# BEAR DETERRENT STUDY

## (TWELVE GAUGE FERRET SHELL TESTS)

## CAPE CHURCHILL, MANITOBA

## 1984

Northwest Territories Renewable Resources

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## ABSTRACT

Polar bear (Ursus maritimus) deterrent tests using 12 gauge ferret shells (plastic slugs) were completed at Cape Churchill, Manitoba between 19 October - 4 November 1984. A total of 119 tests were performed (77 experimental and 42 control). No significant differences were found in the time spent in entry or exit between experimental and control bears in the three outer zones. Bears were hit an average of 2.14 times per experimental animal per trial, while control animals were not hit. Experimental bears returned to the bait site approximately 17 hours after being hit with a 12 gauge ferret shell, while control animals returned significantly later at about 43 hours. At least 87.5% of the marked animals returned to the bait site at least once; some bears returned a minimum of seven times. The deterrent shells were fairly uniform in performance with less than 4% noticeably aberrant. Plastic slugs were fired at an average distance of 24 m from the bears. Researchers had an overall accuracy of 89%. Strong winds affected the accuracy of the ferret shells.

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# INTRODUCTION

As long as men and bears have occupied the same habitat, and competed for resources, there have been conflicts. The expansion of human activities into bear habitat has resulted in an increase in conflicts (Herrero 1970, Manning 1973, Jonkel 1975, Pelton et al. 1976, Schweinsburg and Stirling 1976). Man-bear conflicts can result in the loss of human life, property damage, and the death of the bear. Most man-bear problems result from accidental encounters (e.g., hikers) or because bears are attracted to worksites and camps.

Destroying problem bears has raised concern among wildlife managers and the public with respect to the long-term maintenance of bear populations. Historical evidence shows that the settlement of North America resulted in the extirpation of the grizzly bear (*Ursus arctos*) over much of its previous range (Storer and Tevis 1955, Cowan 1972). The natural history of bears make them particularly vulnerable to extirpation. Age of first reproduction, small litter size, long breeding interval, and low population densities, renders many bear populations susceptible to human influences.

Arguments for maintaining wild bear populations are numerous, and range from the idea that bears play an important role in natural ecosystems to the social and cultural importance of bears (Ehrlich and Ehrlich 1981, Wilson 1984). As a result, research was initiated to develop effective methods to reduce the potential for conflict and to develop non-lethal techniques to manage problem bears. The use of loud noises to deter bears (e.g., cracker shells, gunshots and airhorns) have been tried with variable success (Miner 1983). Electrified fences, food aversion chemicals, and chemical sprays also have been tested with variable results (Gilbert and Roy 1975, Gunson 1980, Herrero 1983, Stenhouse 1982).

Schweinsburg and Stirling (1976) outlined the need for more research of bear deterrent methods. In 1981 the NWT Wildlife Service, in cooperation with industry and other government agencies, initiated a research program to test detection and deterrent techniques to improve problem bear management. The goals of the program are:

1. to develop and test a range of effective detection and deterrent systems for use under varied conditions; and
2. to develop and implement education and training programs for people who may have to deal with problem bears.

To date, one of the most effective methods for deterring bears has been tested by Stenhouse (1982, 1983) and Stenhouse and Cattet (1984) and involves the use of a 38 mm anti-riot rubber bullet gun. The research addressed in this report is based on recommendations made by Stenhouse (1982) and Stenhouse and Cattet (1984). This report describes research completed from 19 October - 4 November 1984, at Cape

Churchill, Manitoba, using prototype 12 gauge Ferret shells (plastic slugs) on polar bears. The 12 gauge plastic slugs were tested for their effectiveness as a bear deterrent because:

1. they are easier to use than 38 mm rubber bullets;
2. they can be fired with a 12 gauge shotgun;
3. they are more accurate than the 38 mm rubber bullet;
4. they could be made available to the general public;
5. they are easier to transport and carry; and
6. they are less expensive than the 38 mm rubber bullet.

# STUDY AREA

The study area is located at Cape Churchill, Manitoba (58°48'N, 93°14'W) (Figure 1), along the coastal zone of the Hudson Bay Lowlands (Coombs 1954), approximately 35 miles east of Churchill, Manitoba.

Several beach ridges parallel the coast and provide relief to the area. In the work area, the elevation of the beach ridges range from 3 - 5 m. The ridge crests are void of vegetation; however, lichen-heath is present on the slopes (Rewcastle 1983). Permafrost is present at varying depths and, in conjunction with the severe climate and prevailing north and northwest winds (Savile 1968), influences the local vegetation.

The northern, eastern, and southern portions of the study area are composed of dry gravel beach ridges interspersed with freshwater lakes and ponds. Vegetation in the area consists of sedges, willows (1-2 m in height), mosses, lichens, and forbs. A large, shallow, brackish lake is located in the western portion of the study area (Figure 1). In 1984, the inland waters were frozen by the first week in November. Snow depth was not significant during the study period.

