Bioforsk Report
Vol. 4 No. 190 2009

Hair snares applied to detect brown bears in Øvre Anárjohka and Lemmenjoki National Parks

Authors:

Hans Geir Eiken[1], Leif E. Ollila[1], Paul E. Aspholm[1], Tuomo Ollila[2], Mari Bergsvåg[1], Martin E. Smith[1], Alexander Kopatz[3], Sari Magga[2], Pekka Sulkava[2], Jouni Aspi[3] and Ingvild Wartiainen[1].

[1]Bioforsk Soil and Environment, Svanhovd, N-9925 Svanvik, Norway
[2]Metsähallitus, Rovaniemi, Finland
[3]Department of Biology, 90014 University of Oulu, Oulu, Finland

www.bioforsk.no

Cover Photo: Landscape in Øvre Anárjohka National Park, Norway (Photo: Leif Ollila)

Main office
Frederik A. Dahls vei 20,
N-1432 Ås
Tel.: (+47) 40 60 41 00
Fax: (+47) 63 00 92 10
post@bioforsk.no

Bioforsk Soil and Environment
Svanhovd
N-9925 Svanvik
Tlf: + 047 464 13 600
Faks: + 47 78 99 56 00
svanhovd@bioforsk.no

Title *Hair snares applied to detect brown bears in Øvre Anárjohka and Lemmenjoki National Parks*

Authors: Hans Geir Eiken, Leif E. Ollila, Paul E. Aspholm, Tuomo Ollila, Mari Bergsvåg, Martin E. Smith, Alexander Kopatz, Sari Magga, , Pekka Sulkava, Jouni Aspi and Ingvild Wartiainen

Date:	*Availability:*	*Project No.:*	*Archive No.:*
21.12.2009	open	4310090	
Report No.:	*ISBN-no.:*	*Number of pages:*	*Number of appendix:*
4 (190) 2009	978-82-17-00599-5	25	1

Employer:	*Contact person:*
Direktoratet for naturforvaltning og Fylkesmannen i Finnmark, miljøvernavdelingen	Ingvild Wartiainen

Keywords: Brunbjørn; brown bear; Ursus arctos; Hårfeller; Hair snares; DNA; Non-Invasive; Ikke forstyrende	*Field of work: Population monitoring; bestandsovervåkning; Molecular ecology; Molekylær økologi*

Abstract: There is limited knowledge on the brown bear (*Ursus arctos*) populations in the neighboring national parks Lemmenjoki in Finland and Øvre Anárjohka in Norway. Lemmenjoki is the largest National Park in Finland with its 2850 km^2, while Øvre Anárjohka National Park is about 1390 km^2. Studies of the bear population within this area are complicated by the fact that the area is one of the largest roadless and remote areas in Northern Europe. In this study we have applied the hair trap technique to monitor the brown bear populations of Øvre Anárjohka and Lemmenjoki during July and August of 2009.The study was limited to 850 km^2 (34 hair traps in a 5 x 5 km grid, 20 % of the total area of the National Parks). The result was a total of 33 hair samples collected in the study period of 8 weeks (4 renewals of scent lure), which is on average 0.5 hair samples per trap/month. DNA from bears was detected in 28 of the samples (85%). We were able to analyze a complete genetic profile for 23 samples. Nine samples from the terrain were also included in the study, and in total we have identified 6 different bears within the study area. The average brown bear density for the study area was found to be 0.07 bears/10 km^2, which is 3 times lower than in the neighboring population in Pasvik-Inari-Pechenga. The three bears identified at the Norwegian side of the border (two females and one male) had been previously detected in Øvre Anárjohka in Norway during 2005-2008, while the three males that were solely on the Finnish side had not been registered before. Comparison with previous monitoring data in Norway confirm that Øvre Anárjohka in Norway might be a low-density reproduction site for brown bears, while the study area in Lemmenjoki in Finland is sparsely populated by a few males. We recommend that a larger study should be performed in the area.

Sammendrag: Det foreligger begrenset kunnskap om bestanden av brunbjørn (*Ursus arctos*) i nabo nasjonalparkene Lemmenjoki i Finland og Øvre Anárjohka i Norge. Lemmenjoki er den største nasjonalparken i Finland med et areal på 2850 km^2, mens Øvre Anárjohka Nasjonalpark er på omkring 1390 km^2. Studier av bjørnebestanden i området er vanskelig da dette området er et av de største veiløse og avsidesliggende områder i nord Europa. I denne studien har vi brukt hårfelle metoden for å overvåke brunbjørn bestanden i Øvre Anárjohka og Lemmenjoki i juli og august i 2009. Studien er begrenset til 850 km^2 (34 hårfeller i et 5 x 5 km rutenett, 20 % av det totale arealet i nasjonalparkene). Resultatet var 33 innsamlede hårprøver i løpet av studieperioden på 8 uker(4 fornyinger av luktstoffet i fellene), noe som i gjennomsnitt utgjør 0,5 hårprøver per felle/måned. DNA fra bjørn ble påvist i 28 av prøvene (85%). Vi kunne analysere en komplett genetisk profil for 23 prøver. Ni prøver som var samlet i terrenget ble også inkludert i studien, og totalt ble det identifisert 6 ulike bjørner innenfor studieområdet. Den gjennomsnittlige bjørnetettheten ble funnet å være på 0,07 bjørner/10 km^2, noe som er 3 ganger lavere enn nabo populasjonen i Pasvik-Enare-Pechenga. De tre bjørnene som ble påvist på den norske siden av grensa (to hunner og en hann) hadde tidligere blitt påvist i Øvre Anárjohka i Norge i perioden 2005-2008, mens de tre hannbjørnene som kun ble påvist på finsk side hadde ikke blitt påvist tidligere. Sammenligninger med tidligere overvåkningsdata i Norge bekrefter at Øvre Anárjohka i Norge kan være et yngleområde med lav tetthet av individer, mens studieområdet i Lemmenjoki i Finland har en liten bestand med noen få hannbjørner. Vi vil foreslå at det blir gjennomført en større studie i området.

Land/Country:	Norge/Norway and Finland/Finland
Fylke/County:	Finnmark (NO) and Lappland (FI)
Kommune/Municipality:	Kautokeino (NO) and Inari (FI)
Sted/Lokalitet: Øvre Anárjohka (NO) and Lemmenjoki (FI) National Parks	

Godkjent / Approved

Ingvild Wartiainen

Prosjektleder / Project leader

Hans Geir Eiken and Paul E. Aspholm

1. Table of Contents

2. Abstract

There is limited knowledge on the brown bear (*Ursus arctos*) populations in the neighboring national parks Lemmenjoki in Finland and Øvre Anárjohka in Norway. Lemmenjoki is the largest National Park in Finland with its 2850 km^2, while Øvre Anárjohka National Park is about 1390 km^2. Studies of the bear population within this area are complicated by the fact that the area is one of the largest roadless and remote areas in Northern Europe. In this study we have applied the hair trap technique to monitor the brown bear populations of Øvre Anárjohka and Lemmenjoki during July and August of 2009.The study was limited to 850 km^2 (34 hair traps in a 5 x 5 km grid, 20 % of the total area of the National Parks). The result was a total of 33 hair samples collected in the study period of 8 weeks (4 renewals of scent lure), which is on average 0.5 hair samples per trap/month. DNA from bears was detected in 28 of the samples (85%). We were able to analyze a complete genetic profile for 23 samples. Nine samples from the terrain were also included in the study, and in total we have identified 6 different bears within the study area. The average brown bear density for the study area was found to be 0.07 bears/10 km^2, which is 3 times lower than in the neighboring population in Pasvik-Inari-Pechenga. The three bears identified at the Norwegian side of the border (two females and one male) had been previously detected in Øvre Anárjohka in Norway during 2005-2008, while the three males that were solely on the Finnish side had not been registered before. Comparison with previous monitoring data in Norway confirm that Øvre Anárjohka in Norway might be a low-density reproduction site for brown bears, while the study area in Lemmenjoki in Finland is sparsely populated by a few males. We recommend that a larger study should be performed in the area.

