anonymous, 2003o).

Fleas
Fleas can be found in the hair coat over the entire body (Fowler, 1986). Infestation is difficult to detect unless there are obvious clinical signs such as excessive scratching, loss of hair or poor coat condition.

Heavy flea infestations may cause anaemia's in young lynxes (Blomqvist et al., 1999). Flea shampoos (pyrethrins) can be used as treatment (Fowler, 1986). Flea control is a matter of prevention, rather than cure. If the lynxes are regularly treated before fleas become a problem, the population will remain as flea-free as is possible (Anonymous, 2003p).

Mange mites

Sarcoptic and Notoedric mange mites occasionally affect lynxes (Mellen and Wildt, 2003). Again infestation is difficult to detect unless there are obvious clinical signs such as excessive scratching, loss of hair or poor coat condition (Blomqvist et al., 1999). Treatments with acaricidial shampoos are usually effective and in-contact animals should also be treated to prevent further spread (Mellen and Wildt, 2003).

9.5 Protozoal diseases

Toxoplasmosis

Toxoplasma gondii is a ubiquitous protozoan parasite (Fowler, 1986) that affects lynxes as well as men (Anonymous, 2001b). Toxoplasmosis is passed in utero and can cause serious disease in neonates. Lynxes can also become infected by consuming food contaminated with infective oocysts and by consuming secondary hosts. The parasite can also be transmitted through faecal contact. Signs include anaemia, blindness, disturbance of the central nervous system, respiratory distress and diarrhoea. Optimal treatment combines the synergistic action of sulfamerazine and pyrimethamine (Fowler, 1986). Prevention consists of freezing meat to -20°C for two days, prior to presentation (Kotton, 2002).

9.6 Mortality

In captivity, the Eurasian lynx can reach an age up to 24 years (Anonymous, 2003a). Adult mortality can have several causes, including nutrient deficiencies, fighting between cage mates, cancer caused by artificial temporary contraception, and diseases such as FIE or FPL, feline respiratory infection, FIP, rabies and nematodes (see this and previous chapters).

10 Recommendations: Additional research

This chapter deals with the additional research already been carried out (husbandry questionnaire) and additional research yet to be done (research programmes).

10.1 Husbandry questionnaire

A husbandry questionnaire was used to obtain the following information:
- dimensions of Eurasian lynx enclosures;
- floor materials used in indoor areas;
- sharing the enclosure with other species;
- different food-items being fed;
- number of kilograms food per day;
- fasting;
- frequency of feeding (number of times a day);
- number of male and / or female lynxes present in the enclosure;
- male separation before the birth of young;
- moment that the separated male is reintroduced again.

An example of the questionnaire can be found in attachment VII. The summary of the results of the questionnaire can be reviewed in table 8 (n=35).

Question	Summarised answer
Outdoor enclosure dimensions (m^2)	466,1
Height of outdoor enclosure (m)	3,9
Indoor enclosure dimensions (m^2)	9,4
Height of indoor enclosure (m)	2,0
Floor materials indoor areas	Concrete or wood, covered with wood shavings, straw or sand.
Sharing enclosure with other species	No
Food-items	Chicken, beef, rabbit, rat and guinea pig.
Amount fed (kg)	1,3
Fasting	Yes
Number of feeding per day	1
Number of male and / or female in enclosure	1.1 1.0
Separation of male before birth	No
	In the four cases when they did separate the male, they removed him on average 3 weeks before the expected birth and reintroduced him again after the young had been removed from the female.

Table 8: Results of the husbandry questionnaire among 35 zoos with Eurasian lynxes

10.2 Research programmes

Research programmes should be initiated to validate and determinate the different subspecies of the Eurasian lynx. After this study has been completed and agreement has been reached on the validation and determination of the different subspecies, the origin of all animals in the population can be determined.

Then the information on breeding activity and success in captivity (numbers born, survival rates, population increase, population viability, founder representation, percentage wildcaught and captive born, etcetera) can be gathered and decisions can be made on which subspecies to maintain in the zoo population (pers. comm.).

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Attachment I – Legal status of the *Lynx lynx* in Europe

Country	**Legal status**	**Legal killings** [a]	**Illegal killings** [a]	**Traffic incidents** [a]	**Other losses** [a]
Albania	year round protection				
Austria	year round protection	0	0	0.2	0
Belarus	no information available				
Bulgaria	year round protection				
Croatia	quota hunt 15-11 to 28-02	8		0.7	1
Czech republic	year round protection	0	okt-20	0.3	0.7
Estonia	hunted 01-11 to 28-02	54	?		
Finland	quota hunt 01-12 to 28-02	50-70	?		
FR Yugoslavia	year round protection			0.3	0.2
France	year round protection	1.2	0.6	1.2	0.8
FYR Macedonia	year round protection				
Germany	year round protection	0	0.5	0.7	
Greece	year round protection				
Hungary	year round protection			1-feb	0.3
Italy	year round protection	0	0.3	0	0.2
Latvia	hunted 01-10 to 15-03	53	?	?	?
Lithuania	year round protection				
Norway	quota hunt 01-02 to 31-03	37			
Poland	year round protection	8			
Romania	hunted 01-10 to 01-03	okt-50	>8	?	?
Slovakia	quota hunt				
Slovenia	quota hunt 01-11 to 15-02	5	0.5	0.2	0.7
Sweden	quota hunt	15	some	48	39
Switzerland	year round protection	0	2	2	3.5
Ukraine	year round protection	0	?		?

[a] Numbers of legal killings, illegal killings, traffic incidents and other losses refer to a mean annual value of the time period 1990-1995.

(Breitenmoser, 2000, Anonymous, 2003e)

Attachment II – Action Plan for countries which inhibit *Lynx lynx*

4.1.1. The Bern Convention adopts this Action Plan.
4.1.2. Establishment of a national lynx management group that produces a national lynx action plan according to this Action plan. Cross-border management is secured.
4.1.3. The lynx is protected by law. Hunting is only allowed if it does not threaten the long-term survival of the population and if the harvest is in accordance with the goals formulated in the action plan.
4.1.4. Law enforcement is intensified in areas where poaching is an important threat for the population.
4.2.1. The lynx should be given strict legal protection and the law should be enforced.
4.2.2. Identify the status of the population and establish a monitoring programme.
4.2.3. The historical decline of the lynx should be analysed, threats to the population identified and measures to remove the limiting factors taken.
4.2.4. Public information campaigns to secure the support of the people for the conservation of the lynx should be launched.
4.2.5. The viability of the population should be increased through measures that allow the establishment of a viable meta-population.
4.2.6. The genetic status of the population should be analysed in order to determine the necessity and strategy of re-stockings.
4.2.7. Carefully designed re-introduction programmes should be carried out in areas that can potentially host viable populations.
4.3.1. The forest and landscape in lynx areas or potential lynx areas should be managed according to the requirement of the species. Deforestation is halted wherever it is a problem for the survival of the lynx and forests are managed in a way to provide good habitat for the lynx and for its most important local prey species.
4.3.2. Sub-populations forming a potentially viable lynx meta-population should be connected by habitat corridors. These corridors are maintained or restored wherever they are important for the survival of a sub-population and the genetic exchange between the sub-populations.
4.3.3. The food supply for the lynx should be guaranteed through proper management and conservation of it most important local prey species. The lynx needs and the impacts of the lynx predation are incorporated in the hunting management of the native ungulate populations.
4.4.1. Livestock husbandry procedures and protective devices apt to prevent depredation of lynx on sheep, goats, or semi-domestic reindeer in the lynx area should be tested and implemented.
4.4.2. The economic loss of livestock owners due to lynx depredation should be compensated for. Compensation systems should aim to promote the co-existence of livestock breeders with lynxes rather than to let the owners simply profit from losses.
4.4.3. Rules should be fixed saying under what conditions and how lynxes causing intolerable losses in livestock herds can be removed.
4.4.4. The impact of lynx on its wild prey populations should be recognised and taken into consideration when defining the hunting management of the local (ungulate) populations.

4.4.5. Harvest of viable lynx populations through hunting should be allowed when the population can tolerate it.
4.5.1. Information campaigns should be launched in order to teach the broad public about all aspects of lynx conservation and management.
4.5.2. Detailed educational programmes should be initiated for specific interest groups such as hunters or livestock owners.
4.5.3. Local people should be integrated into the planning and implementation of lynx action plans. Establishing boards incorporating all local interest groups could do this.
4.5.4. Local people should permanently be involved into decisions concerning lynx management and conservation.
4.6.1. Applied research on Eurasian lynx should be co-ordinated and exchange of methods, ideas and results must be certain.
4.6.2. National or local monitoring systems for the lynx should be designed, tested, implemented and co-ordinated among countries sharing the same lynx population.
4.6.3. Human dimension research projects should be launched in order to understand the conflicts between humans and lynxes.
4.6.4. Research on minimum viable population size, genetic status, population dynamics, habitat requirements must be advanced in regard to the restoration of viable lynx populations.
4.6.5. Long-term research projects should investigate the impact of lynx on its prey population in relation to human influences to the same populations.
4.6.6. Applied and co-ordinated projects should test methods to protect livestock from lynx depredation.

(Breitenmoser, 2000)

Attachment III – Adopted actions

Action	N	S	FIN	EST	LV	LT	UA	PL	CZ	D	SK	H	RO	BG	YU	AL	GR	MK	BIH	HR	SLO	A	I	FL	CH	F
4.1.1.	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
4.1.2.	x	x	x	x		x	x	x	x		x	x	x	x	x	x	(x)	x	x	x	x	x	x	x	x	x
4.1.3.	x	x	x	x	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
4.1.4.																x						(x)	(x)		x	x
4.2.1.						x	?	(x)	x			x			x	x	x	x	x	x	x	x	x		x	x
4.2.2.						x	x	(x)	x	x	x	x			x	x	x	x	x	x	x	x	x		x	x
4.2.3.										x		x		x	x	x	x	x								(x)
4.2.4.						x	?	(x)	x	x		x		x	x	x		x	x	x	x	x	x	x	x	x
4.2.5.						x	x	(x)	x			x			x	x	?	x	x	x	x	x	x		x	x
4.2.6.									(x)						x	x	?	x	x	x	x	x	x		x	x
4.2.7.							?		x	x		x		x			?					(x)	(x)	(x)	(x)	x
4.3.1.						x	x								x	x	?	x			(x)					x
4.3.2.					(x)	x	x	(x)	x			(x)		(x)	(x)	(x)		(x)	x	x	x	x	x	x	x	x
4.3.3.	x	x	x	x		x	x	x	x		x	x	x	(x)	x	x	?	x	x	x	x	x	x	x	x	x
4.4.1.	x	x	x						x			?	?		x	x	?	x	x	x	x	x	x	(x)	x	x
4.4.2.	x	x	x						x						x	x	?	x	x	x	x	x	x		x	x
4.4.3.	x	x	x						x				x		(x)	(x)		(x)	x	x	x	x	x		x	x
4.4.4.	x	x	x	x		x	x	x	x		x	x	x		x	x		x	x	x	x	x	x		x	x
4.4.5.	x	x	x	x	x	(x)		(x)	(x)		x		x						x	x	x				(x)	(x)
4.5.1.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x
4.5.2.	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x
4.5.3.	x	x	x	x		x	x	x	x		x	x	x	(x)	x	x	?	x	x	x	x	x	x	(x)	x	x
4.5.4.	x	x	x	x		x	x	x	x		x	x	x	(x)	x	x		x	x	x	x	x	x	(x)	x	x
4.6.1.	x	x	x	x	x	x	x	x	x		x	x	x	(x)	x	x	x	x	x	x	x	x	x		x	x
4.6.2.	x	x	x	x	x	x	x	x	x		x	x	x	(x)	x	x	x	x	x	x	x	x	x		x	x
4.6.3.	x	x	x												x	x	?	x	x	x	x	x	x		x	x
4.6.4.						x	(x)	(x)	x						x	x	?	x	x	(x)	(x)	x	x		x	x
4.6.5.	x	x	x	x	(x)			(x)	(x)		x		x						(x)	(x)	(x)				(x)	(x)
4.6.6.	x	(x)	(x)										(x)		(x)	(x)	?	(x)	(x)	(x)	(x)	(x)	(x)		x	x

(Breitenmoser, 2000)

Attachment IV – Ground meat diet

Ingredient	Percentage by weight	
Horse muscle or beef muscle[a]		94,10
Cellulose	3,00	
Calcium phosphate, tribasic (31,6% Ca; 17,3% P)	1,25	
Sodium chloride	0,30	
Trace element premix[b]	0,50	
Vitamin premix[c]	0,50	
Choline chloride (60% choline)	0,15	
Taurine	0,10	
Stabilized L-ascorbyl-2-polyphosphate (Roche Rovimix® Dry, 15% vitamin C activity)	0,10	
	100,00	
Dry matter	40,00	

[a]USDA FSIS inspected; selected for appropriate fat content in relation to lynx body condition; may be supplemented with n-6 or n-3 fatty acids.
[b]Containing 640 ppm Cu, 400 ppm Mn, 80 ppm I, and 4 ppm Se.
[c]Containing 800.000 IU/kg vitamin A, 160.000 IU/kg vitamin D_3, 32.000 IU/kg vitamin E, 200 ppm vitamin K, 800 ppm thiamin, 800 ppm riboflavin, 500 ppm pantothenic acid, 4.800 ppm niacin, 800 ppm vitamin B_6, 20 ppm biotin, 64 ppm folacin.

(Mellen, 2003)

Attachment V – Nutrient requirements of the *Lynx lynx*

Nutrient	Maintenance (AAFCO)	Growth (NRC)	Growth and reproduction (AAFCO)
Crude protein, %	26	24	30
Arginine, %	1,04	1	1,25
Histidine, %	0,31	0,30	0,31
Isoleucine, %	0,52	0,50	0,52
Leucine, %	1,25	1,20	1,25
Lysine, %	0,83	0,80	1,20
Meth + Cyst, %	1,10	0,75	1,10
Methionine, %	0,62	0,40	0,62
Phe + Tyr, %	0,88	0,85	0,88
Phenylalanine, %	0,42	0,40	0,42
Taurine, %	0,1-0,2[a]	0,04	0,1-0,2[a]
Threonine, %	0,73	0,70	0,73
Tryptophan, %	0,16	0,15	0,25
Valine, %	0,62	0,6	0,62
Crude fat, %	9,0		9,0
Linoleic acid, %	0,5	0,5	0,5
Arachidonic acid, %	0,02	0,02	0,02
Calcium, %	0,6	0,8	1,0
Phosphorus, %	0,5	0,6	0,8
Magnesium, %	0,04	0,04	0,08
Potassium, %	0,6	0,4	0,6
Sodium, %	0,2	0,05	0,2
Chloride, %	0,3	0,19	0,3
Iron, ppm	80	80	80
Copper, ppm	5	5	5-15[b]
Iodine, ppm	0,35	0,35	0,35
Zinc, ppm	75	50	75
Manganese, ppm	7,5	5	7,5
Selenium, ppm	0,1	0,1	0,1
Vitamin A, IU/kg	5000	3333	9000
Vitamin D_3, IU/kg	500	500	750
Vitamin E, IU/kg	30	30	30
Vitamin K, ppm	0,1	0,1	0,1
Thiamin, ppm	5	5	5
Riboflavin, ppm	4	4	4
Vitamin B_6, ppm	4	4	4
Niacin, ppm	60	40	60
Pantothenic acid, ppm	5	5	5
Folacin, ppm	0,8	0,8	0,8
Biotin, ppm	0,07	0,07	0,07
Vitamin B_{12}, ppm	0,02	0,02	0,02
Choline, ppm	2400	2400	2400

[a]Lower number for extruded diets and fresh frozen diets; higher number for canned diets.
[b]Lower number for canned diets and fresh frozen diets; higher number for extruded diets.

(Mellen, 2003)

Attachment VI – Infant care sheet

INFANT CARE SHEET

PAGE_____

DOB_____ SPECIES_____

ID _____

SPECIAL
INSTRUCTIONS_____

_____

FORMULA_____

Date/Time	Amount fed	Notes	Weight	Elimination

(Mellen, 2003)

Attachment VII – Husbandry Questionnaire

Eurasian lynx ***lynx lynx sspp.*** Management Questionnaire

Name of institution:

Name of respondent: E-mail address:

Section 1 - ENCLOSURE

1) Enclosure dimension in metres:

	Height	Length	Width
Outdoor		x	x
Indoor		x	x

2) What floor materials are used in indoor areas?

3) Is the Eurasian lynx sharing its enclosure with another species?

O NO **O YES, with ……..**

Section 2 - DIET

4) Which different food-items do you feed your lynxes?

5) How many kilograms (KG) do you feed? **kg**

6) Do you feed your lynxes every day?

O NO **O YES**

7) How often do you feed per day? **times**

The questionnaire continues at the next page➔

Section 3 - SOCIAL STRUCTURE

8) How many <u>lynxes</u> are present in the enclosure?

Number of males: …….

Number of female:…….

9) Are male and female separated before the birth of young?

O NO **O YES, …… weeks before expected birth**

Reintroduction of the male occurs:

O when young are …….. weeks old.

O after young have been removed from the female.

Any other comments?

……

……

……

……

THANK YOU FOR YOUR TIME!

Please return this questionnaire before ……. to: Lars Versteege
lars.versteege@nvdzoos.nl
PO Box 20164
1000 HD Amsterdam
The Netherlands

(Krelekamp, 2003)