REDUCING NONSPORT LOSSES ATTRIBUTABLE TO FOOD CONDITIONING: HUMAN AND BEAR BEHAVIOR MODIFICATION IN AN URBAN ENVIRONMENT

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Abstract: Increased bear activity associated with food conditioning led to excessive nonsport kills in Juneau, Alaska. Improvements in garbage handling were sought through public education and enforcement of sanitation ordinances. Aversive conditioning, both physical and ingestional, were used to change bear behavior and reduce nonsport losses. Rubber bullets were used on 14 bears and an emetic (Thiobendazol) was added to garbage cans. All but 1 bear continued to forage in town. Garbage handling was improved, but current containment ordinances failed to functionally limit food availability to bears. Education improved public attitudes and understanding of the problem. Aversives may be useful in settings where single source anthropogenic food sources occur, but are of questionable value in urban locales.

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Food conditioning of bears frequently results in property damage, threats to human safety, and destruction of nuisance animals (Singer and Bratton 1980, Martinka 1982, Herrero 1985, Herrero and Fleck 1990). Early efforts to minimize such losses relied primarily on translocation (Rogers et al. 1976). The propensity for bears to return from great distances or to continue nuisance activities elsewhere is well documented (McArthur 1981, Miller and Ballard 1982, Rogers 1986). Alteration of bear behavior through aversive conditioning has recently received considerable attention (Stenhouse and Cattet 1984, Wooldridge 1984, Hunt 1985, Dalle-Molle and Van Horne 1989).

Two aversive techniques, physical and ingestional, show promise in reducing bear-human conflicts. Physical aversives depend on the infliction of pain, often administered by firing a rubber or plastic projectile at the animal. Chemical or ingestional aversion can employ either a vile tasting compound, or an agent with emetic or nausea-inducing properties. Both methods have foundations in classical animal learning theory. Aversive learning has 2 principal components: the unconditioned stimulus (US) and the conditioning stimulus (CS). An association is established between the pain-discomfort inducing US, and some environmental cue (CS) present at the time the US is applied (Garcia et al. 1985). The animal's activity or location may serve as the CS. Other natural or manufactured external stimuli can also be employed. Use of a unique CS not normally encountered by an animal in their natural surroundings can allow the conditioned response to be elicited over a wide range of background conditions. Manufactured CS used in physical aversive conditioning include such cues as whistles and recorded nonnative bird calls (Hunt et al. 1987). The selection of a CS cue to be associated with the US must consider the learning mechanism in question, including those neurological pathways involved. Clinical tests and neuroanatomical evidence (e.g., convergence of olfactory, gustatory, and gastrointestinal neurological pathways in the vertebrate neocortex) indicate that evolutionary pressures have prepared mammals to make sound-pain and taste-smell illness associations (Garcia and Hankins 1977, Garcia et al. 1985). A conditioned response can be gained even when long CS-US delays exist (Taukulis 1974, Domjan 1980, Garcia et al. 1985). This memorial process that allows a bridge of the CS-US gap is critical to the success of ingestional aversion where a delay of several hours may exist between ingestion and onset of nausea.

Despite some promising results with aversives, the solution to bear problems also involves modifying the behavior of humans through education to reduce the availability of human foods. This paper reviews the results of a 4-year multi-faceted program that sought to modify both bear and human behavior and alleviate excessive bear-human conflicts in Juneau, Alaska.

We would like to thank the City and Borough of Juneau (CBJ), and the Juneau Police Department (JPD) for cooperation and assistance in many aspects of this project. Support was provided by the Alaska Department of Fish and Game (ADF&G) and Federal Aid in Wildlife Restoration funds. We sincerely appreciate the assistance received from numerous employees of the ADF&G. We also thank Bruce Dinneford and Kim Titus for manuscript review.

STUDY AREA AND PROBLEM HISTORY

Juneau is situated on the mainland coast of the

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southeast Alaska panhandle at approximately 58°N latitude. Characterized by extensive spruce-hemlock forests, tidal grass/sedge flats, and abundant salmon and berry resources, the area provides excellent black bear (*Ursus americanus*) habitat. Estimates of black bear densities in forested areas near Juneau range from 2 to 15 bears per square mile (ADF&G unpubl. data). Based on observations of marked and unmarked bears during this study, we estimate a density of 3 to 7 bears per square mile. Brown bears (*Ursus arctos*) are present but rare near town.

