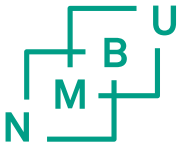
U
B
M
N

Til Marte, Espen, Silje, Cecilie og Richard

"Elsk – og berik med drøm – alt stort som var! Gå mot det ukjente, fravrist det svar.
Ubygde kraftverker, ukjente stjerner –skap dem, med skånet livs dristige hjerner!"

~ Nordahl Grieg
Ny-Hellesund, Søgne, 1936

Preface

This study was conducted as part of the Scandinavian Brown Bear Research Project, so I would like to thank everybody involved with it for the opportunity to do this study and write this thesis. I have to thank Ole-Gunnar Støen for being my guidance counselor and helping me getting this thesis together, a thanks to Sven Brunberg for all he does in Tackåsen, and thanks to everybody who did the data collections I needed so I had numbers to work with. I also have to send big thanks to all the hunters and their dogs for participating in this study and helping us making the approaches by humans with dogs happen! And I really hope all the hunters got something useful from the animations of the simulated hunts they participated in.

Big thanks to my parents, Målfrid (Tulla) and Alfon, for putting up with me and my complaining and nagging though all these months. And thanks to everybody else, especially my family, for all the support and help during the thesis writing period.

To Grandma Emma – now I am finally done with school.

And to Grandma Aslaug – I did it!

Stine Emilie Nøding Hansen

Abstract

The Scandinavian brown bear population was persecuted in the last half of the 1800s and almost went extinct. They got protected in Sweden in 1927 and in Norway in 1973, and have since reached a level that can be hunted. The bears choose areas with as little human activity as possible, but dangerous situations may occur especially during hunting. There have been 32 incidents of bear attacks on humans since 1977, and it is mainly hunters that have been injured by bears. Many of these situations involved hunting where a dog was chasing and/or baying the bear. This has made the public question if it is dangerous to bring dogs with when hiking. In this study I have tried to answer this question and my hypothesis was that bears will have a different reaction to being startled by humans with dogs compared to being startled by humans with no dogs. That is that the bears will have a stronger reaction to being startled by humans with dogs. My first prediction was that a bear will move away from a human with a loose dog at a longer distance than a human with no dog, and my second prediction was that the bears will be moving further away from the initial site after being startled by humans with dogs compared to being startled by humans with no dogs. The study was conducted on the southernmost bear population in Scandinavia (Dalarna and Gävleborg Län), using a total of 112 approaches, of which 71 was humans with no dogs and 41 was humans with dogs. I found that my first prediction was true – that bears moved away from humans with dogs at a further distance than humans with no dogs. This may be because the dog indicates human presence and gives the bear a chance to move away before even seeing the human. It may also be because dogs are usually in hunting situation and the bear moving away from the dog may be necessary for its survival. I also found that my second prediction of the bear moving further away from initial site when approached by humans with dogs compared to humans with no dogs was true. A dog will be able to follow a bear further than a human will, and it may therefore be necessary to move further from a dog than a human to avoid being discovered again. In conclusion: based on my findings my answer to the public concerns about bringing their dogs on hikes in areas with bears is that loose dogs do not elevate the danger for getting into conflicts with bears.

Sammendrag

Den Skandinaviske brun bjørn populasjonen var forfulgt i siste halvdel av 1800-tallet og ble nesten utryddet. Bjørnene ble fredet i Sverige i 1927 og i Norge i 1973, og har i dag økt til jaktbar bestand. Bjørnene velger områder med så lite menneskelig aktivitet som mulig, men farlige situasjoner kan oppstå, spesielt i jakta. Det har vært 32 tilfeller av angrep fra bjørn siden 1977, og det er hovedsakelig jegere som har blitt skadet. Mange av disse situasjonene involverte jakt med hund med los på bjørn. Dette har gjort publikum bekymret for om det er farlig å ta med seg hund på tur i skogen. I dette studiet har jeg prøvd å finne svar på dette og hypotesen min var at bjørner vil ha en annen reaksjon til å bli støkka av mennesker med hund enn å bli støkka av mennesker uten hund. Min første prediksjon var at bjørner vil bevege seg bort fra mennesker med hund på lengre avstand enn mennesker uten hund, og min andre prediksjon var at bjørnene vil bevege seg lengre vekk fra der de oppholdt seg når de blir støkka av mennesker med hund sammenlignet med mennesker uten hund. Studiet ble utført på den sørligste bjørnepopulasjonen i Skandinavia (Dalarna og Gävleborg Län), og jeg fikk totalt 112 ”approacher”, av disse var 71 mennesker uten hund, 41 var mennesker med hund. Jeg fant at min første prediksjon var sann – bjørnene bevegde seg bort fra mennesker med hund på lengre avstand enn til mennesker uten hund. Dette kan være fordi hunder indikerer menneskelig tilstedeværelse og gir bjørnen en sjanse til å bevege seg bort fra mennesket før det har sett mennesket. Det kan også være fordi bjørnen treffer på hunder oftest i jaktsituasjoner og at bjørnen beveger seg bort fra hunden kan bety dens overlevelse. Jeg fant også at min andre prediksjon om at bjørnen beveger seg lengre bort fra der den oppholder seg når den støkkes av menneske med hund enn når den støkkes av menneske uten hund er sann. En hund vil kunne følge etter bjørnen lengre enn et menneske, og det kan derfor være nødvendig for bjørnen å bevege seg lengre bort fra en hund enn fra et menneske for å unngå å bli oppdaget igjen. I konklusjon: basert på mine funn er mitt svar til publikum at det er ikke er farligere å ta med en løs hund på tur i skogen.

