BEAR DETERRENT STUDY

CAPE CHURCHILL, MANITOBA, 1985

P.L. CLARKSON

DEPARTMENT OF RENEWABLE RESOURCES

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ABSTRACT

Polar bear (Ursus maritimus) deterrent research was conducted at Cape Churchill, Manitoba from 5 October to 2 November 1985. The research was conducted to test the effectiveness of non-lethal deterrent techniques for use on problem bears. A minimum of 364 hours of observation was recorded (280 hours during daylight and 84 hours during darkness). A minimum of 69 different bears visited the study site and 60 of these were tested with deterrents. A total of 112 deterrent tests was completed; 46 with the twelve gauge Ferret slug, 38 with a Bear Thumper, 12 with Cart-a-balls, 6 with a sound deterrent, 6 with a flashlight-siren, and 4 with an electric fence. The twelve gauge Ferret slug and the Bear Thumper were the most effective in deterring polar bears. The Cart-a-ball was too inaccurate to be considered an effective deterrent. The sound frequencies and the flashlight-siren had no detectable effect on any bears. The electric fence deterred some bears but not others.

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INTRODUCTION

Conflicts between bears and people have existed for as long as both have used the same areas. The competition for food and other resources has increased as more people live or travel in bear habitat. Because bear-people conflicts can result in human injury or death, property damage, or the need to destroy bears, the topic has received considerable attention (Manning 1973, Jonkel 1975, Pelton et al. 1976). Even though serious bear encounters are extremely rare, public concern for bear problems is high (Herrero 1970). Wildlife agencies responsible for bear problems have had to consider human safety and the impact that conflicts have on bear populations (Stenhouse 1983c, Stirling and Calvert 1983).

Several wildlife agencies and universities have conducted research on problem bear management (e.g., Hunt 1984, Stenhouse 1982). Past research has identified several effective problem bear management strategies (Bromley 1985, Clarkson et al. 1985). These strategies include a better understanding of bears, bear survival requirements, precautions to prevent bear problems, bear detection and deterrent techniques, improved training for people responsible for handling bear problems, and effective public education programs. Although several management strategies have been developed, there are problem situations that still need to be addressed.

The research conducted at Cape Churchill, Manitoba in 1985 was designed to test several bear deterrent techniques. Because of the variety of man-bear problems in the Northwest Territories, it is necessary to have several effective deterrent methods. A deterrent that is effective in one situation may not be appropriate for others. This year's program was developed from the results of past research and associated recommendations; the program was designed to test non-lethal deterrents to determine if they are effective in deterring polar bears.

STUDY AREA

The deterrent research was conducted at Cape Churchill, Manitoba, 58°48'N, 93°14'W (Figure 1). The Cape is located along the coastal zone of the Hudson Bay Lowlands approximately 75km east of Churchill, Manitoba (Coombs 1954). A gravel beach ridge provides a landing strip for twin otter and smaller fixed-wing aircraft.

Several beach ridges in the area provide relief (3-5 m). The area is covered with gravel and a thin layer of top soil. Throughout the area, there are several small fresh water lakes and a large brackish lake to the west of the observation area (Figure 1).

The Cape experiences long winters and short, cool summers. The average temperature for July is 12°C and for January is -28°C. The area averages 225 days of frost per year; has an average of 400 mm precipitation annually; and receives the fewest number of sunshine hours per year of any area in Manitoba (Manitoba Department of Natural Resources 1978). In 1985, tests were completed at the Cape from 5 October to 2 November; the maximum temperature was 8°C and the minimum temperature was -10°C. Freeze-up of the fresh water lakes occurred around 10 October. The area is influenced primarily by north and northwest winds. Maximum wind speed during October was 90 km/h.

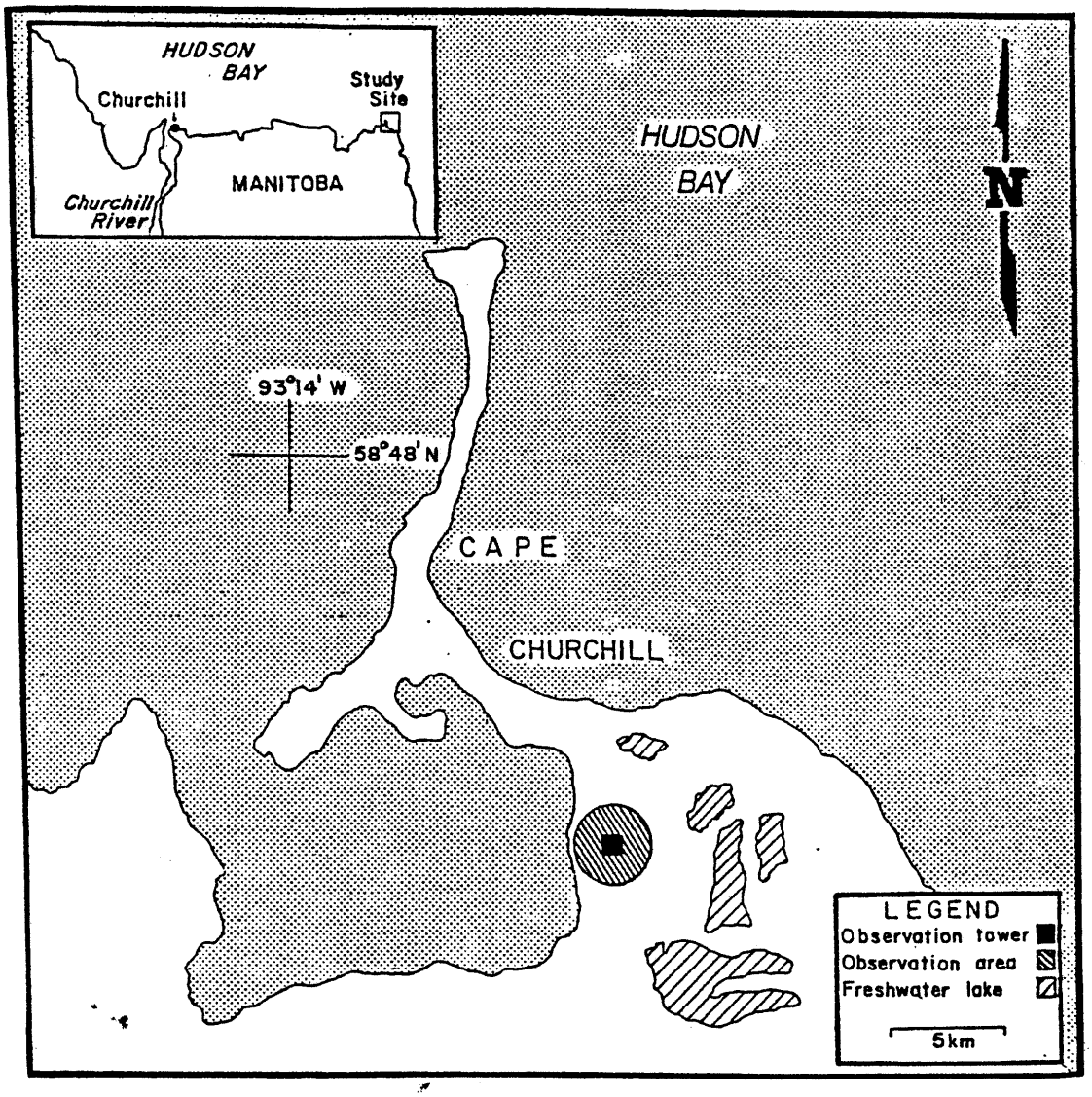

Figure 1. Location of the 1985 bear detection and deterrent study site at Cape Churchill, Manitoba.

The thin layer of top soil and cold climate limits vegetation growth to lichen-heath, sedges, forbs, mosses, and willows (Rewcastle 1983).

Wildlife species observed using the area included polar bear (Ursus maritimus), caribou (Rangifer tarandus), arctic fox (Alopex alopex), ptarmigan (Lagopus spp.), gull (Larus spp.), Canada goose (Branta canadensis), black duck (Anas rubripes) and raven (Corvus corax). During the spring, summer, and fall, the Cape and surrounding area is used by scientific researchers conducting various studies. The area receives some recreational use from residents of Churchill and is a popular site for guided tours (ground and air) in the summer and fall.

Study Population

The Cape Churchill area was chosen as the deterrent study site because of the high concentration of polar bears along the Hudson Bay coast in October and November. During these months the bears begin moving north along the coast and congregate at and near the Cape (Stirling et al. 1977, Latour 1980). Once the ice forms on Hudson Bay, the bears move onto the ice for the winter and remain there until July or August when the ice melts and they swim to shore (Derocher and Miller 1986).

