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BEHAVIORAL RESPONSES OF BEARS
TO TESTS OF
REPELLENTS, DETERRENTS, AND AVERSIVE CONDITIONING

by

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Behavioral Responses of Bears to Tests of Repellents, Deterrents, and Aversive Conditioning.

Director: C. J. Jonkel

Most human-bear conflicts are caused by surprise encounters and bear use of human foods. Investigated were repellents and deterrents with the potential to reduce conflicts. Repellents were tested on 5 captive black bears (*Ursus americanus*) and 1 captive grizzly bear (*U. arctos*) as the bears charged or approached humans. Tested were Halt (capsaicin product), Bear Skunker (simulated skunk spray), Shield (mace product), an air horn, railroad flares, a quickly-opened umbrella, and taped music and bear sounds. Most bears were repelled by Halt or a Bear Skunker/Halt combination. Bears repelled during a test were less likely to be aggressive during the next test. Certain bears that seemed inherently non-aggressive were frequently repelled by stimuli that incited charges by more aggressive individuals. Also discussed are intention movements by bears, and similar movements by humans that appeared to have signal value for bears.

Repellents were delivered to 2 black bears and 2 grizzly bear cubs, aimed at aversively conditioning the bears to avoid humans. These bears were subsequently released into the wild. None is known to have caused further problems or to have been killed through hunting or control actions. Important contributing factors may have been the non-aggressive temperament of each of the bears and the timing of their release.

Deterrents and repellents were tested on approximately 31 free-ranging black bears visiting baits at a sanitary landfill. Tests of taste and odor deterrents included ammonia, male and female human urine, mothballs, Bear Skunker, Boundry (dog deterrent), and Technichem (bear deterrent). Full strength Parson's ammonia and male human urine placed on baits deterred most bears from eating; only ammonia appeared to deter many bears from approaching baits. Pain-inducing repellents triggered by remote control were Bear Skunker and Halt. Halt repelled most bears from the site temporarily. Test responses were the result of the effect of a stimulus on the individual bear, dominance activities by other bears at the site, and the availibility of natural foods in the area. Certain bears appeared to tolerate the more noxious deterrents or returned repeatedly following tests of the triggered repellents.

Presented as an appendix is an extensive bibliography entitled Deterrents, Aversive Conditioning, and Other Practices: An Annotated Bibliography To Aid In Bear Management.

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GENERAL INTRODUCTION

Conflicts between bears and people have increased in frequency as logging, tourism, and exploration for oil and gas have developed in areas used by bears (Jonkel 1970, Schweinsburg 1976). Escalating human-bear problems in the National and Provincial parks of the United States and Canada have been correlated with increases in the number of people visiting the parks, and the unnatural foods made available to the bears by visitors (Herrero 1970, 1970a, 1976, Mundy and Flook 1973, Singer and Bratton 1980, Hastings and Gilbert 1981).

"Bears are omnivorous and highly intelligent, possessing both a genetic and learned ability to utilize resources and deal with environmental change" (Eager and Pelton 1979). They are generally the most dominant non-human members of the communities in which they are found. Encounters with bears are inherently dangerous because of their size and strength. Because their ecological niche has many similarities with that of humans, the potential for conflicts will always exist in areas used by both humans and bears.

Control of human-bear conflicts has commonly involved relocation or destruction of the offending bear. These methods have proven to be ineffective solutions to most problems (Herrero 1976, Jorgensen et al. 1978, Eager and Pelton 1979). State and federal agencies are under growing public pressure to reduce or solve bear problems. With increasing frequency, management agencies are emphasizing the importance of methods that allow humans and bears to coexist. Interest is high in repellents and deterrents to prevent bears from approaching humans, settlements, campgrounds, and garbage dumps. The development of methods that prevent conflicts may be critical to the survival of grizzly bears (Ursus arctos) in the contiguous 48 states.

Efforts to repel or deter wildlife species have focused on insects, birds, deer, and most recently on coyotes; relatively few studies have been conducted on bears. Where applied, preventative measures such as electric fences, bells for hikers, and bear-proof campgrounds and garbage sites, have reduced conflicts (Parks Canada 1972, Herrero 1976, Meagher and Phillips 1980, Hastings and Gilbert 1981, Jope 1982).

Approaches to repellent and deterrent methods should use knowledge of predictable bear behavior from an ecological perspective, with particular focus on bear behavior as it relates to the effect of the food base on a population. The nature and extent of human activity in an area, and the perceptive abilities of the bear, will dictate the choice of repellent or deterrent used (Dorrance and Gilbert 1977).

Both repellents and deterrents must elicit avoidance behavior. A review of the literature revealed a general lack of distinction between the 2 terms and subsequent inconsistencies in their use. The 2 principal situations that cause human-bear conflicts are surprise encounters and bear use of human food sources. With these applications in mind the terms are distinguished as follows within the text of this manuscript:

1. Repellents are activated by humans and should immediately turn a bear away during a close approach or attack.

2. Deterrents should prevent undesirable behaviors by turning bears away before a conflict occurs, such as bears approaching camps, orchards, or garbage dumps. They need not be monitored or manually activated by humans.

3. Aversive conditioning should modify previously established, undesirable behavior through the use of repellents or deterrents. The conditioning must be repeated until avoidance of people or their property has been firmly established.

The purpose of this study was to develop test procedures and to test repellents and deterrents that could reduce bear-human encounters and conflicts. A series of studies conducted in Canada by students from the Universities of Guelph and Montana, in association with the Border Grizzly Project, provided background data for this research (Best 1976, Cushing 1980, Miller 1980).

The objectives of the project were to:

1. systematically test substances or devices on grizzly bears and black bears (U. americanus) that may a) repel bears and can be carried and used by persons likely to encounter bears or b) deter bears and can be left at sites (e.g. camps, cabins, garbage dumps, orchards) to prevent close approaches by bears;

2. describe the behavioral responses of captive bears to tests of potential repellents; and

3. describe the behavioral responses of free-ranging bears to tests of repellents that produced promising responses in the laboratory tests, and to potential repellents and deterrents not appropriately tested under laboratory conditions.

Tests were conducted on snared bears in the wild, on captive bears in a laboratory at Fort Missoula, Missoula, Montana, and on free-ranging bears at a sanitary landfill site at Sparwood, British Columbia. Parts I, II, and III, respectively present the results of the repellent tests on captive bears, aversive conditioning of captive bears, and repellent and deterrent tests on free-ranging bears. Each part is written in a format suitable for publication. General conclusions and management recommendations are presented in Part IV.

As a necessary step toward developing effective research programs in the future and for this study, an annotated bibliography was compiled on deterrents, repellents, aversive conditioning, and other practices that may aid in bear management. The manuscript is included as Appendix 16. The purpose of the compilation is to provide a resource that will be useful to managers and researchers in decision-making and research planning. Its inclusion in this thesis is to provide further background information and to allow for greater distribution.

PART I

TESTS OF REPELLENTS ON CAPTIVE BEARS

Incidences of human injury caused by bears have increased throughout North America (Herrero 1976, Schweinsburg 1976, Singer and Bratton 1980, Hastings et al. 1981, Jope 1982). Rising injury rates reflect increases in human activities in backcountry areas, and in the use of unnatural food sources by bears, both of which raise the chances for bear-human encounters (Mundy and Flook 1973, Herrero 1976, Eager and Pelton 1979, Singer and Bratton 1980, Hastings and Gilbert 1981). Although incidences are low relative to the potential that exists, the trend is symptomatic of growing problems that must be dealt with if humans are to co-exist with natural populations of bears.

Most attacks on humans have been precipitated by people either intentionally or unintentionally getting too close to bears. Bears will attack when surprised, protecting their young, or guarding their food (Jonkel and Servheen 1977). The majority of documented attacks have involved bears that had received "handouts" or fed on human garbage (Eager and Pelton 1979, Follman et al. 1980, Hastings et al. 1981).

Management efforts should minimize the potential for human-bear confrontations. Many parks have significantly reduced bear problems through public education, trail or campground closures, trail rerouting, and garbage management (Martinka 1974, Herrero 1976, Meagher 1980, Hastings et al. 1981). Further preventive efforts should be aimed at reducing or eliminating conflict during an encounter.

The frequency of encounters between competing dominant and subdominant species determines their distribution and densities (Nagy and Russell 1978). This mechanism appears to operate both intra- and interspecifically, affecting grizzly (Ursus arctos) and black bear (U. americanus) populations competing for space and resources (Herrero 1972, 1978, Martinka 1976). Avoidance and tolerance between bears appears to be based on a loose social hierarchy established through aggression and size. Dominance is settled during the first few encounters and thereafter is maintained primarily through visual signals (Hornocker 1962, Egbert and Stokes 1976, Rogers 1977, Herrero 1980).

Interspecific relationships between grizzly and black bears may have considerable relevance to human-bear co-existence. Some evidence suggests that bears defer to people in the same manner as they do dominant bears (Herrero 1970a, Jonkel 1978). Bears generally try to avoid humans (Jonkel 1970, Martinka 1976). Jope (1983) found that grizzlies made no charges at hikers wearing bells. Most injuries have been partially attributable to improper behavior by people (Eager and Pelton 1979, Herrero 1980, Jope 1982). Repellents and deterrents, perhaps used in conjunction with correct body movements by humans, could serve as visual, auditory, or olfactory signals for bears. Application of effective repellents and deterrents during human-bear confrontations may play an important role in establishing and maintaining human dominance over bears, or at least in maintaining stable relationships.

Ideally, when activated, effective repellent stimuli and practices must: a) immediately stop an undesirable behavior and turn a bear away during an encounter, regardless of the animal's motivation, temperament, or past history of encounters with people; b) not allow a second approach or cause increased aggression during subsequent encounters with humans; and c) not cause permanent physical damage to the bear.

A variety of repellents have been tried on captive and free-ranging bears, but few of the results have been documented. Tests of acoustic repellents suggest only limited value during a close encounter or attack, although biologically meaningful sounds may prove more useful with further study. Approaches to the use of sound should be aimed at using sharp, loud sounds, biologically significant sounds, or combinations of sound with other stimuli (Frings and Frings 1963, Haga 1974, Schweinsburg and Smith 1977, Wooldridge and Belton 1980, Miller 1980).

Reports on the effectiveness of visual repellents, such as specific human activities during an encounter, are generally anecdotal, but show promise. Many National Park Service bear-human interactions have been categorized and evaluated (Herrero 1976, Tate and Pelton 1979, Hastings

1982, Jope 1982, Tate 1983). Miller (1980) successfully repelled captive bears using a "loom" stimulus (1m by 1m square plywood board quickly turned broadside). Such stimuli may be most effective in combination with auditory or chemical stimuli that provide additional cues and that address more than 1 sense.

Most commonly, tests of noxious chemicals and natural repellents on bears have involved lachrimating agents. Few tests of riot control agents (such as Mace) have been conducted. The primary reason for this has been the possibility of permanent lung, eye, or skin damage, which appears dependent on dosage, manner of application, and duration of exposure (Cucinell et al. 1971, Gaskins et al. 1972). However, Wooldridge (1978) hypothesized that long-term effects on unrestrained animals would be minimized because the blink reflex deflects much of the spray. Some evidence suggests that animals may become enraged following exposure (Follman et al. 1980).

Promising results have been achieved using a dog repellent spray containing capsaicin ("Halt", Animal Repellents, Griffin, GA). Limited tests have been conducted on captive black bears (Follman et al. 1980), grizzly and polar bears (Ursus maritimus) (Miller 1980), and free-ranging black bears (L. Rogers 1983 pers. comm.). All bears retreated and no aggressive responses were noted.

The objectives of this study were to:

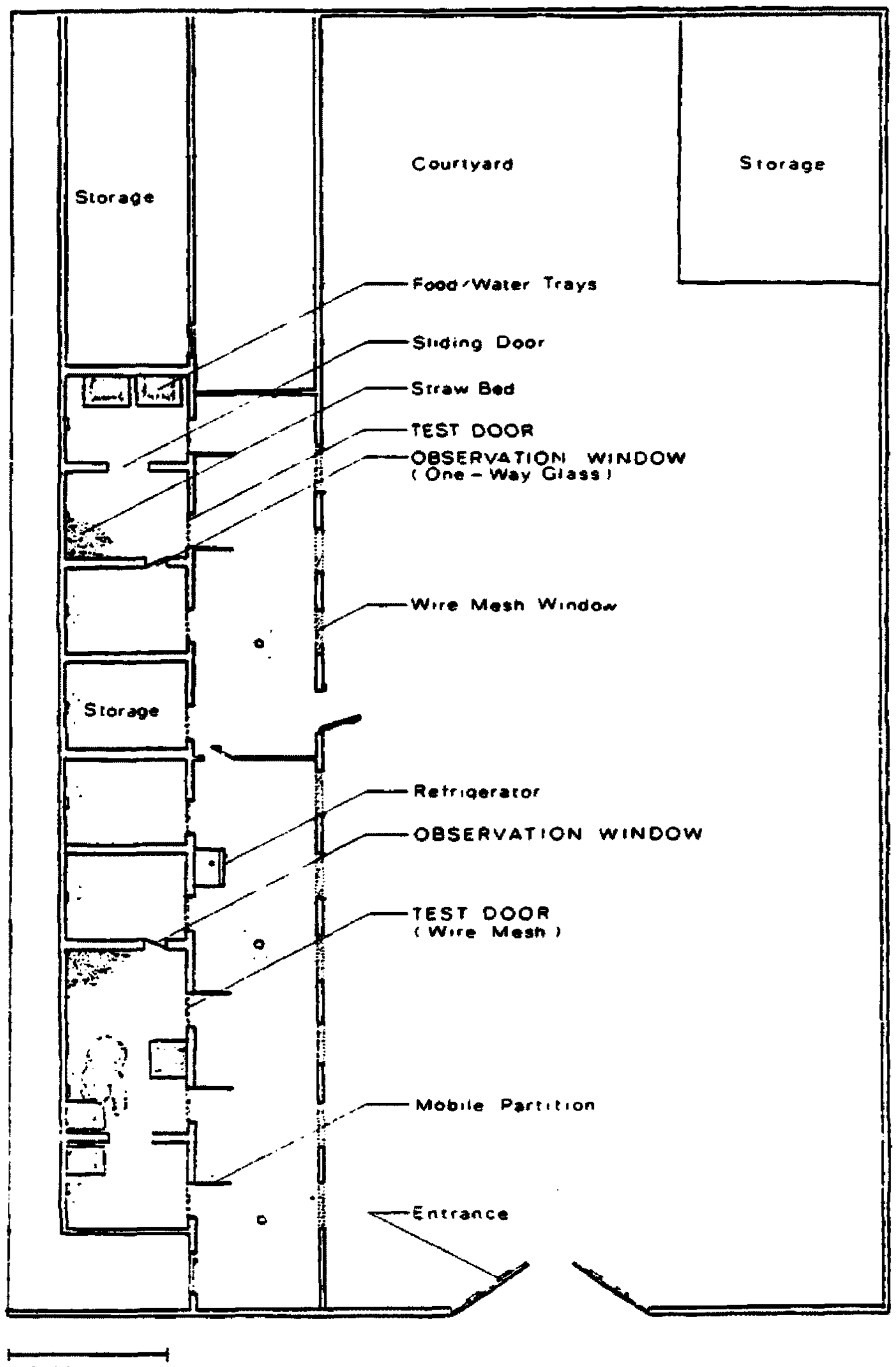
1. systematically test substances or devices that may repel bears and that can be easily carried and used by persons likely to encounter bears; and

2. describe the behavioral responses of captive bears to tests of various claimed or potential repellents.

METHODS AND MATERIALS

In 1981, several tests were conducted on bears restrained in the wild by Aldrich Leg-hold Snares with approximately 4m of cable lead. When construction of a laboratory was completed in an old prisoner-of-war housing unit at Fort Missoula, Missoula, Montana, tests were thereafter conducted at this facility (Fig. 1). Cells in the east wing of the unit were converted into a laboratory; the rest of the building remained unused except for storage. The location and construction of the laboratory provided complete visual isolation, and adequate auditory and olfactory isolation for the tests. To preclude visual contact with bears other than during test sessions, mobile partitions in the hallways, sliding drop-doors inside the cages, and 1-way mirrors were routinely used when feeding bears, cleaning cages, and observing tests. Laboratory windows were left open to allow air to circulate; bears apparently habituated quickly to most of the sounds and odors that filtered in from the outside. Cell lights were

Fig. 1. Floor plan of the Fort Missoula laboratory.


Storage
Courtyard
Storage
Food/Water Trays
Sliding Door
Straw Bed
TEST DOOR
OBSERVATION WINDOW
(One - Way Glass)
Wire Mesh Window
Storage
Refrigerator
OBSERVATION WINDOW
TEST DOOR
(Wire Mesh)
Mobile Partition
Entrance
3 Meters

controlled by an electronic timer to approximate and supplement normal daylight hours.

The studies on captive bears were designed to test claimed or potential repellents in a "charging bear" situation. Repellents tested were fear-provoking stimuli (Appendix 1). During 1981, certain stimuli that gave strong or moderate responses during Miller's (1980) study were re-tested on 2 black bears. During 1982, based on the pilot tests of 1981, tests were conducted on 4 black bears and 1 grizzly bear.

Bears used in the studies were acquired through interagency cooperation. These were problem animals captured because they had damaged livestock or other property, and were destined to be destroyed or relocated (Appendix 2).

Tests were conducted by an "observer" and a "tester." The observer (presence unknown to the bear being tested) watched the animal and took notes on its behavior before, during, and after tests. The tester approached the bear and attempted to provoke a charge response, whereupon the test stimulus was presented.

When tests were conducted on snared bears in 1981, the observer watched the tests from a blind 10m from the bear, and the tester approached to within 2m of the snared bear and attempted to provoke a charge. Each test stimulus was paired with a water spray test. Paired tests were run approximately 1 hour apart and their order of presentation was varied. Paired sets were run twice a day, approximately 10 hours apart.

During the laboratory tests in 1981 and 1982, the observer watched the animal through 1-way glass from an adjacent cell and video-taped each test; the tester presented the test through a barred test door (Fig. 1). Bears were presented with tests of repellent stimuli, and with control tests where the tester presented himself to the bear in the usual manner, but did not deliver a stimulus if the bear charged.

In the laboratory in 1981, each repellent test was paired with a control test; water spray tests were paired as "controls" with the Halt and Skunker tests. Pairs were presented in random order and tested 1 hour apart. Paired sets were conducted twice a day, 10 hours apart.

In 1982. each bear was presented with at least 2 different repellent stimuli and 1 control. Tests included 4 consecutive repetitions of each stimulus and 4 repetitions of a control. The order of presentation of stimuli were varied for each animal. Two tests were run per day, 10 hour apart (0730 to 0930 and 1730 to 1930); if chemicals were used, the tests were run 24 hours apart (and the test cell was thoroughly scrubbed following the test). Tests of additional stimuli were conducted when possible. These were limited by agency deadlines for destruction of bears or the availability of new bears and limited holding facilities.

The format for testing was as follows:

Day 1 Bears were left alone to acclimate to their cell, and initial responses to caretaking activities were recorded.

Days 2-4 Baseline data on each bear's behavior were recorded at 1 minute intervals by monitoring the bear for 1 hour periods at regularly scheduled test times; no tests were run.

Days 5-15 Bears were tested with repellent stimuli.

Each test was conducted as described below. The observer recorded the bear's behavior for 30 minutes before and after each test. At the scheduled test time, the tester presented himself quietly at the test door for 5 seconds, then attempted to provoke a charge by stomping rhythmically (1 beat every 2 seconds) while standing about 0.5m from the door. Except during control tests, the stimulus was delivered if the bear approached to within 1m of the door, if not, the tester withdrew after 1 minute. Once an approach was elicited and the stimulus delivered, the tester then remained at the door for 30 seconds, continuing to provoke the animal by stomping and allowing time for another approach. If the bear reapproached to within 1m of the door, the stimulus was delivered again.

Responses to tests were recorded and evaluated in the following manner:

1. Bear behavior was recorded for 30 minutes at 1 minute intervals, both before and after each test was presented (Appendix 3, 4, 5, and 6). Recorded behavioral codes (Appendix 6) were adapted from Miller (1980). In this paper, only the bear's overall activity and gross body positions were examined. Overall activity was recorded from quiet to heavy (scaled 1 to 7) and was scored relative to the amount and intensity of movement displayed by each bear (Appendix 6).

2. Bear behavior was video taped from 1 minute before to 1 minute after the tester presented the test.

3. Both the observer and tester wrote long-hand descriptions of the bear's response to the test.

4. During each test the bear's response was scored at 3 points; response to the tester's initial presence, immediate response to the delivered test stimulus, and response to continued provocation by the tester following delivery of the stimulus. These responses were scored according to their type (no response, repel, submissive, aggressive, charge), the angle of orientation to the tester in degrees (0, 1-30, 31-60, 61-90, ≥90), and the time (seconds) it took the animal to respond (Appendix 4 and 5). A charge was defined as an approach to within 1m of the test door, and a repel was recorded when a bear retreated farther than 1m from the door and oriented its body at least perpendicularly to the tester (≥90 degrees).

Definitions of aggressive and submissive behavior were subjective, based on knowledge of the individual animal and descriptions from the literature (Hornocker 1962, Henry and Herrero 1974, Egbert and Stokes 1976, Jordan 1976, Pruitt 1974 and 1976, Eager and Pelton 1979).

The small number of bears tested dictated that much of the data analysis be of a qualitative and exploratory nature. Data were compiled on the UM Dec-20 computer system, and analysed with the Statistical Package for the Social Sciences (SPSS, Nie et al. 1975). Descriptions and videotapes of test responses were used to verify recorded test scores and to further evaluate responses.

The intent of this study was to develop a valid testing framework and provide baseline data on which further studies could build. The study is presently continuing using the same format, and at this time the sample size has nearly tripled. These data will be pooled with those of the current study for further analysis.

RESULTS AND DISCUSSION

Responses to Pilot Tests, 1981

Stimuli were tested on Bears 1 and 2 (Appendix 1) while these animals were restrained by foot snares. During 13-16 June, Bear 1 was presented with 4 water spray, 3 Bear Skunker, and 1 Shield tests. On 6 July, Bear 2 received 1 test each of the water spray, air horn, and Bear

Skunker (Appendix 2). This bear was to be relocated, so testing was limited to 1 day.

Reactions to tests were similar for both bears. Initially the bears were reluctant to charge, even when approached closely. Having once charged, they charged quickly during the following test. However, the added negative effect of the snare on the bears' movements appeared to reduce their inclination to recharge during a test, regardless of the stimulus tested. Therefore, responses to continued provocation by the tester were usually submissive.

Tests of the water spray had no effect on either bear (Table 1). Bears would flinch, blink briefly, then continue with no noticeable change in activity.

Bear Skunker seemed to have both immediate and long-term effects on the bears (Table 1). When sprayed, bears blinked rapidly for about 30 seconds and their vocalizations decreased; no further aggressive movements were made toward the tester although they did not attempt to run away. When the tester left the area, bears immediately focused their efforts on trying to escape from the snare. When re-approached during the next test, they behaved in a submissive manner, and could not be provoked into aggression. During subsequent tests, Bear 1 was reluctant to charge when approached by the tester with the Skunker odor.

TABLE 1. Immediate response (%) and continued response (%) of bears to stimuli during 1981.

BEAR	STIMULUS[a]	NUMBER OF TESTS	IMMEDIATE RESPONSE TO STIMULUS				CONTINUED RESPONSE TO TEST			
			Repel	Submissive	Aggressive	Charge	Repel	Submissive	Aggressive	Charge
1 - 1981	Waterspray	4		75	25			100		
(Snared)	Skunker	3		67	33			100		
	Shield	1			100				100	
2 - 1981	Waterspray	1		100				100		
(Snared)	Skunker	1		100				100		
	Air horn	1			100					100
1 - 1981	Waterspray	2			100				50	50
(Laboratory)	Skunker	1	100							100
	Halt	1	100				100			
	Control	3			67	33			33	67
	Bear tape	1				100			100	
	Music	1		100						100
	Air horn	1			100				100	

[a] In order of presentation.

In contrast, when tested with Shield, Bear 1 immediately recharged and continued to display aggressive behavior until the tester left the area. Similarly, Bear 2 reacted to the air horn by becoming more aggressive with each blast, recharging once (Table 1).

During 22-30 July, 1981, additional tests were conducted on Bear 1 in the laboratory at Fort Missoula. Ten tests were run, including 1 each of Bear Skunker, Halt, taped bear sounds, taped music, the air horn, 2 water sprays, and 3 controls.

When initially approached by the tester with Bear Skunker, Bear 1 displayed avoidance and submissive postures. He had not responded this way during the water spray test that preceded this. He apparently remembered the previous noxious effect associated with the odor.

The bear's reactions to application of Skunker were similar to those he had had previously exhibited and to those of Bear 2 when tested while restrained by a snare (Table 1). When the bear charged during the Skunker test, the tester missed the bear's face. The animal turned and ran about 3 feet, then returned and charged again. This time the spray was applied correctly, hitting the bear in the face and eyes. Responding as he had when snared, he made no further aggressive movements toward the tester. Immediately, as the tester left, the bear turned and ran from the room, re-entering a few seconds later. For approximately 24 hours after the test, the bear remained quiet and lethargic, eating less than usual. He could not be provoked into aggression toward the tester during the following test.

Halt seemed to have an immediate repellent effect on him, but no long-term effect (Table 1). When sprayed, the bear immediately turned and ran about 2.5m, blinking his eyes rapidly, then stopped and looked over his shoulder at the tester for about 4 seconds. He then returned to his bed, sat down, and facing the tester, would not charge again. Unlike his behavior following the Skunker tests, he did not seem restless or inclined to leave the area when the tester had retreated. In less than 30 minutes, he appeared to be behaving normally. His behavior and appetite were not visibly affected on the following day. However, he would not charge during presentation of the next test.

In response to presentation of the air horn, Bear 1 remained aggressive throughout the test, but did not charge, as had Bear 2 (Table 1). Taped sounds of a male grizzly bear caused the bear to charge the tester and then remain aggressive during the rest of the test. Taped rock-and-roll music elicited a mixed reaction. During the instrumental section, the bear remained relatively quiet, seemingly confused and nervous. Immediately at the onset of the vocal section, he charged, then remained aggressive to the end of the test.

In response to tests of the water spray and control in the laboratory, Bear 1 always was aggressive or charged (Table 1). The difference between his response to the water spray in the laboratory and when on the snare probably reflects the negative effect the snare had on his aggressive movements.

Overall, the added negative effect of the snare on the bear's movements appeared to inhibit aggressive responses when compared to the laboratory tests. Results of the limited tests on Bears 1 and 2 indicated that the Shield, air horn, taped radio-music, and taped bear-sounds were not promising repellents, whereas the Halt and Bear Skunker appeared to have potential. During tests of Halt by Miller (1980) and this pilot test, all bears were instantly repelled, however, they seemed to recover quickly. Although the Bear Skunker did not repel bears immediately, further aggressive movements toward the tester ceased. It seemed to have a longer-lasting effect than the Halt; bears appeared restless and uncomfortable for some time following a test. One bear displayed submissive and avoidance postures a month later when confronted with the odor. The combination of an odor and pain-inducing cue addressing more than 1 sense may have contributed to the effectiveness of this stimulus. Incorporation of a highly repellent substance such as Halt with the Skunker product may produce an instantly effective, long-lasting repellent.

Bear 1 was held over winter and retested in June of 1982. During October 1981, his food intake slowed. The bear was then provided with a den and bedding material by darkening one cell and placing several bales of hay in both cells. The supplemental (electric) lighting in the laboratory was turned off, and food (but not water) was withheld from him from 15 December to 17 March. He appeared to hibernate normally, and was in good health when he again became active in March and feeding was resumed.

General Behavior During Baseline and Test Periods, 1982

Stimuli were tested on Bears 1, 4, 5, and 6 between 5 July and 8 August, and on Bear 7 between 1 and 15 December, 1982 (Appendix 1). Stimuli tested were controls, a quickly-opened umbrella, railroad flares, Bear Skunker, Halt, and a Skunker/Halt combination.

Responses to tests were influenced by the individual bear and the effectiveness of the stimulus. Behavioral characteristics observed during the baseline observation period appeared to be related to test period responses.

Bears seemed to consistently behave relatively more or less aggressively throughout baseline and test periods. The 3 males (Bears 1, 4, and 7) were consistently more aggressive than the 2 females (Bears 5 and 6). They more frequently approached, rather than avoided confrontations. During baseline observations, the males generally responded to new sounds and the proximity of the keeper with aggressive postures, charges, and vocal displays. Females usually displayed no aggression; 1 female (5) approached boldly, yet non-aggressively, while the other (6) generally remained sitting near the wall in the corner of the cell, with no movements or vocalizations. She appeared highly stressed by captivity. During tests, upon approach by the tester, male bears charged more often than females (Fig. 2). In response to the delivery of stimuli the frequencies of submissive and repel responses to specific stimuli by females were relatively higher (Fig. 3).

Of the males, Bears 1 (1982) and 7 reacted more aggressively to the proximity of humans and test stimuli than Bear 4; Bear 4 was often repelled by stimuli, such as the flare and Skunker, which did not repel the other 2 animals (Table 2). Bear 5 generally avoided aggressive confrontations with the tester; she approached new sounds, the umbrella, and control tests boldly, but avoided the flare and Skunker stimuli. Bear 6 attempted to avoid all confrontations, including those of the control tests (Table 2).

Bears that had difficulty in adapting to captivity and the proximity of humans appeared most stressed by the test periods and least capable of modifying their behavior to reduce or avoid stress during test situations. Bears 1 (1982), 5, and 7 seemed to adapt to captivity more readily than Bears 4 and 6, possibly because they were already habituated to the proximity of humans. Recorded baseline observations

Fig. 2. Incidence of charge responses by individual bears upon appearance of tester.

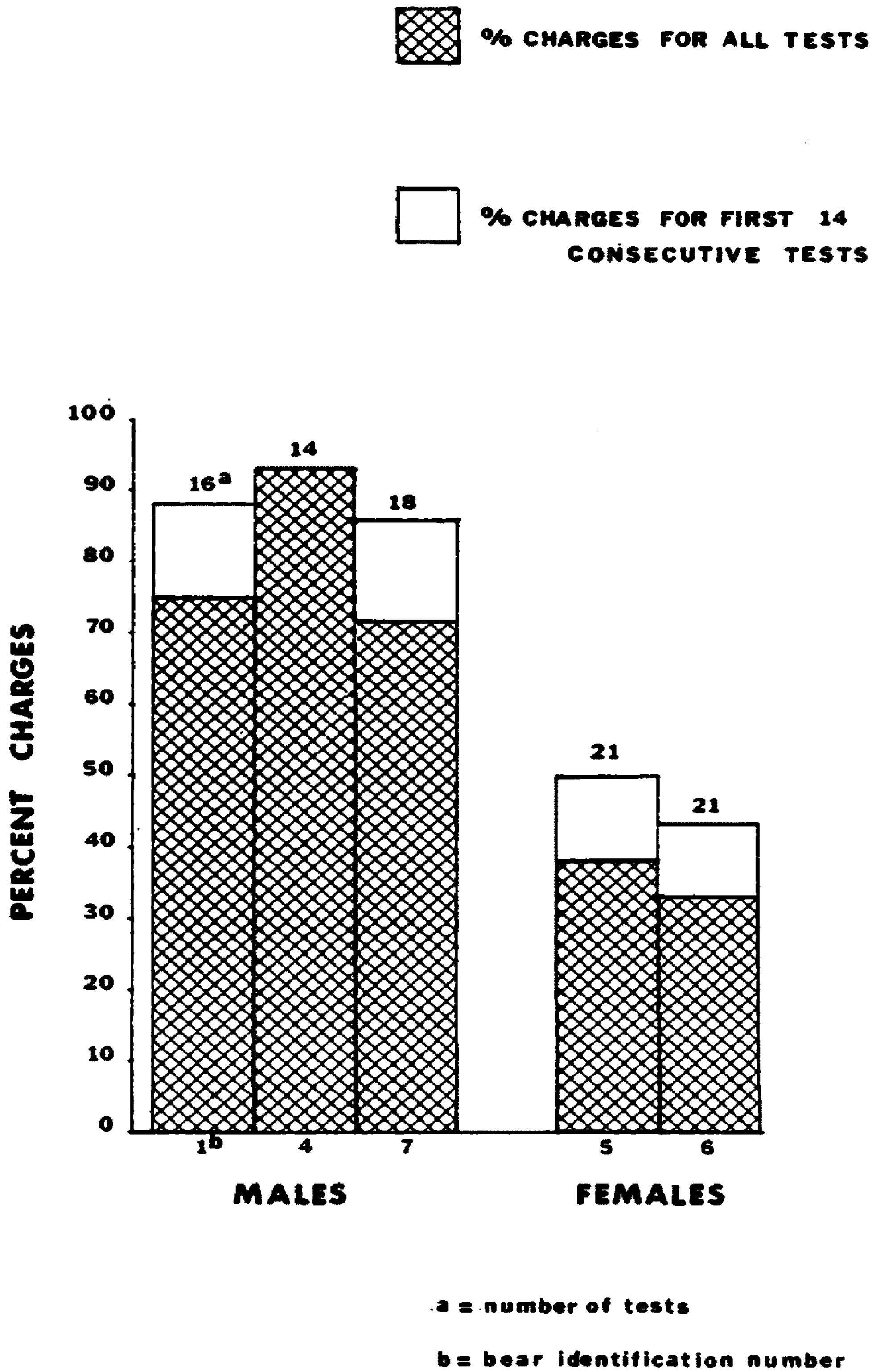

% CHARGES FOR ALL TESTS
% CHARGES FOR FIRST 14 CONSECUTIVE TESTS
PERCENT CHARGES
100
90
80
70
60
50
40
30
20
10
0
16a
14
18
21
21
1b
4
7
5
6
MALES
FEMALES
a = number of tests
b = bear identification number

Fig. 3. Response of charging bears following application of stimulus according to sex and stimulus used.

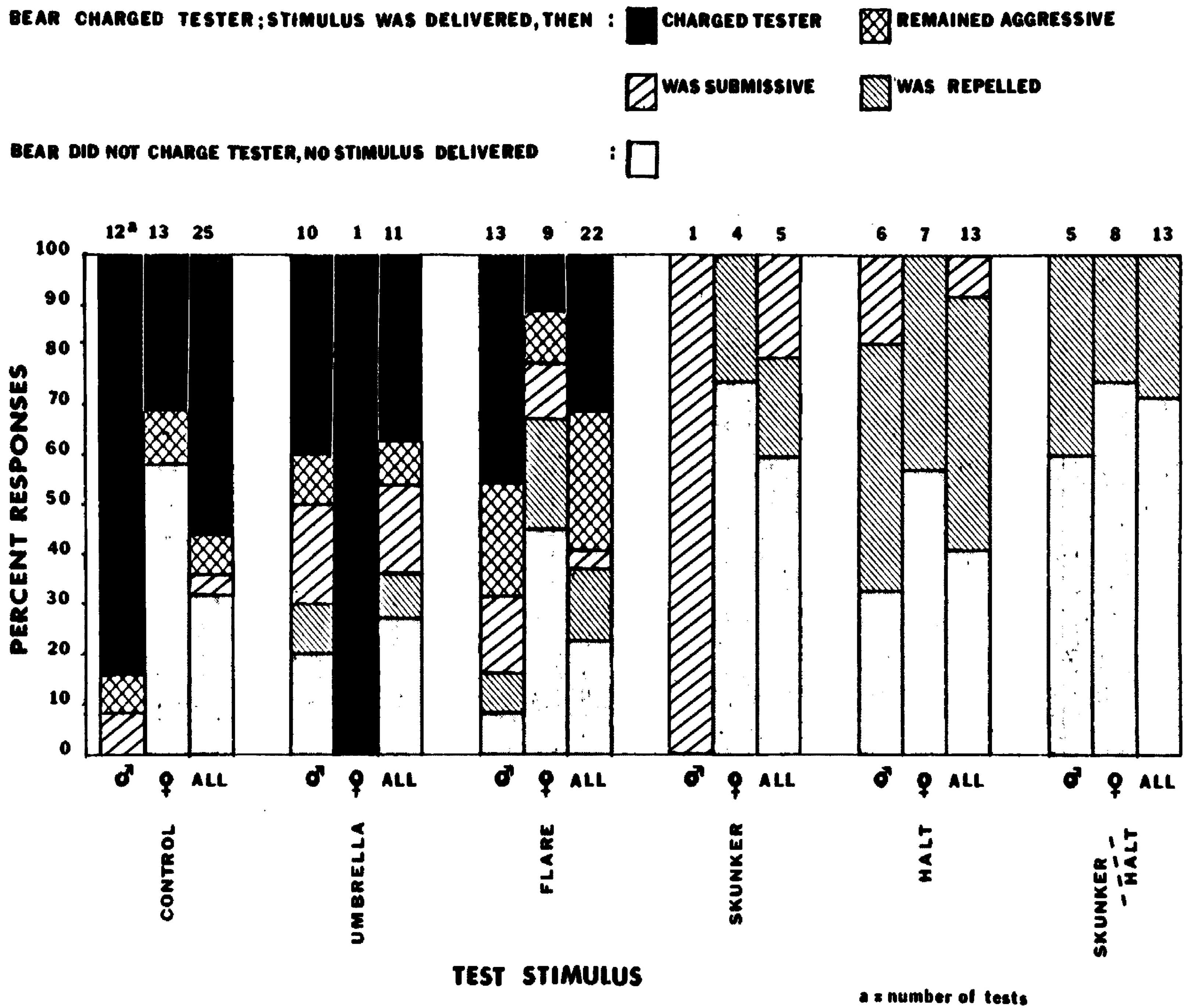

BEAR CHARGED TESTER; STIMULUS WAS DELIVERED, THEN :
CHARGED TESTER
REMAINED AGGRESSIVE
WAS SUBMISSIVE
WAS REPELLED
BEAR DID NOT CHARGE TESTER, NO STIMULUS DELIVERED :
PERCENT RESPONSES
0
10
20
30
40
50
60
70
80
90
100
12a 13 25
10 1 11
13 9 22
1 4 5
6 7 13
5 8 13
♂ ♀ ALL
♂ ♀ ALL
♂ ♀ ALL
♂ ♀ ALL
♂ ♀ ALL
♂ ♀ ALL
CONTROL
UMBRELLA
FLARE
SKUNKER
HALT
SKUNKER — HALT
TEST STIMULUS
a = number of tests

TABLE 2. Effect of test stimuli on individual bears when charging.

