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Suspended baits: Can they help hunters distinguish male from female American black bears?

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Abstract: American black bear (*Ursus americanus*) population dynamics are most sensitive to survival of adult females. To ensure that harvest is sustainable, harvest should be skewed to males. In addition, in jurisdictions with a spring harvest, lactating females should not be harvested. Hunting over bait provides hunters the opportunity to observe bears, yet many hunters have difficulty identifying the sex of bears at bait sites. We evaluated the use of suspended baits to determine whether this technique could help hunters correctly distinguish male from female black bears. We also evaluated hunter knowledge of black bears and hunter familiarity with hunting regulations to determine whether these influenced harvest. The proportion of female black bears harvested at suspended or traditional ground bait sites was similar; however, hunters did not always give bears the opportunity to stand at suspended baits. The suspended bait technique shows promise and should be explored further in a larger study. Using the provincial harvest as the control group (33% females on average), power analysis indicated that a sample size of 1,325 harvested animals would be required in the treatment group to detect a small effect size (10%; i.e., reduction of female harvest from 33% to 29.7%) with $\beta = 0.1$. A 20% effect size (i.e., reduction of harvest from 33% females to 26.4%) would require a sample size of 247 harvested bears in the treatment group, and a 30% effect size (i.e., reduction of harvest from 33% females to 23%) would require a sample size of 101 harvested animals in the treatment group.

Key words: American black bear, baiting, Canada, hunting, hunting methods, Ontario, suspended baits, sustainable harvest, *Ursus americanus*

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Careful management of the harvest of wildlife populations is important for large mammals such as American black bears (*Ursus americanus*), which can have late sexual maturation and comparatively low reproductive rates. Age of primiparity in black bears is generally 3–7 years, and because offspring remain with their mother until they are 17–18 months old, adult females normally reproduce every other year (Jonkel and Cowan 1971, Kolenosky and Strathearn 1987). Consequently, the dynamics of bear populations are sensitive to survival of adult females (Taylor et al. 1987). Male bears are generally more vulnerable to hunters (Bunnell and Tait 1985, Boulay et al. 1999); however, during periods of low natural food abundance hunter success rate increases (McDonald et al. 1994) and both the proportion and mean age of females in the fall harvest increases (Noyce and Garshelis 1997). To ensure sustainability of hunted black bear populations, it may be necessary to achieve a harvest that is skewed toward males and protects adult females. Furthermore, in jurisdictions where there is a spring harvest, the killing of nursing female black bears has been identified as a major concern among anti-hunting groups (Beck et al. 1995). Wildlife managers are responsible for implementing hunting policies that consider public sentiment as well as wildlife population dynamics (Beck et al. 1995, Teel et al. 2002).

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Therefore, a hunting method that reduces the harvest of adult female black bears and minimizes the chance of a hunter mistakenly harvesting a lactating female could help ensure the sustainability of black bear populations and address concerns of anti-hunting groups.

Hunting techniques available to black bear hunters vary among jurisdictions, but in Ontario, Canada, before 1999 when there was both a spring and a fall hunting season, baiting was the most popular method used in the spring (by 70% of resident hunters and 98% of non-residents) and the most popular method of hunting in both seasons combined (60% of residents, 96% of non-residents; de Almeida and Obbard 2002). This pattern remained after the spring season was cancelled in 1999, with about 62% of resident and 95% of non-resident hunters hunting over baits during the fall season (de Almeida and Obbard 2005).

Hunting over baits can enhance harvest selectivity because baiting provides hunters increased opportunities to observe bears (Beck et al. 1995). The technique is often favored among novice hunters (Beck et al. 1995). Hunting over baits can result in a larger proportion of males in the harvest than either stalking or hound hunting (Litvaitis and Kane 1994, Kohlmann et al. 1999). However, in jurisdictions where there is a spring hunt, nursing females frequently appear in the harvest despite legislation to protect females accompanied by cubs-of-the-year (Beck et al. 1995).

It is difficult to accurately determine the sex of smaller bears and the nursing status of a free-ranging bear (Beck et al. 1995). The distance between a bear and a hunter, the low light at twilight during periods of increased bear activity, and the high proportion of inexperienced bear hunters at bait hunting sites limit the ability of hunters to differentiate between the sexes (Beck et al. 1995). A method that improves a hunter's chances of correctly identifying the sex of a bear would be a valuable tool to influence the sex- and age-structure of the harvest.

