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Monitoring of the Pasvik-Inari-Pechenga brown bear population in 2007 and 2011 using hair-trapping

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Pasvik River in the Pasvik Valley between Norway and Russia. Photo: Alexander Kopatz.

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Abstract: The trans-border brown bear population of Pasvik-Inari-Pechenga (Norway-Finland-Russia) has been monitored using genetic analyses of feces collection since 2005. In addition in 2007, hair traps were systematically placed out in the area to collect hairs for genetic analysis, to more precisely determine the minimum numbers of bears. In 2011, we repeated this hair trap study, using the exact same methodology as in 2007, to make a direct comparison of the results from the two years. Brown bear DNA was detected in 68 of 88 hair samples (77%) obtained from hair traps in 2011 and for 56 of these samples, a complete DNA profile could be determined. We identified 20 different bears in 2011, 12 females and 8 males. Only one bear was found in more than one country (Norway and Russia). We detected 11 bears in Norway, 7 bears in Finland and 3 bears in Russia in 2011. Four of these 20 bears were previously unknown, all four from Finland. A comparison of the results from 2007 and 2011 showed that we detected fewer bears in hair traps in 2011 (20 bears) than in 2007 (24 bears), but this modest difference may be coincidental. However, we observed a large drop in the yield of hair samples in the traps in 2011 compared to 2007 (88 versus 196 samples). This observation may be suggestive of some reduced activity of bears within the study area in 2011. In addition, only five (21%) of the bears caught in hair traps in 2007 were recaptured in 2011, which indicates a substantial turnover of individuals and may indicate that more frequent hair trapping monitoring would be beneficial to reliably track changes in the population. Additional samples (mainly scats) collected opportunistically in the field within the Russian and Finnish parts of the study area in 2011 detected four male bears in the Finnish part that had not been detected by hair traps. No additional samples from Norway were included to this study and any comparisons between the hair-trapping and opportunistic sampling at this point remains difficult. However, the results indicate that both methods combined are currently the most feasible methods to monitor brown bear numbers in an area.

Sammendrag: Den grenseoverskridende brunbjørnstammen i Pasvik-Inari-Pechenga (Norge-Finland-Russland) har vært overvåket ved hjelp av genetiske analyser av innsamlete møkkprøver siden 2005. I tillegg, i 2007, ble hårfeller systematisk plassert ut i området for å samle hår til genetiske analyser, for mer presist å bestemme minimum antall bjørn. I 2011 gjentok vi dette hårfellestudiet med nøyaktig samme metodikk som i 2007, for å gjøre en direkte sammenligning av resultatene fra de to årene. Brunbjørn-DNA ble påvist i 68 av 88 hårprøver (77%) registrert i hårfeller i 2011, og for 56 av disse prøvene, kunne en fullstendig DNA-profil bestemmes. Vi identifiserte 20 ulike bjørner i 2011, 12 hunner og 8 hanner. Bare én bjørn ble funnet i mer enn ett land (Norge og Russland). Vi påvist 11 bjørner i Norge, 7 bjørner i Finland og tre bjørner i Russland i 2011. Fire av disse 20 bjørnene var tidligere ukjente, alle fire fra Finland. En sammenligning av resultatene fra 2007 og 2011 viste at vi fant færre bjørn i hårfellene i 2011 (20 bjørner) enn i 2007 (24 bjørner), men denne beskjedne forskjellen kan være tilfeldig. Dog observerte vi en stor nedgang i antall hårprøver i fellene i 2011 sammenlignet med 2007 (88 versus 196 prøver). Denne observasjonen kan være forenlig med noe redusert aktivitet av bjørn innen studieområdet i 2011. I tillegg ble bare fem (21%) av bjørnene fanget i hårfeller i 2007 gjenfanget i 2011, noe som indikerer en betydelig omsetning av individer og kan tyde på at hyppigere hårfelleovervåking ville være gunstig for å pålitelig kunne spore endringer i bestanden. Ytterligere prøver (hovedsakelig ekskrementer) samlet opportunistisk i terrenget innenfor de russiske og finske delene av studieområdet in 2011 fanget opp fire hannbjørner i den finske delen som ikke hadde gått i hårfellene. Ingen ytterligere prøver fra Norge ble inkludert i denne studien og eventuelle sammenligninger mellom hårfellefangst og opportunistisk prøvetaking er derfor vanskelig. Imidlertid kan resultatene tyde på at en kombinasjon av begge metodene er å anbefale for å overvåke brunbjørn i et område.

Land/Country:	Norge/Norway, Finland/Finland and Russland/Russia
Fylke/County:	Finnmark (NO), Lappland (FI), Murmansk (RUS)
Kommune/Municipality:	Kautokeino (NO), Inari (FI), Pechenga (RUS)
Sted/Lokalitet:	Øvre Pasvik (NO), Inari (FI) and Pechenga (RUS)

Godkjent / Approved

Snorre B. Hagen

Prosjektleder / Project leader

Alexander Kopatz and Hans Geir Eiken

Table of Contents

Abstract

The trans-border brown bear population of Pasvik-Inari-Pechenga (Norway-Finland-Russia) has been monitored using genetic analyses of feces collection since 2005. In addition in 2007, hair traps were systematically placed out in the area to collect hairs for genetic analysis, to more precisely determine the minimum numbers of bears. In 2011, we repeated this hair trap study, using the exact same methodology as in 2007, to make a direct comparison of the results from the two years. Brown bear DNA was detected in 68 of 88 hair samples (77%) obtained from hair traps in 2011 and for 56 of these samples, a complete DNA profile could be determined. We identified 20 different bears in 2011, 12 females and 8 males. Only one bear was found in more than one country (Norway and Russia). We detected 11 bears in Norway, 7 bears in Finland and 3 bears in Russia in 2011. Four of these 20 bears were previously unknown, all four from Finland. A comparison of the results from 2007 and 2011 showed that we detected fewer bears in hair traps in 2011 (20 bears) than in 2007 (24 bears), but this modest difference may be coincidental. However, we observed a large drop in the yield of hair samples in the traps in 2011 compared to 2007 (88 versus 196 samples). This observation may be suggestive of some reduced activity of bears within the study area in 2011. In addition, only five (21%) of the bears caught in hair traps in 2007 were recaptured in 2011, which indicates a substantial turnover of individuals and may indicate that more frequent hair trapping monitoring would be beneficial to reliably track changes in the population.

Additional samples (mainly scats) collected opportunistically in the field within the Russian and Finnish parts of the study area in 2011 detected four male bears in the Finnish part that had not been detected by hair traps. No additional samples from Norway were included to this study and any comparisons between the hair-trapping and opportunistic sampling at this point remains difficult. However, the results indicate that both methods combined are currently the most feasible methods to monitor brown bear numbers in an area.

1. Introduction

Estimation of brown bear numbers in an area is notoriously difficult, since this animal is elusive and observations can lead to biased estimates. Therefore, genetic methods based on non-invasive sampling of hairs and feces have been established to estimate bear abundance and numbers in both restricted and larger areas. In the recent past, so called hair-traps have shown their effectiveness in systematic collection of samples. Evenly distributed over a research area, hair-traps are successful in sampling more elusive and shy individuals, such as female bears. (e.g. Woods et al. 1999; Mowat and Strobeck 2000; Romain-Bondi et al. 2004, Kendall 1999; Bellemain et al. 2005; Thompson 2004, Waits & Paetkau 2005; Kendall et al. 2005, 2008a, 2008b; Kendall et al. 2009). Since 2005, Bioforsk Svanhovd has applied these methods in monitoring of brown bear populations in Norway, Finland, Russia and Sweden (see e.g. Smith et al. 2007; Smith et al. 2008; Wartiainen et al. 2008; Eiken et al. 2009a, 2009b, 2011).