STIMULUS	BEAR	NUMBER OF TESTS	DID NOT CHARGE	IMMEDIATE RESPONSE TO STIMULUS			
				Repel	Submissive	Aggressive	Charge
Control	1 (1982)	4					4 (100)[a]
	4	4					4 (100)
	7	4			1 (25)	1 (25)	2 (50)
	5	4					4 (100)
	6	9	8 (90)			1 (10)	
		25					
Umbrella	1 (1982)	6	2 (34)		2 (34)		2 (34)
	4	4		1 (25)		1 (25)	2 (50)
	5	1	1 (100)				
		11					
Flare	1 (1982)	5			2 (40)	1 (20)	2 (40)
	4	4	1 (25)	1 (25)			2 (50)
	7	4				2 (50)	2 (50)
	5	4	3 (75)				1 (25)
	6	5	1 (20)	2 (40)	1 (20)	1 (20)	
		22					
Water	4	1					1 (100)
		1					
Skunker	7	1			1 (100)		
	5	4	3 (75)	1 (25)			
		5					
Halt	1 (1982)	1			1 (100)		
	4	1		1 (100)			
	7	4	2 (50)	2 (50)			
	5	4	3 (75)	1 (25)			
	6	3	1 (33)	2 (67)			
		13					
Skunker/ Halt	7	5	3 (60)	2 (40)			
	5	4	3 (75)	1 (25)			
	6	4	4 (100)				
		13					
		90					

[a] (Percent).

of overall activities and body positions for bears indicated that Bears 1 (1982) and 5 spent more time quietly lying on their sides than all other bears. Bears 1 (1981), 4, 7, and 6 were more frequently involved in light and moderate activities (Tables 3a and 3b). Bear 5 generally appeared relaxed and primarily interested in eating. Bears 1 (1982) and 7 seemed calm but alert at most times; Bear 1 had been much more restless in 1981. Bears 4 and 6 appeared most stressed by captivity, often exhibiting restlessness and displacement activities.

During test periods, bears generally spent more time quietly lying on their bellies or sitting, and less time lying on their sides or involved in eating, drinking, or light and moderate activities (Tables 3a and 3b). These changes were primarily related to post-test observations and reflect tension and alertness associated with the effect of the tests on each bear.

Changes were most substantial for Bears 4, 6, and 7. Bear 4 remained nervous throughout the test period, exhibiting light and moderate overall activities with increased frequency (Table 3a). These reflected an increase in displacement activities. Changes in body positions were most substantial for Bears 6 and 7 which spent more time sitting or standing, suggesting increased alertness or tension (Table 3b).

TABLE 3a. Comparison of overall activities for each bear during baseline and test periods.

PERIOD	BEAR	NUMBER OF OBSERVATIONS	OVERALL ACTIVITY (%)					
			Sleep/ quiet	Elimination	Eat or drink	Light activity	Moderate activity	Heavy activity
Baseline	1 (1981)	1872	(84)	(4)	(11)	(1)		
	1 (1982)	487	(94)		(5)	(1)		
	4	485	(77)		(10)	(13)	(1)	
	7	444	(88)			(9)	(2)	(1)
	5	466	(86)		(6)	(4)	(3)	
	6	353	(98)			(2)		
	Total	4007	(86)		(4)	(8)	(1)	
Test	1 (1981)	867	(95)		(1)	(4)		
	1 (1982)	833	(97)			(4)		
	4	838	(88)		(3)	(6)		(2)
	7	977	(87)			(9)	(3)	(1)
	5	1303	(83)		(9)	(6)	(1)	
	6	1321	(98)			(2)		
Total		6139	(91)		(3)	(5)	(1)	(1)

TABLE 3b. Comparison of gross body positions for each bear during baseline and test periods.

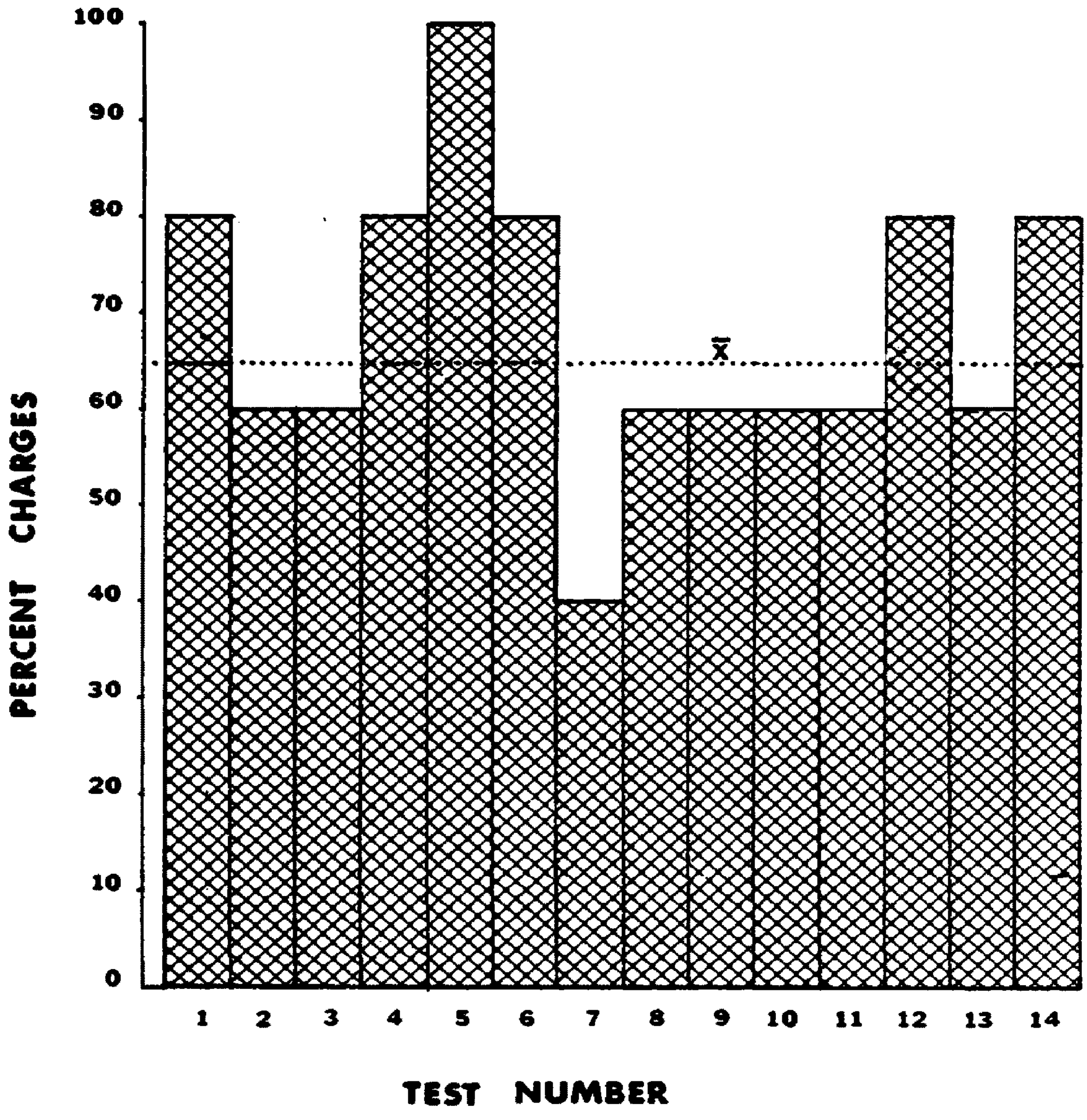
PERIOD	BEAR	NUMBER OF OBSERVATIONS	GROSS BODY POSITION (%)						
			Lying on side	Lying on back	Lying on belly	Sitting	Sitting/ crouched, hunched	Standing	Pullup at door
Baseline	1 (1981)	1872	(47)	(1)	(28)	(12)		(9)	(3)
	1 (1982)	487	(65)		(26)	(8)		(1)	
	4	472	(42)	(22)	(12)	(4)	(3)	(15)	(2)
	7	444	(55)		(34)	(2)	(2)	(7)	
	5	366	(60)	(8)	(22)	(4)		(6)	
	6	353	(37)	(6)	(43)	(8)	(4)	(2)	___
	Total	3994	(50)	(4)	(27)	(8)	(1)	(8)	(2)
Test	1 (1981)	867	(36)		(4)	(12)		(9)	(3)
	1 (1982)	833	(62)	(1)	(24)	(10)	(1)	(2)	
	4	838	(38)	(22)	(27)	(3)	(2)	(8)	
	7	975	(17)		(61)	(11)	(3)	(8)	
	5	1303	(48)	(3)	(33)	(9)		(7)	
	6	1321	(9)	___	(32)	(55)	___	(4)	___
	Total	6137	(33)	(4)	(36)	(19)	(1)	(6)	(1)

Only Bears 5 and 7 appeared to modify their behavior to avoid application of stimuli. However, Bears 5, 6, and 7 were the only bears presented with a series of highly repellent stimuli. Following the first few repellent trials, Bear 5 attempted to avoid application of stimuli by leaving the room during the pre-test periods; leaving the room or backing away from the tester with no aggressive signals when closely approached, or lying without movement and ignoring the tester during a test. Following the first 2 Halt tests, Bear 7 also began to exhibit these behaviors. After the first few Halt tests Bear 6 began to spend more time in the alternate room, however, this bear seemed unable to refrain from charging the tester when approached closely, even when repelled in the preceding test.

Responses to Test Stimuli, 1982

All bears were presented with at least 14 tests. Bears 1 and 4 were tested with identical stimuli, and Bears 5, 6, and 7 were tested with similar but not identical stimuli (Appendix 7). Throughout the tests, bears continued to charge upon the appearance of the tester approximately 66% of the time, indicating that responses to the tester were not influenced by the number of tests delivered to each bear (Fig. 4).

Fig. 4. Incidence of charge responses by all bears upon appearance of the tester during first 14 consecutive tests (N = 90).


100
90
80
70
60
50
40
30
20
10
0
PERCENT CHARGES
X̄
1 2 3 4 5 6 7 8 9 10 11 12 13 14
TEST NUMBER

Bears that charged and were then presented with a control, umbrella, or flare responded immediately by becoming aggressive or charging during 94%, 63% and 65% of the tests, respectively (Fig. 3). Proportionately, the umbrella induced more charge responses and the flare, more repel responses. In response to application of the Skunker/Halt, Halt or Skunker, no bears charged or were aggressive. Bears were repelled during 100%, 86% and 50% of the tests (Fig. 3).

Following the first application of the stimulus, as the tester continued to provoke the bear, bears that had been repelled or submissive immediately, remained so during approximately 90% of the tests, and 92% of those that had charged upon the delivery of the stimulus recharged the tester (Table 4a).

Bears frequently recharged or remained aggressive after having been presented with a control, umbrella, or flare test. Aggressive and recharge responses were much lower to the Halt (15%), Skunker/Halt (8%), and Skunker (0%; Table 4b).

Generally, all bears except Bear 6 charged and then recharged in response to presentation of the control tests (Table 2). Bears seemed to become more inclined to charge with each repetition of the test.

TABLE 4a. Relationship of all bears' immediate response to stimulus with their continued response to provocation following delivery of stimulus.

IMMEDIATE RESPONSE TO STIMULUS	NUMBER OF TESTS	CONTINUED RESPONSE TO TEST	
		Repel/Submissive	Aggressive/Charge
Repel	14	13 (93)[a]	1 (7)
Submissive	8	7 (88)	1 (12)
Aggressive	7	3 (43)	4 (57)
Charge	26	2 (8)	24 (92)

TABLE 4b. Continued response of all bears according to stimulus.

STIMULUS	NUMBER OF TESTS	CONTINUED RESPONSE TO TEST	
		Repel/Submissive	Aggressive/Charge
Control	25	10 (40)	15 (60)
Umbrella	11	6 (55)	5 (45)
Flare	22	13 (59)	9 (41)
Water	1		1 (100)
Skunker	5	5 (100)	
Halt	13	11 (85)	2 (15)
Skunker/Halt	13	12 (92)	1 (8)

[a] (Percent).

The lower proportion of charge responses, and the higher frequency of repel responses to the quickly opened umbrella (Fig. 3), suggest that the stimulus was more effective than the control, but generally not effective enough to repel even less aggressive bears (Table 2). During continued provocation, Bears 4 and 5 recharged and then displayed curiosity about the tester's presence behind the open umbrella, attempting to look around it. Having initially charged the stimulus, Bear 1 then appeared to ignore it.

The flare elicited less immediate charges and more immediate repel responses than the umbrella (Fig. 3), and a higher percentage of bears that were not repelled immediately were subsequently repelled during continued provocation by the tester. However, it also produced more immediate aggressive responses than the umbrella, and during continued provocation by the tester, more bears recharged the flare than the umbrella.

It appeared that bears that had consistently been aggressive (males) frequently charged the flare, while consistently non-aggressive bears (females) were more often repelled or submissive (Fig. 3). Of the males, Bear 7 always responded by charging or with aggression; Bear 1 reacted with more charge and aggressive responses than did Bear 4. Bear 4 was repelled more often by this stimulus than Bear 1 or 7. Bear 5 (female) responded with a charge during the first test, then never charged again. Bear 6 (female) responded aggressively only during the first test (Table 2). When first presented with the lit flare, all bears flinched or backed up slightly, and then invariably poked their noses into the smoke toward the flame, generally to within 20cm of the stimulus. This inspection lasted from 1 to almost 30 seconds.

When sprayed with Halt, bears generally turned, ran a short distance, then paused briefly to rub their eyes with their paws; then with the exception of the 2 following cases, they ran to the adjoining room or to their bed and remained there throughout the tester's continued provocation.

In all but 1 test, bears were immediately repelled by the Halt. The exception was a submissive response by Bear 1. When sprayed, the bear immediately backed into his bed, and then remained facing the tester at approximately a 30 degree angle. After 30 seconds, as the tester turned to leave, the bear recharged. Upon reapplication of the stimulus he turned and ran immediately from the room.

The first test response to Halt by Bear 7, the grizzly, deviated notably from those of other bears. When initially sprayed, the bear immediately turned and ran toward the alternate room, then hesitating before the door. he turned and recharged. Upon reapplication of the stimulus, the bear again turned and ran toward the other room, paused as he had the first time, then turned and ran to his bed, recharging 5 seconds later. This time, while being sprayed he remained standing bipedally against the door for 3 seconds, swinging his head from side to side and growling loudly, then turned and bounded from the room. For the next 2 minutes he could be heard moaning loudly, and moving his bedding around. By the next day he had moved all the straw and his bed from the test room into the alternate room and was lying on a new bed. During subsequent tests, when initially sprayed, he turned and ran immediately from the room. During the first test the bear's initial responses to application of the stimulus were to turn and run immediately; I believe that the recharges occurred because the bear perceived no option for escaping the situation.

Reactions of Bears 5 and 7 to Bear Skunker were similar to those of Bears 1 and 2 in 1981. The less aggressive Bear 5 was initially reluctant to charge at all, probably as a result of the stimulus odor. When a charge was elicited and the stimulus presented, she was immediately repelled. Throughout the remaining Skunker tests, she would not charge the tester. Bear 7 responded to 1 test of Skunker with an immediate reduction in aggressive activity, and vocalizations and would not charge again (Tables 2 and 4b). When next confronted by the odor he would not charge.

Initial reactions by bears to the tester with Skunker/Halt were similar to those of bears to Skunker. Less aggressive bears were reluctant to charge during the first test. Once sprayed, all bears immediately turned and ran from the room. During continued provocation, bears would not recharge (Table 2), although one bear did assume an aggressive stance (Table 4b). In subsequent Skunker/Halt tests, Bear 5 did not charge again, and Bear 7 did not charge during the next 2 tests.

When bears had charged or been aggressive in response to the previous stimulus, they charged upon appearance of the tester during the next test, 94% of the time. However, bears that had been repelled (n=12) during the previous test charged only 42% of the time (Fig. 5).

Bears generally charged the tester if the previous test delivered was a control, flare, or umbrella (Fig. 6). If the previous test had been with Halt, Skunker, or Skunker/Halt combination, bears charged 40%, 0%, and 0% of the time.

Latency to charge was also influenced by the previous test response; bears appeared to learn from and remember test encounters. When bears charged immediately upon the appearance of the tester, 87% of the time they had been aggressive or charged in response to the preceding test stimulus (Table 5). None of the bears charged immediately if they had been repelled during the previous test. Of the bears that did not charge during a test, 80% had been submissive or repelled during the previous test.

General Relationships of Temperament and Stimulus Effect to Bear Behavior

Differences in temperament between bears were indicated by

Fig. 5. Response of individual bears to the appearance of the tester in relation to the previous test response.

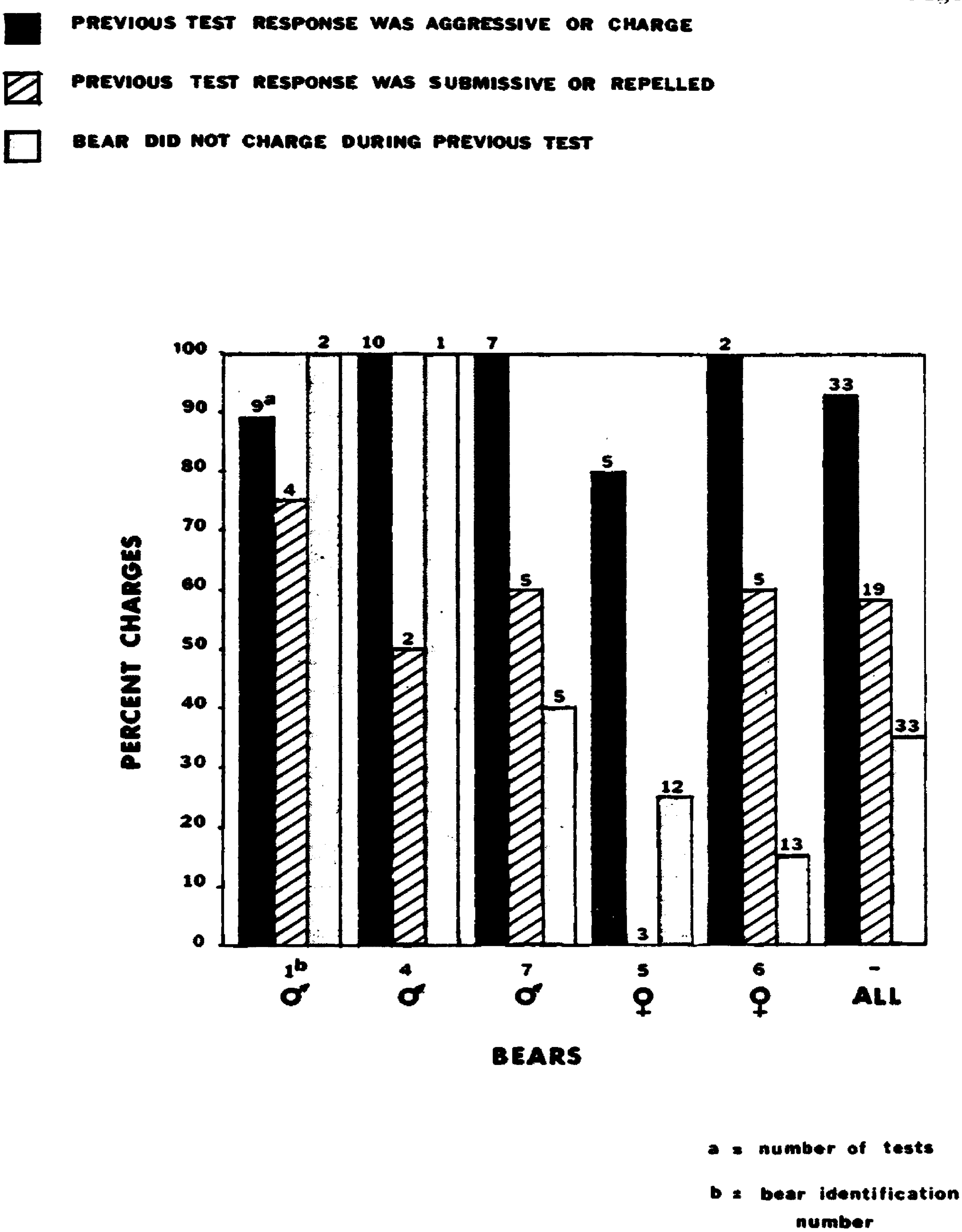

PREVIOUS TEST RESPONSE WAS AGGRESSIVE OR CHARGE
PREVIOUS TEST RESPONSE WAS SUBMISSIVE OR REPELLED
BEAR DID NOT CHARGE DURING PREVIOUS TEST
PERCENT CHARGES
100
90
80
70
60
50
40
30
20
10
0
9a 4 2
10 2 1
7 5 5
5 3 12
2 5 13
33 19 33
1b ♂
4 ♂
7 ♂
5 ♀
6 ♀
- ALL
BEARS
a = number of tests
b = bear identification number

Fig. 6. Response of all bears to the appearance of the tester in relation to the previous test stimulus. Does not include 35 tests where bears did not charge during the previous test.

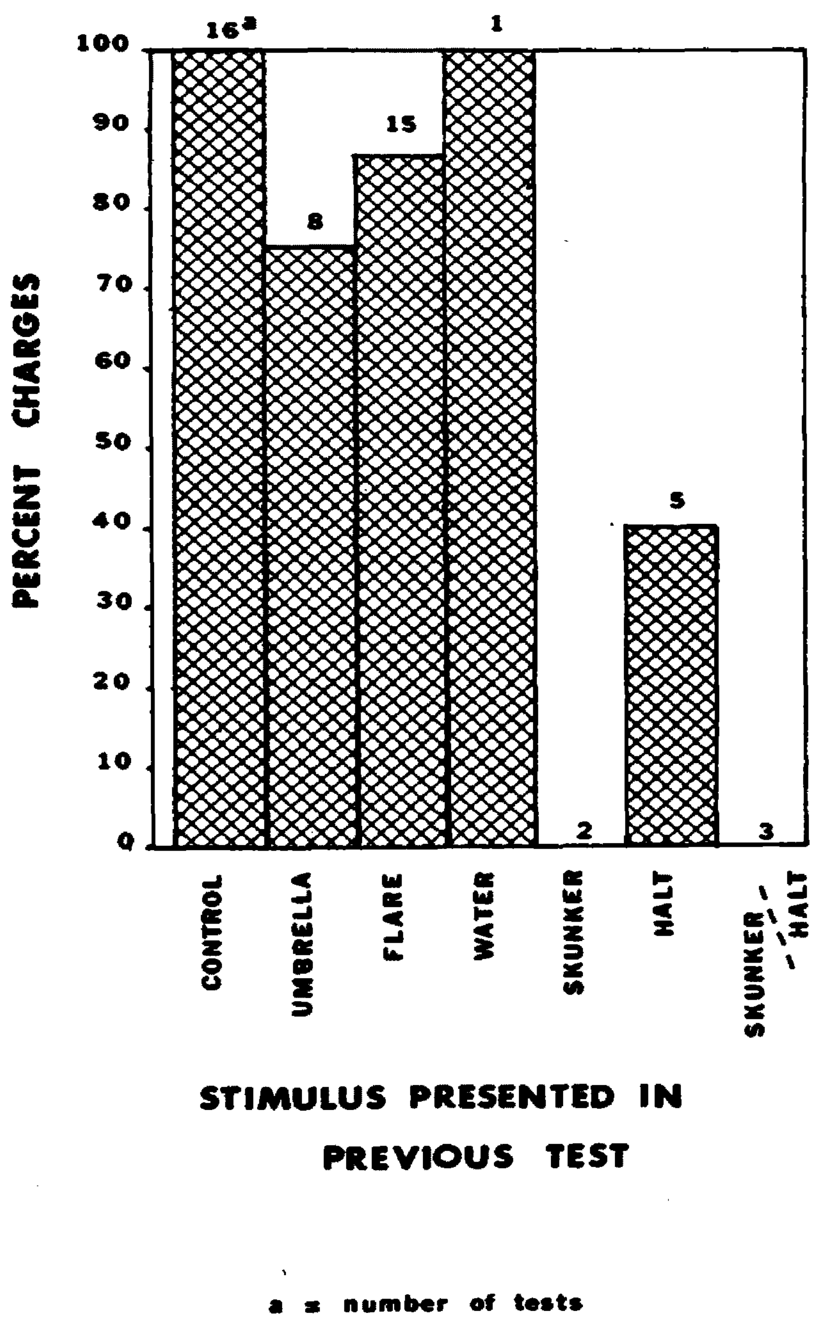

PERCENT CHARGES
100
90
80
70
60
50
40
30
20
10
0
16a
8
15
1
2
5
3
CONTROL
UMBRELLA
FLARE
WATER
SKUNKER
HALT
SKUNKER - HALT
STIMULUS PRESENTED IN PREVIOUS TEST
a = number of tests

TABLE 5. Latency to charge in relation to submissive or aggressive behavior during the previous test. Does not include 30 tests where bears did not charge during the previous test.

TIME TO FIRST CHARGE (SECONDS)	NUMBER OF TESTS	PREVIOUS TEST RESPONSE	
		Repel/Submissive	Aggressive/Charge
0 (Immediate charge)	16	2 (13)[a]	14 (87)
1	10	1 (10)	9 (90)
2	2	1 (50)	1 (50)
5	2		2 (100)
6	10	1 (10)	9 (90)
7	10		10 (100)
8	2	1 (50)	1 (50)
10	3	2 (67)	1 (33)
15	5		5 (100)
20	10		10 (100)
25	9		9 (100)
30	1		1 (100)
35	2		2 (100)
45	2	1 (50)	1 (50)
50	10	1 (10)	9 (90)
55	1		1 (100)
88 (No charge)	10	8 (80)	2 (20)
	52		

[a](Percent).

variations in their initial responses to captivity and human proximity, changes in their behavior during testing, and the strength and characteristics of their responses. Baseline observations of each bear's behavior appeared to provide a general profile of each animal's temperament that was related to the overall test period behaviors. Certain bears were consistently more aggressive than others. The data suggest that these bears may be less easily repelled than others. Overall, bears that appeared to have difficulty adjusting to captivity and human proximity during baseline observations appeared most stressed by tests and less flexible or slower in adapting their behavior to reduce stress during test situations. Observations of responses by bears that had been habituated to people suggested that they adjusted quickly to captivity, and they responded to repellent cues by modifying their behavior both before and during tests to avoid confrontations. These data suggest that certain bears may be more capable of adapting to human-linked situations than others, and that these bears may be most capable of modifying their behavior to co-exist with humans.

Behavioral parallels to the above were observed during studies of black bears in the Smokies (Eager and Pelton 1979). Some bears were consistently more aggressive than others toward humans. Although bears generally exhibited restraint when interacting with humans in situations that could have led to aggressive contact, certain bears were more flexible in tolerating the proximity of humans and other factors involved in panhandling situations. These factors appeared to influence the decision each bear made as to whether it was going to panhandle and to what extent.

Certain stimuli were effective in repelling all bears. Individual differences in temperament among the bears were more important in determining the responses to less effective stimuli; although reactions were variable, responses by individual bears were generally predictable.

Whether or not a bear charged during a test appeared to be determined by its previous test response. All bears that responded aggressively or charged when a stimulus was presented, subsequently displayed a high tendency to charge both in response to the tester's continued provocation and in the following test when initially approached by the tester. During the following test, the frequency of immediate charges in response to the approach of the tester also increased. During repetitions of the control tests, bears received no punishment when charging, and all bears rapidly became more bold or aggressive in their approaches.

Similarly, bears tended to avoid further confrontations if they had been submissive or repelled during presentation of the stimulus. When the stimulus was highly effective such as in Halt and Skunker/Halt tests, the number of times that bears did not charge again during continued provocation and in subsequent tests increased. The addition of an odor cue such as that provided by the skunk mercaptan seemed to increase the stimulus effectiveness. During tests, Skunker alone was not immediately repellent, but it was discomforting. In subsequent tests the odor cue appeared to reduce the frequency of charges upon the appearance of the tester. Less aggressive bears were reluctant to charge when first confronted with the odor.

When the stimulus was not highly effective, yet frightening and perhaps harder to ignore, (such as during the flare tests as compared to the umbrella tests), aggressive bears seemed to charge again more frequently, while submissive bears were repelled or submissive more often. This may explain why reports vary on the effectiveness of certain devices or methods for repelling bears.

Dominance between individual bears has been reported to be settled during the first few encounters, and thereafter maintained primarily through visual signals (Hornocker 1962, Herrero 1980). The apparent speed with which the bears adjusted their behaviors relative to the effectiveness of the test stimuli, suggested that their responses may have been mediated by the same behavioral mechanisms active in the establishment and maintenance of dominance hierarchies between bears. The immediate effectiveness of the Halt, Skunker and Skunker/Halt in reducing charges, both during and in subsequent tests, may reflect the ease with which effective repellents, combined with additional auditory, olfactory, or visual signals can modify bear response patterns during and in subsequent bear-human encounters.

Bear-Human Communication

Throughout the tests bears appeared to signal their submissive or aggressive intentions by displaying specific, repeated head movements, eye contact, and by positioning of their torsos relative to the tester. In communicating a reluctance to charge, the bears often assumed a seated or crouched posture, with their torsos at an angle to the tester. The head was held below shoulder level and swung slowly in an arc from 1 side to the other, generally with a 1 to 3 second hesitation at each side where the profile was presented to the tester. The nose pointed down at about a 30 degree angle, and little prolonged eye-contact with the tester was made. The mouth-open-close, and tongue extension behaviors reported by Eager and Pelton (1979) often occurred in conjunction with these movements.

A mounting tendency to charge was accompanied by increasing the speed of the side-to-side head swing, while decreasing the amount of time spent presenting the head profile. The head and nose were raised slightly. Bears hesitated more often and for longer periods at mid-swing, eyeing the tester directly. Slight shifting of the shoulders and torso toward the tester, lifting of a front paw, or a tensing of the hindquarters were often observed in conjunction with these changes.

During tests in 1982, when a bear did not charge, the initial angle of its torso to the tester was greater than 30 degrees, usually greater than 45 degrees, 83% of the time (Table 6a). When a bear did charge, its angle to the tester was less than 30 degrees 44% of the time. Following application of a stimulus, 83% of the times that bears did not recharge their bodies were positioned at an angle greater than 30 degrees to the tester (again, generally greater than 45 degrees). When bears had positioned themselves at angles less than 30 degrees, they recharged the stimulus 66% of the time (Table 6b).

An increase in the frequency of certain activities was associated with the post-test periods and appeared to reflect stress caused by the test experience. These stress related activities included: yawning; tongue extensions; licking, biting and chewing on toes, claws, and pads; "moan" vocalizations; curling of paws and toes while lying down; scratching; and playing with food or straw.

Similar movements by the tester seemed to bring about predictable responses from bears. The tester provoked all bears to charge, except the non-aggressive Bear 6, by standing upright and facing them, while making direct eye contact and rhythmically stomping the ground with 1 foot. Often, as the tester ceased stomping and turned to leave, the male bears responded by lurching forward aggressively or charging.

TABLE 6a. Relationship of the angle of the bear's torso to the occurrence of charges during initial responses to the tester, prior to delivery of stimuli.

INITIAL RESPONSE TO TESTER	NUMBER OF TESTS	DEGREE ANGLE TO TESTER				
		0	≤ 30	≤ 60	≤ 90	+ 90
Did not charge	35	4 (11)[a]	2 (6)	6 (17)	12 (34)	11 (32)
Charged	55	12 (22)	12 (22)	12 (22)	11 (20)	8 (14)
	90					

TABLE 6b. Relationship of the angle of the bear's torso to the occurrence of charges during continued responses to the tester, following delivery of stimuli.

CONTINUED RESPONSE TO TESTER	NUMBER OF TESTS	DEGREE ANGLE TO TESTER				
		0	≤ 30	≤ 60	≤ 90	+ 90
Repel/Submissive	56	7 (12)	5 (9)	9 (16)	11 (20)	24 (43)
Aggressive/Charge	34	16 (47)	9 (26)	4 (12)	3 (9)	2 (6)
	90					

[a] (Percent).

Attempts to provoke Bear 6 to charge by stomping failed during the first 4 tests. On the fifth test she charged almost immediately when the tester assumed a crouching position, presenting his body sideways and turning his head toward and away from her, quickly averting his eyes and turning his head when eye contact was made. Thereafter, during tests, the bear was provoked in this manner.

This same "submissive" stance also elicited approaches from other bears. It was the first and 1 of very few positions that appeared to allow Bear 1 (after the 1981 test sessions), and a grizzly bear cub (during other studies) to non-aggressively approach humans that were outside their cell door. For Bear 1, averting the eyes alone seemed insufficient to allow a peaceful approach; apparently the human's entire head had to be turned away.

The tester's crouching, "submissive stance" appeared to invite approaches. It elicited an aggressive approach from a threatened, generally non-aggressive bear, while soliciting peaceful approaches from unthreatened, non-aggressive cubs and a generally aggressive bear. Eager and Pelton (1979) also reported that visitors that knelt to photograph panhandling black bears were likely to be charged. These data, and interactions with bears following test periods, suggest that a standing, sideways stance combined with the above mentioned head movements may communicate peaceful intentions but not elicit an approach.

SUMMARY

The data indicate that repellents can be developed that will turn most bears during a charge. Halt and a Skunker/Halt combination repelled most bears, however, tests on a larger number of bears are necessary. These stimuli are not currently available with delivery systems that have the range and accuracy necessary for use on free-ranging bears. Effective repellents appear to reduce the frequency of immediate charges and the overall tendency to charge both during and in subsequent encounters. Additional odor or visual cues combined with these stimuli may increase their effectiveness. Certain bears are more aggressive than others; these bears may be less easily repelled during an encounter. Moderately effective stimuli may increase aggression in more aggressive bears, while decreasing aggression in more submissive bears. Unpunished charges appear to elicit increases in the frequency of aggression in all bears, both during and in subsequent encounters. Certain bears appear more capable of adapting to human-linked situations than others. Effective repellent combinations appear well-suited for bears already habituated to humans; these bears may react from a less basic "fight or flight" level, allowing more time during a human-bear encounter for behavioral modification. Bears communicate their aggressive intentions by displaying visual body signals involving torso positioning, head movements, and eye contact. Similar signals displayed by humans appear to elicit specific responses in bears.

PART II

AVERSIVE CONDITIONING OF BEARS TO BE RELOCATED

In North America, the most widely used methods for control of nuisance bears are to destroy the animals or to relocate them to areas where they presumably will not cause further problems. These methods are expensive, time consuming, and ineffective as long-term solutions to most bear-human problems (Herrero 1976, Jorgensen et al. 1978, Eager and Pelton 1979).

Return rates from relocations are high because bears have the ability to home (Craighead and Craighead 1972, Beeman and Pelton 1976, Alt et al. 1977, Thier and Sizemore 1981, Miller and Ballard 1982). The fate of those that do not return is largely unknown; accumulating evidence suggests that many die because of increased vulnerability associated with increased movement (post-relocation), unfamiliarity with the terrain, and non-territorial status (Jorgensen et al. 1978, Miller and Ballard 1982).

Bear populations have relatively low recruitment rates and generally occur over large areas in low densities (Craighead and Craighead 1972, Martinka 1976). The destruction of nuisance bears may become a significant mortality factor if the causes of bear-human problems are not prevented (Nagy and Russell 1978, McArthur 1979).

Generally, relocations and control kills are only treatments of the symptoms. They do not eliminate the causal factors that create nuisance bears. They do not prevent the problem from recurring, either by the same animal or another that moves in. These methods have their place, but should be used only in conjunction with management measures designed to prevent human-bear conflicts (McCabe and Kozicky 1972, Gilbert 1977, Follman et al. 1980).

Resolution of conflicts through aversive conditioning of bears has met with limited success (Gilbert and Roy 1977, Dorrance and Roy 1978, Hastings and Gilbert 1981, Greene 1982). Application to free-ranging bears is difficult because conditioning must be consistently applied until the undesirable behavior is extinguished. Certain problems, and perhaps certain bears, do not lend themselves to successful aversive conditioning programs. Greene (1982) explored the possibility of capturing problem bears to condition them in captivity, and then releasing them back into the wild. A black bear (*Ursus americanus*) that had frequented a recreation area was caught in a culvert trap and classically conditioned using ultrasonic sound. Only 1 post-release trial was conducted, during which the bear was successfully repelled from the area when the ultrasonic sound was presented.

