# BEAR DETECTION AND DETERRENT STUDY,

# CAPE CHURCHILL, MANITOBA,

# 1981

G. STENHOUSE

N.W.T. WILDLIFE SERVICE

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## ABSTRACT

A bear detection and deterrent program was initiated by government and industry in 1981. Field testing of microwave motion detection units, a recording of barking dogs, a 38 mm multi-purpose riot gun, syringe darts, and an electrified fence was conducted from 16 September to 16 October (Phase 1), and 17-23 October and 1-23 November (Phase 2) at Cape Churchill, Manitoba.

Eighty-six polar bears were tested (N=13, Phase 1; N=73, Phase 2) during the study. Microwave motion detection units were 100% successful in detecting approaching polar bears (N=66) during the daylight hours. The recording of barking dogs did not stop the advance of 87% of the approaching polar bears (N=26) and in four instances elicited aggressive responses. The 38 mm multi-purpose riot gun was successfully used to deter the approach of all bears (N=24) which were struck. All bears darted with an antibiotic (N=8) left the study area. Ninety-three percent (N=39) of the polar bears tested (N=42) passed through the electrified fence.

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# INTRODUCTION

Encounters between bears and humans are increasing as industrial exploration and other forms of human activities increase in bear habitats throughout Canada. For example, the number of problem polar bears killed in the Northwest Territories has increased since 1977 (1977/78, 10 defense or nuisance kills; 1978/79, 16 defense or nuisance kills; 1979/80, 34 defense or nuisance kills; 1980/81, 24 defense or nuisance kills).

There is concern for the safety of men working in bear country. Many confrontations between men and bears have resulted in serious injury or death to man and/or damage to his property. For example, in January 1975 an employee of Imperial Oil, stationed on an offshore drilling island located in the Beaufort Sea, N.W.T., was attacked and killed by a polar bear (Stirling 1975). Manning (1973) also reported on an unprovoked polar bear attack on man. In his summary of some previously unreported polar bear/man encounters, Jonkel (1975) reported on three cases. A man lying on the sea ice at Norwegian Bay, N.W.T. was attacked by a polar bear, which Jonkel felt had mistaken the man for a loafing seal. The second case involved a geologist who was attacked, bitten and hit by a polar bear before the bear was shot by a co-worker. Jonkel concluded that the third reported polar bear attack was probably a suicide on which the polar bear fed.

In every situation where men are living and working in bear habitat, the possibility of encountering a bear exists. Any encounter with a bear is potentially dangerous and must be treated as such.

Where bears are protected, such as in national parks (Martinka 1977, McArthur 1980) or near communities like Churchill, Manitoba (Cross 1974), they tend to lose their fear of people and learn to depend on the available food sources found there. The availability of food and attractive odours draws bears into proximity with people (Stirling et al. 1977) which often results in bolder behaviour. This boldness increases the probability of close contact leading to aggressive and sometimes injurious or fatal attacks on humans.

The need for a detection and deterrent program was highlighted at the 1981 meeting of the International Union for the Conservation of Nature (IUCN) polar bear specialist group, which was held in Oslo, Norway (January 20-22). At this meeting the signatory nations (Canada, Denmark, Norway, U.S.A., and U.S.S.R.) formally recognized that interactions between polar bears and humans can result in loss of property, loss of human life, and destruction of bears. Therefore, this group resolved that "...all signatory nations to the Agreement on the Conservation of Polar Bears should make use of all available information in order to minimize interactions between polar bears and humans, and urges those nations to conduct cooperative investigations aimed at minimizing polar bear--human interactions in the future" (Resolution 3 -- Minutes of the IUCN Polar Bear Specialist Group, Oslo, Norway, January, 1981).

Currently there is no reliable method of detecting and deterring a bear from approaching a camp, a machine, or a man. In response to the need to develop effective detection and deterrent techniques, this program was initiated by government and industry in 1981. The 1981 program was funded by: Cominco Ltd.; Department of Energy, Mines and Resources (EMR); Mobil Oil Ltd.; Department of Indian Affairs and Northern Development (DIAND); Petro-Canada Ltd.; Environmental Assessment and Planning Division and the Wildlife Service Division, Department of Renewable Resources, Government of the Northwest Territories. The Manitoba Department of Renewable Resources provided logistical support at the study site. The Canadian Wildlife Service (CWS) loaned an observation tower, and marked polar bears near the study site to allow identification of individuals. In addition, CWS personnel provided logistical advice and guidance.

The goals of this program are:

1. to develop a variety of effective detection and deterrent programs that can be applied to each type of human installation, whether it be a small exploration camp or a large industrial site or community.

2. to develop and implement education and training programs.

The short-term objectives of this program are to evaluate the effectiveness of commercially available detection and deterrent systems on polar bears by:

1. documenting the behaviour of individual bears during approach and avoidance of deterrent systems,

2. developing objective criteria of detection and deterrence for free-ranging polar bears, and

3. determining whether experienced bears respond with statistically significant different behaviour patterns than inexperienced bears.

The long-term objective is to develop safe and practical techniques, aimed at changing the behaviour of bears rather than those that result in the death of bears.

This paper reports on the results of the first field season conducted at Cape Churchill, Manitoba from 16 September to 23 November 1981.

## SUMMARY OF PREVIOUS WORK ON POLAR BEAR DETECTION AND DETERRENT SYSTEMS

Studies to develop polar bear detection and deterrent systems have been conducted near Churchill, Manitoba by Wooldridge (1978), Miller (1979), Wooldridge and Gilbert (1979), Wooldridge (1980), and Wooldridge and Belton (1980). During the course of those studies numerous techniques and devices were tested:

(1) Detection systems -- trip wire fences and proximity detection units,

(2) Deterrent systems -- commercial chemicals, acoustic repellants, and electrified fences.

### Detection Systems

#### Trip Wire Fences

Application of the trip wire fence system is based on the break-connection principle, which when activated sets off an alarm to warn of an encroaching bear. Problems identified with this technique were:

(1) The trip wire fence system designed and tested during 1977 was faulty because winds and frost loads caused false alarms (Wooldridge 1978). The fence system was modified and further testing in 1978 indicated that 72% (N=58) of all bears crossing the operational trip wire fence system were detected.

(2) A second drawback to the trip wire system was that bears learned to crawl under, run through, or leap over the trip wire fence (Wooldridge and Gilbert 1979).

(3) This trip wire fence showed signs of wear under actual field conditions and required a great deal of maintenance.

The additional modifications made to this fence in 1979 included the use of braided stainless steel fence wire and microswitch assemblies, which markedly increased its effectiveness (Wooldridge 1980). Although the sample size was small (N=16), Wooldridge (1980) concluded that the trip wire fence system could be useful as a detection system for small, temporary camps. Such a system has to be reset after each bear intrusion, which leaves personnel vulnerable during this period.

### Proximity Detection Systems

A proximity detection unit operates on the principle that an electrical field changes within a specified distance from a receiving system as a result of a bear approaching the detection unit. Wooldridge (1978) designed and tested a proximity detection system using an antenna suspended at a height of 150 cm above ground level (AGL). Bears were detected while under the suspended antenna. Initially the system was too sensitive and "overcounted" the number of observed bear intrusions. The circuitry was modified, and 63% (N=41) of all bears that passed under the antenna were detected (Wooldridge and Gilbert 1979). Testing of the technique was discontinued, because of the low degree of reliability in detecting incoming bears, and because constant sensitivity adjustments were required in the field.

## Deterrent Systems

### Chemical Repellants

Miller (1979) tested four categories of chemicals to deter polar bears:

(1) Repellants designed to keep dogs out of gardens (eg., "Git" and "Scram").

(2) Repellants designed to stop an attacking dog (eg., "Halt").

(3) Scents for training dogs to track bears (eg., "Bear Trail").

(4) Household cleaning chemicals (eg., ammonia and "Pinesol").

Chemicals were sprayed on bait sites and the amount of time polar bears spent at those sites were recorded. These tests demonstrated no noticeable behavioural effect on the bears (Miller 1979).

## Electrified Fences

A great deal of research has been conducted on the use of electrified fences as a means of reducing black bear visitations to apiaries (Gilbert and Roy 1977, Gunson 1980).

Wooldridge and Gilbert (1979) initiated testing of an electrified fence system, which enclosed a bait site. Only a small percentage (18%, N=27) of free-ranging polar bears subjected to the electrified fence exhibited shock responses (Wooldridge and Gilbert 1979). Many bears did not receive a shock when they came into contact with the fence, probably because of the good insulatory properties of dry, cold polar bear fur and foot pads, poor grounding conditions, and/or an intermittent charge on the wire.

Wooldridge (1980) redesigned the charge generator and conducted additional field testing in the fall of 1979. However, again only limited success was achieved in deterring polar bears.

Wooldridge (1980) concluded that, "...given arctic environmental conditions and the general physiology and morphology of polar bears, little success will be achieved in the use of such a fence as a deterrent."

## Acoustic Repellants

Wooldridge and Belton (1980) tested natural and synthesized aggresive sounds on captive and free-ranging polar bears in the Churchill region. The sounds were effective in eliciting a fear response in polar bears, but one free-ranging polar bear responded aggressively towards a test sound. Wooldridge (1978) further tested the recordings of natural aggressive polar bear vocalizations on seven free-ranging polar bears. All the test bears exhibited a fear response and left the study site within 5 to 7 seconds (Wooldridge 1978). The following year, Wooldridge and Gilbert (1979) monitored the effectiveness of recorded natural and synthesized aggressive polar bear vocalizations on free-ranging polar bears (N=49). However, only 40% of the polar bears were repelled; 45% of exposed bears investigated the sound sources, while 15% did not demonstrate any response (Wooldridge and Gilbert 1979). Similar results were obtained with synthesized recordings. The authors speculated that poor test results occurred because no visual component accompanied the acoustic stimuli, and/or an inadequate power source.

Wooldridge and Gilbert (1979) concluded that "... while acoustic repellants may initially move an intruding bear, our results indicate that many return." Wooldridge (1980) discontinued tests of biologically significant sounds during his next field season.

The second category of acoustic repellants includes frequently used bear-scaring devices such as thunderflashes, teleshots, gunshots, and aerosol boat horns. Wooldridge and Gilbert (1979) used these devices on six free-ranging polar bears. Four of the bears were repelled but one bear continued to approach the researcher while these devices were being tested. Despite the small sample size, the results demonstrate the potential danger of relying solely on these devices for personal protection during a confrontation with a polar bear. No research has been conducted on the possible habituation of polar bears to the continued use of these devices. Habituation of birds to propane powered noise makers ("blasters") used in crop depredation control has been well documented (Kear 1963, Stockdale 1973).

## Methods Used in Previous Studies

Wooldridge (1978) conducted tests of detection and deterrent systems from the Klein Observation Tower, 25 km east of Churchill. Polar bears were attracted by using a mixture of sardines and cooking oil to five bait sites around the tower. A trip wire fence system and an acoustic repellant system were tested when bears approached the bait site. The acoustic repellant system employed a cassette - amplifier - speaker system mounted in, and played from, an automobile parked under the observation tower. When a bear reached a bait site, the acoustic repellant was activated. Bear approach and exit rates were measured from only one set of markers, located 10 m away from the bait sites, to determine the effectiveness of the acoustic repellants. He made observations between 1200-1700 hours during 4 days in autumn; dates were not specified. The only measure of the effectiveness of the acoustic repellants was if the bears left the 10 m zone. No detailed information was collected on the behavioural responses of free-ranging polar bears to either the trip wire fence or acoustic repellants.