In 2007, a tri-lateral project on monitoring and estimation of the minimum size of the brown bear population inhabiting the area of Pasvik (Norway), Inari (Finland) and Pechenga (Russia) was conducted. Samples were collected systematically over a two month period using hair-traps in a study area of 1400 km^2 divided into a grid of 56 squares. One square had the size of 5 km x 5 km and one hair trap was placed in each square (see Fig. 1). This first hair-trap study in 2007 resulted in 196 hair samples that lead to the detection of 24 different bears (10 females, 14 males) (Smith et al. 2007).

In this study in 2011, we have conducted an exact repetition of the monitoring action in 2007. The objectives of this second hair trap project were to obtain a new estimate the minimum number of brown bears in the trans-border area of Pasvik-Inari-Pechenga and to identify possible changes in bear numbers and bear activity during the four year period. The use of the same methodology in both 2007 and 2011 facilitated a direct comparison of the results from the two projects, thus allowing for more reliable assessment of possible changes and their biological significance. Both of these hair trap projects represent the continuing and international collaboration of monitoring and research of the trans-border population of brown bears by Norwegian, Finnish and Russian managers and scientists.

2. Materials and Methods

2.1 Permissions

Permissions for this experiment were obtained from the National Animal Research Authority (Forsøksdyrutvalget), The Finnmark County Governor (Fylkesmannen i Finnmark), and Finnmarkseiendommen (FeFo, public land administrators). No special permissions were needed in Finland and Russia.

2.2 Study Area

The study area was located in the border areas of Norway, Finland and Russia at approximately 69.4° North and 29.8° East. The study area consisted of 56 squares à 5 km x 5 km (with one hair-trap in each square, see *2.3 Sample collection* for details) that were located as follows: 26 squares were in Finnish jurisdiction (Lapland, Inari municipality), 20 in Norwegian jurisdiction (Finnmark, Sør-Varanger) and 10 squares within Russian jurisdiction (Murmansk, Pechenga) (Fig. 1). The study area is dominated by both arctic and northern boreal ecosystems, represented by a mosaic of peat land and forest. Areas without forest can be described as low arctic and sub-arctic, while areas with tree growth belong to the north boreal forest type, characterized by large areas of downy birch (*Betula pubescens*) and Scots pine (*Pinus silvestris)*.

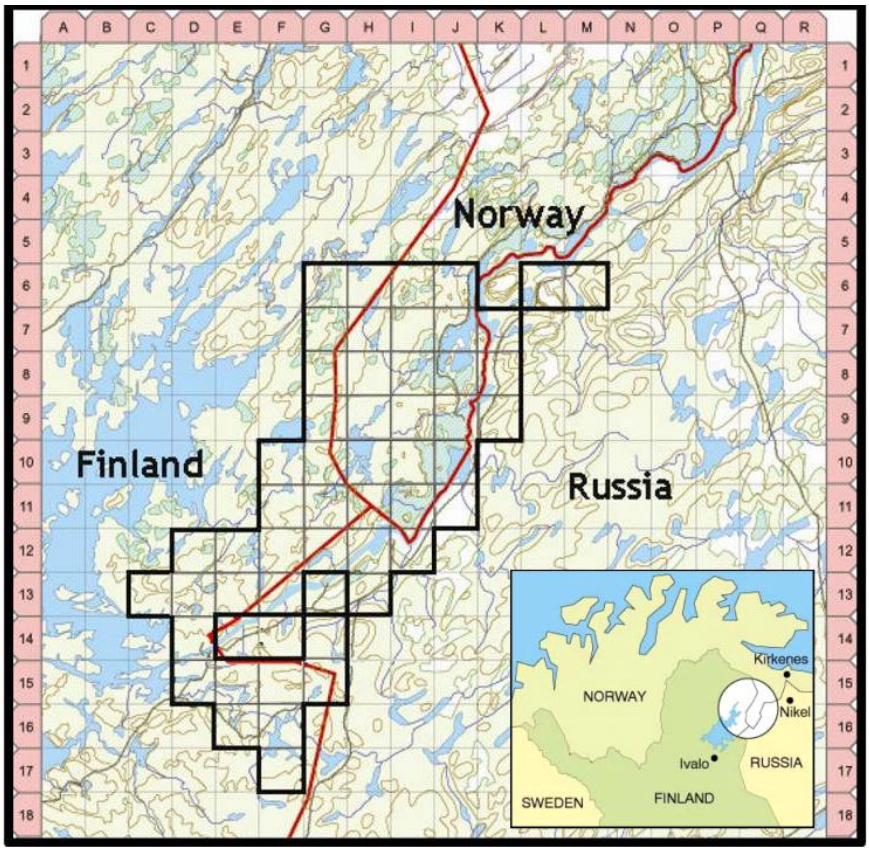


Figure 1: Study area in the trans-border area around Pasvik and the Øvre Pasvik National park (Sør-Varanger) including areas in Finland (Inari) and Russia (Pechenga). The study area was divided in 56 squares a 5 km x 5 km with one hair-trap in each. Hair-traps were moved to a second location within the same square half-way through the collection period (after four weeks). The squares in the grid are marked from C13 in the west to M6 in the east.

2.3 Sample collection

On June 14th 2011 we started by placing one hair-trap in each grid square. A hair-trap or snare consisted of barbed-wire stretched approximately 40 cm above the ground among several trees encircling a strong smelling scent-lure (1.5 liters). 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 usage. It was important that the scent-lure was in the thin liquid form, to ensure that the bears were attracted without food reward. 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 hair on the wire (Fig. 2). The bear's thick hide will not be damaged by the barbed wire and in other hair trap studies, injuries have never been reported or documented.

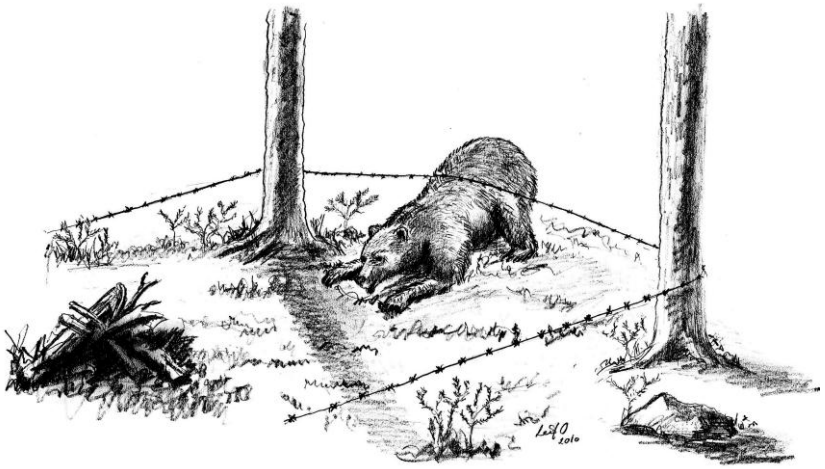


Figure 2: Sketch of a typical hair snare with scent lure in the center ringed by a single barbed wire strung between trees at 40-50 cm from the ground. Drawing by Leif Ollila.