During tests of repellents on captive bears in another phase of this research (problem bears destined to be destroyed), 2 black bears and 2 grizzly bear cubs (U. arctos) were subjected to a brief series of repellent tests and then released into the wild. The goal of the tests was to cause the bears to avoid humans and their properties by conditioning them to fear human proximity.

METHODS AND MATERIALS

Test procedures and stimuli varied for each case. Generally, a "tester" confronted each bear and attempted to provoke an approach by the animal, at which time a stimulus was delivered. Bears were judged to have been repelled when they presented their torso to the tester at an angle greater than 45 degrees and made no aggressive movements toward the tester. An effort was made to avoid overconditioning; the test program ended shortly after any approach of the animal elicited a repellent response. Tests were aimed at conditioning the bear to associate the stimulus effect with their approach or aggression toward the tester; overconditioning could cause an association of the stimulus with an unavoidable test situation, or produce undesirable behaviors toward humans.

Bear 2, an adult black bear and chronic campground nuisance, was tested while restrained by an Aldrich Leg-hold Snare anchored to a tree with a 4m cable lead. Tests were run 1 hour apart and the bear was provoked into aggression by a tester standing and directly facing the bear while stomping a foot.

Bear 3, a yearling black bear, and Bears 81 and 82, sibling grizzly bear cubs, were orphans that had been conditioned to receiving food from humans. These bears were held in captivity for several months and fattened, then tested in a laboratory (Figure 1). Tests were run 10 hours apart and presented quietly, with no provocation other than the continued presence of the tester.

All bears were held in isolation from human activity, and direct visual contact with humans was prohibited except during tests. Bears were presented with a control test, where the tester presented himself, but delivered no stimulus when approached, and then with 1 or 2 repellent tests, depending on the responses of the animal. All animals were tattooed, ear-tagged, and released within 24 hours of their last test.

RESULTS

On 6 July, 1981, Bear 2 was presented with 1 test each of the waterspray, air horn, and Bear Skunker stimuli (Appendix 2). Throughout the tests, the bear was reluctant to demonstrate aggression; most of his activities reflected attempts to avoid confrontations and to escape the snare.

When finally provoked into aggression and sprayed with water, the bear flinched, and then resumed his efforts to escape. In response to the air horn, the animal charged the tester again. Bear Skunker was delivered last; the bear immediately ceased all aggressive movements and became more active in his efforts to escape the snare than he had been previously. When reapproached, he could not be provoked into aggressive activity or even to get up from where he lay. He behaved in a subdued manner, making no vocalizations and repeatedly turning his head away from the tester.

Bear 3 was held from mid-January through 10 June, 1982. During 8 and 9 June she was presented with a control, water spray, and 2 Halt tests. Throughout the tests she would not approach or charge the tester. During the first control and the following Halt test she displayed aggression, standing, hissing, and eyeing the tester directly with little side to side head movement. When sprayed in this stance with Halt, she immediately ran from the room. During the subsequent water and Halt tests she displayed no aggressive movements. She did not vocalize, and remained lying down with her torso at an angle of greater than 45 degrees to the tester, with no movement other than a slow turning of her head from side to side. She was sprayed during both tests, upon which she immediately ran from the room.

Bears 81 and 82 were held from 25 August to 30 November, 1982. Simulated denning cues induced the cubs to den approximately 1 week prior to testing. During 28 and 29 November they were presented with 1 control, 1 foot stomp, and 1 Halt test. Throughout the tests the cubs generally remained huddled in the far corner of their cell, torsos at 60 to 90 degree angles to the tester, turning their heads slowly from side to side, making little eye contact with the tester, and periodically moaning softly.

Neither bear approached during the first (control) test. Bear 82 made a non-aggressive approach during the second test, shortly after the tester had crouched and presented his body sideways to the bears, while turning his head and eyes toward and away from them. At this time the foot stomp was delivered, and the cub immediately ran back to its sibling. During the following Halt test neither bear would approach. When Bear 81 finally got up, apparently to leave the room, she instead turned back toward her sibling, then turned and faced the tester. Both bears were thereupon sprayed with Halt. Their response was a blind panic; they ran about, bumping into each other, trying to huddle behind one another. attempting to climb the cell walls, all the while crying loudly. They did not enter the adjoining room. After the first minute, the tester went to the far end of the facility and sat quietly through the end of the observation period. The cubs began to quiet down after 6 minutes, and finally became silent 21 minutes after the test. Due to the strength of their response, and because they were unlikely to approach again and did not seem to perceive the adjoining room as an option for escape, no subsequent tests were conducted.

Following the tests the cubs were fitted with expanding radio collars, and transported to an artificial den at a release site. They remained in the den until May. A follow-up monitoring and aversive conditioning program was planned for the 1983 season, but both cubs slipped their collars shortly after emerging from the den. Efforts to capture and recollar them failed.

The fate of these bears after their release is unknown. However, since their release none of the 4 bears is known to have caused trouble or been reported in the hunter harvest (K. Alt 1983 pers. comm., R. Klaver 1983 pers. comm.). With the exception of 2 sightings of the grizzly cubs by a hunter early in the spring of 1983, the bears have not been seen since their release.

An aversive conditioning program similar to the above laboratory programs has recently been applied to a 5 year old, male grizzly bear. Following the tests, the bear was fitted with a radio-collar and transported to a man-made den in the wild, in which he remains at this writing. The bear will be monitored and aversively conditioned if necessary during the 1984 season.

DISCUSSION

Bears communicated their aggressive or submissive intent by torso positions, head movements, and eye contact, similar to those displayed by bears during other portions of the project. The stomping activity by the tester produced aggressive responses by the adult black bear as observed during tests of most other bears. It produced a repellent response in the non-aggressive cubs similar to the effect it had had on a non-aggressive adult black bear. The submissive stance assumed by the tester when confronting the cubs elicited an approach, as it had during tests of 2 other black bears.

Although the sample size is small, the data suggest that aversive conditioning of captive bears may be an effective method for initial conditioning of certain problem animals from approaching humans once released into the wild. Factors that were probably important in the apparently successful conditioning and release of these bears were: a) bears were isolated from visual contact with humans except during tests; b) overconditioning during tests was carefully avoided; c) the timing of each bear's release; and d) the non-aggressive temperament of all 4 bears.

The goal of the tests was to condition bears against approaching humans and to cause them to react to human proximity by fleeing. It was hoped that bears would transfer this aversion to human properties. During tests it was important that bears associate their actions (e.g.

an approach, aggression, or retreat) with whether or not a stimulus was delivered. Over-conditioning, subjecting bears to too many tests in the laboratory, may prevent bears from making the necessary associations regarding their activities and encounters with humans. Overconditioning could cause bears to associate humans and the effects of the stimulus with an unavoidable situation, and/or cause bears to be less flexible in modifying their behavior to avoid interactions with humans. Depending on the bear, undesirable behaviors towards humans could result subsequent to their release.

The timing of each bear's release probably enhanced the program's chances of success by reducing the potential for bear-human conflicts. The yearling and cubs were fattened and then released during seasons when their post-release movements would be minimized; their motivation to locate familiar food sources (or denning areas) was reduced, and accumulations of snow further restricted their movements. For the cubs, induced hibernation and placement in an artificial den upon release, reduced post-release movements and extended the period during which bears could dis-habituate (Jope 1982) to humans.

The non-aggressive temperament of all the bears may have been the key factor in the success of this program. This may be a factor critical to the success of any aversive conditioning program. During this study and other phases of the project, certain bears were consistently less aggressive than others, both during baseline and test observations. Non-aggressive bears were generally easily distinguished during baseline observations. They were inclined to avoid aggressive confrontations with humans and were repelled easily during tests, even when confronted with only somewhat effective repellents. Such bears were determined to be likely candidates for successful aversive conditioning and subsequent release. Once released, non-aggressive bears may be most likely to avoid people, least likely to cause further trouble, and more easily conditioned should further aversive conditioning be necessary. The relationship of pre-test laboratory observations of bears with their test responses, may provide a basis for evaluating the suitability of specific valuable bears (e.g. reproductive-age females) for aversive conditioning programs either in captivity or in the wild.

PART III

TESTS OF REPELLENTS AND DETERRENTS ON FREE-RANGING BEARS AT A DUMP

Increasing numbers of bear-human conflicts have been reported in many areas where the activities of humans and bears overlap. Most commonly, conflicts involve property damage (Mundy and Flook 1973, Jonkel 1975, Herrero 1976, Schweinsburg 1976, Singer and Bratton 1980). Approaches to solutions for bear-human conflicts should revolve around preventive measures that preclude the establishment of behaviors that lead to conflicts, and that are based on predictable behavioral and ecological relationships.

Bears are highly mobile, opportunistic omnivores, adapted to exploit the seasonal productivity of their environment (Herrero 1976, McArthur 1979). They undergo a long period of dormancy and are thereby motivated to obtain foods high in starches, sugars, proteins, and fats, in excess of their maintenance requirements (Stebler 1972, Bacon 1973, Mealey 1975). As a result, they possess extremely adaptable behavioral mechanisms that allow them to interact advantageously with changes in their environment (Hornocker 1962, Craighead and Craighead 1972, Egbert and Stokes 1976, McArthur 1979, Eager and Pelton 1979). They are intelligent; their ability to learn has been documented by Burghardt and Burghardt (1972), Bacon (1973, 1979), and Jonkel and Cowan (1971).

They are able to remember rich food sources from year to year (Egbert and Stokes 1976, Gilbert 1977, Merrill 1978), and they are capable of learning from a single experience (Gilbert 1977).

Bear distribution is altered by their attraction to food sources made available by people (Barnes and Bray 1967, Shaffer 1968, Cole 1972, Hastings 1982). Bears appear to quickly learn to associate humans with food, and become bold in their searching for and acquisition of it. McArthur (1980) hypothesized that their behavioral plasticity, together with their opportunistic food habits, is the mechanism by which bears overcome their reluctance to forage near people.

The majority of human-bear problems stem from situations where bears have been fed or are using human food sources such as garbage or bee yards, and/or natural foods are in low abundance (Eager and Pelton 1979). In a sense, we offer bears an attractive fast-food service, high in nutritive value (Herrero 1970, Craighead and Craighead 1972, Eager and Pelton 1979). During years of reduced availability of natural foods, bears appear to rely more heavily on human foods as an alternative food resource. Interestingly, Eager and Pelton (1979) indicate that summers with numerous bear problems often precede a fall mast shortage.

Prevention of many conflicts can be achieved by excluding unwanted animals from the site or decreasing the attractiveness of the resource (Follman et al. 1980, Conover 1981). The strategy of physically preventing access to a resource has been successfully used to deter both black (Ursus americanus) and grizzly bears (U. arctos). Efforts to prevent access to human food sources by bear-proofing sites have significantly reduced conflicts in our national parks (Herrero 1976, Meagher and Phillips 1980, Hastings et al. 1981). Electric fences are widely used to prevent bear depredation of apiaries (Storer et al. 1938, Gard 1971, Hepburn 1974, Wynnk and Gunson 1977, Alt 1980); Effective designs for fences have been reviewed by Boddicker (1978) and Follman et al. (1980). Unfortunately, in many situations physical exclusion of bears may not be cost-effective or even feasible.

An alternative strategy for reducing human-bear conflicts is to modify undesirable behaviors, either by the use of fear-provoking repellent or deterrent stimuli that can reduce the bear's desire to approach a bait or enter an area, or by treating the food resource with some type of chemical repellent that reduces palatability. Both repellents and deterrents should turn bears away. Repellents are activated by humans and should immediately turn a bear away during a close approach. Deterrents should prevent undesirable behaviors by discouraging close approaches; they need not be activated by humans.

Attempts to repel bears from approaches using fear-provoking stimuli have primarily involved pain-inducing repellents. Many treatment reports are anecdotal, and only a few have been consistently applied. Most attempts have involved shooting bears with some form of projectile. Stenhouse (1982) reported 100% success using rubber bullets to repel polar bears (U. maritimus) from approaching baits, but many returned repeatedly. Reports on the effectiveness of shells loaded with birdshot or rocksalt indicate similar results (H. Werner 1983 pers. comm.).

Taste deterrents were tested on free-ranging polar bears coming to bait stations by Miller (1980). Ammonia and Pine Sol placed around baits appeared to reduce the amount of time the bears spent at them. Balloons filled with ammonium hydroxide and placed in backpacks and stuff sacks significantly decreased bear activity at campsites during a study in Yosemite National Park (Hastings et al. 1981). Tests of emetics on captive black bears and on free-ranging black and polar bears using specific baits have produced taste aversions (Colvin 1975, Wooldridge 1980). However, tests of emetics used in conjunction with an electric fence on free-ranging black bears failed to reduce damage at bee yards (Dorrance and Roy 1977). Emetics are limited in their effectiveness by the specificity of the created food aversion and by problems with dosages and field applications. Successful application of emetics during livestock, garbage or campground problems with bears is improbable (Revusky and Bedarf 1967, Hastings et al. 1981).

Gustation serves to select required nutrients and to avoid illness produced by ingested toxins, but it is suggested that because motor neurons are not involved in escaping toxicosis, space discrimination does not occur (Dorrance and Gilbert 1977). However, animals often use visual and olfactory clues to reject food after a food aversion has been established. Space discrimination occurs when pain-inducing stimuli are used, but these stimuli are limited in their effectiveness because they require consistent application until the undesirable behavior is extinguished. Bears will return unpredictably to investigate food sources that they have used in the past, making consistent treatment difficult. Deterrence of bears from certain foods, situations, or food resources in a particular space, may best be achieved by combining a taste deterrent and a pain-inducing stimulus with a constantly advertised olfactory, visual, or auditory clue.

During this study, tests were designed to distinguish effective taste and odor deterrents and pain-inducing repellents. Tests of pain-inducing repellents were of promising stimuli tested on charging bears during a laboratory phase of the project. In the future, further studies will test promising combinations of these stimuli on a larger scale.

Specifically, the objective of this study was to describe the behavioral responses of free-ranging bears to tests of pain-inducing repellents that produced promising responses in laboratory tests, and to potential repellents and deterrents not appropriately tested under laboratory conditions.

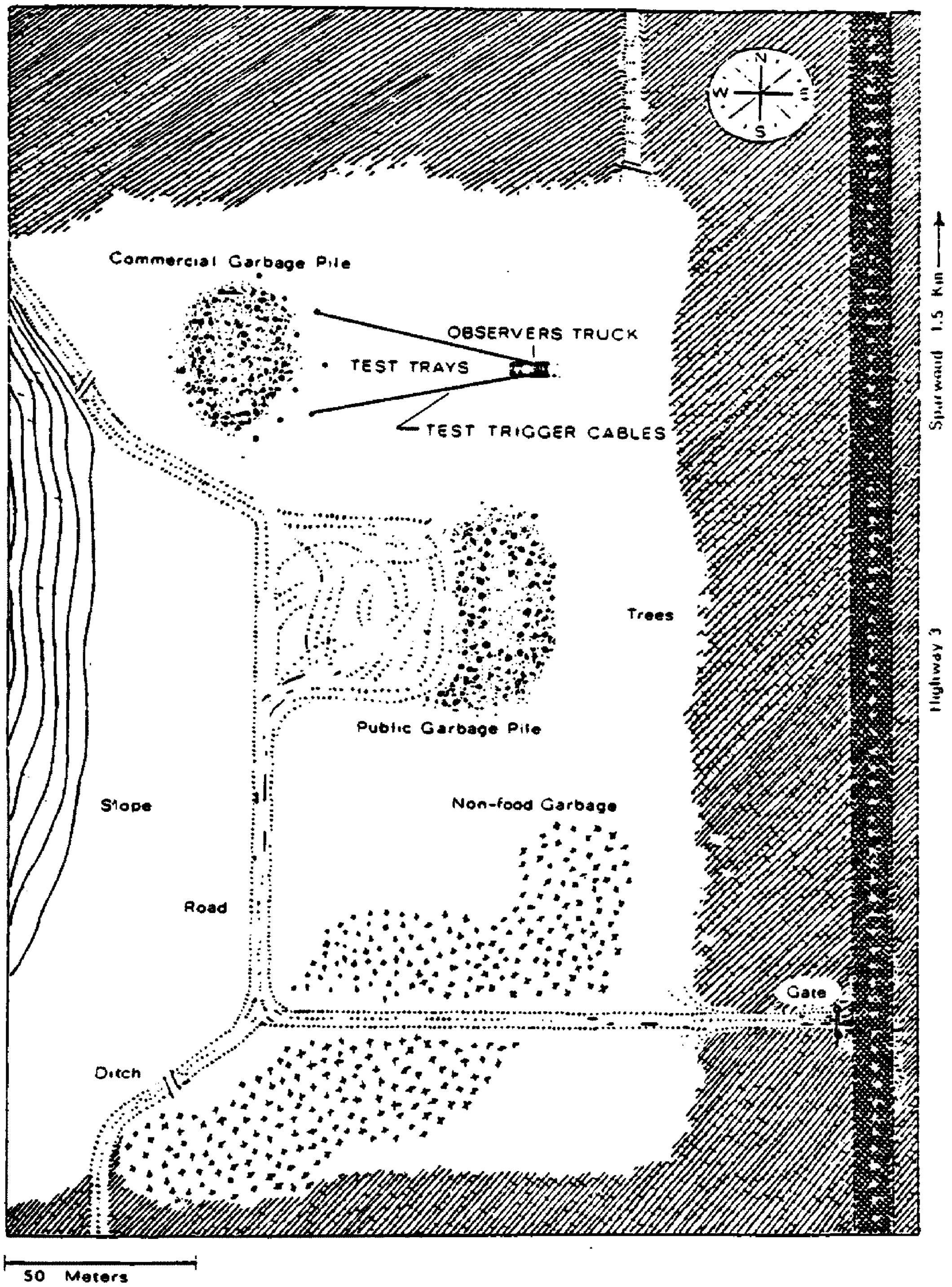
STUDY AREA

The District of Sparwood Sanitary Landfill is located 1.5km S.E. of Sparwood, British Columbia, 100m from Highway 3 (Fig. 7). Landfill operations began in 1971 and currently occupy a 300m X 200m area approximately 5m deep. An estimated 150 to 200 cubic meters of refuse is received daily. This is covered 2 to 3 times per week using a bulldozer.

The vegetation surrounding the site has been classified as an Interior Douglas-Fir (Pseudotsuga menziesii) Zone (Dick 1978) and consists of meadows, shrub thickets, and mixed deciduous and coniferous forests.

Control of black bear activity at the dump is administered by the Ministry of Environment, Kootenay Regional Policy for Nuisance Black Bear Control (Wood, 1980). The policy states that the Ministry "will take such measures as are necessary to discourage bears from frequenting waste disposal sites. Black bears that have obviously become habituated to feeding at these sites will be destroyed." Grizzly bears are to be

Fig. 7. Map of the Sparwood Sanitary Landfill site.



Commercial Garbage Pile
OBSERVERS TRUCK
TEST TRAYS
TEST TRIGGER CABLES
Trees
Public Garbage Pile
Non-food Garbage
Slope
Road
Ditch
Gate
Sparwood 1.5 Km
Highway 3
W
N
S
E
50 Meters

relocated whenever possible. During 1980 and 1981, 20 to 30 black bears were destroyed at the site each year. No bears were destroyed in 1982 so that our tests could be conducted without disturbance.

METHODS AND MATERIALS

Tests were conducted on 30+ free-ranging black bears from early August to mid-November, 1982 (Appendix 8). During 2 weeks prior to testing, 9 bears were culvert-trapped and immobilized using a blow gun system (Carriles in prep.). Bears were marked for positive identification with a tattoo on the inside of the upper lip, and with plastic cattle ear-tags approximately 5 x 5cm, variously colored, and numbered prominently on 1 side. Data recorded for each bear included, sex, age, color and markings, and various physical measurements. A first premolar was extracted to determine age from cementum annuli (Stoneberg and Jonkel 1966).

Bear observations were made from dusk (at approximately 2000), to 0300, or until bear activity at the site had slowed. Bear behavior was observed from a vehicle parked approximately 50m from the trays. Observations were facilitated by military-issue, night vision goggles and 10 x 50 power binoculars.

Bears were identified by number and categorized as adults, subadults, or cubs (Appendix 8). Sibling cubs were treated as 1 unit. Descriptions (and drawings when appropriate) of each bear's color, markings, physical characteristics, and behavior at the site, including interactions with other bears, served to distinguish unmarked bears and to categorize them into approximate age classes. Of the 30 bears frequenting the garbage dump, only 3 proved difficult to distinguish. During data analysis, bears that had been difficult to assign to an adult or subadult category were classified as adults.

Bears were baited to the test site using numbered, 75cm x 75cm stainless steel trays filled with a homemade syrup mixture. The syrup was scented with anise and peanut butter, intended to present a novel food odor. Trays were placed about 15m apart and their order was changed nightly.

Tests were of passive deterrents and remote triggered repellents. Each passive stimulus was placed in a tray and mixed at 1 part stimulus to 2 parts syrup, and on the ground around another baited tray. Trays with stimuli mixed in the baits were presented as taste deterrent tests, while trays with the stimuli around them tested the stimuli as odor deterrents. Passive deterrents included 2 types of ammonia (full strength, and with household detergent), Bear Skunker, Boundry (commercial dog deterrent), human urine (male and female), mothballs, and Technichem (potential commercial bear deterrent). Baited trays with no stimuli were presented as controls.

Pain inducing repellents were actively delivered when a bear attempted to take a bait. Delivery devices were stationed at trays and remotely triggered by a fine cable attached to our truck. Triggered repellents were Halt and Bear Skunker. Attempts to test rock salt fired from a shotgun were discontinued, when the necessary range and accuracy at distances greater than 10m could not be achieved due to ballistic problems associated with the weight of the salt load.

Test site conditions prevented accurate determination of bears that were deterred from closely approaching a specific tray because of its odor. Therefore, reactions to stimuli were only recorded when bears approached to within 2m of a test tray.

Reactions to stimuli were recorded by scoring each bear's approach to a tray and subsequent type of response to the stimulus. Approaches were scored as direct (no visible hesitation during approach) or indirect (visible hesitation). The type of test response was scaled from 1 to 4 (repel to charge); scores had slightly different meanings, depending on whether the test stimulus was passive or active (Appendix 12). Also recorded were the length of time spent at each tray and the location the bear travelled to after being deterred or repelled by a stimulus.

Data were entered into the University of Montana's Dec-20 Computing System, and most of the analyses were done using the Statistical Package for the Social Sciences (SPSS, Nie et al. 1975). Analyses of test responses were limited by the small data base. Testing and analyses during this baseline study were exploratory, serving to build a foundation for further tests. Analysis of results was focused on the effectiveness of the test stimuli and on possible reasons for response differences between age classes and individual animals.

RESULTS

General Use of Site and Test Trays

Of 30 bears identified and tested, 9 were marked with eartags (Appendix 8). Only 1 of the marked bears was a female; 33% were adults, 67% were subadults, and none were cubs. The division by age class was approximately reversed for unmarked adults and subadults.

An average of 8 different bears visited the site per night (Table 7). Approximately 57% were adults, 34% subadults, and 16% cubs. An additional 4 to 5 bears were seen too briefly, or at too great a distance, to describe. These bears were included in daily counts, and when possible, an age class was assigned.

Use of the site by family groups remained consistent throughout the observation period (Table 7). The number of adult and subadult bears using the site decreased following the second and first period,

TABLE 7. Mean number of bears of certain age classes using the dump each night for each test period.

TEST PERIOD	NUMBER OF TEST NIGHTS	NO. OF BEARS USING DUMP EACH NIGHT						
		$\bar{x}$ Bears Each Night				% of Total Bears		
		All	Adult	Subadult	Cub	Adult	Subadult	Cub
All periods (9/22-11/1)	21	8.4	4.8	2.9	0.8	57	34	9
Period 1 (9/22-26)	5	13.8	7.2	4.8	0.8	56	38	6
Period 2 (9/27-10/2)	6	9.7	6.2	2.5	1.0	64	26	1
Period 3 (10/11-13)	3	5.0	2.0	2.0	1.0	40	40	20
Period 4 (10/15-18, 10/30)	5	4.6	2.6	1.4	0.6	57	30	13
Period 5 (10/31-11/1)	2	8.0	4.0	4.0		50	50	

respectively, and then remained relatively consistent until the last period when, for both classes, numbers increased slightly. Certain bears used the site more consistently than others. Only 4 bears were present on over 45% of the test days (Appendix 13).

The seasonal availability of natural foods in the area appeared to influence the number of bears using the site. The decrease in numbers following the first and second period coincided with the ripening of berries at higher elevations, and the reduced availability of berries in areas around the dump. An increase in the percent of scats found on the site and around the dump which contained only garbage suggested that the bears still using the site were subsisting almost entirely on the dump. Earlier, many of the bears appeared to be using the dump in conjunction with natural foods in the area. The first snowfall occurred during 5 October to 8 October. Bears probably also left the site to initiate denning activities. Following a heavy snowfall on 28 and 29 October, use of the site increased slightly, possibly due to the reduced availability of food elsewhere. Though undocumented, on nights when the garbage pile had been buried by the bulldozer, both the number of bears using the site, and overall time spent at the site by bears appeared to decrease.

Generally, all test trays were visited as the night progressed. The sequence of visits to trays appeared to be a function of their location. Trays closest to the timber or to the garbage pile were used first. Trays were visited 475 times. The number of visits to trays, and length of time spent at each, were dependent upon the type of stimulus in the tray and on the individual bears visiting the trays.

The control trays and other stimuli that evoked minimal deterrent responses (less than 25% were deterred), were visited by approximately equivalent numbers of bears per period and the bears stayed for an average of 1.5 to 2.0 minutes (Table 8). However, when compared to the controls, the number of bears deterred and the number of visits, were usually slightly higher than to trays with stimuli placed around them, and higher still for those with the same stimulus mixed in the bait. This suggested that certain bears were at least initially wary of or deterred by baits contaminated with a novel odor, and yet a greater number deterred by a novel taste.

For the stimuli that deterred most bears, visits and the time spent at trays were variable. Individual bears and bears of certain age classes exhibited different tolerances to certain stimuli. The patterns of responses generally fell into 3 categories: low numbers of bears visited a tray and stayed only short periods of time; low numbers visited a tray and stayed long periods of time; or high numbers visited a tray and stayed only short periods of time.

TABLE 8. Mean number and length of visits (minutes), number of visits by certain age classes, and visits during each test period, to each stimulus.

STIMULUS	NUMBER OF TEST NIGHTS	NUMBER OF VISITS	$\bar{X}$ VISITS PER NIGHT	$\bar{X}$ TIME PER VISIT	% VISIT PER AGE CLASS			NUMBER OF VISITS TO EACH STIMULUS BY TEST PERIOD				
					Adult	Subadult	Cub	Period 1 9/22-26	Period 2 9/27-10/2	Period 3 10/11-13	Period 4 10/15-18, 10/30	Period 5 10/31-11/1
Control 1	21	52	2.5	1.7	42	50	8	26	12	4	8	2
Control 2	16	29	1.8	2.1	55	31	14	1	16	6	3	4
Boundary--on	5	25	5.0	1.8	52	44	4	25				
Boundary--around	5	18	3.6	1.9	28	72		18				
Mothballs--on	5	24	4.8	3.4	50	50		24				
Mothballs--around	5	19	3.8	1.6	32	68		19				
Technichem--on	5	19	3.8	2.0	32	68		20				
Technichem--around	5	33	6.6	2.1	52	48		33				
Urine, Male--on	5	23	4.6	0.8	39	57	4	23				
Urine, Male--around	5	37	7.4	2.2	57	41	2	37				
Urine, Fem--on	6	8	1.3	0.5	50	38	12		8			
Urine, Fem--around	6	16	2.6	2.1	69	6	25		16			
Ammonia, Parsons--on	6	6	1.0	1.4	33	67			6			
Ammonia, Parsons--around	6	18	3.0	0.7	50	44	6		18			
Ammonia, Wizard 1--on	8	19	2.3	1.8	68	32				3	16	
Ammonia, Wizard 2--on	8	22	2.8	1.2	50	27	23			5	17	
Skunker--on	6	24	4.0	1.5	54	42	4		23			
Skunker--control	13	13	1.0	0.8	15	85			4		3	6
Skunker--trigger	13	37	2.8	---[a]	41	49	10		11			
Halt--control	9	12	1.3	2.6	50	33	17		8	4		
Halt--trigger	10	21	2.1	---	48	52				8	7	6

[a]Not considered.

Visits to trays by subadults were approximately equal to visits by adults, each making up 47% of the total (Appendix 14). This tended to be slightly higher in proportion to the number of subadults observed using the site, and was due to adult bears commonly causing subadults to move from 1 tray to another. Visits by family groups were generally under-represented, as these bears usually did not compete for the trays. Perhaps because they were disturbed less often, adults averaged longer times on the test trays (mean=2.5 minutes) than subadults (mean=1.4 minutes).

Responses to Passive Tests by All Bears

Bears approached the trays by direct investigation (no visible hesitation) in 87% of the visits (Table 9). Bears displayed a higher frequency of indirect investigations (visible hesitation) when approaching trays with Parson's Ammonia, male human urine, and Wizard Ammonia on the bait. These were approached directly during only 33%, 52%, and 68% of the tests, respectively.

Responses to passive stimuli indicated that the male human urine and full strength Parson's Ammonia applied on baits were the most effective stimuli tested. Bears that approached these trays walked away without eating, or ate briefly then left, during 78% and 67% of the tests, respectively (Table 9). High numbers of bears visited the former trays and usually stayed only a short time. Only a few bears visited baits with Parson's Ammonia on them, suggesting that the odor alone

TABLE 9. Type of approach response (%) and test response (%) to each stimulus by all bears.

STIMULUS	NUMBER OF TESTS	APPROACH		TEST RESPONSE[a]			
		Indirect investigation	Direct investigation	Deterred/repelled 1[b]	Deterred/repelled 2[c]	Not deterred/repelled 3[d]	Not deterred/repelled 4[e]
Control 1	52	10 (19)[f]	42 (81)	8 (15)	5 (10)		39 (75)
Control 2	29	3 (10)	26 (90)	2 (7)	2 (7)		25 (86)
Boundary--on	25	2 (8)	23 (92)	4 (16)	3 (12)		18 (72)
Boundary--around	18	2 (10)	16 (90)	1 (6)		2 (11)	15 (18)
Mothballs--on	24	2 (8)	22 (92)	3 (13)	2 (8)		19 (79)
Mothballs--around	19		19 (100)		1 (5)		18 (95)
Technichem--on	19	2 (10)	17 (90)	1 (5)			18 (95)
Technichem--around	33	2 (6)	31 (94)	3 (9)			30 (91)
Urine, Male--on	23	11 (48)	12 (52)	14 (61)	4 (17)	1 (4)	4 (17)
Urine, Male--around	37	4 (10)	33 (90)	9 (24)	5 (14)	1 (3)	22 (60)
Urine, Fem--on	8	1 (12)	7 (88)	3 (38)	1 (12)		4 (50)
Urine, Fem--around	16	1 (6)	15 (94)	1 (6)	1 (6)		14 (88)
Ammonia, Parsons--on	6	4 (67)	2 (33)	3 (50)	1 (17)		2 (33)
Ammonia, Parsons--around	18	4 (22)	14 (78)	5 (28)	5 (28)		8 (44)
Ammonia, Wizard 1--on	19	6 (32)	13 (68)	3 (16)	3 (16)		13 (68)
Ammonia, Wizard 2--on	22	3 (14)	19 (86)	3 (14)	2 (9)	4 (18)	13 (59)
Skunker--on	24	3 (13)	21 (88)	3 (13)	2 (8)	1 (4)	18 (75)
Skunker--control	13		13 (100)		4 (31)	1 (8)	8 (62)
Skunker--trigger	37		37 (100)	12 (32)	8 (22)	8 (22)	9 (24)
Halt--control	12		12 (100)	3 (25)			9 (75)
Halt--trigger	21	3 (14)	18 (86)	17 (81)	1 (5)	1 (5)	2 (10)

[a]Test response codes (all stimuli were passive except the triggered Skunker and Halt):

Passive Stimuli	Triggered Stimuli
[b]1 = Walk away; no eat	[b]1 = Run away
[c]2 = Eat briefly; leave	[c]2 = Walk away
[d]3 = Eat hesitantly	[d]3 = Orient to, eat hesitantly
[e]4 = Eat continuously	[e]4 = Orient to, eat continuously

[f](Percent).

deterred some bears. Those not deterred generally stayed low to average lengths of time, indicating that certain bears tolerated the substance.

Placement of these stimuli (male urine and Parson's Ammonia) around baited trays deterred bears during only 38% and 56% of the visits, respectively (Table 9). High numbers of bears visited baits with male urine around them, staying average lengths of time, while an average number of bears visited trays with the Parson's Ammonia around them, these only staying short periods, again suggesting that for many bears the odor of the latter was noxious.

The only other passive stimulus that appeared to have deterrent potential was the female human urine applied on baits. Although bears were deterred only 50% of the time, low numbers of bears visited the trays. Placement of this stimulus around trays deterred bears during only 12% of the visits.

Passive stimuli that did not appear to have deterrent potential were the Bear Skunker, Boundry, Halt, mothballs, Technichem, and Wizard Ammonia (ammonia with a detergent additive). The Wizard Ammonia and the passive Bear Skunker stimuli deterred bears during 25% to 33% of the tests (Table 9). The rest of the stimuli deterred bears less than 25% of the time. With the exception of the Technichem, a stimulus mixed with a bait deterred bears more often than when applied around a bait.

Responses to Passive Tests by Age Category and Individual Bear

Visits and responses to specific stimuli by different age classes were not equally distributed (Table 10). Differences in the responses of adults and subadults to the most effective stimuli were compared. Average numbers of visits were made by adults and subadults to baits with male human urine on or around them; however, subadults were more often deterred by the stimulus. During visits, adults and subadults were deterred by male urine on a bait 67% and 85% of the time and by male urine around the baits 23% and 47% of the time, respectively (Table 10).

Few bears of either age class visited trays with Parson's Ammonia on them. Visits by adults were proportionately lower than visits by subadults. Adults and subadults were deterred during 50% and 75% of the visits, respectively. Average numbers of bears in both age classes visited trays with this stimulus around them; adults were deterred during 67% of the visits and subadults were deterred 38% of the time.

Trays with human female urine on the bait were visited by low numbers of adults and subadults. Proportionately, numbers of visits by subadults were lower than visits by adults, and 25% and 100% were deterred, respectively. While average numbers of adults and only 1 subadult visited trays with the stimulus around them; 18% of the adults were deterred, and the subadult was not.

TABLE 10. Type of test response to each stimulus by bears of certain age classes.

STIMULUS	ADULT					SUBADULT					FAMILY GROUP				
	Number of tests	Test Response[a] 1[b]	2[c]	3[d]	4[e]	Number of tests	Test Response 1	2	3	4	Number of tests	Test Response 1	2	3	4
Control 1	22	3(14)[f]	2(9)		17(77)	26	3(11)	2(8)		21(81)	4	2(50)	1(25)		1(25)
Control 2	16	1(6)	2(13)		13(81)	9	1(11)			8(89)	4				4(100)
Boundary--on	13	3(23)			10(77)	11	1(9)	3(27)		7(64)	1				1(100)
Boundary--around	5	1(20)			4(80)	13			2(15)	11(85)					
Mothballs--on	12	1(18)	1(8)		10(84)	12	2(17)	1(8)		9(75)					
Mothballs-around	6		1(17)		5(83)	13				13(100)					
Technichem--on	6	1(17)			5(83)	13				13(100)					
Technichem--around	17	2 (12)			15(88)	16	1(6)			15(94)					
Urine, Male--on	9	4(45)	2(22)		3(33)	13	10(77)	1(8)	1(8)	1(7)	1		1(100)		
Urine, Male--around	21	3(14)	4(19)		14(67)	15	6(40)	1(7)	1(7)	7(46)	1				1(100)
Urine, Fem--on	4	1(25)			3(75)	3	2(67)	1(33)			1				1(100)
Urine, Fem--around	11	1(9)	1(9)		9(82)	1				1(100)	4				4(100)
Ammonia, Parsons--on	2		1(50)		1(50)	4	3(75)			1(25)					
Ammonia, Parsons--around	9	4(45)	2(22)		3(33)	8	1(12)	2(25)		5(63)	1		1(100)		
Ammonia, Wizard 1--on	13	1(8)	1(8)		11(84)	6	2(34)	2(33)		2(33)					
Ammonia, Wizard 2--on	11	1(9)		2(18)	8(73)	6	2(34)	2(33)		2(33)	5			2(40)	3(60)
Skunker--on	13	3(23)	1(8)		9(69)	10	1(10)	1(10)		8(80)	1			1(100)	
Skunker--control	2		1(50)		1(50)	11		3(27)	1(9)	7(64)					
Skunker--trigger	15	5(33)	4(27)	2(13)	4(27)	18	7(39)	4(22)	4(22)	3(17)	4			2(50)	2(50)
Halt--control	6	1(20)			5(80)	4	2(50)			2(50)	2				2(100)
Halt--trigger	10	10(100)				11	7(64)	1(19)	1(9)	2(18)					
Total	223					223					29				

[a]Test response codes:

Passive Stimuli	Triggered Stimuli
b_1 = Walk away; no eat	b_1 = Run away
c_2 = Eat briefly; leave	c_2 = Walk away
d_3 = Eat hesitantly	d_3 = Orient to, eat hesitantly
e_4 = Eat continuously	e_4 = Orient to, eat continuously

[f](Percent).