3. Introduction

There is limited knowledge on the brown bear (*Ursus arctos*) populations in the neighboring national parks Lemmenjoki in Finland and Øvre Anárjohka in Norway. Lemmenjoki is the largest National Park in Finland (2850 km^2), while Øvre Anárjohka National Park is about 1390 km^2. Studies of the bear population within this area are complicated by the fact that the area is one of the largest roadless and remote areas in Northern Europe.

Improved methods for use in monitoring wild animal populations are constantly being developed, and non-invasive sampling of scats and hairs for DNA –analysis has proved to be one of the most efficient approaches (Thompson 2004, Waits & Paetkau 2005). "Hair snaring" is a non-invasive genetic method used in several studies of bears that live in large wilderness areas (Woods et al. 1999; Mowat & Strobeck 2000; Romain-Bondi et al. 2004, Kendall 1999, Kendall et al. 2005, 2008a, 2008b). These studies have documented very good results from hair snares and the subsequent DNA analysis on the hairs. In 2006, Bioforsk Svanhovd took a study trip to the USA and Canada to further study these techniques. Hair snares are a length of barbed-wire stretched ca. 40 cm from the ground among several trees encircling a strong smelling scent-lure. Bears are attracted to the scent-lure, and when they investigate the source they must climb over or under the barbed wire. The result is that the bears will leave some hair on the wire. The bear's thick hide will not be damaged by the barbed wire. In 1998 and 2000 Kate Kendall and her coworkers at the US Geological Survey used a combination of hair snares in a grid of 8 km x 8 km squares, together with hair collected from naturally occurring rub-trees to estimate the density of bears in Glacier National Park, Montana, USA (Kendall et al. 2008a). The population in their 7,933 km^2 study area was estimated at 240 individuals (0.3 bears/ 10 km^2). In 2004 this project was expanded to encompass an area of 31,410 km^2 (Kendall et al 2008b). Using 7 km x 7 km grids they collected 33,741 hair samples from 2558 hair snares. In addition they also collected hair from known rub trees located throughout the area on a regular schedule. Altogether, the project identified 563 brown bears and over 2000 black bears. In 2007, we used hair snaring to monitor brown bears in the Pasvik-Inari-Pechenga area with cooperation from managers and researchers from Norway, Finland and Russia. We placed 56 hair snares within a 5 km x 5 km grid encompassing a 1275 km^2 study area crossing country boarders. We collected 196 hair samples from the three countries and DNA analysis identified 24 different brown bears (Smith et al. 2007). Comparisons between scat collection in the terrain and systematic hair snaring indicate high sensitivity for both methods (Wartiainen et al. 2008). We have further applied hair traps in the Pasvik Valley to precisely quantify the movements of individual brown bears near settlements and compare these with brown bear movements in a more remote control area (Smith et al. 2008). This experiment used 20 traps in a finely-meshed collection grid (2.5 km x 2.5 km squares), and detected 13 different individuals. We observed most bear activity in the remote location with 63 samples from at least 10 bears in 8 of 10 trap sites while the near-human location showed less, but still substantial activity (23 samples from 5 individual bears at 4 of 10 trap sites).

In this study we have applied the hair trap technique to monitor the brown bear populations of Øvre Anárjohka/Lemmenjoki during July and August of 2009. The study

is limited by the fact that the total study area encompasses only 20 % of the total area covered by the two national parks.

4. Materials and Methods

4.1. Permissions

Permission for this experiment was obtained from the National Animal Research Authority (Forsøksdyrutvalget), The Finnmark County Governor (Fylkesmannen i Finnmark), and Finnmarkseiendommen (FeFo, public land administrators). The Norwegian Nature Inspectorate (SNO) in Norway and Metsähallitus in Finland was informed of the hair snare locations and ongoing results.

4.1. Study Area

The study area was located in the border areas between the neighboring national parks Lemmenjoki in Finland and Øvre Anárjohka in Norway at approximately 68.9^{o} North and 25.5^{o} East (Figure 1). The study area was divided equally between the adjacent areas in Øvre Anárjohka (Norway) and Lemmenjoki National Park (Finland), each with 17 grids of 5 km x 5 km. The total area of the 34 grids encompassed 850 km^2 (Figure 1). The study area includes both arctic and northern boreal ecosystems with forests, mountains, hills, lakes, rivers and large mire areas. The north boreal forest type is characterized by large areas of birch (*Betula pubescens*) and pine (*Pinus spp.).*