The following year, Wooldridge and Gilbert (1979) tested polar bear detection and deterrent systems at the Gordon Point Observation Tower, 30 km east of Churchill. Polar bears were again attracted to the test site with a sardine and cooking oil bait mixture. A trip wire fence, a proximity detection system, and an electrified fence were set up around two bait sites near the observation tower. Acoustic repellants were again tested; however, this time the speakers were placed at the bait sites. The movement time between the trip wire fence (outer boundary) and the electrified fence (inner boundary) was used to measure approach and exit rates. The dates of testing and methods of observation were not published by Wooldridge and Gilbert (1979). Limited information was collected on the behavioural responses of polar bears to the detection and deterrent systems. Miller (1979), but not Wooldridge and Gilbert (1979), noted that their research was conducted simultaneously at the Gordon Point Observation Tower.

Wooldridge (1980) further tested the polar bear detection and deterrent devices from the Jones Observation Tower, 35 km east of

Churchill. During that study, no baits were used to attract polar bears because Wooldridge (1980) believed that the bears' natural curiosity would attract them to the occupied tower.

During Wooldridge's (1980) study, a trip wire detection system and an electrified fence was placed around the base of the Jones Observation Tower. The effectiveness of these systems was based on the detection of an intruding bear (for the trip wire system) and stopping the approach of a bear (for the electrified fence). Wooldridge (1980) did not present data on the number of days of field testing, the times of observations, the dates of the study, or the approach and retreat times of bears tested.

I considered the techniques used by Wooldridge (1978), Wooldridge and Gilbert (1979), and Wooldridge (1980), then altered the methods to provide more precise information on the approach and exit behaviour of test bears. In addition, I monitored the behaviour of bears which were not tested, and the effectiveness of detection and deterrent systems.

# STUDY AREA

The study area was located at Cape Churchill, Manitoba (58°48'N, 93°14'W), (Fig. 1), and is within the coastal zone of the Hudson Bay Lowlands (Coombs 1954). The eastern half of the study area is composed chiefly of gravel beach ridges interspersed with freshwater lakes and ponds, and the western half is mainly a large, shallow brackish lake (Fig. 1). The inland waters were frozen by the third week in October. Vegetation in the area is typical of subarctic regions (Hustich 1975), mainly consisting of sedges (*Carex* spp.), willow (*Salix* spp.), mosses, lichens and forbs.

## Study Population

Polar bears come ashore along the Manitoba and Ontario coasts when the Hudson Bay ice melts in early August. Females with cubs and pregnant females move 20-50 km inland, adult males congregate along the coasts, and subadults of both sexes are found inland from the adult males (Knudsen 1973, Stirling et al. 1977). On land polar bears utilize birds, mammals, carrion, small marine mammals and kelp (found on the tidal flats) as summer food (Nero 1971).

The bears gradually move north along the Manitoba coast during September through November, and large numbers congregate in the Cape Churchill region during those months (Russell 1975, Latour 1980). At freeze-up, usually in mid-November, the bears disperse onto the new ice to hunt seals.

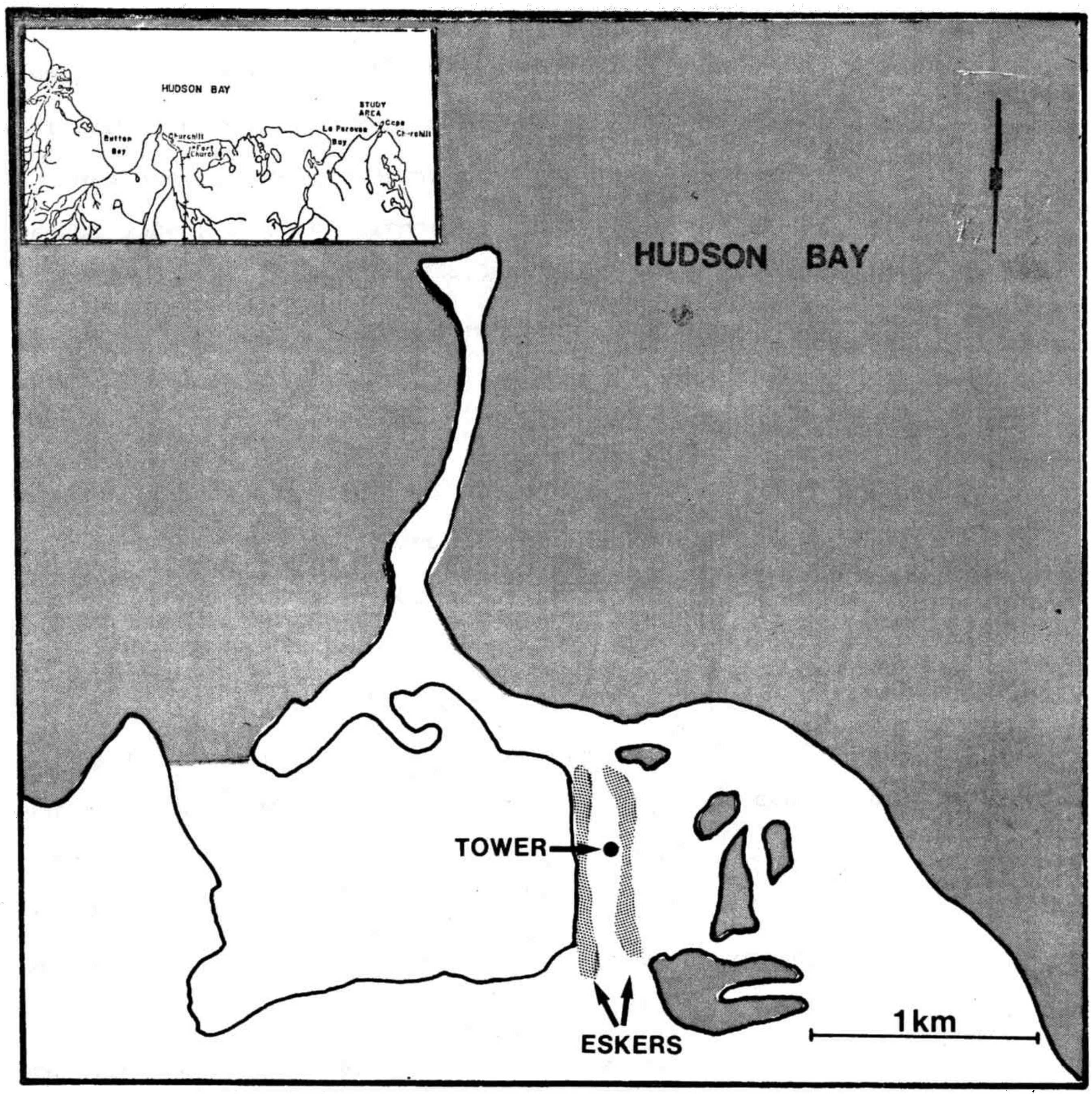


Figure 1. Location of the 1981 bear detection and deterrent study site at Cape Churchill, Manitoba.

# METHODS

Observations were made from a tower 13.5 m high, which was 1.5 km south of the Hudson Bay coast (Fig. 1). An observation hut, which doubled as living quarters for two observers, was bolted to the top of the tower (Fig. 2). Windows on each side of the hut allowed a 360° unobstructed view of the surrounding area. As focal animals (Altmann 1974) approached, observations were made with binoculars (10x50) and occasionally with a 15-60x Bushnell spotting scope. Data were collected daily between 0800-1700 hours (except during periods of reduced visibility) from 16 September to 23 November. No baits were used to attract bears to the observation tower.

A commercial microwave detection system was installed to form a partial perimeter detection boundary around the observation tower. Painted wooden stakes were positioned to mark four zones which formed a series of concentric circles around the observation tower (Fig. 3). The four zones were 175 m, 80 m, 60 m, and 40 m from the base of the observation tower. The lake to the west of the tower was approximately 190 m from the tower and large areas of willows were located approximately 210 m east of the tower. These biophysical parameters dictated the choice of 175 m for the first timing zone boundary (Zone A). The painted stakes were used to record approach and exit rates of the bears.

Approaching bears were randomly assigned to 1 of 2 treatment conditions; experimental (treatment 1) or control (treatment 2). Experimental bears were tested for their behavioural responses to the deterrent systems.

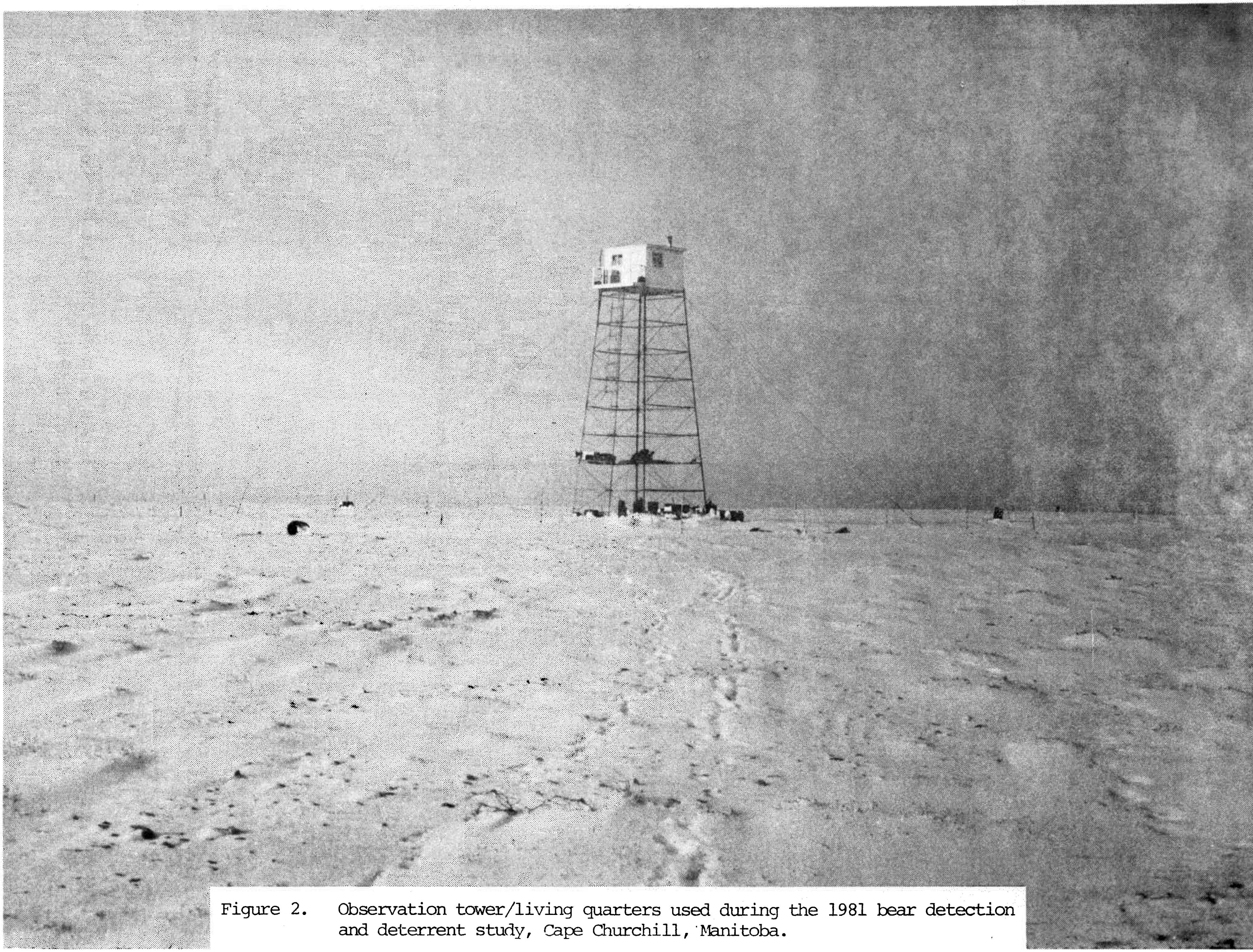

Figure 2. Observation tower/living quarters used during the 1981 bear detection and deterrent study, Cape Churchill, Manitoba.

