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Observations of bears in relation to onset of the early big-game hunting and variations in pine cone production in Gardiner Ranger District, Montana

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Abstract

The early big game hunt in hunting district 316 (HD 316) on the Gardiner Ranger District, south west Montana USA, takes place within the Primary Conservation Area for the Yellowstone grizzly bear (*Ursus arctos horribilis*). Outside of the hunting season, HD 316 is also a popular area for hiking, horseback riding and camping during the whole bare ground season. The hunting activity has been an object for concern due to increased grizzly bear mortality. The mortality is mainly related to conflicts between hunters and bears (usually grizzlies) and the reason for the conflicts points towards the scattered remains from harvested ungulates. Years when the cone production of whitebark pine (*Pinus albicaulis*) is low have shown an increase in these human-bear conflicts in the Greater Yellowstone Area (GYA). The purpose of this study is to:

- Investigate if bear observations by backcountry travelers increase in HD 316 at the onset of the early big-game hunting season.
- Investigate if the fluctuations in cone production of whitebark pine affect the amount of bear observations in HD 316

The study is based on information from backcountry travelers interviewed on trails in the eastern part of Gardiner Ranger District where hunting district 316 constitutes the greatest part. The data was collected between May and November (1998-2008). The annual production of whitebark pine (*Pinus albicaulis*) cones (1998-2008) was compared to the annual proportion of observed bears during hunting season (1998-2008).

More bears, grizzlies and black bears (*Ursus americanus*) pooled, were seen during the hunting season in HD 316 than before hunting season. There are an inverse correlation between the annual cone production of whitebark pine and the proportions of annual bear observations. Poor cone production years had more bear observations during both hunting season and non-hunting season compared to good cone years, but the difference between the two seasons were greater during good cone production years. When cone production was good, bears were 4,34 times (95% CI: 2,35 - 8,01) more likely to be observed during hunting season compared to non-hunting season. During poor cone years, bears were 3,82 times (95% CI: 2,42 - 6,05) more likely to be observed during hunting season compared to non-hunting season. The corresponding numbers for grizzly showed a significant 7,44 times (95% CI 3,15 – 17,6) and 4,34 times (95% CI 2,56 – 7,37), respectively. The numbers of observed black bears were relatively low, but showed a tendency of more observations during hunting season in both poor and good cone years.

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1. Introduction

In 2007, the Yellowstone grizzly bear (*Ursus arctos horribilis*) was removed from the Endangered Species list. Before it was delisted in 2007 it had been threatened for 32 years in the lower 48 states. In the fall of 2009 the grizzly was again put back on the list due to a combination of threats; habitat change with decimated whitebark pine (*Pinus albicaulis*) forests and increased human caused mortality (NRDC 2009). For the survival of the population, concern for the long-term status continues (Tyers 2009 personal communication). Consequently, the Recovery Plan for this species requires limiting human-caused mortality, which is one part of a comprehensive strategy to maintain the population at a prescribed level (Tyers 2009 personal communication). In 1974 just before the time of listing, the amount of grizzlies in the Greater Yellowstone Area (GYA) was estimated at 136 (Craighead et al. 1974). In 2007 the population had recovered (Haraldson et al. 2008), and the number of grizzlies was estimated at approximately 571 (Gunther 2008). The Yellowstone grizzly bear population is estimated to increase about four percent each year (Servheen 2009).

Black bears (*Ursus americanus*) in Yellowstone are considered to be common, but no current estimate is available (Gunther 2006). The black bear is sympatric with the grizzly (Lavière 2001), and the species share most of the food habits in the Yellowstone ecosystem (Gunther 2006). Due to its shorter claws that are more adapted to tree climbing, the black bears ability of digging is limited; the amount of roots and other in soil located food in black bears diet is therefore less abundant (Herrero 1985). The slight differences in the diet and habitat use make the competition between the two bear species limited (Lavière 2001).

One crucial food source for both bears is seeds from the whitebark pine (Herrero 1985). This tree grows at higher altitudes up to 3,200 meter (10,500 ft) in the Yellowstone area (McCaughey et al. 2001). The seeds, that average 180 mg/seed, are rich in fat (McCaughey et al. 1986), and are especially important for bears in the fall before hibernation (Mattson et al. 1991). Variations in cone production of whitebark pine are normal (U.S.F.W.S. 2003) and this variation affects the bears in Yellowstone in their behavior and demography (Mattson et al. 1992). When this food supply is scarce, bears are forced to look for other food sources which often results in extended travel (U.S.F.W.S. 2003). This increases the risk of human-bear conflicts (Mattson et al. 1992). Due to the grizzly bears in and around Yellowstone National Park, government agencies developed a regulation in 1985 requiring all people on public lands to keep all bear attractants inaccessible to bears while recreating (GNF 2007). Human foods, garbage, scented or flavored toiletries, horse food, pet food and carcasses are all bear attractants (Herrero 1985). These “rewards” can create habituated and food conditioned bears that have to be destroyed for the protection of people (Herrero 1985). This unnecessary removal of bears contributes to the decline of the bear population and can also lead to more restrictive hunting regulations in the future (Tyers 2009 personal communication).
In recent years, confrontations with hunters have been the most significant source of human-caused grizzly bear mortalities in the Greater Yellowstone Area (GYA) (Tyers