The climate of the study area is characterized by long, cold winters and short, cool summers. The average July temperature is 12°C and the average January temperature is

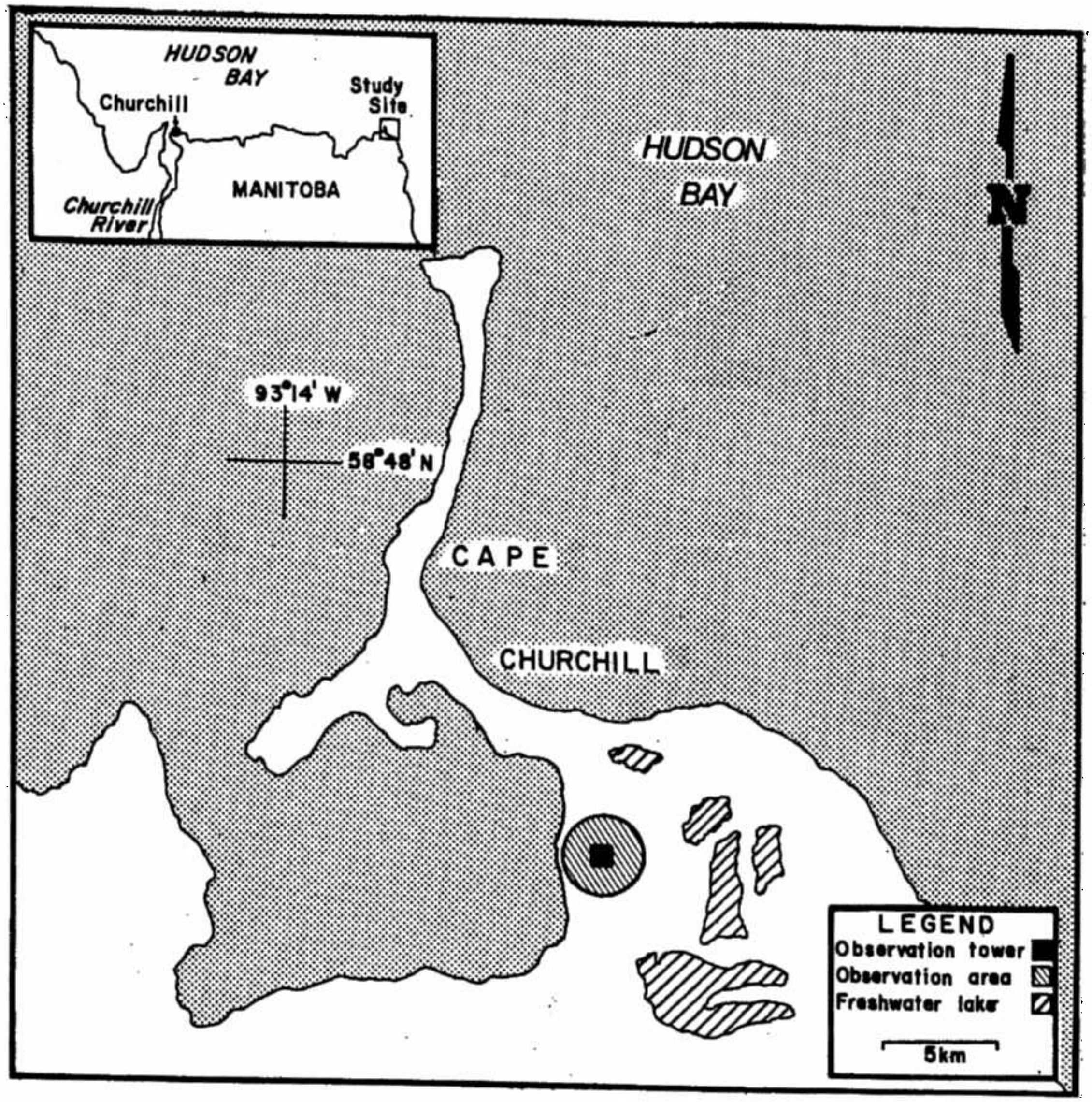


Figure 1. Bear deterrent study area at Cape Churchill, Manitoba, 1984.

-28°C. Frost may occur during any month with an average of 255 days of frost per year. The area receives 400 mm of precipitation annually and has the fewest number of sunshine hours per year of any area in Manitoba. This is likely due to the short winter days and the fog conditions created by Hudson Bay (Manitoba Department of Natural Resources 1978).

# STUDY POPULATION

The polar bear (*Ursus maritimus*) population in the study area is located in polar bear management zone A1 (Stirling et al. 1977). The bears come ashore in July and August as the Hudson Bay ice melts. They spend the summer and fall on land until the ice forms between late October and early December. They lead a sedentary existance while on land, resting and feeding on various species of vegetation. Flightless birds, small mammals, carrion, and kelp form part of their summer diet (Nero 1971, Russell 1975). The bears segregate themselves along the coast and inland by age and sex class. Pregnant females and females with cubs move to the inland areas for the summer, while adult males remain along the coastal area. Immature bears inhabit areas between the coastal and inland sites (Stirling et al. 1977). In the fall, as ice forms in the Bay, the bears congregate along the coast. By late October - early November a large number of bears concentrate near Cape Churchill, Manitoba (Stirling et al. 1977, Latour 1980). This is a result of the northward movement of bears along the coast.

The age and sex classes of polar bears in the Cape Churchill area appear to be skewed towards adult and sub-adult males. Yearling and two year old cubs also are represented, however, not in the proportions expected from a standard age distribution. Pregnant females and females with cubs rarely use the area.

By 24 October, 20 - 30 different bears were in the area, and by 1 November, 30 - 50 were observed. As the ice formed along the edges of the Bay, the bears moved closer to the coast. Most had moved onto the ice by 6 November.

# METHODS

Information was collected from the Canadian Wildlife Service (CWS) observation tower located 1.5 km south of the Hudson Bay coast (Figure 1) at Cape Churchill, Manitoba. Living and observation quarters were located in a small hut at the top of the 13.5 m tower.