Every second week between Mid-June and Mid-August, each hair snare was inspected for hairs (Tab. 1, Fig. 3) and supplied again with 1.5 liters of lure to maintain the same level of attraction throughout the sampling period. Half-way through the collection period (after four weeks), the hair-traps were moved to a second location within the same square (Tab. 1). Experience has shown that translocation of hair-traps during the season increases the probability of detecting more brown bears in an area (Mowat and Strobeck 2000; Boulanger et al. 2006). After two months, in Mid-August, the traps were taken down and removed from the forest (Tab. 1), which concluded the field part of the project.

Table 1: Schedule and sessions of the hair-trapping project in the area of Pasvik-Inari-Pechenga in 2011.

Day 1	Set-up	scent lure
Day 14	1st check	scent lure
Day 28	2nd check	translocation/scent lure
Day 42	1st check	scent lure
Day 70	2nd check	Removal

2.4 Additional samples

In the Russian and Finnish parts of the study area, fecal and hair samples were also collected opportunistically in the field throughout the study period. The location and date were recorded for these additional samples before they were subjected to DNA analysis. In the Norwegian part of the research area, a similar, opportunistic field sampling was conducted as part of the national monitoring project of brown bears in Norway, but these samples were not included in this work, as they will be first published in a national report next year.

2.5 Remote wildlife cameras

In order to learn more on the activities of brown bears and other species at the hair-traps, two wildlife cameras (Scout Guard SG550M MMS camera) were mounted in square grids I07, K08, J08 and J09. These cameras were triggered by movement of animals when visiting the hair-trap.

2.6 DNA-extraction

DNA was extracted from the hair samples using reagents from Qiagen (DNeasy Tissue Kit). The root tip from 5 to 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 degree centigrade. 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, the volume of elution buffer was reduced to 30 μl (1 to 2 hair) or 50 μl (3 to 4 hairs). DNA extraction is further described in Eiken et al. 2009 as well as Smith et al. 2007 and DNA isolation from feces were as previously described (Wartiainen et al. 2009).

2.7 Analysis of DNA profile and gender

Genetic analysis of STRs (short tandem repeats) 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 (Paetkau and Strobeck 1994, 1995; Paetkau et al. 1995; Taberlet et al. 1997; see Eiken et al. 2009). Sex determination was based on the X-and Y-specific DNA sequences of the amelogenine 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). All procedures were done under the strict conditions of the ISO/IEC 17025 accreditation of our laboratory and in accordance to the guidelines of the analysis of forensic animal material, recently published by Linacre et al. (2011).

3. Results and discussion

3.1 Hair samples collected at hair-traps in 2011

We obtained 88 hair samples by hair-trapping: 66 hair samples originated from Norway, 14 from Finland and 8 samples from Russia. Out of 20 squares in Norway, we obtained hair samples in 12 grid squares; in Finland 11 out of 26; and in Russia 5 out of 10 (Fig. 4). In summary, we sampled hairs from half of the grid squares (28 of the 56, see also Appendix 1). The yield of samples showed that the hair-traps captured an average of 0.8 samples per trap per month.

Figure 3: A hair snare for brown bears in the Pasvik Valley in 2011, Norway and hair of a brown bear collected by the wire. Photo: Alexander Kopatz.

3.2 DNA analysis of the hair samples collected at hair-traps in 2011

The following DNA analysis detected brown bear DNA in 68 of 88 hair samples (77%). For 56 of samples (64%) we were able to determine a complete DNA profile and identity (Appendix 2). These successfully genotyped samples identified 20 different brown bears, 12 females and 8 males (Tab. 2). We detected 11 different individuals in Norway, 7 different individuals in Finland and 3 different individuals in Russia. Hair-trapping detected 6 individuals twice and 12 once (Appendix 2). Figure 4 shows the research area and the results of the hair-trapping. Only one individual (FI105/MO15) was detected in two countries (NOR/RUS, Table 2). Two bears (10%) have been detected three different times: FI105/MO15 was detected in three different grids in Norway and Russia and FI78/MO19 was detected in three different grids in Norway.

Table 2: Identity, gender and genetic profile (8 STRs) for the 20 different brown bears documented by hair-trapping 2011 in Pasvik-Inari-Pechenga (Norway, Finland and Russia), country of registration, and the years of previous registration; F = females, M = males.

ID	Gender	MU05		MU09		G10L		MU10		MU23		MU50		MU51		MU59		Country	Previous detection
FI101	M	117	127	110	114	182	182	145	149	170	172	120	124	145	145	226	242	NOR	2010
FI105/MO15	M	115	127	098	110	182	190	135	149	170	178	126	130	141	147	226	242	NOR, RUS	2010
FI109	F	125	125	112	112	182	192	135	147	172	174	124	126	141	149	240	250	NOR	2010
FI110	F	121	125	112	116	182	192	135	135	172	176	120	124	139	141	240	250	NOR	2010
FI111	F	121	125	112	116	182	182	135	143	172	174	120	124	145	149	240	250	NOR	2010
FI38/MO18	F	121	125	110	112	182	182	145	147	174	176	106	106	139	147	240	242	RUS	2005, 2007
FI43/MO3	F	109	125	112	112	182	182	135	147	174	176	120	126	139	149	240	248	NOR	2005, 2007, 2008, 2009, 2010
FI64/LL21	F	115	127	112	118	184	192	135	145	172	174	120	124	139	141	240	250	FIN	2007
FI69	M	121	127	110	116	184	192	135	145	172	174	120	130	141	145	250	250	NOR	2007
FI70	M	115	121	098	120	182	182	145	147	172	174	120	120	145	145	250	250	NOR	2007, 2008, 2009, 2010
FI71	M	115	125	098	110	182	184	135	145	170	174	120	126	145	147	226	250	NOR	2007, 2008, 2009
FI74	F	121	129	098	116	182	192	135	145	172	172	106	124	141	149	226	250	NOR	2007, 2008, 2009, 2010
FI78/MO19	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	NOR	2008, 2009, 2010
FI98/MO17	F	109	117	112	112	182	182	135	135	172	174	106	106	139	143	242	242	RUS	2010
LL22	F	115	127	098	098	184	192	145	147	172	174	120	124	141	145	242	250	FIN	2007
LL36	F	115	117	098	110	182	184	135	145	170	176	120	126	145	145	226	250	FIN	**NEW**
LL37	F	115	117	110	112	180	182	135	147	172	172	120	130	145	145	248	250	FIN	**NEW**
LL38	M	109	117	110	112	182	184	135	135	172	172	106	130	141	145	240	250	FIN	**NEW**
LL39	F	109	115	098	112	182	184	135	147	172	172	120	130	141	145	240	250	FIN	**NEW**
MO8/LL44	M	115	123	102	112	172	184	147	147	168	170	106	118	149	151	226	248	FIN	2007