Adult bears made an average number of visits to baits with Wizard Ammonia on them and were deterred approximately 13% of the time. Subadult use of these trays was low; bears were deterred during 67% of the visits. Conversely, the number of visits to the Skunker control trays, and trays with Skunker mixed with the bait, was low and high respectively; adults were deterred proportionately more often than subadults by both tests.

Only adult (AD) Bears 4 and 12, and subadult (SA) Bears 5 and 10, were present on over 45% of the test days (Appendix 13). These bears accounted for about 38% of the visits to the test trays (Appendix 14). Recurrent use of specific trays by certain bears suggested that some bears were more tolerant of noxious stimuli than others. Bears 10 (an aggressive male), and 12 (thought to be a dominant male) accounted for 48% of the visits to trays with male urine on the bait. Bear 12 accounted for 60% of the deterred visits to this stimulus. Only 5 bears visited trays with the Parson's Ammonia on the bait; 33% of the visits were by Bear 9 (SA), and 100% of the non-deterred visits were by Bears 9 and 40 (AD). Both bears appeared to be low-ranking animals that reacted submissively to the advances of most bears. Only 6 bears visited baits with the female urine on them; 38% of the visits were by Bear 5; 100% of the deterred responses were by Bears 5 and 4 (also low-ranking bears). Of the 7 bears that visited trays with female urine around them, only Bear 12 was deterred. In tests of the Wizard Ammonia, 100%

of the non-deterred responses were by the low-ranking Bear 40 and the generally non-competitive Bears 22 and 23 (female with cubs).

Responses to Active Tests by All Bears

Bears were allowed to eat at the remote-triggered baits until they could be sprayed in the eyes. No aggressive reactions were displayed in response to any of the triggered tests. The triggered Skunker repelled bears 54% of the time (Table 9). When repelled, 25% of the time bears backed off, then returned to the same tray in less than one minute; 50% went immediately to another tray or to the garbage pile (Appendix 15). The remaining 25% left the site, returning on the average, 11 minutes later. Bears often returned to the triggered Skunker tray shortly thereafter.

Bears were repelled by the triggered Halt during 18 of 21 tests (Table 9). When repelled, bears usually ran 20 to 25m toward the timber, then stopped briefly to paw at their eyes. Then, during 61% of the tests, they ran into the timber without looking back; during 39% of the tests, they went directly to the garbage pile, another tray, or the site perimeter (13% each; Appendix 15). During the 3 tests where bears were not repelled, the spray appeared to have contacted the animals in the upper neck region. These bears had been hit with triggered stimuli several times before and when sprayed, they merely hesitated briefly, then resumed eating.

When bears were repelled by Halt, during 86% of the tests the animals returned and resumed foraging at the site on the average, 17 minutes later. In the remaining 3 cases, 1 bear returned 24 hours later, and 2 were never seen again. (However, these 3 tests were delivered during the last 2 days of testing.) Upon re-entering the site, 50% first returned to the garbage pile; the other 50% returned to another test tray. Bears generally did not return to the triggered Halt tray until some time later in the evening.

Responses to Active Stimuli by Age Category and Individual Bear

Adult and subadult bears reacted similarly to tests of the triggered stimuli. Average numbers of bears of each age class visited the trays (Table 10). The triggered Skunker repelled 60% and 61% of the adult and subadults bears, respectively. During 4 tests of the Skunker trigger on cubs, none were repelled. Adults and subadults were repelled by the triggered Halt during 100% and 73% of the tests, respectively.

Visits by Bears 4 (AD), 5 (SA), 35 (SA), and 21 (cub), made up 65% of the triggered Skunker tests (Appendix 14); 27% of the trials were by Bear 5. Although this low-ranking bear was repelled in 70% of the tests he visited the tray repeatedly.

Bears 5, 10 (SA), and 44 (AD) accounted for 67% of the visits to the triggered Halt trays. The latter 2 were aggressive bears. The 3 tests where bears were not instantly repelled were on Bears 5 and 10

(Table 9).

All trays were checked at 0700 each morning, 11 hours after they had been placed at the site. Only the Parson's Ammonia mixed with the bait consistently reduced bait consumption during the 11 hours each night that the baits were available to the bears. Generally, trays were empty each morning except for trays with the Parson's Ammonia in them. These always remained at least half full. Exceptions to the above were trays with human female urine and Wizard Ammonia on them, and the triggered Skunker tray, in which a small amount of bait remained in 33%, 13%, and 17% of the cases, respectively.

DISCUSSION

Animals function best where the predictability of the environment is maximized and stress is minimized (Geist 1970, McArthur 1979). Previous experience, as well as an immediate stimulus, determine behavior. Learning is the modification of current behavior by previous experience in the same situation (Scott 1972). Consistent use of methods that reduce the attraction of bears to human-associated food sources should reduce human-bear conflicts, minimizing stress on bear populations.

Bears initially approach human-linked situations with trepidation (Tate and Pelton 1979, Stenhouse 1982). Effective repellents and deterrents should prevent naive bears from acquiring unwanted behaviors, and stop bears that already exhibit undesirable behavioral patterns. Repeated repellent or deterrent treatments should deter bears from the action permanently through learning (e.g. aversive conditioning).

During studies of black bears in the Smokies, Tate and Pelton (1979) observervered that bears varied in the extent to which they used human food sources and in their tolerance of human activities. Certain bears consistently appeared less capable of adapting to human-linked situations. During tests of deterrents and repellents Miller (1980) and Stenhouse (1982) noted repeated returns by specific bears. Miller further remarked that certain individuals could not be deterred or repelled.

During this study similar differences between bears relative to their ability to tolerate human-linked situations, were reflected in their use of the dump site and responses to test stimuli. These differences, combined with environmental influences such as seasonal changes in natural food availability and weather extremes, appeared to govern the overall number of bears using the dump. Certain bears were observed consistently using the dump site; others were seen only intermittently. Beds, scats, and other bear sign found on the site and in the surrounding area, suggested that some bears relied primarily on the dump for food, while others appeared to use the site as they travelled through the area, or as an alternative food source in conjunction with natural foods in the area. Hence, during certain times of the year when bears were drawn into the area by an increased availability of natural foods, the number of bears using the dump site also increased.

Bears visiting the trays for the first time or only occasionally, were generally cautious when approaching the more noxious trays and often stayed for shorter periods. Certain bears that consistently used the site, apparently dependent on garbage as a major source of food throughout their active season, often tolerated the most noxious baits or repeatedly returned to visit the remotely triggered stimuli.

Bear activity at the garbage dump was largely regulated by social hierarchies. Responses to tests were primarily dependent on the type of stimulus, in combination with tolerances by individual bears and the behavior of other bears present at the site. Activities by dominant animals affected the trapping and tagging efforts, as well as the number of visits to, and time spent at specific -est trays by bears. Low ranking bears and family groups appeared to avoid conflict with dominant bears by using alternative, and often less optimal, food opportunities such as those presented by our culvert trap and the most noxious test trays.

Non-effective, passive deterrent stimuli were generally approached directly, and were visited by an average number of bears in a night. These stimuli deterred more bears when mixed with baits than when placed around them; suggesting that certain bears were, at least initially, wary of the chemical taste. Proportionately, numbers of visits by subadults were higher and their stays at trays shorter than for adults, because they were forced off these palatable baits by dominant animals.

Effective passive stimuli that deterred most bears were visited inconsistently, depending on the stimulus and the individual bear. In general, bears stayed at these for shorter periods. Differences in tolerance levels by age classes or individuals were evident. Certain bears would not eat from trays with certain stimuli.

Passive stimuli that deterred most bears during or shortly after approaches were the male human urine and the full strength Parson's Ammonia placed on baits. These deterred 18 of 23 bears, and 4 of 6 bears, respectively. Although proportionately more bears were deterred by the urine, high numbers of bears visited the stimulus. Few bears visited the ammonia trays; the odor cue alone was apparently effective in deterring some bears. Only the Parson's Ammonia mixed with baits consistently reduced bait consumption by deterring most bears from eating throughout the 11 hours each night that the baits were available to them. Both adults and subadults were highly deterred by these stimuli, but proportionately, subadults were more frequently deterred. The Parson's Ammonia applied around baits also appeared relatively effective. However, a higher number of bears visited these baits and many subadults appeared to tolerate the chemical odor in order to eat the bait. Although female human urine mixed in baits deterred only 4 of 8 bears, only a small number of bears visited these trays. Bears may have been deterred by the odor. All subadults, but only 25% of the adults were deterred by this stimulus.

Actively delivered Halt repelled most bears from the site. Bears generally returned within 17 minutes, but none returned initially to the same tray. Most bears sprayed with Skunker responded by merely moving to another tray or to the garbage pile. The majority returned soon afterwards to the same tray. Although most bears were initially repelled by Skunker, several subadults that consistently used the dump (and some of the most noxious test trays), were not repelled in subsequent tests; the stimulus failed to repel cubs during all tests. These bears tolerated the disturbance; the positive reward of the bait appeared to outweigh the negative effect of the stimulus.

The results of tests suggest that a combination of full strength ammonia (a taste and odor deterrent) and actively triggered Halt (a pain-inducing repellent), may turn most bears during or shortly after approaches, and subsequently deter most close approaches. Further, large-scale testing of these promising stimuli at the site is necessary. The ammonia should be placed on (or if not possible, around or near to) the food resource. Initially, consistent application of the remotely triggered capsaicin (in a form that can be accurately sprayed at bears from 10+m) will be required to repel bears that return to the site. If an additional cue is presented simultaneously with delivery of the capsaicin (such as an auditory cue), then bears may be conditioned to be repelled by presentation of this cue even if direct application of the capsaicin has not occurred.

In general, subadults appeared to be more easily deterred by noxious stimuli than adults. However, certain low-ranking individuals that used the dump consistently, often returned to use the most noxious trays. Differences in responses to stimuli between bears, such as to the male and female urine, the Skunker, and to the different tests of ammonia, may reflect the influence of hierarchical status and life experiences on bear responses, and may be important in the development of effective stimuli. Biologically meaningful stimuli such as the urine and Skunker may prove to be easily incorporated into the learning process and have wider application among individuals.

Certain bears may not be deterred unless they are physically obstructed from entering a site, or are constantly repelled with highly effective pain-inducing stimuli. Such bears may be more dependent on the food resources at the site than others. If efforts to deter bears using preventative measures fail, relocation or destruction of the animals may be necessary.

The data suggest that certain measures may reduce the attractiveness of the site to bears. Increased rates of garbage burial and consistent application of deterrents or repellents to foods at the site, may be effective in preventing initial use by naive bears and in reducing the overall number of bears frequenting the site. Increased rates of application of these preventative measures during seasons when natural foods attract bears to the area, may increase their effectiveness.

Responses to stimuli will be influenced by the individual bear, the availability of alternative food sources in the area, the palatability and nutritive value of food at the site, and the behavior of other bears in the area. Brief surveys for bear sign in areas surrounding planned or existing sites that have the potential to attract bears, may serve to predict bear behavior patterns and potential conflicts, and to develop preventative strategies.

PART IV

CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

The purpose of this project was to develop a testing format on which further studies could build and to test stimuli with potential as bear repellents and deterrents. Test conditions and stimuli were developed to address the 2 principal situations that cause human-bear conflicts: surprise encounters and bear use of human food sources. When the opportunity arose to release certain captive bears back into the wild, the possibility of aversively conditioning bears to avoid humans was also explored.

Suitability of Test Procedures

Results of this project agree with Miller's (1980) observations: laboratory tests of repellents on angry captive bears are an effective method for testing several stimuli in a short time and for distinguishing which stimuli may be effective repellents for free-ranging bears. In addition, the results of tests of problem bears before they are destroyed, allow progress to be made toward a long-term solution to the problem of human-bear conflicts.

The apparent success of the aversive conditioning program on captive problem bears suggests that this may be an effective method for initial conditioning of certain problem bears from approaching humans once released into the wild. Observation of bear behavior during laboratory tests may provide a basis for evaluating the suitability of specific bears for successful aversive conditioning programs.

By testing repellents and deterrents at dump sites, many stimuli can be can be tested on free-ranging bears without disturbing bears in critical natural habitats where they may concentrate. Dump sites also provide the opportunity for rapid further testing of promising laboratory repellents on free-ranging bears. This is a first step toward later tests on angry or surprised, free-ranging animals. Dump conditions may expose limitations of stimuli that were not apparent during laboratory tests. Where laboratory data are difficult to interpret, further tests in the field may clarify the responses.

Both the laboratory and dump situations provide opportunities for observing bear behavior. Throughout this study bears were quite predictable as individuals, but not as a group. The causes and effects of individual variation between bears in terms of responses to stimuli, humans, food, and interactions with other bears can be explored.

Summary of Results and Implications for Management

Laboratory results indicate that stimuli can be developed that will repel most bears. Halt, a product containing capsaicin, and a Bear Skunker (synthesized skunk spray)/Halt combination were highly repellent stimuli. Inclusion of an odor cue with a repellent stimulus seemed to increase its effectiveness. Effective stimuli appeared to reduce aggression and the frequency of immediate charges in a subsequent encounter. Bears that were not repelled or submissive in response to a stimulus displayed an increased frequency of aggressive interactions and immediate charges during the following encounter. Responses to test stimuli were dictated by the effectiveness of the stimulus in combination with the character of the individual bear. Certain non-aggressive bears were repelled consistently more easily than others.

With its present delivery system, Halt does not have the necessary range or accuracy to be effective on free-ranging bears. Canisters with more concentrated solutions of capsaicin and longer, wider, spray distances should be developed. By simultaneously combining additional visual, odor, or auditory cues with the use of the capsaicin, many bears may be repelled from approaching during initial or subsequent encounters without direct application of the spray.

In the laboratory, bears signalled their submissive or aggressive intentions by presenting their bodies at certain angles, making specific, repeated head movements, and making or avoiding eye contact with the tester. Similar actions by the tester appeared to have signal value for bears. The tester elicited aggression in most bears by standing and directly facing them while stomping, or by turning away from them following such a presentation. Aggressive or non-aggressive approaches were elicited by assuming a crouching, sideways stance combined with a repeated turning of the head and eyes, briefly toward and then away from the animal.

Test period data and various confrontations with captive bears following test periods, suggest that during an encounter with a bear when an immediate charge does not occur, an effective signal for communicating peaceful intentions and not eliciting an approach may be to stand sideways and to display the previously mentioned head movements. Then, while maintaining the stance and talking to the animal, attempt to leave the site.

None of 4 bears subjected to the captive aversive conditioning program and then released, has been involved in further human-bear conflicts or been harvested. The program appears to have been a success, however the ultimate fate of these bears is unknown. Observation of bear responses to tests in the laboratory appeared to provide a basis for determining the temperament of individual bears, which was correlated with their responses during the aversive conditioning program.

Successful laboratory aversive conditioning programs may require that: bears be non-aggressive, the timing of their release minimize the potential for conflicts with humans or other bears, and overconditioning during tests be avoided. Due to the introductory nature of this research, to determine the effectiveness of this approach bears should be monitored following their release. Further aversive conditioning in the wild may be necessary.

Data from the field tests indicated that certain taste deterrents applied to baits deterred most bears during or shortly after approaches, thereby reducing overall bait consumption and subsequent use. Most bears were deterred from eating by the male human urine or full strength Parson's Ammonia applied to baits; the ammonia odor appeared to deter many bears from approaching. Only the Parson's Ammonia reduced bait consumption throughout the 11 hour period each night that baits were available to bears.

Tests of the pain-inducing stimulus Halt effectively repelled bears both in the laboratory and in the field, but bears appeared to recover quickly. Although its application generally caused bears to leave the dump site, most bears returned to use the garbage pile or alternative trays within 17 minutes of the test.

A combination of the pain-inducing repellent capsaicin and full strength ammonia as a taste deterrent and constantly advertised odor deterrent, may have potential for reducing the number of initial visits by naive bears, and return visits by bears frequenting the site. Further tests of this combination should be conducted on a large scale at a dump or dumpster site. To be effective, the capsaicin must be remotely triggered and in a form that can be applied to a bear's face at ranges up to 10m. An odor or other additional cue could be added to the capsaicin to increase its effectiveness. Once hit with the capsaicin/stimulus combination, bears may then be repelled by delivery of the stimulus, whether or not they are accurately sprayed. The ammonia (to reduce bait consumption) should be applied on or as close to the attractant food source as possible.

Use of the site and responses to test stimuli appeared influenced by the availability of alternative foods in areas surrounding the site, dominance activities by bears in the area or using the site, and differences between individual bears. Certain (often low-ranking) bears that may have been more dependent on the dump for food than others, repeatedly returned after being sprayed with repellent stimuli. This suggests that certain bears may not be deterred from subsequent approaches, and perhaps, that aversive conditioning with repellents may not be feasible on them. Relocation or destruction of these bears may be necessary.

General Recommendations for Reduced Human-Bear Conflicts

Repellents and deterrents should be used as tools to aid, not substitute for, preventative measures that reduce the potential for human-bear conflicts. Situations that create the potential for problems, and therefore the need for repellents and deterrents, can be identified and must be minimized, to achieve overall success. To effectively reduce conflicts on a large scale, three basic preventative management efforts are needed:

1. the reduction of bear access to human food sources, especially garbage, on public and private lands;

2. increased efforts to educate the public as to the effect of their activities on bear populations; and

3. increased agency commitment and interagency cooperation in reducing conditions that are attractive to bears.

These are not exclusive and should be applied in combination with each other (and deterrents and repellents if necessary) where the potential for human-bear problems exists.

Where feasible, bears should be physically excluded from sites that pose a constant attraction. Electric fencing provides the most effective option at present, but where it would not be feasible or the cost would be prohibitive, implementation of repellent and deterrent methods should be considered.

Bear access to garbage must be minimized wherever possible. Proper attention to garbage removal should include: accelerated pickups or burial during seasons when bear use of natural foods in the area increases; leaving little garbage for overnight bear use; splitting garbage bags when dumped so that "shy" bears cannot handily take these "purses" off the site into the surrounding cover (where additional bears may be introduced to the resource); and locating garbage piles and dumpsters away from cover. Contingent on further research, regularly applying effective taste and odor deterrents at garbage sites may also reduce the attractiveness of the site. Deterrence of certain bears may require consistent application of a pain-inducing stimulus until the bears no longer visit the site. Periodic reapplication of pain-inducing stimuli may be necessary.

Public education programs should be intensified. The public must realize the critical impact that bear use of human food sources has on human-bear coexistence. This is a difficult, delicate, task to address because it involves personal attitudes and rights. The problem would not be overstated if agencies were to emphasize the fact that feeding a bear is almost equivalent to killing it. The public must also understand that repellents and deterrents do not necessarily make them or their camps "bear proof"; that proper food handling procedures must still be followed; and that incorrect use of repellents, such as using repellents as a back-up to allow closer viewing of bears, will place further stress on bear populations. Increased opportunities to view bears from a distance, as has been done in Glacier National Park, may help to increase acceptance of these restrictions.

Agencies must take a positive, not a defensive position in managing bears. Preventative measures that reduce the potential for bear problems should be incorporated into planning documents. Such actions have significantly reduced problems in our national parks, but should not stop at agency lines, as they frequently do now. Interagency cooperation should increase public acceptance and cooperation with these efforts.

"Bear-proof" procedures for food handling (including garbage) and food storage, and against bear feeding, should be implemented and enforced on both public and private lands. Violators must be effectively disciplined or fined.

Further research on repellents, deterrents, and aversive conditioning methods should be thoroughly coordinated and documented, and information gathering should be standardized between agencies. Investigations should initially be concerned with developing methods that are flexible and can be used in several types of situations, are cost effective, are easy to operate, and require a minimum of maintainance.

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APPENDICES

APPENDIX 1. Descriptions of test stimuli.

Ammonia: Parson's Ammonia. Full strength ammonia. Ingredients: Ammonium hydroxide solution, Ethoxylated alkyl alcohol, Perfume, Color, Clarifying Agent, salts (inert), contains 0% Phosphorus per recommended use. Distributed by Armor and Dial, Phoenix, AZ.

Wizard Ammonia. Ingredients: approximately 6% ammonia, 94% household detergent. Distributed by Alliance Int. Sales Ltd., Vancouver, B.C.

Technichem Bear Repellent: A secret formula designed to deter bears from eating food items to which it has been applied. Distributed by Technichem Corp., Boise, ID.

Bear Skunker: A potential natural repellent for bears in a spray bottle. Ingredients: the active components of natural skunk scent. Distributed by Bear Country Products, Orinda, CA.

Bear Tape: A one-minute tape recording of a caged male grizzly bear vocally challenging a person outside its cage.

Boundary: A commercial, aerosol, dog and cat deterrent, for application to "forbidden" areas. Active Ingredients: 1.9% methylonyl Ketone; 0.1% related compounds, 98% inert ingredient. Distributed by Lambert Kay, Cranbury, N.J.

Shield: A commercial, aerosol, non-lethal, riot control agent. Ingredients: 1% orthochlorobenzalmalononitrile (CS) in a non-toxic solvent. Distributed by We Care America, Chesterfield, MO.

Radio Music: A one-minute recording of instrumental and vocal, rock and roll music. (Donna Summers, "Bad Girls").

Flare: A handheld, commercial highway flare, that ignites when struck. Distributed by Olin Corp., Peru, Indiana.

Halt: A commercial, aerosol, dog repellent. Ingredients: .35% Capsaicin (derived from Oleoresin of Capsicum), 99.65% inert ingredients. Distributed by Animal Repellents, Griffin, GA.

Human Urine: Male and female: less than one week old, kept cold, and in airtight canning jars until use. Donated by friends.

Appendix 1. (Continued).

Moth Balls: Enoz Brand. Ingredients: 100% Naphtalene. Distributed by Home Products Inc., St. Louis, Mo.

Miracle Brand. Ingredients: 100% naphtalene. Distributed by The Sterling Co., St. Louis, Mo.

Air horn: Falcon 3 Commander: A moderate, to high pitched pocket-sized, portable, freon-powered horn. Distributed by Falcon Safety Products, Inc., Mountainside, N.J.

Umbrella: A handheld, black umbrella, that opens to approximately .75m.

APPENDIX 2. Bears tested during captive bear studies, June, 1981, to December, 1982.

BEAR NO.	COAT COLOR	WEIGHT (LBS.)	AGE	SEX	DEPREDATION	CAPTURE	DISPOSITION
Black Bear							
01 (588-Ace)	Black	350	3.5	M	killed penned steer	MDFWP, Lincoln, MT	relocated to Olympic Game Farm, WA.
02 (331-Barney)	Black	125	9.5	M	campground nuisance	MDFWP, Thompson Falls, MT	relocated to Lolo Pass Area, MT
03 (107-Cub)	Chocolate brown; small white on chest	75	1.5	F	orphan; root cellar break-in	Conf. Salish & Kootenai Tribes Flathead Reservation, MT	relocated to Flathead Reservation, MT
04 (04-Davey)	Chocolate brown; large white on chest	125	4.5	M	killed calf	Conf. Salish & Kootenai Tribes Flathead Reservation, MT	destroyed
05 (266-Easy)	Chocolate brown	100	4.5	F	roadside panhandler	Glacier National Park, MT	relocated to Bear Country USA, S.D.
06 (06-Fredda)	Liver brown; large white on chest	110	10.5	F	killed calf	Conf. Salish & Kootenai Tribes Flathead Reservation, MT	destroyed
Grizzly Bear							
07 (81-George)	Chocolate brown/ silver-tipped	485	4.5	M	campground nuisance; cabin and vehicle break-ins	Yellowstone National Park, MT	destroyed
81 (531-Cub)	Chocolate brown/ silver-tipped	85	Cub	F	orphan; campground nuisance	MDFWP, Cabinet Mountains Area, MT	relocated to Swan Valley Area, MT
82 (530-Cub)	Chocolate brown/ silver-tipped	75	Cub	F	orphan; campground nuisance	MDFWP, Cabinet Mountains Area, MT	relocated to Swan Valley Area, MT

APPENDIX 3. Test observations- Laboratory Data Form.

BEAR:
OBSERVER:
TESTER:
DATA:

TEST:
T NUM:
T REP:

TEMP:
OUTTEMP:
OUTCLOUD:
OUTWIND:

TEST RESPONSE	1	2	3	4	5
IR					
TR					
CR					
RR					

HR/MIN	TEST PER	OA	GBP	TA	TP	HP	HO	EP	VOC	FFP	HFP	MISC	NOI	RM/QUAD	IA	TFL	BEGR	TOTR	COMMENTS

APPENDIX 4. Labels of variables on Laboratory Data Form

Abbreviation	Explanation
BEAR	ID number for bear
CUB	ID number for cub in family
DATE	Julian date
HOUR	Time of test (24 hr.)
MINUTE	Time of test
OUTTEMP	Outside temperature conditions
OUTCLOUD	Outside cloud conditions
OUTWIND	Outside wind conditions
TEMP	Temperature inside cell (Fahrenheit)
TPER	Test condition
TEST	Repellent tested
OA	Overall Activity
GBP	Gross Body Position
HP	Head Position
HO	Head Orientation
EP	Ear Position
VOC	Vocalizations
FFP	Front Feet Positions
HFP	Hind Feet Positions
MISC	Miscellaneous
NOISE	Outside Noises
IA	Initial Angle
IR (1-5)	Initial Response
TR (1-5)	Test Response
CR (1-5)	Continued Response
RR (1-5)	Recharge Response
IR1, TR1, CR1, RR1	Response Strength
IR2, TR2, CR2, RR2	Response Type
IR3, TR3, CR3, RR3	Response Angle
IR4, TR4, CR4, RR4	Response Delay
IR5, TR5, CR5, RR5	Seconds Delay
ROOM	Room
QUAD	Quadrant
BEGR	Begin relax--min.
TOTR	Total relax--min.
TFC	Time to first charge--seconds
TNUM	Test number
TREP	Repetition number of test

APPENDIX 5. Values of variables on Laboratory Data Form.

BEAR
- (0) Ace--1981
- (1) Ace--1982
- (2) Barney
- (3) Cub--BB
- (4) Davey
- (5) Easy
- (6) Fredda
- (7) George
- (81) Cub #1
- (82) Cub #2

OUTTEMP
- (1) Hot
- (2) Warm
- (3) Cool
- (4) Cold
- (9) No data

OUTCLOUD
- (1) Clear
- (2) Patchy clouds
- (3) Overcast
- (4) Low clouds
- (5) Intermittent rain
- (6) Rain or sleet
- (7) Snow
- (8) Clear with full moon
- (9) No data

OUTWIND
- (1) No wind
- (2) Light wind
- (3) Moderate wind
- (4) High wind
- (9) No data

TPER
- (0) 30 Min. Pre-test
- (1) 30 Min. Post-test
- (2) 30 Min. Pre-control
- (3) 30 Min. Post-control
- (4) No above test
- (5) Test
- (6) Recharge response
- (7) Reapproach
- (9) Baseline

TEST
- (0) Control
- (1) Umbrella
- (2) Flare
- (3) Halt
- (4) Skunker/Halt
- (5) Water
- (6) No above
- (7) Skunker
- (9) Baseline
- (-1) Boat horn
- (-2) Bear tape
- (-4) Rock & roll music
- (-6) Foot stomp
- (-8) Shield

IA
- (0) 0 degree angle
- (1) 30 degree angle
- (2) 60 degree angle
- (3) 90 degree angle
- (4) 90 degree angle
- (9) No data

IR1, TR1, CR1, RR1
- (0) No intensity
- (1) Weak
- (2) Moderate
- (3) Strong
- (9) No data

IR2, TR2, CR2, RR2
- (0) Did not charge
- (1) Repel
- (2) Submissive, no response
- (3) Aggressive
- (4) Charge
- (9) No data

IR3, TR3, CR3, RR3
- (0) 0 degree angle
- (1) ≤30 degree angle
- (2) ≤60 degree angle
- (3) ≤90 degree angle
- (4) +90 degree angle
- (9) No data

IR4, TR4, CR4, RR4
- (0) Immediate reaction time
- (1) Delayed reaction time

ROOM
- (50) Snare

TFC
- (00) Immediate
- (85) Sprayed but no charge
- (88) Never charged

APPENDIX 6. Values of activity class variables on Laboratory Data Form (adapted from Miller 1980).

OVERALL ACTIVITY (OA)

(1) Sleep or quiet
(2) Elimination
(3) Eat or drink
(4) Light activity
(5) Moderate activity
(6) Heavy activity
(7) "Frozen"

GROSS BODY POSITION (GBP)

(1) Lying side
(2) Lying back
(3) Lying belly
(4) Sitting
(5) Sit crouched, hunched
(6) Standing
(7) Standing up
(8) Pull up at door
(9) No data

HEAD POSITION (HP)

(0) Head normal
(1) Head extended
(2) Head curled
(3) Hibernator position
(4) Chin on paw or tire
(5) Head down
(6) Head up
(7) Head low but level
(8) Head shake
(9) No data

HEAD ORIENTATION (HO)

(0) No special direction
(1) Sniffing object
(2) Sniffing self
(3) Eat or drink
(4) Looking up or down
(5) Looking about
(6) Directed to object
(7) Directed stare
(8) "Frozen"
(9) No data

EAR POSITION (EP)

(0) Ears relaxed or up
(1) Ears directed forward
(2) Ears mobile
(3) Ears partly back
(4) Ears flattened

VOCALIZATION (VOC)

(0) None
(1) Deep sigh
(2) Panting
(3) Groan or moan
(4) Hiss
(5) Jaw pop
(6) Chugging
(7) Growl (moderate)
(8) Growl (vigorous)
(9) No data

FRONT FOOT POSITION (FFP)

(0) Typical
(1) Extend forward, back in air
(2) Spread eagled
(3) On wall or tire
(4) Front feet in well, tray
(5) Curled or tucked
(6) Manipulating objects
(7) Scratching
(8) Split forward and back
(9) No data

HIND FOOT POSITION (HFP)

(0) Typical
(1) Extend forward, back in air
(2) Spread eagled
(3) On wall or tire
(4) In the air, wall, tray
(5) Curled or tucked
(6) Split in the air
(7) Scratching
(8) Extended back
(9) No data

MISCELLANEOUS (MISC)

(0) Snore
(1) Mouth open
(2) Lip extended and canines showing
(3) Biting
(4) Licking
(5) Yawn
(6) Sniffing air
(7) Eyes closed
(8) Digging or sweeping
(9) No data

NOISE (NOISE)

(0) None or faint
(2) Dogs barking
(3) Voices or working outside
(4) Lab door
(5) Truck, car, or motorcycle
(6) Work noises (inside)
(7) Test disturbance
(8) Airplane

APPENDIX 7. Responses to tests by test number for each bear.

BEAR	IMMEDIATE RESPONSE TO STIMULUS	N	TEST NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Did not charge	2		U[a]	U											
(1982)	Charged															
	Submissive	5		U	U									F	F	H
	Aggressive	1										F				
	Charge	8	U			U	F	C	C	C	C		F			
	Total	16														

BEAR	IMMEDIATE RESPONSE TO STIMULUS	N	TEST NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14
4	Did not charge	1							F							
	Charged															
	Repel	3			U			F								H
	Aggressive	1		U												
	Charge	9	U			U	F			F	C	C	C	C	W	
	Total	14														

[a]Stimuli tested:

C = Control
F = Flare
H = Halt
S = Skunker
S/H = Skunker/Halt
U = Umbrella
W = Water

APPENDIX 7. (Continued).

BEAR	IMMEDIATE RESPONSE TO STIMULUS	N	TEST NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
5	Did not charge	13						F	F	F	S/H	S/H	S/H		S		S	S	H		H	H	U
	Charged																						
	Repel	3												S/H		S				H			
	Charge	5	C	C	C	C	F																
	Total	21																					

BEAR	IMMEDIATE RESPONSE TO STIMULUS	N	TEST NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
6	Did not charge	14	C	C	C	C					S/H	S/H	S/H	S/H	H	H	H	H	H				H
	Charged																						
	Repel	4						F	F												H	H	
	Submissive	1								F													
	Aggressive	2					F													H			
	Total	21																					

BEAR	IMMEDIATE RESPONSE TO STIMULUS	N	TEST NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
7	Did not charge	5							H	H							S/H	S/H	S/H	
	Charged																			
	Repel	4					H	H								S/H				S/H
	Submissive	2												C	S					
	Aggressive	3		F	F						C									
	Charge	4	F			F						C	C							
	Total	18																		

[a]Stimuli tested: C = Control; F = Flare; H = Halt; S = Skunker; S/H = Skunker/Halt; U = Umbrella; W = Water

APPENDIX 8. Black bears tested at the Sparwood sanitary landfill, Sparwood, British Columbia, August-November, 1982.

BEAR	EAR TAGS[a]				LIP TATTOO[b]	COAT COLOR	APPROXIMATE WEIGHT (LBS.) IN SEPTEMBER	AGE CLASS	KNOWN AGE	KNOWN SEX
	Left		Right							
	No.	Color	No.	Color	No.					
Marked										
01	1	white	1	orange	01	Black	130	AD	4.5	M
02	2	orange	2	white	02	Black	130	SA	3.5	M
04	4	yellow	4	orange	04	Cinnamon	175	AD	5.5	M
05	5	orange	5	yellow	05	Black	125	SA	2.5	M
06	6	white	6	yellow	06	Black	125	SA	3.5	M
07	7	yellow	7	white	07	Chocolate brown	155	AD	4.5	M
08	8	yellow	8	yellow	08	Black	175	AD	5.5	M
09	9	white	9	white	09	Black	120	SA	2.5	F
10	10	yellow	10	yellow	10	Chocolate brown	110	SA	2.5	M
Unmarked										
11	Hit on road; shot 9/30/82					Black	130	SA	2.5	M
12						Black	250	AD		
20						Black	130	AD		F
21						Liver brown	60	Cub	0.5	
22						Black	150	AD		F
23						Black	60	Cub	0.5	
30						Black	200	AD		
31						Dark brown	250	AD		
32						Black	130	SA		
33						Light brown	130	AD		
34						Black	130	AD		
35						Black	130	AD		
36						Black	100	Yrl		
37						Black	200	AD		
38						Black	175	AD		
39						Black	150	AD		
40						Black	150	AD		
41						Dark brown	225	AD		
42						Chocolate brown	175	AD		
43						Black	100	SA		
44						Black	225	AD		
45						Black	125	AD		

[a]Ear tags are large plastic cattle tags, approximately 5 x 5 cm in width, and marked on one side only.

[b]Lip tattoos are black; all on the upper lip, generally on the right side of the muzzle.

APPENDIX 9. Test observations- Field Data Form.

LOCATION:
OBSERVERS:
DATE:
TEMP:
CLOUD:
WIND:
DIRECTION:

DUMP
SET-UP: (Drawing of location of garbage and tray placement)

BAIT STATIONS: 1 (Stimulus 2 3 4 5 6 7 8 9 10

				DESCRIPTION						TEST RESPONSE									
HR IN	HR OUT	TRAY NO.	BEAR NO.	COLOR	MARKINGS	AGE CL.	WGHT	SEX	APPR	TR1 STGTH	TR2 TYPE	TR3 N	TR4 LOC	TR5 SPEED	DELAY (SEC)	DISTURB	NO. BEAR PRESENT	AM TRAY STATUS	COMMENTS

APPENDIX 10. Labels of variables on Field Data Form.

DATE	Julian Date
TEMP	Temperature--general
CLOUD	Cloud cover
WIND	Wind--general condition
DIRECTN	Wind direction (blowing from)
HOURIN	Time arrive (24 hr.)
MININ	Time arrive (60 min.)
HOUROUT	Time leave (24 hr.)
MINOUT	Time leave (60 min.)
TRAY	Repellent or deterrent tested
BEAR	ID number for individual bear
AGECLASS	Age class for bear
AGEYEARS	Age (lab estimate) of bear
SEX	Sex of bear
WEIGHT	Weight (kg.) of bear
NUMBEARS	Number of bears at site
DISTURB	Disturbance of test
APPROACH	Approach to tray by bear
TR1	Strength of test response
TR2	Type of test response
TR3	Distance (m) retreated
TR4	Location of retreat
TR5	Speed or reaction to test
TR6	Delay time (sec.) for reaction
HOURRET	Reapproach time (24 hr.)
MINRET	Reapproach time (60 min.)
RELOC	Reapproach to location
AMTRAY	Status of tray at 0700 (7 a.m.)
BEARDIST	ID of bear is cause of disturbance

APPENDIX 11. Values of variables on Field Data Form.