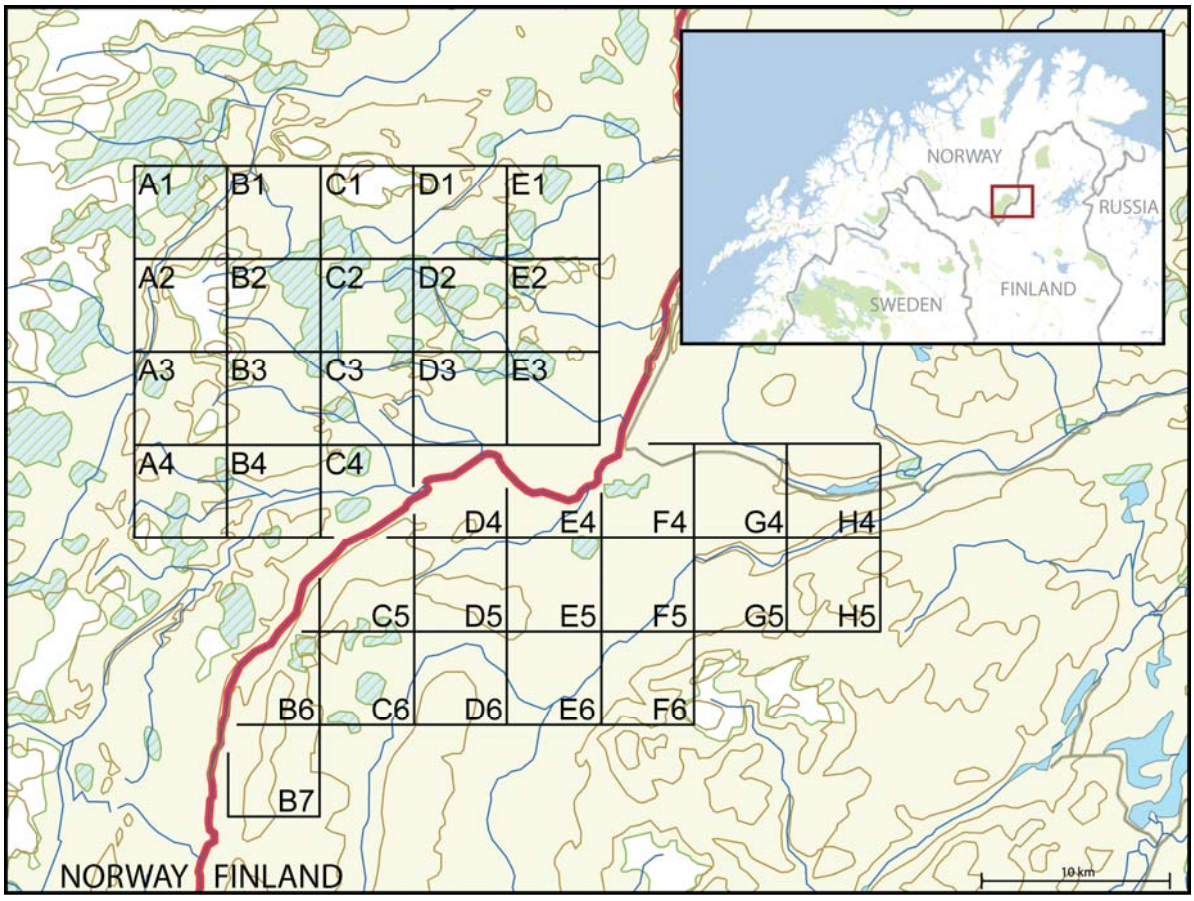

Figure 1. Study area in national parks Lemmenjoki in Finland and Øvre Anárjohka in Norway. The study area consisted of 34 squares a 5 km x 5 km with one hairtrap in each. Each hairtrap was moved to a second location within the same square half-way through the collection period. The squares in the grid are marked from A1 in the northwest to H5 in the southeast.

4.2. Collection method for hairs

Each hair snare was made of approximately 30 m of barbed wire that was spent around several trees (no nails or staples) approximately 40 cm above the ground, with the scent lure in the center (Figure 3&4). Our hair trap method was modified and adjusted to our project after the protocol first described by Kendal et al. 2008a. Each hair snare was inspected for hairs every second week (Figure 2 and 9) and the scent-lure was renewed with an additional 1.5 liters of lure added to the center of each trap. A collection period was 2 weeks (total of 4 collection periods). The scent-lure was made of ground fish waste, mostly heads, which was mixed with cattle blood in about equal volumes of each section. The mixture was allowed to ferment for several months until the mixture was liquefied. Then it was stored in airtight containers until used. It was important that the scent-lure was in the thin liquid form, so that the bears were attracted without getting any type of food reward. The total collection period for the hair traps was 2 months (July and August).

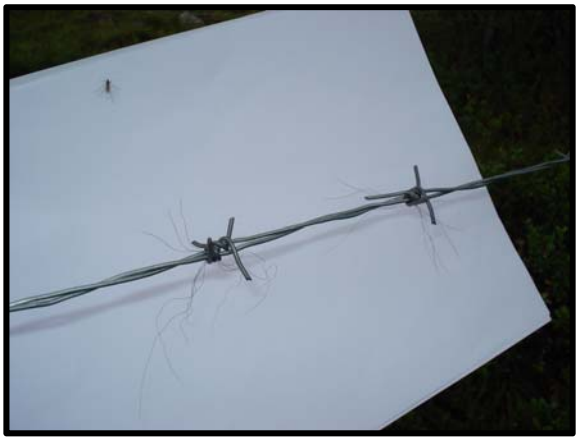

Figure 2. Barbed wire from a hair snare with snagged hairs. Using a white sheet of paper it was easy to see also a few hairs. Photo: Hans Geir Eiken

4.3. DNA-extraction

DNA was extracted from the hair samples using reagents from Qiagen (Dneasy Tissue kit, www.qiagen.com). The root tip from 5 – 10 hairs were cut and transferred to a 1.5 ml test tube together with a lysis-buffer (180 µl ATL buffer and 20 µl Proteinase K) and incubated for one hour at 55^{O} C. Extraction of DNA then follows the procedure described by the manufacturer. We also used the same techniques to analyze samples composed of fewer than 5 hairs. When the hair samples obtained were very small or matted together the extraction was conducted on 0.3 to 0.5 cm wide section of the matted hair or the entire hair straw. DNA was eluted in 100 µl of buffer solution. In some cases, when only a few or even a single hair was available in the sample then the volume of elution buffer was reduced to 30 µl (1 to 2 hair) or 50 µl (3 – 4 hairs). DNA extraction from scats were as previously described (Wartiainen et al. 2009)

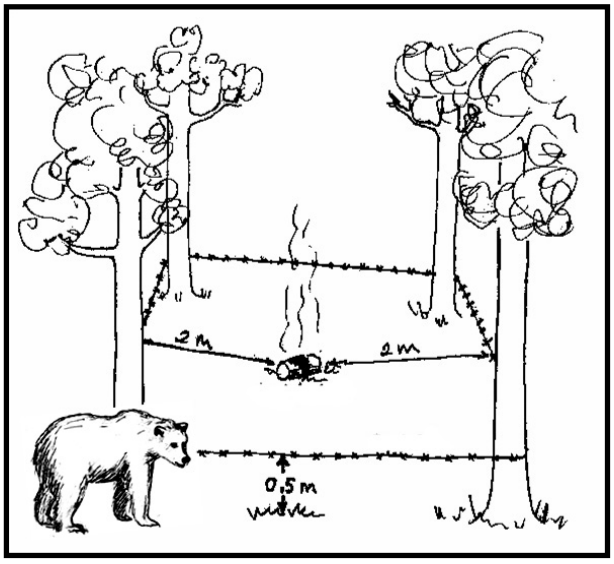

Figure 3. Sketch of a typical hair snare with scent lure in the center ringed by a single barbed wire strung between trees at 40-50 cm from the ground. Drawing by Leif Ollila

4.4. Analysis of DNA profile and gender

Genetic analysis of micro-satellites on the brown bear followed a modified protocol from Taberlet et al. (1997). We have used eight different genetic markers, Mu05, Mu09, G10L, Mu10, Mu23, Mu50, Mu51 and Mu59, to construct DNA profiles (see Eiken et al. 2009). Sex determination was based on the X-and Y-specific DNA sequences of the amelogenin gene (Yamamoto et al. 2002). The PCR protocol, capillary electrophoresis and the determination of DNA profiles and comparisons with DNA profiles in Svanhovd Genetic database have been previously described (Wartiainen et al. 2009, Eiken et al. 2009).

5. Results

5.1. Collection of hairs from brown bears in hairtraps

The 34 hair snares were placed in the study areas early in July and taken down late in August (sampling time ~8 weeks) (Figure 4). Hairs were collected every second week for a total of 4 inspections. The overall result from both areas was 33 hair samples from 14 different hair snares (out of 34 traps). In Øvre Anárjohka, Norway, 18 samples were collected from 5 different traps/squares (Table 1), while in Lemmenjoki, Finland, 15 samples were collected from 9 different traps/squares (Table 2). On average, the hair traps collected approximately 0.5 hair samples per trap/month.

Figure 4. A hair snare for brown bears in Øvre Anárjohka, Norway. (Photo: Leif Ollila)

5.2 Other samples from the study area in 2009

A total of 9 additional biological samples (1 hair sample and 8 scats) were collected in the terrain within the study area during the study period (see Appendix 1). Out of these 9 samples, 5 were from the Norwegian side of the border, while the 4 remaining samples were from Finish side.

Table 1. Results from inspections of 17 hair snare locations within Øvre Anárjohka National Park in Norway. Snares were relocated within each 5 x 5 km squares in the grid after the second inspection. The total number of collected hair samples was 18.