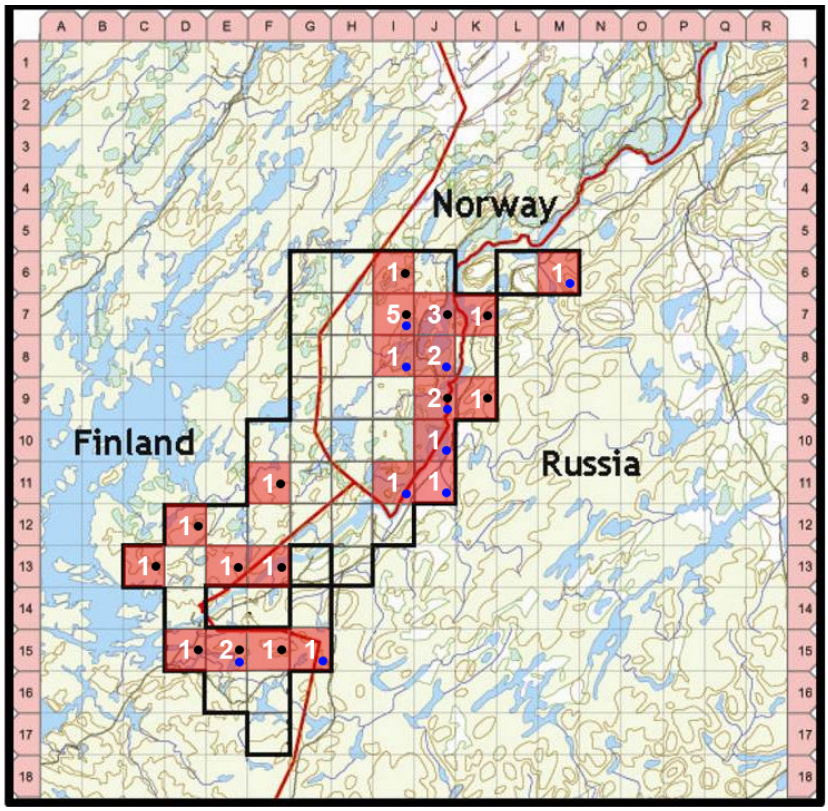
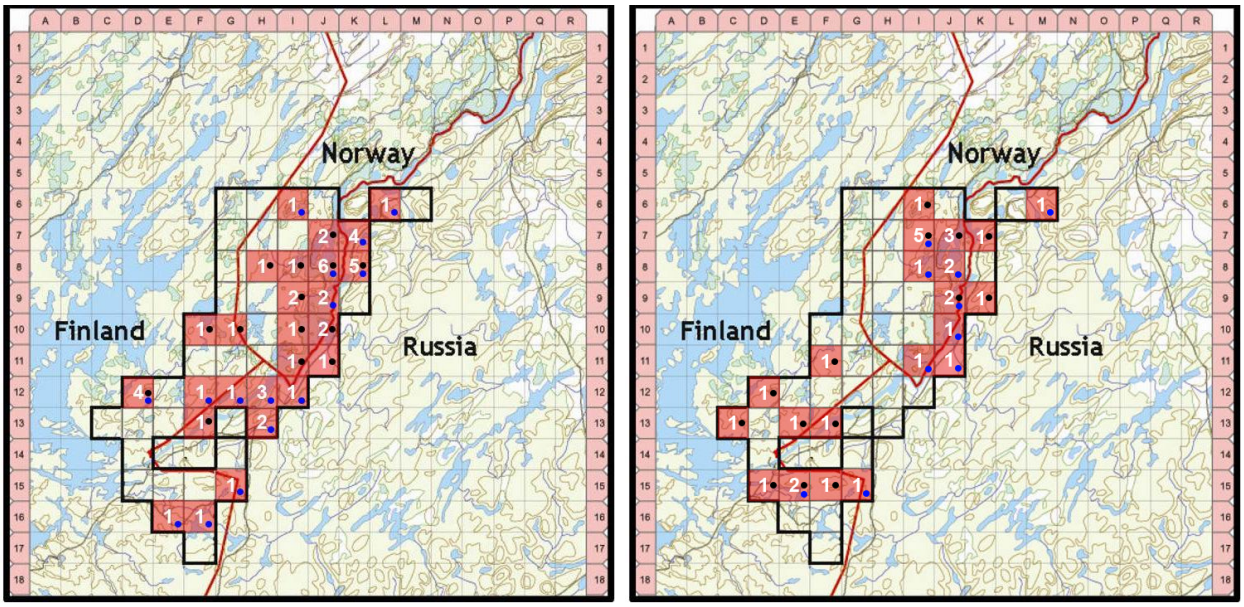


Figure 4: Results of the hair-trapping project to monitor brown bears in the trans-border area of Pasvik (Norway), Inari (Finland) and Pechenga in 2011, divided into a 5 km x 5 km grid. The red shaded grid squares indicate traps, in which bear hair samples were collected and identified. The number represents the number of individual bears identified and the gender is indicated by the colored dot (black = females, blue = males). The figure includes only individuals that have been identified by a full DNA-profile.

3.3 Comparison of the hair-trapping results from 2007 and 2011

This monitoring effort was performed as an identical repetition of the hair trap study of 2007 as possible. In 2007, 196 samples were captured in the hair traps and 129 (66%) of these samples were successfully genotyped, resulting in the identification of 24 individuals (10 females, 14 males; Smith et al. 2007). Now, after four years, when repeating this method in 2011, we obtained only 88 hair samples of which 56 (64 %) were successfully genotyped, and identified 20 individuals (12 females, 8 males). Thus, we sampled less than half (~45 %) of the number of samples in 2011 as compared to 2007, but detected almost the same number of individuals (20 vs. 24 individuals i.e. 83%). The following sampling efficiency was 0.8 samples per trap per month in 2011 versus 1.75 samples/trap/month in 2007 (Smith et al. 2007).

We detected 11 bears in the study area in Norway, 7 in Finland and 3 in Russia in 2011. In 2007 we detected 13 bears in Norway, 9 in Finland and 6 in Russia and the study identified 11 new, formerly undetected brown bears (Smith et al. 2007). Only five (21%) of the 24 identified bears in 2007 were resampled in 2011. The sparse recapture show the necessity of repeated genetic monitoring, which supplies us with valuable information on the changes and the temporal continuity of a population. More frequent, systematic monitoring with hair-traps should be discussed among the stakeholders to investigate the turnover as well as reproduction and immigration of new individuals.



2007 **2011**

Figure 5: Monitoring of brown bears in the trans-border area of Pasvik-Inari-Pechenga in Norway, Finland and Russia in 2007 and 2011. Red squares represent bear activity detected by hair-traps. The number are the identified individuals and the gender is indicated by the colored dot (black = female, blue = male).

The lower capture and recapture frequency of individuals during summer 2011 may be caused by increased roaming activity of bears, perhaps because of unavailable food resources within the research area, such as the low amount of berries available this summer, as locals have been reporting. Another reason which could have influenced the slight decrease in the number of bears in Norway and Russia, can be less reproduction, due to a decrease of females in the area, caused e.g. by an increase in mortality. Moreover, the immigration of bears from outside the research area might also have been slightly lower than four years ago. The latter is still obscure for the investigated brown bear population, since the bears from Pasvik do not show much connectivity and genetic exchange to the neighboring bear populations e.g. at Troms or Karelia (Kopatz et al., *submitted*; Schregel et al., *in preparation*).

Previous studies, such as the one in 2007 described differences in sampling success and that more samples were obtained in the second part of the schedule in late summer (e.g. Smith et al. 2007). In 2011, we could not observe large differences between the amount of samples gained in the first and the second half of the summer.

Based on sparse data from the wildlife cameras (see 3.5), we have no indications that increased "trap shyness" is a reason for the detected lower amount of samples in 2011. Previous studies support this, and have shown that a bear visits a hair-trap at least once during a season (Boulanger et al. 2006).