Content

1. Introduction

The brown bear population in Scandinavia was large and healthy until the last half of the 1800s, when it became a problem for the human farming community (Swenson et al. 1995). Brown bears became persecuted with bounty, leading to a rapid decline of the population (Swenson et al. 1995). The bears became protected in Sweden in 1927 and in Norway in 1973, causing the brown bear population to increase again (Swenson et al. 1995). In 1943 the Swedish bear population had reestablished to a level that could be hunted (Bischof et al. 2008). Today the brown bears are hunted by the sit-and wait method (still hunting), stalking, or with dogs (Bischof et al. 2008). About 37 % of all harvested bears are shot by hunters using dogs during the hunt (Bischof et al. 2008).

Through the previous persecution the Scandinavian brown bear evolved into bears that are very cautious around humans. Bears prefer to have their home range as far from human activity as possible (Nellemann et al. 2007; Ordiz et al. 2011), often choosing difficult terrain but still having access to food (Martin et al. 2010). Bears cannot avoid areas with human activity completely; if they have to use these areas they do so when the human activity is as low as possible(Martin et al. 2010). The avoidance of human encounters and confrontations shows a clear increase during the summer and fall when the human presence increase (Ordiz et al. 2011; Ordiz et al. 2013). Especially the hunting influences the daily movements of the bears and they become more night active during this period, keeping still and in cover during most of the day (Ordiz et al. 2011; Ordiz et al. 2012). The bears also choose resting sites with more cover during the summer and the fall when there is more people in the forest than the rest of the year (Ordiz et al. 2011).

People living close to large carnivores are often concerned for how they act around humans. Studies on how the Scandinavian brown bear reacts to humans out in the forest hiking or picking berries show that bears avoid humans as much as possible, and that when humans get too close the bear either move away from the human, or stay in hiding where it is (Moen et al. 2012). However, with this knowledge came other concerns from the public – will the bears act differently when you bring a dog out with you hiking in the forest?

After about 100 years of no attacks from bears there have been 32 incidents of bear attacks on humans since 1977 (Sahlèn et al. 2013b). Most of these situations involved hunting, or other situations where bears may behave aggressive; presence of cubs, carcass, den site and presence of dog (Sahlèn et al. 2013b). Most of the attacks done by bear occurred in September to November (69 % of the incidents) which is in the hunting season for bear and moose, and it is also the time of year when the bears get ready for denning (Sahlèn et al. 2013b). The incidents of attack was positively related to number of bear shot by hunters, and dogs were present in 69 % of the attacks; in 19 of the 21 situations with dog present the dog was chasing and/or baying the bear (Sahlèn et al. 2013b).

All in all Sahlèn et al. (2013b) found that it was not the increased bear population causing the increase in attacks by bears, but rather what outdoor activity people were engaged in; especially the increase of hunters and hunters with dogs. It is very stressful for a bear to be chased by a baying dog; thus causing the bear to react aggressively (Sahlèn et al. 2013b). Also the denning season is special because the bears undergo physical and psychological changes in preparation for denning, and may thus be slower in reaction making it necessary for them to react aggressively as an alternative defense to flight (Sahlèn et al. 2013a). This may cause a very strong connection for bears between baying dogs and the risk of being shot, causing them to have a different reaction to hikers with dogs than to hikers without dogs.

To answer the question whether the bears act differently when encountering humans with dogs out hiking in the forest, I collected data in cooperation with bear hunters and their dogs approaching bears as part of simulated hunts, i.e. hunting bears with dogs without killing the bear. We used dogs that not only hike in the forest with their owners in a leash, but are loose searching for and approaches bears and likely provoke a reaction from the bears; which would be the most serious bear encounter situation a hiker with a dog would experience. Using data from both human approaches without dogs previously collected (Moen et al. 2012), and approaches by hunters with dogs, I could compared these two situations.

My hypothesis is that the bears will have a different reaction to being startled by humans with dogs compared to being startled by humans with no dogs, i.e. that the bears will have a stronger reaction to being startled by humans with dogs. The reasoning behind this hypothesis is that dogs imply a chance of being hunted and shot, because 37 % of all bears killed during hunt is killed by hunters with dogs (Bischof et al. 2008). While approaches by humans are more similar to encounter in the forest as berry pickers and hikers, not necessarily hunters, and bears killed by hunter without dogs (67 %) are usually not aware of the hunter (Bischof et al. 2008).

My first prediction (P1) is therefore that a bear will move away from a human with dog at a longer distance than a human with no dog, and my second prediction (P2) is that the bears will be moving further away from the initial site after being startled by humans with dogs compared to being startled by humans with no dogs.