In cooperation with the NWT Department of Renewable Resources (NWTRR), Canadian Wildlife Service (CWS) personnel captured 50 polar bears within the Cape Churchill area. Bears were immobilized from a helicopter, tattooed, ear-tagged, sexed, weighed, aged, and a letter painted on their back to facilitate subsequent identification during deterrent research and aerial population surveys. Of the total number of marked bears (n=50), 26 were observed at the study site and 19 were tested. Tests completed with marked bears allowed calculation of return rates for experimental and control animals.

Ground tests were based from a 2.4 $m^3$ steel cage developed and used by Stenhouse (1982). Most of the tests (n=119) were conducted outside the cage. However, the cage provided a safe working environment during periods when several bears were present. Six trials were completed from inside the cage because the bears were too close to the researchers.

Bears were attracted to the area with beluga whale (Delphinapterus leucas) and ringed seal (Phoca hispida) meat and fat. The carrion was placed inside a partially collapsed 45 gallon steel drum, which was anchored to a buried second drum filled with rock. The site was baited as often as required (approximately 5-6 times/day). Prior to conducting the tests, a small amount of fuel was poured into the drum and ignited. The burning carrion created a smudge and attracted bears from a greater distance. Bait sites (assumed to be an optimal attractant) were used to simulate a man-bear situation. In addition, whale oil and small pieces of carrion were placed on and near the drums to generate attractive odours.

Tests were conducted during daylight hours (0700-1800 hours) from 22 October - 4 November 1984. This was the period when bear densities were highest in the Cape Churchill area in 1984.

The core study area surrounded the tower with a radius of 175 m. Coloured markers were placed at intervals of 40 m, 60 m, 80 m, and 175 m from the tower as described by Stenhouse (1982). The markers created four circular zones (A, B, C, D) (Figure 2). The zones were used to measure entry and exit rates of bears in the study area. Bears were randomly assigned to experimental or control groups at a ratio of two experimental bears to one control bear to ensure an adequate sample of "tested" bears. Tests were conducted

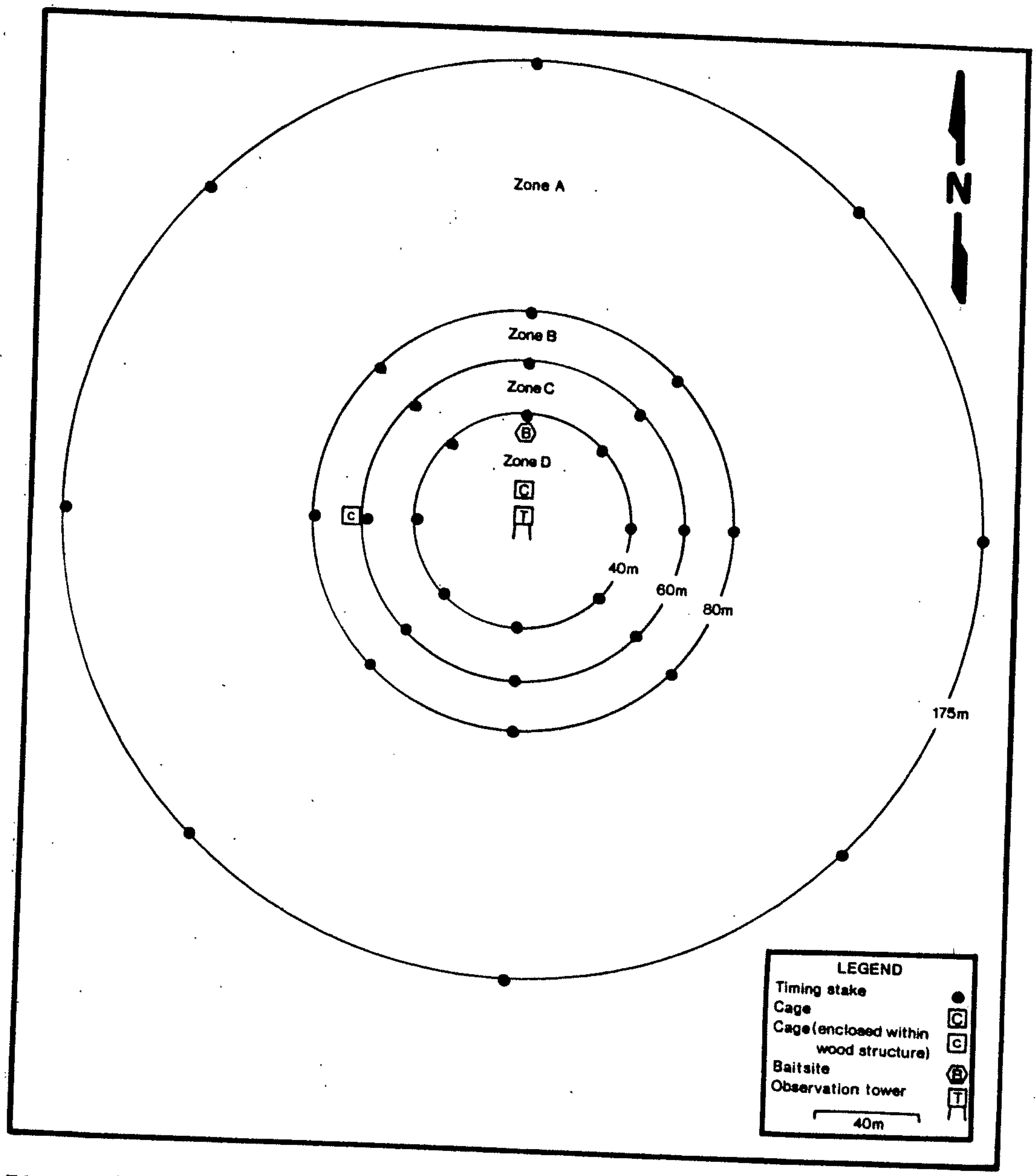


Figure 2. Design of the study site to conduct deterrent tests at Cape Churchill, Manitoba, 1984.

to determine the effectiveness of the prototype 12 gauge Ferret shells as a deterrent on bears. Comparative analysis was completed using entry and exit rates of experimental and control bears.

The prototype 12 gauge Ferret shells were developed under contract by AAI Corporation (Baltimore, Maryland) for the NWT Department of Renewable Resources. The Ferret shells were developed for a 12 gauge (18.5 mm) shotgun with a cylinder or improved choke. Shells tested had a 125 gr. load (8.0 g) and a solid Texin/480-AR projectile. The listed "effective range" of the prototype Ferret shell was 40 - 50 m. The muzzle velocity of the shell was 152 m/sec and a muzzle energy of 95J[1]. Figure 3 illustrates the projectile used in this study.

All shots were fired with a Remington 1100 improved 12 gauge semi-automatic shotgun with ramp sights. The tip of each Ferret shell was covered with black shoe polish to mark each bear tested, which facilitated measurement of short-term return rates and documentation of the hit site location.

Control animals were allowed to approach the bait site and remain in the area as long as they wanted. Experimental bears were allowed to enter the study zone uninterrupted until they arrived at the bait site. Each experimental bear

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1 J=joule, defined as a unit of work determined by multiplying the unit force and the unit distance (Physical Science Development Committee 1965).

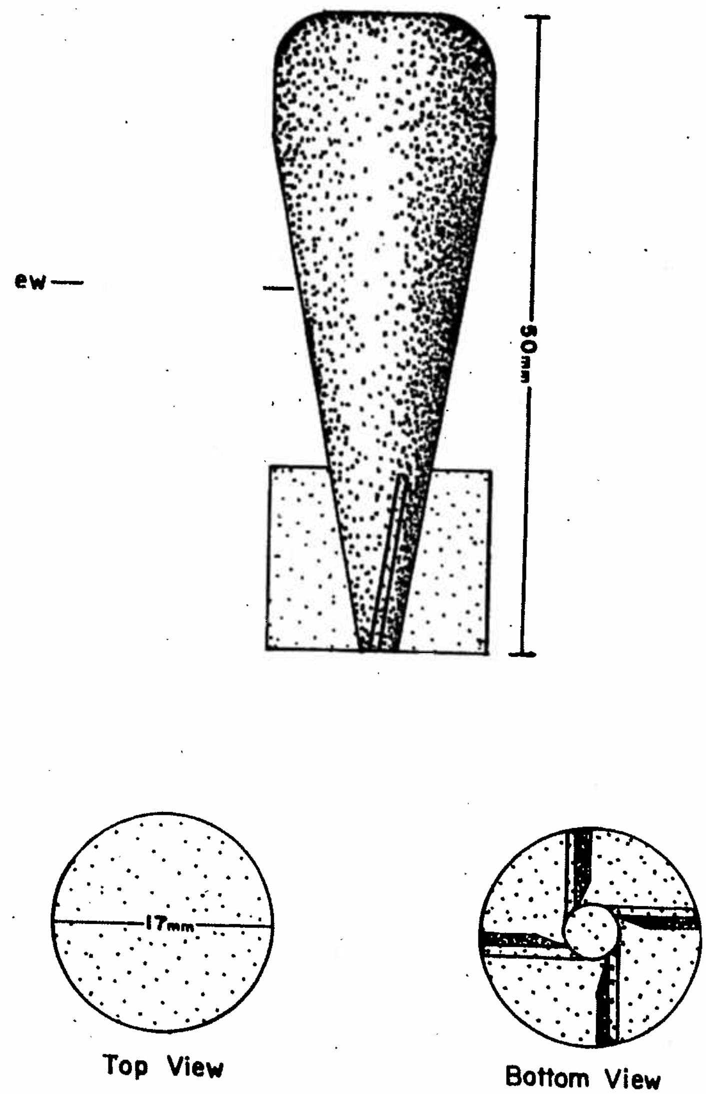


Figure 3. Twelve gauge prototype Ferret shell (Texin 480-NR) used during deterrent tests, Cape Churchill, Manitoba, 1984.

was allowed to remain at the bait for approximately two minutes before it was tested, to ensure that bears were attracted to the site. In many cases, the two minute period was extended because of other bears near the shooter and the time required for an accurate shot.

The following data were recorded for each bear:

1. date, time, wind speed, wind direction, and temperature;
2. direction of approach and exit;
3. tag, mark, number or identifying characteristics, and sex and age of the bear if known;
4. approach and exit times in each zone;
5. amount of time at the bait site;
6. aggressive encounters at the bait site;
7. order of feeding when more than one bear was at the site;
8. number of shots fired at the bear;
9. hit location of Ferret shell;
10. response of other bears in the area during deterrent tests;
11. distance between the shooter and the bear; and
12. general comments about Ferret shell performance.

The distance between the bait site, where all bears were hit, and the researcher, ranged from 15-45 m. The actual measurement was determined with a series of "distance stakes". An effort was made to ensure that experimental bears were aware of the researcher's presence before testing.

The study design is similar to that used by Stenhouse (1982, 1983) and Stenhouse and Cattet (1984). Not all of the information collected is analyzed in this report, as some information was collected to facilitate multi-year comparisons of data.

Statistical analyses were completed using one-way analysis of variance, t-tests, and F-tests (Sokal and Rohlf 1981). Most tests involved comparing the experimental and control bears for significant differences in behavioural responses to the tests.

## Entry and Exit Zones (A, B, C, and D)

The amount of time each study bear spent in each of the four zones was recorded. The approach was considered to begin as soon as the bear entered zone A and continued until the animal entered zone D. In zone D, the area near the bait, it was difficult to separate approach and exit times because many bears made repeated visits to the bait without ever leaving the zone. Therefore, the total amount of time that animals spent in zone D was used, rather than entry and exit times. Exit rates were determined once a bear had been struck with a ferret shell and had left zone D. For a control, the time bears spent in the zones after the initial entry was designated to the exit catagories.

Return rates were determined for marked experimental and control bears. As data was only collected during the day and early evening, return rates represent the time between visits to the study area during periods of operation. It is likely that bears returned during darkness. However, although tests were not completed on the basis of a 24 hour day, it is important to note that return rate comparisons between experimental and control bears are valid and representative of the overall trend. For this study, a "trial" was considered to be the period of time that each bear spent in the study area.

The behaviour of all study bears was recorded while they remained in the study area. The behavioural catalogue is based on the list provided by Stenhouse (1983). Table 1 lists the behavioural classes used during the study. The list only provides a description of those activities pertinent to this study and does not represent a comprehensive behavioural catalogue for polar bears.

Table 1. Polar bear behavioural catalogue used during the 12 gauge Ferret shell deterrent tests, Cape Churchill, Manitoba, 1984.

| 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 |
| flinch/jump | |
| **Locomotion** | **Ingestion** |
| walk | drink |
| trot | chew |
| gallop | tear |
| | lick |

# RESULTS

A total of 119 trials were completed; 77 bears were tested with Ferret shells and 42 bears were designated as control animals. In total, 44 different bears were studied: 31 (70%) males and 13 (30%) females. Table 2 outlines the age and sex classes of the study population. Of the 44 bears studied, 19 (43%) were captured and marked during the helicopter tagging operation. These bears were identified with dye markings applied at the time of capture. The experimental animals were hit an average of 2.14 times per trial (n=185) (s=1.43). None of the bears hit with the Ferret shells showed any signs of injury (e.g., broken skin or penetration).

## Entry and Exit Rates (Zones A, B, C, and D)

There were no significant differences ($p<0.05$) in the amount of time that experimental and control bears spent in zones A, B, and C during entry and exit periods (Table 3). Some of the bears wandered from zone to zone, while others moved directly to the bait site. The variances of all comparisons were tested for significant differences at $p=0.05$, and none were found. The time study animals spent in zone D is also shown in Table 3. There was a significant difference ($0.01<p<0.025$) in the amount of time that bears struck with a Ferret shell spent in zone D. Bears struck with a Ferret shell spent less time in this zone.

Table 2. Age class and sex composition of the polar bear study population, Cape Churchill, Manitoba, 1984[1].

| Age Category | Male | Female |
|---|---|---|
| Cubs of the year | 0 | 1 |
| Yearlings | 4 | 6 |
| Two year old cubs | 6 | 2 |
| Sub-adults | 4 | 2 |
| Adults | 17 | 2 |
| | ---- | ---- |
| Total | 31 | 13 |

[1] Age classes and sex composition data were derived from capture data and visual observation during field trails.

Table 3. Time[1] that study bears spent in each zone, Cape Churchill, Manitoba, 1984.

| | Approach | | | Total Time[2] | | Exit | |
|---|---|---|---|---|---|---|---|
| | | | | Test Zones | | | |
| | A (175-80 m) | B (80-60 m) | C (60-40 m) | D[2] (40-0 m) | C (40-60 m) | B (60-80 m) | A (80-175 m) |
| Experimental | | | | | | | |
| Mean ($\overline{x}$) | 7:53 | :38 | :41 | 13:45 | 2:08 | 1:32 | 18:56 |
| Standard Deviation(s) | 21:23 | :24 | :47 | 19:08 | 5:16 | 2:08 | 27:09 |
| Confidence Interval[3] | 4:48 | :05 | :11 | 4:16 | 1:11 | :29 | 6:17 |
| Sample size (n) | 76 | 75 | 73 | 77 | 77 | 77 | 71 |
| Control | | | | | | | |
| Mean ($\overline{x}$) | 5:52 | :35 | :50 | 22:13 | 2:41 | 1:43 | 16:40 |
| Standard deviation (s) | 25:19 | :24 | :36 | 26:09 | 7:58 | 3:55 | 21:06 |
| Confidence Interval[3] | 6:09 | :11 | 4:02 | 2:25 | 1:13 | 6:53 | |
| Sample size (n) | 42 | 42 | 42 | 42 | 40 | 36 | |

1 values given as minutes:seconds.
2 values represent the total time spent in zone D.
3 p=0.05.

## Return Rates

Return rates for experimental and control bears were determined for 24 bears. These bears could be positively identified (Table 4). The results indicate that experimental bears returned to the bait site significantly ($p<0.01$) sooner than control bears. The return rates of marked bears are described in Table 5. The return rates represent a minimum number of return visits as bears returning at night were not observed. Although only 24 bears were marked for identification, other unmarked bears were tested when they approached the bait site. Bears that returned to the bait site after being deterred were again tested. The testing of unmarked bears, and the retesting of returning bears, resulted in the completion of more test trials than the actual number of identifiable bears (Tables 3 and 4).

## Behavioural Responses

The response behaviour of experimental bears was variable. Some bears exhibited minimal overt behavioural responses when hit with the Ferret shell and continued feeding on the bait. Other bears jumped up, snapped at the hit location, and galloped from the area. Most of the bears struck with a plastic slug exhibited some form of

Table 4. Summary statistics for the return rates of experimental and control polar bears, Cape Churchill, Manitoba, 1984.

| | Experimental (hours) | Control (hours) |
|---|---|---|
| Mean ($\bar{x}$) | 16:58 | 43:15 |
| Standard deviation(s) | 23:59 | 41:24 |
| Confidence interval[1] | 6:56 | 18:09 |
| Sample size (n) | 46 | 20 |
| Range | 00:12-118:54 | 2:12-144:00 |

[1] p=0.05.

Table 5. Number of times marked polar bears returned to the test site at Cape Churchill, Manitoba, 1984.

| # Times | # of Animals | Percentage |
|---|---|---|
| 0 | 3 | 12.5 |
| 1 | 7 | 29.1 |
| 2 | 4 | 16.7 |
| 3 | 3 | 12.5 |
| 4 | 2 | 8.3 |
| 5 | 1 | 4.2 |
| 6 | 1 | 4.2 |
| 7 | 3 | 12.5 |
| 8+ | 0 | 0.0 |

behavioural response. When two or more bears were present at the bait site, the bear struck with a Ferret shell occasionally showed signs of aggression towards the other bear(s).

The behavioural responses of experimental bears were distinguished according to three catagories:

1. deterred off the bait, but returned during trial;
2. deterred off the bait, and did not return during trial; and
3. undeterred and stayed at bait.

Table 6 outlines the behavioural responses of bears struck with a Ferret shell. Of the 136 bears that left the bait site after being struck with a plastic slug, 100 (74%) walked away, 30 (22%) trotted away, and 6 (4%) galloped from the study site. All of the control bears walked away from the study area.

None of the bears showed any signs of aggression towards field staff performing the tests. Two bears, struck more than once with a Ferret shell, appeared to associate the deterrent with the shooter. These bears ran from the bait site when they heard the shooter lock the shell into the chamber.

The locomotory behaviours displayed by bears entering and exiting the study zone are outlined in Table 7. Only the dominant behaviours displayed by the animals are described because displayed behaviour was often a complex combination of many different actions.

Table 6. Responses of polar bears hit with 12 gauge Ferret shells, Cape Churchill, Manitoba, 1984.

| Response | Number | Percentage |
|---|---|---|
| Deterred off the bait, but returned during trial | 69 | 37.0 |
| Deterred off the bait, did not return during trial | 67 | 36.0 |
| Undeterred, stayed at the bait | 29 | 16.0 |
| Shots missed, no response | 20 | 11.0 |
| | ==== | ====== |
| Total | 185 | 100.0 |

Table 7. Locomotory responses of polar bears[1] during entry and exit of the study area, Cape Churchill, Manitoba, 1984.

| Group | Behaviour[2] | Entry A | Entry B | Entry C | Entry D | Exit C | Exit B | Exit A |
|---|---|---|---|---|---|---|---|---|
| Experimental | Walk | 92 | 97 | 96 | 84 | 79 | 81 | 100 |
| Control | Walk | 98 | 100 | 98 | 98 | 100 | 100 | 100 |
| Experimental | Trot | 4 | 3 | 4 | 12 | 17 | 16 | 0 |
| Control | Trot | 2 | 0 | 2 | 2 | 0 | 0 | 0 |
| Experimental | Gallop | 4 | 0 | 0 | 4 | 4 | 3 | 0 |
| Control | Gallop | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1 Experimental bears n=75, control bears n=42.
2 All numbers represent percentages.

The locomotory behaviours displayed by bears entering and exiting the study zone are outlined in Table 7. Only the dominant behaviours displayed by the animals are described, because displayed behaviour was often a complex combination of many different actions.

## Distance - Accuracy

The overall accuracy of the shooters using the Ferret shell was 89% (n=185) from an average distance of 24 m. The performance of the shells was fairly uniform; only eight shells (4%) were defective. The defective shells tended to undershoot the target by as much as 2 m. Some shells showed traces of unburned powder in the casing after firing, a function of a flaw in the design of the wadding (Dennis Trump, pers. comm.).

The major factors affecting the accuracy of the Ferret shells were distance, wind speed, and wind direction in relation to the target. The wind affected the trajectory of the shell, and often caused the shell to strike outside the target area. Shell drifting of 0.5-1.5 m was common at distances of 25 m or greater in a moderate wind. Winds in the study area averaged 20-35 km/hr; gusting winds were common. Seventeen trials (9%) were conducted at distances of more than 30 m. Because of reduced accuracy at greater distances, fewer tests were conducted to prevent hitting the bear in a vulnerable location (e.g., face). Preferred target areas included the shoulder or rump areas; however, because of variable wind conditions, many animals were struck in the ribs, legs, paws, and stomach. The most effective impact locations were areas with thin fat deposits such as the lower leg or neck. No bears were injured during testing.

The maximum effective range of this model of Ferret shell was 20-25 m (Table 8). At distances greater than 30 m, the impact energy was not sufficient to deter the bear. It is important to note that the Ferret shells did not have sufficient power to activate the semi-automatic action of the shotgun.

Table 8. Accuracy of 12 gauge Ferret shells tested at Cape Churchill, Manitoba, 1984.

| Distance (m) | Number of Shells | Accuracy |
|---|---|---|
| 10 | 0 | - |
| 15 | 1 | 100% |
| 20 | 108 | 93% |
| 25 | 35 | 91% |
| 30 | 24 | 83% |
| 35 | 8 | 75% |
| 40 | 6 | 67% |
| 45 | 3 | 67% |
| Total | 185 | - |

# DISCUSSION

The objective of this study was to determine the effectiveness of 12 gauge Ferret shells in deterring polar bears. Given one set of conditions, the shells used in this study might be effective, while given another they may have no effect. With human safety a primary goal in the development of any deterrent technique, it is desirable to produce a product that will work 100% of the time. However, given the wide range of potential man-bear situations, it is unlikely that a single effective deterrent technique will ever be developed.

The results of the 1984 tests indicate that 12 gauge Ferret shells have good potential as a deterrent under certain conditions. However, the data indicate that an effective 12 gauge Ferret shell for deterring polar bears has not yet been developed.

The impact of the test shells on experimental polar bears was not sufficient to consistantly and rapidly deter the bears. Experimental bears were hit an average of 2.14 times per trial indicating that a single hit was not a sufficient deterrent. Furthermore, 87.5% of the marked experimental bears returned to the bait site at least once. Because the bears returned an average of 17 hours after being struck with a Ferret shell, the data indicate that the shells had limited long-term value for deterring bears. During testing, experimental bears returned sooner than control bears. This may be due to the fact that the control bears, having spent more time near the bait site, satisfied their interest and were no longer attracted to the area.

The effect of the Ferret shells varied greatly between trials. Some bears left the bait site immediately after being struck with a Ferret shell, while others remained at the bait and left only after being struck several times. Even then, some bears left reluctantly. Most of the experimental and control bears walked from the area when they did leave.

The accuracy and consistency of the shells were good during periods of low wind conditions; however, with high or gusting winds, the shells drifted off target. The effectiveness and accuracy of the Ferret shells decreased at distances greater than 30 m. Therefore, the "effective range" is less than would be desired by people attempting to deter a bear.

The Ferret shell should be improved to increase its deterrent effect and thus improve its adversive conditioning. This could be accomplished by increasing the force (impact energy) at which the Ferret shell strikes the bear. The Ferret shell must generate a significant effect (e.g., painful stimulus), but not injure the bear. This is a difficult engineering problem because the projectile is small. Given that none of the experimental bears were injured by the Ferret shells, it is possible that powder loads could be increased. Ballistic tests will be required on new powder loads before additional tests can be completed on live bears. It would be advantageous to develop a series of Ferret shells that are effective at different distances.

Variability is a key factor in the study of animal behaviour; animals can respond differently to each situation (Scott 1958). Making the experience of being hit by a Ferret shell more unpleasant would increase the effectiveness of this method. Hitting a bear several times in conjunction with other deterrents (e.g., cracker shells) may prove more effective as well.

Polar bears in the Cape Churchill area have little to eat for several months and are restricted in their movements in the late summer and fall. Therefore, tests were conducted on bears that were difficult to deter from a food source (i.e., bait site). In other situations where the attractiveness of the area to the bear is less, it may be easier to deter bears. Deterrents should only be used after adequate precautions have been taken to reduce the chance that a bear will be encountered. If people feed bears, maintain an unclean camp, or provide some other attractant, the level of effectiveness of any deterrent will be reduced.

# CONCLUSIONS

The Ferret shells tested are not suitable for wide distribution for deterring polar bears. The test results indicate that additional ballistics engineering and design work is required to develop an effective 12 gauge plastic slug. The effectiveness of any technique as a bear deterrent is based on several factors.

The 12 gauge Ferret shells work well in some situations. Testing the shells in field situations will further demonstrate their usefulness as a deterrent as they presently exist.

Man-bear conflicts often result because people living and working in bear country are unfamiliar with the precautions that can be taken to prevent attracting bears. Practice, planning, and responsible actions by people who live and work in bear country are necessary to ensure the survival of wild bear populations. Deterrents are designed for use only after the necessary precautions have been taken.

The Ferret shell tests showed that under conditions of strong attractants (e.g., exposed bait) and positive reinforcements (e.g., food), polar bears in the Cape Churchill area, are not effectively deterred from the study area. However, given the extreme conditions under which the tests were conducted, there are indications that the product may have potential for deterring bears at distances of 20 - 30 m if the attractants are weak and positive reinforcement is prevented.

# RECOMMENDATIONS

1. Test the 12 gauge Ferret shells under different field situations to further determine the potential of the product as it exists.
2. Complete additional tests with 12 gauge Ferret shells to test different loads, projectile weights, materials, and shapes with the objective of increasing the deterrent effect and the effective range. Testing on carcasses should be continued as standard policy before completing tests on live animals.
3. Determine the consequences of using the deterrent shells in a shotgun without a modified or improved choke.
4. Use a pump action shotgun for field tests and use.
5. Hit the bear more than once, in rapid succession, when the shells are used.
6. Utilize the deterrent shells in conjunction with other deterrent methods.
7. Develop a series of deterrent shells, of differing powder loads, for use under different conditions (e.g., wind velocity and distance).

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# LITERATURE CITED

Coombs, D.B. 1954. The physiographic subdivisions of the Hudson Bay Lowlands south of 60 degrees north. Can. Dept. Energy, Mines and Res. Geogr. Bull. No. 6. 16 pp.

Cowan, I. McT. 1972. The status and conservation of bears (Ursidae) of the world - 1970. Pages 343-367 in Herrero, S. (ed.), Bears-their biology and management. IUCN Publ. New Ser. No. 23, Morges, Switzerland.

Ehrlich, P. and A. Ehrlich. 1981. Extinction: The causes and consequences of the disappearance of species. Ballantine Books, N.Y. 384 pp.

Gilbert, B.K. and L.D. Roy. 1975. Prevention of black bear damage to beeyards using aversive conditioning. Pages 93-102 in Phillips, R.L. and C. Jonkel, (eds.), Proc. 1975 Pred. Symp. Montana For and Cons. Exp. Station. 268 pp.

Gunson, J.R. 1980. Black bear - beeyard management in Alberta. Paper presented at Vertebrate Pest Manage Sem., Can. Pest Manage. Soc., Edmonton, Alberta, Aug. 1980. 10 pp.

Herrero, S. 1970. Human injury inflicted by grizzly bears. Science 170:593-598.

Herrero, S. 1983. Bears and the Canadian Pacific Railway construction camps in Glacier National Park, British Columbia. Prep. for MacLaren Plansearch Corp., Vancouver, B.C., Rec. 1982. Unpubl. rep. 49 pp. (as cited in Stenhouse and Cattet 1984).

Jonkel, C.J. 1975. Of bears and people. Western Wildlands, 2(1):30-37.

Latour, P.B. 1980. Social behaviour of polar bears (*Ursus maritimus* Phipps) concentrated on land during the ice-free season of Hudson Bay. M.Sc. Thesis. Univ. Alta., Edmonton.

Manitoba Department of Natural Resources. 1978. Taiga, tundra & tidel: an introduction to Manitoba's coastal region. Manitoba Dept. of Nat. Res. 32 pp.

Manning, T.H. 1973. Polar bear killed in self-defense. Can. Wildl. Serv. Files Bear Proj. Spec. Rep. 86. 2 pp.

Miner, G.D. 1983. Responses of captive grizzly and polar bears to potential repellents. Pages 275-279 in Meslow, E.C. (ed.), Bears-their biology and management. Int. Assoc. of Bear Res. and Manage. 5th Int. Con. on Bears Res. and Manage.

Nero, R.W. 1971. The great white bears. Manitoba Department of Mines, Resources, and Environmental Management, Winnipeg, Manitoba. 17 pp.

Pelton, M.R., C.D. Scott and G.M. Burghardt. 1976. Attitudes and opinions of persons experiencing property damage and/or injury of black bears in the Great Smoky Mountains. Pages 157-167 in Pelton, M.R., J.W. Lentfer and G.E. Fold (eds.), Bears-their biology and management. IUCN Publ. New Ser. 40, Morges, Switzerland.

Physical Science Study Committee. 1965. Physics. 2nd ed. D.C. Heath and Company, Lexington, Mass. 686 pp.

Rewcastle, C. S. 1983. A survey of selected plant communities in the vicinity of Churchill, Manitoba. Manitoba Department of Natural Resources, Wildlife Branch, Biological Services. Technical Report No. 83-11. 75 pp.

Russell, R.H. 1975. The food habits of polar bears of James Bay and southwest Hudson Bay in summer and autumn. Arctic 28:117-139.

Savile, D.B.O. 1968. Land plants. Pages 397-416 in Beals, C.S. (ed.), Science, history and Hudson Bay. Department of Energy, Mines and Resources, Ottawa.

Schweinsburg, R.E. and I. Stirling. 1976. More research needed to minimize conflicts between men and polar bears. Oilweek 27(5):55-56.

Scott, J.P. 1958. Animal behaviour. Univ. Chicago Press, Chicago, Il. 331 pp.

Sokal, R.R. and J.F. Rohlf. 1981. Biometry. 2nd ed. W.H. Freeman, New York. 859 pp.

Stenhouse, G.B. 1982. Bear detection and deterrent study, Cape Churchill, Manitoba, 1981. NWT Wildl. Serv. File Rep. No. 23. 65 pp.

Stenhouse, G.B. 1983. Bear detection and deterrent study, Cape Churchill, Manitoba, 1982. NWT Wildl. Serv. File Rep. No. 31. 58 pp.

Stenhouse, G.B. and M. Cattet. 1984. Bear detection and deterrent study, Cape Churchill, Manitoba, 1983. NWT Wildl. Serv. File Rep. No. 44. 62 pp.

Stirling, I., C. Jonkel, P. Smith, R. Robertson and D. Cross. 1977. The ecology of the polar bear (Ursus maritimus) along the western coast of Hudson Bay. Can. Wildl. Serv. Occ. Pap. No. 33. 64 pp.

Storer, T.I. and L.P. Tevis, Jr. 1955. The California grizzly. The Univ. of California. 335 pp.

Wilson, E.O. 1984. Biophilia: the human bond with other species. Harvard Univ. Press, London, England. 157 pp.