Trap nr.	Set-up date	First check	No. hairs	Second check	No. hairs	Third check	No. hairs	Fourth check	No. hairs
1: A-1	1 July	18 July	0	1 Aug	0	14 Aug	0	27 Aug	0
2: A-2	2 July	15 July	0	30 July	0	13 Aug	0	25 Aug	0
3: A-3	2 July	15 July	0	30 July	6	13 Aug	1	25 Aug	0
4: B-1	1 July	18 July	0	1 Aug	0	14 Aug	0	27 Aug	0
5: B-2	2 July	15 July	0	31 July	0	13 Aug	0	25 Aug	0
6: B-3	2 July	15 July	0	30 July	0	13 Aug	0	25 Aug	0
7: B-4	5 July	15 July	0	30 July	1	12 Aug	0	25 Aug	0
8: C-1	1 July	18 July	0	29 July	1	11 Aug	0	27 Aug	0
9: C-2	2 July	17 July	0	29 July	0	11 Aug	0	26 Aug	0
10: C-3	2 July	16 July	0	29 July	0	11 Aug	0	26 Aug	0
11: C-4	5 July	15 July	0	30 July	5	12 Aug	0	25 Aug	0
12: D-1	4 July	17 July	0	29 July	0	11 Aug	0	27 Aug	0
13: D-2	2 July	16 July	0	31 July	0	13 Aug	0	26 Aug	0
14: D-3	------	16 July	---	30 July	0	12 Aug	0	26 Aug	0
15: E-1	4 July	16 July	0	29 July	0	11 Aug	0	26 Aug	0
16: E-2	5 July	16 July	0	30 July	0	12 Aug	0	26 Aug	0
17: E-3	5 July	16 July	0	30 July	0	12 Aug	4	26 Aug	0
TOT.			0		13		5		0

Table 2. Results from inspections of 17 hair snare locations within Lemmenjoki National Park in Finland. Snares were relocated within each 5 x 5 km squares in the grid after the second inspection. The total number of collected hair samples was 15.

Trap nr.	Set-up date	First check	No. hairs	Second check	No. hairs	Third check	No. hairs	Fourth check	No. hairs
18: B-6	30 June	15 July	0	5 Aug	2	18 Aug	0	1 Sept	0
19: B-7	30 June	16 July	0	5 Aug	0	18 Aug	3	1 Sept	0
20: C-5	30 June	15 July	0	4 Aug	0	17 Aug	0	31 Aug	1
21: C-6	30 June	16 July	0	5 Aug	2	18 Aug	0	1 Sept	0
22: D-4	30 June	15 July	0	4 Aug	0	17 Aug	0	31 Aug	0
23: D-5	30 June	15 July	0	4 Aug	0	17 Aug	0	31 Aug	0
24: D-6	1 July	16 July	0	5 Aug	0	18 Aug	1	1 Sept	0
25: E-4	30 June	15 July	0	4 Aug	0	17 Aug	0	31 Aug	0
26: E-5	1 July	17 July	0	6 Aug	0	19 Aug	0	31 Aug	0
27: E-6	1 July	16 July	0	5 Aug	0	19 Aug	0	31 Aug	0
28: F-4	1 July	17 July	0	6 Aug	0	19 Aug	0	31 Aug	1
29: F-5	1 July	17 July	1	6 Aug	2	19 Aug	0	31 Aug	0
30: F-6	1 July	17 July	1	5 Aug	0	19 Aug	0	31 Aug	0
31: G-4	2 July	19 July	0	7 Aug	0	19 Aug	0	4 Sept	1
32: G-5	2 July	19 July	0	7 Aug	0	20 Aug	0	4 Sept	0
33: H-4	2 July	19 July	0	7 Aug	0	20 Aug	0	4 Sept	0
34: H-5	2 July	19 July	0	7 Aug	0	20 Aug	0	4 Sept	0
TOT.			2		6		4		3

.

5.3. DNA analysis, sex determination and genetic profiles

Of the 33 samples, we detected brown bear DNA in 28 samples (85 %). We were able to analyze a complete genetic profile for 23 of the samples, which gave a success rate of 70 % for the total number of collected samples and 82 % success for DNA-positive samples. Analysis of the genetic profiles identified 5 different individual bears (FI56, FI60, FI88, LL31 and LL32) with 2 females and 3 males (Table 3 and figures 5 & 6). The three bears on the Norwegian side of the border (FI60, FI56/LL33 and FI88) had been previously identified in Øvre Anárjohka in Norway during 2005-2008, while the two males that were solely on the Finnish side (LL31 and LL32) had not been registered before. Appendix 1 shows all the tests and DNA analysis results.

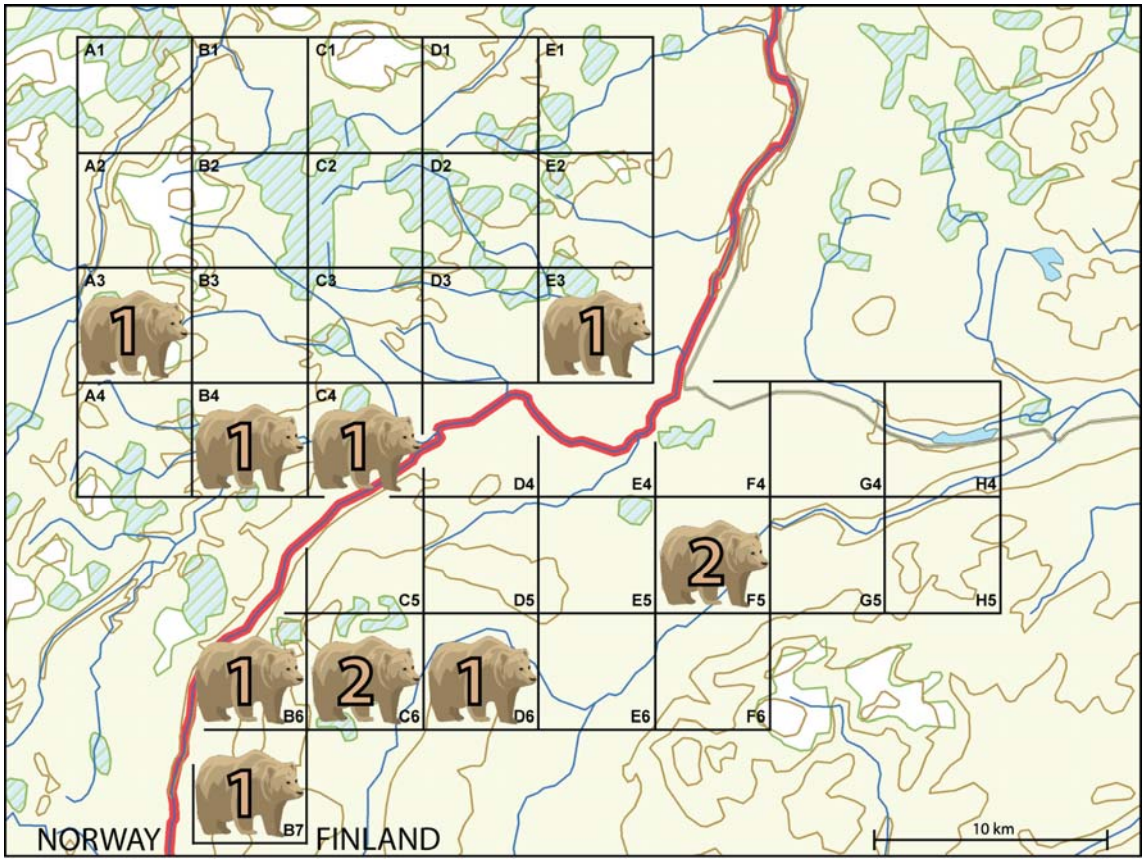

Figure 5. Number of different brown bears identified at each hair trap location in Lemmenjoki in and Øvre Anárjohka National Parks. The figure includes only individuals that have been identified by a full DNA-profile. The 34 squeres were 5 km x 5 km in size with one hairtrap in each. The sampling period was approx. 8 weeks, and the trap was relocated to a second position within the same square in the grid after 4 weeks.