2. Material and Method

2.1 Study Area

This study was conducted on the southernmost population of brown bears in Scandinavia, in Dalarna and Gävleborg counties in south-central Sweden (61^{o}25' N, 14^{o}29' E) (Fig 1). The area consists of rolling hills, mainly (>90%) below timberline (~720 m a.s.l). The forest is heavily managed, dominated by Scots pine (*Pinus silvestris*) and Norway spruce (*Picea abies*) mixed with deciduous trees, mainly birch (*Betula pendula* and *B. pubescens*), mountain ash (*Sorbus aucuparia*) and willows (*Salix* spp.) in early successional stages. The understory layer consists of grasses, herbs, heather, and berry-producing shrubs. There is also a well-developed network of roads, paved public roads and gravel roads, used by logging trucks and for access to cabins, small communities and villages, and for getting to fishing and hunting areas (also including bear hunting areas).

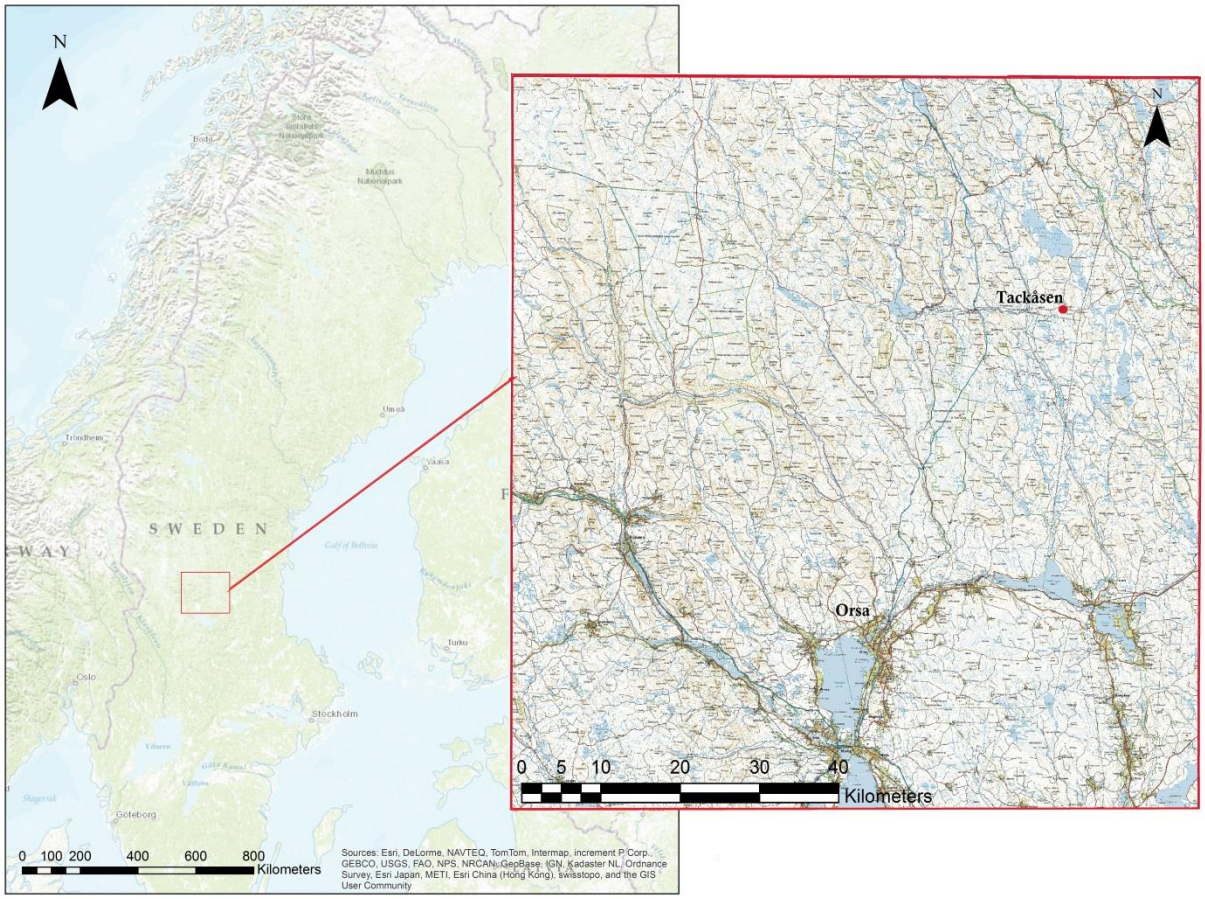

Fig. 1: Map of the study area in Dalarna and Gävleborg counties in south-central Sweden (61°25' N, 14°29' E), with the field station in Tackåsen marked with a red dot.

2.2 The bears

Bears were captured and handled March-May the year of the approaches. Methods used for capturing and marking the bears are described by Arnemo et al. (2006) and Dahle et al. (2006). The bears were equipped with GPS collars (GPS Pro-4 or GPS Pro-4 PlusX from VECTRONIC Aerospace GmbH, Berlin, Germany), and VHF transmitter implant (IMP 400L form Telonics, USA). A bear is approached no more than six times a year and with at least 14 days between each approach. The capturing of the bears was approved by the Swedish Environmental Protection Agency (permit Dnr 412-7327-09 Nv) and the approaches were approved by appropriate ethical committees like Djuretiska nämnden in Uppsala, Sweden (permit C 47/9).