Urban by Alaska standards, with a population of approximately 28,900 and a land base of 5,010 km^2, Juneau might be considered sparsely populated. However, due to the topography, most useable land lies within one-half mile of the coast. Exceptions occur in 2 glacial valleys that provide much of Juneau's residential property. The result is a nearly continuous band of human habitation adjacent to the shoreline and extending along 55 km of the city's 75 km of main road. The juxtaposition of salt water, human dwellings, forested areas, and mountains result in few areas of human habitation lying more than one-quarter mile from occupied black bear habitat. Coastal mountains rise rapidly to meet the Juneau Ice Fields and bears confine their movements to the narrow band of forest, avalanche slopes, and alpine available. Hence, travel routes to low-elevation food sources invariably bring bears into proximity of human dwellings.

ADF&G records and anecdotal information suggest that bear encounters with humans have been a common occurrence since Juneau's establishment in the late 1890s. We assume that some level of bear-human conflicts has been an accepted consequence of living near bear habitat and that the destruction of nuisance animals has been the common method of problem resolution. Longtime Juneau residents fail to identify any period when bear problems or defense of life and property (DLP) kills have been excessive. Harvest data documenting DLP numbers only extend back to the early 1970s. From 1973 through 1986 an average of 2.1 bears per year were taken in nonsport situations (Fig. 1). Although records are not complete, bear complaints registered with ADF&G and JPD averaged less than 100 per year over that period. Nuisance bear activity increased in 1987 when nearly 300 complaints were recorded and 14 nuisance animals were killed.

Media coverage of the killings led to public demands for nonlethal solutions. Concerned individuals outside Alaska threatened to demonstrate at the southern terminals of Juneau-bound cruise ships, a major factor in Juneau's tourist-based economy. These events prompted city officials to request ADF&G's assistance in determining causes and possible solutions to the problem.

A program was developed and 2 goals established: a reduction of bear activity in areas of human habitation, and a reduction of nonsport bear kills. Given the suspected correlation between bear activity in town and the availability of human foods, primarily garbage, the following objectives were identified:

1. As an alternative to lethal action, develop physical or chemical aversive techniques to alter behavior of food-conditioned and habituated bears and reduce recruitment into these groups until human food attractants could be reduced.
2. Through education and enforcement of city ordinances, alter human behavior thought to contribute to food conditioning of bears, thereby improving garbage-containment practices and reducing the need for aversive conditioning or bear removal.

Translocation was generally avoided and bears were never relocated more than once. Destruction of nuisance animals was considered a last resort alternative to be employed when aversion or translocation failed, or when individual bears were an immediate threat to public safety.

METHODS

Bear Behavior Modification

Physical Aversive Conditioning.—We selected rubber 12-gauge shotgun slugs and buckshot (Cart-A-Ball and Cart-A-Buck, imported from France by Bumble Bee Wholesale) as aversive conditioning agents to provide the unconditioned stimulus for this study. Juneau police officers also employed 12-gauge explosive cracker shells and hand-thrown seal control bombs (distributed by Cal Seal Control Corp., San Pedro, Calif.). All bears using areas of human habitation, except cubs-of-the-year, were designated as candidates for physical aversive conditioning. Rubber slugs were used when bears were greater than 20 m away, while rubber buckshot was used on bears at closer ranges. We attempted to strike bears on the rump or shoulder to avoid injury. Due to pellet scatter, rubber buckshot was only aimed at the rump or hip to avoid eye injury. Physical aversives were applied at every reasonable opportunity. However, because bears were often encountered on private property and near dwellings, human safety had primacy in all aversive action decisions. ADF&G and JPD coordination was