3.4 Collection and analysis of additional samples from the field in Finland and Russia in 2011

A total of 23 feces were collected in the terrain within and around the study area during the same period in Finland and Russia. Out of these 23 feces samples, 10 were collected in Finland and 13 in Russia. The feces found in Norway during this field work were not included into this study and report, since they will be analyzed under the national monitoring project of brown bears in Norway. Additionally to the feces, two hair samples from Russia and one hair sample from Finland were collected at the border fence and in the field.

From the 26 additional samples, 14 samples (53.9%) could be successfully genotyped with the eight markers to determine the bear identity. Of these samples, 10 were collected within and 4 outside the study area (8 in Finland, 2 in Russia; Appendix 3). For 2 additional samples we could confirm that they were from bears, but no identity could be assigned due to low sample quality. The 10 negative samples (38.4%) may not contain enough DNA for analysis or may be from another species. The DNA analysis of the additional samples detected 4 other male brown bears within the Finnish part of the research area, which were not detected by hair-trapping. We detected three more individuals, but these were sampled outside the research area and therefore cannot be included into this study (Appendix 3 and 4). FI78/MO19 was captured additionally by a hair sample collected opportunistically at the border fence in Russia. An interpretation of these results is difficult without the results from the analysis of the additional samples from Norway, which will be published later.

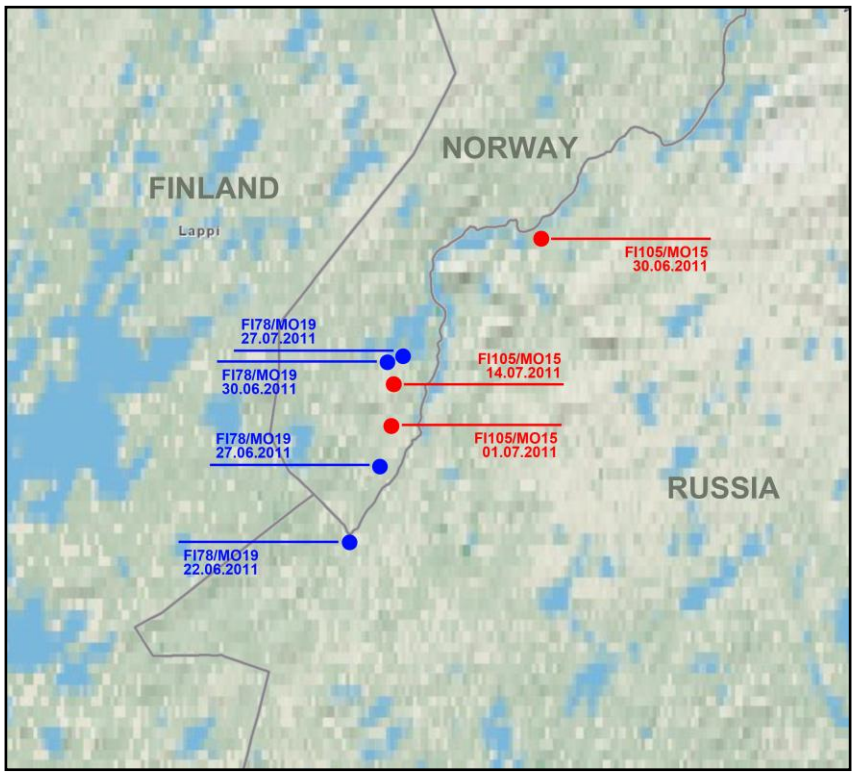


Figure 6: Geographical location of samples from two different male brown bears that were identified and recaptured during hair-trapping in the study area in Pasvik-Inari-Pechenga in 2011. Except for the hair sample obtained on 22.06.2011 for individual FI78/MO19, which was collected at the border fence between Norway and Russia.

3.5 Remote wildlife cameras

The wildlife cameras mounted at four the hair-traps recorded brown bear presence at two traps. One male has been taped while visiting the first trap at J08 and has been identified as individual FI78/MO19 (Fig. 7 and 9). The camera placed at K08 filmed a brown bear running away (Fig. 8A). If not triggered by brown bears some cameras captured moose, occasionally with a calf, and one hare (Fig. 8).

Equipped with only two wildlife cameras, the chances of filming an animal was relatively low. Nevertheless we succeeded in recording one male at one hair-trap, while it investigates the wooden pile doused with the lure (Fig. 7 and 9) as well as one bear running away at another location (Fig 7A). The other footage contained several moose and one hare. Whether moose is attracted by the lure or visited the hair-traps by chance cannot be said. It is assumed that ungulates avoid places which smell of dead animal and carcass as the lure is supposed to attract bears. This behavior may be further investigated by using a higher number of cameras in future monitoring.

The remote wildlife cameras did not document any harm or danger to wildlife caused by the hair-traps. No brown bear as well as other animals were injured while visiting a hair-trap. Our observations are in accordance to other monitoring projects using hair-traps to detect Grizzly bears as well as black bears, e.g. in the United States and Canada.

In 2007 the cameras were damaged or destroyed by curious bears. This was not the case in 2011. The only difference were the color of the camera boxes: in 2007 the cameras were mounted in white boxes (from the artic fox project), which probably draw the bears' attention and curiosity. In 2011 we used cameras protected by a wood-pattern camouflaged hard-shell, and these cameras were not damaged by bears.

Figure 7: Brown bear, later identified by its DNA as male FI78/MO19, recorded at trap J08 in summer 2011. Photo: Bioforsk Svanhovd.

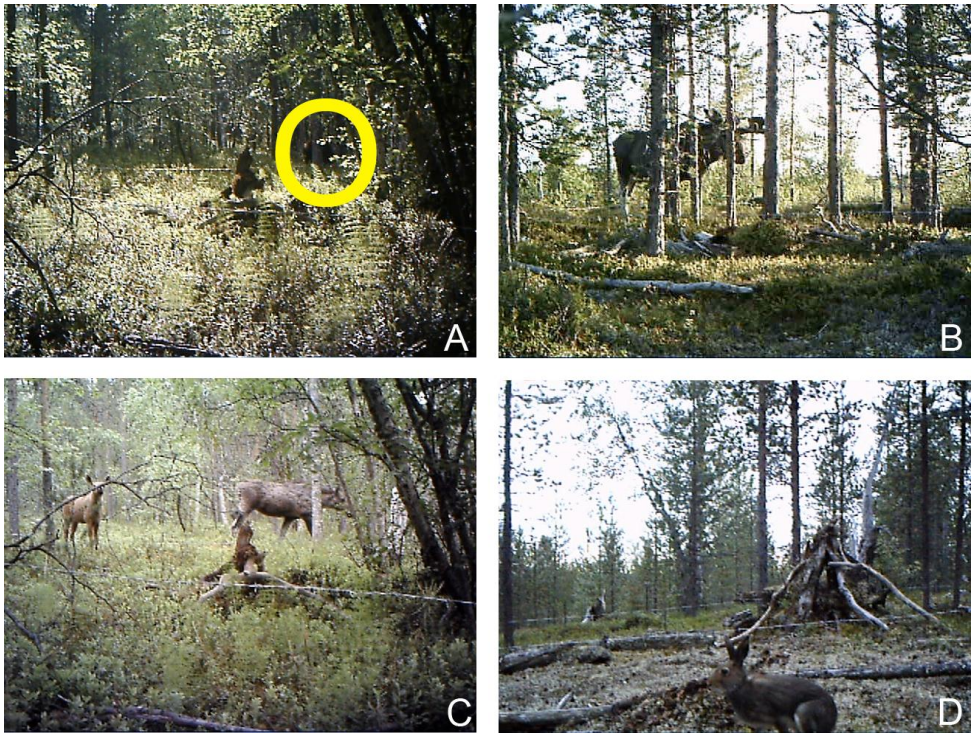


Figure 8: Brown bear running (A); moose (B); moose cow and a calf (C) and a hare (D) triggered movement sensitive wildlife cameras in Pasvik, Norway, in summer 2011. Photo: Bioforsk Svanhovd.