2009 personal communication). The hunting related mortalities in GYA are also increasing (Haroldson 2010 unpublished data). In 2008 there were 20 losses related to hunting out of the 37 human caused grizzly bear mortalities in GYA (Haroldson et al 2009). The State of Montana regulates an early big game hunting season in Hunting District (HD) 316. With the appropriate permit, from September 15 to November 29 (2009), hunters can harvest elk (*Cervus elaphus*), moose (*Alces alces*), mule deer (*Odocoileus hemionus*), white tailed deer (*Odocoileus virginianus*), black bear, mountain goat (*Oreamnus americanus*) and bighorn sheep (*Ovis canadensis*) (MFWP 2009). HD 316 is the only district in the northern region of GYA that offers this early hunt.

Any form of human activity in bear country presents the risk of conflict between people and bears; hunting in particular creates a high potential for encounters (Tyers 2009 personal communication). The nature of hunter activities also creates the potential for confrontation. That is, hunters are secretive in their movements in an effort to surprise game and spend much of their time hunting at dawn and dusk when bears are more active. By contrast, travelers in bear country are advised to make noise to alert bears to their presence to avoid a confrontation. Most backcountry hunters travel with saddle and pack stock. Therefore, they have the ability and need to transport special horse feed that is highly sought after as a food item by bears (Tyers 2009 personal communication). Also, simply because they can transport more supplies, including food, horse parties can have a greater quantity of attractants on-site in the backcountry, which generates storage problems. In addition to the usual kinds of attractants often available at camps, hunters can generate harvested game and associated gut piles. These food sources are particularly appealing to bears in the fall when they are attempting to maximize calorie intact prior to entering dens for the winter (Tyers 2009 personal communication). A common opinion among hunters, hikers and outfitters in HD 316 is that more bears are observed during hunting season (Tyers 2009 personal communication). This was investigated (Ruth et al. 2003) in HD 316 by monitoring the movements of GPS telemetry collared grizzlies at the time before and after the start of the hunting season. Haroldson et al. 2004 did a similar study between 1989 and 2000 with consideration to the status of the whitebark pine cone production. Both reports support that grizzlies spent more time in the hunting district during the hunting season. The reports also suggest that this behavior is most likely due to the gut piles and crippled game caused by hunters. In addition to the studies by Ruth et al 2003 and Haroldson et al. 2004, the following study is conducted to investigate the effect the early big game hunting has on the amount of bear observations.

The aim of this study is to (i) investigate if the number of bear observations increases in HD 316 during the hunting season; (ii) investigate if the annual variation in cone production of whitebark pine affects the amount of observations.

2. Study Area

This study was conducted along approximately 560 km of backcountry trails on the eastern part of Gardiner Ranger District which constitutes most of HD 316 (appendix 1). Gardiner Ranger District is one of five Ranger Districts in the Gallatin National Forest in southwest Montana and is located juxtaposed to the northern boundary of Yellowstone National Park (figure 1). A majority of the Gardiner district is located within the 3,820 km^2 Absaroka-Beartooth Wilderness. The western half of the district lies within the Absaroka mountain range which is characterized by large drainage valleys and mountain divides. The eastern half is within the Beartooth Mountains, a high elevation plateau characterized by exposed bedrock slopes, lakes, and glaciers. Elevations in the study area range from 1,530 meters in the valley near Gardiner to 3,900 meters on the crest of the Beartooth Plateau on the eastern end of the district. Elevations above 2,300 meter are typically snow covered from late October through early June each year. The total annual precipitation in the study area is for the western part approximately 40 cm in average; the east side receives slightly more (USFS Gardiner Ranger District). Winter high temperatures average between 0 and 5 degrees Celsius (NRCS 2009); snow pack on the east side often average more than 3 meter compared to approximately 1 meter in the western portion of the study area.