Among the samples collected opportunistically in the terrain, 5 of the 8 scats were positive for brown bear DNA, and all of them gave a full DNA profile (see Appendix1), and these samples represent two different bears (FI88 and LL34). The single hair sample from Siikapalo in Lemmenjoki also gave a full DNA profile (LL31). This additional sampling in the terrain identified one bear that had not been sampled in the hairtraps (LL34), while the two other bears had also been registered in the hairtraps. In total, 6 different bears were identified from 42 non-invasive samples (hairs and scats).

Table 3. Identity, gender and genetic profile (8 markers) for the 6 different brown bears documented during the hair snare project in Øvre Anárjohka-Lemmenjoki 2009. M = Males, F = Females

ID	*Gender*	*MU05*	*MU09*	*G10L*	*MU10*	*MU23*	*MU50*	*MU51*	*MU59*	*Previous registration*
FI88	*F*	*114 / 122*	*110 / 116*	*180 / 180*	*150 / 150*	*172 / 172*	*105 / 125*	*139 / 145*	*236 / 252*	*2008*
FI60	*F*	*120 / 122*	*96 / 110*	*180 / 180*	*138 / 150*	*169 / 172*	*105 / 125*	*139 / 145*	*250 / 252*	*2005, 2006, 2008*
FI56/ LL33	*M*	*114 / 126*	*112 / 116*	*180 / 182*	*150 / 150*	*170 / 172*	*105 / 105*	*139 / 139*	*236 / 242*	*2005*
LL34	*M*	*126 / 126*	*110 / 122*	*190 / 190*	*140 / 144*	*170 / 172*	*119 / 123*	*145 / 147*	*228 / 232*	
LL31	*M*	*114 / 124*	*108 / 114*	*180 / 180*	*132 / 132*	*170 / 170*	*105 / 123*	*139 / 143*	*244 / 250*	
LL32	*M*	*116 / 122*	*96 / 118*	*176 / 180*	*142 / 144*	*168 / 170*	*119 / 123*	*137 / 137*	*250 / 250*	

5.3. Distribution of samples from the 6 individuals

Samples from the two female bears (FI88 and FI160) were both found within a small area south in the Øvre Anárjohka National Park in Norway (Figure 6). The four different male bears were all found in the adjacent areas in the Lemmenjoki National Park in Finland. Only the male FI56/LL33 was registered on both side of the border.

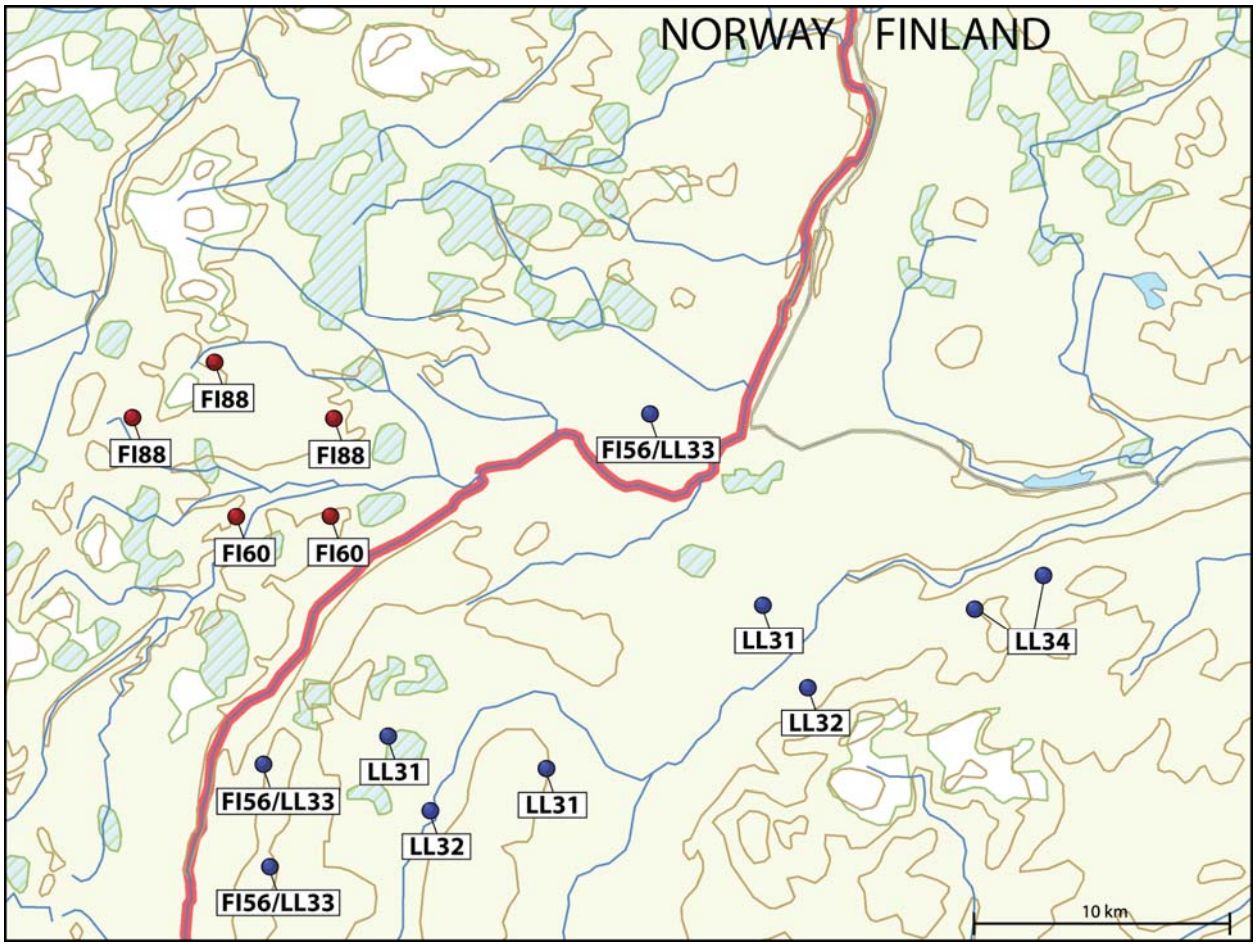

Figure 6. Geographical location of samples from the 6 different brown bears that were identified in the study area in Øvre Anárjohka and Lemmenjoki in 2009. Red dots are females and blue dots are males. The number on the bears together with the prefix "FI" or "LL" gives the bears a unique ID number in the Svanhovd genetic database.

The average brown bear density for the study area (850 km^2) based on our results was 0.07 bears/10 km^2.

6. Discussion

We have identified six different brown bears in a study area of 850 km^2 in the southern end of Øvre Anárjohka National Park (1390 km^2) and in the northern end of Lemmenjoki National Park (2850km^2) in 2009. Based on these results we have estimated the brown bear density to be approximately 0.07 bears/10 km^2. We have no basis to extrapolate this density estimate beyond the limited study area.