When on land, the bears disperse along the coast and inland by age and sex class. Pregnant females and females with cubs move inland 20-50 km for the summer (Knudsen 1973). Adult males

remain along the coastal areas. Immature bears inhabit areas between the coastal and inland sites (Stirling et al. 1977). While on land, the bears rest and will opportunistically feed on carrion, flightless birds, small mammals, sea kelp and other vegetation (Nero 1971, Russell 1975).

During deterrent testing in 1985, 20-30 bears were in the Cape area by 15 October and by 30 October more than 60 bears had visited the test site. The bears visiting the test site were from all sex and age classes; however, there were few females with cubs.

The bears at Cape Churchill fall within polar bear management zone A1. These bears are not legally hunted while in Manitoba, but are taken by native hunters on a quota system once they enter the Northwest Territories. The bears along the Hudson Bay coast have been studied by the Canadian Wildlife Service (CWS) for several years. With the present population estimate study being conducted by the CWS, there are several marked bears in the area. Some of the bears are also fitted with radio collars or have glue-on transmitters.

With the deterrent studies beginning in 1981, some bears returning to the Cape have been exposed to deterrent testing in previous years (Stenhouse and Cattet 1984). The effects of previous deterrent attempts on bears are difficult to determine, as bears tested in previous years may not be identifiable.

METHODS

The study site surrounds the Canadian Wildlife Service (CWS) observation tower at Cape Churchill, Manitoba. The observation tower and observation trailer provided facilities for accommodation, deterrent testing, and data recording; two bear-proof cages were used to store equipment and bait (Figure 2). Deterrent testing at Cape Churchill was conducted from 5 October to 2 November 1985. Most of the testing was done during daylight hours (0800 to 1800 hrs). Because bear identification and data recording (entrance and exit times, hit location) were difficult to obtain during the dark hours, few tests were conducted at night.

Experimental and Control Bears

Bears that approached the test site were classified as experimental or control bears. Experimental bears were used to test various deterrents. After approaching the bait site, storage cage, or the observation trailer area, these bears were deterred. In most cases the bears were allowed one to two minutes at the site before being deterred. Control bears were not deterred from the bait site or study area. Control bears were not deterred to provide a comparison with bears that were deterred. The behaviour of control and experimental bears was compared on entrance and exit times and return visits to the bait site.

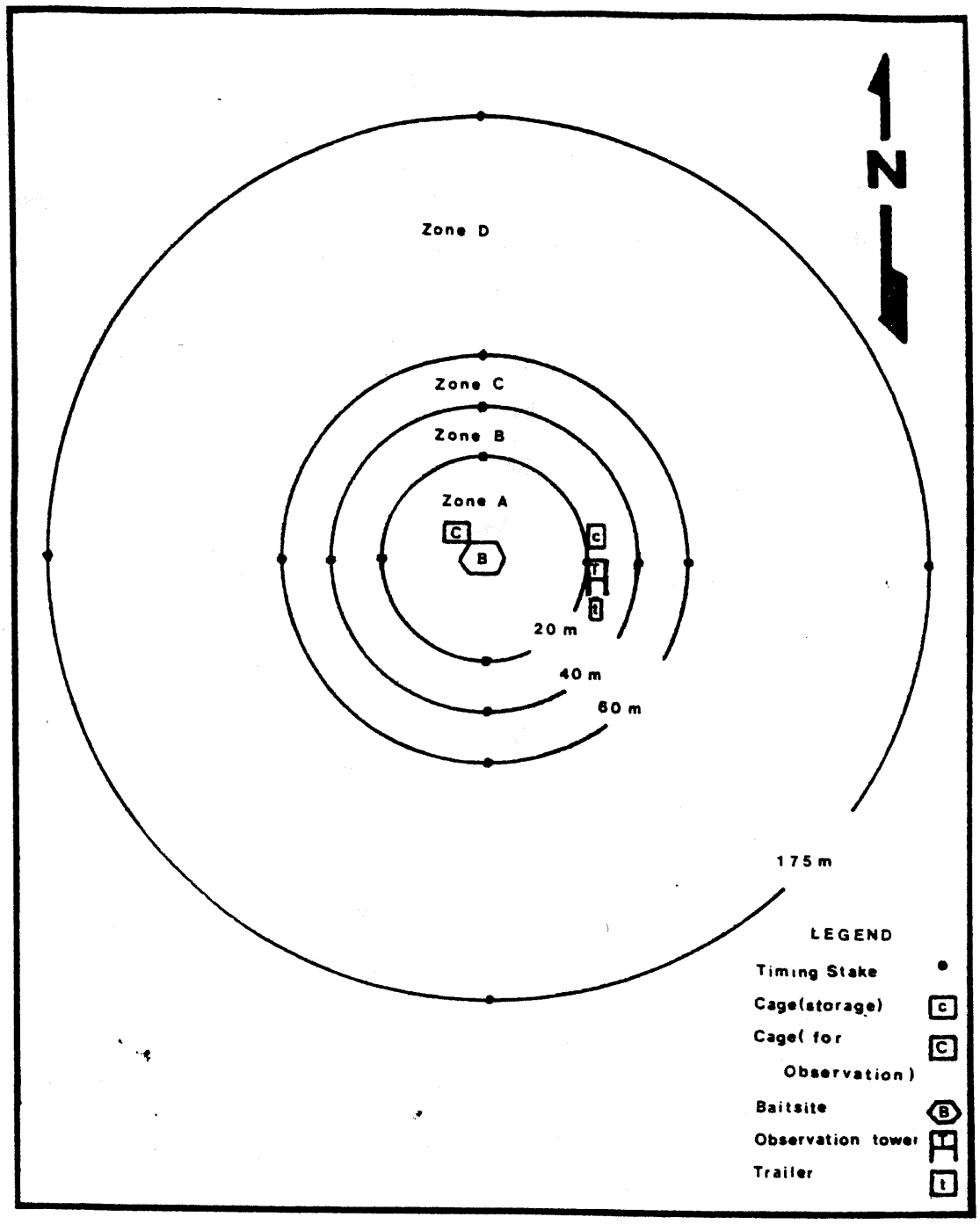

Figure 2. Design of study site at Cape Churchill, Manitoba, 1985

Because several deterrents were being tested, more bears were used as experimental bears than control bears, as control bears could be used for comparison with different deterrent tests.

Data Recording

All data from the deterrent tests were recorded on data sheets designed for previous deterrent testing (Appendix A). Field notes were also made on additional information observed during testing. Some video footage was taken of different deterrent testing and bear responses. Several 35 mm slides were taken throughout the testing period. The behavioural catalogue developed by Stenhouse and Cattet (1984) was used to describe bear behaviour when they approached the study area or were deterred (Table 1). The catalogue only provides a description of those activities pertinent to this study and is not a complete behavioural catalogue for polar bears. Only behaviour directly relevant to the deterrent tests was recorded.

Timing Zones

With the addition of the observation trailer on the study site, it was necessary to change the bait site location and timing zones. The bait site was relocated from north of the observation tower to 35 m west of the tower and trailer (Figure 2). To make the comparisons of entrance and exit times more

Table 1. Behavioural catalogue of polar bears observed during the 1985 bear deterrent study, Cape Churchill, Manitoba.[1]

Behavioural Catalogue	
Lying and resting	**Exploring/curiosity**
lying stretched	lateral head shift
lying curled	stand on hind legs
sitting	sniff - air
	sniff - substrate
	head-up-down
Agonistic	**Comfort Movements**
charge/rush	roll
lip smack/snarl	scratch
snort	lick
head-up-down	shake
bite or snap	defecate
hiss	urinate
Locomotion	**Ingestion**
walk	drink
trot	chew
gallop	tear
	lick

[1]Adopted from Stenhouse and Cattet (1984).

consistent, the timing zones were centred around the bait. With the bait site at the centre of the timing zones, a bear could approach or exit from any direction and be of equal distance from the bait as it crossed the different timing zones. Boundaries to timing zones were marked with painted wooden stakes at 20 m (A), 40 m (B), 60 m (C) and 175 m (D). Because of the wide range of bear activity in the D zone (sleeping, resting, playing, passing by), only zones A, B and C were used for entrance and exit comparisons. Entrance and exit times were recorded for comparison as a means of qualifying the effects of the different deterrents on the bears. Comparison of exit times of deterred and control bears was conducted to indicate whether or not the deterrent influenced the behaviour of bears.

Bait Site and Smudging

The bait site was constructed from a 205-litre empty oil barrel, with the top half removed. The barrel was placed on its side and half-filled with gravel. In the remaining space, a small fire was constructed, hence the upper side of the barrel became a large grill. Pieces of rotten beluga whale (*Delphinapterus leucas*) meat were then placed on the heated barrel to increase the amount of odour being released. Bait was also soaked in a predator lure called "Ten Dead Horse" produced by Mountain Scent Research, Stevensville, MT. By smudging the bait, the attraction to the site was increased as the odour was stronger and carried farther.