4. Concluding remarks

During the last years and projects, hair-traps have shown their power in detecting bear abundance and individuals. In 2011, we detected 20 different brown bears by hair-trapping in a study area of 1400 km^2 at the trans-border area of Pasvik, Norway (11 bears), Inari Finland (7 bears) and Pechenga, Russia (3 bears). In accordance to our results we can conclude:

Hair-trapping:

- In 2011, we collected less than half of the samples by hair-trapping over the same area and we identified less individuals (20 vs. 24) compared to 2007.
- Only five (21%) individuals, detected in 2007, were recaptured in 2011, which indicate substantial turnover of individuals and may suggest that more frequent monitoring using hair traps would be beneficial to reliably track changes, and their causes, in the population.
- Only one male showed trans-border movement – between Norway and Russia.
- In summary, we collected less samples and found a slight decrease in detected brown bears; both findings may be caused by less bear activity within the study area, compared to 2007.

Additional sampling in the terrain in Finland and Russia:

- With the help of additional, opportunistic collected samples we detected four male brown bears within the Finnish part of the research area, which were not sampled by hair-trapping.
- No additional samples from Norway were included into this analysis and therefore the interpretation will be done later, when the results of the national monitoring in Norway are published.
- The combined application of both, feces collection and hair-trapping in Finland and Russia, may deliver the most reliable numbers and insights when monitoring and studying a brown bear population.

Remote wildlife cameras:

- The sensor triggered cameras did not record any harm to wildlife when using hair-trapping to monitor brown bears.

Figure 9: Still picture of the video take by a remote camera of bear FI78/MO19 visiting a hair-trap at the Pasvik Valley, Norway. Photo: Bioforsk Svanhovd.

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Appendix 1. Locations and results from hair-trap inspections of 56 grid squares within trans-border area of Pasvik-Inari-Pechenga in Norway, Finland and Russia. Hair-traps were relocated within each 5 x 5 km squares in the grid after the second inspection; I6-F15 = grid numbers; Y = samples collected, NS = no samples collected. The total number of collected samples at hair-traps was 88.

Grid	Location	UTM	Latitude N	Longitude E	1st check	2nd check	Country
H07	1	35	7681410	576278	NS	NS	NOR
	2	35	7681645	576307	NS	NS	
H08	1	35	7678493	574671	NS	NS	NOR
	2	35	7680097	575374	NS	NS	
H09	1	35	7673177	576905	NS	NS	NOR
	2	35	7673363	577379	NS	NS	
H10	1	35	7668298	577092	NS	NS	NOR
	2	35	7670070	576539	NS	NS	
H11	1	35	7665106	575781	NS	Y	NOR
	2	35	7662205	576340	NS	NS	
I06	1	35	7687496	579872	Y	NS	NOR
	2	35	7686022	580643	NS	NS	
I07	1	35	7684183	581234	Y	Y	NOR
	2	35	7684489	582719	Y	NS	
I08	1	35	7676848	582185	NS	Y	NOR
	2	35	7679835	582478	NS	NS	
I09	1	35	7672427	580539	NS	NS	NOR
	2	35	7673436	582536	NS	NS	
I10	1	35	7667670	581648	NS	NS	NOR
	2	35	7670265	583277	NS	NS	
I11	1	35	7663352	583631	Y	NS	NOR
	2	35	7664705	582349	NS	NS	
I12	1	35	7659868	579494	NS	NS	NOR
	2	35	765998	582680	NS	Y	
J06	1	35	7688254	586252	NS	NS	NOR
	2	35	7688422	585483	NS	NS	
J07	1	35	7683794	584956	NS	NS	NOR
	2	35	7684234	587562	Y	Y	
J08	1	35	7677316	587027	Y	NS	NOR
	2	35	7676846	585324	Y	Y	
J09	1	35	7674129	586105	NS	Y	NOR
	2	35	7673626	587184	NS	NS	
J10	1	35	7669339	585975	Y	NS	NOR
	2	35	7670093	586238	NS	NS	
J11	1	35	7664670	584713	Y	NS	NOR
	2	35	7665501	585367	NS	NS	
K07	1	35	7682524	590566	NS	NS	NOR
	2	35	7682473	589736	Y	NS	
K08	1	35	7678879	589745	NS	NS	NOR
	2	35	7678585	590308	NS	NS	

Grid	Location	UTM	Latitude N	Longitude E	1st check	2nd check	Country
G06	1	35	7685867	573162	NS	NS	FIN
	2	35	7685867	573162	NS	NS	
H06	1	35	7685923	574726	NS	NS	FIN
	2	35	7685923	574726	NS	NS	
G07	1	35	7681699	573199	NS	NS	FIN
	2	35	7681699	573199	NS	NS	
G08	1	35	7679941	572329	NS	NS	FIN
	2	35	7679941	572329	NS	NS	
G09	1	35	7672798	572884	NS	NS	FIN
	2	35	7672798	572884	NS	NS	
F10	1	35	7666002	568870	NS	NS	FIN
	2	35	7665356	567942	NS	NS	
G10	1	35	7666325	572035	NS	NS	FIN
	2	35	7667317	571606	NS	NS	
F11	1	35	7659814	567363	NS	NS	FIN
	2	35	7659252	568436	Y	NS	
G11	1	35	7662787	571720	NS	NS	FIN
	2	35	7660883	569694	NS	NS	
D12	1	35	7653493	555713	NS	NS	FIN
	2	35	7654396	556501	NS	Y	
E12	1	35	7655181	557605	NS	NS	FIN
	2	35	7656440	558098	NS	NS	
F12	1	35	7656232	566624	NS	NS	FIN
	2	35	7655558	567754	NS	NS	
G12	1	35	7656235	569015	NS	NS	FIN
	2	35	7655811	570165	NS	NS	
C13	1	35	7653435	547575	Y	NS	FIN
	2	35	7650730	548844	NS	NS	
D13	1	35	7649482	555463	NS	NS	FIN
	2	35	7649447	552908	NS	NS	
E13	1	35	7649062	558963	NS	NS	FIN
	2	35	7647917	559883	Y	Y	
F13	1	35	7652745	564700	NS	NS	FIN
	2	35	7652745	566070	NS	Y	
D14	1	35	7645624	554555	NS	NS	FIN
	2	35	7646589	556589	NS	NS	
D15	1	35	7642168	556354	Y	NS	FIN
	2	35	7640568	557346	NS	Y	
E15	1	35	7637766	562356	NS	NS	FIN
	2	35	7640056	561244	Y	Y	
F15	1	35	7639507	565329	NS	NS	FIN
	2	35	7641226	567903	NS	Y	
G15	1	35	7638453	569281	NS	NS	FIN
	2	35	7640748	571946	NS	Y	
E16	1	35	7634302	558805	Y	Y	FIN
	2	35	7634654	560519	NS	NS	