2.3 The approaches

In this study there were in all 112 approaches. Of these 71 approaches were humans with no dogs, of which 21 were female and 8 were males, age ranging 2-20 years. 21 were humans with dogs that chased the bear, and 20 were humans with dogs that startled the bears; of these 41 approaches there were 15 females and 111 males, age ranging 2-13 years. The numbers of male and female bears approached do not equal the number of approaches because the bears were approached more than once, with time between each approach. And some of the numbers of bears used in the different tests will vary from the total numbers of successful approaches because of lack of data for some of the bears.

2.3.1 Approaches with no dogs

The data from the human approaches are from the same dataset as the one used by Moen et al. (2012). The human approaches were done by the observer starting a bit away from the bear, with the goal of passing the bear at about 50 meters distance. The direction of the passing was so the observers was upwind of the bear. If there were two or more observers they would talk to each other, and if an observer went alone he or she would talk to themselves; mostly behave as one would on a normal hike in the forest. All this made sure that the approaches were conducted as similar to a hike as possible. For further information see the paper by Moen et al. (2012).

I used the results from human approaches from the berry season (14^{th} of July - September) because the availability of berries influences the bears foraging behavior and how much they move around, and be comparable with the data I collected during simulated hunts.

2.3.2 Approaches with dogs

Approaches with dogs was done as part of a study in cooperation with bear hunters and their dogs doing simulated hunts, i.e. simulating hunting without killing the bear. An observer and a hunter with a dog approached the bear at its last known position where the dog was released to search for the bear on the track known from earlier GPS positions, or the hunter let the dog try to pick up the scent of the bear in the wind. Data were collected in 2011, 2012 and 2013 and gave a total of 41 successful simulated hunts, where humans with dogs successfully approached a bear.

The approaches with dogs were done from 1st of August to the start of the hunting season for bears on 21st of August. It was used 6 different breeds in the approaches: Plot Hound, Laika, Swedish Elkhound, Norwegian Elkhound, Mixed Breed, and Karealian Bear Dog.

Before any approach could be done the GPS collar of the bear in question had to be programmed to register the bears GPS position every minute for four hours during the approach. The first approach of the day was scheduled from 8.00 am to 12.00 am local time, and for the afternoon approach was scheduled from13.00 pm to 17.00 pm local time. For the GPS Pro-4 collars this was done via a web-based SMS scheduling service about one week before the approach. For the GPS Pro-4 PlusX collars an e-mail had to be sent to VECTRONIC with the necessary information about collar number and time, whereupon they did the scheduling and programming of the collar.

The bears were found based on their latest GPS position followed by a triangulation of their VHF signal. The triangulation was conducted by using a roof-mounted omni-directional antenna on the car to pick up the bears signal, followed by a more detailed localization with a hand held yagi-antennae. The hunter was equipped with a handheld GPS (Garmin Astro 320, © 2011 Garmin Ltd.) connected to the dogs GPS collar (Garmin Astro 320, © 2011 Garmin Ltd.), enabling us to gather data on the hunter and the dogs movements as well as the movements of the bear during the simulated hunt. The hunter would then get the last position of the bear, and based on the position and the wind direction decide from which direction to approach the bear. The observer(s) made notes during the simulated hunt, and monitored the bears' position and movements using the VHF-tracking equipment. The hunter decided when to let the dog off the leash. The dog was monitored by the handheld GPS unit connected to the dogs GPS collar. If the dog did not get the scent of the bear and did not pick up the trail it was called back and let off the leash again closer to the bear where it was more likely to get the scent of the bear or the tracks.

When the dog came near to the bear it was supposed to chase it as it would do during a normal hunt; with both chasing and baying, but some dogs only startled the bears making the simulated hunt approaches comparable to the human approaches. This is because the dog scared up the bear at whatever distance the bear found the dog uncomfortably close, just as though the set goal for

the human approaches where to pass the bear at 50 meters this of course varied to both closer and further from the bear than 50 meters based on when the bear found the human uncomfortably close.

The GPS data from the handheld GPS and the dog collar was entered onto a computer using DNRGPS 6.0.0.8 (Garmin application, Minnesota, USA). All the GPS data from hunter, dog and bear was then uploaded to ArcGIS 10.1 ArcMap^{TM} (Esri, New York, USA) for further use and data analysis.

2.4 Definitions and Analyses

Both types of approaches was split into three different time periods: The *Control period* was the hour before the simulated hunt, followed by the *Simulated Hunt* which should last at about 1.5 hours, and lastly *After Approach* which was the hour after the simulated hunt.

A successful simulated hunt was easily recognized by a quick change in the bears movement pattern and speed of movement. The bear moved away from the daybed/feeding area (*Initial Site*). The simulated hunt started when the dog was let off the leash.