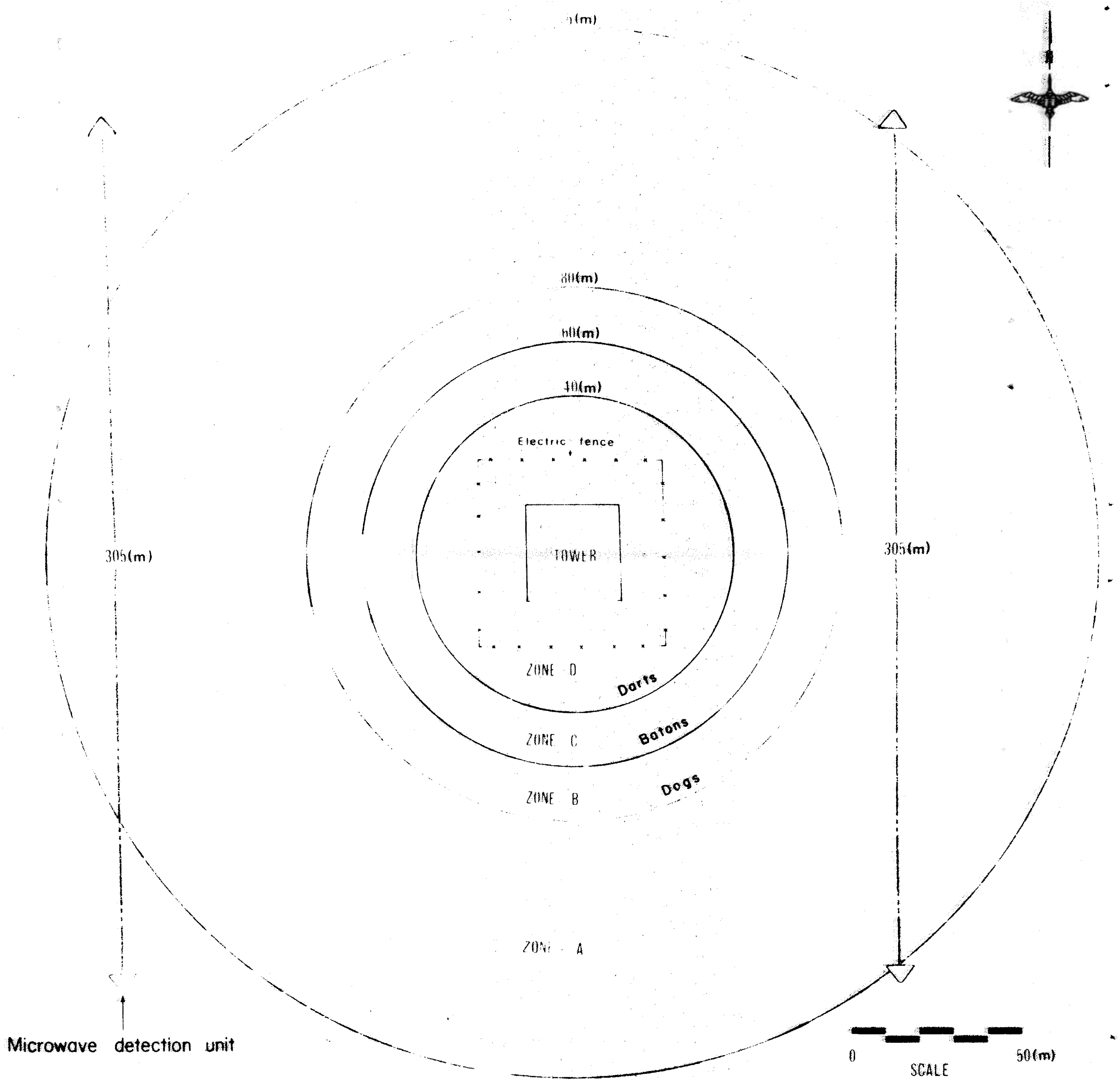


Figure 3. Location of timing zones, microwave detection units, electrified fence, and the observation tower at the study site, Cape Churchill, Manitoba, Fall 1981.

At the 80 m line, each experimental bear was exposed to an acoustic repellant. A recording of barking dogs was played as long as the bear remained within this timing zone (Zone B = 80 to 60 m). If the bear entered the 60 m timing zone (Zone C), a rubber baton was fired at the bear from the tower. Within the 40 m timing zone (Zone D), a syringe dart filled with tetracycline was fired at the bear from the tower. If the bear continued to approach the tower, the electrified barbed-wire fence was activated. An exit was defined as a bear leaving a timing zone and heading away from the observation tower (eg., C to B to A).

Trials were conducted only when single bears were within the test area, except for females with cubs. Solitary bears were used to prevent bias that might result from observational learning or social and spatial relationships that could alter the behaviour of the focal animal.

Data were recorded on cassette tapes and subsequently transcribed onto coded sheets for computer analyses. The descriptions of behaviour were enhanced by filming responses of individual bears to the study site and deterrents with a 16 mm Bolex H-16 camera.

Data were analyzed on a Hewlett-Packard 3000 computer. The data were organized and statistical tests were conducted using Statistical Package for the Social Sciences (SPSS) (Nie et al. 1974). SPSS programs were used to conduct analyses of variance and to test selected data; a Mann-Whitney U test and the Wilcoxon test for matched subjects also was used.

The following data were collected during each experimental trial:

1. location, date, time
2. temperature, wind direction and speed
3. direction of approach of bear
4. description of bear;
   (a) tag or mark (if present)
   (b) sex and age class (if possible)
   (c) single bear or female with cub
5. behaviour of bear during approach (see following section on behavioural catalogue)
6. behaviour of bear upon encountering deterrents (see following section on behavioural catalogue).

The data sheets (Appendix) were organized to facilitate consistent categorization of bear behaviour.

During the second treatment condition (control) no deterrent devices were tested, however, data on approach and exit rates, and behaviour while within the zones were collected.

## Behavioural Catalogue

A behavioural catalogue was compiled from the behaviour of tested experimental and control bears (Table 1). Observations focused on behavioural states, and frequency of occurrence to analyze behavioural sequences.

The catalogue is not a complete compilation of the polar bear's behavioural repetoiré because no social, sexual or hunting behaviour categories are included. I divided the behavioural catalogue into six behavioural units: lying and resting; agonistic; locomotion; exploratory/curiosity; comfort movements;

Table 1. Behavioural catalogue of experimental and control polar bears observed during the 1981 bear detection and deterrent study, Cape Churchill, Manitoba.

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

and ingestion. Head-up-down behaviour is listed under both the agonistic and exploratory/curiosity behavioural units (Table 1) because:

(1) two instances were observed where the head-up-down behaviour occurred immediately following a charge by experimental bears; and,

(2) the head-up-down behaviour was also observed immediately preceeding and following exploratory/curiosity behaviour.

## Identification of Individuals

Ten polar bears were recognizable either by morphological characteristics, or from markings applied by researchers. From 16 September to 8 October bear densities at the study site were relatively low, and after continued observation three bears could be identified from their appearance. During this same period, two bears were artificially marked. One bear was marked when he opened an equipment box and bit into a pressurized tin of blue acrylic spray paint; the paint marked the right side of his head. The second of the two marked bears was struck with a syringe dart, which did not penetrate the skin but instead sprayed the yellow tetracycline on the hind quarters. CWS personnel marked five adult male polar bears in the Cape Churchill region during the last week of October with commercial hair dye (Fig. 4).

After 8 October, the large number of polar bears prevented recognition of individuals using differences in morphological characteristics and consequently, only individuals with artificial markings were recognizable.

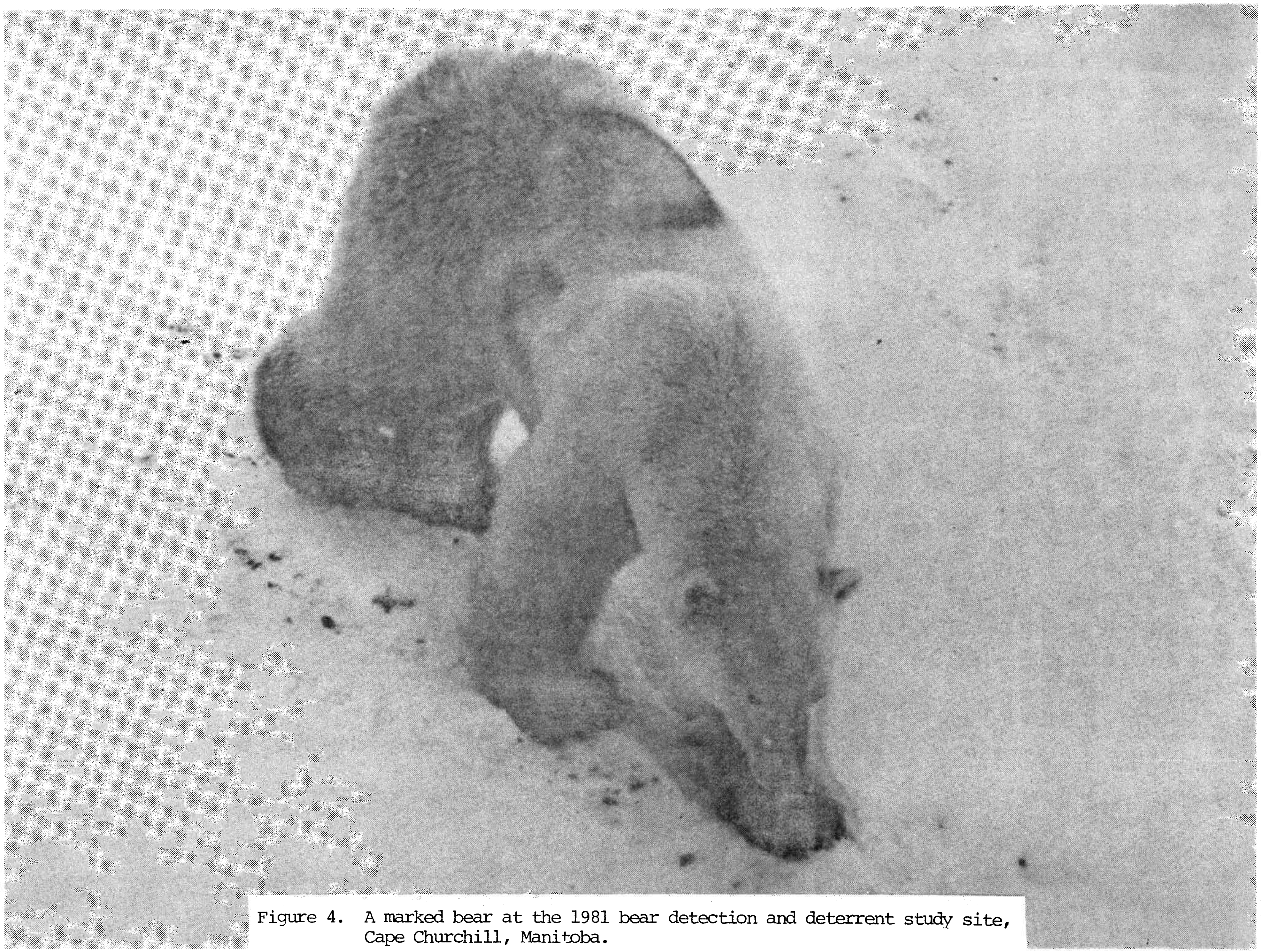

Figure 4. A marked bear at the 1981 bear detection and deterrent study site, Cape Churchill, Manitoba.

## Assumptions

1) Polar bear behavioural responses to deterrents would be similar if a ground base camp had been used instead of a tower.

2) The stimuli behind approaching the observation tower ~~was~~ were similar to what would be found in a typical field camp/installation experiencing bear problems.

# MATERIALS

## Microwave Detection Units

Four sets of Racon 14000-06 outdoor perimeter motion detection units were obtained for use in this study. These microwave units are designed for use as components in high security protection systems for nuclear power plants, prisons, industrial sites, and various types of government installations.