Grid	Location	UTM	Latitude N	Longitude E	1st check	2nd check	Country
F16	1	35	7635711	565075	Y	NS	FIN
	2	35	7634498	562959	NS	NS	
F17	1	35	7628311	564167	Y	NS	FIN
	2	35	7626598	566443	NS	NS	
G12	1	35	7653285	572488	NS	NS	RUS
	2	35	7653029	572174	NS	NS	
H12	1	35	7654683	573845	NS	NS	RUS
	2	35	7654906	574013	NS	NS	
H13	1	35	7649739	574909	NS	NS	RUS
	2	35	7649209	572920	NS	NS	
G14	1	35	7648838	570192	NS	NS	RUS
	2	35	7648997	570096	NS	Y	
F13	1	35	7648116	567228	NS	NS	RUS
	2	35	7648016	567243	NS	NS	
M06	1	35	7691157	602189	Y	NS	RUS
	2	35	7689986	601891	NS	NS	
L06	1	35	7689419	599940	NS	NS	RUS
	2	35	7689516	600078	NS	Y	
K07	1	35	7681480	593337	Y	Y	RUS
	2	35	7681407	593236	NS	NS	
K08	1	35	7675260	592304	NS	NS	RUS
	2	35	7675470	592655	NS	NS	
K09	1	35	7671681	590213	NS	Y	RUS
	2	35	7671565	590108	Y	Y	

Appendix 2. Complete genetic profiles of all samples that were positive for brown bear DNA collected during the hair snare project 2011 at the trans-border area around Pasvik. SMP no. = sample number; country of sampling; SMP = sample material (H=hair); I6-F15 = grid numbers; M = males, F = females; ID = individual no.

SMP no.	Date	Country	SMP	Grid	UTM	North	East	Gender	MU05		MU09		G10L		MU10		MU23		MU50		MU51		MU59		ID
BH155	26.06.2011	NOR	H	I7	35	7684183	581234	M	117	127	110	114	182	182	145	149	170	172	120	124	145	145	226	242	FI101
BH156	26.06.2011	NOR	H	I7	35	7684183	581234	M	117	127	110	114	182	182	145	149	170	172	120	124	145	145	226	242	FI101
BH157	26.06.2011	NOR	H	I7	35	7684183	581234	M	117	127	110	114	182	182	145	149	170	172	120	124	145	145	226	242	FI101
BH158	26.06.2011	NOR	H	I7	35	7684183	581234	M	117	127	110	114	182	182	145	149	170	172	120	124	145	145	226	242	FI101
BH205	01.07.2011	NOR	H	J10	35	7669339	585975	M	115	127	098	110	182	190	135	149	170	178	126	130	141	147	226	242	FI105/MO15
BH203	14.07.2011	NOR	H	J9	35	7674129	586105	M	115	127	098	110	182	190	135	149	170	178	126	130	141	147	226	242	FI105/MO15
BH204	14.07.2011	NOR	H	J9	35	7674129	586105	M	115	127	098	110	182	190	135	149	170	178	126	130	141	147	226	242	FI105/MO15
RUH008	30.06.2011	RUS	H	M6	35	7691157	602189	M	115	127	098	110	182	190	135	149	170	178	126	130	141	147	226	242	FI105/MO15
BH174	08.08.2011	NOR	H	J7	35	7684234	587562	F	125	125	112	112	182	192	135	147	172	174	124	126	141	149	240	250	FI109
BH175	08.08.2011	NOR	H	J7	35	7684234	587562	F	125	125	112	112	182	192	135	147	172	174	124	126	141	149	240	250	FI109
BH176	08.08.2011	NOR	H	J7	35	7684234	587562	F	125	125	112	112	182	192	135	147	172	174	124	126	141	149	240	250	FI109
BH278	12.07.2011	NOR	H	I7	35	7684183	581234	F	121	125	112	116	182	192	135	135	172	176	120	124	139	141	240	250	FI110
BH279	12.07.2011	NOR	H	I7	35	7684183	581234	F	121	125	112	116	182	192	135	135	172	176	120	124	139	141	240	250	FI110
BH171	27.07.2011	NOR	H	J7	35	7684234	587562	F	121	125	112	116	182	192	135	135	172	176	120	124	139	141	240	250	FI110
BH172	27.07.2011	NOR	H	J7	35	7684234	587562	F	121	125	112	116	182	192	135	135	172	176	120	124	139	141	240	250	FI110
BH173	27.07.2011	NOR	H	J7	35	7684234	587562	F	121	125	112	116	182	192	135	135	172	176	120	124	139	141	240	250	FI110
BH177	08.08.2011	NOR	H	J7	35	7684234	587562	F	121	125	112	116	182	192	135	135	172	176	120	124	139	141	240	250	FI110
BH178	08.08.2011	NOR	H	J7	35	7684234	587562	F	121	125	112	116	182	192	135	135	172	176	120	124	139	141	240	250	FI110
BH274	12.07.2011	NOR	H	I7	35	7684183	581234	F	121	125	112	116	182	182	135	143	172	174	120	124	145	145	240	250	FI111
BH186	08.08.2011	NOR	H	J7	35	7684234	587562	F	121	125	112	116	182	182	135	143	172	174	120	124	145	149	240	250	FI111
RUH006	14.07.2011	RUS	H	K7	35	7699876	597936	F	121	125	110	112	182	182	145	147	174	176	106	106	139	147	240	242	FI38/MO18
BH200	14.07.2011	NOR	H	J9	35	7674129	586105	F	109	125	112	112	182	182	135	147	174	176	120	126	139	149	240	248	FI43/MO3
BH201	14.07.2011	NOR	H	J9	35	7674129	586105	F	109	125	112	112	182	182	135	147	174	176	120	126	139	149	240	248	FI43/MO3
BH202	14.07.2011	NOR	H	J9	35	7674129	586105	F	109	125	112	112	182	182	135	147	174	176	120	126	139	149	240	248	FI43/MO3
FLH013	02.08.2011	FIN	H	F11	35	7659252	568436	F	115	127	112	118	184	192	135	145	172	174	120	124	139	141	240	250	FI64/LL21
FLH010	18.08.2011	FIN	H	F13	35	7652745	566070	F	115	127	112	118	184	192	135	145	172	174	120	124	139	141	240	250	FI64/LL21
BH164	14.07.2011	NOR	H	I8	35	7676848	582185	M	121	127	110	116	184	192	135	145	172	174	120	130	141	145	250	250	FI69
BH275	12.07.2011	NOR	H	I7	35	7684183	581234	M	115	121	098	120	182	182	145	147	172	174	120	120	145	145	250	250	FI70
BH276	12.07.2011	NOR	H	I7	35	7684183	581234	M	115	121	098	120	182	182	145	147	172	174	120	120	145	145	250	250	FI70
BH277	12.07.2011	NOR	H	I7	35	7684183	581234	M	115	121	098	120	182	182	145	147	172	174	120	120	145	145	250	250	FI70