During bear management information workshops conducted by the Ontario Ministry of Natural Resources (OMNR) across Ontario from 1995–97, several bear outfitters suggested that using baits suspended some distance above the ground might enable hunters to better discriminate between male and female bears. By forcing a bear to stand up to retrieve bait, the hunter would have an opportunity to assess the sex of the bear (enlarged nipples, presence or absence of penis) and, if female, whether it was lactating (swollen mammae). This would increase the chance of hunters detecting lactating females during the spring season and would increase the chance of a hunter correctly identifying the sex of a bear during any season. This hunting method could reduce or eliminate the killing of lactating females during a spring season and reduce the overall harvest of adult females in any hunting season.

In Ontario, outfitters generally provide information sessions to their clients before the hunt on hunting regulations and techniques used to distinguish male from female bears. We evaluated the efficacy of suspended baits in enabling hunters to discriminate between male and female bears and evaluated hunters' knowledge of hunting regulations and their ability to correctly identify the sex of black bears following the outfitter information session.

Methods

The study was conducted during the spring bear hunting season (May–Jun 1998) in the Bear Management Areas of 3 outfitters in central and northern Ontario, Canada: Loring Bear Outfitters near Parry Sound (PS); Bear Paw Camp near Sudbury (S); and Canoe Canada Outfitters near Atikokan (A; Fig. 1). In 1998 it was illegal to shoot or attempt to shoot a cub or a female black bear accompanied by a cub during the spring season (Fish and Wildlife Conservation Act, Statutes of Ontario, 1997; Chapter 41, Ontario Regulation 665/98, Section 61(1); http://www.e-laws.gov.on.ca).

At each outfitting camp, pre-existing bait sites were randomly assigned as being suspended or ground sites. At traditional ground bait sites, 20-L pails were buried in the ground and filled with butcher's scraps or surplus baked goods. Suspended bait sites were created by hanging 2–3 kg of bait wrapped in burlap or onion bags 2.5 m above ground from a sturdy tripod constructed from poles or a taut rope strung between trees (Fig. 2). Additional bait was spread on the ground at suspended bait sites. Outfitters and field assistants assigned hunters to each type of bait site for each hunting session each day ensuring as much as possible that hunters with equal experience were sent to each bait type. Field assistants interviewed hunters before their first hunting session but after the outfitter's information session and after every hunting session.