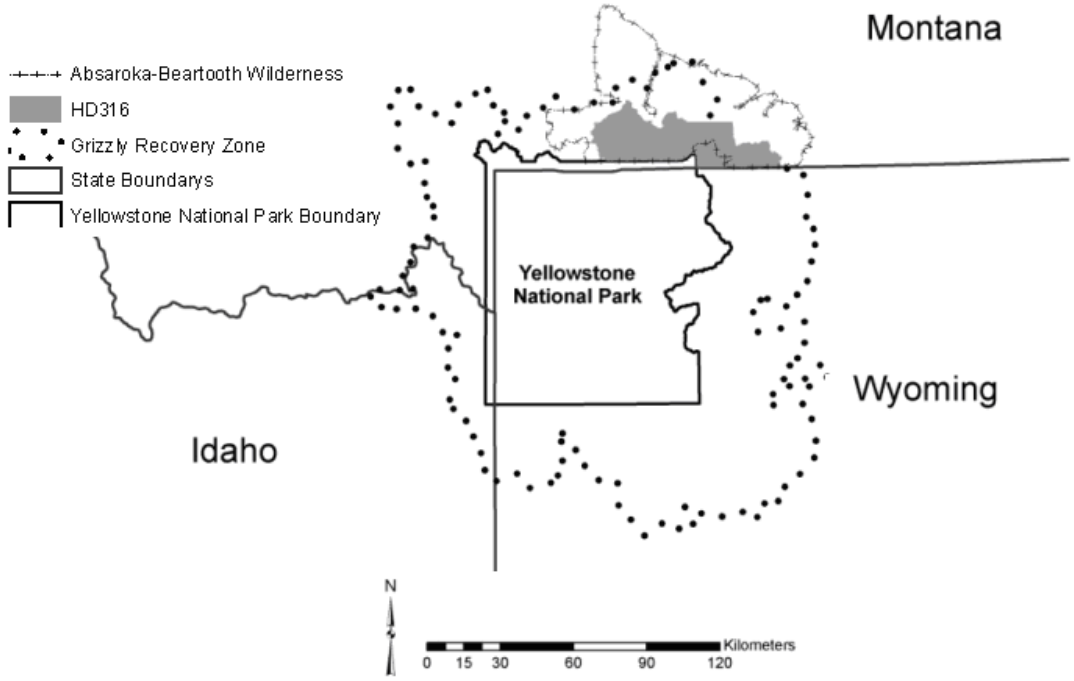

Figure1: The hunting district 316 (HD 316) north of Yellowstone National Park, USA. It is located within the grizzly bear recovery zone as well as the Absaroka-Beartooth Wilderness; a remote backcountry where travel is restricted to horseback or foot. (Map: J. Zimmer, U. S. Forest Service 2009)

The study area has a rich diversity of wildlife. In addition to both species of bears, the study area contains populations of other carnivores including mountain lion (*Felis concolor*), Canada lynx (*Lynx canadensis*), bobcat (*Felis rufus*); wolverine (*Gulo gulo*), pine marten (*Martes americana*), weasel (*Mustela sp.*); gray wolf (*Canis lupis*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*). In addition to the ungulates harvested during the early big game hunt, there are also bison (*Bison bison*) present in the area. The wilderness in the Gardiner District is a popular area during the summer for hiking, horse back riding, fishing and camping. The fall offers hunting possibilities as well while during winter the recreation opportunities are limited. In the wilderness all the motorized and mechanized activities are prohibited. The non-wilderness portion of the district facilitates a variety of year-round recreation activities. Forest Service management also allows timber harvesting and mineral exploration outside the wilderness portion of the district.

3. Methods

From 1998 to 2008, Forest Service employees collected information from approximately 3,400 backcountry trail users. Trails were traveled at least six times each year; four times during spring and summer and two times during the hunting season to collect information from people and to locate campsites. The information from the extensive survey contains people's mode of travel and character of activity; knowledge of bear safety and food storage; use of guns or bear spray and bear observations etc. Samples of this collected information were used in this study. With a few exceptions, most backcountry users that were contacted were willing to answer simple questions from forest service employees. The backcountry visitors traveled alone or in groups; groups of people were counted as one person. The data was collected from May to November depending on the snow conditions in spring and fall. The dates for the start and ending of hibernation for bears depend on latitude, local climate, age, sex and accessible food (Pelton 1982). For grizzlies in Yellowstone the average dates of emergence and denning are at the end of March and at the beginning of November respectively (Linnell et al. 2000). The Forest Service employee's interactions with the backcountry users were therefore more or less juxtaposed with the time when bears were awake. Among other questions, trail users were asked if they had seen bears; before the hunting season (15 May – 14 September) and during hunting season. The early big-game hunting season starts 15 September and ends at the end of November. The last day of the hunting season in this analysis was set to 20 November due to no data post this date. The observed bears were separated in to Grizzlies, Black bears and Unknown bears.

The data used in this study on all visitors located in the backcountry includes: Date of the collected information; if the visitors are hunting or not; if they have seen bears and what species of bear they saw.

3.1. Whitebark pine

Every year since 1980 the Interagency Grizzly Bear Study Team (IGBST) has presented information concerning the status of the cone production in whitebark pine. Data from the years 1998 to 2008 (Haroldson et al 1998-2008), were used in this study. The information is based on annual surveys from twenty-five transects scattered inside and outside Yellowstone National Park. Three transects Deaf Jim (A), Mt. Washburn (B) and Woody Creek (C) (appendix 1) are closest to the study area. They were expected to represent the status of the cone production in the study area and were therefore used in this study. The average cones/tree from the transects for each year from 1998 to 2008 were rated in good and poor cone production years (table 1) by using the median 8,8 cones/tree as the dividing line. Years between 1998 and 2008 were therefore considered to be either a good or a poor cone production year. Bear observations were then placed in either a good or a poor cone year and used in comparisons between non-hunting season and hunting season. The annual trend of cone production was also compared with the annual trend of bear observations.

Good and poor cone years

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Average cones/tree A, B and C [1]	7,6	24	8,8	27,5	0,2	23,7	1	6,7	27,9	13,8	5,6
Rating	Poor	Good	Poor	Good	Poor	Good	Poor	Poor	Good	Good	Poor

Table 1: Rated years of average cone production on transect A, B and C with the median 8, 8 as the dividing line. Years with ≤ 8, 8 cones/tree were considered to be poor years, > 8, 8 cones/tree were placed in the good year category, ([1] Haraldson et al. 1998-2008).

3.2. Analyses

The collected field data was stored and revised in Microsoft Excel. Chi-square test (Minitab) was used to look for any significant differences in data between the pooled pre hunting season (15 May – 14 September) and during hunting season (15 September – 20 November). The odds ratio was calculated to evaluate the strength of association between bear observations during hunting season and non-hunting season as well as poor cone years and good cone years, by using the VassarStats, Website for Statistical Computation: http://faculty.vassar.edu/lowry/VassarStats.html.

4. Results

The amount of interviewed visitors during hunting season between 1998 and 2008 shows a downward trend. This is analogous to the estimated number of hunters in HD 316 during the same period (Frey 2009, unpublished data). Since most of the backcountry travelers are hunters during the hunting season, hunters see more bears than non hunters during the fall. The amount of bear observations in HD 316 (1998-2008) before hunting season (15 May – 14 September) compared to the number of bear observations during hunting season (15 September – 20 November) showed an increase in bear observations during the hunting season (figure 2). Among the 2,658 backcountry travellers (non hunters and hunters) that were asked between 1998 and 2008, 130 backcountry travellers saw bears: 91 grizzlies, 32 black bears and seven were unknown.

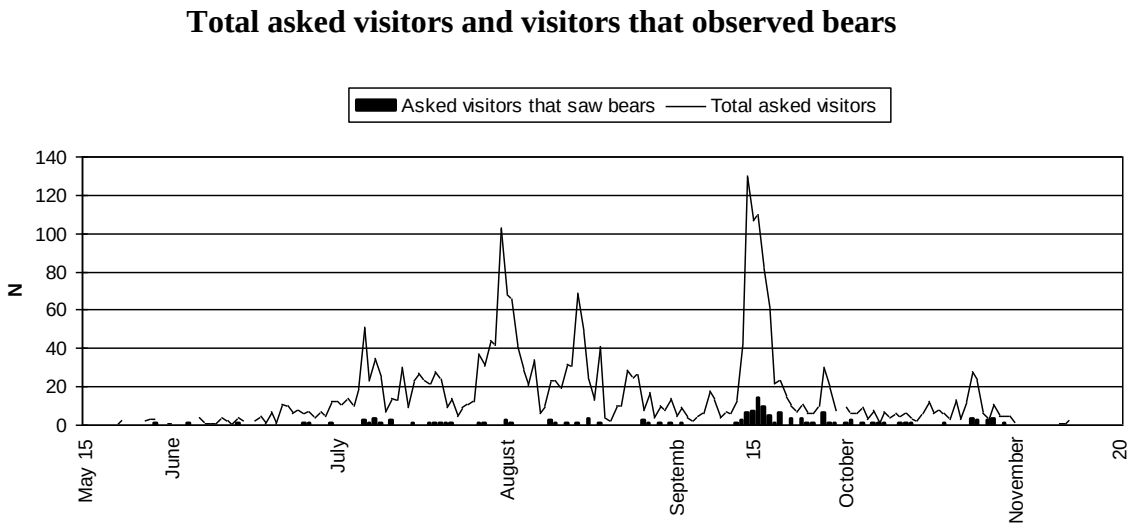

Figure 2: All the asked 2658 backcountry travellers and the 130 visitors that saw bears between 1998 and 2008. The early big-game hunting season in HD 316 starts the 15th September and ends (2009) 29th November.

4.1. Bear observations and cone production

The annual trend from the three whitebark pine transects was compared with the annual trend of bear observations from May to November between 1998 and 2008 (table 2). The result showed an inverse correlation between amounts of bear observations and cone production (table 2 and figure 3).