The model 14000-06 is a cold weather system which is tested and certified to operate at $-40^{o}C$. These units operate as bistatic systems, which means that the transmitter and receiver are set up at opposite ends of the area to be protected. An RF signal is continuously transmitted to the receiver, thus creating an invisible fence. If an intruder penetrates this invisible fence, signal variations occur. These variations are detected, processed, and used to trigger an alarm relay. This system has an effective operating range of 456 m.

To obtain maximum distance coverage the terrain between the receiver and transmitter must be level. Small ridges or depressions which may lie between a receiver and transmitter unit result in areas of "non-coverage". The terrain irregularities on the study site were gravel beach ridges running in a north-south direction.

Landform restrictions caused by the gravel beach ridges at the study site meant that only 2 of the 4 microwave detection systems could be installed. One system was installed along the west perimeter, approximately 150 m from the tower, while the other was used to monitor the eastern perimeter, approximately 100 m from the tower (Fig. 3). To install the system, a 819 cm (O.D.) x 1.8 m steel pipe was secured with a frozen mixture of loose gravel in a hole approximately 1 m in depth. The receiver or transmitter was then bolted to the pipe (Fig. 5). Once secured, antennae adjustments were made with a multimeter and the system's operational status was tested. The receiver and transmitter were established 305 m apart.

This detection system is designed to be powered by 16.5 V.A.C., but I used 12 V.D.C. automotive batteries (Delco 625 amp.). Once detection sensitivity was adjusted, alarm relay wires (18 gauge shielded coaxial cable) were used to connect the receiver units to the control panel in the observation tower. When an alteration of the signal (dopler shift) between the receiver and transmitter occurred, a sonalert audio warning device and a light were activated within the observation tower. The detection system was operated on a 24 hour basis, and voltage checks on the power supplies were made every second day. Visual confirmation of a warning of an approaching bear was possible only when light conditions permitted.

## Recording of Barking Eskimo Dogs

Recordings of 20 eskimo dogs were made during feeding time at the Eskimo Dog Research Foundation, Yellowknife, N.W.T. These recordings were made with a Uher 4000-L recorder and Grampion parabolic reflector. At the study site these recordings were broadcast through 4 University Sound wide angle paging/talkback

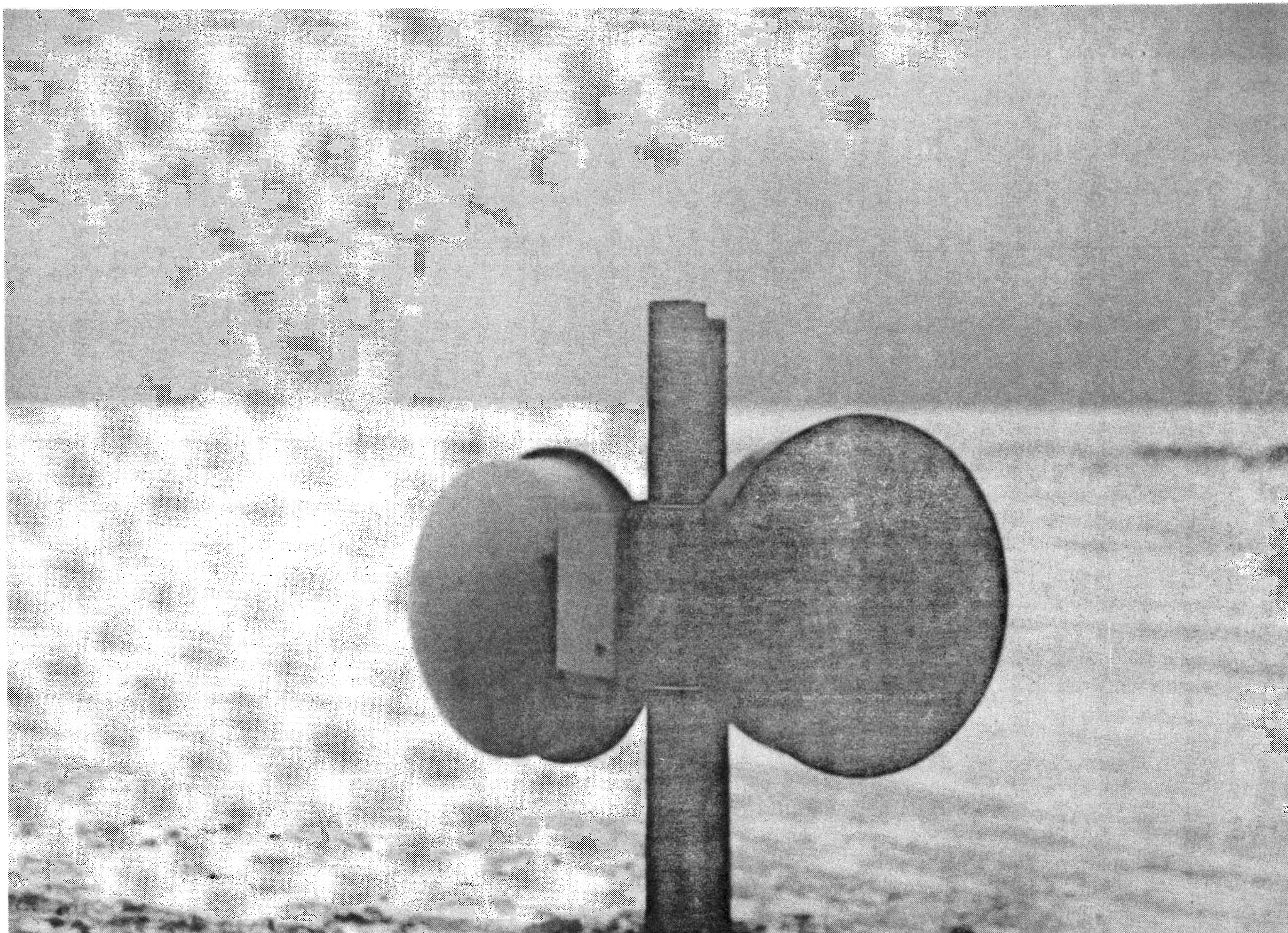

Figure 5. Microwave detection units installed at the 1981 bear detection and deterrent study site, Cape Churchill, Manitoba.

speakers (CFID 32-8), which were mounted on each of the four observation tower legs 4 m AGL. A 60 watt power amplifier (Sony XM-120) and a cassette player (Sony XK-21), mounted inside the observation tower, were used to generate the sounds. This sound system also was powered by a 12 volt DC automotive battery (Delco 625 amp.). Sound levels for all trials were 110 dB, measured on a sound meter 1 m from the speaker.

## Rubber Batons

Anti-riot rubber baton projectiles (38 mm) were tested during the study. Each baton is a cylindrical rubber projectile sealed in a waterproof aluminum cartridge case (101 mm x 37 mm, weight 135 gm). The balistic information for the rubber baton is presented in Figure 6. The 38 mm multi-purpose riot gun has a conventional single shot break-open design (Fig. 7). The firing mechanism is a double action type requiring a firm, long trigger pull; the firing pin has an automatic reset to avoid accidental discharge when closing the breech. The barrel of this weapon is chambered to improve muzzle velocity and to provide greater accuracy. The balance and handling characteristics of this weapon are similar to those of a shotgun. The gun and cartridges were obtained from Schermuly Limited, Wiltshire, England.

## Darting with Cap-Chur Equipment

Tests were conducted to determine the effects of darting polar bears with an antibiotic (oxytetracycline hydrochloride - tetracycline 100). Projectile syringes were filled with the

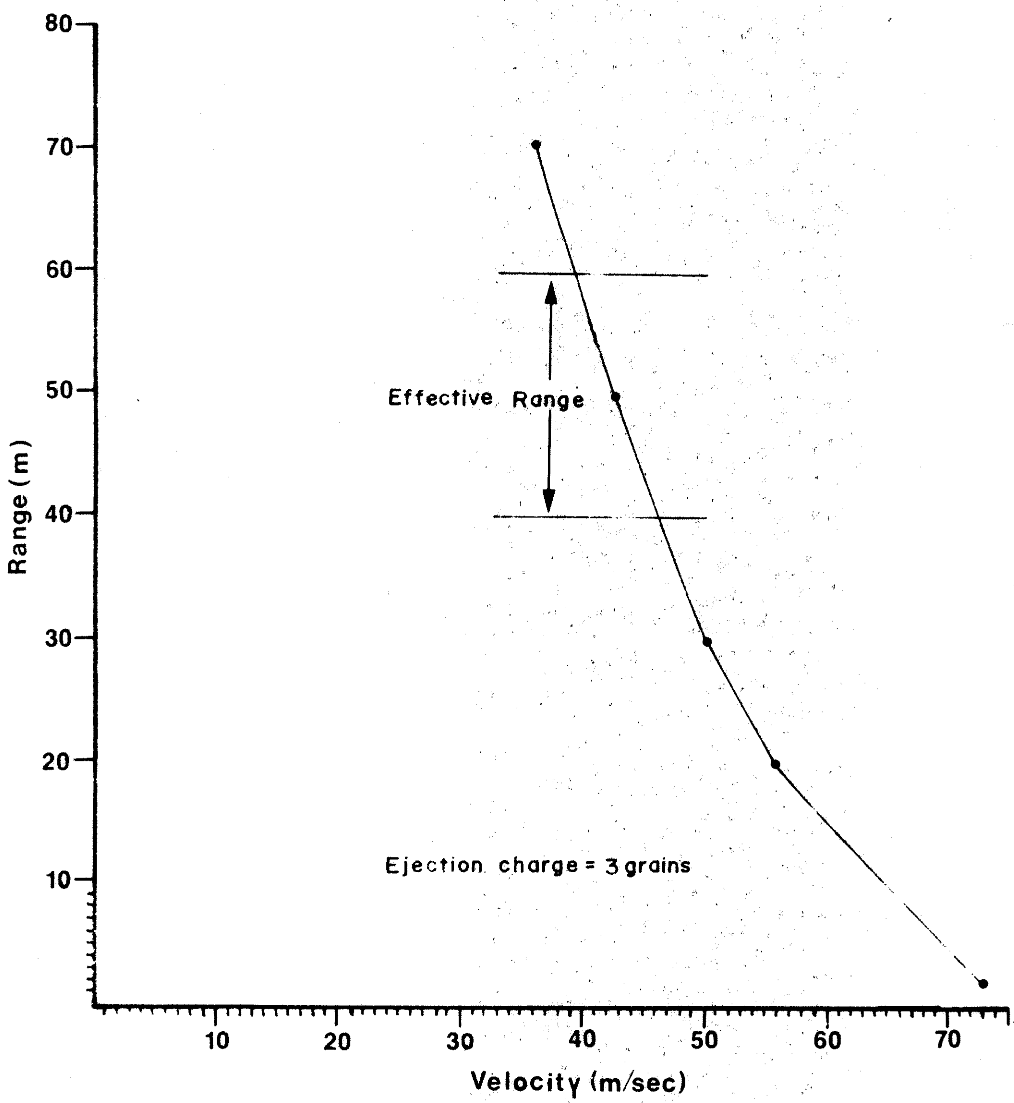


Figure 6. Balistic data for multi-purpose riot gun (38 mm) used during the 1981 bear detection and deterrent study, Cape Churchill, Manitoba.