SMP no.	Date	Country	SMP	Grid	UTM	North	East	Gender	MU05		MU09		G10L		MU10		MU23		MU50		MU51		MU59		ID
BH159	24.07.2011	NOR	H	I7	35	7684489	582719	M	115	125	098	110	182	184	135	145	170	174	120	126	145	147	226	250	FI71
BH160	24.07.2011	NOR	H	I7	35	7684489	582719	M	115	125	098	098	184	184	135	145	170	170	120	126	147	147	226	226	FI71
BH162	24.07.2011	NOR	H	I7	35	7684489	582719	M	115	125	098	110	182	184	135	145	170	174	120	126	145	147	226	250	FI71
BH193	27.07.2011	NOR	H	J8	35	7676846	585324	M	115	125	098	110	182	184	135	145	170	174	120	126	145	147	226	250	FI71
BH154	26.06.2011	NOR	H	I6	35	7687496	579872	F	121	129	098	116	182	192	135	145	172	172	106	124	141	149	226	250	FI74
BH165	27.06.2011	NOR	H	I11	35	7663352	583631	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	FI78/MO19
BH166	27.06.2011	NOR	H	I11	35	7663352	583631	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	FI78/MO19
BH168	27.06.2011	NOR	H	I11	35	7663352	583631	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	FI78/MO19
BH206	27.06.2011	NOR	H	J11	35	7664670	584713	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	FI78/MO19
BH207	27.06.2011	NOR	H	J11	35	7664670	584713	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	FI78/MO19
BH208	27.06.2011	NOR	H	J11	35	7664670	584713	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	FI78/MO19
BH209	27.06.2011	NOR	H	J11	35	7664670	584713	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	FI78/MO19
BH188	30.06.2011	NOR	H	J8	35	7677316	587027	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	FI78/MO19
BH189	30.06.2011	NOR	H	J8	35	7677316	587027	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	FI78/MO19
BH190	30.06.2011	NOR	H	J8	35	7677316	587027	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	FI78/MO19
BH191	30.06.2011	NOR	H	J8	35	7677316	587027	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	FI78/MO19
BH192	27.07.2011	NOR	H	J8	35	7676846	585324	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	FI78/MO19
RUH005	14.07.2011	RUS	H	K09	35	7683993	592174	F	109	117	112	112	182	182	135	135	172	174	106	106	139	143	242	242	FI98/MO17
FLH012	29.06.2011	FIN	H	C13	35	7653435	547575	F	115	127	098	098	184	192	145	147	172	174	120	124	141	145	242	250	LL22
FLH011	17.08.2001	FIN	H	D12	35	7654396	556501	F	115	127	098	098	184	192	145	147	172	174	120	124	141	145	242	250	LL22
FLH001	16.08.2011	FIN	H	F15	35	7641226	567903	F	115	117	098	110	182	184	135	145	170	176	120	126	145	145	226	250	LL36
FLH009	18.08.2011	FIN	H	E13	35	7647917	559883	F	115	—	110	112	180	182	135	147	172	172	120	130	145	145	250	250	LL37
FLH002	30.07.2011	FIN	H	E15	35	7640056	561244	F	115	117	110	112	180	182	135	147	172	172	120	130	145	145	248	250	LL37
FLH007	17.08.2011	FIN	H	E15	35	7640056	561244	M	109	117	110	112	182	184	135	135	172	172	106	130	141	145	240	250	LL38
FLH008	17.08.2011	FIN	H	D15	35	7640568	557346	F	109	115	098	112	182	184	135	147	172	172	120	130	141	145	240	250	LL39
FLH006	16.08.2011	FIN	H	G15	35	7640748	571946	M	115	123	102	112	172	184	147	147	168	170	106	118	149	151	226	248	MO8/LL44

Appendix 3. Additional samples collected opportunistically in the terrain in Finland and Russia**.** Complete genetic profiles of all additional samples that were positive for brown bear DNA. SMP no. = sample number; SMP = sample material (F=feces, H=hair); I6-F15 = grid numbers, * = samples collected outside of the research area; M = males, F = females; ID = individual no.

SMP no.	Date	Country	SMP	Grid	UTM	North	East	Gender	MU05		MU09		G10L		MU10		MU23		MU50		MU51		MU59		ID
FLF005	25.08.2011	FIN	F	—*	35	7607009	556575	M	115	117	112	116	182	182	145	147	170	172	120	126	139	147	242	248	FI83/LL46
FLF003	05.08.2011	FIN	F	F15	35	7639887	566074	F	115	117	098	110	182	184	135	145	170	176	120	126	145	145	226	250	LL36
FLF010	18.07.2011	FIN	F	D15	35	7640740	556690	M	109	117	110	112	182	184	135	135	172	172	106	130	141	145	240	250	LL38
FLF008	17.08.2011	FIN	F	E15	35	7641184	560337	F	109	115	098	112	182	184	135	147	172	172	120	130	141	145	240	250	LL39
FLF001	23.08.2011	FIN	F	—*	35	7600295	550325	M	115	117	098	112	182	186	143	145	170	172	106	106	131	143	226	256	LL41
FLF002	23.08.2011	FIN	F	—*	35	7600457	550341	M	115	117	098	112	182	186	143	145	170	172	106	106	131	143	226	256	LL41
FLF004	25.08.2011	FIN	F	G07	35	7607009	556575	M	109	117	098	112	182	184	141	147	164	172	118	120	145	147	232	232	LL42
FLF007	25.08.2011	FIN	F	G07	35	7607009	556575	M	109	117	098	112	182	184	141	147	164	172	118	120	145	147	232	232	LL42
FLF006	25.08.2011	FIN	F	G07	35	7607009	556575	M	125	127	098	124	182	182	135	149	170	172	120	124	147	149	248	250	LL43
FLF009	17.08.2011	FIN	F	E15	35	7641187	560332	M	117	121	110	112	182	184	135	147	172	172	120	130	145	147	248	250	LL45
FLH015	12.08.2011	FIN	H	D12	35	7645957	557401	M	109	115	110	118	182	190	135	149	170	172	106	120	141	145	242	252	LL40
RUF008	22.07.2011	RUS	F	—*	35	7698747	613504	F	121	121	110	124	182	186	141	145	172	176	120	126	141	149	242	256	MO16
RUH010	22.06.2011	RUS	H	I12	35	7656178	581660	M	115	123	112	116	182	182	147	147	170	172	120	130	145	145	240	248	FI78/MO19
RUH009	08.07.2011	RUS	H	K09	35	7670879	589821	F	109	117	112	112	182	182	135	147	172	174	106	106	139	143	240	242	FI98/MO17

Appendix 4. Identity, gender and genetic profile (8 STRs) for the 7 different brown bears detected by additional, opportunistic sampling during the field season in Inari (Finland) and Pechenga (Russia) and the year of registration; F = females, M = males. "NEW" in the column on previous detection means that this individual has not been detected in previous years by non-invasive genetic monitoring and was therefore not included in our brown bear DNA database. * = individual was detected only outside of the research area.

ID	Gender	MU05	MU09	G10L	MU10	MU23	MU50	MU51	MU59	Country	Previous detection
FI83/LL46	M	115 117	112 116	182 182	145 147	170 172	120 126	139 147	242 248	FIN	2008*
LL40	M	109 115	110 118	182 190	135 149	170 172	106 120	141 145	242 252	FIN	**NEW**
LL41	M	115 117	098 112	182 186	143 145	170 172	106 106	131 143	226 256	FIN	**NEW***
LL42	M	109 117	098 112	182 184	141 147	164 172	118 120	145 147	232 232	FIN	**NEW**
LL43	M	125 127	098 124	182 182	135 149	170 172	120 124	147 149	248 250	FIN	**NEW**
LL45	M	117 121	110 112	182 184	135 147	172 172	120 130	145 147	248 250	FIN	**NEW**
MO16	F	121 121	110 124	182 186	141 145	172 176	120 126	141 149	242 256	RUS	**NEW***