2.4.1 Flight Initiation Distance

To decide if the bears were active or passive during the hour before the simulated hunt I used the definitions made by Moen et al. (2012), with a bear being passive if it remained within an initial cluster of maximum 70 meter in diameter the hour before the approach; and the bear was defined as active if its cluster size was above 70 meter in diameter that hour. The bears were also defined as passive if they were active in most of the hour before the approach, but became passive, laying down or stopped traveling, just before the approach. It was necessary to know whether the bear was active or passive in order to find the *Flight Initiation Distance* (FID) of the bear. The FID is the distance between the bear and the human at the point of time the bear starts running away from the humans (P1), and it was determined by using the coordinates from the GPS minute positions from the bears during the approach. I used Pythagoras ($\sqrt{a^2 + b^2} = \mathrm{c}$) in excel to find the meters (m/min) the bear had moved between two succeeding positions. The *Upper Control Limit* (UCL) is a statistical quality control method (Montgomery D. C 2005), and it was used to

determine the FID of the bears. I used the UCL specifications found by Moen et al. (2012) because of the similarities between the approaches. For the passive bears the UCL were recognized as movement speed exceeded 33.5 m/min (2.01 km/h), and for the active bears as speed exceeded 101.3 m/min (6.08 km/h) (Moen et al. 2012). The point of time for the bears' speed exceeding the UCL was the time of the FID. The actual distance between the bear and the human and the bear and the dog was found by using the GPS positions of the humans, bears and dogs I plotted in ArcGIS.

I also looked at how long time the dog spent within 35 meter of the bear before the bear started moving away. This time period was used as an explanatory factor to the flight initiation distance model, looking at if it had any effect on the distance between the bear and the human when the bear moved away. The 35 meters is set because it is the radius of the area of the GPS positions around a bear's daybed when resting.

Other explanatory variables were the age of the bears, the sex of the bear, the sighting distance in the area the bear was at the time it was approached, and the presence of dog. In the statistical analysis of the flight initiation distance I was able to use all the bears, not just the once startled, because before the bears started moving there was no effect of whether they were just startled or also chased.

2.4.2 Flight distance

The *Flight Distance* was the total distance the bear moved from initial site to second site (P2). This distance was measured from the point of flight initiation distance to the second site where the bear settled down again. Also here all the explanatory variables used in the statistical tests were: activity of the bear, age of the bear, sex of the bear, sighting distance at initial site, and the presence of dog. For the flight distance I used only the startled bears from the approaches by humans with dogs. This is because the chased bears were not comparable to the approaches by humans with no dogs where the bear did not get chased, just startled.

2.4.3 Habitat

After all the simulated hunts had been completed the cluster where the bear had stayed during the control period, and where they had settled after being approached was found. From these cluster; I chose an initial null-point using ArcGIS as guidance to where to do the habitat protocol. Habitat

protocols were carried out at initial site and second site within 14 days of the approach, looking at the vegetation cover in the area the bear had been staying.

As in the study done by Moen et al. (2012) all sites I searched for sign of the bear like scratching and excrements. Also the location of the daybed was attempted found by looking for compressed grass and other vegetation; hair in the area with compressed vegetation helped determine that it was a daybed. The daybed became the new null-point when doing the habitat protocol. If the daybed could not be found I used the chosen GPS point as zero-point. I looked at the vegetation and its cover within a 30 meter radius around the null-point. When deciding the concealment of the site I used a cover cylinder (Ordiz et al. 2009) to record the horizontal vegetation cover based on *sighting distance* in all the cardinal directions (Fig. 2).

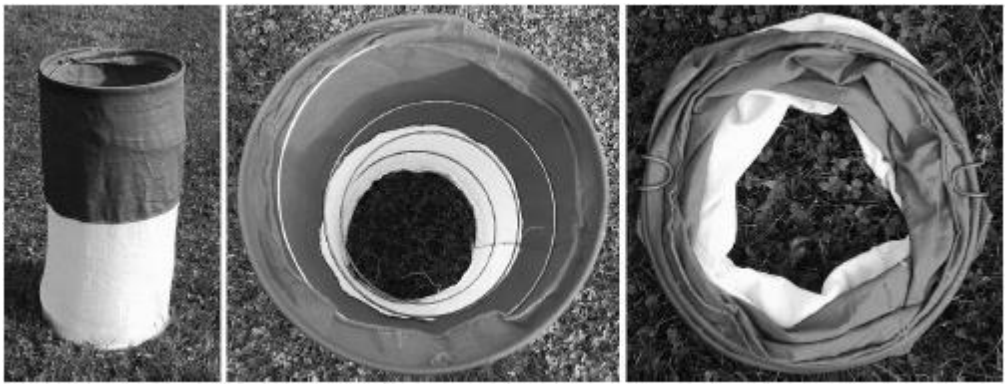

Fig. 2: Cover cylinder to measure sighting distance of the horizontal cover in the field. (Ordiz et al. 2009)

Due to lack of sighting distance for some of the second sites I have not been able to look at the possible change in sighting distance for the habitat before and after the bears was startled. And I have not been able to compare the sighting distance change of the approaches by humans with dogs to the approaches by humans with no dogs.

2.5 Statistics

The statistics were done in "Rstudio" (Rstudio.Ink) – an open source integrated development environment for R, and the statistical programming language and environment R version 2.15.2.

Generalized liner mixed-effect models (GLMM) and the "MASS" package were used to account for the random effects of the individual bear (bear ID), and thus minimize biases and pseudo replication. I used it to determine if and which of the bears traits affected the different responses from the bears

3. Results

3.1 Flight Initiation Distance

Flight initiation distance was determined for all the approaches. For the humans with dogs the average flight initiation distance was 156 ± 6 m (range 11 – 833 m, n = 40), and for the humans with no dogs the flight initiation distance was 79 ± 15 m (range 13 – 324 m, n = 71). There was a significant longer flight initiation distance during an approach by humans with dogs compared to approaches by humans with no dogs (Table 1).

Table 1

Test results from the generalized linear mixed model for flight initiation distance explaining whether the presence of dogs had an effect on the flight initiation distance of the bears when comparing approaches of humans with no dogs (n = 71) to approaches by humans with dogs (n = 40). β is the beta-value, SE is the standard error, df is the degrees of freedom, T is the t-value, and P is the p-value of the test.

Explanatory variables	β	SE	df	T	P
Presence of dog (no dog = 0, dog = 1)	103.06892	35.39037	60	2.9123436	0.005
Age	-5.54644	2.93357	60	-1.8906808	0.0635
Sex	2.59081	25.43015	60	0.1018796	0.9192
Activity of the bear (passive = 0, active = 1)	42.34496	33.66888	60	1.2576881	0.2134
Sighting distance	1.79166	1.2203	60	1.4682136	0.1473

The average time a dog spent within 35 meter of the bear before the bear started moving away was 24 ± 15 seconds (range 0 – 201 seconds, n = 36). The presence of a dog for a period of time within 35 meters of a bear had no effect on the flight initiation distance for approaches by humans with dogs (Table 2).

Table 2

Test results from the generalized linear mixed model for flight initiation distance from approaches by humans with dogs (n = 36), explaining whether time spent within 35 meters of the bear by the dog had any effect on the flight initiation distance to humans. β is the beta-value, SE is the standard error, df is the degrees of freedom, T is the t-value, and P is the p-value of the test.

Explanatory variables	β	SE	df	T	P
Time dog spent within 35 m of bear	-0.03997	0.86133	7	-0.0464078	0.9643
Age	-20.6655	12.91031	7	-1.6006995	0.1535
Sex	25.0088	74.00063	22	0.3379539	0.7386
Activity of the bear (active = 1, passive = 0)	148.4263	128.2218	7	1.1575746	0.285
Sighting distance	-0.58887	4.63842	7	-0.1269549	0.9025

3.2 Flight Distance

The average flight distance of the bears startled by humans with dogs was 3482 ± 1237 m (range 105 – 20999 m, n = 19), and the average flight distance of the bears startled by humans with no dogs was 1206 ± 274 (range 99 – 6291 m, n=71). The flight distance of the bears was longer when the bear was startled by humans with dogs than when approaches by humans with no dogs (Table 3).

Table 3

Test results from the generalized linear mixed model for flight distance explaining the effect of presence of dogs on the flight distance of the bears when comparing approaches of humans with no dogs (n = 71) to approaches by humans with dogs when the bear was only startled and not chased (n = 19). β is the beta-value, SE is the standard error, df is the degrees of freedom, T is the t-value, and P is the p-value of the test.

Explanatory variables	β	SE	df	T	P
Presence of dog (no dog = 0, dog = 1)	764.098	325.661	48	2.3462985	0.0231
Age	20.8697	31.4701	48	0.6631576	0.5104
Sex	147.0661	286.3369	48	0.5136122	0.6099
Activity of the bear (active = 1, passive = 0)	118.9403	385.9561	48	0.3081705	0.7593
Sighting distance	-22.4674	14.5917	48	-1.539739	0.1302

4. Discussion

4.1Flight Initiation Distance

The presence of a dog had a significant impact on the flight initiation distance. I found that the bears moved away at a longer distance to humans with dogs than to humans with no dogs; proving my first prediction (P1) to be true. There may be several reasons why a bear would move away from humans with dogs at a longer distance than humans with no dogs. It may be because the dog was loose – causing it to reach the bear before the human and thus disturbing it, making the bear aware of a human presence even though the bear did not see, hear or smell the human yet. Thus causing it to flee the area before ending up in a "fight" situation (Frid & Dill 2002). Zedrosser et al. (2011) argue that humans can have a large evolutionary influence on bear behavior. Because the Scandinavian brown bear was hunted to near extinction it is possible that the bears that remained was very shy of humans and therefore survived (Swenson 1999). It is these surviving shy bears that reestablished the Scandinavian brown bear population. Bears have been hunted through centuries, and this may have accordingly developed some innate responses in the bears. They have learned to recognize predators, that is humans as predators (Bischof & Zedrosser 2009), and have consequently developed responses for this (Frid & Dill 2002). So another of the reasons why bears moving away from humans with dogs at a longer distance than humans with no dogs may be because the bears that flee from dogs have a higher survival than the bears that does not flee from dogs, and thus will reproduce more and hence develop an innate weariness of dogs.