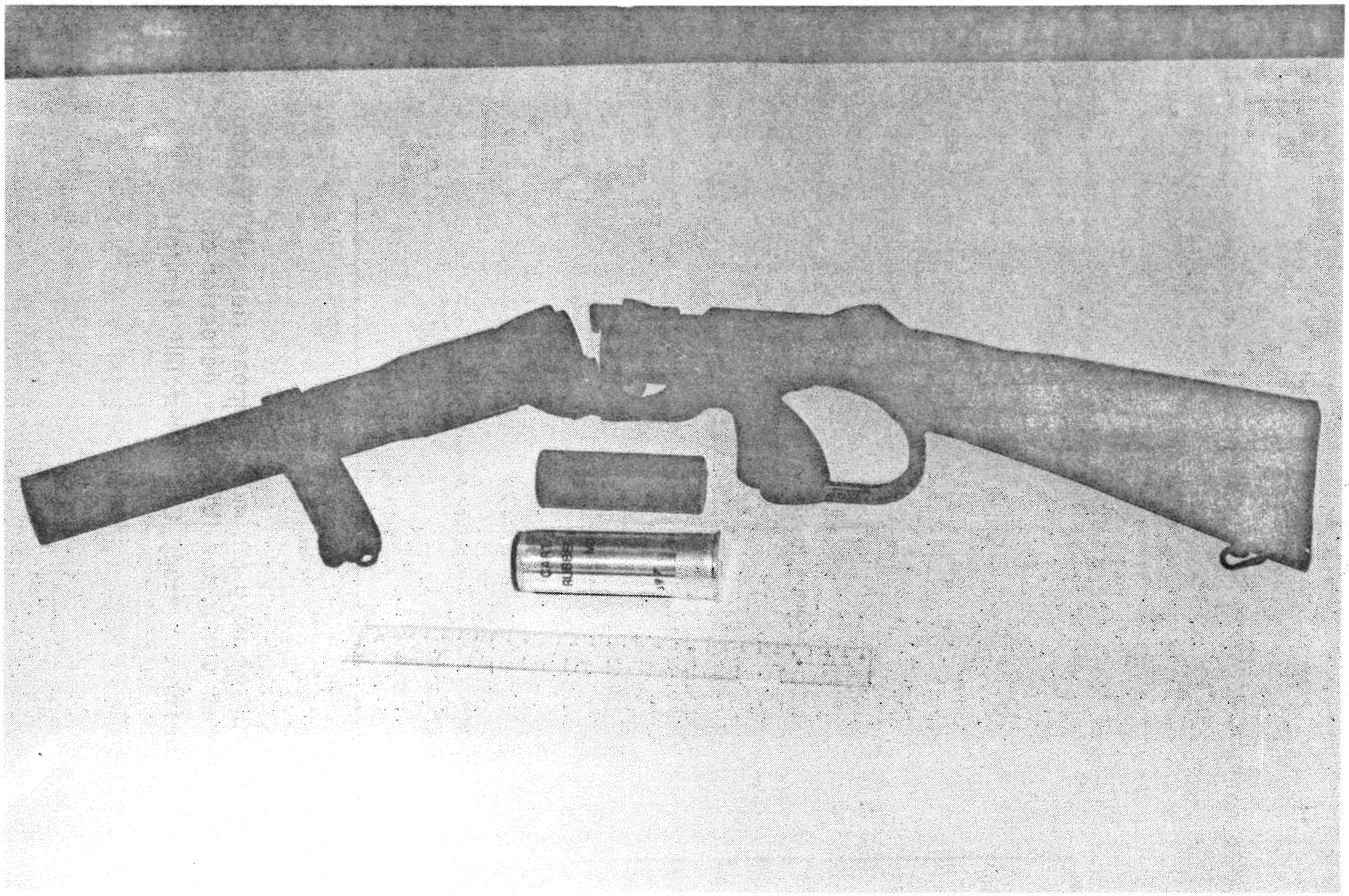

Figure 7. Multi-purpose riot gun (38 mm) used during the 1981 bear detection and deterrent study, Cape Churchill, Manitoba.

antibiotic (5 ml) and fitted with a 3 cm collared needle. Cap-Chur (Palmer Industries Ltd.) darting equipment was used to fire the loaded syringes from the observation tower towards the test bears in Zone D (Fig. 8). In all tests, medium velocity (coded yellow) powder charges were used. The shot, aimed at the hind quarters of each bear, inflicted a painful, but harmless intramuscular injection (J. Haigh pers. comm.).

## Electrified Fence

After reviewing the construction of the electrified fence system tested by Wooldridge and Gilbert (1979) and Wooldridge (1980), I realized that a major problem with this type of fence was related to the method of shock delivery. During those studies, a barbless electrified wire was used, which essentially slid over the intruding bear's fur. In the present study a barbed-wire electified fence was tested.

The fence formed a 33 $m^2$ enclosure around the base of the observation tower (Fig. 3). Three round steel posts (2.4 m x 0.05 m) were spaced evenly between four round steel corner posts (2.4 m x 0.7 m). Four 7 cm long ceramic insulators were then attached to each fence post (Fig. 9). Barbed wire was then attached to each of the insulators to form a four strand fence. The barbs (1.91 cm long) were spaced at 10 cm intervals. These are the longest commercially available barbs in Canada.

The top and second wires were charged (hot), while the lower and third wires were grounded. Bears received shocks when in contact with a pair of wires (one charged, the other grounded),

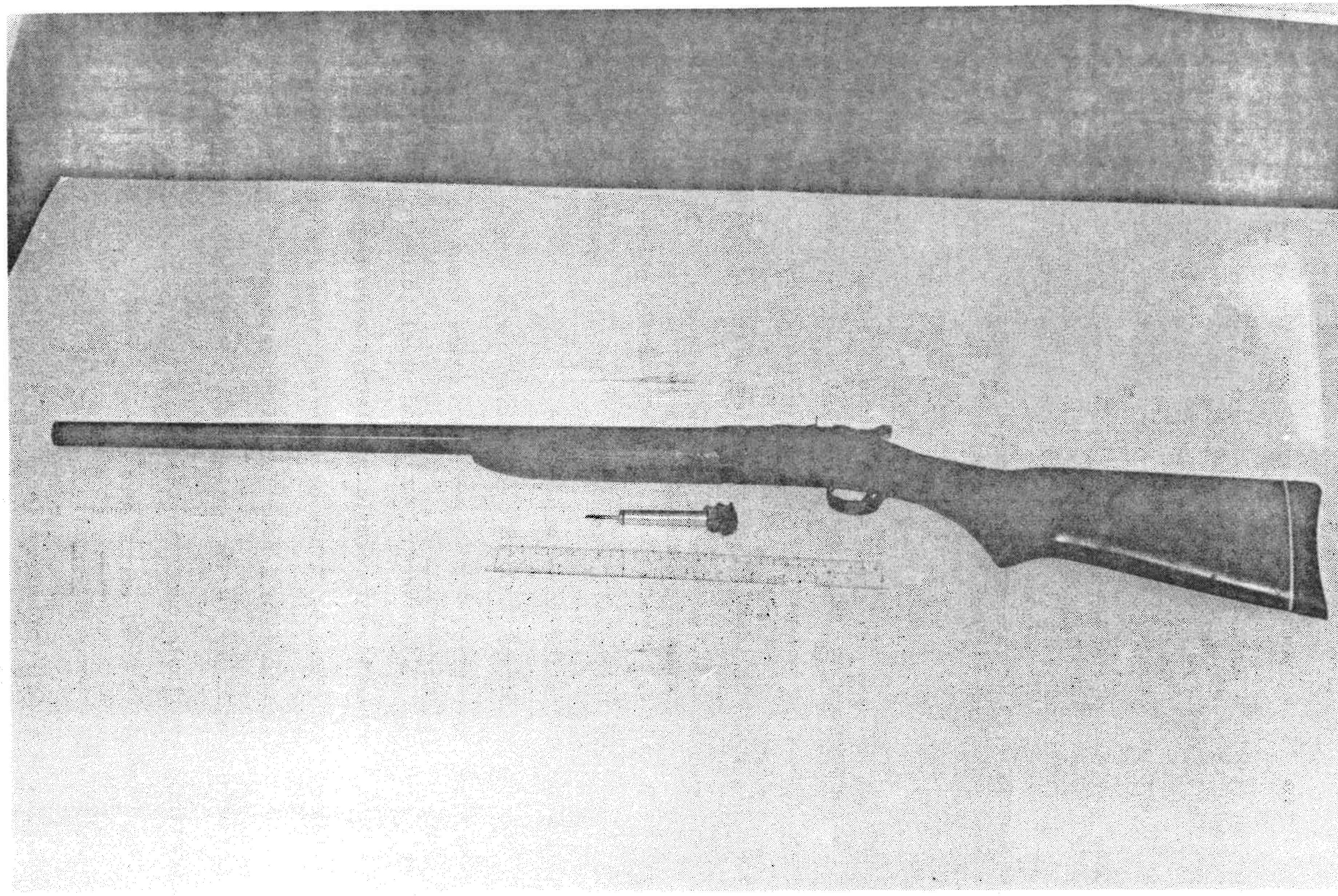

Figure 8. Cap-Chur syringe dart rifle used during the 1981 bear detection and deterrent study, Cape Churchill, Manitoba.

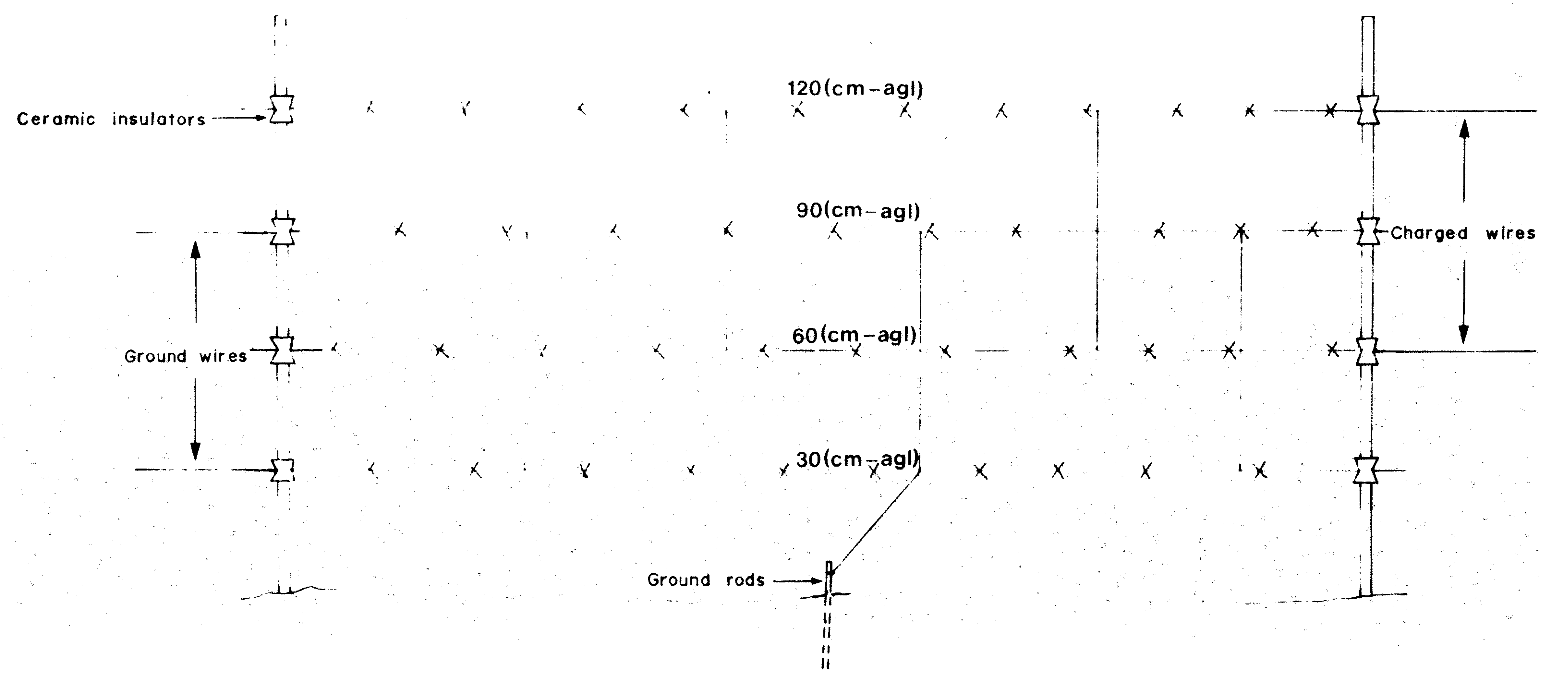


Figure 9. Schematic diagram of the electrified fence used during the 1981 bear detection and deterrent study, Cape Churchill, Manitoba.

independent of ground conditions at the study site. A 2 m electrical ground rod was implanted in the substrate on each side of the fence. Each ground rod was connected to the two ground wires. Short lengths of plastic coated 18 gauge copper wire were used to join the like-charged wires every 4 m to maintain a constant current along the fence.