Bait was placed on the barrel three to four times/day depending on the number of bear visits and whether or not a control bear visited the site. Because control bears were not deterred, they often removed all the bait from the bait site. Pieces of bait were also dropped around the barrel. The fire in the barrel was ignited each morning and kept going throughout the day.

The entire study site smelled of food, garbage, waste water and rotten bait and was designed to be attractive to bears. The bait stored in the large steel cage was especially attractive to bears visiting the site.

Marking and Identifying Bears

To identify individual bears during deterrent testing, the bears were marked. Canadian Wildlife Service biologist, Andy Derocher, marked 96 bears with letters (double capital letters painted on the bear's back with hair dye) and marker-darted (a dart that sprays a dye on the fur upon impact leaving a dark patch on the bear) 90 other bears. Derocher was marking bears as part of a population study along the Hudson Bay coast. Marker-darted bears were identified based on the size of the bear and location of the dark patches. Lettered bears were identified by the double letters painted on their back. Information on sex, age and weight was recorded for lettered bears at the time of marking.

Unmarked bears that approached the bait site were marked during their first deterrent test. A Bear Thumper was used to mark bears by filling the plastic projectile with a green-coloured latex paint. The paint stayed on the bears for about three weeks and did not appear to have any affect on the bears. The plastic container was marred with a knife to create a weak spot that would break upon impact with a bear, and leave an identifiable painted patch on the bear. The twelve gauge Ferret slug was also used to mark bears. A small amount of black paste shoe polish, which would leave a small black mark where the slug hit the bear, was placed on the tip of the Ferret slug. The Ferret slug worked well for marking bears, as the accuracy of the Ferret allowed researchers to choose the location of identifying marks.

One unmarked control bear was marked by pouring the green paint on its head and neck when it was sitting below the observation trailer. The green paint and shoe polish are only recommended for short term marking as signs of fading were evident after approximately two weeks.

As bears approached the test site, their age class (adult, subadult, 2 year old, yearling) was determined and recorded. Attempts were also made to identify the sex of bears, but confirmation of known sexes from marked bears showed that determining sex from a brief visual observation was unreliable.

Deterrent Testing

Bear Thumper

The Bear Thumper was tested for its effectiveness as a deterrent by hitting bears that approached the bait with a Thumper slug. If the bear was unmarked, a marker slug filled with green paint was used to mark and deter the bear at the same time [1]. Most deterrent testing was done when the bears were at the bait site. The Bear Thumper was fired from the ground near the base of the trailer and tower (25 m - 35 m from the bait site). If necessary, more than one shot was fired. Bears that approached the trailer, tower, and storage cage were also deterred with the Thumper (12 - 25 m). With the Aim-point sight on the Bear Thumper, it was possible to use the Thumper during both the day and night, as only an outline of the bear was needed for accurate aiming and shooting. Hit locations and bear responses were recorded for all deterrent tests.

Twelve Gauge Ferret and Cart-a-ball Slugs

Both the Ferret and Cart-a-ball were fired from a Remington 870, short-barrelled slug gun, equipped with rifle sights. Deterrent tests with the twelve gauge slugs were conducted as the

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[1] Marked bears were deterred using a Thumper soft slug silicon-filled container.

bears approached the bait site. Shots were fired from an average distance of 30 - 35 m. To record the hit location and to mark bears, a small amount of black paste shoe polish was placed on the tip of the slug. As many shots as needed to deter the bear were fired and the number of shots and hit location were recorded.

Electric Fence Testing

Two different electric fence enclosures (net fence and high visibility fence) were set up outside the tower and trailer area (Figure 2). One cm fiberglass rods were driven into the gravel and then frozen in place to increase rigidity. The net fence design was attached to the poles with electrician's tape. The high-visibility fence was attached to the poles with insulators. Both three and four strands of the high-visibility wire and ground-wire were tested. Both fences used a Speedrite charger as a power source. This charger has the capability to produce a pulsed charge of 4600 volts.

Bait was placed in the middle of the enclosure to attract bears. To increase the chance of a bear receiving a shock, the electrified wires were lightly baited to encourage the bear to place its nose or tongue on the wires. As the bear approached the fence, its behaviour and reaction to the fence was recorded.

Sound Deterrent Tests

To test different sound frequencies as bear deterrents, the sound generator and amplifier were set up in the observation

trailer with wires attached to four speakers placed on the roof of the trailer. The sound system was powered by a twelve volt battery. Bears that approached the trailer were tested with the different sound frequencies that ranged from 500 - 12,500 Hz. The sound was emitted in three forms: 1) a steady single frequency tone; 2) a pulsed single frequency tone; and 3) a tone that changed frequencies and sounded similar to a siren. All sound tests were conducted at a maximum power output of 120 watts. Bears were tested at different distances from the speakers and their reactions to the sounds were recorded.

Flashlight-Siren

A flashlight which had an attached siren was tested to determine its effectiveness in deterring polar bears. The siren was tested on bears that approached the tower and trailer area. Tests were conducted by pointing the flashlight-siren at the bear and turning on the siren for one minute. Reactions of the bear were recorded.

Decibel Levels of Deterrents

To measure the intensity of sound used during the acoustic deterrent tests, a portable, hand-held decibel reader was used. Readings were taken directly in front, at 90° and 180° from the front of the speakers. Decibel readings were taken from 1 m, 10 m, 20 m, 40 m, and 60 m.

Decibel readings were taken for the three cracker shells (Stoneco, Schreckpatronen, and Report) being used by various agencies to deter bears. Because the cracker shells travel different distances, all sound recordings were measured from the firing location. The Bear Thumper, Ferret slug, and Cart-a-ball slug were also tested for noise levels made during firing. Decibel levels were recorded at the muzzel, 20 m, 40 m and 60 m. The flashlight siren was also tested for maximum decibel level.

During all decibel readings, the temperature, windspeed and wind direction were recorded.

MATERIALS

Bear Thumper

The Bear Thumper was developed by Loren Butler, Mountain Scent Research, Stevensville, Montana. The Thumper was developed as a bear deterrent tool similar to the 38 mm riot gun, but was designed to solve some of the problems associated with the use of the riot gun (expense of slugs, inaccuracy, restricted weapon status).

The Bear Thumper is 965 mm (38 in.) long and weighs approximately 3.8 kg (8.5 lbs.). The barrel is custom made from standard steel Dom and is rifled to increase accuracy. The barrel can be attached to a Mod 267 Smith and Wesson gas and flare gun. For better accuracy, an Aim-point sight was mounted on the Bear Thumper. The Aim-point sight allows quick aiming during day or night providing there is enough light to see the outline of a bear.

The Bear Thumper slug is comprised of a component system which has a primer, case, black powder, gas check, and projectile. The slug can be custom loaded for each specific deterrent attempt or preloaded. Variations in loading can be achieved by adjusting the amount of black powder or by using a different projectile. Black powder loads can vary from 3.0 g (50 grains) for a light load to 4.5 g (75 grains) for a heavy load. Federal 209 primers are used for both slugs.

The case is 103 mm (4 in.) long and 32 mm (1.25 in.) wide and made from aluminum.

Mountain Scent offers two different projectiles. The Bear Thumper Soft Slug and the Bear Thumper Liquid Slug. Both slugs are 30 mm (1.38 in.) in diameter and 75 mm (3 in.) long and have a soft plastic casing (20 cc volume). The Soft Slug is filled with a low tension latex and weighs 36.9 g (615 grains). When loaded with 3.0 g (50 grains) of FF black powder the Soft Slug travels 158.5 m/s (520 f/s) and has an impact energy of 502 joules (369.35 F.P.E.) at 7.6 m (25 ft.). The Liquid Slug can be filled with water, dye, or any other liquid to provide weight for deterring or marking a bear. When filled with water, the slug weighs 42.0 g (700 grains). When filled with water and loaded with 3.0 g (50 grains) of FF black powder, the Liquid Slug travels 128 m/s (420 f/s) and has an impact energy of 372.6 joules (274 F.P.E.) at 7.6 m (25 ft.). When using the Liquid Slug at temperatures below 0°C (32°F), a non-freezing liquid is recommended.

Twelve Gauge Slugs

Ferret Slug

The latest generation of the twelve gauge Ferret slug was completed in June 1985 by AAI Corporation, Baltimore, Maryland. Previous testing of the Ferret had shown it to be inconsistent and in some cases it had too much impact which could have result-

ed in penetration of a bear's hide (Stenhouse 1983b, Stenhouse and Cattet 1984, Derocher and Miller 1986). The latest modifications of the Ferret involved producing a sturdier gas check. Trump (1985) describes the development of the different Ferret slug generations and explains why the latest generation was selected for further testing.

The Ferret tested had an impact energy of 101.7 joules (75 F.P.E.) at 50 m (54.7 yds) and impact velocity of 161.3 m/s (529.2 f/s). Figure 3 shows the characteristics of the slug and gas check used in the Ferret. The latest generation of the Ferret was produced for testing by AAI for $15.00/Cdn per shell.