Through time, experience and mother-cub interaction the bears have learned defense to different situations and thus survival (Bischof & Zedrosser 2009). The bears will respond similar to non-lethal disturbances as to lethal disturbances because they cannot know which of the situations that are lethal; so it is better to overestimate danger and loose time for feeding and rest than to underestimate danger and die (Frid & Dill 2002). Frid and Dill (2002) also argue that the bigger the risk for the prey, and the further it is to a new place to settle, the earlier the prey should start moving away from danger towards safety. Bears may be afraid of dogs because they are often encountered with humans hunting bears, and hence a dog may make the bear aware of the humans and the possible danger earlier than it would be of humans with no dogs, making it possible for the bear to move away from the human earlier than if it did not encounter dogs.

The time a dog spent within 35 meter radius of the bear (bears resting and feeding site) had no significant impact on how close the human came before the bear started moving away. And none of the dogs spent much time within 35 meters of the bear before it started moving away; on average the dogs spent about half a minute near the bear before it moved away from the feeding area. This may be the time needed to identify the dog as a dog and realize what it may imply, causing the bear to start moving away from the dog and the human.

4.2 Flight Distance

Also for the flight distance the presence of dogs had a significant impact. The bears startled by humans with dogs moved a further distance than the bears startled by humans with no dogs. This makes also my second prediction (P2) true.

Approaches by humans affect the bears in other ways than that they move away from humans. Ordiz et al. (2013) found that the bears change their behavior for several days after the encounter. These findings are only for approaches of humans with no dogs, but I would expect the results to be applicable to approaches of humans with dogs as well. Ordiz et al. (2013) also found that the closer one had come to the bear during the approach the stronger the effect on the bear behavior became. So an approach by humans with dogs may cause a lot stronger reaction from the bears than and approach by humans with no dogs, because the dogs run right up to the bears getting a lot closer than humans passing by at some distance do. This is a very fascinating point that would make an interesting study.

Many bears may have experience from being hunted by humans with dogs, and the approaches by humans with dogs may have caused the bear to start behaving as it does in situations where it is hunted. That the bear moved further away from initial site after being startled by humans with dogs compared to humans with no dogs may be one such response. The bear may have felt that it was necessary to move further away from humans with dogs than humans with no dogs because a dog would be able to follow the bear further and it would therefore be prudent to take extra measures to avoid further persecution from the dogs and its humans. The bears may also have had other responses as to become more night active after an approach as it does during times of high

human activity level in the forest (Ordiz et al. 2012). This is especially true for the hunting season. The hunting have a strong influence on the movement pattern of the bears; they became more vigilant keeping a lookout for hunters, hence losing time foraging and resting, and they also becomes much more night active in this period.

4.3 Conclusion

I found that the bears move away from humans with dogs at a longer distance than to humans with no dogs. This proves my first prediction. I also found that the bears startled by humans with dogs moved further away from the initial site than the bears startled by humans with no dogs. This proves my second prediction. These findings are in accordance with my hypothesis that the bears would have a stronger reaction to the humans with dogs than the humans with no dogs.

Based on these findings my answer to the public concerns about bringing their dogs on hikes in areas with bears is that there is no elevated danger in coming into conflicts with bears, even with the dogs loose. The bears are actually avoiding humans with dogs more than they avoid humans with no dogs. And though there have been incidents of humans with dogs attacked by bears, they almost always happen to hunters during hunting with dogs. Hunters willingly go into situations they know may become dangerous; especially bear hunters when shooting at a bear. In general being in the forest in bear populated areas both with and without a dog poses little danger from the bears during a normal hiking situation.

References

Arnemo, J. M., Ahlqvist, P., Andersen, R., Berntsen, F., Ericsson, G., Odden, J., Brunberg, S., Segerström, P. & Swenson, J. E. (2006). Risk of capture-related mortality in large free-ranging mammals: experiences from Scandinavia. *Wildlife Biology*, 12 (1): 109-113.

Bischof, R., Fujita, R., Zedrosser, A., Söderberg, A. & Swenson, J. E. (2008). Hunting Patterns, Ban on Baiting, and Harvest Demographics of Brown Bears in Sweden. *Journal of Wildlife Management*, 72 (1): 79-88.

Bischof, R. & Zedrosser, A. (2009). The educated prey: consequences for exploitation and control. *Behavioral Ecology*, 20 (6): 1228-1235.

Dahle, B., Støen, O.-G. & Swenson, J. E. (2006). Factors influencing home-range size in subadult brown bears. *Journal of Mammalogy*, 87 (5): 859-865.

Frid, A. & Dill, L. M. (2002). Human-caused disturbance stimuli as a form of predation risk. *Conservation Ecology*, 6 (1): 11.

Martin, J., Basille, M., Van Moorter, B., Kindberg, J., Allaine, D. & Swenson, J. E. (2010). Coping with human disturbance: spatial and temporal tactics of the brown bear (Ursus arctos). *Canadian Journal of Zoology*, 88 (9): 875-883.