The fence was charged by a commercial livestock fencer unit (BEE Model #8088) and used with a matching fence transformer (BEE Model #7077, Baker Engineering Enterprises Ltd.). These units were powered by a 12 volt automotive battery (Delco 625 amp.) and provided a 1 second pulsed charge of 30,000 volts at 1.75 amps. The power supply and the fencer units were housed in an enclosed plywood box mounted on an elevated platform (3.65 m), which was attached to the superstructure of the observation tower. This system was activated from within the observation tower.

# RESULTS

The first phase of the study period was 16 September to 16 October (31 days), during which 13 polar bears were tested. As the rubber batons and the microwave units had not arrived, only the barking dogs recording, the Cap-Chur darting equipment, and the electrified fence were tested.

The second phase of this study was conducted from 17-23 October, and 1 - 23 November (30 days). Seventy-three polar bears were tested with the full range of experimental detection and deterrent devices during phase 2.

## Approach Behaviour

Polar bears that passed through each timing zone only once during one approach to the tower were classified as direct approach bears (eg., A to B to C). Bears that moved back and forth between timing zones were classed as indirect approach bears (eg., A to B to A to B) (Table 2). During the study period 57 (66.2%) of the bears directly approached, and 29 (33.7%) bears indirectly approached the tower. However, 32 (69%) of the experimental bears and 25 (62.5%) of the control bears directly approached the tower. These data suggest that the experimental treatments did not influence the type of approach.

## Phase 1

Due to the small sample size collected during Phase 1 (N=13), direct and indirect approach times of experimental and control

Table 2. Number of polar bears in the two approach categories for each phase of the field study during the 1981 polar bear detection and deterrent study, Cape Churchill, Manitoba.

| Type of approach | Phase 1[a] Subject type | | Phase 2[b] Subject type | | Totals |
|---|---|---|---|---|---|
| | Control | Experimental | Control | Experimental | N (%) |
| Direct | 5 | 2 | 20 | 30 | 57(66.2%) |
| Indirect | 1 | 5 | 14 | 9 | 29(33.7%) |
| Total | 6 | 7 | 34 | 39 | 86(100.0%) |

[a] 16 September - 16 October (31 days) (N=13)

[b] 17-23 October and 1-23 November (30 days) (N=73)

bears were combined. Combining both types of approach did not significantly change the mean amount of time experimental bears spent in each timing zone while approaching the tower (Zone A, $t=0.82$, $p>0.05$; Zone B, $t=1.12$, $p>0.05$; Zone C, $t=0.22$, $p>0.05$). Of the five indirect approaches made by experimental bears, four shifted between Zones A and B and one bear shifted between Zones B and C. The only indirect approach by a control bear occurred between Zones A and B. A summary of the time spent in each zone is presented in Table 3.

Zone A (175-80m)

There were no significant differences ($u=9.23$, $p>0.05$) in the time spent by control and experimental bears (N=13) in Zone A during approaches to the tower. However, experimental bears subjected to a deterrent spent significantly less time ($u=0.12$, $p<0.01$) in Zone A during exit than did control bears. The deterrents applied in the inner zones caused the bears to leave the vicinity of the tower more rapidly than bears not subjected to deterrents.

Zone B (80-60 m)

When an experimental bear entered Zone B, the barking dogs recording was played. The experimental subjects spent significantly more time ($u=39.67$, $p<0.05$) in Zone B during approaches than control bears. The experimental bears (N=7) stopped momentarily when the recording started and looked towards the

Table 3. Summary of the time spent in each experimental zone during Phase 1 of the study period[1] during the 1981 bear detection and deterrent study, Cape Churchill, Manitoba.

| Subject type | Test Zone: Approach A (175-80cm) | Approach B (80-60cm) | Approach C (60-40cm) | Approach D (40-0cm) | Exit C (40-60cm) | Exit B (60-80cm) | Exit A (80-175cm) |
|---|---|---|---|---|---|---|---|
| **Experimental** | | | | | | | |
| Mean ($\bar{X}$) | 2:09 | 1:02 | :45 | :21 | :36 | :40 | 1:54 |
| Variance ($s^2$) | :54 | :59 | :13 | :10 | :11 | :09 | 6:23 |
| Confidence interval[2] | :26 | 2:02 | :19 | :14 | :19 | :16 | 1:27 |
| Sample size (N) | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| **Control** | | | | | | | |
| Mean ($\bar{X}$) | 2:14 | 1:01 | :48 | 14:05 | :57 | 1:08 | 9:13 |
| Variance ($s^2$) | :59 | :34 | :14 | 102:14 | :26 | 3:27 | 59:26 |
| Confidence interval[2] | :24 | :48 | :20 | 5:41 | :31 | 1:35 | 5:36 |
| Sample size (N) | 6 | 6 | 6 | 6 | 6 | 6 | 6 |

1 All times given in minutes:seconds.

2 Confidence interval is $p = 0.05$.

tower, but they soon continued to approach the tower. No experimental bears were repelled by the barking dogs recording during Phase 1 of the study. However, experimental bears spent significantly less time ($u=74.8$, $p<0.01$) in this zone during exit than did control bears, which again suggests that the deterrents used in Zone D increased the rate of bear departure from the vicinity of the tower.

Zone C (60-40 m)

No deterrents were used in Zone C during Phase 1 of the study and there were no significant differences ($u=7.18$, $p>0.05$) in the time spent by experimental and control bears in this zone during approach toward the observation tower. The effect of the deterrents applied in Zone D (an increase in the rate of departure of experimental bears from the vicinity of the tower) is demonstrated by a significant difference ($u=52.4$, $p<0.01$) between the time spent by experimental and control bears leaving Zone C.

Zone D (40 m - tower)

Seven experimental bears were struck with syringe darts. Darts bounced off two of the bears; the antibiotic probably did not penetrate the skin. Nevertheless, all seven experimental bears left the study area after being struck with a dart. Four of the bears trotted and three bears (including the two bears not receiving injections) walked out of the area.

Experimental bears spent significantly less time ($u=103.7$, $p<0.01$) in this zone than did control bears.

Because all the experimental bears left the study area after being struck with a syringe dart, there were no observations of experimental bears approaching the electrified fencing during normal testing periods. However, eight bears were tested "outside" the normal testing period (on 14 occasions bears were outside the electrified fence prior to the daily testing period, and we were able to test the effectiveness of the fence on eight of these bears, which approached the fence). Of the eight bears tested, three were successfully repelled by the electrified fence. Each of the three bears received a shock when they chewed on one of the two charged strands of barbed wire. The remaining five bears did not attempt to chew the wire; instead they passed through the fence. Two of the bears crawled under the bottom strand, and three squeezed between the second and third strands of wire. None of the five bears overtly responded to an electrical shock during contact with the charged fence, possibly because the barbs were too short to penetrate the fur and touch the skin. All control bears which approached the non-electrified fence passed through it and continued to approach the tower.

## Experimental Bears Receiving Multiple Exposure to Deterrents

Three individually recognizable experimental bears returned to the study area (one bear returned 2 days later, and two bears returned 4 days later). Each bear was initially deterred with a syringe dart. All three bears approached through Zones A, B and C and were struck by syringe darts when they entered Zone D for the second time; the three bears galloped from the study area.

Two marked bears, which were used as test subjects for the electrified fence experiment, made repeat visits to the study site. Both received shocks from the fence during the first trial and immediately trotted from the study area. Upon approaching the fence for a second time (one 2 days later, and the other 1 day later) both bears carefully sniffed, but did not touch, the charged strands. Each bear cautiously touched one of the ground wires, then chewed and pulled on the ground wires. Both bears then passed between the second and third barbed wire strands, apparently without receiving a shock, and approached the observation tower. Both bears returned a third time, and without hesitation, passed through the electrified fence between the second and third strands. Each bear circled the fence and crossed through it at the same location previously used.

## Phase 2

### Zone A (175-80 m)

The time spent in Zone A was not significantly different ($t=0.38$, $p>0.05$) for directly approaching experimental or control bears (Table 4). However, the exit rates of experimental and control bears were significantly different ($u=2.08$, $p<0.05$). Experimental subjects spent significantly less time in Zone A when leaving the study site, the result of exposure to deterrents. The frequency of occurrence of the behavioural categories (Table 5) emphasize that the 30 experimental bears leaving Zone A were only involved in locomotory activities; 27 galloped, 2 trotted,

Table 4. Summary of time spent in each experimental zone by direct approaching bears during Phase 2 of the 1981 bear detection and deterrent study, Cape Churchill, Manitoba.

| Subject type | Test Zone: Approach A (175-80cm) | Approach B (80-60cm) | Approach C (60-40cm) | Approach D (40-0cm) | Exit C (40-60cm) | Exit B (60-80cm) | Exit A (80-175cm) |
|---|---|---|---|---|---|---|---|
| Experimental | | | | | | | |
| Mean ($\bar{X}$) | 2:21 | 1:27 | :12 | - | - | :25 | 1:27 |
| Variance ($s^2$) | :58 | 1:41 | :08 | - | - | :07 | 5:50 |
| Confidence interval[2] | :29 | 3:19 | :94 | - | - | :11 | 1:25 |
| Sample size (N) | 30 | 30 | 26 | 1 | 1 | 26 | 30 |
| Control | | | | | | | |
| Mean ($\bar{X}$) | 2:31 | 1:02 | :38 | 16:52 | 2:26 | 1:25 | 8:14 |
| Variance ($s^2$) | 1:21 | :32 | :09 | 161:10 | 22:21 | 4:41 | 102:28 |
| Confidence interval[2] | :25 | :27 | :15 | 6:09 | 2:25 | 1:00 | 5:24 |
| Sample size (N) | 20 | 20 | 20 | 20 | 20 | 20 | 20 |

1 All times given in minutes:seconds.

2 Confidence interval is p = 0.05.

Table 5. Occurrence of behavioural categories during approach and exit of directly approaching bears through timing zones A and B[a] during the 1981 bear detection and deterrent study, Cape Churchill, Manitoba.

| Zone and subject type | Behavioural Category | | | | |
|---|---|---|---|---|---|
| | Sleeping/ resting | Agonistic | Locomotory | Curiosity/ investigatory | Comfort movements |
| Zone A approach | | | | | |
| Experimental (N=30) | 3 | 0 | 22 | 2 | 3 |
| Control (N=20) | 2 | 0 | 12 | 4 | 2 |
| Zone A Exit | | | | | |
| Experimental (N=30) | 0 | 0 | 30 | 0 | 0 |
| Control (N=20) | 3 | 0 | 10 | 6 | 1 |
| Zone B approach | | | | | |
| Experimental (N=30) | 0 | 4 | 10 | 16 | 0 |
| Control (N=20) | 4 | 0 | 7 | 4 | 5 |
| Experimental (N=26) | 0 | 0 | 26 | 0 | 0 |
| Control (N=30) | 2 | 0 | 7 | 6 | 5 |

[a] Phase 2

and 1 bear walked away. The 10 control bears that walked through Zone A when leaving also engaged in other behavioural activities.