6.1. Hair collection and DNA analysis

The hair traps used in this project collected less samples in average (0.5 samples/trap/month) relative to the very similar study the Pasvik-Inari-Pechenga area in 2007 (1.75 samples/trap/month, see Smith et al. 2007 and 2008). In the 2008 hair trap project in Pasvik in Norway a more dense grid was applied in addition to more frequent renewal of the scent lure. In this project we experienced a very high efficiency of 4.25 hair samples per trap/month. All these three projects have been performed using an identical approach. Field personnel and project management have been overlapping to a high degree between the three different projects and years. We believe therefore that the differences in sampling success are mainly a result of differences in brown bear density within the study areas. Temperature and humidity may influence DNA quality in preparations from brown bear hairs and the resulting possibility to identify bears (Murphy et al. 2007). Thus, it is possible that temperature, rain and other weather conditions may influence the result of a sampling round in the traps. However, the influence of weather conditions will be random in all hair trap projects, and we believe that the influence on the final result will be limited in seasons with normal weather. However, to avoid this minor uncertainty, it is possible that future comparisons between different hair trap projects should also considerer sample quality and weather conditions.

In the much larger project in Glacier National Park in Montana in the United States in 1998 and 2000 that has been the model for our project, Kate Kendall and colleagues (Kendall et al. 2008a) found 0.3 – 1 hair samples from brown bears per trap / month. This result is from a large area with a substantial number of brown bears, but with a less dense grid (7 km x 7 km squares). It is difficult to compare with similar projects in other countries and on other continents due to different combinations and density of species, different vegetation, topography, habitat conditions, etc, but also this comparison indicate that our results reflect a low density of brown bears in Øvre Anárjohka/Lemmenjoki.

Bear DNA was found in 28 of 33 samples (85%), which is as expected from previous studies and a good result. The finding of bear DNA in 6 of 8 scats collected in the terrain is also as expected. We have previously documented that sampling of males and females occurs very equal using hair traps (Wartiainen et al. 2008, Smith et al. 2008), and the sampling of 3 males and 2 females in this project does not represent any contradiction to this experience.

6.2. Genetic profiles, detection of individuals and bear density

Based on the hair trap result alone it seems that there is a very restricted female area with two different individuals (FI60 and FI88) on the Norwegian side of the border, while the Finnish study area might be a region with a sparse male population (4 different individuals). This is the first systematic monitoring of bears in this area and

we can only document a density of 0.07 bears/10 km^2. If this is correct, the density is at least 3 times lower than the density of bears in the neighboring population in Pasvik-Inari-Pechenga. No firm conclusions should be made about the whole area from this very limited study. The study area encompasses only about 20% of the total area of the two National Parks. However, if this density also relates to the whole area, a total population of about 30 bears should be expected. The results should no doubt be tested in projects that cover larger parts of the potential area for bears, preferably collected throughout the entire season. The observed bear density is also very low compared to other large, remote and roadless areas in other countries (Kamchatka Russia: 0.81-1.30/10 km^2 (Revenko 2004); Glacier National Park, Montana, USA: 0.3/10 km^2 (Kendall et al. 2008a); and approximately 0.3/10 km^2 for mid-Sweden (Solberg et al. 2006)).

6.3. Comparison with monitoring in Øvre Anárjohka in Norway 2005-2008

We have compiled the monitoring data from 2005-2008 for Øvre Anárjohka and adjacent areas in Norway (Svanhovd Genetic Database, Eiken et al. 2007, Wartiainen et al. 2009), and the sampling from 12 different individuals is illustrated in figure 7.

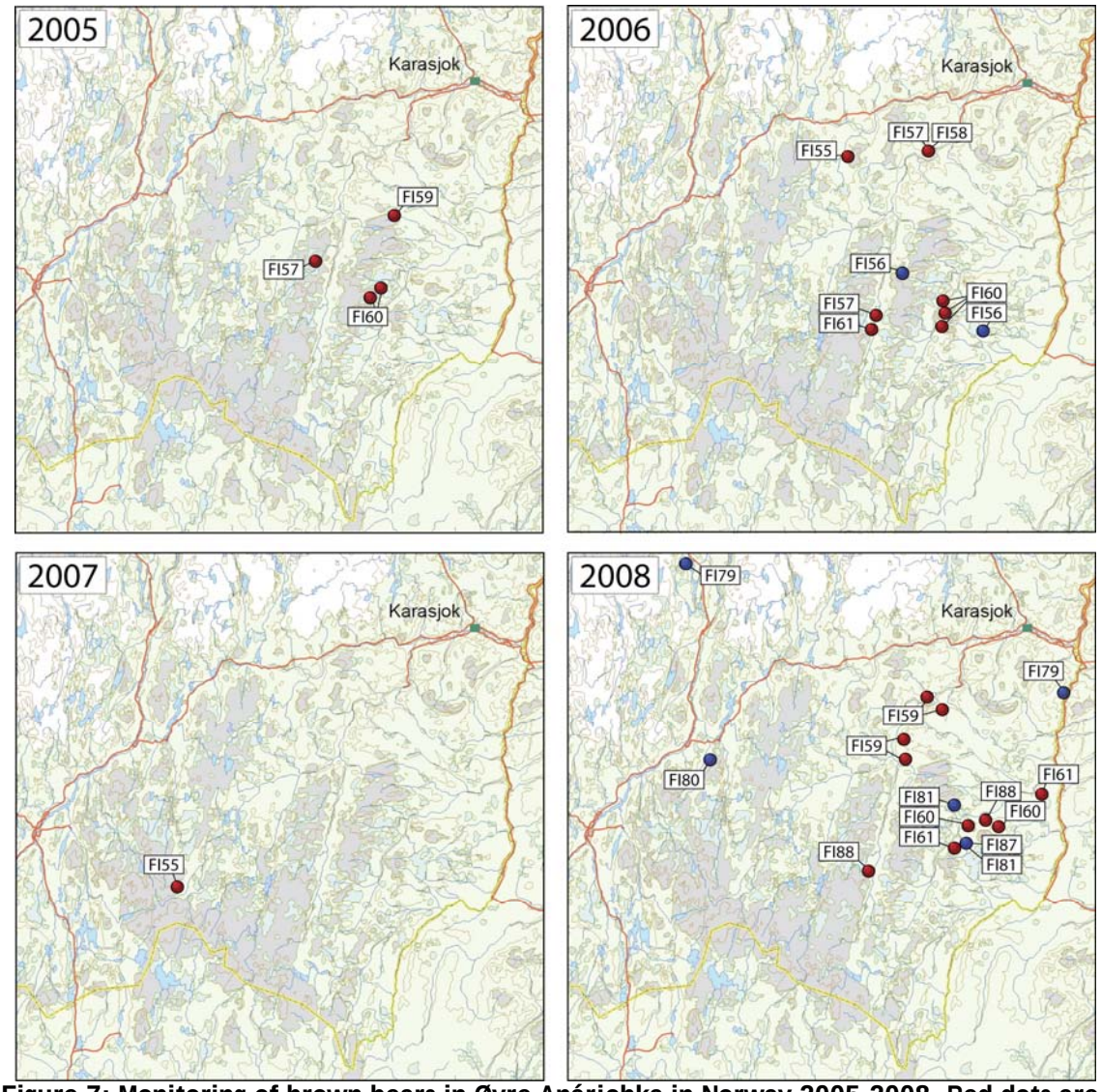

Figure 7: Monitoring of brown bears in Øvre Anárjohka in Norway 2005-2008. Red dots are females and blue dots are males.