Cart-a-ball

The Cart-a-ball is a French-made, crowd-control, twelve gauge slug (Figure 4). The slug is presently distributed by Bumble Bee Wholesale, Berkley, California for $12.00 Cdn/package of five slugs. The Cart-a-ball is recommended by the manufacturer for use on humans up to 30 m. The Cart-a-ball has a muzzle velocity of 330 m/s (1082 f/s) and an impact energy of 42.7 joules (31.5 F.P.E.).

Both the Cart-a-ball and Ferret slugs were shot from a Winchester 870 slug gun (open bore) mounted with rifle sights.

Sound Deterrent Equipment

To test the effectiveness of different sound frequencies as potential bear deterrents, Calgary Controls was contracted to de-

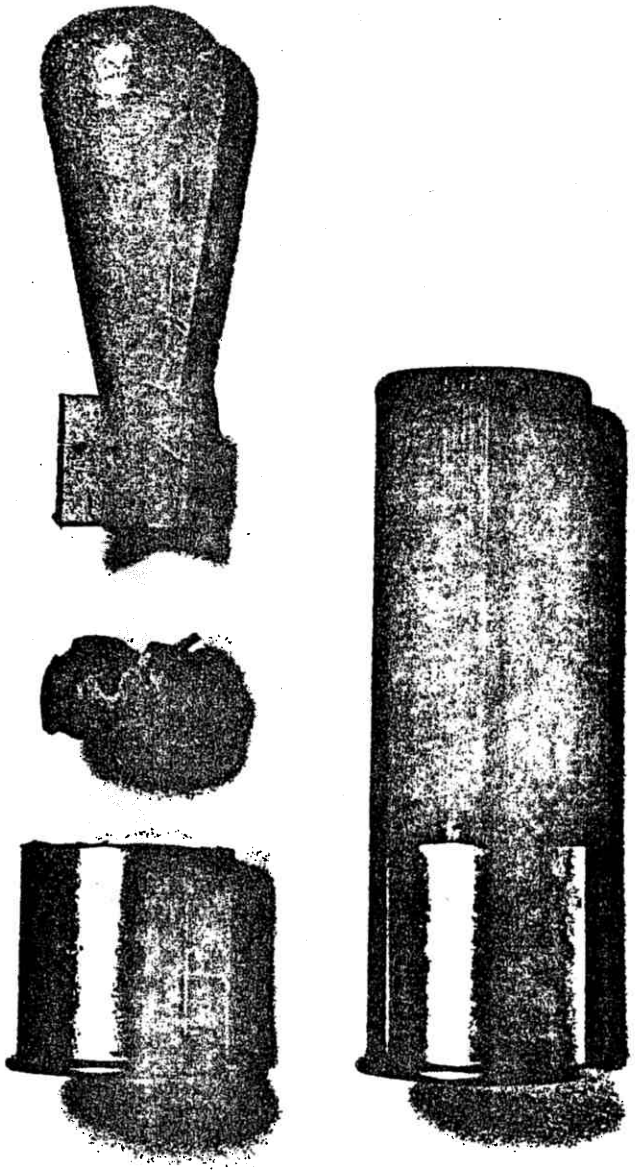


Figure 3. Twelve gauge Ferret slug tested at Cape Churchill, Manitoba, 1985.

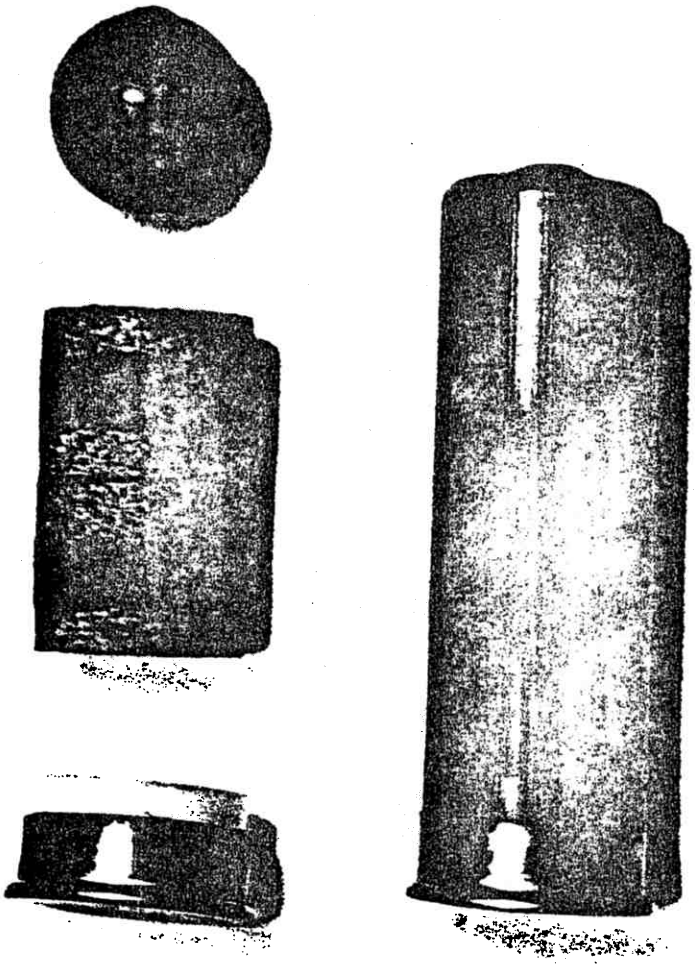


Figure 4. Twelve gauge Cart-a-ball tested at Cape Churchill, Manitoba, 1985.

sign and manufacture an appropriate sound system. A square-wave high-power tune-generator/amplifier system was designed and assembled (Figure 5). The sound system used four 30 watt - 8 ohm horn speakers. A 120 volt AC/24 volt DC power supply adapter was purchased for the system for conversion to AC or DC power. The sound generator had a steady and pulse tone mode, volume control and field case.

Electric Fences

Two electric fence designs were tested; 1) a high-visibility fence, and 2) a net fence. The high-visibility fence was made from 17 gauge steel wire which was then wrapped with yellow plastic strapping (one cm wide)(Figure 6a). A ground wire was placed 2.5 cm away from the electrified wire to help ensure that the circuit would be completed if a bear touched the fence (Figure 6b). Three strands of the wire were tested intially, but a fourth strand was added after a bear had crawled under the fence.

The net fence was made from a braided plastic-wire twine running horizontally and plastic twine running vertically (Figure 6c). Both fence designs were erected on 1 cm (diameter) 1.5 m fiberglass poles. The Speedrite electric fence controller was used on both fences.

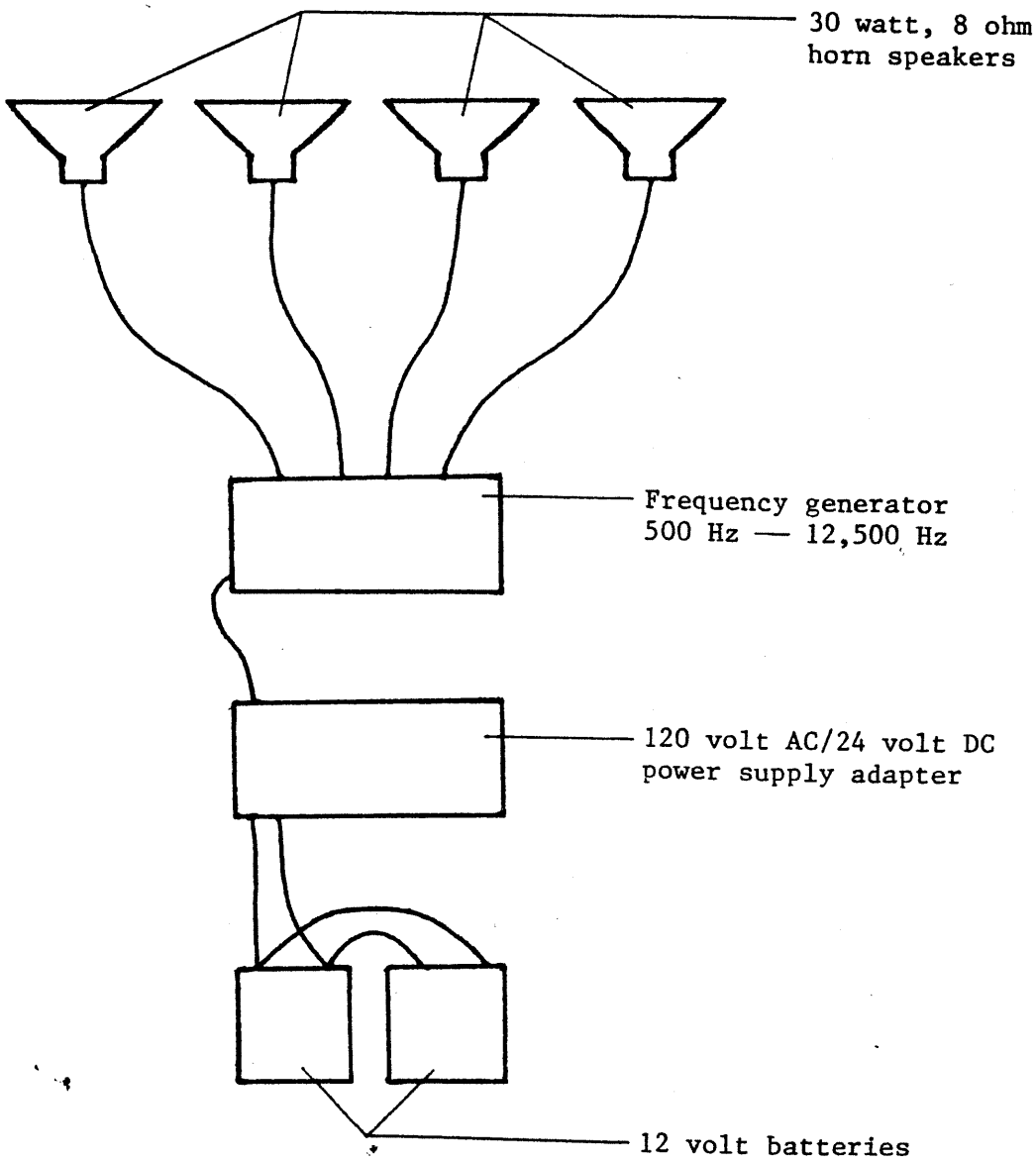
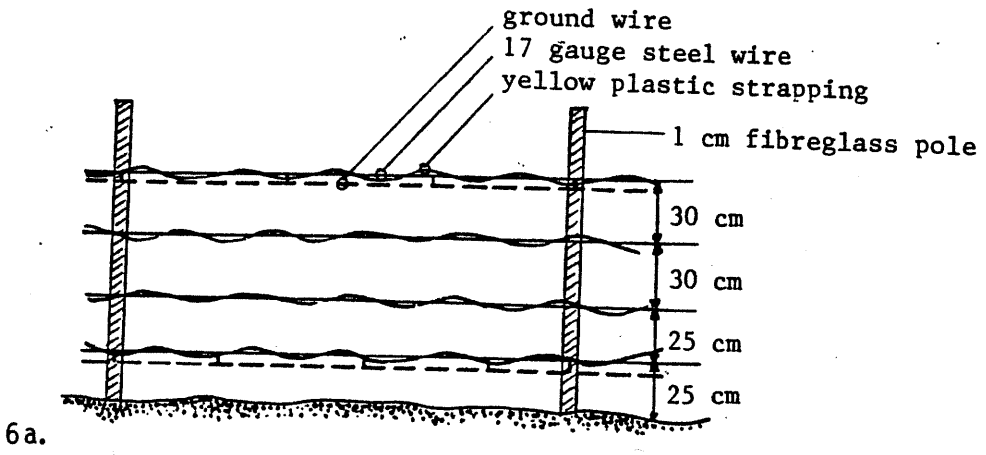
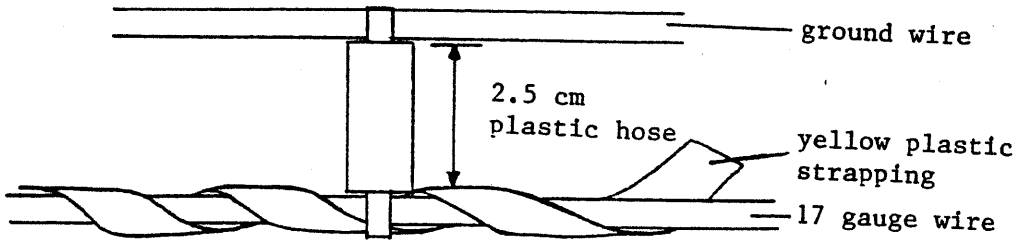


Figure 5. Sound deterrent system tested at Cape Churchill, Manitoba, 1985.



6a.



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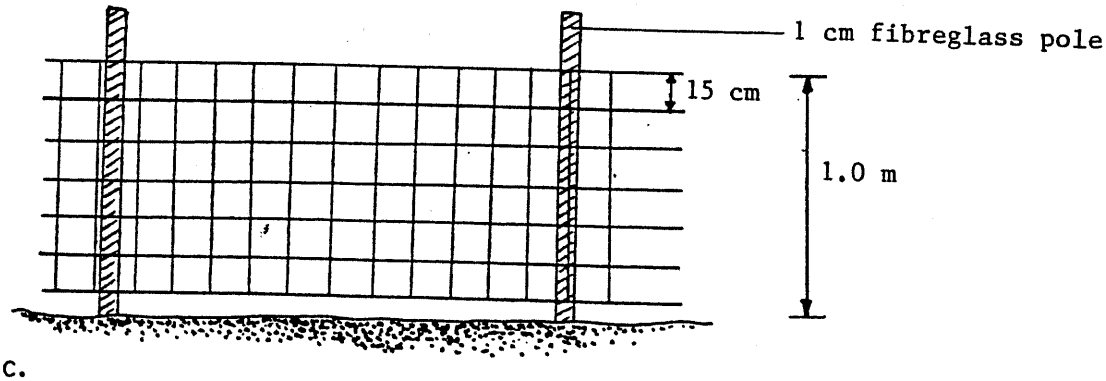

6c.

Figure 6. Portable, high-visibility electric fence system tested at Cape Churchill, Manitoba, 1985.
6a. High visibility fence.
6b. Ground wire attachment.
6c. Net fence.

Flashlight-Siren

A hand-held flashlight-siren was tested to determine whether or not it was an effective deterrent. The siren has a maximum decibel level of 90. Two C size batteries power the flashlight-siren. A switch determines whether the flashlight or siren is on.

Bait

Bait was obtained from a resident in Churchill. Five plastic pails of rotten beluga meat and blubber were flown to the Cape for use during testing. To enhance the odour of the bait, a commercially-produced predator lure "Ten Dead Horse" was added to some of the beluga. The bait was stored in the large, steel-barred cage.

RESULTS

Deterrent research was conducted at Cape Churchill from 5 October to 2 November 1985. A minimum of 364 hours of observation was recorded; 280 hours during daylight and 84 hours during darkness. Few deterrent tests were conducted during the darkness because of the difficulty in collecting data (entrance time, hit location, behavioural response, exit time).

A minimum of 69 different bears visited the study site; 60 of these were tested with deterrents, 7 walked through the testing zone, and 2 were used as controls and were not deterred. Five different bears were used as controls; however, 3 of them were later deterred. An additional 20 unmarked bears walked through the testing zone. A total of 112 deterrent tests was completed; 46 with the Ferret slug, 38 with the Bear Thumper, 12 with Cart-a-balls, 6 with the sound deterrent, 6 with the flashlight-siren, and 4 with the electric fence.

Marked Bears

A total of 69 bears had been previously marked or was marked during deterrent testing. Eleven bears approaching the study site had been letter-marked by CWS in August 1985 (Table 2). One bear (X9648) was identified by an ear tag number. Eighteen bears were identified by marker-dart locations. The other 39

Table 2. Known age and sex classes of polar bears tested at Cape Churchill, Manitoba, 1985[1].

Polar bears Letters	X #	Sex	Age	Summer Weight*
G	9163	m	03	157 kg
HM	4192	m	09	316 kg
D	4197	m	13	338 kg
XD	9779	f	3-4**	143 kg
YY	9771	f	02**	130 kg
YA	0710	m	18	300 kg
YG	0689	f	15	270 kg
XR	9522	f	08	255 kg
XL	9776	f	3-4**	136 kg
XY	9796	m	3-4**	184 kg
XT	9792	m	02	118 kg
--	9648	m	20	---

*Summer weights - bears are probably much lighter than this by the time they reach the Cape.

**Estimated ages only, the teeth have not yet been aged.

[1]Information supplied by Andy Derocher, CWS.

identifiable bears were marked with the Bear Thumper (19), Ferret slug (16) or Cart-a-ball (4). Ferret slug and Cart-a-ball marks were similar and only identifiable by their hit location and the age class of the bear.

Deterrent Tests

Bear Thumper

The Bear Thumper was the first deterrent tested at Cape Churchill in 1985. A total of 38 deterrent tests was conducted on 27 different bears (Table 3). All of the tests were successful in deterring the bears. Six bears were hit with two slugs before being deterred. During the 38 deterrent attempts, 54 shots were fired and 38 (70%) were hits. The 16 (30%) misses were caused by wind, distance, and shooter inaccuracy. The Bear Thumper was shot from an average distance of 26 m.

During deterrent tests, both soft and marker slugs were used. The marker slug was filled with green latex paint and shot at unmarked bears. The marker slugs broke upon impact with the bear if the animal was within 30 m. Beyond 30 m, the impact was insufficient to cause the plastic container to break. When the slug broke, a green identifiable patch was left on the bear. If a bear had been marked previously, the soft slug (latex-filled) was used.

The Aim-point scope on the Bear Thumper made it possible to deter bears during both day and night. Bears could be deterred

Table 3. Responses of polar bears to Bear Thumper deterrent tests, Cape Churchill, Manitoba, 1985.

	Bears	Deterrent Attempts (bears / attempts)	Shots Fired (hit/missed)	Hits Per Deterrent Test (no of tests/hits)	Mean Distance (range) m	Successful Deterrent Attempts	Unsuccessful Deterrent Attempts
No.	27	38 (17/1)(9/2)(1/3)	54 (38/16)	(32/1) (6/2)	26 (4-45)	38	0
%	100	100 (45) (47) (8)	100 (70/30)	84 16		100	0

during the evening providing there was enough light to see a silhouette of the bear. Although it was possible to adjust the powder load, and therefore the speed and impact of the slug, all slugs shot were loaded with the same volume of black powder to ensure consistency in the results.

When hit with the Thumper slug, most of the bears jumped and looked at the hit location, then ran from the bait site in a direction away from the shooter. Some bears made an aggressive snorting sound when hit, but none of the bears showed any aggression towards the shooter.

Twelve Gauge Ferret Slugs

The Ferret slugs were used in 46 deterrent tests on 36 different bears (Table 4). All of the tests were successful in deterring the bears. Although all the bears were deterred, some attempts required more than one shot: two deterrent attempts required four shots, five attempts used three shots, 14 attempts needed two hits and the remaining 25 attempts required only one hit. Some bears were hit with a Ferret slug as they were leaving the test area to further enforce the negative experience of being deterred. The additional hit may not have been necessary to actually deter the bear from the bait site.

Eighty Ferret slugs were fired during deterrent testing and 76 (95%) hit their target (Table 4). The four misses were caused by a combination of wind, distance, and shooter inaccuracy. All Ferret slugs used were dipped in black shoe polish to help determine hit location.

Table 4. Responses of polar bears to twelve gauge Ferret slug tests, Cape Churchill, Manitoba, 1985.

	Bears	Deterrent Attempts (bears / attempts)	Shots Fired (hits/missed)	Hits Per Deterrent Test (no of tests/hits)	Mean Distance (range) m	Successful Deterrent Attempts	Unsuccessful Deterrent Attempts
No.	36	46 (26/1)(10/2)	80 (76/4)	(25/1)(14/2)(5/3)(2/4)	32 (20-45)	46	0
%	100	100 (51) (43)	100 (95/5)	54 30 11 5		100	0

When hit with the Ferret slug, the bears reacted similarly to those deterred with the Bear Thumper.

Cart-a-ball Slugs

Deterrent tests with the Cart-a-ball slug were stopped after only 12 deterrent attempts on seven different bears (Table 5). Testing was stopped because the Cart-a-ball was too inaccurate at the distances being tested (20-40 m). Of the 23 shots fired 11 (48%) were misses (Table 5). Although it was difficult to hit the bears with a Cart-a-ball, the bears were deterred in all 12 attempts. In three attempts, when the bears were not hit, the noise must have deterred the bears.

Shoe polish was placed on the Cart-a-ball used during testing and identifiable marks were left on bears hit. When hit with the Cart-a-ball, the bear's initial reaction was to jump, look at the hit location, then run from the bait site.

Electric Fence

The two portable electric fence designs tested were not successful in preventing bears from entering the enclosure. The main problem with both fence designs was that the 1 cm fiberglass rods were not suited for the gravel terrain at the Cape. It was difficult to erect a fence that was sturdy enough to withstand pressure from the wind and/or bears. The net fence was set up but because of constant wind and drifting snow, was never effectively tested.

Table 5. Responses of polar bears to twelve gauge Cart-a-ball tests, Cape Churchill, Manitoba, 1985.

	Bears	Deterrent Attempts (bears / attempts)	Shots Fired (hits/missed)	Hits Per Deterrent Test (no of tests / hits)	Mean Distance (range) m	Successful Deterrent Attempts	Unsuccessful Deterrent Attempts
No.	7	12 (3/1)(3/2)(1/3)	23 (12/11)	(3/0)(7/1)(1/2)(1/3)	30 (20-48)	12	0
%	100	100 (25)(50)(25)	100 (52/48)	25 59 8 8		100	0

The high-visibility fence with three and four strand construction was less resistant to the wind than the page wire fence and, therefore, tests were conducted with the former. Three different bears tested the fence (D, XD, unmarked subadult)(Table 6). The fence was also tested and penetrated during three nights; however, no direct observations were made.

During the first electric fence test, D bear approached the three strand fence and touched the lower wire with his nose. Upon touching the fence, D bear jumped back and then cautiously walked around the perimeter of the enclosure for five minutes before leaving the fence area and walking towards the bait site. Enroute to the bait site, he carefully walked around a tripwire that was not connected to a fence charger.

The second electric fence test involved XD bear which approached the fence, walked along one side to the lowest spot along the ground and crawled under the lower wire. The bear did not appear to receive a shock. The third test also involved XD bear but this time the high-visibility wires had been lightly baited with rotten whale meat to encourage the bears to put their tongues or noses on the wire, ensuring they would receive a shock. Bear XD approached the fence, placed her nose on the middle wire, received a shock, and quickly jumped back and ran away from the fence.

The fourth observed test involved an unmarked subadult bear that circled the four strand fence and placed his paw on the lower wire. The bear did not seem to receive a shock but left

Table 6. Polar bear responses to portable, high-visibility electric fence tests at Cape Churchill, Manitoba, 1985.

Bear	No. of Strands	Wire	Voltage	Temp.	Conditions	Response
D	3	unbaited	3.8 kvolt	+2°C	snow cover	deterred
XD	3	unbaited	3.8 kvolt	-2°C	snow cover	penetrated
Unknown[1]*	3	unbaited	3.8 kvolt	-5°C	snow cover	penetrated
XD	3	baited	4.3 kvolt	0°C	snow cover	deterred
Unknown[2]	4	baited	4.3 kvolt	-7°C	snow cover	penetrated
Subadult	4	baited	4.6 kvolt	+3°C	snow cover	deterred
Unknown[3]	4	baited	4.6 kvolt	-4°C	snow cover	penetrated

*Unknown bears penetrated the fence during the evening and were not directly observed.

the fence area after several more minutes of investigating the fence. Penetrations of the fence during the evenings were not observed directly, but by inspecting the fence each morning following penetration(s), it appeared the bears were able to enter the enclosure by crawling under the fence and lifting the wires, or by pushing the wire down to the ground. In all cases, the wires were shorted out when they contacted other wires or the ground.

Sound

The sound tests were not effective in deterring polar bears. Six different deterrent attempts were completed, but in each test no adverse reaction was observed (Table 7). The bears either ignored the sound or focused their attention on where the noise was coming from. During these tests, bears even approached the trailer where the speakers were located.

In all six deterrent tests, the bears were exposed to frequencies of 500 - 12,500 Hz in a steady and pulsed tone. When no reaction was noted for a steady or pulsed tone at a set frequency, the sound generator was adjusted and made to sound like a siren. Still no bears were deterred.

Flashlight-Siren

The flashlight-siren was tested on six bears that approached the observation trailer. The siren was held at arms length, turned on and pointed at the bear for 15 seconds. In all six tests, the siren attracted the attention of the bears but did not

Table 7. Sound deterrent tests conducted on polar bears at Cape Churchill, Manitoba, 1985.

Bear	Distance/Direction[1]	Wind Speed	Response
X9648	6 m/90°	5-10 km	No reaction
G	30 m/0°	5 km	No reaction
Unmarked subadult	20 m/0°	0	No reaction
Unmarked adult1	15-35 m/0°-90°	5 km	No reaction
Unmarked adult2	10 m/0°	8-10 km	No reaction
Ferret marked subadult	25 m/0°-45°	5-10 km	No reaction

[1]Direction refers to the position of the bear relative to the front of the speakers.

deter any of them. The siren was tested at distances ranging from 2-15 m. At 1 m, the siren had a decibel level of 89. At 15 m, the decibel level of the siren had dropped to 64.

Decibel Levels of Deterrents

Many deterrents have a noise component associated with them that may in itself deter a bear or be associated with another negative experience (plastic slug) and contribute to overall deterrence. To understand the different sound intensities, decibel levels were measured for the deterrents tested.