Nine experimental bears indirectly approached the tower by moving back and forth between Zones A and B (eg., A to B to A to B). This pattern of movement appeared to be related to the recording of the barking dogs, which was played once the bear entered Zone B. When the recording was initiated the bears walked away, out of Zone B. The recording was shut off once the bear crossed back into Zone A, where the bears looked back at the tower before returning to Zone B. Three of these experimental bears returned to Zone B twice (eg., A to B to A to B to A to B) while the other six bears re-entered Zone B only once (eg. A to B to A to B). Four of the nine indirectly approaching polar bears did not continue to approach the observation tower and left the study area.

## Microwave Detection System

A total of 66 bears were detected (and visually confirmed) crossing through the microwave detection lines during the daylight hours prior to 16 November, 1981. On 16 November the transmitter used to monitor the west perimeter was destroyed by a bear, which broke the welded joints and pulled the microwave dish from the control box. The microwave system on the eastern perimeter detected intruding bears throughout Phase 2 of the program. The 12 volt automotive batteries used to power the detection system required recharging every 3 days. On two occassions an alarm was registered when an arctic fox (*Alopex lagopus*) and a red fox

(*Vulpes vulpes*) crossed a detection line. No false alarms occurred as a result of weather (eg., snowfall or blowing snow).

Frequently polar bears stood on their hind legs and investigated the microwave dishes by shaking them with their front paws. The bears attempted to chew the plexiglass face plates on the front of the microwave units, but could not remove them. Realignment of the transmitter and receiver was occasionally necessary. Bears also attempted to chew the coaxial alarm relay cable, which led from each receiver to the control panel inside the tower. This behaviour stopped when snow covered the cable.

Since it was not possible to verify bear intrusions from the detection units at night, the audio and visual alarms inside the tower were turned off after sunset. However, the microwave units were operated on a 24 hour basis to determine their power requirements.

## Zone B (80-60 m)

Directly approaching experimental bears spent significantly more time in Zone B than did the control bears ($u=2.06$, $p<0.05$) because the experimental bears stopped when the recording of the barking dogs was activated. Despite this hesitation however, 87% (N=26) of the experimental bears continued to approach the tower. Two bears (two females with cubs) galloped from the study area when the recording was played. Both sets of cubs stayed together and immediately followed the female once she began to gallop from the area.

In addition, four experimental bears charged by galloping for approximately 20 m towards the tower when the recording was played. These bears then abruptly stopped, stood on all four legs in a rigid posture, and snorted. This sequence of behaviour is a common threat display.

Striking the experimental bears with rubber batons caused the bears to leave the study site; they spent significantly less time in Zone C than did the control bears during exit ($u=11.32$, $p<0.01$). All ($N=26$) experimental bears struck with a rubber baton galloped through Zone B and A.

When the times for indirect approaching experimental ($N=9$) and control ($N=14$) bears were pooled, experimental bears spent significantly more time than control bears in Zone C ($u=3.14$, $p<0.05$) because of their hesitation in response to the recording of barking dogs.

Zone C (60-40 m)

Experimental bears entering this zone were struck with a rubber baton; correspondingly, they spent significantly less time ($u=21.66$, $p<0.01$) in this zone than control bears. Of the 26 experimental bears that entered Zone C, 24 (92%) were struck with a rubber baton. Two bears were fired at, but were missed by the rubber baton. The baton landed directly in front of one of the two bears, which galloped from the study area. The rubber baton landed behind the second bear, which continued to approach the tower. Three of the 24 bears hit by rubber batons spun around in a circle before galloping from the study area. One bear urinated when hit with a rubber baton, and galloped from the study area. The remaining 20 bears turned and galloped from the study area in the same direction from which they had approached when struck with a rubber baton.

There was no blood or sign of physical injury observed on any of the bears hit with rubber batons.

A Wilcoxen test was conducted on the approach times of the experimental subjects to determine if significant differences existed in the amount of time individual bears spent directly approaching the tower through Zones B and C. The experimental bears (N=26) spent significantly more time in Zone B than Zone C during approach ($T=336$, $p<0.01$).

Zone D (40 m - tower)

As a result of the effectiveness of the rubber batons, only one experimental bear was darted with tetracycline within Zone D during Phase 2 of the study. Once hit, this bear immediately trotted from the study area.

During Phase 2 of this study, no experimental bears reached the electrified fence. Instead, 42 polar bears were tested "outside" of the normal experimental procedures. On 54 occassions polar bears reached the electrified fence prior to the daily study period. Of the 42 bears tested, only three (7%) were repelled by the fence. Two of those bears were shocked when they chewed on the top charged wire. The third bear was shocked when its nose came into contact with the charged second barbed wire strand. All three bears receiving a shock turned and trotted from the study area. The remaining 39 (93%) polar bears managed to pass through the electrified fence. The majority (28 or 72%) of the bears passed between the wires of the fence (Fig. 10), while five (13%) bears crawled under the bottom strand of barbed wire. The remaining six (15%) bears stood on the top strand with their front feet, stretched the wire (occasionally "shorting" the fencer units), and climbed over the top.

The barbs on the fence probably were not long enough to penetrate through the fur to contact the skin. However, polar bear fur was found attached to the wire barbs along the fence wherever entry occurred.

## Other Factors Affecting Approach and Exit Rates

An analysis of variance (ANOVA) was performed on the two groups of bears (experimental vs. control) that made direct approaches and exits through Zones A, B and C. In these five way ANOVA's, the time spent in each zone was considered the dependent variable when matched with: time of day (eg., 0800-1100, 1100-1400, and 1400-1700 hours); week of testing (Phase 2 was subdivided into four, 7 day periods); the direction of approach (Fig. 11); temperature; and wind direction.

Results of this analysis demonstrated that none of the five dependent variables had a significant effect ($p>0.10$) (including main effects and all possible interactions) on the time spent in Zones A, B and C during approach or exit for the experimental and control bears.

Figure 10. Experimental bear crawling through electrified fence at the study site, Cape Churchill, Manitoba.

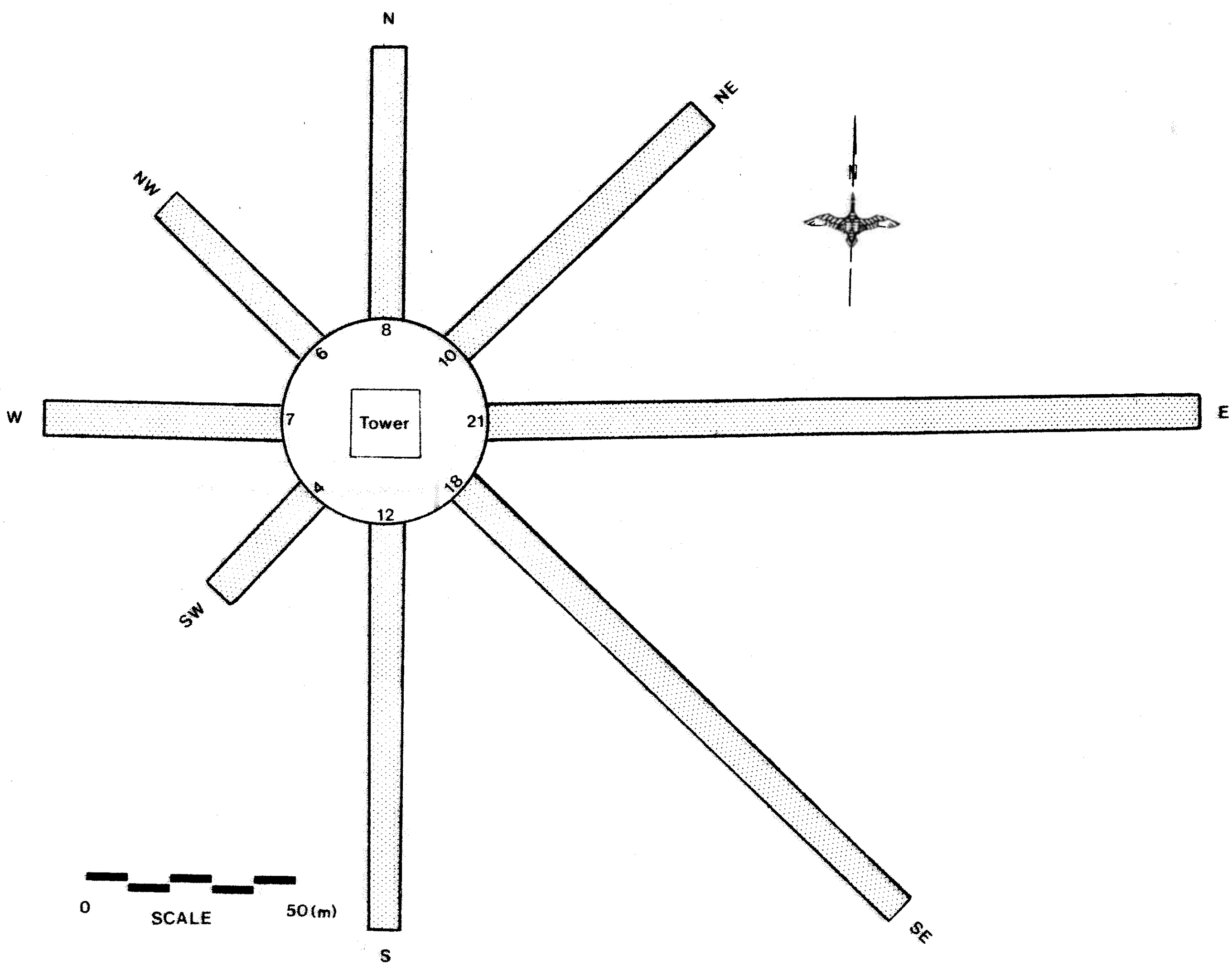


Figure 11. Direction and frequency of approach of experimental and control bears during Phase 1 and 2 of the 1981 bear detection and deterrent study, Cape Churchill, Manitoba.

## Experimental Bears Receiving Multiple Exposure to Deterrents

Seven randomly selected polar bears were identified by artificial markings during Phase 2. Those bears received experimental treatments on their first approach. Each bear passed through Zones A and B without hesitation, and was struck with a rubber baton upon entering Zone C. There was no significant difference ($p>0.05$) in the amount of time spent in each timing zone (A, B and C) during direct approach and exit between the artificially marked polar bears and unmarked bears.

Three of the seven marked bears returned to the study site. One bear returned 5 days after the initial test; it was again repelled by a rubber baton in Zone C. This bear did not return to the study area (during daylight hours) for the remainder of the study (7 - 23 November).

The remaining two bears exhibited a different behavioural reaction during their second approach. One bear returned 4 days and the other bear returned 9 days after the first test. Both of these bears galloped through Zones B and A once the recording of the barking dogs was activated. They did not enter Zone C. It is possible that both these bears associated the recording of the barking dogs with the aversive stimuli provided by the rubber batons.

## Behavioural Sequence Analysis

The behavioural sequences of experimental polar bears were analyzed using Markov chains. Markov chains are sequences of behaviours where transitions between two or more behavioural acts are dependent on one another at some level of probability greater than chance. This type of analysis assumes stationarity, which is the probability that one behaviour following another does not change over time (Lehner 1979). I tested the data from the marked experimental bears for stationarity (Lemon and Chatfield 1971), and found that this assumption was not violated. However, when the behavioural sequences of all experimental bears (N=30) were pooled, the population was not homogeneous and therefore, the between-bear variation precluded further analysis of the data using Markov chains (Chatfield 1973, Bekoff 1977).

# DISCUSSION

## Detection System

The Racon microwave units were effective in detecting approaching polar bears; we observed no bears that crossed between the units that were not detected by the system. The units are relatively simple to install, and can be maintained and operated with only a basic knowledge of electronics. There are, however, three possible limitations to the microwave system that will require some modifications;

1) a bear-proof housing must be designed to enclose and protect the microwave units,

2) the microwave units and their power requirements were not tested at the extreme low temperatures comparable to arctic winter conditions, and

3) restrictions imposed on the effective range by irregular terrain.

The Racon system has a maximum range of 457 m over flat terrain (maximum range of grade fluctuations is 4-6 cm). Terrain modifications (eg., levelling) may be required at some sites.