Moen, G. K., Stoen, O. G., Sahlen, V. & Swenson, J. E. (2012). Behaviour of solitary adult Scandinavian brown bears (Ursus arctos) when approached by humans on foot. *PLoS One*, 7 (2).

Montgomery D. C. (2005). Chapter 4: Methods and Philosophy of Statistical Process Controll. In *Introduction to statistical quality control*, pp. 147-163: John Wiley & Sons, Inc.

Nellemann, C., Støen, O.-G., Kindberg, J., Swenson, J. E., Vistnes, I., Ericsson, G., Katajisto, J., Kaltenborn, B. P., Martin, J. & Ordiz, A. (2007). Terrain use by an expanding brown bear population in relation to age, recreational resorts and human settlements. *Biological Conservation*, 138 (1-2): 157-165.

Ordiz, A., Stoen, O. G., Langebro, L. G., Brunberg, S. & Swenson, J. E. (2009). A practical method for measuring horizontal cover. *Ursus*, 20 (2): 109-113.

Ordiz, A., Støen, O.-G., Delibes, M. & Swenson, J. E. (2011). Predators or prey? Spatio-temporal discrimination of human-derived risk by brown bears. *Oecologia*, 166 (1): 59-67.

Ordiz, A., Støen, O.-G., Sæbø, S., Kindberg, J., Delibes, M. & Swenson, J. E. (2012). Do bears know they are being hunted? *Biological Conservation*, 152: 21-28.

Ordiz, A., Støen, O. G., Sæbø, S., Sahlen, V., Pedersen, B. E., Kindberg, J. & Swenson, J. E. (2013). Lasting behavioural responses of brown bears to experimental encounters with humans. *Journal of Applied Ecology*, 50 (2): 306-314.

Sahlèn, V., Støen, O.-G., Ordiz, A., Arnemo, J. M., Brunberg, S., Kristoffersson, M., Kindberg, J. & Swenson, J. E. (2013a). *Den entry behavior in Scandinavian brown bears Ursus arctos; implications for preventing human injuries*. Norwegian University of Life Sciences: Norwegian University of Life Sciences, Department of Natural Resource Management.

Sahlèn, V., Støen, O.-G., Ordiz, A., Arnemo, J. M., Brunberg, S., Kristoffersson, M., Kindberg, J. & Swenson, J. E. (2013b). *Human injuries and fatalities caused by brown bears in Scandinavia 1977-2012*. Norwegian University of Life Sciences: Norwegian University of Life Sciences, Department of Natural Resource Management.

Swenson, J. E., Wabakken, P., Sandegren, F., Bjärvall, A., Franzén, R. & Söderberg, A. (1995). The near extinction and recovery of brown bears in Scandinavia in relation to the bear management policies of Norway and Sweden. *Wildlife Biology*, 1 (1): 11-25.

Swenson, J. E. (1999). Does hunting affect the behavior of brown bears in Eurasia? *Ursus*: 157-162.

Zedrosser, A., Steyaert, S. M. J. G., Gossow, H. & Swenson, J. E. (2011). Brown bear conservation and the ghost of persecution past. *Biological Conservation*, 144 (9): 2163-2170.

Appendix

Appendix 1. Hunting simulation protocol filled in during the simulated hunts

HUNTING SIMULATION 2013

Hunt nr. H00 _13	**Date**	**Obs.**	**Frcv. GPS**
Bear ID	**Bear name**	**Collar**	**Frcv. Imp**
Habitat protocol nr. initial site		**Second site**	
Scat collected from initial site		**Second site**	
Status of hunt	Conducted	Not conducted	Disturbed before
Minimum distance when triangulating		**Other disturbance in forest**	

Bear location before hunt:	N:	E:
	Time	Moving
HUNTING TEAM	**Handler**	**Dog**

HUNT			
Start of schedule (GMT)		**End of schedule** (GMT)	
Hunt start (GMT from tracklog)		**Dog released** (GMT)	
Coordinates start hunt	N:	E:	
Coordinates dog released	N:	E:	
Dog behavior:			
Barking: Start (GMT):	Stop (GMT):	Start (GMT):	Stop (GMT):
Start (GMT):	Stop (GMT):	Start (GMT):	Stop (GMT):
Returned:		**Recalled**	
Dog returned for good (GMT):		Dog re-called for good (GMT):	
Hunting ended	GMT Time	N:	E:

Wind before hunt	Direction:	Strength:
Wind direction during hunt	Steady	Variable
Wind near bear	Direction:	Strength:
Temperature	**Weather**	

Bear detected by observers?	N Y	# bears: # COY/Yrl:
Description	Category: S HM V	Time: kl. …….. B D A
	Distance ……. meter	Visibility: VG G R P
If heard, describe in short		
Did the bear become aware of the observers?	N Y	**Bluff charge?** N Y
Did the observers feel threatened?	N Y If yes, why?:	

Comments handler:

Comments Sven/Tobias:

Norges miljø- og
biovitenskapelige
universitet

Postboks 5003
NO-1432 Ås
67 23 00 00
www.nmbu.no