The sound deterrent system was measured for decibel levels at 1 m, 10 m, 20 m, 40 m and 60 m distances and at 0°, 90° and 180° from the direction the speakers were facing (Table 8). Decibel readings of the sound system were conducted during wind conditions of 5-10 km from the north (180° from the speaker direction). The testing showed that low frequencies (0.5 - 3.0 kHz) were affected very little by direction and distance, whereas high frequencies (4.0 - 12.5 kHz) were affected by direction, distance, and wind.

The Bear Thumper, Ferret slug, and Cart-a-ball all make a noise when fired. To measure the intensity of the noise, decibel levels were recorded at the muzzel, 20 m, 40 m and 60 m (Table 9). Because projectile deterrents are fired directly at bears, decibel readings were measured only in the direction that the deterrent was fired. Measuring was conducted at -3°C with a wind speed of 10-15 km. All three deterrents had similar decibel

Table 8. Decibel levels of the sound deterrent system tested at Cape Churchill, Manitoba, 1985.

Frequency (kHz)	1 m	10 m	20 m	40 m	60 m
In front of speakers (0°):					
0.500	114	101	91	89	83
0.650	114	101	95	91	88
1.0	106	98	92	84	83
1.5	115	106	102	98	93
2.0	115	105	101	92	92
3.0	105	94	82	77	66
4.0	92	84	69	57	56
5.0	74	60	45	45	34
12.0	76	60	55	44	35
90°:					
0.500	102	80	78	68	69
0.650	89	88	77	85	68
1.0	89	80	68	58	60
1.5	93	88	84	77	68
2.0	90	81	64	55	52
3.0	88	77	71	63	59
4.0	75	63	61	50	44
5.0	50	54	48	42	35
12.0	49	43	48	40	35
180°:					
0.500	-	84	78	78	73
0.650	-	75	83	69	75
1.0	-	74	64	64	65
1.5	-	86	78	75	66
2.0	-	80	68	66	53
3.0	-	72	64	54	48
4.0	-	61	55	41	40
5.0	-	49	42	40	33
12.0	-	35	34	34	36

Wind noise affected recording below 40 db.

Table 9. Decibel levels of the Bear Thumper, Ferret slug and Cart-a-ball tested at Cape Churchill, Manitoba, 1985.

Deterrent	Decibel Level			
	Muzzle	20 m	40 m	60 m
Bear Thumper	122	117	110	101
Ferret Slug	127	109	100	89
Cart-a-ball	123	123	114	103

levels at the muzzle; however, as distance increased from the muzzel, the Ferret slug decibel levels dropped more quickly, indicating that the noise from the Ferret is at a higher frequency.

To deter bears, twelve gauge cracker shells are often used by people living and working in bear country (pers. obs.). Cracker shells make a loud noise and will deter away some approaching bears. Three commonly-used cracker shells (Stoneco, Schreckpatronen, Report Flare), were fired and the decibel levels measured. All three cracker shells tested had two noises; one initial noise when fired and the noise when the cracker shell exploded 120-150 m from the firing location. Decibel readings were taken for both explosions from the firing location (Table 10). The decibel level at the second explosion site would have been higher than recorded.

The three cracker shells were similar in decibel level for both explosions. The Stoneco shell travelled approximately 30 m farther than the other two shells.

Entrance and Exit Times

Entrance and exit times through the zones to the bait site were recorded for all bears observed in the test area (Table 11). It was not possible to obtain accurate entrance and exit times on all bears deterred, as some bears approached the bait site undetected or were deterred from locations other than the bait site. Times listed in Table 11 indicate the amount of time spent in each zone by the bears. After being deterred, bears

Table 10. Decibel levels of cracker shells tested at Cape Churchill, Manitoba, 1985.

Cracker Shell	Decibel Level		
	1st explosion[1]	2nd explosion[2]	distance travelled (m)
Stoneco	102	110	150
Schreckpatronen	118	118	120
Report Flare	117	117	120

[1]First explosion was at the firing site.

[2]Explosion of the cracker shell.

Table 11. Entrance and exit times (in seconds) of bears into and from the study area during deterrent testing at Cape Churchill, Manitoba, 1985.

Deterrent	Test Zone					
	Entrance			Exit		
	C	B	A	C	B	A
Bear Thumper						
$\bar{x}$	78	40	41	6	18	26
SD	128	24	29	5	29	18
range	20-515	5-80	15-110	2-20	3-130	3-65
total time (sec)		159			50	
sample size[1]		14			18	
Ferret						
$\bar{x}$	130	70	95	8	18	23
SD	301	99	233	6	13	181
range	15-1520	15-350	10-1165	5-25	5-65	10-75
total time (sec)		295			48	
sample size		25			30	
Cart-a-ball						
$\bar{x}$	75	22	38	8	22	26
SD	55	3	16	3	27	25
range	20-130	20-25	20-50	5-10	10-70	10-70
total time (sec)		135			56	
sample size		3			5	
Control Bears						
$\bar{x}$	180	587	38	997	180	1750
SD	199	1250	41	1239	211	4198
range	35-560	20-3135	10-120	89-3085	10-465	10-10360
total time (sec)		805			2927	
sample size		6			6	
Walk Through Bears						
$\bar{x}$	58	210	70	56	39	86
SD	58	348	46	50	53	116
range	15-150	25-955	25-130	5-115	5-155	5-330
total time (sec)		338			181	
sample size		6			6	

[1]Sample size will vary from actual deterrent attempts because accurate times were not recorded for all attempts.

quickly travelled through zones A, B, and C and continued to leave the test site but at a slower pace.

The average exit times resulting from being hit by the Bear Thumper, Ferret slug and Cart-a-ball were similar (50-56 sec) for test zones A, B, and C. The control and walk-through bears took considerably more time to exit the test site (Figure 7).

Return Visits

When testing bear deterrents, it is important to determine whether or not the deterrent is successful in deterring the bear initially and then keeping it from returning to the bait site. When conducting tests at Cape Churchill, all bear visits to the test site during the observation period were recorded. Unfortunately, some bears visited the site during the night and these visits were not recorded. The return times recorded only represent bear visits during daylight hours.

There were 66 different bears deterred during Cart-a-ball, Ferret, and Bear Thumper tests; 44 (66%) were deterred only once and did not return during the observation period. Ten bears initially deterred by the Ferret, and 9 bears deterred by the Bear Thumper returned a second time and were again deterred. One bear deterred by the Bear Thumper returned three times. Four bears were deterred by both the Ferret and Bear Thumper. Time between return visits varied from 1 to 175 hours.

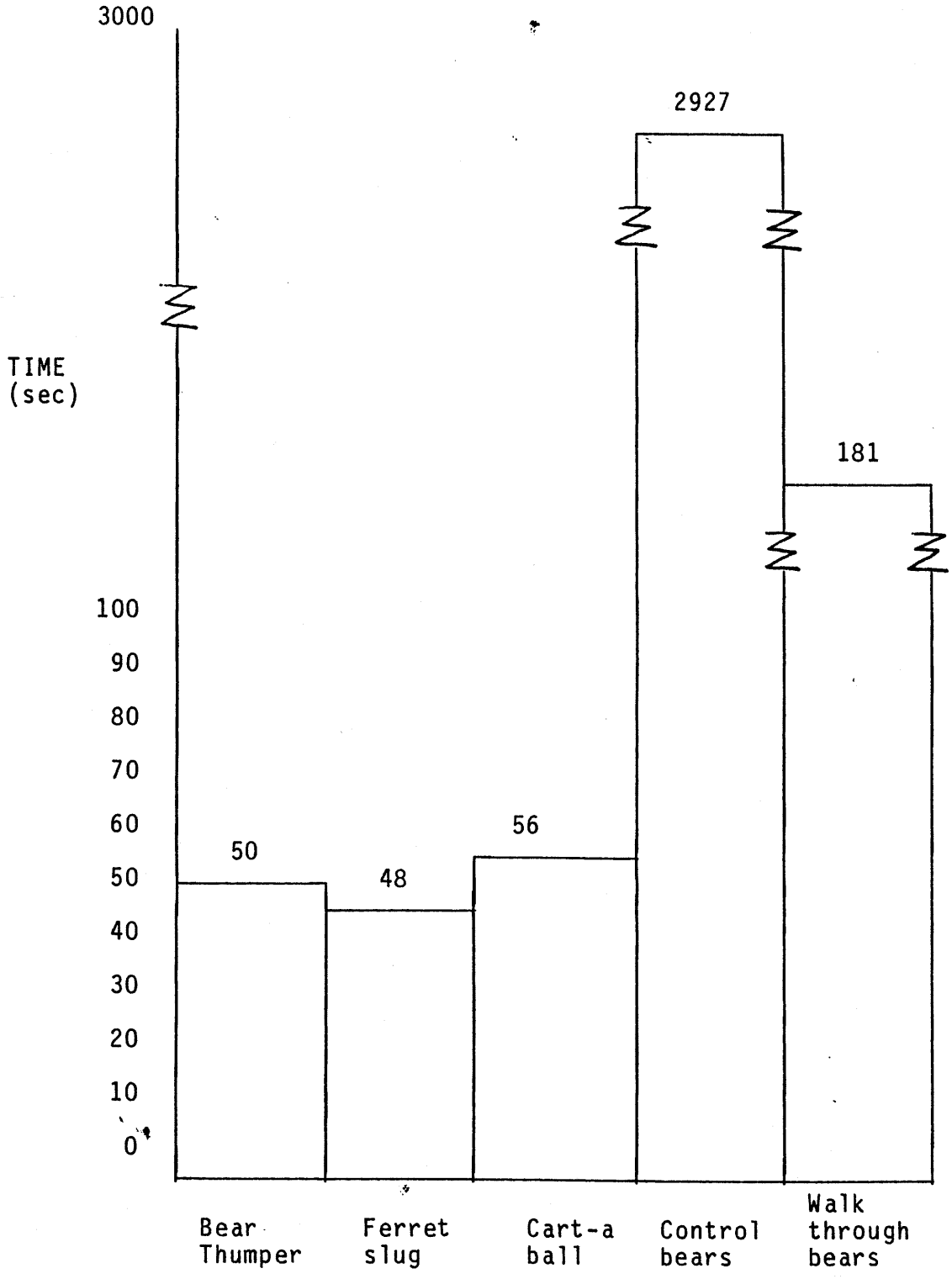

Figure 7. Exit times of bears from the study site (Zones A, B, and C) at Cape Churchill, Manitoba, 1985.

DISCUSSION

Several deterrent techniques were tested at Cape Churchill; some proved effective, others require more development, while some proved ineffective. In addressing bear-people conflicts, it is important to test a variety of deterrents. Given the diversity of bear-people conflicts, it is essential to have available several effective deterrents.

Bear Thumper

The Bear Thumper was effective in deterring polar bears from the bait site. It was also useful for marking bears. As with other deterrents, there are advantages and disadvantages associated with its use. The size of the Thumper slug prevents hide penetration and tissue damage even at close range, making the Bear Thumper safe for bears.

By hand-loading each Thumper slug, it is possible to make a slug that is best for each specific bear conflict. If a large bear is approaching a camp, a slug with a heavy powder load could be used. Loading the slugs does require some time which may be inconvenient in some situations. To avoid missing deterrent opportunities, slugs can be preloaded with a medium load so that they are available for immediate response to a problem bear.

The Bear Thumper slugs are much less expensive than the 38 mm batons ($2.50 Cnd for an empty liquid slug vs $11 - 14.00 for the 38 mm shell). Slugs filled with a liquid (dye, water) are more cost effective.

Practical use of the Bear Thumper as a deterrent will probably be limited to wildlife agencies and possibly a few industrial camps with frequent bear problems. The Bear Thumper is not a restricted or prohibited weapon, but because is it a "specialty weapon", it is doubtful that the general public or most industry personnel will purchase it for deterring or marking bears.

Twelve Gauge Ferret Slug

Deterrent testing of the Ferret slug began in 1982; however, the 1985 tests proved most effective in deterring polar bears. Stenhouse (1983b) found that 88% (N=22) of the bears were not deterred from the bait site. The 12% (N=3) that were deterred, quickly returned to the bait site. In 1983, 55% (N=27) of the bears hit with the Ferret were deterred while 45% (N=22) were not deterred (Stenhouse and Cattet 1984). Derocher and Miller (1986) found that only 84% (N=29) of the bears hit with the Ferret were deterred. Testing in the fall of 1985 resulted in all of the bears hit with the slug being deterred. The modifications to the Ferret slug over the past years have made it more effective in deterring bears. The major advancement in

the Ferret slug was the development of an improved gas check. Previous problems of impact inconsistency of these slugs were caused by faulty gas checks.

The Ferret slug also works well for marking bears and this will be beneficial when deterring problem bears. People deterring problem bears with the Ferret will be able to determine if it is the same bear returning. The accuracy of the Ferret is acceptable for deterrent work. If the cost of the slug can be reduced to an acceptable level ($1-2.00 Cdn/slug), the Ferret will be an effective and practical deterrent for wildlife agencies, industry, and the public. Because it is a twelve gauge slug, it is adaptable to present bear protection equipment and strategies.

Other Deterrents

Other deterrents tested were not as effective as the Bear Thumper and 12 gauge Ferret slug. The Cart-a-ball deterred bears, but inaccuracy and the potential for hide penetration at close range significantly reduces its effectiveness as a non-lethal, effective deterrent. The portable electric fence systems did not deter all bears, but they were effective in deterring some bears and continue to have potential application. Acoustic deterrent testing with the sound generator and flashlight-siren had no effect in deterring bears. The sample size for these tests was small and a larger sample size should be

tested before acoustic deterrents are considered ineffective. Previous testing by Wooldridge and Belton (1980) and Stenhouse (1982, 1983b) found sound to have only a minimal effect on bears.

Return Visits

It is difficult to extrapolate results regarding return times at Cape Churchill to return times for bears in actual camp settings because of the following:

1. The bears were only deterred from the bait site and not chased from the area as they might be in a real camp situation. The bears learned to avoid the bait site but remained in the area. Several bears were observed approaching the bait site but would stop 60-40 m away from the bait and not approach closer.
2. The Cape is a natural migration and staging area for bears in the fall. The bears wait there for the ice to form on Hudson Bay. There is no incentive for them to move.
3. The bait site was not monitored 24 hours/day and bears learned to visit the site during evening hours.

CONCLUSIONS

The following conclusions have been drawn from polar bear deterrent research conducted at Cape Churchill during 1985:

1. The Bear Thumper is effective in deterring and marking polar bears at a distance of up to 35 m.
2. The twelve gauge Ferret slug is effective in deterring and marking polar bears at a distance of 30 to 50 m.
3. The Cart-a-ball slug is too inaccurate to be an effective deterrent.
4. The present portable electric fence design should be modified and tested. The present design is not effective in deterring all bears.
5. The acoustic deterrent with the sound generator is not effective in deterring bears.
6. The flashlight-siren does not deter bears.

RECOMMENDATIONS

1. Continue to test the Bear Thumper for deterring and marking polar bears at Cape Churchill.
2. Continue to test the Ferret slug for deterring and marking polar bears at Cape Churchill.
3. If possible, test the Bear Thumper and Ferret slug on black and grizzly bears.
4. Modify present design and support structure and continue to test the portable electric fence system on polar bears.
5. Test the portable electric fence system on black and grizzly bears.
6. Continue to test the acoustic deterrent system using the sound generator to increase the sample size of bears tested.
7. Initiate research to develop deterrent techniques that do not require the use of firearms.
8. Initiate a territory-wide program for field testing the Ferret slug in real problem bear situations.

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APPENDIX A. Bear Deterrent Data Form

POLAR BEAR DETERRENT TEST CAPE CHURCHILL 1985

DATE ____ MON____ LOC_____ TAPE #_____ TIME_____

SHOTGUN_____ WEATHER_____°, _____C, _____ _____ KM/HR

SEX: M F U EST ACT IDENT. LETTERS:_____

AGE: COY YRLG 2YRCUB MARKINGS:_____

SUBADLT ADULT LOCATION:_____

ADULT + COY + YRLG X #: _____ WEIGHT:_____ EST ACT
1 1
2 2 BAIT:_____

BEH BEFORE APPROACH:_____

APPROACH:

A- IN				OUT				
BEH								
DIR								
B-IN				OUT				
BEH								
DIR								
C-IN				OUT				
BEH								
DIR								
D-IN				OUT				
BEH								
DIR								

COMMENTS:_____

FEEDING ORDER:_____

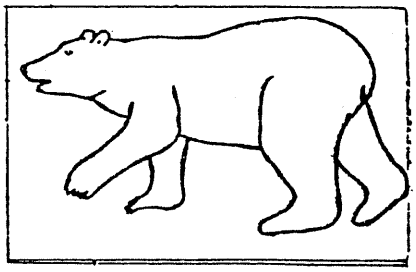
AGGRESSIVE ENCOUNTERS AT BAIT:_____

OTHER BEARS IN AREA:_____

TIME ARRIVE BAIT: _____ BEHAVIOR PRE-HIT:_____

HIT: TIME	SHOT #	LOAD	BEHAVIOR	COMMENTS:
	1			
	2			
	3			
	4			
	5			

HIT LOCATION:



RESPONSE OTHER BEARS:_____

EXIT:

D-IN				OUT				
BEH								
DIR								
C-IN				OUT				
BEH								
DIR								
B-IN				OUT				
BEH								
DIR								
A-IN				OUT				
BEH								
DIR								

COMMENTS:_____