BEAR
- (0) Unidentified
- (99) No data

TEMP
- (1) Hot
- (2) Warm
- (3) Cool
- (4) Cold
- (9) No data

CLOUD
- (1) Clear
- (2) Patchy clouds
- (3) Overcast
- (4) High clouds
- (5) Intermittent rain
- (6) Rain or sleet
- (7) Snow
- (8) Clear with full moon
- (9) No data

WIND
- (1) No wind
- (2) Light wind
- (3) Moderate wind
- (4) High wind
- (9) No data

DIRECTN
- (0) No wind
- (1) N
- (2) NE
- (3) E
- (4) SE
- (5) S
- (6) SW
- (7) W
- (8) NW
- (9) No data

TRAY, RELOC
- (9) Garbage pile
- (1) Control 1
- (2) Control 2
- (10) Mothballs—on
- (11) Mothballs—around
- (20) Technichem—on
- (21) Technichem—around
- (30) Urine, Fem—on
- (31) Urine, Fem—around
- (40) Urine, Male—on
- (41) Urine, Male—around
- (50) Boundary—on
- (51) Boundary—around
- (60) Ammonia, Parsons—on
- (61) Ammonia, Parsons—around
- (70) Ammonia, Wizard 1—on
- (71) Ammonia, Wizard 2—on
- (80) Skunker—on
- (81) Skunker—control
- (82) Skunker—trigger
- (90) Halt—control
- (92) Halt—trigger
- (93) Area perimeter
- (94) Pit
- (95) On site
- (99) No data

AGE CLASS
- (0) Unknown
- (1) Adult
- (2) Subadult
- (3) Yearling
- (4) Family group (cub)
- (5) SA to AD
- (6) YRL to SA
- (9) No data

AGE YEARS
- (00) Unknown
- (99) No data

SEX
- (0) Unknown
- (1) Female
- (2) Male
- (9) No data

DISTURB
- (0) No disturbance
- (1) Vehicle dumping
- (2) Vehicle on site
- (3) Train
- (4) Lights from vehicle
- (5) Lights from flashlight
- (6) People on site
- (7) Bear to area
- (8) Bear to location
- (9) Our work noise
- (10) Snow
- (11) Rain
- (12) Wind
- (13) Other bear hit with test
- (14) Heavy smoke
- (88) Unknown disturbance
- (99) No data

APPROACH
- (0) Unknown
- (1) Avoid
- (2) Walk by
- (3) Sniff and walk by
- (4) Indirect investigation
- (5) Direct investigation
- (9) No data

AMTRAY
- (0) Empty
- (1) Less than half left
- (2) More than half left
- (3) Full

APPENDIX 12. Values of test responses on Field Data Form.

TR1
(1) Strong intensity
(2) Moderate intensity
(3) No intensity
(4) Weak intensity
(9) No data

TR2

Passive		Triggers	
(1)	Walk away; no eat	(1)	Run away
(2)	Eat briefly; leave	(2)	Walk away
(3)	Eat hesitantly	(3)	Orient to; eat hesitantly
(4)	Eat continuously	(4)	Orient to; eat continuously

TR4
(0) Unknown
(1) Left site
(2) Site perimeter
(3) To garbage pile
(4) To another tray
(5) To same tray
(6) To our truck
(99) No data

TR5
(0) Immediate reaction
(1) Delayed reaction
(9) No data

APPENDIX 13. Total number of days individual bears within each age class were observed at the dump site during the test periods.

ADULT			SUBADULT			FAMILY GROUP (CUBS)		
Bear	Days present N	%	Bear	Days present N	%	Bear	Days present N	%
0[a]	2	(10)	2	7	(33)	21	9	(43)
1	1	(5)	5	11	(52)	23	6	(29)
4	12	(57)	6	1	(5)			
7	3	(14)	9	6	(29)			
8	9	(43)	10	15	(71)			
12	10	(48)	11	5	(24)			
20	9	(43)	32	1	(5)			
22	6	(29)	35	8	(38)			
30	2	(10)	36	3	(14)			
31	1	(5)	43	1	(5)			
33	7	(33)	66[b]	1	(5)			
34	1	(5)						
37	1	(5)						
38	6	(29)						
39	6	(29)						
40	8	(38)						
41	6	(29)						
42	1	(5)						
44	1	(5)						
45	1	(5)						
88[c]	1	(5)						

[a]Unidentified bear.

[b]Unidentified adult.

[c]Unidentified subadult.

APPENDIX 14. Number of visits to each stimulus by individual bears within each age class.

STIMULUS	ALL BEARS	Adult N	0[a]	1	4	7	8	12	20	22	30	31	33	34	37	38	39	40	41	42	44	45	88[b]
Control 1	52	22			2		1	9					3				1	3	2				1
Control 2	29	16			1		3	3	1				1			2		1			4		
Boundary--on	25	13			1			4			1		4			2		1					
Boundary--around	18	5						3					1									1	
Mothballs--on	24	12			1	1		1					2			2	1	2				1	1
Mothballs--around	19	6			1			2			1				1		1						
Technichem--on	19	6						2						2				1				1	
Technichem--around	33	17			1		1	5			1	1	5			1	1	1					
Urine, Male--on	23	9						6					1				1					1	
Urine, Male--around	37	21			4		1	2	1		2	1	5		2		1	2					
Urine, Fem--on	8	4			1		1	1										1					
Urine, Fem--around	16	11			2			2								1	3	3					
Ammonia, Parsons--on	6	2						1										1					
Ammonia, Parsons--around	18	9	1				2	1	2								2		1				
Ammonia, Wizard 1--on	19	13			6					3								2	2				
Ammonia, Wizard 2--on	22	11			2			1		4								2	2				
Skunker--on	24	13	1		1		1	2	1							2	1		2	2			
Skunker--control	13	2			2																		
Skunker--trigger	37	15	1		5			1		2							1	1	2		2		
Halt--control	12	6			1				1				2					1					1
Halt--trigger	21	10					1	1					1					1	1		3		
Total visits by bears	475	223	3		31	1	11	47	6	9	5	2	25	2	3	10	13	23	12	2	9	4	3

STIMULUS	Subadult N	2	5	6	9	10	11	32	35	36	43	66[c]	Cubs N	21	23
Control 1	26		11		3	8			3	1			4	4	
Control 2	9	2	4			1	1				1		4	4	
Boundary--on	11	1	2		1	2	3		2				1	1	
Boundary--around	13		1			7	3		2						
Mothballs--on	12		2		2	6	1	1							
Mothballs--around	13		1		1	7	2		2						
Technichem--on	13		3			4	2	2	1			1			
Technichem--around	16	1	2			8			4	1					
Urine, Male--on	13	1	2		2	5	1		1			1	1	1	
Urine, Male--around	15	1	5			6	2		1				1	1	
Urine, Fem--on	3		3										1	1	
Urine, Fem--around	1								1				4	4	
Ammonia, Parsons--on	5		1		2		1								
Ammonia, Parsons--around	8		4		1	1	2						1	1	
Ammonia, Wizard 1--on	6		2			3			1						
Ammonia, Wizard 2--on	6		1			4			1				5	1	4
Skunker--on	10		7				1		1		1		1	1	
Skunker--control	11	2	4			1			2	2					
Skunker--trigger	18	2	10			1			5				4	4	
Halt--control	4		2			1	1						2	2	
Halt--trigger	11	1	5			4				1					
Total visits by bears	223	11	72		12	69	20	3	27	5	2	2	29	25	4

[a] Unidentified bear.
[b] Unidentified adult.
[c] Unidentified subadult.

APPENDIX 15. Reaction of bears after being deterred/repelled by each stimulus.

TEST	N	NO DATA	LEFT SITE	TO SITE PERIMETER	TO GARBAGE PILE	TO ANOTHER TRAY	TO SAME TRAY	TO OUR TRUCK
Control 1	13		1[a] (8)[b]		2 (15)	8 (62)	2 (15)	
Control 2	4		2 (50)			1 (25)	1 (25)	
Boundary--on	7					5 (71)	1 (14)	1 (14)
Boundary--around	1					1 (100)		
Mothballs--on	5			1 (20)	1 (25)	2 (40)		
Mothballs--around	1					1 (100)	1 (20)	
Technichem--on	1					1 (100)		
Technichem--around	3				1 (33)	2 (67)		
Urine, Fem--on	4		1 (25)			3 (75)		
Urine, Fem--around	2					2 (100)		
Urine, Male--on	18	2 (11)				12 (67)	4 (22)	
Urine, Male--around	14	1 (7)			4 (29)	9 (64)		
Ammonia, Parsons--on	4					4 (100)		
Ammonia, Parsons--around	10					7 (70)	3 (30)	
Ammonia, Wizard 1--on	6					6 (100)		
Ammonia, Wizard 2--on	5				3 (60)	2 (40)		
Skunker--on	5				1 (20)	3 (60)	1 (20)	
Skunker--control	4				1 (25)	2 (50)	1 (25)	
Skunker--trigger	20	1 (5)	4 (20)	3 (15)	1 (5)	6 (30)	5 (25)	
Halt--control	3		2 (67)	1 (33)				
Halt--trigger	18	1 (5)	10 (56)	2 (11)	2 (11)	3 (17)		

[a] Number of occurrences.

[b] (Percent).

APPENDIX 16. Deterrents, aversive conditioning, and other practices: an annotated bibliography to aid in bear management.

DETERRENTS, AVERSIVE CONDITIONING, AND OTHER PRACTICES: AN ANNOTATED BIBLIOGRAPHY TO AID IN BEAR MANAGEMENT

by

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Submitted to the

National Park Service

Montana Cooperative Wildlife Research Unit
University of Montana
Missoula, Montana

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INTRODUCTION

Conflicts between bears and people have escalated with the expansion of human populations and activities into areas used by bears. Human injuries and property damage by bears in parks of the United States and Canada have also increased as the number of visitors has grown (Jonkel 1970, Herrero 1976, Hastings et al. 1981). In general, when people and their activities are superimposed over bear habitat, the potential for bear-human conflicts exists. There is an increasing concern among private citizens and organizations using bear country, and the agencies responsible for bear management, to find ways to repel a bear in an encounter and to deter bears from approaching human settlements, camps, garbage dumps, and other properties. Current methods of controlling problem bears, such as relocation or destruction, have proven costly, time consuming, non-selective, and ineffective as long-term solutions to the problem (Herrero 1976, Jorgensen et al. 1978, Eager and Pelton 1979).

Knowledge of bear ecology and predictable behaviors can serve as a basis for efforts that attempt to prevent human-bear conflicts. Adjusting travel patterns of hikers and campers in parks can minimize contact between bears and people and restrictions on development in bear habitat can also reduce conflicts. Education of hikers and campers about proper conduct in bear country can do much to reduce human-bear confrontations and injuries (Martinka 1974, Herrero 1976, Meagher 1980). The bears themselves ensure that many close encounters do not result in a conflict; their senses allow them to detect people and adopt the necessary avoidance behavior.

Unfortunately, bears are often attracted to human activities and settlements. Garbage dumps, camps, and tourists that feed bears create alternative food sources for bears (Eager and Pelton 1979, Hastings 1982). Other items such as camping equipment, cleaning products, or even clothing may give off odors that attract bears; once a bear is close, an attack may occur (Cushing 1980). Effective repellent and deterrent devices would minimize the potential for human-bear conflict in many of these situations, saving bears, money, and even people.

Both repellent and deterrent stimuli should elicit avoidance responses. A review of the literature revealed inconsistent use of these terms and a general lack of distinction between them. The 2 principal situations that cause human-bear conflicts are surprise encounters and bear use of human food sources. With these applications in mind, I have distinguished the terms as follows:

1. Repellents are activated by humans and should immediately turn a bear away during a close approach or attack.

2. Deterrents should prevent undesirable behaviors by turning bears away before a conflict occurs, such as bears approaching camps, orchards, or garbage dumps. They need not be monitored or manually activated by humans.

3. Aversive conditioning should modify previously established, undesirable behavior through the use of repellents or deterrents. The conditioning must be repeated until avoidance of people or their property has been firmly established.

THE BIBLIOGRAPHY

The purpose of this bibliography is to present in one manuscript most of the available published and unpublished technical information pertaining to repellents, deterrents, and aversive conditioning that may be applicable to bear management. The study of alternatives to lethal control of bears is a relatively new field. These compiled references constitute an essential first step in identifying the state-of-the-art and data gaps, as an aid in developing meaningful new research programs. Also, the bibliography will enumerate documents that can be used by management agencies and research personnel in decision making.

I have attempted to assemble the major portion of the available literature on deterrents, repellents, and aversive conditioning specifically related to bears. I have also referenced much of the work that has been done on bear behavior, and human-bear interactions and encounters.

Most of the deterrent and aversive conditioning studies to date have focused on coyotes, deer, birds, and rats. I have referenced many of the coyote studies and a few of the studies on other species. Also included are several pertinent citations on canid behavior. Potential analogies between ursid and canid behavior and the approaches used in these behavioral studies may be of value.

Further citations include books and papers on relevant subjects ranging from aggression to data analysis methods. My intent in referencing these is to give researchers a few general starting points into the literature. Finally, I have included several bibliographical sources, the majority of which reference ursid or canid literature.

USE OF THE BIBLIOGRAPHY

Section 1--References are listed in alphabetical order and numbered consecutively. A symbol occurring after the number indicates that the reference has been annotated and is presented in Section 2. Symbols denote the following:

- OA = Original Abstract
- CH = C. Hunt Annotation
- WR = Wildlife Review Abstract
- DI = Dialog Information Retrieval Service Abstract.

Section 2--References listed with a symbol following the reference numbers in Section 1 are presented with annotations. Original abstracts were used to annotate the articles if available. However, if an abstract was too long or generally not related to the bibliography's focal interest, I substituted a more relevant annotation. Included are some references I was unable to review but that appeared to be of value.

The section encompasses most of the referenced articles pertaining specifically to deterrents, repellents, and aversive conditioning for bears, and several on bear behavior and human-bear interactions. Many I have also included many of the articles on repellents, deterrents, and aversive conditioning of coyotes.

Section 3--References are cross-indexed by species and subject. Species are grouped into 3 categories: Ursids, Canids, and General Animal. There are 6 subject categories:

- Deterrents, Repellents, Aversive Conditioning, Relocations;
- Human-Bear Interactions, Encounters;
- Behavior, Physiology;
- Management, Depredations;
- Research Techniques; and
- Bibliographies.

SOURCES

Sources searched in completing this project were:

1. Bear Bibliography Project, Cooperative Parks Study Unit, University of Alaska, Fairbanks, Alaska. (Black and Grizzly bear files; key words = repel, deter, aversive conditioning, habituation, human interaction, human encounter);

2. Denver Public Library, Fish and Wildlife Reference Service, Denver, Colorado. (3 searches = bears; coyotes; aversive conditioning, repel, deter, attract);

3. Dialog Information Retrieval Service, Maureen and Mike Mansfield Library, University of Montana, Missoula, Montana. (Data Bases: Biosis Previews, 1969-Present; C. A. B. Abstracts, 1972-Present; key words = bears, deterrents, repellents, aversion);

4. Wildlife Review (1935-Present);

5. Journal of Wildlife Management;

6. Journal of Mammalogy;

7. Several bibliographies, countless literature cited lists and references lists;

8. I also contacted many active researchers in the field to get their most recent publications.

Readers are urged to correspond with me regarding errors or omissions.

I wish to thank Mr. Cliff Martinka and the National Park Service for making this compilation possible. I also thank Dr. Fred Dean (Bear Bibliography Project), Mr. Wayne Coffey (Fish and Wildlife Reference Service), Mr. Don Wooldrige, Dr. Bart O'Gara and Dr. Joe Ball (Montana Cooperative Wildlife Research Unit), for their effective help and interest in the project. I am grateful to Kathy Smith, Robyn Meadows, and Alicia Hunt whose secretarial skills and attitudes were indispensable in completing this bibliography.

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411.OA
Walton, A. 1978. Beehive condominiums house queen bees that mate in the wild on Vancouver Island. Australian Bee J. 59(8):15-17.

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Warren, P. 1975. The bear-bee yard conflict in B.C. Prog. Rep. for May to Sept. 1975. Memo. 31 pp.

413.OA
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414.
Wells, M.C., and M. Bekoff. 1982. Predation by wild coyotes: Behavioral and ecological analysis. J. Mammal. 63(1):118-127.

415.CH
Whisenhunt, M.H. 1957. Bear-bee investigation. PP. 2-3 In: Eglin Field Deer Investigation. Fed.Aid Wildl. Restoration Proj. Fla. Game and Fresh Water Comm. Tallahassee. Unpublished.

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417.
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418.
Whittaker, P.L. 1977. Black bear management in Great Smokey Mountains National Park. Rep. to the Superintendent, Great Smokey Mountains Natl. Park. 14 pp.

419.
Wilcoxin, H.C., W.B. Dragoin and P.A. Kral. 1971. Illness-induced aversions in rat and guard: relative salience of visual and gustatory cues. Science 171:876-878.

420.
Williamson, J.F., Jr., and J.B. Whelan. 1980. Computer assisted black bear management in Shenandoah National Park. 13 + 4 pp. In press In: E.C. Meslow (ed.) Proc. of the 5th Int. Conf. on Bear Res. and Manage. 10-13 Feb. 1980. Madison, Wisc.

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424.OA
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426.CH
Wooldridge, D.R. 1978b. Studies on the effects of aerosol CN Mace and the Taser electronic stun weapon on captive and free-ranging black bears (*Ursus americanus*, Pallas). Res. Proposal prepared by Wooldridge Biol. Consulting, Burnaby, B.C., Canada. Unpublished. 40 pp.

427.CH
Wooldridge, D.R. 1980. A field study of electronic polar bear detection and deterrent devices. Rep. to the Gov. Northwest Territ. Unpublished. 45 pp.

428.CH
Wooldridge, D.R. 1980a. Lasers: their applications in the detection of polar bears in the Arctic. Phase I: Feasibility study, Churchill, Manitoba, and Calgary, Alberta. The Boreal BioCon Group Inc. Vancouver, B.C. Calgary, Alberta, Canada. Unpublished. 13 pp.

429.OA
Wooldridge, D.R. 1980b. Polar bear electronic deterrent and detection systems. In press *In*: E.C. Meslow (ed.) Proc. of 5th Int. Conf. Bear Res. and Manage., 10-13 Feb. 1980. Madison, Wisc.

430.OA
Wooldridge, D.R. 1980c. Chemical aversion conditioning of polar and black bears. PP. 167-173 *In*: C.J. Martinka and K.L. McArthur (eds.). Bears--their biology and management. The Bear Biol. Assoc. Conf. Ser. No. 3. U.S. Gov. Printing Off., Washington, D.C.

431.CH
Wooldridge, D.R. and B.K. Gilbert. 1979. Polar bear detection and deterrent systems, 1979. Rep. to the Gov. Northwest Territ. Canada. Unpublished 37 pp.

432.OA
Wooldridge, D.R. and P. Belton. 1980. Natural and synthesized aggressive sounds as polar bear repellents. PP. 85-92 In: C.J. Martinka and K.L. McArthur (eds.). Bears--their biology and management. Bear Biol. Assoc. Conf. Ser. NO. 32. U.S. Gov. Printing Off., Washington, D.C.

433.WR
Woolpy, J.H. and E.E. Ginsburg. 1967. Wolf socialization: a study of temperament in a wild social species. Am Zool. 7(2):337-363.

434.
Worley, D., K. Greer, and D. Palmisciano. 1980. Possible relationships between trichinellosis and abnormal behavior in bears. In press In: E.C. Meslow (ed.) Proc. of the 5th Int. Conf. on Bear Res. and Manage. 10-13 Feb. 1980. Madison, Wisc.

435.OA
Wynnyk, W.P. and J.R. Gunson. 1977. Design and effectiveness of a portable electric fence for apiaries. Prog. Rep. Alberta Fish and Wildl. Div. Edmonton. Unpublished. 11 pp.

436.
Young, F.M. (Compiler), and C. Beyers (eds.). 1980. Man meets grizzly, encounters in the wild from Lewis and Clark to modern times. Houghton Mifflin Co., Boston. 298 pp.

437.
Young, R.W. 1959. Brown bears do attack. Outdoor Life. 124(8):32-35+.

SECTION II - ABSTRACTS/ANNOTATIONS

5.CH
Andrews, R.D. 1964. Effects of tear gas on some mammals. J.Mammal. 45(2):321.

This paper reported the effects of tear gas on some mammals that utilized ground dens: the oppossum, raccoon, striped skunk, gray fox, and woodchuck. Tests were conducted on 3 mammals of each species, in a cage constructed to simulate a den. Tear gas did not appear to be an effective method of forcing mammals from dens; only the fox left the exposure box. Twenty-four hours after exposure the gray fox and woodchuck appeared normal, the conjunctivas of the raccoon and skunk were swollen and infected, and the cornea of one eye of the raccoon was opaque. The conjunctivas returned to normal in 3 days, the cornea in 7 days. Twenty-four hours after exposure the oppossum had difficulty breathing and in 48 hours it died. An autopsy showed widespread alveolar emphysema in both lungs. Necropsies of the other mammals revealed no resultant tissue damage.

7.WR
Anon. 1958. At long last a solution to the troublesome problem of the bears and the bees. Fla. Wildl. 12(1):14-17, 40.

Each Florida bear is worth $400 on the basis of hunter expenditures. But Florida bear country is also honey-producing country. Beekeepers were killing about 175 bears a year, or about $70,000 worth of bears. Harmless booby-trap type exploders were tried. They seemed to prevent initial attacks on hives, but not habitual attacks. Electric fences had the same effect. But properly made platforms are 100% effective. They are placed on 8-ft. cypress posts and have a 2-ft. overhang at the top. A platform should last at least 15 years. It will protect 50 hives at a cost of about $8.50 a year, which is less than the value of one hive.

9.CH
Anon. 1977. Tabasco sauce repels coyotes. Natl. Wool Grower, 67:21.

Success in reducing coyote predation on sheep, using undecovanillylamide--a synthetic compound that tastes like tabasco sauce--was reported from the University of Wyoming. The compound remained stable for 6 months. South Dakota State researchers were quoted that olfactory repellents showed little promise of being useful as deterrents. Tests in the area of taste aversion were still inconclusive, and electric fence designs were not sophisticated enough to deter predation by coyotes.

12.OA
Ayres, L.A., L.S. Chow, and D.M. Graber. 1983. Black bear activity patterns and modifications induced by human presence in Sequoia National Park [Abstract only] Proc. 6th Int. Conf. Bear Res. and Manage. Feb.28-22,1983, Grand Canyon, Ariz. p. 13.

Black bears (*Ursus americanus*) wearing radio-transmitting collars with motion-sensing devices were monitored at 15-minute intervals for 12 h and 24 h periods during the spring and summer of 1981 and 1982. Bears not in contact with humans demonstrated crepuscular activity schedules with 2 periods of activity and 2 of inactivity. In contrast, bears visiting campgrounds and utilizing anthropogenic foods were most active between 2300 h and 0200 h with only a single active period, although immature, inexperienced bears were also apt to visit the campground in the daytime. Subadult bears were more active than adults; females with cubs were more active than those without cubs. We propose, based on visual observations, that "activity" as defined by transmitter mode is highly correlated with searching for and consuming food. Bears differed strikingly in their personal activity schedules, but the availability of anthropogenic food dramatically altered these schedules, and reduced the overall time devoted to foraging for some individuals.

16.CH
Bacon, E.S. 1980. Curiosity in the American black bear. PP.153-158 In: C.J. Martinka and K.L. McArthur (eds.) Bears--their biology and management. Bear Biol. Assoc. Conf. Ser. No.3, U.S. Gov. Printing Off., Washington, D.C.

American black bears (*Ursus americanus*) were tested to quantify their response to novel objects placed in their environment. The results indicate that the level of orientation may be greater in the black bear than in other North American carnivores. The exploration of objects by the black bear is characterized by a high degree of contact with the objects. This contact consists primarily of manipulating the objects with the forepaws and chewing the objects. The intense curiosity of the black bear should be recognized and considered in the management of this species and in the evaluation of human-bear conflicts.

18.CH
Bacon, E.S., and G.M. Burghardt. 1976. Ingestive behaviors of the American black bear. PP.13-24 In: M.R. Pelton, J.W. Lentfer, and G.E. Folk, Jr. (eds.) Bears-their biology and management. Int. Union Conserv. Nat. Ser. Publ. 40, Morges, Switzerland.

Behaviors associated with the procurement and consumption of food by captive black bears were described. Three major categories were reported: foraging, predation, and consumption. Observations were documented using super-8 movie film and video-tapes. Orientation to food items involved both sight and smell. These senses appeared to be well-developed and efficiently integrated. The presence of a high degree of visual acuity and pattern discrimination in bears was suggested. The captive conditions under which tests were conducted may have affected the intensity and duration of the ingestive behaviors, but the topography and sequencing probably were unaffected.

25.CH
Barker, L.M., M.R. Best, and M. Domjam (eds.). 1977. Learning mechanisms in food selection. Baylor Univ. Press, Waco, Tex. 632 pp.

Contains 23 papers, including 17 presented at the Symposium on Learning Mechanisms in Food Selection, Baylor University, Waco, Texas, 3-5 March 1976, and an appendixed bibliography on conditioned taste aversion. Papers were classified under general headings including: the development of food preferences, food aversion learning, long-delay learning, non-gustatory aspects of food aversion learning, and pharmacological aspects of food aversion learning. The bibliography lists 632 articles. Articles are classified in a topical index under the following categories: conditioning variables, extinction and retention variables, methodological variables, physiological manipulations, comparative/field aspects, and general information.

27.CH
Barnes, V.G, Jr. and O.E. Bray. 1967. Population characteristics and activities of black bears in Yellowstone National Park. Natl. Park 199 pp.

Studies of the activities and population dynamics of the Yellowstone black bear were reported. Fourty-seven bears were captured and eartagged; 44 were classified as "roadside area" bears and 3 as "backcountry" bears. Backcountry and roadside areas appeared to be used by two separate populations of bears

Backcountry bears utilized the spruce-fir habitat type most heavily and during all seasons. Bears concentrated in whitebark pine stands in the fall. Lodgepole pine forests received little use. In 1965 and 1966, a minimum of 21 and 28 individual black bears, respectively, were observed in the backcountry. Densities in the area in which all observations occurred were 1/5.2 square miles. The average age ratio was 69% adults, the average cub-adult ratio was 30:100. and the litter size, 1.8. The sex ratio was 120:100 and appeared to coincide with the roadside population's. Three mortalities occurred, two of which happened in roadside areas. The backcountry black bear-grizzly ratio was 38:100.

A minimum of 78 black bears were seen in roadside areas. In 1965 and 1966 roadside beggars comprised 65 and 60%, respectively, of the population, campground raiders 60 and 62%, roadside beggars-campground raiders, 25 and 27%, and dump bears 12 and 7%.

Seasonal utilization of roadside areas was greatest from June through August, corresponding with heaviest visitor use. Bears concentrated in campgrounds, dumps, and along roads where traffic was slowest. Bear proof garbage containers appeared to determine bear utilization of campgrounds. Campgrounds that were non- or 50% bear-proof received heaviest use, resulting in more damages to property. The number of damages generally increased and then declined the first year after campgrounds were bear-proofed. Bear-proofing garbage cans along the roads appeared to have no effect.

Daily use of campgrounds was greatest from 8 a.m. to 4 p.m.; visits by black bears during daylight hours were most common in non- and 50% bear-proof campgrounds. Roadside begging activity peaked from 10 a.m. to noon, and from 2 to 6 p.m. Black bear use of the dumps was light, presumably due to heavy utilization by grizzlies. Feeding by black bear generally occurred from 9 a.m. to 7 p.m., whereas use by grizzlies was predominantly at night.

All bears using campgrounds eventually caused damages unless they were removed or destroyed. Roadside incidents were infrequent. Ninety-two percent of the control actions on black bears were in campgrounds. Of 71 relocation operations only 14.1% were successful. Of these, fall transplants were most successful. Bears were moved a mean distance of 19.0 miles. Homing behavior was most prevalent in adult animals.

Black bear densities in the roadside areas were 1/1.2 square miles and 1/1.0 square miles in 1965 and 1966, respectively. Average age ratio was 68% adults, and the average cub-adult ratio 28:100. Average litter size was 2.0 in June and 1.7 by September. Fourty-four percent of the roadside population was removed through human-related mortality.

Intraspecific sociability among adult bears appeared limited to the breeding season. Physical contact was avoided, aggression infrequent, and dominance usually displayed by larger animals and females with cubs using bluff charges and vocal threats.

32.OA
Beattie, J.B. 1983. Human-brown bear interactions at Katmai National Park and Reserve. [Poster session abstract] Proc. 6th Int. Conf. Bear Res. and Manage. Grand Canyon Squire Inn, Grand Canyon, Ariz. p. 59.

Interactions between brown bears (*Ursus arctos*) and people were documented at Brooks Camp, the main visitor facility and park headquarters, for 10 days during the tourist season of July and August, 1982.

Criteria for potentially dangerous interactions were developed:

1. Bear(s) 30 feet or closer to people.

2. Bear(s) agitated: running, vocal, displaying aggressive and/or unusual behavior within 100 feet of people.

3. Sow with young within 100 feet of people.

4. Three or more bears within 100 feet of people.

5. Bear(s) in human use areas: lodge or Park Service facilities, bridge, trails or falls viewing area.

Spatial and temporal patterns show that most interactions occurred in areas of human use and their numbers peaked at times of high visitor use. Trends in the frequency of property damage indicated more damage at the campground and lodge and Park Service facilities.

To increase visitor safety and minimize the effects of people on the bear habitat and population, planning and management recommendations were made for Brooks Camp to reduce conflicts between bears and people in overlapping use areas.

33.CH
Beeman, L.E., and M.R. Pelton. 1976. Homing of black bears in the Great Smokey Mountains National Park. PP. 87-95 *In*:M.R. Pelton, J.W. Lentfer, and G.E. Folk, Jr. (eds.) Bears-their biology and management. Int. Union Conserv. Natl. Ser. Publ. 40. Morges, Switzerland.

The ability of black bears to return to their homesite was investigated. Nuisance bears were relocated to various parts of the Park. Males comprised 87% of the subjects; 20% of relocated bears were less than 4.5 years of age. No significant difference was noted between age classes in the ability to home. Males that had been moved at least once were more likely to home, and homed in less time than inexperienced males. Bears were moved 5.8 to 64.8 kilometers. They were less likely to return home when moved greater distances. When released on the periphery of the Park, they were less likely to return home than those released in the central part of the Park. Bears appeared to be strongly motivated to home.

35.CH
Bekoff, M. 1975. Predation and aversive conditioning in coyotes. Science 187:1096.

The author presents a brief critique of the work done by Gustavson et al. (Science 184:581). He objects to the methodology they used to arrive at the conclusion that coyote predation may be controlled by aversive conditioning using lithium chloride-laced baits.

50.OA
Brett, L., W. Hankins, and J. Garcia. 1976. Prey-lithium aversions III. Buteo hawks. Behav. Biol. 17:87-98.

While mammalian predators, such as the coyote, follow an olfactory spoor in hunting, hawks rely primarily on visual information. Also mammalian predators kill with their teeth, whereas hawks kill with taloned feet and so do not taste their prey immediately. In this experiment, captive Buteo hawks were studied to determine (1) if hawks can learn to avoid prey that have been paired with illness as effectively as the coyote, and (2) if distal visual cues are more significant than proximal taste cues in the conditioning of such aversions. Lithium chloride illness followed consumption of "poison" mice that differed from alternative "safe" mice in taste and/or color.

Acquisition, generalization, and extinction data indicated that (1) hawks, like the coyote, can acquire pronounced aversions for prey, and (2) while visual cues were sufficient to inhibit attack directed at the prey, taste cues were much more effective in inhibiting consumption.

51.CH
Brown, C.P. 1952. Control of nuisance game species. Final Rep. Pittman-Robertson Proj. 24-F. N.Y. State Conserv. Dep., Div. Fish and Game.. 28 pp.

Tests of repellents and deterrents were conducted on deer in New York State from 1946 to 1952. A file of 137 abstracts was built to ascertain what deterrents and repellents had been tested on deer and to evaluate their effectiveness. The most promising of these were then tested on deer in two categories; those using gardens and field crops, and those in orchards and nurseries. Procedures, findings, discussion, and conclusions for each of the following tests were reported: electric fence (Vermont type), tung-nut pomace, blood-meal, digester-water spray, Goodrite Z.I.P., Diamond-L, and Acme Toxo. The electric fence proved most effective in deterring deer from orchards and field crops. Tests of Goodrite Z.I.P. and Diamond-L were inconclusive. Ineffective materials were blood-meal, tung-nut pomace, and a digester spray consisting of rendering plant by-products, bentomite, lime, cow dung, and water.

58.CH
Burns, R.J. 1980. Evaluation of conditioned predation aversion for controlling sNake River Range Coyote predation. J. Wildl. Manage. 44(4):938-942.

The failure of an attempt to instil a prey-killing aversion using lithium chloride was investigated. Tests were conducted on captive, adult coyotes. The data suggested that these animals learned to avoid the salty taste of LiCl, associating the flavor with sickness. The author proposed that if free-ranging coyotes did stop eating LiCl baits because of a flavor/sickness association, this could lead to the false conclusion that LiCl conditioned bait aversion, and possibly prey-killing aversion had been established among coyotes.

63.DI
Caron, D.M. 1978. Bears and beekeeping. Bee World. 59(1):18-24.

Five bear species have been reported as pests of honeybees: 3 which inhabit Asia, the brown bear of Europe, USSR and Japan, and the black bear in North America. Some estimates of the considerable damage caused by bears are given; in many parts of North America compensation is paid. The construction of a sturdy electric fence, considered to be the best protection around hives is described; a hive platform, at least 2.5 m high with an overhang, has also been used. Suitable location of apiaries can reduce bear damage. Various other control measures are discussed briefly.

73.OA
Chester, J.M. 1980. Factors influencing human-grizzly bear interactions in a backcountry setting. PP. 351-357 In: C.J. Martinka and K. McArthur (eds.) Bears—their biology and management. The Bear Biol. Assoc. Conf. Ser. No. 3. U.S. Gov. Printing Off. Washington, D.C.

Interactions between humans and 7 species of wildlife, including grizzly bears (Ursus arctos horribilis), were investigated in backcountry areas of the Gallatin Range, Yellowstone National Park, during the summers of 1973 and 1974. Grizzly bear distribution, movements, and behavior and human behavior were examined. Because grizzlies utilized area with elevations much in excess of the study area's average trail elevation, the likelihood of the off-trail-party observing a grizzly bear was 3-4 times greater than that of a trail-traveling party. During the hiking season, grizzlies exhibited and elevational migration. The frequencies of on-trail and combined on- and off-trail observations and sign discoveries per party tended to peak during those periods that grizzlies were found at low elevations. Activity patterns of grizzlies at the point of first observation or after the bears had become aware of the human presence did not indicate behavioral traits likely to accentuate the possibilities of human-bear confrontations. Some backcountry travelers engaged in activities that could increase detrimental encounters with grizzly bears.

81.0A

Colvin, T.R. 1975. Aversive conditioning black bears to honey utilizing lithium chloride. Proc. Annu. Conf. S.E. Assoc. Game and Fish Comm. 29:450-453.

Seven caged black bear (Ursus americanus) were fed granular lithium chloride mixed in honey. At the maximum dosage (80g dissolved in .9 liters of honey) and minimum dosage (20 grams/.9 liters) ingestation resulted in sickness. A single treatment resulted in six of the treated bears being conditioned to refuse to eat pure honey for periods varying from 15 to 220 days. One bear continued to relish pure honey and exhibited no aversion.

84.0A

Conover, M.R. 1981. Evaluation of behavioral techniques to reduce wildlife damage. PP 332-344 In: J.M. Peek and P.D. Dalke (eds.) Proc. Wildl.-Livestock Relationships Symposium, Apr. 20-22, 1981, Coeur d'Alene, Idaho. Published by: For., Wildl. and Range Exp. Station, Univ. of Idaho, Moscow, Idaho.

Assets and liabilities of different experimental techniques to reduce wildlife damage at dairies, feedlots and agricultural areas are discussed. Most behavioral techniques function either by increasing the animal's fear of an area (fear-provoking stimuli) or by reducing the animal's desire to feed on the crop or object (chemical repellents). Limiting the effectiveness of fear-provoking stimuli is the restricted area that can be protected and rapid habituation by the target animals. Research currently is aimed at designing fear-provoking stimuli that more closely mimic key stimuli or real predators to delay habituation. Chemical repellents (taste repellents and aversive-conditioning compounds) are effective only when applied directly to the material being protected. Taste repellents are useful only when maintained on the material and when alternate food supplies are available. In theory, aversive-conditioning compounds can protect untreated food sources by creating specific food aversions. Unfortunately they have not lived up to their potential. One problem is that most aversive-conditioning chemicals, such as lithium chloride, can be tasted. When this chemical was used in a aversive-conditioning program, coyotes averted from its taste rather than from the food upon which it was placed.

85.CH

Conover, M.R., J.G. Francik, and D.E. Miller. 1977. An experimental evaluation of aversive conditioning for controlling coyote predation. Wildl. Manage. 41(4):775-779.

This paper further explored aversive conditioning of coyote predation by distribution of sheep carcasses or bait packages containing an emetic agent, lithium chloride. Captive coyotes were used to test 2 questions: can aversion to a previously-eaten "safe" prey be conditioned by lacing carcasses with LiCl; and can aversion be conditioned in the absence of chemical cues in the carcass? In both cases, coyotes did develop an aversion to the dead carcasses, but not to live prey species. Two problems may be inherent in attempting to achieve aversive conditioning through ingestion of LiCl. LiCl itself may be detected and the coyotes may learn to avoid only laced carcasses. The second is that prompt vomiting after ingestion may not allow sufficient LiCl absorption to induce adequate conditioning.

86.

Cornell, D., and J.E. Cornely. 1979. Aversive conditioning of campground coyotes in Joshua Tree National Monument. Wildl. Soc. Bull. 7(2):129-131.

In August, 1977, park rangers and monument visitors reported that several coyotes were begging for food from visitors in Hidden Valley Campground in Joshua Tree National Monument, California. The number of coyotes seen in the campground increased from 3 in August to more than 12 in November. Although Joshua Tree supports a large population of coyotes, large concentrations in or near campgrounds are unusual. The coyotes at Hidden Valley approached humans more closely than coyotes normally do in other areas of the monument. Because of this apparent lack of fear of humans, they posed a potential hazard to monument visitors. These coyotes were offered a variety of baits laced with lithium chloride in an attempt to discourage their scavenging in the campground and begging food from visitors. Illness induced by ingestion of these handouts appeared to be effective in dispersing the concentration of coyotes at the campground.

87.CH
Craighead, J.J., F.C. Craighead Jr. 1972. Grizzly bear-man relationships in Yellowstone National Park. PP. 304-332 In: S. Herrero (ed.) Bears--their biology and management. Int. Union Conserv. Nat. Resour. Publ. New Ser. No. 23, Morges, Switzerland.

The biology and ecology of the grizzly bear in Yellowstone National Park were studied during 1959-1972. Bear-man relationships were examined. Behaviors of grizzlies in the wild and those frequenting garbage dumps, campgrounds, or conditioned by food handouts were analyzed. Bear-man conflicts in the Park were reviewed. The effects of control measures, such as sanitation of campgrounds, dump closures, and relocation or elimination of bears, were evaluated.

Garbage dumps appeared to have become traditional feeding areas for grizzly bears during the summer months. Most Yellowstone grizzlies appeared to use these areas at one time or another. Dumps appeared to reduce grizzly-man encounters and injury by concentrating bears in a restricted-visitor-use area during the height of the visitor season. Revised Park policies involving a rapid phase-out of the garbage dumps were designed to encourage bears to adopt more natural feeding habits, and to reduce bear-man conflicts. However, the policy appeared to be forcing bears into campgrounds and other areas of high visitor use, both inside and outside of the Park. Relocation of problem bears was only moderately successful. A slow phasing out of these traditional feeding areas was recommended. The authors believed that continuance of the rapid-phase-out policy, coupled with the existing guidelines for elimination of problem bears could reduce the Yellowstone grizzly bear population to dangerously low levels.

91.0A
Cushing, B.S. 1980. The effects of human menstruation on the polar bear. In press In: E.C. Meslow (ed.) Proc. of 5th Int. Conf. on Bear Res. and Manage., Feb. 10-13, 1980. Madison, Wisc.

This research was an experimental investigation to determine what types of odors and sounds are possible attractants to the polar bear (Ursus maritimus). The polar bear made an ideal study animal because its responses to the odor from their natural prey, the ringed seal (Phoca hispida), could be established and used as a definitive attractant. The responses to seal scents were then utilized as a standard for determining the relative attractiveness of other substances. In the laboratory portion of this study, only seal scents and menstrual blood odors elicited a maximal response from all of the captive bears. In the field, used tampons were detected by scent 65.4% of the time. After detection, the bears tracked the scent to its source and the used tampons were then usually consumed. In both the laboratory and field, other animal scents and human female blood were also presented to the bears. The responses to blood and other animal scents were generally minimal or none. The lack of responses to these latter odors, together with the strength of the responses to menstrual odors, clearly indicate that menstrual odors attract polar bears, and that some aspect peculiar to menstrual blood elicited this attraction. The field results also indicate that free-ranging polar bears were attracted by potential food and pseudo-food scents. Two captive bears displayed a strong positive response to ringed seal vocalizations which had been recorded under water. and no response to the control vocalizations. Polar bears are therefore capable of recognizing and differentiating the underwater calls of their major prey species.

92.0A
Cushing, B.S. 1980. The effects of human menstrual odors, other scents, ringed seal vocalizations on the polar bear. M.S. Thesis. Univ. of Mont., Missoula, Mont. 49 pp.

An experimental look at the question of whether or not human menstrual odors act as an attractant to a large carnivore, the polar bear (Ursus maritimus, Phipps). The polar bear's response to odors and scents from their natural prey, the ringed seal (Phoca hispida), were utilized as a baseline criterion for determining relative attraction. Menstrual odors, by female volunteers and used tampons, were presented to captive bears. Used tampons and controls were placed in the field to elicit responses from free-ranging bears. Responses to menstrual odors varied, but in the laboratory only seal menstrual odors elicited an active and strong response. In the field bears tracked the scent to its origin and usually consumed the tampon. Non-menstrual blood elicited no response from the animals, indicating that it is some unique aspect of menstrual blood that is acting as the attractant. Menstrual odors always receive an attraction response with some individual variation of intensity.

98.0A
Dean, F.C., and C.M. Tracy. 1977. The bear bibliography project. PP. 13-14 In: C.J. Martinka and K.L. McArthur, (eds.) Bears--their biology and management. The Bear Biol. Assoc. Conf. Ser. No. 3, U.S. Gov. Printing Off., Washington, D.C.

Over 6,000 references on bears have been assembled, including published and unpublished materials. The FAMULUS programs are being used to produce and search files on brown and American black bears (Ursus arctos and U. americanus). As of July 1977, over 1,000 references on each of these two species had been computerized. Effective searches by subject (based on title), author, date and keywords (for about 5%) are possible. Draft review copies were distributed. Announcements of general availability and search costs will be made as soon as feasible. Work is continuing, although additional support will be needed for maximum productivity.

99.WR
Dermid, J. 1954. Wham! and the deer scamper. Wildl. in N.C. 18(10):12-13. Oct. 1954.

Smoldering ropes that periodically set off powerful firecrackers are being tried in North Carolina to drive deer, bear, waterfowl, and other animals from crops. A rope with 12 firecrackers burns about 6 hours with explosions approximately every half hour. It may protect several acres. The method is inexpensive and adaptable.

101.0A

Dorrance, M.J. and B.K. Gilbert. 1977. Considerations in the application of aversion conditioning. PP. 136-144 In: W.B. Jackson and R.E. Marsh (eds.) Test methods for vertebrate pest control and management materials. Am. Society for Testing and Materials, Special Technical Publ. 625 pp.

Recently several researchers have tested aversive conditioning as a method of reducing damage and discouraging approach by carnivores. This paper discusses some general biological considerations in the application of aversive conditioning. Its effectiveness as a control technique will depend, in part, on the characteristics of the wildlife species involved (for example, social organization, individual and species behavior, feeding strategy, annual mortality, and movement); characteristics of the resource being protected (for example, whether it constitutes prey, carrion, space, etc. to the predator, and its desirability and necessity to the predator); and the selection of appropriate aversive stimuli and substrates. Appropriate tests of aversive conditioning are discussed. Specific situations are detailed where aversive conditioning might be most valuable in the control of problem wildlife.

102.0A

Dorrance, M.J. and L.D. Roy. 1978. Aversive conditioning tests of black bears in beeyards failed. Proc. Vertebr. Pest Conf. 8:251-254, England.

This study evaluated the effectiveness of emetic compounds (lithium chloride and cupric sulfate) in honey baits as a technique for preventing black bear damage in fenced beeyards. LiCl and CuSO4 in honey baits did not reduce black bear damage at beeyards. Our experience indicates that LiCl is not a suitable emetic for producing taste aversions in free-ranging black bears.

111.OA
Eagar, J.T., and M.R. Pelton. 1978. Panhandler black bears in the Great Smokey Mountains National Park: methods for ethological research. PP. 138-151 In: R.D. Hugie (ed.) Fourth East. Black Bear Workshop. Apr. 3-6, 1978, Greenville, Maine.

A study of panhandler black bears (Ursus americanus) in the Great Smokey Mountains National Park and their interactions with visitors provides a vehicle for analyzing methods of ethological research. Initially one must define the research problem by familiarization with the situation in which the animal exists. Secondly, objectives must be realistically specified. Both photographic and written records are essential. While data sheets and field notes provide the necessary broad picture, frame analysis of filmed sequences allows a detailed delineation of behavioral elements which is not possible by simple ocular observation.

112.CH
Eagar, J.T., and M.R. Pelton. 1979. Panhandler black bears in the Great Smokey Mountains National Park. Final Rep. to U.S.D.I., Natl. Park Serv. from Univ. of Tenn., Knoxville, 180 pp.

An intensive study of the panhandling black bear was conducted during 1976-78. Observations were made to develop a behavioral profile of the panhandler black bear. Bear reactions to different stimuli were categorized; differences between panhandling sessions containing aggressive acts and those that did not were determined. The relevance of setting to the occurrence of aggression, and behavioral elements that could serve as warning signals were investigated. The effects of panhandling on the normal behavior and activity patterns were examined. An internal approach/avoidance conflict appeared to exist for all bears involved in panhandling sessions. Of 392 panhandling sessions, 44% contained at least one aggressive act. Bears showed restraint in aggressive encounters; less than 6% resulted in physical contact. The most common precipitating factor for an aggressive act was crowding of the bear, accounting for 64% of the acts. Petting or crowding, alone or in combination, accounted for 78% or all contact aggression. Of sessions involving petting and/or crowding, 47% led to aggression with contact. The mean length for sessions without aggression was 23.19 minutes, compared to 47.61 minutes for those with aggression. Males exhibited more aggressive acts per session than did females. Data were pooled for bears for which more than 15 sessions had been recorded. Those bears accounted for 81% of the aggressive acts observed. However, bears in this group averaged a lower number of aggressive acts per session and became aggressive less quickly than did the bears that panhandled less frequently. An apparent warning signal of impending aggression was the performance of a scratching-grooming, yawning, mouth-open-close, and tongue extension pattern.

113.0A
Eagar, J.T., and M.R. Pelton. 1980. Focus on ursid aggression. In press In: E.C. Meslow (ed.) Bears—their biology and management. Proc. of 5th Int. Conf. Bear Res. and Manage., Feb. 10-13, 1980. Madison, Wisc.

A study to develop a behavioral profile of panhandler black bears (*Ursus americanus*) was undertaken during the summers of 1976, 1977, and 1978 in the Great Smokey Mountains National Park. This paper focuses on an important aspect of that project--ursid aggression. Seven distinct types of aggression directed at park visitors were recorded using video tapes, 8 mm movie, and 35 mm cameras and field-note techniques. For each aggressive act the apparent precipitating factor was recorded (e.g., handfeeding, toss feeding, photographing, crowding, petting, etc.). Of 392 panhandling sessions, 43.9% contained at least 1 act, and 624 aggressive acts were recorded. The overall frequency of occurrence of each type of aggression was tabulated, as was that for each precipitating factor. Further analysis showed that certain actions by visitors were more likely to result in particular types of aggression. Less than 6% of all aggression led to actual physical contact with visitors; these were examined to ascertain what precipitated agonistic behavior of such high intensity. All analyses were performed for individual bears as well as on the entire data set. The results indicated that some animals were simply more aggressive than others. This was discussed in terms of sex-age differences, the approach-avoidance conflict, and the frequency of interacting with visitors. Management implications are discussed in light of the above results. Some of the recommendations include changes in present programs of visitor education, enforcement of regulations, and removal of garbage.

115.CH
Egbert, A.L., and A.W. Stokes. 1976. The social behavior of brown bears on an Alaskan Salmon Stream. PP. 41-56 In: M.R. Pelton, J.W. Lentfer, and G.F. Folk, Jr. (eds), Bears--their biology and management. Int. Union Conserv. Nat. Ser. Publ. 40, Morges, Switzerland.

Alaska brown bears were observed fishing at McNeil falls, Alaska, during the summers of 1972 and 1973. Behavioral characteristics of various sex and age classes were described. Frequencies of different types of behaviors were correlated with different social and environmental factors and the dynamics of their social behavior during a 40-day summer fishing season were described. Most agonistic encounters consisted of simple avoidance or withdrawal of one animal at the other's approach. Slight shifts in body orientation, and ear or head position appeared to signal intent. Large adult males appeared to be a serious threat to most bears; they may signigicantly influence mortality rates in the younger age classes. Females with young were highly intolerant of other bears and were the only individuals to consistently challenge adult males. Adolescent males from ages 4 1/2 to 8 1/2 were the least aggressive group. Behavioral changes occurred as the season progressed, especially in the adolescent and sub-adult classes. Bears became habituated to the proximity of others. As distances decreased, a corresponding increase in low-intensity threats was observed. An increase in agonistic encounters was correlated with a decrease in salmon abundance, especially among the younger classes. Social dominance behavior was described. Its primary function appeared to be to determine when and where an individual bear fished. Comparisons were made between brown bear social systems and behavior and that of gregarious carnivores.

Ellins, S.R., S.M. Catalano, and S.A. Schechinger. 1977. Conditioned taste aversion: a field application to coyote predation on sheep. Behav. Biol. 20(1):91-95.

Predation by free-ranging coyotes (*Canis latrans*) on two sheep herds was inhibited by a procedure in which sheep carcasses laced with toxic lithium chloride were placed adjacent to the herds. When the lithium chloride bait was removed or replaced with nontoxic sodium chloride bait, bait takes and suppression of attacks on live prey continued. The blocking of attack behavior had not extinguished after 9 weeks at the termination of the study.

117.WR

Erickson, A.W. 1965. The black bear in Alaska/its ecology and management. Alaska Dep. Fish and Game, Juneau. 19 pp.

Description; distribution and abundance; population dynamics; food, predatory habits and cannibalism; parasites, diseases and pathological conditions; behavior; hibernation; physiological conditions; and management of *Ursus americanus*. With a bibliography of 84 titles.

118.WR

Erickson, A.W. 1965a. The brown-grizzly in Alaska/its ecology and management. Alaska Dep. Fish and Game, Juneau. 42 pp.

Description; distribution and habitat requirements; abundance, population dynamics; food, predatory habits and cannibalism; bear attacks; parasites, diseases and pathological conditions; behavior; harvest data; size of the kill; the chronology of the kill; hunter residence; sex composition of the kill; size composition of the kill; and management of *Ursus arctos*. With a bibliography of 113 titles.

119.CH
Erickson, A.W., and R.J. Somerville. 1965. Polar bear segment; bear studies; Alaska wildlife investigations. Vol. V. Annu. Proj. Segment Rep. Fed. Aid in Wildl. Res. Proj. W-6-R-5. Alaska Dep. of Fish and Game, Juneau, 25 pp.

The biology and ecology of the polar bear in Alaska was summarized. Included were reviews of polar bear distribution and abundance, population dynamics, food habits, movements, parasites and diseases, hunting and harvesting, and management. Also presented was a bibliography referencing 70 polar bear related papers.

128.OA
Fish, J.F., and J.S. Vania. 1971. Killer whale, Orincas orca, sounds repel white whales, Delphinapterus leucas. Fish. Bull., U.S. 69:531-535.

This study was conducted to determine if the migration of white whales up the Kvichak River, Bristol Bay, Alaska, could be stopped by playing high intensity underwater sounds to them. While in the river, the whales feed on salmon smolt migrating down to the sea. Transmission of killer whale sounds was found to be an effective means for keeping the whales out of the river. During control periods when sound was not projected, the whales moved freely in and out of the river. A permanent playback system could be installed with little difficulty and would result in a signigicant reduction in the number of smolts consumed by belugas in the Kvichak River.

132.WR
Floyd, J. 1960. Crop damage by deer and bear, suggestions for control. Fla. Wildl. 14(5, Nov.):18-21.

Article reviews for laymen techniques for prevention of deer and bear damage in Florida. The approach is good, ideas expensive but helpful, expectations a little optimistic. Chief contribution--a bear-proof platform 8 feet off the ground for protecting bee hives. Repellents and outrigger electric fence recommended against deer.

133.CH
Follman, E.H., R.A. Dieterich, and J.L. Hechtel. 1980. Recommended carnivore control program for the Northwest Alaskan Pipeline Project including a review of human-carnivore encounter problems and animal deterrent methodology. Final Rep. for Northwest Alaska Pipeline Co. Inst. Arctic Biol., Univ. of Alaska, unpublished. 113 pp.

This report represents the first phase of a project initiated by the Northwest Alaskan Pipeline to implement animal deterrent methods that would reduce contact between carnivores and pipeline workers. A literature review of the state-of-the-art approaches to animal deterrence and methods of dealing with problem animals was presented. Human-carnivore encounter problems were reviewed on a broad scale and as they occurred on the Trans-Alaska pipeline system. Existing and proposed laws and regulations regarding these problems were summarized. Methods to avoid and minimize human-carnivore conflicts included: animal deterrents such as fences, sound, noxious substances, and electromagnetic radiation; aversive conditioning using emetics and electroshock; and translocation and dispatch. Based on the review, recommendations were made to avoid and minimize adverse encounters between workers and carnivores along the pipeline corridor. Recommendations include strict adherence to proper food storage and garbage disposal methods, and prompt disciplinary action to any employees caught feeding animals. The design and description of 3 fences and gates were proposed, each designed for specific work camps or compressor stations at different locations, each with different animal deterrent capabilities. A control program for problem animals was outlined. Recommended environmental briefing topics for employees that emphasize the potential carnivore-human problems associated with the construction of the pipeline were presented. Further studies of animal deterrent methods were recommended.

134.0A
Follman, E.H., and J.L. Hechtel. 1983. Bears and pipeline construction in the far north [Abstract only] Proc. 6th Int. Conf. Bear Res. and Manage. Feb. 22-28, 1983. Grand Canyon Squire Inn, Grand Canyon, Ariz. p. 22.

Serious problems were encountered with nuisance bears and other carnivores during construction of the trans-Alaska oil pipeline between Prudhoe Bay on the Arctic Ocean and the ice-free port at Valdez. Industry and government agencies anticipated problems and made plans to deal with them, but these actions were found to be inadequate in many areas of the right-of-way. The most serious problems occurred north or the Yukon River. an area inaccessible by road prior to 1974 when the gravel road to Prudhoe Bay was built in preparation for pipeline construction. No hunting was permitted within 8 km of the right-of-way in this area. The pipeline traversed black and grizzly bear habitat and problems were encountered with both species, particularly at certain of the unfenced construction camps. Inadequate refuse disposal and widespread animal feeding created dangerous situations but surprisingly few serious incidents of injury. Although the extent of long-term impact of the project on the bears can only be speculated upon at this time, the effects that bears and other carnivores had on the project have been assessed and will be presented in this paper.

In an effort to minimize the environmental effects of their project, the builders of the proposed Alaskan natural gas pipeline sought assistance in greatly reducing problems with nuisance animals. A review of animal deterrent methodology ensued which yielded a recommended carnivore control program including designs for fences to be erected around construction camps. The 3-year delay in starting the pipeline project postponed the influx of large numbers of construction workers into northern Alaska, but survey work has continued. Certain aspects of the control program have been implemented, for example, the installation of fences around 100-man survey camps. These were found to be quite effective in deterring bears in two traditionally troublesome areas. Details of the fence design and other aspects of the carnivore control program will be reviewed.

139.
Frings, H. 1964. Sound in vertebrate pest control. Proc. of the 2nd Verteb. Pest Conf. pp. 50-56.

A broad view of human problems arising from conflicts with other vertebrates and the possibility of resolving the problems through the use of attracting or repelling sounds. This field has been only slightly explored and great advances are projected by the authors. PART I (POSSIBILITIES WITH INVERTEBRATES) appeared in Sound 1(6): 13-20, Nov.-Dec. 1962. It dealt almost exclusively with the control of invertebrates with sound.

144.0A
Garcia, J. and F.R. Ervin. 1968. Gustatory-visceral and telereceptor-cutaneous conditioning--adaptation in internal and external mileus. Communications in Behav. Biol. Part A, 1, pp. 389-415.

Two traditional assumptions of learning are considered in the light of recent evidence. First, do all the stimulus elements in the learning situation become conditional stimuli. When animals suffer a general malaise, they display avoidance responses to chemical stimuli (gustatory, olfactory) but not to telereceptive stimuli (auditory, visual). When they suffer peripheral pain, the converse is true. Second, is immediate reinforcement necessary for all learning? When a gustatory stimulus is followed by injection of a noxious agent then learning occurs even when reinforcement is delayed for hours. The effectiveness of perceptible stimuli as either signals or reinforcers, as well as the optimal intervals and combinations for associative learning, depend upon central neural integration of the specific afferent inputs under consideration. Gustatory and visceral systems send afferent fibers directly to the nucleus of the fasciculus solitarius. Telereceptive and cutaneous systems do not. Neural mechanisms subserving adaptive responses within the internal milieu are distinct from those subserving adaptive conditioning in the external milieu.

145.0A
Gard, R. 1971. Brown bear predation on sockeye salmon at Karluk Lake, Alaska. J. Wildl. Manage. 35(2):196-199.

Effects of predation by brown bears (Ursus arctos) on sockeye salmon (Oncorhynchus nerka) were studied at Grassy Point Creek, a tributary of Karluk Lake on Kodiak Island, Alaska, during the summers of 1964 and 1965. In 1964 bears were allowed free access to the stream, but in 1965 an attempt was made to exclude them with an electric fence. Bears were efficient predators in the stream, killing up to 79% of the salmon in 1964; however, only 9.6% of the dead females sampled were unspawned bear-killed fish. The maximum estimate of eggs lost to bear predation in 1964 was about 1 million, compared with a total loss, from all causes, of 8 million potential eggs. As a result of certain behavioral patterns of sockeye salmon, bears usually take spawned-out rather than unspawned females. The ratio of males to females in each year's escapement approached 1:1; the ratio among bear kills was about 3:2. Males acted as a buffer against predation on females. The fence reduced bear predation by two-thirds. It is concluded that bear predation has little adverse effect on the production of sockeye salmon.

148.
Gates, N.L., J.E. Rich, D.D. Godtel, and C.V. Hulet. 1978. Development and evaluation of anti-coyote electric fencing. J. Range Manage. 31(2):151-153.

Highlight: An electric fence with alternating ground and charged wires was tested for anti-coyote properties. Under the conditions tested, the fence was coyote-proof. The fence may evolve as an effective, nonlethal method of preventing coyote depredation of domestic livestock.

153.CH
Gilbert, B.K. 1981. Polar bear deterrent studies: recommendations for research and management. Rep. to the Gov. Northwest Territ., Canada. Unpublished. 4 pp.

Recommendations for research and improved management were summarized. Recommendations were directed toward preventative techniques that included physical pain, reduction of bear access to food and garbage, model studies under penned conditions, and an interagency cooperative funding effort. It was recommended that information gathering for management purposes be improved by initiating thorough and standardized documentation of management and research activities. The installation of concertina barbed wire fences around human properties was recommended for immediate application for protection of humans and bears.

154.OA
Gilbert, B.K. and L.D. Roy. 1977. Prevention of black bear damage in beeyards using aversive conditioning. PP. 93.102 <u>In</u>: R.L. Phillips and C. Jonkel (eds.) Proc. of the 1975 Predator Symposium. Mont. For., and Conserv. Exp. Station. Univ. of Mont., Missoula.

A study of the effectiveness of an emetic compound, lithium chloride, in the prevention of black bear damage to beeyards was initiated in the Peace River area of the province of Alberta. The sample studied consisted of 60 beeyard, divided approximately equally into four categories: unfenced unbaited, unfenced baited, fenced unbaited, and fenced baited. Each beeyard was visited an average of 3.3 times by bears. The resulting average damage of 4.34, 2.04, 0.68, and 0.24 hives damaged per visit, respectively, for each beeyard category. The lithium chloride in combination with electric fences effected a 94% reduction in damage compared with that sustained by unprotected beeyards.

160.CH
Graber, D.M. 1982. Ecology and management of black bear in Yosemite National Park. Final Rep. to the Natl. Park Serv., Rocky Mountain Reg., Technical Rep. No. 5. Coop. Natl. Park Res. Study Unit. 206 pp.

Black bears in Yosemite were studied over a 5-year period, beginning in 1974. The study was initiated in response to increasing concern over escalating property damages and injuries caused by bears, and concern that wild, healthy bear populations may be harmed by actions of park visitors and staff. Black bear physical characteristics, population dynamics, food habits, home range and habitat use, social behavior, and winter ecology and behavior were investigated. Yosemite black bears were large in comparison to black bears from other populations. Adult males averaged 142 kg. and females 87 kg. Fifty percent of the population were adults (4 years of age or older), 30% were juveniles (1-3 years old), and 20% were cubs; 60% of the bears 2-10 years old were females. First reproduction occurred at 4 years of age; cubs per adult female averaged 0.72, with an average litter size of 2.0. The data indicated the population was younger and had a higher reproductive rate than was found in other non-hunted or park populations. Annual mortality was high, between 18% and 35% and almost entirely due to human actions. Plants comprised 75% of the diet. Fifteen percent of the diet were foods of human origin. Efforts to eliminate human foods from the bear diet contributed to great fluctuations in the proportions of types of food eaten annually. The lower elevations contained the best bear habitat. Bears used higher elevations in the summer than in spring or fall. Bears only used the red fir (Ablies magnifica), and lodgepole pine (Pinus contorta) areas of the park where human food could also be obtained. Availability of human foods and natural fall foods may have influenced winter behavior patterns. Bears appeared to be attracted to concentrations of human foods in campgrounds. Bears occasionally tested people, but generally treated them as dominant bears. Injuries were rare. Although the Yosemite bear population appeared exceptionally fertile, traditional management practices of relocation and destruction had resulted in a high mortality rate. Management practices aimed at eliminating human foods from bear diets and a visitor education program were expected to drastically reduce bear/people conflicts.

166.0A
Greene, R.J. 1982. An application of behavioral technology to the problem of nuisance bears. The Psychological Record, 32:501-511.

An appropriate and effective means of repelling nuisance bears is currently not available to recreation area personnel. Those methods which have been employed with limited success in other settings would be disruptive to campground and picnic area users.

By applying long-established behavioral technology which is used extensively by other disciplines, new methods can readily be developed to coerce a bear to leave an area where it is not wanted. This case study demonstrates that a nuisance bear can be trained by classical conditioning procedures to associate an unobtrusive, ultrasonic tone with the aversive sound of a load horn. This learned association was accomplished by repeated presentation of both stimuli to the animal while confined in a culvert trap.

A postconditioning test demonstrated that the previously neutral sound, inaudible to humans, was capable of immediately prompting the bear to leave a well-baited campsite. The bear's behavior further indicated that the conditioned stimulus did not elicit the startle, fear, or flight responses which normally would result from direct use of the horn. Only the accompanying autonomic responses became conditioned to the ultrasonic tone; apparently overt behaviors were thwarted by confinement in the trap, precluding their being conditioned as well. Nevertheless, the uncomfortable or disturbing autonomic responses were triggered by presentation of the ultrasonic tone, presumably causing the bear to feel ill at ease in the situation and to leave in a deliberate, determined manner.

This example of stimulus control of a bear's behavior illustrates the pragmatic potential of behavioral technology in the management of nuisance bears and lays the groundwork for further exploration of this potential.

Current continuations of this research employs the sight and sound of humans as conditioned stimuli; this direct approach attempts to restore a nuisance bear's "natural fear of humans".

171.CH
Gunson, J.R. 1977. Black bears and beehives in Alberta. Proc. Annu. Conf. West. Assoc. State Game and Fish Comm. 57:182-192.

Bear-beeyard complaints in the Peace River area of Alberta for the period 1972-76 were reviewed. Also summarized were the results of research into alternative methods to lethal control of bear depredations. These included bear translocation, electro-shock, and studies of electric fence effectiveness. The authors suggested that by combining electro-shock conditioning with highly-charged electric fences, most of the bear-bee problems could be eliminated.

174.CH

Gustavson, C.R. 1977. Comparative and field aspects of learned food aversions. PP 23-43 In: L.M. Barker, M.R. Best, and M. Domjam (eds.) Learning mechanisms in food selection, Baylor Univ. Press, Waco, Tex.

The results of taste aversion conditioning experiments on a variety of species were summarized. In general, reduction in consumption, or avoidance of food with a specific flavor occurred after an animal had consumed the flavored food and subsequently become ill. The intensity of the flavor and illness directly affected the strength of the resulting aversion.

Inter-specific differences appeared best predicted by an examination of feeding requirements of a species, rather than categorization by broad taxonomic or ecologic divisions such as trophic feeding level. Emetic responses to toxicosis were possibly of no significant value in the establishment of learned food aversions.

To understand the influence of dietary requirements on learned food aversions, 2 sets of variables producing the dietary characteristic of a population were important:

1. variables affecting the feeding of specific individuals--
   a) the morphological, anatomical, and physiological systems of the animal determining the limits of food items available for exploitation,
   b) the availability of the specific food in the environment (i.e. the density and accessibility),
   c) availability of alternative food sources in reference to the specific dietary item,
   d) the wholesomeness of the food as compared to the other resources; and

2. social interaction events with conspecifics--
    a) reproductive habits,
    b) offspring caretaking habits as they effect mobility,
    c) territorial patterns of a species,
    d) population density of a predator.

The availability of alternative foods was probably the most important factor in determining the success of programs designed to alter the diets of free-ranging animals.

176.WR
Gustavson, C.R., J. Garcia, W.G. Hankins, and K.W. Rusiniak. 1974. Coyote predation control by aversive conditioning. Sci. 184:581-583.

Conditioned aversions were induced in coyotes by producing lithium chloride illness in them following a meal, and the effects upon eating and attack behavior were observed. One trial with a given meat and lithium is sufficient to establish a strong aversion which inhibits eating the flesh of that prey. One or two trials with a given flesh (lamb or rabbit) specifically suppresses the attack upon the averted prey but leaves the coyote free to attack the alternative prey. A method of saving both prey and predator is discussed.

Gustavson, C.R., D.J. Kelly, and M. Sweeney. 1976. Prey-lithium aversions I: Coyotes and wolves. Behav. Biol. 17:61-72.

Captive coyotes were fed rabbit flesh treated with lithium chloride (LiCl) and captive wolves were fed similarly treated sheep flesh. One or two treatments inhibited predatory attack upon the living prey, but left the appetite for alternative prey unaffected. A caged cougar refused to eat deer meat after one meal of venison laced with LiCl. Sheep flavored baits and sheep carcasses laced with LiCl, distributed on a 3000 acre sheep ranch in southeastern Washington, were consumed by feral coyotes. A comparison of this year's sheep losses with the rancher's past records suggested a 30-60 percent reduction in sheep killed by coyotes following this application of taste aversion conditioning in the field.

178.0A

Haga, R. 1974. [On attempts of prevention of damage done by the Yezo brown bear by the use of a bear frightening contrivance.]. Obihiro Chikusan Daigaku, Gakunjutsu Kenya Hokoku, Dai-L-Bu [Res. Bull. Obihiro Zootech. Univ. Ser. 1] 8(4):757-762. Canadian Wildl. Ser. Trans. Tr-Jap-11.

Recently, a great deal of damage has been done to both men and beasts by the Yezo-Brown Bear. The author made a study on the prevention of such occurrences by the development of a bear-frightening contrivance.

Figure 1 shows the structure of the contrivance which was composed of a sound amplifier, speakers, battery, generator and a strobe flash unit.

Grazing bears ran away from the area of the sound speaker when the sound of the barking of many dogs was broadcast. Also, bears were repulsed by the stimulus of high frequency sounds (2000-4000 c/s) broadcast over a long period of time. However, the bears did not run away at the sound of a pile-hammer, a gun firing or the sound of a jet plane mixed with metallic noises.

183.0A

Hastings, B.C. 1982. Human-bear interactions in the backcountry of Yosemite National Park. M.S. Thesis, Utah State Univ., Logan. 184 pp.

The objective of this study was to quantitatively document interactions between black bears and backcountry visitors, and to identify the factors affecting those encounters. Nine hundred and ninety-two interactions were observed. The most common responses of visitors to bears were to watch, walk toward, and talk to others and/or point at the bear. Bears responded to humans largely by walking away, watching, travelling around, walking toward, and running away from people.

Each behavior for both species was categorized into one of our response classes; (1) fear/avoidance, (2) neutrality, (3) approach, or (4) aggression. Over 65 percent of visitor responses were neutral. People were least likely to react to bears with fear/avoidance behavior. Bears also were most likely to be neutral. Of particular interest is the low occurrence of aggression shown by bears. Less than two percent of all responses fell into this category, which resulted in injury or even contact between visitors and bears. When ursid aggression did occur, bears appeared to be more aggressive in June, with younger visitors, and at close distances. Both human aggression and fear were correlated with short interactions.

Bear behavior was greatly altered by possession of camper foods. Bears were more neutral and walked toward people less after they had begun to eat. They also showed much less fear of visitors at this time.

Other correlations of both human and ursid behavior with biotic and abiotic variables (temporal, spatial, environmental, etc.) are presented and discussed. Recommendations for improved management are also suggested.

184.0A
Hastings, B.C., and B.K. Gilbert, 1981. Aversive conditioning of black bears in the backcountry of Yosemite National Park. Proc. of the second Conf. on Sci. Res. in the Natl. Parks. 2:294-303.

Dramatic increases in human-bear contacts and damages have occurred in the backcountry of Yosemite National Park in recent years. One solution to the attraction of bears to campgrounds is to break the positive association which has developed to foodsacks. Experiments testing the effectiveness of aversive techniques were conducted. Noxious chemicals were placed in foodsacks in campgrounds. Some aversive effect was apparent in the initial studies, but the bears continued to obtain food from visitor foodsacks. Further studies in a similar area resulted in a substantial decrease of bear activity. Management alternatives are discussed.

185.CH

Hastings, B.C., B.K. Gilbert, and D.C. Turner. 1981. [Black bear behavior and human-bear relationships in Yosemite National Park] Final Rep. to the Natl. Park Serv., Rocky Mountain Reg. Technical Rep. No. 2, Coop. Natl. Park Resour. Studies Unit. 42 pp.

Preliminary results were presented of studies initiated to reduce contact between bears and people, and to prevent bears from obtaining food rewards from people. Human-bear interactions were examined largely through observations and interviews. Some studies of aversive conditioning were conducted using stuff sacks baited with food and ammonium hydroxide. Behavior of humans and bears was categorized into 4 categories: fear/avoidance, neutrality, approach, and aggression. During an interaction, both bears and humans usually reacted neutrally. Ursid aggression was rare, correlated primarily with the month of June, young visitors, and close distances between species. Throwing objects, yelling, clapping hands, and banging pots were most effective in removing bears from camps. These animals were more difficult to remove once they had begun to eat. Bears appeared to rarely orient toward empty water bottles with caps removed or backpacks with the zippers and flaps left open. Large "organized" groups of campers were more likely to attract bear activity, interactions, and especially damages. As many as 41% of the visitors may have had interactions with bears in 1979. In general, visitors appeared reluctant to report bear incidents. Aversion of bears to food sacks showed potential as a management tool. Balloons filled with ammonium hydroxide, placed in various sacks and packs, and then stored in campgrounds using various methods, caused a significant decrease in bear activity and interactions at both the treated and untreated sites. Other management alternative were explored, including permanent campgrounds, and portable, bear-proof food containers. Various management recommendations were made based on the data collected.

190.OA
Herrero, S. 1970. Man and the Grizzly Bear (Present, Past, But Future?). BioScience 20(21):1148-1153.

Relationships between grizzly bears and man are traced from Paleolithic time to today. Injuries to human beings inflicted by grizzly bears in the national parks of North America are summarized. Ideas are developed concerning the value of grizzly bears to man, and ways in which this value can be enhanced. It is concluded that grizzlies and man can and should coexist in the national parks of North America.

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

Human injuries inflicted by grizzly bears in national parks of North America were examined. Factors related to grizzly bear attacks on humans were discussed and suggestions for public and private means of reducing the risk of human injury were made; 79% of all known injuries occurred in U.S. parks, the remainder in Canadian parks. The rate of injury was estimated at approximately 1 person per 2 million visitors: hiking, 31%; camping, 61%; and provoking the bear, 6%; 71% of the injuries were caused by a sow with one or more cubs. The data suggested that "playing dead" was a good strategy if attacked by a sow protecting her cubs. It is suggested most camping incidents were probably related to grizzlies that had fed on human garbage or food, especially in the presence of human beings. Bear access to human food sources should be eliminated in the national parks.

192.CH
Herrero, S. (ed.) 1972. Bears--their biology and management. Int. Union Conserv. Nat. Publ. New Ser. 23. Morges, Switzerland. 371 pp.

Contains 45 papers presented at the Third International Conference on Bear Research and Management at Binghamton, New York, U.S.A., and Moscow, U.S.S.R., June 1, 1974. Papers are presented under the following categories: bear behavior; bears in national parks; management of bears and techniques; status of bears; and biology of bears.

193.CH
Herrero, S. 1972a. Aspects of evolution and adaptation in American black bears (Ursus americanus Pallas) and brown and grizzly bears (U. arctos Linne of North America. PP. 221-231 In: S. Herrero (ed.) Bears--their biology and management. Int. Union Conserv. Nat. New Ser. 23. Morges, Switzerland.

The evolution and historic and present distribution of black bears and the brown/grizzly bear group were reviewed. Physiological, behavioral and ecological differences between the two species were discussed in terms of the different habitats favored by each. It was hypothesized that grizzly/brown bears are more aggressive, or more inclined to actual attack than are the black bears, because of the different selective pressures that have acted on each group. Black bear use of the forest biome was tied to cub care and reproductive success. Aggressiveness in the grizzly appeared to be an adaptation to cub care on the treeless tundra, grassland and forest biomes.

195.CH
Herrero, S. 1976. Conflicts between man and grizzly bears in the National parks of North America. PP. 121-45. In: M.R. Pelton, J.W. Lentfer, and G.E. Folk, Jr. (eds.) Bears--their biology and management. Int. Union Conserv. Nat. Resour. Publ. New Ser. No. 40, Morges, Switzerland.

Causes and characteristics of grizzly bear attacks on man in the National Parks of North America were investigated. Data for the period 1872-1969 was compared with that of 1970-1973, and also to analyses carried out by other authors. Circumstances of actual attacks were examined. Female bears with cubs were the most dangerous age/sex class. Very old grizzlies were another class disproportionately involved in incidents with man. In the event of an actual attack, it was suggested that playing dead may decrease the intensity of the attack. Several National Park management programs were evaluated for effectiveness with respect to human safety and grizzly bear preservation. The asthetic value of the grizzly bear was discussed.

198.CH
Herrero, S. 1978b. The grizzly bear "stopper"--a feasible technology? Bear Biol. Assoc. 78(2):4-5.

Discussed the use of grizzly "stoppers" such as knock-out drugs, Mace, electric stun guns or attractants which would hold a bear's attention while the victim escaped. Alternative methods presented for minimizing conflicts included: control of human use in prime grizzly habitat, education of recreationists regarding grizzly behavior and ecology, proper conduct in grizzly country, and acceptance of the fact that a few people will be injured by grizzlies each year.

199.OA
Herrero, S. 1980. Social behavior of black bears at a garbage dump in Jasper National Park. 40=13 pp. In press In: E.C. Meslow (ed.) Proc. of 5th Int. Conf. on Bear Res. and Manage., Feb. 10-13, 1980. Madison, Wisc.

Black bears, (Ursus americanus) visiting and feeding at the town dump in Jasper National Park were observed for over 750 hours on 141 days. Thirty four (34) bears out of a visiting population estimated at 65 were individually identified.

Observations were made regarding patterns of visitation, intraspecific agonistic interactions, interactions with people, the use of trees, and characteristics of individual and age/sex classes.

PATTERNS OF VISITATION:

The female with young class visited and fed at the dump more than any other group. Their average family size of 2.75 suggests that food from the dump contributed to reproductive success. Most adult males seldom visited the dump during May or June; they came more frequently after this. Sub-adults were frequent dump users until August when they stopped visitation.

AGONISTIC INTERACTIONS

Social interactions between bears were characterized by tolerance, avoidance and spacing. We did, however, observe 141 intraspecific agonistic interactions; in 131 of these were able to identify the dominant animal. Females with young dominated all other age/sex classes, including adult males, in 89 out of 91 agonistic interactions. Females with young, even when not accompanied by their young to the dump, used agonistic signals to maintain an individual distance of 3 to 30 meters.

Twelve postural and four vocal components of the agonistic repertoires are described, and frequency of use of all such signals is given for each identified bear. Agonistic signals were stereotyped but not invariant. Physical contact was rare.

Agonistic interactions were more frequent early in the season than later.

INTERACTION WITH PEOPLE:

The dump was visited by 7,500 to 10,000 tourists, most of whom came specifically to watch the "Jasper bears". Despite hundreds of close approaches by humans, including 57 situations in which we observed people to throw rocks or chase bears, a bear never struck, bit, or contacted a person. Bears on 15 occasions directed agonistic signals toward humans. These signals differed in frequency, but not in type, from those used in intraspecific encounters.

THE USE OF TREES:

Numerous observations documented the importance of trees to black bears. Trees were used for clawing, stretching, scratching, and climbing. After having climbed a tree, bears were seen nursing, playing, sleeping or relaxing. Safety from harrassment appeared to follow climbing. Females and their young, and sub-adults, climbed much more than did other groups.

CHARACTERISTICS OF INDIVIDUALS AND AGE/SEX CLASSES:

We found that after observing 10 or so social interactions by an identified individual, that we qualitatively could describe a bear's personality. Age/sex classes as well had common and somewhat predictable characteristics. Some of the specific characteristics of individuals and age/sex classes are described.

203.CH
Hornocker, M.G. 1962. Population characteristics and social and reproductive behavior of the grizzly bear in Yellowstone National Park, M.S. Thesis. Univ. of Mont. 94 pp.

The behavior of individuals and groups of Yellowstone grizzly bears, and their population size and structure as it relates to their behavior, are presented. Population data were gathered throughout the Park, but the behavioral studies were confined to the Trout Creek refuse dump area. Detailed are grizzly bear social structure and behavior, dominance behavior, and reproductive behavior. Six dominance classes are recognized. In order of descending dominance, they are: The Dominant Class, Sub-dominant Class, Aggressive Class, Cautious Class, and Subordinate Class. Criteria used to classify males included aggressiveness, size, and age. For females, aggressiveness and reproductive condition governed their behavior toward males, while aggressiveness, age, and size determined their social rank in terms of other members of the population. Young bears were classified mainly by age and size. Females with offspring, particularly those with cubs of the year, exhibited excessive hostility toward males. This behavior varied significantly from year-to-year depending on the animal's reproductive status. The breeding season extended from about 10 June to 10 July. Sexually stimulated males were more aggressive than at other seasons of the year. Males high in the dominance order were extremely intolerant of all others except females in breeding condition.

207.CH
Hugie, R.D. (ed.). 1978. Fourth East. Black Bear Workshop. Apr. 3-6, 1978. Squaw Mountain, Greenville, Maine. 409 pp.

Contains reports and papers presented at the Fourth Eastern Black Bear Workshop. Presented were black bear status reports from 15 U.S. states, and 4 Canadian provinces, and 25 papers on various aspects of black bear biology, ecology, physiology, management, and research.

209.0A
Hunt, C.L. 1984. Behavioral responses of bears to tests of repellents, deterrents, and aversive conditioning. M.S. Thesis. Univ. of Montana., Missoula. 137 pp. (Also includes a 136 pp. bibliography entitled Deterrents, Aversive Conditioning, and Other Practices: An Annotated Bibliography To Aid In Bear Management).

Most human-bear conflicts are caused by surprise encounters and bear use of human foods. Investigated were repellents and deterrents with the potential to reduce conflicts. Repellents were tested on 5 captive black bears (Ursus americanus) and 1 captive grizzly bear (U. arctos) as the bears charged or approached humans. Tested were Halt (capsaicin product), Bear Skunker (simulated skunk spray), Shield (mace product), an air horn, railroad flares, a quickly-opened umbrella, and taped music and bear sounds. Most bears were repelled by Halt or a Bear Skunker/Halt combination. Bears repelled during a test were less likely to be aggressive during the next test. Certain bears that seemed inherently non-aggressive were frequently repelled by stimuli that incited charges by more aggressive individuals. Also discussed are intention movements by bears, and similar movements by humans that appeared to have signal value for bears.

Repellents were delivered to 2 black bears and 2 grizzly bear cubs, aimed at aversively conditioning the bears to avoid humans. These bears were subsequently released into the wild. None is known to have caused further problems or to have been killed through hunting or control actions. Important contributing factors may have been the non-aggressive temperament of each of the bears and the timing of their release.

Deterrents and repellents were tested on approximately 31 free-ranging black bears visiting baits at a sanitary landfill. Tests of taste and odor deterrents included ammonia, male and female human urine, mothballs, Bear Skunker, Boundry (dog deterrent), and Technichem (bear deterrent). Full strength Parson's ammonia and male human urine placed on baits deterred most bears from eating; only ammonia appeared to deter many bears from approaching baits. Pain-inducing repellents triggered by remote control were Bear Skunker and Halt. Halt repelled most bears from the site temporarily. Test responses were the result of the effect of a stimulus on the individual bear, dominance activities by other bears at the site, and the availibility of natural foods in the area. Certain bears appeared to tolerate the more noxious deterrents or returned repeatedly following tests of the triggered repellents.

Presented as an appendix is an extensive bibliography entitled Deterrents, Aversive Conditioning, and Other Practices: An Annotated Bibliography To Aid In Bear Management.

211.CH

Hunt, C., and C. Jonkel. 1981. Bear deterrent tests. Border Grizzly Proj. Special Rep. No. 56. School of For., Univ. of Mont., Missoula. Unpublished. 11 pp.

Tests of deterrents on two captive black bears were reported. Bears were tested while restrained by an Aldrich foot snare and under captive conditions. Tests were focused on testing a simulated skunk odor produced by Bear Country Products. Limited tests of other stimuli included Shield (a mace product), an air horn, taped grizzly bear sounds, taped music, and Halt (a dog repellent). Results of tests with the skunk odor suggested the product had potential for use as a bear deterrent. Although bears were not immediately repelled upon application of the spray, an immediate decrease in aggressive behavior was was observed. Bears seemed to quickly learn to associate the mercaptan odor with an encounter they wished to avoid, and displayed submissive and avoidance postures up to one month later when confronted with the odor. Bears were repelled using Halt, but were easily provoked into aggression when reapproached. Other stimuli tested did not produce favorable results. Implications of the data as they relate to further research were discussed.

221.CH

Jonkel, C. 1977. Workshop on man/bear conflicts: Management, deterrents, aversive conditioning, and attractants. N.S.F. Rep. 2, 2 Feb. 1977. Unpublished. 5 pp.

The proceedings of the workshop were briefly summarized. Topics on the agenda included a determination of what was available in terms of bibliographies and literature searches on the workshop subject, reports from primarily Canadian sources on ongoing and completed projects, management options to avoid man-bear conflicts, and research approaches to testing deterrents and management ideas. The discussion of management options and approaches to testing included a review and evaluation of many of the deterrents or aversive conditioning agents currently being tested or in use. A list of deterrents and management ideas most likely to be effective was developed. Additional management approaches discussed were early warning detection systems, relocation of bears, use of bear monitors, garbage disposal and clean camps, training sessions for employees, and determination of attractant materials.

223.OA
Jonkel, C.J. 1970. The behavior of captured North American bears (with comments on bear management and research). BioScience 20(22):1145-1147.

Bears and man conflict for space and resources, a condition which may lead to the extinction of bears. Observations of wild black bears (*Ursus americanus* Pallas), grizzly bears (*U. arctos* L.), and polar bears (*U. maritimus* Phipps) held in snares indicate that only the grizzly is unusually aggressive. All bears appear prone to forming strong habits, suggesting that increased research into bear behavior can provide a basis for their survival.

225.OA
Jope, K.L. McArthur. 1983. Implications of habituation for hikers in grizzly bear habitat. [Abstract only]. Proc. 6th Int. Conf. Bear Res. and Manage. 18-22 Feb. 1983. Grand Canyon Squire Inn, Grand Canyon, Ariz. p. 30.

Behavior of grizzly bears (Ursus arctos) toward people was studied by examining hikers' reports of grizzly bear observations and by intensively observing grizzlies in an area of Glacier National Park that was heavily used by day-hikers. Of concern were the apparent habituation of grizzly bears to people in the study area, the increasing rate of human injuries by grizzly bears in the park, and the increased involvement of lone adult and subadult bears in injuries to hikers. Associations between environmental circumstances, including the presence and behavior of people, and grizzly bears' behavior were evaluated. Human use of the study area was associated primarily with season and weather. Numbers of grizzly bears observed were also associated with season as it reflected patterns of habitat use. Behavior of grizzly bears was associated primarily with the level of human activity, the presence of bear-bells, and the climatic circumstances under which the bears were seen. Although grizzly bears' fear response toward people appeared to habituate, they maintained a degree of vigilance that was related to conditions affecting the ease of scent perception. Charges, which have been associated with hiker injuries, involved only people who did not have bear-bells. Charges occurred primarily along trails that received little human use although grizzly bears were also startled by hikers on trails with high levels of human use. Evidence indicated that habituation of grizzly bears' fear response did not lead to the increasing trend in the rate of human injuries. On the contrary, habituation may contribute to a reduction in the rate of injuries that result from fear-induced aggression. A possible mechanism for the increased rate of injuries is presented. Other types of aggression relevant to danger of human injury by grizzly bears are discussed.

226.0A

Jope, K.L. 1982. Interactions between grizzly bears and hikers in Glacier National Park, Montana. Final Rep. 82.1. Coop. Park Studies Unit, Oreg. State Univ., Corvallis, Oreg.

Behavior of grizzly bears (Ursus arctos) toward people was studied by examining hikers' reports of grizzly bear observations during 1980-81 in an area of Glacier National Park, Montana, that was heavily used by day hikers. Of concern were the apparent loss of fear of people by grizzly bears in the study area and the increasing rate of human injuries by grizzly bears in the park. Most hiker injuries had been inflicted after the hiker was charged by the bear. In the study area, only hikers that did not have bear-bells were charged. Although bears were occasionally startled by hikers on trails with the high levels of human use, charges occurred primarily on trails with little human use. This finding, as well as the tendency for hiker injuries to occur in areas of the park that received relatively little human use, indicated that habituation of grizzly bears to high numbers of hikers in the habitat may reduce the rate of injuries resulting from fear-induced aggression.

227.CH

Jordan, R.H. 1976. Threat behavior of the black bear (Ursus americanus. PP. 57-63 In: M.R. Pelton, J.W. Lentfer, and G.E. Folk (eds.) Bears--their biology and management. Int. Union Conserv. New Ser. Publ. 40, Morges, Switzerland.

Elements of threat in black bears occurred in stereotyped reliable sequences. Representative descriptions in the following contexts were described: threats by free-ranging and captive bears directed toward conspecifics, toward humans, threat behavior of cubs, and stiff-legged walking. Sequences were documented using Super-8 movie film. Offensive and defensive threats toward humans and other bears were similar. Males and females appeared to threaten in the same way. Threats by captive bears were identical to those of wild bears in terms of the elements present.

229.CH

Jorgensen, C.J., R.H. Conley, R.J. Hamilton, and O.T. Sanders. 1978. Management of black bear depredation problems. PP. 297-319 In: R.D. Hugie (ed.). Fourth East. Black Bear Workshop. Apr. 3-6, 1978. Greenville, Maine

This paper reviewed five types of bear depredations: livestock and poultry, wild game, apiaries, general depredations, and attacks on humans. Characteristics and number of specific losses were included and monetary losses summarized. Management options and methods for control were reviewed. A good literature review was included in each category of depredation.

234.0A

Keay, J.A., and J.W. Van Wagtendonk. 1980. Effect of backcountry use levels on incidents with black bears. In press In: E.D. Meslow (ed.) Proc. of 5th Int. Conf. Bear Res. and Manage., Feb. 10-13, 1980. Madison, Wisc.

Bear incidents, defined as occurrences of property damage by bears, have increased dramatically in the Yosemite backcountry in recent years. Since backcountry zones do not receive even visitor use, incidents could be compared between zones of various use levels. Data collected over a 4-year period show that as visitor use in a zone increased, reported bear incidents increased linearly. Since the zones were not of equal area, the data were further analyzed on a per 400 hectare basis. This analysis showed a similar relation with nearly a one-to-one relationship between incidents and use. Managers of backcountry areas must balance backcountry use with the level of bear incidents they feel is acceptable.

235.0A

Kendall, K.C. 1983. Trends in grizzly-human confrontations, Glacier National Park, Montana [Abstract only]. Proc. 6th Int. Conf. Bear Res. and Manage. Feb. 18-22, 1983. Grand Canyon Squire Inn, Grand Canyon, Ariz. p. 31.

Grizzly bears were involved in 25 incidents resulting in 28 injuries and 6 deaths in Glacier National Park between 1939 and 1982. Total park visitation predicted the number of incidents which occurred, but visitor distribution did not determine the location of incidents. Fifty-six percent of the incidents occurred in high visitor-use areas totaling 10% of the Park area. Forty-four percent of the incidents were located in the remainder of the Park which received less than 10% of the visitor use. Fewer incidents took place in June and more occurred in September than expected by monthly visitation. All hiker injuries caused by grizzly bears occurred between 0820 and 2000 hours and 53% occurred between 1400 and 1700 hours. The annual amount of bear-caused personal injuries and property damage which occurred from 1973 through 1983 was examined to test the hypothesis that there are years of significantly high and low levels of bear-caused problems. Mechanisms for the differences between years were discussed.

241.OA
Krames, L., N.W. Milgram, and D.P. Christie. 1973. Predatory aggression: differential suppression of killing and feeding. Behav. Biol. 9, 641-647.

Lithium chloride injections administered to rats after the feeding upon mice prey suppressed subsequent feeding, but not mouse killing. When administered immediately after killing (and before feeding), the same noxious stimulation did suppress subsequent killing. Differential recovery of killing and feeding was observed after the treatments were discontinued. It is concluded that predatory aggression consists of two separable behaviors: killing and feeding.

245.WR
Lacy, James, et all. 1952. Safeguard your livestock from bears, wolves, coyotes, killer dogs. Univ. of Wisc. Ext. Serv. (Wisc. Conserv. Dep. Coop.), Circular 411. April, 1952. 8 pp.

Recommends: high fences topped with charged wire; predator-proof shed for night use; keeping cows or goats with sheep to fight of predators; use of a good sheep dog; licensing of dogs and destruction of strays; disposal of carcasses or trimmings that might lure carnivores; belling sheep; notifying Conservation Department as soon as predation occurs, so that immediate action can be taken. The state has trappers and bear dogs. Bear can be hunted during deer season and there is no bag limit. Bear may be trapped throughout the year in 23 counties. Landowners or leasees may hunt or trap bear at any time on their lands. Laws pertaining to damage from predators or deer are quoted.

247.CH
LeCount, A. (ed.). 1979. First Western Black Bear Workshop. Mar. 20-22, 1979, Ariz. State Univ., Phoenix. 339 pp.

The proceedings of the First Western Black Bear Workshop were presented. State and provincial status reports from Western North America and a bibliography of recent black bear literature were included. This paper provides a good reference source of individuals and state personnel currently involved in bear black research and management in Western North America.

251.0A
Lehner. P.N., R. Krumm, and A.T. Cringan. 1976. Tests for olfactory repellents for coyotes and dogs. J. Wildl. Manage. 40(1):145-150.

Five coyotes (Canis latrans) and 3 dogs were individually trained to run from a start box across a 6,400 meters squared enclosure to a visual stimulus where they received a food reward. Candidate repellents were presented in the area of the visual stimulus, and their ability to inhibit the test animal's food-getting response was measured. Of the 45 candidate repellents tested, only -chloro-acetyl chloride repelled all of the test animals; however, it is a strong irritant and lachrymator and would be impractical for us in close proximity to sheep. Cinnamaldehyde showed some promise as a repellent. However, no chemical odor was found that consistently would repel coyotes and dogs but not adversely affect sheep.

254.0A
Leonard, R.D. 1983. A review and correction of bear management practices in some Canadian National Parks. [Abstract only]. Proc. 6th Intl. Conf. on Bear Res. and Manage., Feb. 18-22, 1983. Grand Canyon Squire Inn, Grand Canyon, Ariz. p. 34.

National Parks and National Historic Parks of Prairie Region lie in a broad triangle from the Yukon to Baffin Island southward to Manitoba. A wide range of habitat types, differences in visitor use patterns, and presence of grizzly (Ursus arctos), and black (Ursus americanus), and polar bears (Ursus maritimus) create complex problems that were examined in a review of bear management activities. Data from each park on number

and types of human-bear interactions, bear handlings, garbage management, visitor use patterns, relevant adjacent land-use practices and other factors were compiled. A regional bear management goal, based on policy and general enough to apply to natural and historic parks, was developed. More specific bear management objectives were developed for those parks which possessed resource management objectives in approved documents such as Park Management Plans, Conservation Plans, and Interim Management Guidelines. Six criteria which were believed to be important in a successful bear management program were used as tools in measuring the degree that present activities were fulfilling the assigned bear management objective and/or goal. Data from 8 parks were used to address each criterion. A matrix of 48 cells was set up to assess achievement quantitively. Achievement for individual parks ranged from 0 to 55%. Historic Parks scored lowest and newly-established parks scored highest. Mean park achievement was 34%. Individual criteria showed wide variations between 0 and 63%. Integration of bear management activities into planning processes and collection of biological data on bears were weak at 0 and 6%, respectively. Recognizing and correcting effects of adjacent land uses and preparation of annual summaries of human-bear interactions were low at 34 and 31%. Although data collected listed no maulings or deaths of humans, the evaluation detailed deficiencies in the present program and pointed to increased probability of problems as parks go through planning and development phases. To correct the situation a number of recommendations were made and initial steps of an implementation schedule are being undertaken. A regional directive was drafted which outlined responsibilities of visitor services, general works, interpretation and resource conservation of bears. Bear management plans were assigned to individual parks, with each sub-activity responsible for their relevant portion. The plans will detail all forms of action and planning necessary to upgrade or sustain bear management for a 3-5 year period. Each sub-activity is to produce an annually updatable, procedural guideline dealing with ongoing operational activities of handling problem bears, trail closure, garbage collection and storage, visitor education, and other requirements. Methods for monitoring the success of the plan were included as integral components.

257.
Linhart, S.B. 1975. Coyote depredations control research by the U.S. Fish and Wildlife Service. Proc. Coyote Res. Workshop, No. 14-17, 1074, Denver, Colo. Coyote Res. Newsl. 3(1):27 [Abstract].

Fifteen field trials were conducted to assess changes in coyote predation of pastured sheep associated with the nocturnal use of two types of strobe light and siren devices. Device 1 (10 trials) was composed of an electronic timer wired to a commercial strobe light, siren, and 12 vDC battery. Signals (10 sec.) were generated according to a fixed-interval sequence ($\bar{x}$ = 8 min., range = 2-15 min.) during darkness and for 102 h following sunrise. Device 2 (5 trials), a more portable, less expensive unit, was fabricated in a similar manner but utilized smaller components. Ten-second signals were generated at 7- or 13 min. intervals and activated either a strobe light or siren. Selection of test ranches was based on incidence of predation; a minimum of 5 sheep kills during a 3- to 23-day predevice period was required to start field trials. Subsequently, 1 or 2 Device 1, or 3 to 6 Device 2 units were placed within pastures of between 2 and 243 ha, and these were searched routinely for coyote-killed sheep. Ranchers were paid for sheep losses; all other methods of coyote damage control were discontinued during tests. Tests ended if ≥ 2 cumulative sheep kills occurred while devices were in operation, if lambs were marketed or corraled or if winter prevented access to pastures. Results were positive, but varied considerably among ranches. For Device 1, tests on 3 ranches ran between 8 and 20 nights; on 3 other ranches, tests lasted between 41 and 46 nights; whereas on the remaining 4 ranches tests ended after 76 to 103 successive nights. For all 10 tests, the devices afforded a mean of 53 (SD - 33.7); range = 8-103) nights of protection. For Device 2, tests on 4 ranches lasted between 94 and 136 nights, whereas on the 5th ranch the test ended on the 27th night when 2 kills occurred. A mean of 91 (SD = 40; range = 27-136) nights of protection was obtained for all 5 tests. Implications of these data to coyote management and suggestions for additional research are discussed.

262.0A
Lord, W.G. 1980. Bear depredation of beehives. M.S. Thesis. N.C. State Univ., Raleigh, vi + 69 pp.

A survey of 62 states and provinces (S/P) in the USA and Canada revealed that bear damage to hives is a problem in 39 of them. Nine S/P have compensation programs and there are bear control programs in 29; the most common and most effective measure is the erection of electric fencing, but hunting and trapping are also used. Substantial numbers of bears are being killed by or for beekeepers in 4 S/P. Surveys of North Carolina beekeepers from 1977 to 1979 showed considerable annual losses due to bear damage, which occurred mainly from April to the end of June, with a smaller peak in August to November. In a 3-year study of 116 apiaries there were 26 attacks on 24 of them. Overall there were no signigicant differences due to variation in understory density, tree stand, or history of bear attacks. The presence of a bear fence was significant (at the 1% level) in preventing damage to hives.

264.0A
Lord, W.G., and J.T. Ambrose. 1981a. Black bear depredation of beehives in North Carolina. 1977-1079. Am. Bee J. 121(6):421-423.

Surveys revealed that during 1977-1979, commercial beekeepers lost 6.5% on average of their total income through bear damage. The depredation will probably continue, as areas of suitable bear habitat are constantly being reduced. The most effective method of control is the proper construction and maintenance of electric fences.

266.0A
Loucks, D.E. 1978. A preliminary review of human-black bear interactions and recommended strategies for the AOSERP study area. Proj. TF3.2. Alberta Oil Sands Environ. Res. Program, Edmonton, Alberta, Canada. 61 pp.

The purpose of the report was to examine the components which have resulted in the establishment and maintenance of "nuisance" bear populations (i.e., the interaction between bears and a food supply generated by man's activity), and the management strategies which may be implemented to reduce the problem, with particular reference to the AOSERP study area.

Case studies from the Canadian Western National Parks, Yellowstone National Park, Glacier National Park, and the Peace River area, examining the evolution of the interaction problem and management strategies implemented, were used to supply the background information for a problem analysis of human-bear interactions in AOSERP study area.

The analysis of human-bear interactions in the AOSERP study area indicated that the major conflict arises from nuisance bears attracted to areas by garbage. Recommendations emphasize a preventative policy, whereby garbage is made bearproof (i.e., sanitary landfill surrounded by an electric fence, garbage incineration, etc.), thus saving the costs of transporting and relocating nuisance animals.

Maehr, D.S. 1982. Beekeeping enters the solar age. Am. Bee J. Apr. 1982, PP. 281-282.

The design of a solid state solar powered electric fence was reported. The designer maintained he had not experienced bear depredation on any apiary enclosed by a fence of this design. The design was simple and more reliable than conventional electric fence systems. The principle components of this system were: a reliable, powerful fence charger, solar powered if possible, at least 4 alternating hot ground barbed wires. The gel battery was designed to provide a full charge even in total darkness for 14 days. This system was reported to have been effective in protecting sheep from coyotes, and crops from elephants in Africa.

275.CH
Martinka, C.J. 1974. Preserving the natural status of grizzlies in Glacier National Park. Wildl. Soc. Bull. 2(1):13-17.

An integrated program of visitor information and travel restrictions was reported. Bear control and removal of unnatural foods were accompanied by fewer injuries (0.2/1,000,000 visitors) and bear-caused deaths (1.0/hear) than in previous years. Current and proposed grizzly management programs and grizzly/human relationships were discussed.

278.CH
Martinka, C.J., and K.L. McArthur (eds.) 1980. Bears—their biology and management. The Bear Biol. Assoc. Conf. Ser. No. 3., U.S. Gov. Printing Office, Wash. D.C. 375 pp.

Contains 60 papers presented at the Fourth International Conference on Bear Research and Management at Kalispell, Montana, U.S.A., February, 1977. Papers are presented under the following categories: concept of critical habitat as applied to grizzly bear; computers and models in bear research and management; anatomy and physiology of bears; black bears in Japan; biology of polar bears; biology, ecology, and management of black bears in eastern habitats; biology, ecology, and management of black bears in western habitats; biology, ecology, and management of Eurasian brown bears; biology, ecology, and management of grizzly bears; and a monograph.

282.CH
McArthur, K.L. 1979. The behavior of grizzly bears in Glacier National Park—a literature review. Natl. Park Serv. Prog. Rep. 71 pp.

Existing information on grizzly bear behavior was reviewed. Included were a discussion of the evolution and biology of the grizzly bear, interactions between bears, and interactions with people. Some studies of black bears and concepts of animal behavior were reviewed where they contributed to an understanding of the grizzly.

283.OA
McArthur, K.L. 1980. Habituation of grizzly bears to people: a hypothesis. In press In: E.C. Meslow (ed.). Proc. of 5th Int. Conf. Bear Res. and Manage., Feb. 10-13, 1980. Madison, Wisc.

Reports of grizzly bear (Ursus arctos) observations between 1977 and 1979 in Glacier National Park were examined to test the hypothesis that the behavior of grizzlies is different in areas with high levels of human activity than in areas with relatively little human activity. In the study area, which receives heavy human use, as well as in the remainder of the park, females with young were much more likely than adults and subadults to avoid human-use areas and showed very little habituation to people in the study area. A mid-season increase in habituated behavior by adults and subadults occurred in both the study area and parkwide, but adults and subadults in the study area showed a much greater degree of habituation throughout the season. Early-season habituation exhibited by adults and subadults in the study area probably reflects long-term habituation to frequent human contact. Bears that habituate to contact with people are able to take advantage of sources of natural food located in the vicinity of human-use areas. However, if behavioral changes associated with habituation to people contribute to unacceptably high levels of human-bear conflicts, they may compromise the continued preservation of grizzly bears in national parks.

284.0A
McArthur, K.L. 1981. Factors contributing to effectiveness of black bear transplants. J.Wildl. Manage. 45(1):102-110.

One hundred seventy transplants of 112 black bears (Ursus americanus) in Glacier National Park during 1967-77 were evaluated to identify factors that contributed to transplant success. Distance, number of ridges, elevation gain, and physiographic barriers between the trapping and release sites were highly correlated with the success of transplants. Differences in the importance of distance and elevation gain between males and females and between inexperienced and experienced bears were identified. Adult transients may make up a substantial portion of the nuisance bear population.

285.0A
McArthur K.L. 1981a. Methods in the study of grizzly bear behavior in Glacier National Park. Proc. 2nd. Conf., Sci. Res. Natl. Parks 6:234-247.

Confrontations between grizzly bears (Ursus arctos) and people in national parks have primarily involved (1) the unexpected close-range encounter of a female with young by hikers on a backcountry trail, and (2) the aggressive foraging in a campground by a grizzly that has learned to associate human presence with food availability. Between 1968 and 1972, following a concerted effort to make human food unavailable to grizzly bears in Glacier National Park, the rate of grizzly/human confrontations declined. Beginning in 1972, however, the number of encounters in the park began to increase dramatically. An unprecedented proportion of the encounters involved single adults and subadults rather than family groups, and it became fairly common for a grizzly to ignore or approach park visitors, generally on the most heavily used trails. It is hypothesized that grizzly bears habituate to park visitors in much the same way that they habituate to other bears in feeding aggregations; human-bear habituation may result in circumstances that are conducive to increased confrontation rates. Methods currently being used to test this hypothesis and some preliminary results are presented.

287.CH
McAtee, W.C. 1939. The electric fence in wildlife management. J. Wildl. Manage. 3(1):1-13.

The general use and construction of electric fences for wildlife management were summarized. Fence construction for specific wildlife species as reported by various researchers were detailed. The author included suggestions for improvements in construction, reviewed objections to their use, and made some cautionary suggestions.

291.0A
Meagher, M., J.R. Phillips. 1980. Restoration of natural populations of grizzly and black bears in Yellowstone National Park. 17 + 10 pp. In press In: E.C. Meslow (ed.). Proc. of the 5th Int. Conf. on Bear Res. and Manage. Feb. 10-13, 1980. Madison, Wisc.

Yellowstone National Park embarked on an intensive bear management program in 1970, with the intention of restoring and maintaining natural populations of grizzly and black bear. The park closed the last of its large open pit garbage dumps in 1971. During the decade 1970-1979, bear management has gone through several phases. The period 1970 through 1974 covered the intensive phase of translocating and/or removing incorrigibles with strong ties to sources of human foods. Efforts to educate people were coupled with increased law enforcement. Intensified sanitation, refinement of management techniques and development of a monitoring system to provide management information all marked this period. The next period, 1975 through 1978, represented a transition from a time of correcting a situation to awareness that a high level of preventive bear management must be a routine and never-ending part of park operations. With the 1979 season, the bears knowledgeable about human food sources appear to be essentially gone from the populations. Thus, over a time of ten years, the park appears to have attained the objective of restoring natural populations to the extent that outside influences beyond the park′s control will permit. In the future, the long term coexistence of bears and people in Yellowstone will be successful if we are unable to detect behavioral or numerical changes in either grizzly or black bear populations which can be attributed to human influence.

292.0A
Merrill. E.H. 1978. Bear depredations at backcountry campgrounds in Glacier National Park. Wildl. Soc. Bull. 6(3):123-126.

Ecological and human-use parameters of 56 backcountry campgrounds in Glacier National Park were measured to determine factors which predispose these sites to black bear (Ursus americanus) and grizzly bear (U. arctos) depredation. Examination of 50 bear incidents indicated that an unexpectedly high number of bear incidents occurred in deteriorated campgrounds in mature forests which were within 5 km of a developed area. and which had large party limits and good fishing nearby. Changes in present campground management are recommended to minimize human-bear conflicts.

294.0A
Mihalic, D.A. 1974. Visitor attitudes toward grizzly bears in Glacier National Park, Montana. M.S. Thesis. Mich. State Univ., East Lansing. 131 pp.

The grizzly bear (Ursus arctos horribilis) is probably among the world's most dangerous animals, yet there are surprisingly few human deaths caused by bears, especially in national parks. The publicity generated by each gives the illusion that bear incidents are a relatively common occurrence. A total of six persons have been killed in North American national parks since 1872. However, there are advocates to remove bears from national parks for safely reasons. The dilemma faced by park managers is one of human-grizzly bear coexistence, or how to allow visitor use while at the same time preserving natural animal populations.

Most studies of the human-grizzly bear coexistence problem have been ethological in nature. These studies, and the few dealing with the human portion of the problem, suggest that an answer lies in the study of human attitudes. Interviews were administered to 158 visitors to Glacier National Park, Montana, to discover their attitudes toward the grizzly bears, how their attitudes are formed, and what effect attitudes have on visitor behavior in hypothetical bear-encounter situations.

Miller, G.D. 1980. Behavioral and physiological characteristics of grizzly and polar bears, and their relation to bear repellents. M.S. Thesis Univ. of Mont., Missoula. 106 pp.

The purpose of this study was to develop and evaluate techniques to monitor the behavior and physiology of grizzly and polar bears and to relate the physiological parameters to the bears' behavior. This information was then integrated into tests of possible bear repellents.

Using captive animals (2 male grizzlies Ursus arctos horribilis, and 2 female polar bears U. maritimus) behavioral observations were made while simultaneously measuring heart rate, deep body temperature, and sub-cutaneous temperature. Observations were done first on undisturbed animals and then while the animals were presented with possible repellent stimuli. In addition to laboratory studies, possible repellents were tested on free-ranging polar bears.

The physiological parameters are related to the behavioral parameters, but the relationships are complex. It is possible to predict what a bear's behavior is by analyzing the physiological parameters that can be monitored with radio-telemetry.

The behavior and physiology of the bears were also observed during repellent tests. Fifteen to 18 stimuli were tested on each bear. The stimuli were chosen from a list of possible repellents that included recorded bear and people sounds, bells, horns, chemicals, and others. Extremely loud and sharp sounds were consistently repellent, as were most of the chemicals. The use of captive animals is a valid method for testing many stimuli in a relatively short time.

The field tests of possible repellents were made on free-ranging polar bears near Churchill, Manitoba. The polar bears were attracted to the observation area with sardine baits. After a 2-week control period, commercial dog repellents and household chemicals were broadcast around 10 bait sites. A speaker was placed at another site to test recorded sounds on the bears and a freon-powered horn was tested in the area when possible.

Most bears (81%, n = 31) were repelled with the horn, but the behavioral reactions to the taped sounds were variable. The chemical repellents did not prevent bears from visiting the sites, but the bears spent less time at all the treated sites than at the controls. The field tests compliment the laboratory tests by allowing tests with a few stimuli on many different bears.

298.0A

Miller, G.D. 1980a. Responses of captive grizzly and polar bears to potential repellents. 11 + 7 pp. In Press <u>In</u>: E.C. Meslow (ed.). Proc. of the 5th Inter. Conf. on Bear Res. and Manage. Feb. 10-13, 1980. Madison, Wisc.

A series of possible bear repellents were tested on two male grizzly bears and two female polar bears. The tests were performed at the Churchill Bear Laboratory, Churchill, Manitoba.

Each bear was implanted with radio-transmitters to monitor its heart rate, body temperature, and sub-cutaneous temperature in order to measure the bear's physiological response in addition to the observed behavioral response.

After the implantations and an appropriate recovery period, a series of basal observations were performed. The bears' activity, posture, and facial expressions were observed while the physiological parameters were measured periodically. Stimuli were chosen randomly from a list of possible deterrents and appropriate controls. Fifteen to 18 stimuli were tested on each bear. The stimuli included recorded bear and people sounds, bells, horns, whistles, a Thunderflash, commercial dog repellents, a few household chemicals, and a "loom" stimulus that consisted of suddenly presenting the surface of a 3' X 5' piece of plywood to the charging bear.

The results indicated that though some recorded sounds induce caution in the animals, only the extremely loud and sharp sounds are consistently repellent (Thunderflash, Boat-horn, and Cap-chur gun). On the other hand, all of the chemicals sprayed in the bears' faces were effective repellents but with varying intensities. Though some of the stimuli were very effective, the duration of the response was consistently short-lived (five minutes or less).

Finally. the utility of coupling the physiological response to the behavioral response is discussed with respect to bear repellent studies.

299.0A
Miller, S.D., and W.B. Ballard. 1982. Homing of transplanted Alaskan brown bears. J. Wildl. Manage. 46(4):869-876.

Forty-seven brown bears (Ursus arctos) were captured and transplanted in Alaska in 1979. Post-release data were adequate to evaluate the survival and homing movement for 20 adults and 9 young. At least 12 adults (60%) successfully returned from an average transplant distance of 198 km. Age (for males) and distance transplanted (sexes combined) were directly related to observed incidence of return (P = 0.05). Sex or reproductive status did not appear to be related to observed incidence of return. Initial post-release movements of non-homing as well as homing bears indicated that most bears were aware of the correct homing direction. None of the transplanted females was known to have produced young in the year following transplanting. Six of 9 cubs or yearlings transplanted with their mothers were lost. Transplanting nuisance brown bears does not appear to be a reliable management procedure.

309.0A

Mysterud, I. 1980. Bear management and sheep husbandry in Norway, with a discussion of predatory behavior significant for evaluation of livestock losses. 1980. PP. 232-241 In: C.J. Martinka, and K.L. McArthur (eds). Bears--their biology and management. Bear Biol. Assoc. Conf. Ser. No. 3. U.S. Gov. Printing Off., Washington, D.C.

During the 19th century, the brown bear (*Ursus arctos*) population in Norway was reduced to remnant level. The population has since been restored and recently seems to be increasing. Concern is present for bear management in connection with sheep predation, as sheep husbandry is important throughout Norway, the stock in 1976 amounting to 1.6 million animals. The management technique now practiced combines selective hunting of troublemakers with monetary compensation for sheep killed.

The number of sheep killed by bears is insignificant compared with the total sheep mortality, and bear predation is important only locally, primarily in areas in Hedmark, Hordaland, and Finnmark counties. Ethical arguments against bears are raised in connection with observations of overkill, and a research program has been initiated to analyze predation patterns in greater detail.

Overkill by bears is not restricted to surplus killing. In most cases, small amounts are consumed from each carcass--nutritionally valuable parts such as breast fat deposits and udders. This behavior may represent extreme food selection under plentiful prey conditions and should be compared with selective grazing among herbivores. The organization of behavior in predatory mammals relevant to livestock losses is discussed.

311.OA
Nelson, D.A. 1974. Bear damage and control. Canadian Beekeeping 4(9): 67-69.

Beekeepers in most Canadian provinces suffer losses through bear damage; an estimate for Alberta in 1973 is $200,000. It is estimated that the figure would have been $500,000 if the Peace River bear control program had not been undertaken. It was concluded from this operation that electric fences are probably the most effective in preventing hive damage by bears. Five suitable types of fence are described; hives should be situated at least 3 feet (1m) inside the fence, and the battery must be well maintained.

314.CH
Olsen, A. and P.N. Lehner. 1978. Conditioned avoidance of prey in coyotes. J. Wildl. Manage. 42(3):676-679.

The effectiveness of a conditioned avoidance procedure using self-delivery of punishment to inhibit predatory behavior in coyotes was investigated. Also evaluated were the importance of prominent conditioned stimuli and the effect of alternate prey on the establishment and duration of conditioned avoidance. Tests were conducted on 8 captive coyotes. A coyote-getter was used for the delivery of the aversive agents, vanillyl-undecenoylamide and later lithium chloride. One each of representative olfactory, visual, and auditory stimulus was chosen as a conditioned stimulus. An overall increase in magnitude of the apparent punishment, in addition to an increase in prominent stimuli present for association between punishment and live prey, provided the most effective establishment of prey avoidance. The data suggest that the visual stimulus was most important in the establishment of a conditioned avoidance. The significance of an alternative prey in sustaining a conditioned response appeared highly variable.

319.OA
Pecharsky, L. 1975. Evaluation of electric fence efficacy at beeyards in Peace River area: 1974. Wildl. Invest. Prog. Rep. Alberta Dep. of Lands and For. Fish and Wildl. Div. Edmonton. Unpublished 24 pp.

Sixty-two electrically-fenced beeyards were monitored during the 1974 Peace River honey-producing season. Greatest bear activity at these yards occurred in spring and fall. Nine penetrations resulted from 80 bear visits to 39 yards. Charge condition proved to be the most important factor in determining fence efficacy. About 250 electric fences were constructed in the Peace River area in 1974. Of these. 206 were claimed under the subsidy program. Cost-benefit calculations indicated a saving of 208 dollars per fence per year. The electric fence subsidy program should continue in 1975.

320.CH
Pelton, M.R., J.W. Lentfer, and G.E. Folk (eds.) 1976. Bears--their biology and management. Int. Conserv. of Nat. Res. Publ. New Ser. No. 40. Morges, Switzerland. 467 pp.

Contains 28 papers presented at the First International Conference on Bear Research and Management at Calgary, Alberta, Canada, November 6-9, 1970. Papers were presented under the following categories: the ecology, population characteristics, movements and natural history of bears; denning-control mechanisms; site selection and physiology; polar bear studies; bear behavior; and bears and human beings. A summary of panel discussions held in each category is presented.

325.OA
Poelker, R. and L.D. Parsons. 1980. Black bear hunting to reduce forest damage, 1980. PP. 191-193 In: C.J. Martinka and K.L. McArthur (eds.) Bears--their biology and management. Bear Biol. Assoc. Conf. Ser. No.3. U.S.Gov. Printing Off., Washington, D.C.

Before 1973, the State of Washington had a spring black bear (*Ursus americanus*) season from 1 April to 30 June throughout most of the area west of the Cascades in an attempt to alleviate damage to forest tree reproduction. Extensive efforts by professional control hunters were still needed to keep damage at an acceptable level. Indications that sport hunting might be more effective in controlling damage resulted in an effort to concentrate sport hunting in problem damage areas. The general spring season was discontinued and a system of special hunts, by unit, was established. The extent of the area open to hunting was reduced by about 75%. Success of the program was evaluated by comparing 3 years' data collected under the unit system with 3 years' data from the general open season. The bear kill increased from an average of 503 per year in the general open season to 740 per year under the unit system. Bear tag sales increased by 81% during the same period.

328.CH

Pruitt, C.H. 1976. Play and agonistic behavior in captive black bears. PP. 79-86 *In*: M.R. Pelton, J.W. Lentfer, and G.E. Folk, Jr. (eds). Bears-- their biology and management. Int. Union Conserv. Nat. New Ser. Publ. 40. Morges, Switzerland.

Instances of intra-specific social play, solitary play, naturally-occurring aggression, and experimentally manipulated aggression were examined. Observations were documented using super-8 movie film. Types of behavior shown during initiation of play or aggression were placed in five categories: biting, paw movement, locomotion, head movements, and vocalizations. Agonistic behavior was observed to have three clear stages: preparation to attack, physical contact or threat, and resolution. Predictability and possible signal value of body postures in social interactions of play and aggression were briefly discussed.

334.OA

Riegelhuth, R. 1966. Grizzly bears and human visitation. M.S. Thesis. Colo. State Univ., Fort Collins. 80 pp.

A study was conducted to gain insight into relationships between grizzly bear Ursus arctos and human visitation in wildlands. Data were primarily secured from responses to questionnaires received from 16 parks, wilderness areas, and other wildland designations.

Data indicated that back country (roadless area) visitation by non-hunting recreationist, at present levels of use, is not an important factor with regard to grizzly survival and well-being. Except for some attraction to garbage dumps, respondents reported no increased use by grizzlies of visitor concentration sites as human visitation increased.

Wildland units over 1,000 square miles in extent were considerably more successful than smaller areas in maintaining grizzly numbers. Similarly park-type management was much more successful in perpetuating a grizzly population than was wilderness area management. Hunting and predatory animal control are important factors, and under certain conditions can lead to serious population reduction.

The incidence of unprovoked grizzly attack on non-hunting recreationists though always a possibility, is extremely rare.

335.CH
Riley, A.L., and C.M. Clarke. 1977. Conditioned taste aversion: a bibliography. PP. 593 -610 In: L.M. Barker, M.R. Best, and M. Domjam (eds.). Learning mechanisms in food selection. Baylor Univ. Press, Waco, Tex.

This bibliography listed 632 articles dealing with conditioned taste aversions from 1950-1976. References were classified in a topical index under the following categories: conditioning variables, extinction, and retention variables, methodological variables, physiological manipulations, comparative/field aspects, and general information.

341.OA
Roop, L.J. 1983. Relocation of grizzly bears in the Yellowstone region. [Abstract only]. Proc. 6th Int. Conf. Bear Res. and Manage. Feb. 18-22, 1983. Grand Canyon Squire Inn. Grand Canyon, Ariz. p. 44.

Various state and federal agencies have for decades used relocations as a means of managing nuisance or problem grizzly bear (Ursus arctos horribilis) in the Yellowstone region. The "Guidelines for management involving grizzly bears in the Greater Yellowstone Area", of which all agencies responsible for managing grizzly bear are presently signatories, require that nuisance bear be relocated in most circumstances. During 1981 there were 32 relocations of grizzly bear in the Yellowstone population. Case histories of relocations in the past several years are discussed. Transplantings or relocations of bear are analyzed by time of the year, nature of the problem, history of the bear, distance and direction of relocation, sex and age of the bear, etc. The effectiveness of relocation as a management practice is discussed. Common factors of past successful and unsuccessful relocations are used to give guidelines for evaluating the success or failure of future relocations.

346.0A

Rozin, P., and J.W. Kalat. 1971. Specific hungers and poison avoidance as adaptive specializations of learning. Psychol. Rev. 78(6);459-486.

Learning and memory are considered within an adaptive-evolutionary framework. This viewpoint is illustrated by an analysis of the role of learning in thiamine specific hunger. Consideration of the demands the environment makes on the rat and the contingencies it faces in the natural environment, appreciation of the importance of the novelty-familiarity dimension for these animals, and the realization of two new principles of learning, permit a learning explanation of most specific hungers. The two new principles "belongingness" and "long-delay learning" specifically meet the peculiar demands of learning in the feeding system. In conjunction with the importance of the novelty dimension, they are discussed in an attempt to develop the laws of taste-aversion learning. It is argued that the laws or mechanism of learning are adapted to deal with particular types of problems and can be fully understood only in a naturalistic context. The "laws" of learning in the feeding system need not be the same as those in other systems; manifestation of a learning capacity in one area of behavior does not imply that it will be accessible in other areas. This notion leads to speculations concerning the evolution and development of learning abilities and cognitive function. Full understanding of learning and memory involves explanation of their diversity as well as the extraction of common general principles.

347.OA
Rusiniak, K.W., C.R. Gustavson, W.G. Hankins, and J. Garcia. 1976. Prey lithium aversions II: Laboratory rats and ferrets. Behav. Biol. 17:73-85.

Lithium-induced prey aversions were studied in the laboratory rat and ferret. Both species acquired aversions, blocking consumption of flavored foods and the flesh of mice. In the rat, attack was also blocked when illness immediately followed mouse-killing, when mice were dipped in a strongly aversive flavor, and when illness followed killing and eating of prey dipped in an artificial flavor with strong olfactory and gustatory properties. Testing context was of some importance. The ferret, on the other hand, continued to attack, killing mice with its feet rather than with a bite to the neck. Strong footshock produced a transient inhibition of attack that was specific to the training situation. These results with laboratory species are in distinct contrast to those with wild predators.

351.OA
Schafer, E.W., Jr., R.B. Brunton, and N.F. Lockyer. 1977. Learned aversion in wild birds: a method for testing comparative acute repellency. PP.186-197 In: R.E. Marsh, W.B. Jackson (eds.). Am. Soc. Testing and Materials.

A method was developed to measure the comparative acute learned aversion of a number of wild bird species to repellent chemicals. It was shown that both the innate acute response and the intensity and duration of the learned response of bird to repellents vary among species. Two repellents, methiocarb and thiram, were tested by the described method. Methiocarb produced the stronger and more lasting response in most species; thiram was much more variable in its acute effects, and the intensity and duration of the learned response tended to be weaker and shorter.

Factors relating to improving the test methodology presented are discussed, especially with regard to the species tested.

352.CH
Schmidt, D.R. 1982. A brown bear (Ursus arctos) encounter in the Brooks Range, Alaska. Canadian Field-Nat. 96(3):347.

A human-brown bear encounter in which the human initiated the physical contact was described. The bear approached from about 75m. An explosive device, shouting, and waving of the arms and throwing rocks were not effective in deterring its approach. The animal stopped at 4m. and directed its aggression at alder bushes, then gave chase when the author attempted to run away. The bear retreated only after the author had swatted it on the nose and assumed a low, wide-spread stance with direct eye contact.

358.CH
Sebeok, T.A. 1977. How animals communicate. Ind. Univ. Press, Bloomington, Ind., and London, England. 1128 pp.

Contains 38 papers on animal communication classified under the following categories: theoretical issues, mechanisms of communication, and communication in selected groups. Sections on communication in ursids, canids, felids, and other selected carnivores were included. Reviews of the state-of-knowledge and references for each group are useful.

362.CH
Silver, W.T. 1953. Comparative effectiveness and cost of chemical repellents. Job Compl. Rep. No. 13-R-6. Job No. IIIA. N.H. Fish and Game Dep., Res. and Manage. Div. Unpublished 5 pp.

The relative effectiveness of Goodrite Z.I.P. and Diamond-L in deterring deer from browse were compared. Data from a small sample size suggested there was no significant difference between the effects of the two chemicals. Although both repellents appeared to offer a significant amount of protection to browse during this study, previous experiments showed no effect on the deer when food was scarce.

364.0A

Singer, F.J., and S.P. Bratton. 1980. Human-Black bear conflicts in the Great Smokey Mountains National Park. PP. 137-139 In: C.J. Martinka and K.L. McArthur, (eds.). Bears--their biology and management. Bear Biol. Assoc. Conf. Ser. No. 3. U.S. Gov. Printing Off., Washington, D.C.

An evaluation was made of 1,028 reports of human-black bear (*Ursus americanus*) incidents involving personal injuries, property damage, and bear control actions in Great Smoky Mountains National Park, 1964-1976. Respective totals for personal injuries and incidents of property damage were 107 (range, 1-23 per year) and 715 (range, 9-116 per year). Captures and relocations for the period numbered 332, and 18 bears were destroyed. Seventy-six percent of the nuisance bears were males. Improper food storage, violations of park regulations, and high levels of visitor use at certain campsites, shelters and along a few main roads and trails are factors contributing to human-bear conflicts.

365.CH

Sixth International Conference on Bear Research and Management. 18-22 February 1983. Grand Canyon Squire Inn, Grand Canyon, Ariz. [Abstracts] 65 pp.

Contains the program and abstracts of papers for the sixth conference presented by the Bear Biology Association, Grand Canyon Squire Inn, Grand Canyon, Arizona, 18-22 February 1983. Topics of papers involve various aspects of bear biology and ecology.

372.OA
Stenhouse, G.B. 1982. Bear detection and deterrent study, Cape Churchill, Manitoba, 1981. Rep. No 23 for the Gov. Northwest Territ., Canada. 65 pp.

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=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 38mm 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=50) of the polar bears tested (N=54) passed through the electrified fence.

373.CH
Stenhouse, G.B. 1983. Bear detection and deterrent research program: A summary. Rep. to the Gov. Northwest Territ. Wildl. Serv. Dept. of Renewable Resour. 3 pp.

Polar bears at Cape Churchill, Manitoba, were tested with deterrent and detection devices as they approached an observation tower during the 1981 and 1982 field seasons. Results are summarized in this report; an in-depth report is currently in preparation.

In 1981, microwave motion detection units were 100% successful in detecting approaching bears during daylight hours. Bears struck by rubber batons fired from a riot gun were successfully deterred as they approached the tower. All bears darted with an antibiotic left the area. An electrified barbed wire fence allowed 93% of the bears to pass through and enter the area.

In 1982, the microwave detection units again detected all approaching bears. A trip-wire fence warning system appeared to have potential for use in small camps. Audio-sirens and recordings of barking dogs were ineffective in deterring bears. The rubber batons were effective in deterring bears from a food source; however, some bears required two to four hits before leaving. Plastic slugs did not deter bears from the site.

Work on this project will be continued in 1983.

379.OA
Stokes, A.W. 1970. An ethologist's views on managing grizzly bears. BioSience 20(21):1154-1157.

Grizzlies should be managed using ecological principles. Food shortage and social intolerance probably limit bear numbers. Removal of artificial food may cause a drop in carrying capacity with temporary increased movement to campgrounds and dispersal outside park boundaries. Bears should be removed promptly from trouble spots and released in unsaturated habitat. Prompt publication of research will lead to better public understanding of bear problems.

381.CH
Stonorov, D., and A.W. Stokes. 1972. Social behavior of the Alaska brown bear. PP. 232-242. In: S. Herrero (ed.). Bears--their biology and management. Int. Union Conserv. Nat. New Ser. 23, Morges, Switzerland.

Alaska brown bears were observed during the summer of 1970 as they concentrated on the McNeil River Falls, Alaska, during the salmon run. The social behavior and visual signals used to set up and maintain a social structure while dividing the food resource over space and time were investigated. The social hierarchy appeared to be based on sex, age, and size, and was established and maintained by aggressive encounters. Individual behavior components displayed during encounters were examined to assess the value of threat or appeasement signals in reducing physical contact. Orientation, in conjunction with various movements, appeared to be the primary means of conveying information to opponents. Certain components were associated with dominance or subordinance. The data were inadequate to show whether these components would modify the behavior of an opponent. Conflict was also minimized by spacing between individuals. Social intolerance by dominant bears restricted some bears from using the Falls altogether.

382.CH
Storer, T.I., G.H. Vansell, and B.D. Moses. 1938. Protection of mountain apiaries from bears by use of electric fence. J. Wildl. Manage. 2(4): 172-178.

Tests of electric fences designed to protect mountain apiaries from bear depredation were reported. Electric fence enclosures were tested on black bears attempting to use bait piles in Yosemite. Later, these fences were tested at commercial apiary sites. Fences were highly successful in keeping bears out. Construction of the most effective fence design is detailed. Recommendations include using 4-strand barbed wire with all strands charged, an interrupted current with 30-50 impulses per minute and of not more than 0.1 second duration, and a current to exceeding 0.015 ampheres.

385.OA
Stuart, T.W. 1980. Exploration of optimal backcountry travel patterns in grizzly bear habitat. PP. 25-32. In: C.J. Martinka and K.L. McArthur (eds.). Bears—their biology and management. The Bear Biol. Assoc. Conf. Ser. No. 3. U.S.Gov. Printing Off., Washington, D.C.

Trade-offs among backcountry management objectives were explored for the northern half of Glacier National Park, Montana. Parametric linear programming was employed to quantify the trade-offs among 5 objectives, consisting of 3 measures of trail-related contact between grizzly bears (Ursus arctos) and humans (dangerous, nondangerous, total), a measure of solitude at the backcountry campsites, and the volume of backcountry overnight use. Contact indices were developed for these measures of contact for 3 time periods for each of 85 trail segments in the study area. Optimal patterns of backcountry overnight use were identified for various combinations of objectives within 2 management models. The first model minimizes all trail-related contacts between humans and grizzlies. The second model minimizes only dangerous contacts. Parametric linear programming is shown to be a powerful technique for dealing with multiobjective problems of the size and complexity considered in this study.

391.0A
Tate, J. 1983. Behavioral patterns in human-bear interactions. Paper [Abstract only]. Proc. 6th Int. Conf. Bear Res. and Manage. 18-22 Feb. 1983. Grand Canyon Squire Inn, Grand Canyon, Ariz.

Interactions between panhandling black bears (Ursus americanus) and park visitors were analyzed to determine whether distinct patterns existed, if particular actions by humans were more likely to lead to agonistic behavior by bears, and to ascertain the effectiveness of agonistic displays in interspecific communications. During the study, conducted in Great Smoky Mountains National Park from 1976 through 1978, continuous field notes were used to record the behavior exhibited by both species in these encounters. For each panhandling session the frequency of occurrence of the following visitor activities was tabulated: toss feeding, handfeeding, photographing, photographing while kneeling, petting, harassing, high noise level, and the sum of all visitor acts. The number of aggressive acts performed by bears and the level of aggression, based on a numerical ranking of the seven types of aggression by apparent severity, were also recorded. Of 67 sessions, 38 (56.7%) contained aggression. The total number of interactional behaviors by visitors was 1,332, most (69.7%) of which were recorded in sessions containing agonistic behavior. While toss feeding was the most likely of visitor acts to occur overall, the percentages of harassing, handfeeding, and petting ranked higher in aggressive sessions. Multiple regression analysis showed greater predictability based on the level of aggression rather than the number of aggressive acts, indicating that both people and bears distinguished among the intensity of different types of aggression. Discriminant analysis used to compare aggressive and non-aggressive sessions, resulted in 9 (24.5%) misclassified observations; all involved one adult female or her yearling son. Sequential analysis of human-bear interactions, utilizing 94 aggressive acts as focal points, revealed much disparity in frequency of visitor acts prior to and subsequent to agonistic behavior. Visitor activities peaked immediately preceding aggression and subsided substantially thereafter. Similarly, bears were more likely to approach people prior to aggression and to retreat afterward. The trend was especially pronounced when aggressive acts of higher intensity were involved. The outcome of human-bear interactions was influenced by the invasion of individual space and the duration of the panhandling session. Results indicated that bears used agonistic displays as a form of interspecific communication. Moreover, their value as signals was reinforced because such delays were effective at establishing greater distance between visitors and bears, hence alleviating the inherent stress of the interactions.

392.0A

Tate, J., M.R. Pelton. 1980. Human-bear interactions in Great Smokey Mountains National Park. In press In: E.C. Meslow (ed.). Proc. of 5th Inter. Conf. on Bear Res. and Manage. 10-13 Feb. 1980. Madison, Wisc.

An ethological investigation of panhandler black bears (Ursus americanus), conducted in the Great Smoky Mountains National Park from 1976 through 1978, focused on agonistic behavior exhibited by these bears in their interactions with park visitors. Seven different types of aggression were reported. Apparent precipitating factors for such behavior were divided into 20 categories, e.g., handfeeding, petting, photographing, crowding. Of 392 panhandling sessions, 43.9% contained at least one incidence of agonistic behavior; overall 624 aggressive acts were recorded. Some types of aggression were more likely to occur, and certain precipitating factors were likely to result in specific types of agonistic behavior. Less than 6% of all aggression led to actual physical contact with visitors. Analysis by individual bears showed that some animals reacted more aggressively in their interactions with people. This was discussed relative to sex-age differences, the approach-avoidance conflict, and frequency of panhandling. Management implications included the need for visitor education, enforcement of National Park Service regulations, removal of garbage, and priorities in relocation of bears.

394.CH
Thier, T. and D. Sizemore. 1981. An evaluation of grizzly relocations in the Border Grizzly Project area, 1975-1980. Border Grizzly Proj. Spec. Rep. 47. Univ. of Mont., Missoula. 16 pp.

Factors that may affect successful relocation of problem grizzly bears were examined: sex and age of bear, type of offense, distance relocated, time in captivity, and season of release. Bears not known to have returned to the area of capture or come into conflict with people during the 1975-1980 period were considered successfully relocated. Of 26 relocations, 62% were successful. All relocations greater than 120km were successful; only 44% were successful when the distance was less than this. Animals less than 4.5 years old made up 87% of the successful moves. Females were involved in 58% of the relocations; 80% of these were successful. Successful relocations occurred for 16% of the adult males, 60% of males less than 4 years of age, 83% of the adult females, and 78% of the females less than 4 years of age. The most important factor in determining the relocation outcome was the distance the animal was moved; the type of offense was second. Individuals involved in livestock predation were negatively correlated with success. Campground offenses, near-residences, and orphaned cubs were positively correlated with success. The influence of being near garbage was not a significant factor. The season of relocation and days in captivity did not appear to be primary factors in determining relocation outcomes. Management recommendations based on the data were made.

399.WR
Tilgner, D.J. 1960. Some psycho-physiological considerations with regard to game repellents. (A theoretical approach). [Quelques considerations psycho-physiologiques relatives aux repulsifs a gibier. (Approche theorique)] [Psycho-physiologische mittel zur wildabsehr (Theoretischer annaeherungsversuch).] Int. Cong. Game Biol. 4:128-130. In English with Dutch and German Summary.

A short general discussion in which the author suggests use of the techniques of experimental physiology and behavior to assay the worth of repellents before field testing.

411.OA
Walton, A. 1978. Beehive condominiums house queen bees that mate in the wild on Vancouver Island. Australian Bee J. 59(8):15-17.

Groups of hives are reinforced, banded together and anchored to prevent bear damage.

413.OA
Watanabe, H., N. Taniguchi, and T. Shider. 1973. Conservation of wild bears and control of its damage to forest trees. Bull. of Kyoto Univ. For., 1973. No. 45. p. 198.

Describes research in Ashu Experimental Forest, Kyoto, on some aspects of the distribution and behavior of Selenarctos thibetanus japonicus, with particular reference to tree species (listed) found to contain lairs in the crowns and to damage done by bears to Cryptomeria japonica. In both natural mixed forest and plantations, bears damage C. japonica tress of 20-30cm d.b.h. by stripping the bark and gnawing the cambium; several trees, usually close together, are damaged at a time. Coating stems with repellents (cyclohexmide or a pheno compound) was not consistently effective. Tables and figures have English captions.

415.CH
Whisenhunt, M.H. 1957. Bear-bee investigation. PP. 2-3 In: Eglin Field Deer Investigation. Fed.Aid Wildl. Restoration Proj. Fla. Game and Fresh Water Comm. Tallahassee. Unpublished.

Solutions to bear-bee conflicts were briefly investigated under a multi-scope project involving deer, bear, and other wildlife. Using a pull-type simulator booby trap, naive bears were prevented from entering apiaries, but bears that had already tasted honey were not. The only practical deterrent appeared to be bear-proof platforms for the hives. An experimental culvert-type bear trap on wheels was being tested for trapping and relocating bears causing damage to bee yards. Early results indicated that the trap was effective.

424.0A
Wooldridge, D.R. 1978. A field and captive study of repellency and induced aversion techniques on 3 families of vertebrate pests: Ursidae, Canidae, and Cervidae. M.S. Thesis. Simon Fraser Univ., Burnaby, B.C. 106 pp.

The effectiveness of two non-destructive techniques for repelling vertebrate pests was determined in this study. Biologically significant sounds and aversion conditioning chemicals were studied in experiments on captive and free-ranging animals.

Aggressive vocalizations between two captive polar bears (Ursus maritimus, Phipps) were recorded. Analysis of these sounds led to the synthesis of six sounds which duplicated or exaggerated specific components of the natural sounds. Three control sounds, of simplified spectral content and pattern were also synthesized. Experimental and control sounds were tested on five captive polar bears and two captive brown bears (U. arctos I) and on thirteen free-ranging black bears (U. americanus, Pallas) in British Columbia and on eighteen free-ranging and one captive polar bear in Churchill, Manitoba.

Experiments with aversion conditioning chemicals involved the ingestion of lithium chloride (LiCl), alpha-naphthyl-thiourea (ANTU) or emetine hydro-chloride (EHCl) to determine if the generation of an unpleasant physiological response to these chemicals following ingestion could lead to a conditioned aversion to baits or live prey. Experiments were carried out on two captive black bears and seven captive Columbian blacktailed deer (Odocoileus hemionus columbianus, Richardson). The acceptability of treated dogfood baits to free-ranging black and polar bears at dump sites in the British Columbia interior and at Churchill, Manitoba was determined.

Sheep and cattle killed by bears and coyotes (Canis latrans, Say) were treated with LiCl, ANTU, or EHCl and the time to consume each carcass was determined through field observation.

Biologically significant sounds were effective as repellents on five captive polar bears and on two captive brown bears, and on all free-ranging black and polar bears. A captive polar bear fitted with a heart rate transmitter showed significant increases in heart rate with the same ranking as those sounds which were effective in field tests. Chemical agents were capable of producing conditioned responses to baits in tests on captive and free-ranging black bears, and in tests on free-ranging polar bears. Bait consumption by free-ranging black and polar bears was significantly reduced over controls for all chemicals tested. Tests using carcasses as baits for free-ranging black bears and coyotes, and using apples as baits for captive deer, proved inconclusive. Approximate effective doses for aversion conditioning chemicals for black and polar bears were: ANTU--25 mg/kg; EHCl--2.0-4.0 mg/kg; and LiCl--100-350 mg/kg. All doses were administered orally.

The problems associated with the successful application of both of these techniques, and their implications and potential as management tools is discussed.

426.CH

Wooldridge, D.R. 1978b. Studies on the effects of aerosol CN Mace and the Taser electronic stun weapon on captive and free-ranging black bears (Ursus americanus, Pallas). Res. Proposal prepared by Wooldridge Biol. Consulting, Burnaby, B.C., Canada. Unpublished. 40 pp.

This research proposal outlined experiments and suggested techniques for testing chloro-aceto-phenone (CN Mace) and the Taser electronic stun weapon on captive and free-ranging black bears. Tests of CN on captive animals were designed to obtain baseline information on the physiological and behavioral responses of animals exposed to minimal doses of CN. The occurrence of short- or long-term vision impairment would be observed. Tests on free-ranging bears were designed to provide data on the effectiveness of CN Mace as a repellent and/or conditioning agent for black bears. Data from these studies would possibly be extrapolated to free-ranging polar or grizzly bears. The stun weapon, manufactured by Taser Systems, Inc., City of Industry, California, delivers short, high voltage, low amperage shock impulses, controlled from the operator's hand. The result of shock administration is the victim's inability to remain standing or to initiate further activity. Tests on captive bears were designed to establish potentials and wave forms capable of effective immobilization of black bears. Tests of free-ranging bears would allow further analysis of bear responses under field conditions. The appendix includes summaries of previous studies on CN Mace and CS (O-chlorobenzylidene malonitrile), and detailed fact sheets on the Taser weapon and its effects.

Wooldridge, D.R. 1980. A field study of electronic polar bear detection and deterrent devices. Rep. to the Gov. Northwest Territ. Unpublished. 45 pp.

This study evaluated the performance of an improved trip-wire polar bear detection device and an electric fence designed to deter bears from approaching human properties. Improved designs were based on results of previous studies. Free-ranging polar bears were observed from a 6m high tower near Churchill, Manitoba, Canada. The trip-wire system was successful in detecting all incoming bears. A smaller system suitable for small camps was also described. Tests of various electric fence designs indicated that they were not a promising deterrent method, because of the arctic environment and polar bear morphology and physiology. Behavioral information from this and previous research were collected to provide a predictive capability relative to the behavior of polar bears around human habitations. Bears usually approached the test site from downwind; the final approach was often slow and of a zig-zag nature. Bears at the site displayed a high level of anxiety, directed toward human activity, the fences, or the tower itself. Most bears, when disturbed by human activity, would move away from what they were investigating and leave the area. Deterrents and repellents did not offer consistent effectiveness or significant long-term protection. Attractants within the site tended to keep bears in the area. Results indicated that research efforts should be concentrated on developing detection devices; they showed more promise in reducing human-bear conflicts than did the deterrent systems.

428.CH
Wooldridge, D.R. 1980a. Lasers: their applications in the detection of polar bears in the Arctic. Phase I: Feasibility study, Churchill,

Manitoba, and Calgary, Alberta. The Boreal BioCon Group Inc. Vancouver, B.C. Calgary, Alberta, Canada. Unpublished. 13 pp.

The performance of a Radionics Helium-Neon gas laser and a Tropel 20X collimator under arctic conditions was examined. Evaluations included the effects of beam dispersion over distances on a collimated visible red laser, beam intensity over distances as affected by arctic conditions, effective distances over which a laser of this type might be used, the laser's thermal sensitivity, and the detector's light sensitivity under arctic conditions. Research was conducted at Churchill, Manitoba in mid-November, and at Calgary, Alberta, in late December, 1979. Results indicated the laser had potential for use as a detection device for polar bears, both on off-shore drilling islands, drillships, and on land. Phase II of the study was planned to test the system on the Beaufort Sea ice.

Wooldridge, D.R. 1980b. Polar bear electronic deterrent and detection systems. In press In: E.C. Meslow (ed.) Proc. of 5th Int. Conf. Bear Res. and Manage., 10-13 Feb. 1980. Madison, Wisc.

Over a two-season study period in Churchill, Manitoba, the responses of free-ranging polar bears (Ursus maritimus, Phipps) to acoustic and electrified fence repellent, and to proximity and trip-wire detection systems, were evaluated. In the first year, 9 bears were repelled 100% of all trials with synthesized aggressive sounds. Positioning of speakers, amplitude, and timing are important factors in the effectiveness of these sounds.

Thirty-four polar bears approached the electrified fence and received a 20,000 volt shock. Seventy-six percent were repelled and showed obvious signs of a conditioned response to the fence, and later, to the trip-wire fence lines.

In the first season, 42 approaches to the single wire trip-wire fence were recorded, with 100% detection success. In the second season, 42 approaches were recorded, and 72% of these were detected. Naive bears, unexposed to the electrified fence, were detected 87% of all approaches.

The proximity antenna detection system was approached 13 times in the first season study, and the device counted all intrusions. Forty-one approaches were observed in the second season, with 63% of all approaches detected. Alterations to the electronic circuitry accounted for the reduced count.

These devices can be employed in practical field situations to provide an increase in the safety of personnel who must work in close proximity to free-ranging polar, black, or grizzly bears. Current research is aimed at continued refinement and development of new techniques.

430.OA

Wooldridge, D.R. 1980c. Chemical aversion conditioning of polar and black bears. PP. 167-173 In: C.J. Martinka and K.L. McArthur (eds.). Bears--their biology and management. The Bear Biol. Assoc. Conf. Ser. No. 3. U.S. Gov. Printing Off., Washington, D.C.

Emetine hydrochloride (EHCl), alpha-naphthyl-thiourea (ANTU), and lithium chloride (LiCl) were tested as aversion conditioning chemicals on black bears (*Ursus americanus*, Pallas) and on polar bears (*U. maritimus*, Phipps) from 1975 to 1977. Captive black bears were fed varying doses of EHCl and LiCl to establish effective dose levels of these chemicals. Four cow kills, treated with LiCl and ANTU, showed an apparent 50% increase over controls in the time taken by free-ranging black bears to consume the carcasses. ANTU, EHCl, and LiCl reduced the consumption of Gainesburger baits by free-ranging polar and black bears. Approximate effective dosages of each chemical (orally administered and based on body weight) are 25 mg/kg for ANTU, 100-350 mg/kg for LiCl, and 2.0-4.0 mg/kg for EHCl.

431.CH

Wooldridge, D.R. and B.K. Gilbert. 1979. Polar bear detection and deterrent systems, 1979. Rep. to the Gov. Northwest Territ. Canada. Unpublished 37 pp.

The efficiency of modified versions of trip-wire and proximity fence systems tested in previous studies were evaluated, along with acoustic repellents, electrified fences, thunderflashes, teleshot, and the effect of some human approaches. Seventy-two percent of the bears were detected upon entering the test site through the trip-wire as compared to 63% of bears entering through the proximity detector system. Variable results produced by the acoustic repellents indicated that a strong visual component may have been necessary in conjunction with application of acoustic repellents. Recorded natural sounds were not as effective as the synthesized variants in repelling bears. Coincidental exposure to a pain-inducing stimulus could significantly enhance this system. Bears shocked by the electric fence were repelled 76% of the time. Tests of the other miscellaneous repellents were reported briefly. The "tried and true" stimuli such as thunderflashes worked well on naive bears, but had only limited effect on problem bears. Recommendations were made regarding future research; further studies using the trip-wire system appeared the most promising. It was suggested that long-term aversions to a location may only be gained by the presentation of frightening or painful stimuli. Active repellents or combined stimuli were thought likely to produce long-lasting aversions.

432.0A

Wooldridge, D.R. and P. Belton. 1980. Natural and synthesized aggressive sounds as polar bear repellents. PP. 85-92 In: C.J. Martinka and K.L. McArthur (eds.). Bears--their biology and management. Bear Biol. Assoc. Conf. Ser. NO. 32. U.S. Gov. Printing Off., Washington, D.C.

Aggressive sounds were recorded during a confrontation between 2 male polar bears (Ursus Maritimus, Phipps). These sounds were analyzed for frequency content, envelope, rhythmic patterns, and duration. Nine synthetic versions were generated to simplify, duplicate, or exaggerate components of the original sounds. The behavior of 5 captive polar bears, 2 captive brown bears (U. arctos L.), 13 wild black bears (U. americanus, Pallas) and 18 wild polar bears was observed in response to these sounds. One or more of the variants produced a significant repellent effect in each bear tested. We defined a repellent effect as an immediate and rapid movement away from the speaker, with a continued retreat as long as the sound was produced. The effects of these sounds on the heart rate of captive polar bears were measured with an implanted heart-rate transmitter. The 4 sounds with the greatest apparent effect in the field also produced the greatest increases in heart rate in the captive implanted polar bears.

433.WR
Woolpy, J.H. and E.E. Ginsburg. 1967. Wolf socialization: a study of temperament in a wild social species. Am Zool. 7(2):337-363.

A detailed analysis was made of the process by which the wolf comes from a state of unfamiliarity and fear of humans to a state of familiarity and friendliness. The nature of the process was found to depend on the age of the animal as well as the technique employed by the experimenter. Although young cubs were found to respond positively to almost any form of human contact, the older cubs and juveniles required much more time and effort to socialize, and fully-matured adults offered very special problems which required specialized techniques to overcome. Periods beyond which no socialization could occur were not found. Wolves socialized as cubs had to be reinforced repeatedly in order to maintain their social bond with humans; however, adult wolves retained their socialized behavior even after being left with unsocialized animals and not handled for 18-22 months. Wolves socialized with the aid of tranquilizing drugs (chlorpromazine, librium, and reserpine) did not retain their socialization when the drugs were withdrawn on a variety of schedules. The development of fear responses as the animals grew older, and the association of fear with the unfamiliar, closely parallel the increasing difficulty of acquiring socialized behavior as well as the decreasing difficulty of retaining that behavior once it is acquired. Socialization is viewed as a conditioning process which must take place after the development and in the presence of the free expression of the subjective components of fear, a separable aspect of the general phenomenon of genetic wildness.

435.OA
Wynnyk, W.P. and J.R. Gunson. 1977. Design and effectiveness of a portable electric fence for apiaries. Prog. Rep. Alberta Fish and Wildl. Div. Edmonton. Unpublished. 11 pp.

The design and effectiveness of a portable electric fence is described. Materials included PVC posts, wire rope, concrete rebar stakes, 12-volt fencers and other incidentals. The experimental models were light-weight and portable, effective, and eliminated the use of insulators. None of the 14 fences were penetrated by bears. Recommendations are made for more extensive use of 12-volt systems, research into the effect of rainfall on insulation and research into use of herbicides at beeyards.

SECTION III--KEY WORD INDEX

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