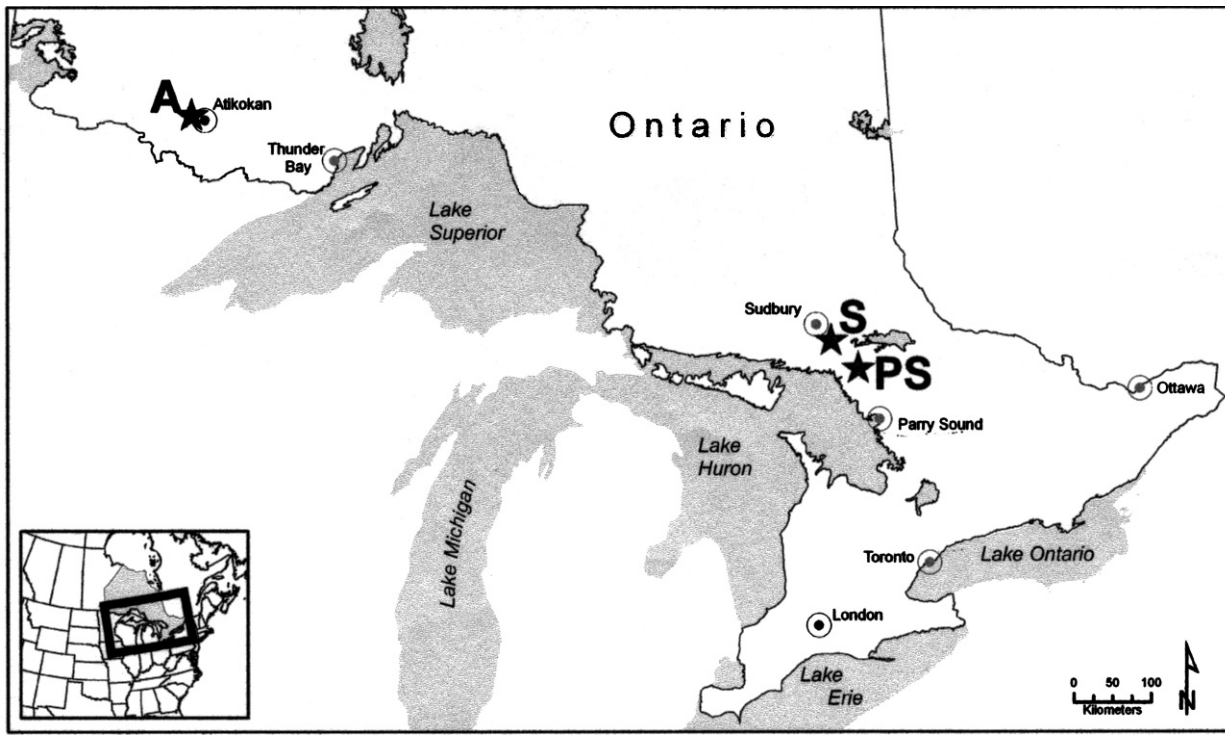

Fig. 1. Locations of 3 sites to study the effect of suspended baits on the harvest of black bears in central and northern Ontario, Canada, 1998: Loring Bear Outfitters near Parry Sound (PS); Bear Paw Camp near Sudbury (S), and Canoe Canada Outfitters near Atikokan (A).

In pre-hunt interviews, hunters reported their total years of hunting experience, number of years hunting black bears, and number of years of hunting in Ontario. We then asked questions that evaluated the information retained by hunters from the outfitter information session provided prior to the first hunting session and the general knowledge about bear hunting.

Our evaluation of the information provided by the outfitter and retained by the hunter was scored out of 12 and based on answers to the following questions: (1) Did the outfitter discuss Ontario black bear hunting regulations? (Yes [1] or No [0]); (2) Did the outfitter discuss how to distinguish between male and female black bears? (Yes [1], No [0], and How [up to 3 points based on our evaluation of quality of information]); (3) Did the outfitter discuss how to distinguish between lone females and females with young? (Yes [1], No [0], and How [up to 3 points]); and (4) Did the outfitter discuss how to distinguish between cubs-of-the-year and yearlings? (Yes [1], No [0], and How [up to 2 points]).

The hunter's general knowledge of bear hunting was scored out of 13, where the score was based on answers to the following questions: (1) Do you consider that you are familiar with Ontario hunting regulations (Yes [1] or No [0]); (2) Is it legal to harvest a female accompanied by cubs-of-the-year during the spring season (Yes [0] or No [1]); (3) Do you consider that you can distinguish between male and female bears (Yes [1], No [0], and How [up to 3 points based on our evaluation of quality of information]); (4) Do you consider that you can distinguish between non-nursing and nursing females (Yes [1], No [0], and How [up to 2 points]); and (5) Do you consider that you can distinguish between cubs-of-the-year and yearlings (Yes [1], No [0], and How [up to 3 points]).

In post-hunt interviews, all hunters were interviewed after each hunting session using a standard questionnaire to gain information on the following: type of bait site (ground or suspended); hunter's location (ground or tree stand); distance to the bait from shooting location (m); number and types of

Fig. 2. Suspended bait hanging from pole tripod with tree stand in background, Chapleau, Ontario, Canada, May, 1998.

bears observed; how long the bears stayed at the site (min); estimated age, sex, and reproductive status of all observed bears as well as the evidence used to estimate these variables; whether the bear stood up; the length of time a hunter spent observing before making a shooting decision; and the reasons for shooting or not shooting at a bear.

Field assistants examined all harvested bears, recorded the sex of the bear, and assessed whether harvested females were lactating. Field assistants also measured the distance (to the nearest m) between hunter location and the bait at each site. We removed a pre-molar tooth for aging (Stoneberg and Jonkel 1966); animals $\geq$5 years were considered adults for analysis (Kolenosky 1990).

We compared hunter knowledge of regulations and bear hunting practices among study sites using 1-way analysis of variance (ANOVA). We tested the null hypothesis that values for variables for suspended and ground baits did not differ using *t*-tests, χ^2, or Fisher's exact tests where appropriate with $\alpha = 0.05$. Statistical analyses were performed using SYSTAT® version 8.0 (SPSS 1998) or Statistix 7® (Analytical Software 2000).

Following the study we performed a power analysis (Cohen 1977, Lenth 2006) to determine the number of harvested animals, and thereby the number of hunters or hunting sessions required to rigorously test whether using suspended baits can reduce female harvest. We used the long-term (1990–2003) harvest rate of females in the provincial harvest (33.1%; de Almeida and Obbard 2005) for comparison. We determined sample sizes necessary to test the equality of 2 proportions (i.e., proportion [$p1$] < proportion [$p2$]) where $p1 = 0.33$, the long-term provincial harvest rate of females, and $p2$ represents the harvest rate under a suspended-baits management scenario. We evaluated 2 scenarios. In the first, we assumed a matched study design with equal sample sizes in the treatment and control groups. In the second scenario we assumed we would have access to provincial harvest data for the year of the study so determined the sample size required in the treatment group if the control group was the

Table 1. Mean (SD) experience level and knowledge scores of black bear hunters at 3 outfitter locations in northern Ontario, Canada, 1998. Hunter knowledge and the information hunters retained from outfitter information sessions were scored based on our long-term experience regarding the value of specific characteristics as indicators of age, sex, and reproductive status of American black bears. (*P*-values are for 1-way ANOVA of overall outfitter effects; Tukey's post-hoc test used for pairwise comparisons.)

	Outfitter location			
Scores	**Parry Sound**	**Sudbury**	**Atikokan**	**Combined**
Years of hunting experience	2.7 (2.2)	1.7 (2.6)	1.9 (4.4)	2.0 (3.5)
Years of hunting experience in Ontario	2.3 (1.7)	1.5 (2.5)	1.1 (3.3)	1.5 (2.7)
Information retained from outfitter session (maximum = 12; $P = 0.752$)	7.3 (1.7)	8.0 (2.2)	7.5 (2.7)	7.6 (2.3)
Hunter knowledge (maximum = 13; $P = 0.007$)	9.6[a] (1.3)	8.6 (2.2)	7.5[a] (1.6)	8.3 (1.9)
Combined evaluation scores (maximum = 25)	16.9 (2.9)	16.6 (3.7)	15.0 (3.6)	15.9 (3.5)

[a]Means with the same superscript differ ($P = 0.006$)

provincial harvest (we assumed information would be available on the sex of 3,000 harvested animals). The test of equal proportions tested whether the harvest rate using suspended baits was less than the long-term average for the province, which is largely determined by harvest over ground baits (de Almeida and Obbard 2005). We set $p2$ at various values from a small effect size (10% reduction in harvest of females) to a large effect size (30% reduction), so $p2$ had values of 0.297 (10% [small] effect size), 0.280 (15% effect size), 0.264 (20% effect size), 0.248 (25% effect size), and 0.230 (30% effect size).

We assumed that any reduction in the harvest of females would be beneficial in ensuring a sustainable harvest. Therefore, we were concerned about Type II error, the possibility of not detecting a difference when one exists, so we set power = 90% (i.e., $\beta = 0.10$). We also determined sample sizes necessary with power set = 80% (i.e., $\beta = 0.20$). We were less concerned about Type I error, the possibility of rejecting the null hypothesis when no difference exists, so we set $\alpha = 0.20$. We used a 1-tailed test because we expected that using suspended baits would reduce the harvest of females. If no difference was detected in female harvest between ground baits and suspended baits or there was an increase in harvest of females over suspended baits, we assumed this would have no effect on the status quo (i.e., no incentive to change hunting methods and begin using suspended baits).

Results

Hunter knowledge

Forty-three hunters participated in the study at the Parry Sound ($n = 11$), Sudbury ($n = 11$), and Atikokan ($n = 21$) sites; they averaged 2 years of hunting experience (Table 1). Scores of hunter knowledge of regulations and the ability to distinguish males, females, nursing females, cubs, and yearlings ranged from 9–22 out of 25 points (36–88%) and averaged 16 (64%; Table 1). Knowledge that appeared to be particularly lacking included the ability to distinguish between cubs and yearlings and either a lack or inconsistent use of the descriptors that we believe are most useful for distinguishing among males, females, and nursing females.

There were no apparent differences among people hunting with the 3 outfitters for combined evaluation scores ($F = 1.426$; 2, 40 df; $P = 0.25$) or for scores relating to information retained by hunters from outfitter sessions ($F = 0.288$; 2, 40 df; $P = 0.75$). There was a difference among outfitters in the apparent level of knowledge of their client hunters ($F = 5.558$; 2, 40 df; $P = 0.007$; Table 1). Tukey's pairwise comparison post-hoc test indicated that Parry Sound hunters were more knowledgeable than Atikokan hunters ($P = 0.006$). Hunter knowledge increased with total years of hunting experience ($r_s = 0.323$, $P = 0.035$), reflecting the difference in the proportion of first-time hunters between the areas (9% and 67%, respectively). Overall, 49% of hunters were first-time hunters ($n = 1, 6, 14$ in Parry Sound, Sudbury, and Atikokan, respectively).

Baiting type

Hunters used 26 suspended bait and 30 ground bait sites distributed equally among the outfitters. Hunters preferred tree stand locations (94%) over ground locations (6%). On only 3 of 47 occasions a hunter observed a bear at a suspended bait site from a ground level location. Mean distance between hunters and bait was similar at suspended ($\bar{x} = 14.4$,

SD = 3.0 m, $n = 17$) and ground sites ($\bar{x} = 14.7$, SD = 4.2 m, $n = 16$; $t = 0.308$, $P = 0.76$).

We obtained data on 203 hunting sessions including 104 at suspended bait sites and 99 at ground bait sites. The 43 hunters averaged 4.7 sessions each before harvesting a bear; a bear was observed during 25% of these sessions. There was no difference between the number of bears visiting suspended ($n = 36$) or ground bait sites ($n = 29$) for all locations combined ($\chi^2 = 0.754$, $P = 0.385$), or for each outfitter location (PS: $\chi^2 = 0.077$, $P = 0.782$; S: $\chi^2 = 0.529$, $P = 0.467$; A: $\chi^2 = 0.257$, $P = 0.612$). In total, 65 bears were sighted and the average length of a visit was 18.6 min (SD = 20.6, $n = 47$) with no difference between the time spent at suspended ($\bar{x} = 19.0$, SD = 21.5, $n = 28$) versus ground bait sites ($\bar{x} = 18.3$, SD = 19.8, $n = 19$; $t = 0.115$, $P = 0.909$).

The average time from sighting a bear until deciding whether to shoot was 16.0 min (SD = 19.4, $n = 45$), with no difference between suspended (17.6 min, SD = 22.1 min, $n = 24$) and ground bait sites (14.1 min, SD = 16.2 min, $n = 21$; $t = 0.616$, $P = 0.541$). The reasons hunters gave for not shooting at a bear included (occurrence in parentheses): Bear was too small (14) or a poor target (9), nursing female (3), female (3), radiocollared (2); poor visibility (9); or hunter was waiting (2), or indecisive (1). Twenty-nine percent of bears sighted were harvested and 44% of the hunters were successful. The proportion of males:females harvested was 0.79:0.21. Nineteen bears were harvested with no difference between suspended ($n = 7$) and ground bait sites ($n = 12$; $\chi^2 = 1.316$, $P = 0.251$). The harvest rate at ground bait sites (12 out of 29 sightings = 41.4%) appeared to be higher than at suspended sites (7 out of 36 sightings = 19.4%), but the difference was not significant using our $\alpha = 0.05$ criteria ($\chi^2 = 3.736$, $P = 0.053$).

Hunters were asked to estimate the age and to assess the sex and reproductive status of every bear observed. We ranked the value of the various descriptors (characteristics) used by hunters to make these estimates from 1–6 based on our long-term familiarity with bears (Table 2). Hunters used weight and body size appropriately to estimate the age class of bears. We considered body proportions (i.e., height at shoulder, massiveness of neck, shoulders, and forelegs) to be a valuable descriptor of age class, but this was seldom used by hunters. Descriptors we rated as valuable for assessing sex such as enlarged nipples, penis, neck size and shape, and body shape and proportions were infrequently or never used by hunters. Few hunters reported the reproductive status of females, and those who did based their assessment primarily on visual sightings of young. Other characteristics we ranked as valuable to determine reproductive status such as the presence of swollen mammae and hair loss surrounding the nipple area were never used.

Table 2. Descriptors to estimate age, sex, and reproductive status of black bears visiting bait sites in central and northern Ontario, Canada, 1998 including our ranking of value in determining age class or sex (1 = most useful, 6 = least useful) and frequency of use by hunters (%). Sample size is number of times a descriptor was used by hunters; more than 1 descriptor may have been used to assess a bear.

Category	Evidence descriptor	%	Rank
Age ($n = 84$)	Presence of young	1.2	1
	Body size	46.4	1
	Length of body	2.4	2
	Weight	19.0	2
	Body proportions	2.4	2
	Body shape	10.7	2
	Height (at shoulder)	1.2	3
	Head size	3.6	3
	Head shape	0	4
	Shape of snout	10.7	5
	Ear size	2.4	6
Sex ($n = 64$)	Penis	3.1	1
	Vulva	0	1
	Presence or absence of young	9.4	1
	Enlarged nipples (presence or absence)	3.1	1
	Nipples (presence or absence)	3.1	2
	Head shape	18.8	2
	Head size	15.6	2
	Neck shape	1.6	2
	Neck size	3.1	2
	Body proportions	3.1	3
	Body shape	29.7	3
	Body size	9.4	3
	Paw size	1.6	4
	Stance	1.6	5
	Pigeon-toed	3.1	6
Reproductive status ($n = 7$)	Young seen	71.4	1
	Young heard	28.6	2
	Swollen mammae	0	3
	Hair loss around nipples	0	4

Hunters estimated the correct age and sex of harvested bears 74% of the time (Table 3). The proportion of animals for which sex was correctly identified (4 of 7; 57%) when harvested at suspended bait sites did not differ from the proportion for which sex was correctly identified (10 of 12; 83%) when

Table 3. Harvest data for a study of black bear hunting in Ontario, Canada, 1998, including hunter's experience (years), combined score of hunter (%), age, sex and reproductive status of bear, and the evidence descriptors used to estimate. Actual (Act) and estimated (Est) values are reported for harvest data.

Years	Test score %[d]	Bait type[e]	Age[a]			Sex[b]			Reproductive status[c]	
			Act	Est	Evidence used by hunter	Act	Est	Evidence used by hunter	Act	Est
0	80	S	A	A	body shape, weight	M	M	pigeon-toed, body size	S	S
4	68	S	SA	Y	body size	M	M	proportions	S	S
0	68	S	SA	SA	body size	M	M	head size	S	S
2	64	S	Y	Y	body size	M	M	body size	S	S
1	76	S	Y	Y	height, body shape, weight	M	U		S	U
1	76	S	A	A	weight, height	F	M	body size, no swollen nipples	S	S
2	68	S	A	A	body size	F	M	body size, absence of young	L	S
1	72	G	A	A	body size	M	M	absence of young, body size,	S	S
0	72	G	A	A	weight	M	M	penis, neck size, pigeon-toed	S	S
0	80	G	A	A	body shape, height, weight	M	M	body shape, head shape, stance	S	S
0	60	G	A	A	body size, body shape	M	M	head shape, body size	S	S
2	52	G	A	A	length, head size	M	M	head shape, body size	S	S
0	40	G	SA	A	height, body size	M	M	head size	S	S
0	64	G	SA	A	height, body shape	M	M	head size, body shape, absence of young	S	S
1	36	G	SA	SA	body size	M	M	neck shape, neck size	S	S
0	52	G	Y	SA	head shape, ear size	M	M	absence of young	S	S
0	52	G	Y	Y	body size	M	M	no swollen nipples	S	S
15	88	G	A	SA	body size	F	M	body size	S	S
4	88	G	SA	SA	body size	F	M	head size, paw size	S	S

[a]Age: adult (A), subadult (SA), yearling (Y)
[b]Sex: female (F), male (M), unknown (U)
[c]Reproductive status: lactating (L), single (S; not lactating), unknown (U; no evidence descriptors were used by hunters)
[d]Test score: Percent score out of 25 for information retained by hunter from outfitter information session and general knowledge of bear hunting
[e]Bait type: suspended bait (S), ground bait (G)

harvested at ground bait sites ($P = 0.31$, Fisher's exact test; Seigel 1956). There was no obvious relationship between overall test scores or years of hunting experience and correct identification of the age and sex of the harvested bear (Table 3).

Three family groups were observed (1 female with cubs and 2 females with yearlings). Of 36 bears sighted at suspended bait sites, only 11 (31%) stood up at the site; 2 of 7 (28.6%) bears harvested at suspended sites stood up before being shot. There were no cases where a hunter observing a bear standing up at a suspended bait site was able to conclude that the bear was nursing. One nursing female was mistaken for a male and harvested (5.5% of total harvest); although harvested at a suspended bait site, this bear was shot while approaching the bait and had no chance to stand and investigate it. In this case, the hunter had only 1 year of experience. However, a hunter with 15 years experience mistook an adult female bear for a subadult male bear, based largely on body size (Table 3).

The proportion (2 of 7; 29%) of females harvested at suspended bait sites was similar to the proportion (2 of 12; 17%) harvested at ground bait sites ($P = 0.60$, Fisher's exact test). Sample sizes were too small to test whether the proportion of lactating females harvested differed between treatments (1 of 2 versus 0 of 2).

Power analysis

Detecting a small effect size (10%; reduction of female harvest from 33% to 29.7%) in a matched study design with $\beta = 0.1$ would require a sample size of 1,841 harvested animals in each of the treatment and control groups (Fig. 3). A 20% effect size (reduction of harvest from 33% females to 26.4%) would require a sample size of 461 harvested bears in each group, and a 30% effect sizes (reduction of harvest from 33% females to 23%) would require a sample size of 200 harvested animals. Fewer samples would be required for $\beta = 0.2$.

Detecting a small effect size (10%; reduction of female harvest from 33% to 29.7%) using the provincial harvest as the control group ($n2 = 3{,}000$) with $\beta = 0.1$ would require 1,325 harvested animals in the treatment group (Fig. 4). A 20% effect

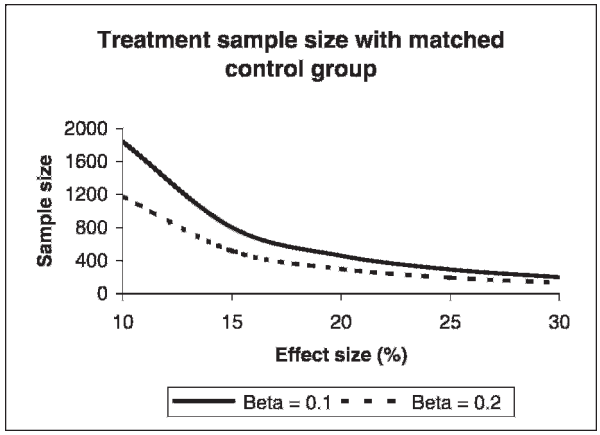

Fig. 3. Power analysis for test of equality of 2 proportions for a controlled experiment assuming hunters over ground baits harvest 33% females (*p*2) and hunters over suspended baits harvest fewer females (*p*1). Effect size of 10% = harvest of 29.7% females, 15% = 28% females, 20% = 26.4% females, 25% = 24.75% females, 30% = 23% females; 1-tailed test ($p1 < p2$), equal sample sizes. (a) $\alpha = 0.2$, $\beta = 0.1$; (b) $\alpha = 0.2$, $\beta = 0.2$. Sample size is number of harvested bears from Ontario, Canada study site, 1998.

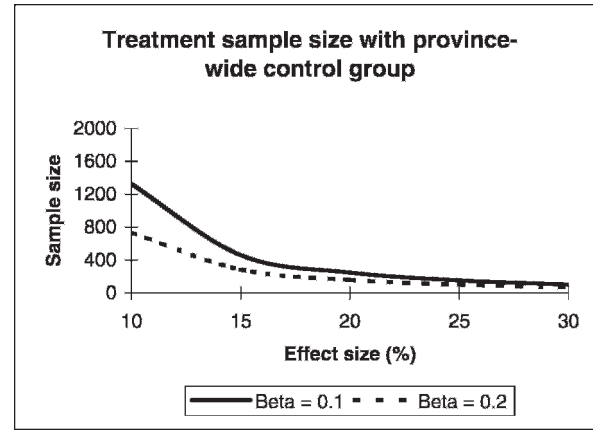

Fig. 4. Power analysis for test of equality of 2 proportions for an uncontrolled experiment comparing treatment to provincial total, assuming hunters over ground baits harvest 33% females province-wide (*p*2), and hunters over suspended baits harvest fewer females (*p*1). Sample size (number of harvested bears) for *p*2 is presumed minimum sample from provincial harvest ($n2 = 3{,}000$). Effect size of 10% = harvest of 29.7% females, 15% = 28% females, 20% = 26.4% females, 25% = 24.75% females, 30% = 23% females; 1-tailed test ($p1 < p2$). (a) $\alpha = 0.2$, $\beta = 0.1$; (b) $\alpha = 0.2$, $\beta = 0.2$.

size (reduction of harvest from 33% females to 26.4%) would require 247 harvested bears, and a 30% effect size (reduction of harvest from 33% females to 23%) would require 101 harvested bears. Again, fewer samples would be needed for $\beta = 0.2$.

The success rate in our study (19 successful hunters of 43 = 44.2%) was similar to the long-term average success rate for all of Ontario's non-resident bear hunters (44.7%; de Almeida and Obbard 2005). Assuming a hunter success rate of 44%, the number of hunters required to participate in a larger study can be calculated. For example, a matched study design with equal sample sizes in the treatment and control groups, $\beta = 0.1$, $\alpha = 0.20$, and a 20% effect size would require a harvest of 461 bears or 1,047 hunters in each group. In contrast, a study using the provincial harvest as the control group ($n2 = 3{,}000$), $\beta = 0.1$, $\alpha = 0.20$, and a 20% effect size would require a sample of only 247 harvested bears or 561 hunters in the treatment group. Sample size (number of harvested bears) for other combinations of effect size and β may be read directly from Figs. 3 and 4.

Discussion

We provide insight into the types of physical characteristics hunters use to assess a bear's age, sex, and reproductive status. Low evaluation scores and use of inappropriate descriptors to identify bears may be associated with the high proportion of first-time hunters in this study, although we note that neither scores nor hunting experience appeared to be strongly related to correct estimation of age and sex of harvested bears. This highlights the importance of improving education and awareness among hunters and outfitters. It also provides direction in the development of comprehensive education tools such as pamphlets, fact sheets, photographs, and videos to help hunters focus on the most reliable indicators of a bear's sex and reproductive status. Such information should also be provided to outfitters to incorporate into their pre-hunt information sessions.

There were no differences between the behavior of bears or hunters at suspended or ground bait sites. Suspending baits did not affect the length of a bear visit at a site, the time until a shooting decision was made, or the success rate in harvests. In addition, the proportion of harvested animals for which sex was correctly identified and the proportion of females harvested were similar between bait site types. These results suggest that suspended baits are as effective

as traditional ground baits. However, the success rate of hunters at suspended baits in this study (7 of 21, 33.3%) was lower than the overall success rate reported for non-resident hunters across the entire province, which is typically about 44% (de Almeida and Obbard 2005). Hunters at suspended bait sites may have been more cautious in deciding to shoot because they knew they were participating in a research study focused on identification of females.

In this study, 4 females were harvested; 2 were at suspended bait sites and one of these was lactating. There were insufficient data to determine if fewer nursing females were shot at suspended baits than at ground baits. For analysis, we strictly assigned harvested bears to the bait site where they were harvested. However, only about one-third of the bears that visited suspended bait sites stood or had the opportunity to stand. Thus, these incidents are not an accurate assessment of whether hunters can better distinguish female black bears using suspended baits. To fairly assess this method, hunters must receive training and education that encourages them to use the method appropriately so that bears are given the chance to stand and reveal their ventral surface.

Other jurisdictions (Litvaitis and Kane 1994, Kohlmann et al. 1999) have harvest rates by bait hunting similar to Ontario's (~33% females). Such jurisdictions could use our power analysis to design their own studies of the effectiveness of suspended baits.

We believe that suspended baits provide a potentially effective tool to distinguish females from males. Based on comments provided by hunters and our observations of bears at a suspended bait site near Chapleau, Ontario (M.E. Obbard, unpublished data), physical attributes such as penis, vulva, swollen mammae, and hair loss surrounding nipples of lactating females are readily seen on a standing bear. However, these attributes are most obvious when the bear stands so that its ventral surface is exposed to the observer.

Where sustainability of the black bear population is a concern, the use of suspended baits (in conjunction with hunter education programs that provide information on reliable external characteristics that can help identify a bear's sex, such as long hairs on penis or around the vulva) has the potential to decrease the proportion of female black bears in the harvest in spring and fall hunts. In jurisdictions where there is only a fall hunt, this method could be effective in reducing the harvest of adult females when their vulnerability to harvest increases during years of food shortage.

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