Observations in relation to cone production

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Proportion of people that saw bears	4,5	5,3	9	4,7	7,7	3,4	6,3	3,3	1,8	0,6	7,4
Average cones/tree A, B and C[1]	7,6	24,0	8,8	27,5	0,2	23,7	1	6,7	27,9	13,8	5,6
Rating	Poor	Good	Poor	Good	Poor	Good	Poor	Poor	Good	Good	Poor

Table 2: The proportion of asked people that saw bears from May to November (1998-2008) in relation to cone production of whitebark pine (*Pinus albicaulis*), ([1] Haraldson et al. 1998-2008).

Observations in relation to cone production

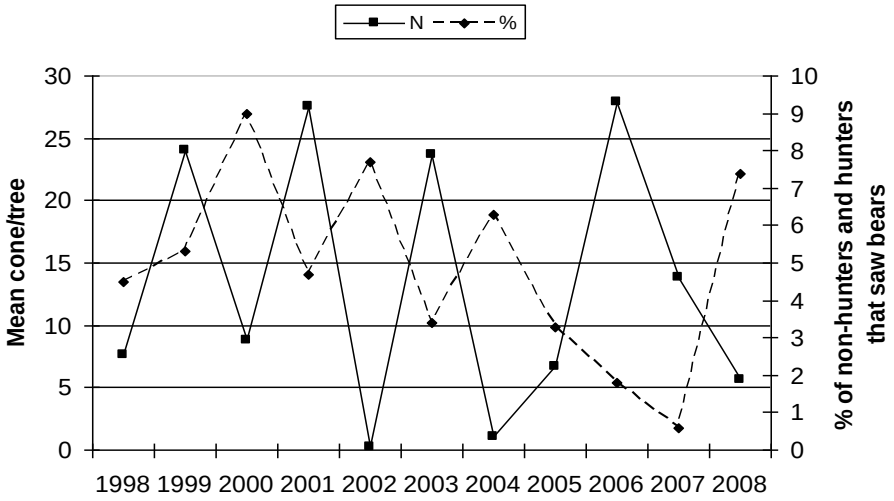

Figure 3: The proportion of asked people that saw bears from May to November (1998-2008) in relation to cone production of whitebark pine (*Pinus albicaulis*).

The poor cone years (-98, -00, -02, -04, -05 and -08) were separated from the good cone years (-99, -01, -03, -06 and 07); figure 4 demonstrates the difference of the proportion of bear observations between good and poor cone years of whitebark pine categorized in non-hunting season and hunting season. There are significantly more bear observations (grizzly and black bear pooled) during hunting season for both poor (Chi-Sq = 31,717; DF = 1; P-Value < 10^{-4}) and good (Chi-Sq = 23,393; DF = 1; P-Value < 10^{-4}) cone production years respectively (table 3). The difference in proportions between the two seasons is bigger during years of good cone production compared to years of poor cone production. The two species separated show that the proportions of grizzly observations were significantly higher during hunting season for poor (Chi-Sq = 34,262; DF = 1; P-Value < 10^{-4}) and good (Chi-Sq = 28,437; DF = 1; P-Value < 10^{-4}) cone years respectively (table 3). The odds ratio for grizzly exceeded 2 in both scenarios. For black bear, the corresponding result for poor and good cone years showed no significance, but a tendency of more observations during hunting season.

Proportion of people that saw bears during poor and good cone years

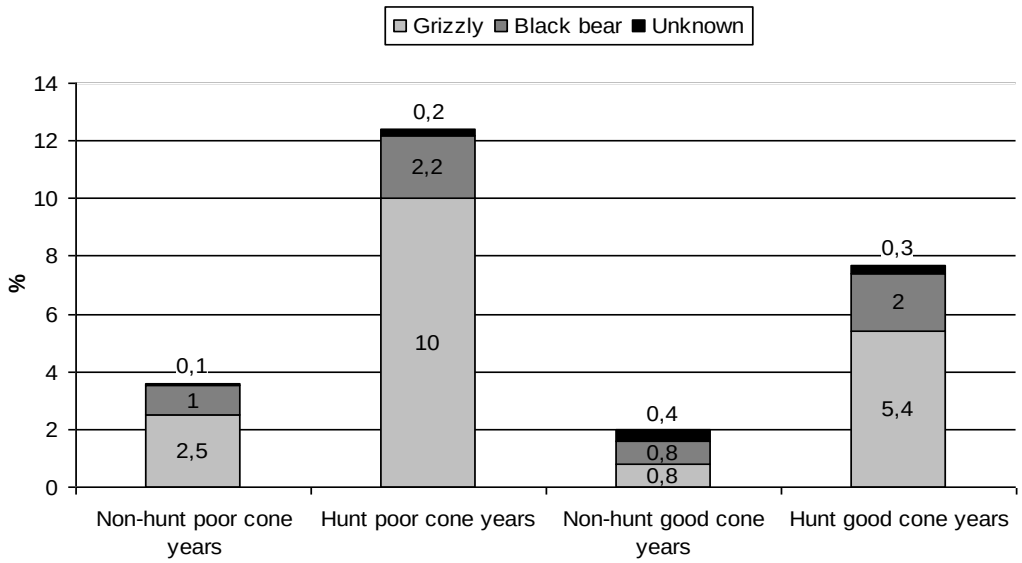

Figure 4: Proportions of backcountry travelers in HD 316 that saw bears during poor and good cone years respectively (1998-2008) in comparison with non-hunting season and hunting season.