## Deterrent Systems

The detection system warns (eg., horns, buzzers or lights) camp personnel of an approaching bear. This warning system gives trained personnel additional time to prepare to deter an intruding bear. The deterrents I tested require practice if they are to be used effectively and safely, especially the batons.

The recording of barking dogs caused most approaching bears to stop for a short period of time. However, the majority of bears then continued to approach the observation tower; four polar bears charged the tower when the recording was played. These bears may have been dominant adult males who interpreted the recording as a threat. Any recording which elicits this range of behavioural responses has no application as an effective independent bear deterrent system.

The recording used in these tests was made prior to feeding time; possibly barking and growling sounds of angry dogs would be more effective.

There is some evidence that the bears associated the barking with the batons or darts. Two of the marked bears returned after being struck by a baton, but galloped away once the recording was played. However, a third marked bear, previously struck with a baton, did not leave the area when the recording was played on his second approach. This bear galloped from the study area when struck by a baton for a second time.

These three observations highlight the need for further investigation. The results, although ambiguous, suggest that aversive conditioning may be possible and that this deterrent technique has potential.

Experimental bears, which indirectly approached the tower began to cross in and out of timing zones when the recording of the barking dogs was played. It is possible that these bears had experienced previous contact with dogs.

The 38 mm multi-purpose riot gun proved to be the most effective deterrent technique tested. All polar bears struck by a baton immediately galloped from the study area. The polar bear that galloped from the study area after the baton landed in front of it may have been struck by gravel knocked loose when the baton hit the ground. The 38 mm multi-purpose riot gun does require that field personnel undertake intensive training to insure accuracy with this weapon. Death or injury is possible if a bear is struck in vulnerable spots (eg., the eye and temple). All batons should be directed at the chest or hind quarters. Currently, the multi-purpose gun is a single shot weapon. If this system proves effective in deterring bears during future field tests, it would be practical to have a weapon with multiple shot capabilities.

The limited tests to determine the effectiveness of darting polar bears with tetracycline indicated that bears can be deterred; however, this technique does have limitations. First, the Cap-Chur system requires different powder charges to propel the syringe dart, depending on the distance required. If an incorrect powder charge is selected, the dart will not be effective. For example, if the powder charge is too weak, the dart will not reach the bear, and if it is too powerful it will propel the dart through the bear, killing it. Secondly, the injection fluid freezes in cold weather. Third, training is necessary to properly prepare a syringe dart; an imporperly prepared dart could inject air into a blood vessel killing the bear. While polar bears may be repelled by darting with tetracycline, I feel that the potential danger to bears does not meet the necessary management requirements of an effective and safe deterrent technique.

The four strand barbed wire electrified fence did not deter 93% of the encroaching bears tested. Bears which received a shock and were repelled by the fence system quickly learned which of the four wires provided an aversive stimuli. The bears which did not receive a shock, and passed through the fence, seemed unaffected by the charged barbed wire. It is likely that the barbs on the fence did not penetrate the fur and contact the skin. Thick fur coupled with frozen terrain resulted in poor grounding conditions, and hence, no shock was administered. It is questionable whether any fence of this design will be effective in deterring polar bears in Arctic conditions; however, it is possible that a stronger, more elaborate electrified fence (eg., eight wires, to a height of 3 m and a metal ground plate) would be effective.

A summary of the responses of polar bears to the deterrent systems is presented in Figure 12.

The annual congregation of polar bears at Cape Churchill may affect the return rate of test bears to the study site. These bears congregate here to wait for the ice to form on Hudson Bay. Once a bear was tested, it moved out of the study area but remained within the immediate area waiting for freeze-up. While some bears did return to the study site after an experimental trial, it is possible that under normal conditions (eg., when other travel routes are available) it will not return.

Experimental bears may have learned that they could return to the test site at night and not receive any aversive stimuli. In other words, they may have been temporarily repelled, but the modification of behaviour may not have permanently deterred them from approaching the tower.

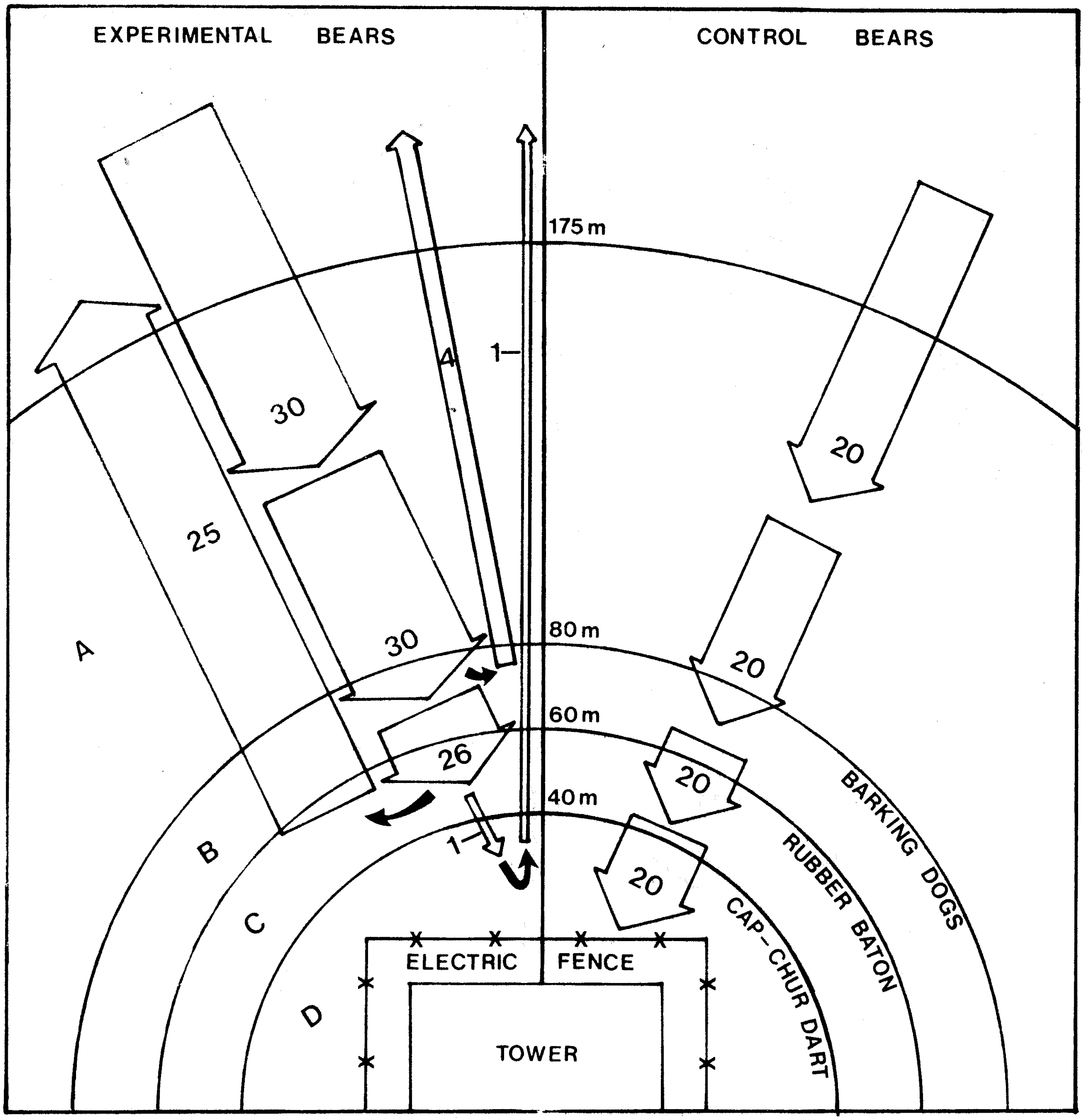


Figure 12. Responses of polar bears to deterrents tested during Phase 1 and 2 of the 1981 bear detection and deterrent study, Cape Churchill, Manitoba.

The behavioural responses of the bears to the deterrents all occurred when tests were conducted from an observation tower. They were not rewarded with food, garbage, etc., at the study site. The behavioural responses to the deterrents may be entirely different when a bear is in a cook tent, at a garbage dump, or at a food cache, in a typical field setting. In addition, behavioural responses may differ among age/sex classes, and between seasons.

There is no published information available that adequately describes the behavioural repetoire of free-ranging polar bears. This information is critical to an understanding of the polar bears' behavioural responses to any deterrent system.

It is as equally important to understand the response of a bear to a detection or deterrent system, as it is to know that a bear infact will flee from that deterrent. The possibility of triggering natural or learned aggressive responses can not be ignored (eg., habituation). To anticipate and describe such responses it is important to understand bear behaviour, (eg., how bears respond to aggressive or novel situations).

# RECOMMENDATIONS

Initial studies at Cape Churchill proved promising; however, further tests with existing equipment, tests using new techniques, and studies at other locations are recommended. Recommended options for the 1982 programs include:

A) Cape Churchill, Manitoba

1) undertake a program to mark bears inorder to determine return rates and the success of the deterrent systems,

2) initiate tests to determine the response of bears to rubber batons fired from the ground,

3) initiate tests to determine whether or not bears can be repelled from a food source (bait site) with deterrent equipment,

4) initiate a night testing program (increasing testing to 24 hour periods) of detection and deterrent techniques,

5) continue with tests to develop an effective electrified fence,

6) continue tests with recordings of aggressive barking dogs,

7) initiate tests with automatic detection and deterrent systems (eg., synchronize auditory alarm systems with microwave detection units), and

8) initiate tests to study groups of bears simultaneously entering the study site.

B) Yukon Bear Program

It is recommended that the program expand to facilitate testing with grizzly bears and possibly black bears. It will be necessary to locate a test site that:

1) offers good visibility (acceptable open space),

2) is reasonably remote and yet accessible by ground to field crews, and

3) supports a high density bear population.

It is proposed that the Deterrent Biologist work with the Yukon Territory Bear Biologist to examine potential study sites in 1982.

C) Coats Island Study

The NWT Wildlife Service will be initiating an intensive caribou research program on Coats Island during the spring of 1982. Polar bears congregate on the island in the spring, and consequently, the probability of man-bear conflicts is high.

It is recommended that a pilot program be initiated to:

1) determine whether or not bears can be repelled with rubber batons from the ground,

2) test the microwave units under small camp situations, and

3) experiment with automatic detection and deterrent systems.

D) Little Cornwallis Island - Polaris Mine

The Polaris Mine site on Little Cornwallis Island is frequented by polar bears in spring and fall on an annual basis. To begin developing suitable detection and deterrent techniques for the mine site it is recommended that we:

1) examine the mine site design and layout in relation to known polar bear movements,

2) work with Cominco to evaluate the eskimo dog program and determine how to compliment the program with additional detection and deterrent systems,

3) undertake to test the microwave detection units and automatic deterrent devices, and

4) undertake to test the application of rubber batons from the ground.

E) Other Programs

1) Test the microwave detection units under severe and long-term Arctic conditions.

2) Initiate a review examining the potential of using trained bear dogs at some sites.

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APPENDIX Field Data Forms.

| Subject | Date | Temp. & Wind |
|---|---|---|
| Direction of Approach | | |
| Time sighted | | |

| Sex | Age | Weight | Tag-Marks |
|---|---|---|---|

Detected IN = ☐ Yes ☐ No ; OUT= ☐ Yes ☐ No

| Zone | LATENCY TIMES - (Secs.) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A - B | | | | | | | | | |
| B - C | | | | | | | | | |
| C - D | | | | | | | | | |
| D - E | | | | | | | | | |
| E - F | | | | | | | | | |

# BEHAVIORAL CATALOGUE

Approach - 500 m:

(A-B) 500m-Detection:

(B-C) Detection-Discharge:

(C-D) Discharge -- Oth:

(D-E) Oth - Battons;

(E-F) Battons - Fence:

Fence:

Other: