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Experiences with live-capture and radio collaring of lynx *Lynx lynx* in Norway

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Lynx have been captured for radio-collaring as part of three research projects in Norway between 1987 and 1996. Box traps, padded leghold traps, foot snares, combinations of foot snares and leghold traps, chasing animals up trees, catching neonates at lairs, and darting individuals while crossing roads have all been used to capture individuals. Mortality was particularly high (2 of 3 died) in the first project in Aust-Agder and Nord-Trøndelag (1987-88). Methodological improvements reduced this mortality rate to one lynx of 17 (6%) in Nord-Trøndelag (1994-96) and two of 17 (12%) in Hedmark (1995-96). Lessons from these accidents should reduce future mortality even further. Leghold traps and foot snares placed around a carcass of a prey animal killed by the lynx are far more effective than box traps, but maintain a higher risk of injuries. Lynx appeared more likely to return to roe deer carcasses than those of semi-domestic reindeer. There was no selection for lighter lynx. It is important to reduce the time-span between capture and immobilisation to lower the risk of injuries. It is recommended to avoid capturing and immobilising lynx at extremely low or high temperatures. Non-target animals getting caught can pose a minor problem when leghold traps stay open for longer periods.

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INTRODUCTION

The Eurasian lynx *Lynx lynx* is distributed over most of Norway. Recent population estimates indicate that the population is expanding, but, as a top predator the lynx will always be found at relatively low densities, and will therefore always be vulnerable to changing environmental conditions (Kvam 1996). Lynx are also responsible for very high levels of depredation on domestic sheep *Ovis aries* and semi-domestic reindeer *Rangifer tarandus*, resulting in a complex management situation which tries to balance conservation with depredation reduction (Aanes et al. 1996, Kvam et al. 1995)

In Stortingsmelding nr. 27 (1991-92) from the Ministry of Environment to the Norwegian Parliament it is emphasised that research on the basic ecological requirements of the lynx will have high priority. Some of the problems hindering closer studies of the lynx in the wild are connected with trapping and radio collaring, which is necessary to obtain detailed knowledge about the species. Field studies of wildlife demand live-capturing techniques that are both humane and efficient. This is especially important in field studies of vulnerable species.

The Norwegian authorities have been very restrictive concerning live trapping and immobilising large carnivores. Unauthorised live trapping of wild animals is illegal in Norway, and comprehensive planning and testing of techniques had to be carried out to get permission to carry out a study of lynx ecology requiring live-capture and radiotelemetry. The Animal Welfare Act of December 20 1974 sets strict restrictions on methods of live-capturing animals. There are also important problems related to the uncertain status of the population, and to the risk of capturing vulnerable or threatened non-target species like arctic fox *Alopex lagopus*, Golden eagle *Aquila chrysaëtos* and wolverine *Gulo gulo*. As a result all live capture for research requires that technqiues are approved by an ethical committee attached to the Minsitry of Agriculture and that a license is provided by the Directorate for Nature Management.

Linscombe and Wright (1988) and Olsen et al. (1988) report results from live-capturing of furbearers, Onderka et al (1990) and Skinner and Todd (1990) of coyotes *Canis latrans* and Travaini et al. (1996), Linhart et al. (1986) and Olsen et al. (1986) of red fox *Vulpes vulpes*. But only one study known to us has been published on techniques and results obtained during live-capturing and trapping of Canadian lynx *Lynx canadensis* (Mowat et al. 1994). So far, there have not been any reports on experience acquired under live capture situations of Eurasian lynx.

Since 1987 the Norwegian Institute for Nature Research (NINA) has been working with various aspects of lynx biology. Our aim with this article is to focus on some of our experiences with live-capturing of lynx in Norway. Future live-capturing of lynx may also involve other techniques not described herein (e.g. using trained dogs, Koehler and Hornocker 1991). But the techniques we have utilised will certainly be important also in the years to come.

STUDY AREAS

In 1988 lynx were live-captured in Bygland (58°53' N, 7°50' E) in Aust-Agder county, and in Verdal (63°45' N, 9°30'E) in Nord-Trøndelag county (Figure 1a). In 1993-96 one study area was located in Lierne, Høylandet, Overhalla and Grong municipalities (64°N, 12°E) in Nord-Trøndelag county and a second study was located in Trysil, Åmot, Stor-Elvdal, Elverum, Løten, Våler and Ringsaker municipalities in Hedmark county (Linnell et al. 1996) (Figure 1b).

METHODS

Trap types

Padded leghold traps (Victor No.3 Soft Catch™ trap *U.S. Patent 4, 184, 282*), snares (Swedish Lule- snaran), and modified leghold traps, combined with snares which are flung up the lynx's leg when the trap closes, have been used in the Aust-Agder and Nord-Trøndelag projects. The "Swiss-snare" was used extensively in the Hedmark project. This system, developed over several years in Switzerland, uses two spring-mounted arms to toss a spring-loaded snare up the lynx's leg (Breitenmoser et al. 1993). The traps were set around lynx kills, and anchored to trees with steel- chains or cables. Lynx kills were found by tracking lynx in snow during the winter months December-May (all three projects), and by monitoring radio-collared roe deer (in Hedmark).

Box traps, measuring 100cm x 80cm x 200cm, were used during winter 1993/94 and 1994/95. They are of a traditional type: constructed of wood or metal frames, woven wire sides and a sliding door at both ends. The box traps were set out in paths where the lynx usually travel, often on narrow tracks where the lynx needed to walk through or make a long diversion. They were baited with meat or with urine from captive lynx in Nord-Trøndelag, but unbaited in Hedmark.

All trap types were tested on captive lynx in 1987-88 and authorised for use on wild lynx by the Ministry of Agriculture, Veterinary section. The Swiss-snare has also been extensivelly tested under field conditions for live capture of lynx over 10 years in the Alps.

Live-capturing of lynx kittens (<4 months) was accomplished by scaring them up into trees and catching them in a big net as they jumped down. A younger kitten (6 weeks old) was caught by hand while lying in its natal lair. A single radio-collared lynx was recaptured by darting it from a car while it walked along a road.

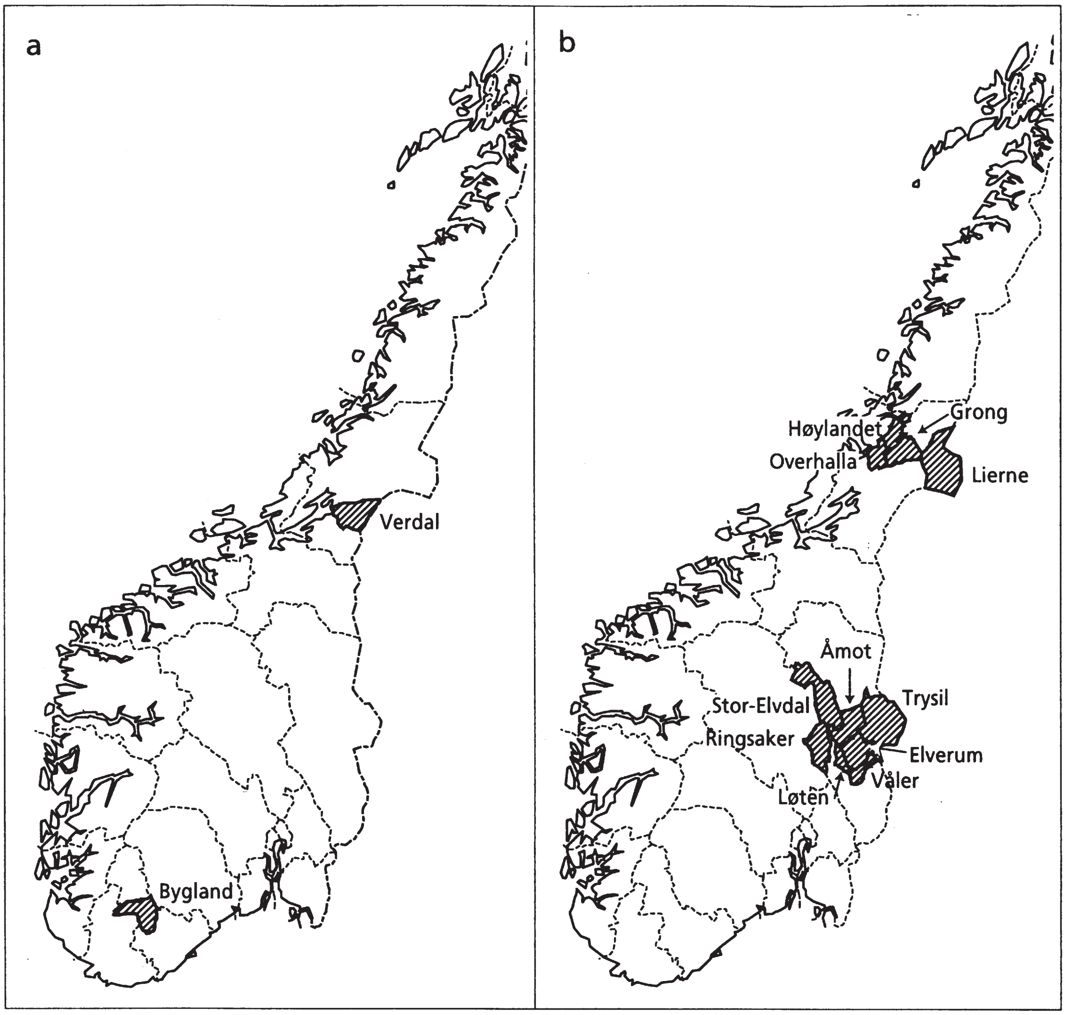

Figure 1
Map of Norway. Municipalities where lynx were captured in 1988 (a) and from 1994 (b) are hatched.

Alarm system

All trap types were connected to radio alarm systems which alerted the field workers when the lynx was trapped. Alarms for snares and legholds were constantly monitored. This was necessary to secure that immobilisation of lynx caught was performed within one hour, in accordance with the recomendations on capturing routines made by the Veterinary authorities. Box traps were not constantly monitored, but alarm signals were checked once or twice a day.

Anaesthetics

In most countries biologists with special training are permitted to immobilise wild animals for radio-collaring. Norway is one of very few countries where only a veterinarian may immobilise wild animals. This is very good from an animal welfare point of view, but it calls for good co-ordination, and may be experienced as an extra burden and cost by the field biologists. In 1988 the lynx were immobilised with ketamine HCl (*Ketalar* ®) or a mixture of ketamine HCl and xylacine (*Rom-*

pun ®). From 1993 they were immobilised with Ketamine HCI in combination with medetomidine HCl (*Domitor* ®, Zalopine ®). Another new factor in 1993 was the use of a suitable antidote, atipamezol HCl (*Antisedan* ®), to suspend the effect of medetomidine. The injections were set with a blowpipe or a dart gun in all captures in Aust-Agder and Nord-Trøndelag. In Hedmark, a blowpipe was used in the two box trap captures, however, in all Swiss-snare captures the lynx were manually restrained using a net and the injection applied using a standard syringe. After immobilisation the lynx were weighed, measured, evaluated for general physical condition, and fitted with radio-collar. Antidote was applied both subcutaneously and intravenously.

RESULTS

Trapping results in Aust-Agder and Nord-Trøndelag

From 1988, 72 trap sets have been set out, and up to 4 box-traps have been used for longer periods. As Table 1 shows, 20 lynx have been captured. In 1988 2 of the 3 captured animals died of reasons connected to trapping or immobilisation routines. The lynx project was therefore terminated until better trapping procedures could be established and improved immobilisation routines were available (see Trapping mortality section).

Live trapping of lynx was taken up again in Lierne, Nord- Trøndelag county in winter 1992/93, but without any trapping success that season. There were a total of 13 capture attempts, 8 on semi-domestic reindeer carcasses and 1 on a roe-deer *Capreolus capreolus* carcass. During the winter 1993/94 the project was moved to Høylandet/Grong, where trap sets were set out. Thirteen of the 15 trapping attempts were on roe-deer carcasses, 1 on a hare *Lepus timidus* and 1 in a lynx-track. In that season 6 lynx, 5 females and 1 male were captured; 4 in leghold traps and 2 in box traps (Table 1). In winter 1994/95 there were 33 capture attempts, 24 were on roe-deer, 5 on reindeer,1 on a hare, 2 on domestic sheep and 1 in a lynx-track. Of the 10 lynx which were live-captured that winter 3 were recaptures and 3 were kittens (Table 1). In 1995/96 there was low trapping activity and there were only 8 sets out that winter. Only 1 male juvenile lynx was captured (Table 1). Two sets were on reindeer and 6 on roe-deer. Eight of the 13 lynx captured in leghold traps, where the exact time of alarm was noted, were captured in the evening (1755-2145). Three animals were captured at night (0125-0345) and 2 in the morning (0635 and 0700).

Of the 44 sets on roe-deer carcasses and 16 on reindeer carcasses in Nord-Trøndelag only 2 animals (16.7%) have been captured on reindeer kills. Due to a small data set there are no statistical significant differences in capture rate (Mann-Whitney U - Wilcoxon Rank Sum W Test: z=-1.852, n=44, p=0.064). But if the chances of successful capture had been independent of prey type, approximately 26,7% of the lynx should have been caught on reindeer kills.

Trapping results in Hedmark

Between Febuary 1995 and October 1996 a total of 55 capture attempts were made using Swiss-snares placed around lynx-killed carcasses in Hedmark. Of these 47 were roe deer, 2 were sheep, 2 were red fox, 1 was an eight month old moose calf, and 1 was a red deer *Cervus elaphus*. An additional attempt was made using snares placed around a beaver carcass that had been placed out as a bait to attract foxes. Of these 56 attempts, 13 (23%) resulted in the capture of lynx (Table 1). Apart from the capture on the beaver-bait all the other captures were on roe deer. This catch-average is believed to be low because much effort was put into recapturing individuals. Our experience is that these individuals often avoid returning to a carcass where snares have been set again. All captures were between 1850 and 2200 in the evening. Following early failure to catch lynx after this time, we closed the snares after 2300. In only one occasion did a lynx return to feed after we had closed the traps.

Up to four box-traps were open at any moment. Despite being open for over a year each, we only captured 2 lynx. On one other occasion a lynx walked through when the trap was open but not armed. The adult male that was darted from a car was already radio-collared and showed no fear of cars. Using the working radio-collar he was located and followed until it became obvious that he would cross a road.

Table 1. Lynx captures from 1988 to 1996.

Date	Weight	Time of alarm	Time before immob.	Immob. period	Sex	Age	Trap type	Bait	Results
Aust-Agder									
10.03.88	?	?	?	45 min.	♂	Juvenile	Snare	In track	OK
26.03.88	?	(*)	480 min	(*)	♀	Juvenile	Snare	In track	Died
01.05.88	16 kg	0830	60 min	(**)	♂	Adult	Soft-catch	Reindeer	Died
Nord-Trøndelag									
16.01.94	15 kg.	1757	60 min	15 min.	♀	3 years	Soft-catch with snare	Roe-deer	OK
24.01.94	9.5 kg	1815	20 min.	60 min	♀	8 months	Soft-catch with snare	Roe-deer	OK
08.02.94	15 kg	1755	(***)	(***)	♀	3 years	Soft-catch with snare	Hare	OK
02.04.94	22.5 kg	2040	53 min.	27 min.	♂	4 years	Soft-catch with snare	Roe-deer	OK
07.04.94	16.5 kg	1200	116 min.	16 min.	♀	3 years	Box trap	Lynx urine	OK
21.04.94	12.5 kg	1400	109 min.	32 min.	♀	1 year	Box trap	Lynx urine	OK
15.02.95	11.5 kg	0635	70 min.	(****)	♀	9 months	Soft-catch with snare	Roe-deer	Died
02.03.95	12.5 kg	0345	37 min	31 min	♀	10 months	Soft-catch with snare	Roe-deer	OK
18.03.95	24 kg	2017	78 min	50 min	♂	7 years	Soft-catch with snare	Roe-deer	OK
11.04.95	20.5 kg	2140	55 min	60 min	♂	2 years	Soft-catch with snare	Roe-deer	OK
06.05.95	11.5 kg	2145	57 min	68 min	♀	1 year	Soft-catch with snare	Reindeer	OK (R)
09.05.95	17 kg	0125	95 min	56 min	♀	2 years	Soft-catch with snare	Roe-deer	OK (R)
15.08.95	4 kg	2200	210 min	30 min	♂	2.5 months	Chased up in a tree		OK
15.08.95	4 kg	2200	210 min	26 min	♀	2.5 months	Chased up in a tree		OK
21.08.95	2.9 kg	1930	210 min	68 min	♂	2.5 months	Chased up in a tree		OK
24.11.95	8.5 kg	1820	69 min	51 min	♂	5.5 months	Soft-catch with snare	Roe-deer	OK (R)
04.05.96	14 kg	0244	33 min	51 min	♂	1 year	Soft-catch with snare	Roe-deer	OK
Hedmark									
09.02.95	22.5 kg	1913	120 min	57 min	♂	Adult	Swiss-snare	Roe deer	OK
23.02.95	10.5 kg	1900	?	52 min	♀	9 months	Swiss-snare	Roe deer	OK
01.03.95	9 kg	1855	4 min	39 min	♀	10 months	Swiss-snare	Roe deer	OK
14.03.95	17.5 kg	2130	<20 min	51 min	♀	Adult	Swiss-snare	Roe deer	OK
17.03.95	11 kg	2050	25 min	56 min	♂	10 months	Swiss-snare	Roe deer	OK
29.03.95	18 kg	2200	70 min	55 min	♂	Adult	Swiss-snare	Roe deer	OK
02.01.96	14 kg	1940	20 min	47 min	♀	1.5 years	Swiss-snare	Roe deer	OK
04.02.96	16 kg	1900	80 min	(*****)	♂	Adult	Swiss-snare	Roe deer	Died
11.02.96	20.5 kg	2030	40 min	47 min	♂	Adult	Swiss-snare	Roe deer	OK
21.03.96	11.5 kg	2034	40-110 min	60-170 min	♀	10 months	Swiss-snare	Roe deer	OK(******)
24.03.96	20 kg	2200	10 min	55 min	♂	Adult	Swiss-snare	Beaver (bait)	OK (R)
28.03.96	14.7 kg	2000	10 min	?	♀	Adult	Swiss-snare	Roe deer	OK
10.05.96	13 kg	?	?	54 min	♂	Adult	Box trap	none	OK (R)
09.07.96	1.6 kg	1000	—	60 min	♂	6 weeks	Picked-up in lair		OK
16.07.96	14 kg	?	?	52 min	♀	Adult	Box trap	none	OK
23.08.96	18 kg	1850	—	38 min	♂	Adult	Darted in road		Died (*******) (R)
08.10.96	16 kg	1905	2 min	41 min	♀	Adult	Swiss-snare	Sheep	OK

(*) The lynx managed to destroy the snare due to poor routines for mounting traps. It escaped with the snare around its leg. Died of blood loss and injuries caused by the snare.

(**) In a period of 5 hours 9 injections was administered without any apparent effect. Then the lynx died.

(***) The lynx tore itself out of the trap and ran away with the snare around its leg. It was immobilised from a helicopter the day after.

(****) The lynx broke one of its legs. The veterinarian put the animal to death.

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(******) The lynx required three injections over 30 min before it was possible to handle her probably because of the use of wrong drug dosage. During anathesia the lynx stopped breathing for a minute. Rapid treatment restarted breathing and the lynx was released unharmed.

(*******) The lynx died some hours after release. Application of antidote to Medetomide before ketamine had sufficently worn off may have been cause of stress leading to death.

(R) Recapture. ? Data missing or not known.

The neonatal kitten was captured by following the radio-collared mother as she returned from a hunting trip to the natal lair. The lair was located by approaching her quietly. The single kitten was found under a large stone. In this operation we failed to locate the other two siblings because the mother had split the litter between two lairs. A small radio-transmitter was implanted inside the peritoneal cavity.

Trapping selection

Overall 19 females and 18 males have been live-captured since 1988, 16 females and 17 males in leg hold traps (Table 1). The age distribution ranges from 2,5 months to 7 years. All lynx were in normal condition. The similarities of mean weights of lynx live captured versus those shot by hunters in Nord-Trønderlag indicates that there is no selection for individuals in poor condition (Table 2).

Leghold traps seems to trap more juvenile females than juvenile males. Five of 6 and 3 of 4 trapped juveniles were females in Nord-Trøndelag and Hedmark respectively. This might be a result of either a sex based differences in behaviour or reflect a skewed sex-ratio in the study populations (Kvam 1991). The radio collared lynx seemed to be of normal weight and condition, and live-capturing techniques do not seem to select for weak or starving animals. None of the animal have died of hunger or been inflicted with diseases after being radio collared.

Table 2. Mean weight of radio collared lynx and lynx shot by hunters in Nord- Trøndelag from 1993 to 1995.

	Radio collared lynx (kg.)			Lynx shot (kg.)		
	N	mean	SD	N	Mean	SD
Adult ♀	4	15,9	1.7	3	16.2	1.6
Juv. ♀	3	11,5	1.4	3	13.3	2.2
Adult ♂	3	22,3	1.8	11	20.9	2.6
Juv. ♂	1	13,7	-	4	13.8	1.4

Injuries

In box traps there were no injuries apart from minor damage to a tooth and claws, neither to lynx nor non-target animals. Box traps are recommendable in situations where the veterinarian cannot arrive within one hour. We had restricted immobilisation of lynx in box traps to occur within 6-12 hours.

In 1988 one lynx died from extensive blood loss due to injured blood veins in a foreleg. The lynx was caught in a snare. But since the wire became tangled in trees and brush, the animal managed to tear loose the snare and run away with the trapping device around its leg. Major injuries were experienced as a result of rushing through the wood while the trapping device hit trees along the track.

Both, in 1995 in Nord-Trøndelag and in 1996 in Hedmark a lynx fractured a leg in a trap and was euthanised by the veterinarian. Based on the lesson learnt in 1988, trees and brushes were avoided when the trap was mounted. But in one case the lynx managed to jump over a fallen log while still in the trap and in the other the attachment cables left enough room for the lynx to reach and twist his snare-wire around a small bush some distance from the kill. In both cases the resulting leverage was sufficient to break the leg. If trapping occurs in areas were there are risks of the animal getting tangled up in small trees or brush, extra care must be taken to anchor the traps tightly, so as to reduce movement and the risk of injuries. This is also pointed out by Mowat et al. (1994).

In 1988 one lynx died in a trapping situation in Verdal after having received 9 injections of ketamine HCl. As the initial dose was too low, the next had reduced effect due to antagonist effect of the raised adrenaline level of the animal´s blood. The proximate reason for the death of this lynx was too much anaesthetic, but the ultimate reason was respiration depression caused by the heavy dose of anaesthetic. A similar situation occured in 1996 in Hedmark when a lynx required three injections to achieve anathesia. Mid-way during the marking procedure this animal momentarily stopped breathing. However, breathing was restored immediatelly and this individual recovered with no signs of ill-effect. The initial problem may have been caused by using too weak a concentration of drug.

The animal darted from a car was released alive after processing. However, the next morning it was found dead. Although autopsy results were inconclusive it is felt that the antidote against *Medetomide*™ was given intravenously before the ketamine HCL portion had worn off to a sufficient degree. This resulted in a rapid return to consciousness in a stressful situation before full locomotion ability was restored. The combination of stress and an reduced thermalregulatory ability (a side-effect of ketamine HCl) was hypothesised to have led to death.

Some lynx had minor oral injuries to tongue and teeth from biting on the traps and some had small wounds as a result of freezing to the trap when biting. To reduce oral injuries we coated all leghold traps with rubber and the Swiss-snares with hard plastic. This was pointed out by Englund (1982) as an effective way of reducing oral injuries at low temperatures. Under 0° C saliva freezes when the lynx bites the metal, and the pain may cause the lynx to chew the trap intensely.

Non target species

Since 1993 we have captured 16 non-target animals: 2 red foxes *Vulpes vulpes*, 13 badgers *Meles meles*, 1 sheep, 3 hares *Lepus timidus*, 3 cats *Felis catus*, 3 dogs *Canis familiaris*, 2 jays *Garrulus glandarius* and 1 magpie *Pica pica*. The foxes, 1 badger and the birds were trapped in leg hold traps or snares, and the rest in box traps. Both foxes were euthanised due to injuries sustained from the leghold traps, although the badger was released unharmed. One of the jays and the magpie were killed in the trap, but the other was in good condition, and was released.

Catching non-target animals was not a major problem with any of the trap types. Chances of capturing non-target animals in leghold traps increased with time after mounting the traps. Foxes are usually very cautious, but feed on animals killed by lynx after some days. To reduce the risk of catching non-target animals, we recommend taking down leghold traps after 2-3 days. Box traps maintain a higher risk of catching non-target animals, but the chances of injuries are low. If the box trap is checked regularly, this should not pose any problem.

DISCUSSION

Box traps

Only 2 lynx in Nord-Trøndelag and 2 in Hedmark were captured in box-traps. In both cases in Nord-Trøndelag urine was used as bait. Based on experience from the test period 1987-88 meat was rejected as bait for lynx in box traps. Meat baits tended to attract non target species, and lynx urine was considered more lynx -specific. Three more lynx were trapped in box-traps in Nord-Trøndelag, but managed to escape. On the first occasion the trap mechanism did not work (probably frozen), the second time only one of the sliding doors fell down, and the third time the lynx managed to break one of the doors.

Box traps maintain low capturing efficiency and are cumbersome to transport, but they require little maintenance and have a low frequency of injuries. Our box traps were made of wood or metal frames and woven wire, and free ranging animals may avoid traps made of unfamiliar materials (Copeland 1995). We can recommend them for use at locations with high lynx activity along a predictable path and where regular maintenance is possible.

Leg hold traps

Trapping with padded leghold traps and snare is laborious. Tracking in search of fresh carcasses of animals killed by lynx is very time consuming, and setting up the traps requires time and skill. Still it seems to the most effective way to live-capture lynx. The main problem with these traps has been a relatively high frequency of injuries, although experience gained should reduce the chances of this from happening again. The method requires good working routines and a veterinarian that can wait at or near the capture site that can immobilise the captured animal within one hour. We had some trap failures with our leghold traps. Most often the cause was a frozen trapping mechanism, traps being packed with snow or grass, or failure due to other animals releasing the trap. Reducing the time the lynx is in a stressful situation to a minimum is important. The adrenaline caused by stress counteracts the anaesthetic. Some lynx try quite hard to free themselves from the trap, and reducing the time spent in the trap will reduce the risk of injuries. One lynx managed to break the snare, and run away with the snare around its leg, but was recaptured within some hours using a helicopter (Table 1). The alarm systems used throughout the Nord-Trøndelag and Hedmark studies have been vital in reducing the time lynx spend in traps and must be regarded as a vital component of the trapping systems.

Our data indicates that lynx return more often to roe-deer kills than to reindeer kills. This can be a result of the reindeer moving in large herds. When in close vicinity of a reindeer herd, the lynx can perhaps find a new prey just as easy as returning to the old one. The age of the roe-deer and reindeer carcasses examined were found to be similar. There are no studies of lynx preferring roe-deer as compared to reindeer (Sunde 1996, Sunde et al.1996). Where a choice exists, roe-deer carcasses are recommended as bait prior to reindeer carcasses.

Immobilisation

In 1994 immobilisation of lynx in both Nord-Trøndelag and Hedmark was based on medetomidine and ketamine administrated at the same time. Initially, the ketamine portion of the combination was quite large, according to previous recommendations in literature (Jalanka 1991, Felleskatalog 1994-95). As the knowledge of immobilisation of lynx was somewhat sparse, this was accepted by both veterinarian and field biologists connected to the project. The medetomidine effect was easily reversed by atipamezol, but the ketamine HCl- effect was not reversed accordingly. As the techniques on immobilisation improved, the ketamine portion of the delivered drug was lowered from one immobilisation to the next. The veterinary opinion today is that the use of ketamine HCl may be unnecessary as long as external fitting of radio- collar is the main issue.

A short anaesthesia is desirable as the risks associated with anaesthesia rise with time. When medetomidine is used as the only anaesthetic, intravenous administration of atipamezol can be used to wake up the animal, although subcutaneous or intramuscular administration is acceptable under winter conditions. Under warm summer conditions, the importance of short anaesthesia is high considering the partial suppression of mechanisms that control body temperature. However, as long as ketamine is used in combination, sufficient time must pass for the ketamine portion to wear off before giving the atipamezol antidote against medetomidine. The main factor that determines a successful capture appears to be the rapid administration of drugs following capture to reduce the stress, and the possibility of injury.

Handling kittens

Immobilising and radio collaring of young kittens may raise special problems. In our case everything went smoothly. But there are some important questions:

1. How will the mother react if the kitten does not respond normally to being anaesthetised?
2. Do the mother and kitten/kittens always manage to locate each other again? In two of three cases the mother stayed in the area (<700 m away) under the whole operation.

In the third case one of two kittens stayed near the immobilisation site after being given the antidote, while the other kitten ran away and was not in contact with the mother for a longer period (<24 hour). This may indicate that stressing situation like live-capturing disrupts and endangers the necessary close relationship between mother and kittens. In Hedmark, the mother returned to her neonate within 6 hours and moved him to the other lair where his siblings were being kept.

3. How does the kitten react in a situation like this, alone and with a lot of people around ? There is reason to believe that this is a very stressing situation and that young animals like lynx kittens may suffer more from this kind of treatment than adult animals. One of the kittens did not respond to the anaesthetics, probably because of high adrenaline level. The neonate kitten behaved very calmly when picked up and placed in a dark bag.

We will recommend that when handling kittens the time spent restrained before immobilisation should be as short as possible, and the kittens kept in the area where they were left by their mother so as to avoid abandonment. This can be done by replacing them in their natal lair, placing them in a tree or somewhere were they can hide. However, it appears that when sufficient precautions are taken it is possible to capture and radio-tag kittens from 6 weeks onwards. Development of techniques that allow research with these younger age classes will certainly improve our understanding of lynx biology.

CONCLUSION

The lynx seem to be a robust animal, that can endure the situation of being captured quite well. But trapping and immobilisation is always a risky operation. And the risk of injuries and harm to the individual in question have to be weighed against the possible benefit for the species in the form of improved knowledge of lynx ecology resulting in better management practices and increased chance of future survival for the species. In view of the present management problems surrounding lynx in Norway the need for better biological data to strengthen the scientific basis of management is enormous. Capturing techniques and immobilisation procedures must be refined continuously as soon as improvements are available. The increased success from 1994 to 1996 can first of all be accounted for by more experience, better field protocols and the use of more suitable drugs with available antidote.

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SAMMENDRAG

Erfaringer med levende-fangst og radiomerking av gaupe *Lynx lynx* i Norge

I perioden 1987-96 har det gjennom tre ulike forskningsprosjekter i Norge blitt fanget og radiomerket gaupe. Fangstmetodene vi benyttet var båser, fotsakser, fotsnarer og kombinasjoner av fotsnarer og fotsakser, driving av dyr opp i trær og forbi gæværposter for immobilisering med bedøvelsesgevær, samt fangst av unger på hi. Dødligheten i forbindelse med fangsten var stor (to av tre dyr) i det første prosjektet i Nord-Trøndelag og Aust-Agder i årene 1987-88. Forbedringer av fangstmetodikken reduserte denne dødeligheten til ett tilfelle av 17 fangssituasjoner (6%) i Nord-Trøndelag i perioden 1994-96, og to tilfeller av 17 fangstsituasjoner (12%) i Hedmark i perioden 1995-96. Erfaringene som ble gjort i forbindelse med disse tilsammen tre siste uhellene burde kunne bidra til ytterligere å redusere dødeligheten ved eventuell framtidig forskningsfangst av arten. Fotsakser og fotsnarer plassert rundt gaupas byttedyr er betydelig mer effektiv som fangstmetode enn bruk av båser, men den første metoden er mer beheftet med risiko for skader på dyr som fanges. Gaupa synes videre å returnere oftere til kadavre av rådyr som den har drept, en kadavre av tamrein. Fangsten var ikke selektiv på kjønn eller kondisjon hos gaupa. Ut fra hensynet til sikkerheten hos fangstobjektet er det spesielt viktig å bruke minst mulig tid fra dyret er gått i fangstinnretning til det immobiliseres. Det bør videre unngås å drive fangst ved spesielt lave temperaturer. Andre arter enn selve fangstobjektet kan skades og forulykke i fotsakser som står aktivisert over lengre perioder.

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