Hunting season compared to Non-hunting season

All bears (Grizzly, black bear and unknown)

	Hunting season: Total/Saw bears	Non-hunting season: Total/Saw bears = Ref. (OR) 1	Odds Ratio	95 % CI
Poor cone years	459/57	839/30	3,82	2,42 - 6,05
Good cone years	299/23	1061/20	4,34	2,35 - 8,01
Poor & Good	758/80	1900/50	4,01	2,79 - 5,77

Grizzly

	Hunting season: Total/Saw grizzly	Non-hunting season: Total/Saw grizzly = Ref. (OR) 1	Odds Ratio	95 % CI
Poor cone years	459/46	839/21	4,34	2,56 – 7,37
Good cone years	299/16	1061/8	7,44	3,15 – 17,6
Poor & Good	758/62	1900/29	5,36	3,42 – 8,40

Black bear

	Hunting season: Total/Saw black bear	Non-hunting season: Total/Saw black bear = Ref. (OR)1	Odds Ratio	95 % CI
Poor cone years	459/10	839/8	2,31	0,91 – 5,90
Good cone years	299/6	1061/8	2,70	0,93 – 7,83
Poor & Good	758/16	1900/16	2,51	1,25 – 5,04

Table 3: Bear observations from the hunting season in relation to bear observations from non-hunting season, separated in poor and good cone production years respectively (1998-2008).

Poor cone years compared to Good cone years

All bears (Grizzly, black bear and unknown)

	Poor cone years: Total/Saw bears	Good cone years: Total/Saw bears = Ref. (OR) 1	Odds Ratio	95 % CI
Hunting seasons	459/57	299/23	1,70	1,02 - 2,83
Non-hunting seasons	839/30	1061/20	1,93	1,09 - 3,42
Both seasons	1298/87	1360/43	2,20	1,51 - 3,20

Grizzly

	Poor cone years: Total/Saw grizzly	Good cone years: Total/Saw grizzly = Ref. (OR)1	Odds Ratio	95 % CI
Hunting seasons	459/46	299/16	1,97	1,09 – 3,55
Non-hunting seasons	839/21	1061/8	1,27	0,47 – 3,39
Both seasons	1298/67	1360/24	3,03	1,89 – 4,86

Black bear

	Poor cone years: Total/Saw black bear	Good cone years: Total/Saw black bear = Ref. (OR)1	Odds Ratio	95 % CI
Hunting seasons	459/10	299/6	1,09	0,39 – 3,03
Non-hunting seasons	839/8	1061/8	1,27	0,47 – 3,39
Both seasons	1298/18	1360/14	1,35	0,67 – 2,73

Table 4: Bear observations from the poor cone production years in relation to bear observations from good cone production years, separated in hunting season, non-hunting season and both seasons (1998-2008).

The analysis revealed a few significant differences when comparing the poor cone years with the good cone years (table 4). These are for All bears, where the pooled hunting seasons and non-hunting seasons (Both seasons) had significantly higher proportion of bear observations during the poor cone years (Chi-Sq = 16,223; DF = 1; P-Value < 10^{-4}); the pooled non-hunting seasons for All bears also showed a significantly higher proportion of observations (Chi-Sq = 4,949; DF = 1; P-Value = 0,026). For Grizzly, poor cone years showed significantly more observations for both seasons (Chi-Sq = 23,180; DF = 1; P-Value < 10^{-4}) and hunting seasons (Chi-Sq = 4,507; DF = 1; P-Value = 0,034) and non-hunting season (Chi-Sq = 9,535; DF = 1; P-Value = 0,002) respectively. No significance was found in the proportion of black bear observations.

5. Discussion

The harvest in HD 316 is mainly focused on elk and all deer (mule deer with very few white tail deer) with an estimated cull of 108 elk in 1999 (no data for 1998) down to 17 elk in 2008. The all deer cull has been rather constant with an average of 28 deer per year between 2001 and 2008 (no data for 1998-2000) (MFWP 2009). With rumen content excluded, which is approximately 14 % of live weight (Wilmers et al. 2003), the weight of gut piles produced from elk and all deer during 1999-2008 was over 34 tons in HD 316. Since the late 1990's, elk have changed their land use and start the movements out of Gallatin National Forest in to private land and Yellowstone National Park earlier in the season (less disturbance from wolves, grizzlies and hunters); elk have become less available in HD 316 and hunters have abandoned their familiar hunting areas (Frey and Haroldson 2009, unpublished data, Zimmer 2010, personal communication). This should explain the downward trend in the number of interviewed backcountry visitors during the hunting season. The reason for the increase in observations during hunting season, points towards the gut remains, carcasses and uncertain amount of wounded game created by the hunters. It can not be eliminated though that an uncertain amount of bears might be specialized in food searching in camps; due to a learnt behaviour from visiting camps with accessible rewards (Herrero 1985).

There is a reason to believe that hunters see relatively more bears than non hunters due to the nature of their activity. Except for the noisier transportation with horses on trails, hunters stalk around a considerable time off the trails. They are silent and actively searching for game; especially during early and late hours in the day. Non-hunters, on the other hand, are more active during mid day when bears are less active (Zimmer 2009, personal communication). Therefore there might be a risk of overestimating the observation result.

There is an increase of bear observations a few days before the start of the hunting season. Even so, the actual starting date of the hunting season of 15 September was used in this study as the dividing line between non hunting season and hunting season. This eliminates the difficulty of choosing a reasonable date adjusted to the bear movements; the effect would also be negligible with a little change of the result. As an example, moving the date to 10 September would give 185 (156 hunters and 29 non-hunters) more visitors and seven bears (six grizzlies and one black bear) to the hunting season (1998-2008). It is however an interesting behaviour of bears that brings up questions: Does the increasing activity from the preparing hunters trigger the bears to move in to the area? Or have the earlier years of repeated early elk hunting imprinted or taught bears towards this behaviour?

The cone production of whitebark pine in the study area was predicted to correspond with the data from transects A: Deaf Jim, B: Mt. Washburn and C: Woody Creek (A, B and C from the original reports). The longest distance between the three transects (A, B and C) in average to the farthest of the 25 transects, (CSC) in the southern region, is approximately 300 km as the crow flies. Certain years show better cone production in the southern region compared to those transects closer to Gardiner Ranger District and

vice versa. The annual trend of the three transects together shows a bigger variation compared to the annual trend of the average from all transects. Still, the total average from all 25 transects does not differ considerably from the three transects.

Significantly more bears were observed by backcountry travellers during hunting season for both poor and good cone years. More bears were also seen during non-hunting season when cone production was poor compared to good cone years.
In this study, the pooled good cone years showed a greater difference in grizzly observations between non-hunting season and hunting season (OR=7,44), compared to the pooled poor years (OR=4,34). One explanation for this may be that more grizzlies are located at higher altitudes during good cone years (Mattson et al. 1992), where whitebark pines grow and where relatively few people occur. In poor cone years, however, the grizzlies get attracted to the hunting activity at lower altitudes, where more people are. The proportion of grizzly observations increases and creates this higher odds ratio. Due to the need of substitute food sources to whitebark pine during the poor cone years with extended travel (Mattson et al. 1992), the proportion of observations is already relatively high during the non-hunting season. This should explain the lower odds ratio of 4,34. The hunting season seems to have a greater influence on the proportion of observations than the influence from the status of cone production – odds ratio: 4,01 vs. 2,20 (table 3 & 4).

Most bear observations in Gardiner Ranger District are associated with grizzlies. Results show that even black bear observations increase during hunting season; it would therefore be wrong to refer to just grizzlies. The abundance of grizzlies in the area at this time could be one explanation to the lower number of black bear observations, since black bears usually avoid grizzlies (Herrero 1985).

Seeds from the cones of whitebark pine may not seem to be a very efficient bear food in terms of size and availability. One should remember though that bears steal these seeds from red squirrel caches on the ground; caches that could contain a huge number of cones and with seeds averaging 78 percent oil (Busch 2000). Compared to protein and carbohydrates, fat has twice the density of calories; this makes the seeds a food rich in energy to fatten on before hibernation (Herrero 1985). The inverse correlation between the ratio of bear observations during hunting season, with its gut piles and carcasses, and cone production shows how important Whitebark pine is to bears.

There is also another side to this issue; the same reason that might be a hazard for the grizzly population in Yellowstone ecosystem is also a help for the grizzly. The game remains might even save some grizzlies life over the winter. Also, a carcass or a couple of gut piles for a pregnant sow before the hibernation might be crucial for a successful reproduction (Herrero 1985). The game remains produced by the hunters are especially an asset for bears during years of poor cone production. Still, the cost could be greater than the gain for the grizzly population in Yellowstone.

5.1. Management implications

In addition to earlier studies, this study shows how the early big-game hunting season in HD 316 and the availability of whitebark pine cones affect the behavior of bears. The early big-game hunting season in combination with poor production of whitebark pine cones, presents a higher risk for confrontations with bears compared to non-hunting season and good cone production. As noted by Mattson et al. (1992), annual surveys of the cone status in Yellowstone are one important tool to predict high or low numbers of bear encounters. Improvements and change of the hunting activity could be necessary, by removing parts that contributes to the decline of the grizzly population.

A not so popular solution of the increasing hunter caused bear mortality would be to remove the early big game hunt in HD 316; not popular in the sense that hunters lose hunting possibilities during rutting season of elk. Despite that, the bears would be closer to denning if hunting started at the general hunting season at the end of October. As a side effect, a closing of the early hunt could perhaps generate interesting research possibilities by analyzing movements and behaviors of bears and other wildlife accustomed to the early hunt. Since elk have started shifting their land uses towards the more peaceful areas and move away earlier from HD 316, the picture may change in the future and the hunter caused bear mortality may decrease (Frey and Haroldson 2009 Unpublished data). The bad food storage in the camps could be a reason for more concern for managers than the scattered gut piles. The bad food storage and the left attractants are located where people are and bears may associate these rewards with people and camps. Gut piles are usually spread out randomly in the terrain and are often consumed when hunters have left. These bears may not necessarily have to associate gut piles with people.

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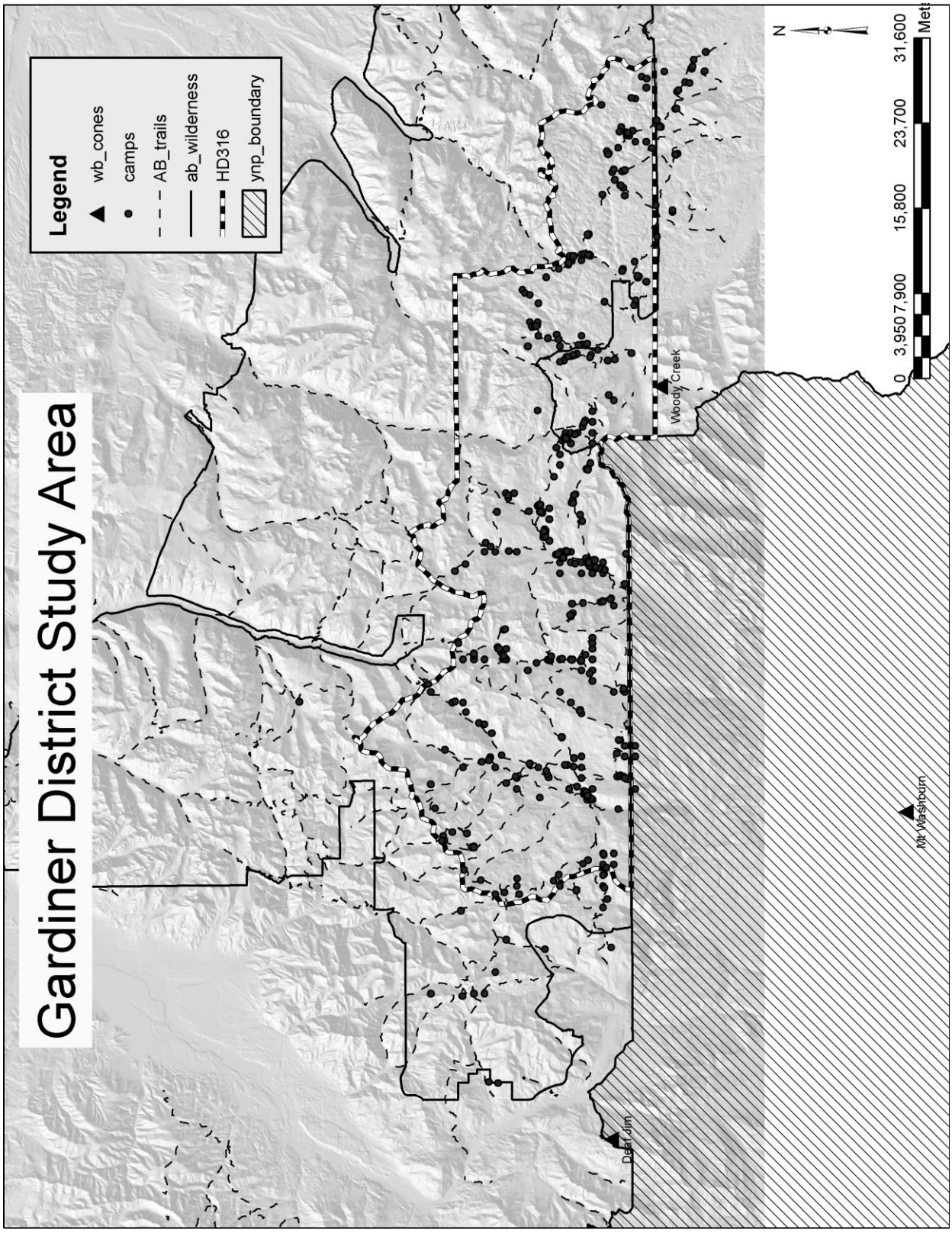
Appendix 1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AB_trails
ab_wilderness
HD316
ynp_boundary
N
0
3,950
7,900
15,800
23,700
31,600
Woody Creek
Mt Washburn
Dead Jim