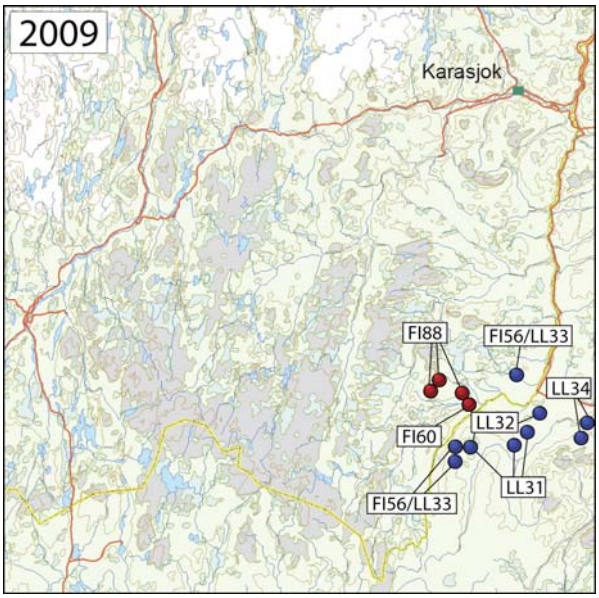

Figure 8. Summary of monitoring of brown bears by hair traps in Øvre Anárjohka and Lemmenjoki in 2009 (se also figure 6 for a map with higher resolution). Red dots are females and blue dots are males.

These previous results from Norway 2005-2008 were compared to the present results (Figure 8). The female FI60 have been found located close to the study area since 2005, and the female FI88 was found in the same area in 2008. The male FI56/LL33 (both in Norway and Finland) had been registered in the area in 2006. Thus, it could be expected that these individuals were sampled in the hair traps in 2009. In addition, the monitoring 2005-2008 has detected 9 other individuals (5 females and 4 males) in scats from a much larger area in Øvre Anárjohka National Park and adjacent areas in Norway. At least 4 of these 5 females are quite far away from the study area, and might not be expected to be sampled in our study area of 2009.

We can confirm a small population of females in Øvre Anárjohka, Norway, but also the data from Norway 2005-2008 indicate a low density of brow bears in a larger area of the park. In the Finnish part of the study there were not detected any females, and we do not have any other documentation indicating any reproduction in the area.

7. Concluding Remarks

We have monitored brown bear activity using hair traps in an 850 km^2 area in the border zone between Øvre Anárjohka in Norway and Lemmenjoki in Finland. The area represents only 20 % of the total protected area of the National Parks. We detected 6 different individuals and we have also compared the data with previous data from Norway (12 individuals: 2005-2008). The study area and the number of traps are very limited in the project, but we can sum up the following:

- The hair snares sampled approximately 0.5 hair samples per/month, which is more than 3 times lower than in a similar trial in Pasvik-Inari-Pechenga in 2007.
- The proportion of successful hair samples in the DNA analysis was at a high level (85 %).
- Bear densities was found to be 0.07 bear / 10 km^2, which is also 3 times lower than densities found for the neighboring Pasvik-Inari-Pechenga- population of bears.
- Comparisons with previous monitoring data in Norway confirm that Øvre Anárjohka in Norway might be a reproduction site for brown bears, but the population might be very limited and exists at a low density.
- The study area in Lemmenjoki in Finland is sparsely populated by a few males.
- A larger hair trap study should be performed for both Øvre Anárjohka and Lemmenjoki. A future study should include the majority of potential brown bear areas to achieve more reliable results for the whole area than this limited trial presented here.

Figure 9. Bear hair captured in a hair snare. (Photo: Hans Geir Eiken)

8. Acknowledgements

We thank Oddleif Nordsletta and Magne Asheim for useful advice and field logistic assistance. We also thank all the field- and laboratory workers that have participated in the project. The project was funded by

- Finnmark County Governors Office, Environmental Department
- Region 8 Citizens Advisory Council for Predator Management in Norway
- Metsähalillitus, Finland

9. Referances

Eiken H.G., Andreassen R.J., Kopatz A., Bjervamoen S.G., Wartiainen I., Tobiassen C., Knappskog P.M., Aspholm P.E., Smith M.E., and Aspi, J. 2009. Population data for 12 STR loci in Northern European brown bear (*Ursus arctos*) and application of DNA profiles for forensic casework. Forensic Sci. Int. Gene. Suppl. Series 2:273-274.

Kendall, K. C. 1999. Sampling grizzlies with noninvasive techniques. "*National Park Service Natural Resource Year in Review: 1998*.", pp 20-22.

Kendall, K. C. 2005. Northern Divide Grizzly Bear Project, Northern Rocky Mountain Science Center Webpage: http://www.nrmsc.usgs.gov/research/NCDEbeardna.htm .

Kendall, K. C., J. B. Stetz, D. A. Roon, L. P. Waits, J. B. Boulanger and Paetkau D. 2008a. Grizzly Bear Density in Glacier National Park, Montana. Journal of Wildlife Management 72:1693–1705.

Kendall, K. C., Stetz J. B., Boulanger J., Macleod A., Paetkau D. and Whithe G.C. 2008b. Demography and genetic structure of a recovering grizzly bear population. Journal of Wildlife Management 73:3-17.

Murphy M. A., K. C. Kendall, A. Robinson and Waits L.P.. 2007. The impact of time and field conditions on brown bear (Ursus arctos) faecal DNA amplification. Conservation Genetics 8:1219–1224.

Mowat, G., and Strobeck C. 2000. Estimating population size of grizzly bears using hair capture, DNA profiling, and mark–recapture analysis. Journal of Wildlife Management 64:183–193.

Revenko, I. A. 1998. Status of Brown Bears in Kamchatka, Russian Far East. Ursus 10:11-16.

Romain-Bondi, K. A., R. B. Wielgus, L. Waits, W. F. Kasworm, M. Austin and Wakkinen W. 2004. Density and population size estimates for North Cascade grizzly bears using DNA hair-sampling techniques. Biological Conservation 117: 417-428.

Smith M. E., Ollila L., Bjervamoen S. G., Eiken H. G., Aspholm P. E., Kopatz A., Aspi J., Kyykkä T., Ollila T., Sulkava P., Makarova O., Polikarpova N., og I. Kojola. 2007. Monitoring of the Pasvik Pasvik-Inari brown bear population using hair snares. In the Interreg-report: "DEVELOPMENT OF MONITORING AND RESEARCH OF BROWN BEAR POPULATION IN NORTH CALOTTE AREA." Bioforsk Svanhovd, pp1-9, see www.barentswatch.com

Smith M.E., Eiken H.G., Ollila L.E., Tobiassen C., Bjervamoen S.G., Aspholm P.E. and Wartiainen I. 2008. Hair snairs applied to detect brown bears in the vicinity of farms in the Pasvik Valley 2008. Bioforsk Report 3:169, pp 1-22.

Solberg K. H., E. Bellemain, O.-M. Drageset, P. Taberlet P. and Swenson J.E. 2006. An evaluation of field and non-invasive genetic methods to estimate brown bear (*Ursus arctos*) population size. Biological Conservation128:158-168.

Thompson, W. L., editor. 2004. "Sampling Rare or Elusive Species." Island Press, Washington D.C. 429 pages.

Taberlet, P., J. –J. Camerra, S. Griffin, E. Uhres, O. Hanotte, L.P. Waits, C. Dubois-Paganon, T. Burke and Bouvet J. 1997. Noninvasive genetic tracking of the endangered Pyrenean brown bear population. Molecular Biology 6:869-876.

Wartiainen, I., C. Tobiassen, S. G. Bjervamoen, M. E. Smith, S. Wikan og Eiken H.G. 2008. DNA analyse av sporprøver fra brunbjørn, Øst-Finnmark 2007. Bioforsk Rapport 3;127, pp 1-28.

Wartiainen, I., Tobiassen C., Brøseth H., Bjervamoen, S.G. og Eiken, H.G. 2009. Populasjonsovervåkning av brunbjørn 2005-2008: DNA analyse av prøver samlet i Norge i 2008. Bioforsk Rapport 4:58, pp 1-34.

Waits L. and Paetkau D. 2005. Noninvasive genetic sampling tools for wildlife biologists: A review of applications and recommendations for accurate data collection. J Wildlife Management 69:1419–1433.

Woods, J. G., D. Paetkau, D. Lewis, B. N. McLellan, M. Proctor, and Strobeck, C. 1999. Genetic tagging of free-ranging black and brown bears. Wildlife Society Bulletin 27:616–627.

Yamamoto K., T. Tsubota, T. Komatsu, A. Katayama, T. Murase, I. Kita and Kudo, T. 2002. Sex identification of Japanese black bear, Ursus thiabetanus japonicus, by PCR based on amelogenin gene. The Journal of Veterinary Medical Science 64:505-508.

10. Appendix 1. Complete genetic profiles of all samples that were positive for brown bear DNA collected during the hair snare project 2009.

A1-H5=Trap numbers, OC=Opportunistically collected in the terrain, M= Males, F=Females

Sample No.	Date	Trap no.	UTM	N	E	Sex	MU05	MU09	G10L	MU10	MU23	MU50	MU51	MU59	ID
BF137	02.07.2009	OC	35	7648074	424700	F	114 / 122	110 / 116	180 / 180	150 / 150	172 / 172	105 / 125	139 / 145		FI88
BF138	02.07.2009	OC	35	7651497	424838										
BF177	31.07.2009	OC	35	7659089	426948										
BF208	25.08.2009	OC	35	7646250	429560	F	114 / 122	110 / 116	180 / 180	150 / 150	172 / 172	105 / 125	139 / 145	236 / 252	FI88
BF209	25.08.2009	OC	35	7646258	429560	F	114 / 122	110 / 116	180 / 180	150 / 150	172 / 172	105 / 125	139 / 145	236 / 252	FI88
BH126	29.07.2009	C1	35	7657374	430083										
BH127	30.07.3009	C4	35	7644784	430338	F	120 / 122	96 / 110		138 / 150	169 / 172	105 / 125	139 / 145	250 / 252	FI60
BH128	30.07.2009	C4	35	7644784	430338										
BH129	30.07.2009	C4	35	7644784	430338	F	120 / 122	96 / 110	180 / 180	138 / 150	169 / 172	105 / 125	139 / 145	250 / 252	FI60
BH130	30.07.2009	C4	35	7644784	430338	F	120 / 122	96 / 110	180 / 180	138 / 150	169 / 172	105 / 125	139 / 145	250 / 252	FI60
BH131	30.07.3009	C4	35	7644784	430338	F	120 / 122	96 / 110	180 / 180	138 / 150	169 / 172	105 / 125	139 / 145	250 / 252	FI60
BH132	30.07.2009	B4	35	7644888	429992	F	120 / 122	96 / 110	180 / 180	138 / 150	169 / 172	105 / 125	139 / 145	250 / 252	FI60
BH133	30.07.2009	A3	35	7646133	424406	F	114 / 122	110 / 116	180 / 180	150 / 150	172 / 172	105 / 125	139 / 145		FI88
BH134	30.07.2009	A3	35	7646133	424406	F	114 / 122	110 / 116	180 / 180	150 / 150	172 / 172	105 / 125	139 / 145	236 / 252	FI88
BH135	30.07.3009	A3	35	7646133	424406	F	114 / 122	110 / 116	180 / 180	150 / 150	172 / 172	105 / 125	139 / 145	236 / 252	FI88
BH136	30.07.2009	A3	35	7646133	424406	F	114 / 122	110 / 116	180 / 180	150 / 150	172 / 172	105 / 125	139 / 145	236 / 252	FI88
BH137	30.07.2009	A3	35	7646133	424406			110 / 116				105 / 125			
BH138	30.07.2009	A3	35	7646133	424406			110 / 116					139 / 145		
BH140	12.08.2009	E3	35	7648595	441384										
BH141	12.08.2009	E3	35	7648595	441384	M	114 / 126	112 / 116	180 / 182	150 / 150	170 / 172	105 / 105	139 / 139	236 / 242	FI56/LL33
BH142	12.08.2009	E3	35	7648595	441384	M	114 / 126	112 / 116	180 / 182	150 / 150	170 / 172	105 / 105	139 / 139	236 / 242	FI56/LL33

BH143	12.08.2009	E3	35	7648595	441384	M	114 / 126	112 / 116	180 / 182	150 / 150	170 / 172	105 / 105	139 / 139	236 / 242	FI56/LL33
BH144	13.08.2009	A3	35	7647255	424329	F	114 / 122	110 / 116	180 / 180	150 / 150	172 / 172	105 / 125	139 / 145	236 / 252	FI88
FLF001	04.09.2009	OC	35	7638819	458315	M	126 / 126	110 / 122	190 / 190	140 / 144	170 / 172	119 / 123	145 / 147	228 / 232	LL34
FLF002	16.07.2009	OC	35	7635362	441474										
FLF003	04.09.2009	OC	35	7638159	457018	M	126 / 126	110 / 122	190 / 190	140 / 144	170 / 172	119 / 123	145 / 147	228 / 232	LL34
FLH001	17.07.2009	F5	35	7638690	442314	M	114 / 124	108 / 114				105 / 123	139 / 143	244 / 250	LL31
FLH002	05.08.2009	C6	35	7634100	431644	M	114 / 124	108 / 114	180 / 180	132 / 132	170 / 170	105 / 123	139 / 143	244 / 250	LL31
FLH003	05.08.2009	C6	35	7634100	431644	M	116 / 122	96 / 118	176 / 180	142 / 144	168 / 170	119 / 123	137 / 137	250 / 250	LL32
FLH004	16.07.2009	F6	35	7634979	445942										
FLH005	05.08.2009	B6	35	7635218	429247	M	114 / 126	112 / 116	180 / 182	150 / 150	170 / 172	105 / 105	139 / 139	236 / 242	LL33/FI56
FLH006	05.08.2009	B6	35	7635218	429247										
FLH007	06.08.2009	F5	35	7641153	445812	M	116 / 122	96 / 118	176 / 180	142 / 144	168 / 170	119 / 123	137 / 137		LL32
FLH008	06.08.2009	F5	35	7641153	445812			96 / 118				119 / 123			
FLH009	18.08.2009	D6	35	7633999	439602	M	114 / 124	108 / 114	180 / 180	132 / 132	170 / 170	105 / 123	139 / 143	244 / 250	LL31
FLH010	31.08.2009	C5	35	7639100	430512										
FLH011	18.08.2009	B7	35	7633323	428996	M	114 / 126	112 / 116	180 / 182	150 / 150	170 / 172	105 / 105	139 / 139	236 / 242	LL33/FI56
FLH012	18.08.2009	B7	35	7633323	428996	M	114 / 126	112 / 116	180 / 182	150 / 150	170 / 172	105 / 105	139 / 139	236 / 242	LL33/FI56
FLH013	31.08.2009	F5	35	7642449	447084										
FLH014	04.09.2009	G4	35	7646705	453606	M	122 / 128	116 / 116		144 / 150	170 / 170	105 / 123	139 / 143	236 / 240	
FLH015	16.07.2009	OC	35	7635362	441474	M	114 / 124	108 / 114	180 / 180	132 / 132	170 / 170	105 / 123	139 / 143		LL31
FLH016	18.08.2009	B7	35	7633323	428996	M	114 / 126	112 / 116	180 / 182	150 / 150	170 / 172	105 / 105	139 / 139	236 / 242	LL33/FI56