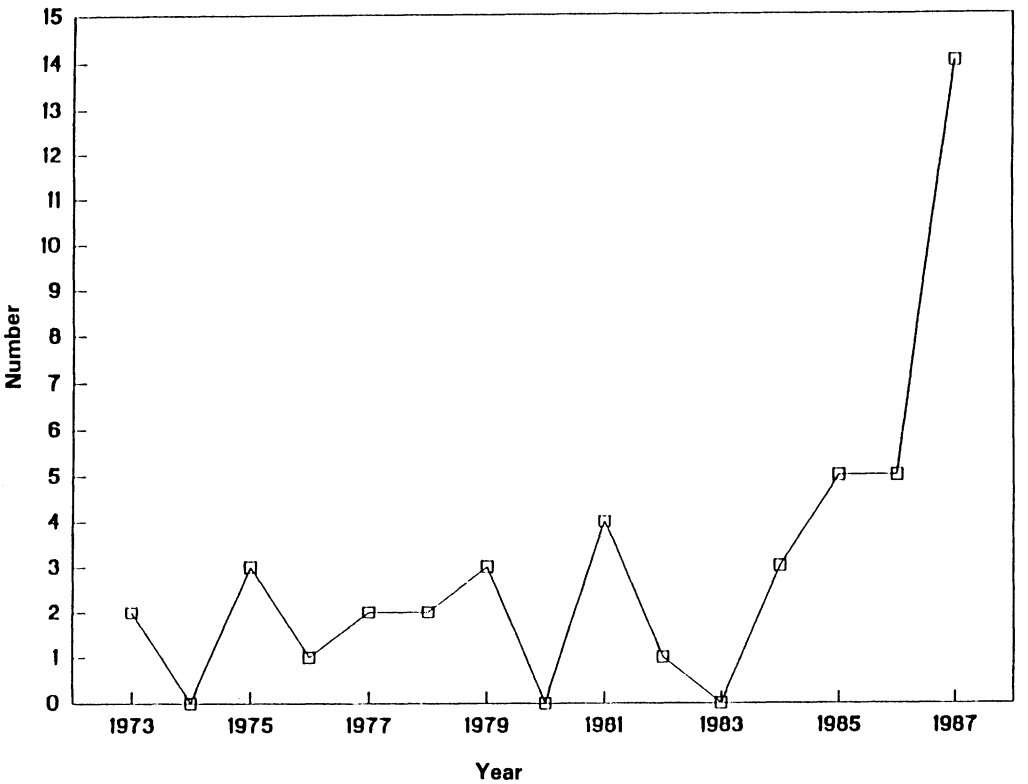

Fig. 1. Nonsport black bear kills in Juneau, Alaska from 1973 through 1987.

maintained through use of hand-held radios.

An aversive treatment was considered to include the time from initial encounter with a bear until visual contact was lost for more than 30 min. Thus, a single treatment may include contact with a bear at multiple residences. We recorded the subject bear's activity before and immediately after each aversive application. Presence or absence of a human food attractant was noted, and history of bear use at the site was gained through interview of residents.

Due to the difficulty in identifying individual bears, and the need for determining long-term responses, collaring and tagging several nuisance animals was necessary. Five known food-conditioned bears were captured, radiocollared, and ear-tagged in 1987 and 7 in 1988. Bears were immobilized and fitted with radio collars and colored ear tags with discrete numbers. Because marked bears were to be the subject of aversive study, they were released at or near the capture location. Bears were transported <8 km when release at the capture site was not practical due to human proximity. Some bears receiving treatment were unmarked. Identification of those animals was based on previous knowledge of the animals' habits and physical description.

Use of a manufactured CS for the physical aversive trials was not initiated at the outset. Rather, we hoped for an association between the pain (US), and either human presence or the bear's activity at the time of treatment. Multiple instances of bears reacting to sounds such as cocking of guns or approach of particular vehicles led us to suspect that auditory CS cues were being developed. Testing of potential ultrasonic CS cues was conducted on captive animals but due to inconclusive results (ADF&G unpubl. data) they were never employed in the field during this study.

Ingestional Aversive Conditioning.—Trials were conducted during July and August 1989. For the US we selected Thiabendazole (TBZ), an antihelmitic antifungal chemical known to produce aversive post-ingestional effects in elevated dosages (Polson 1983). Lithium chloride (LiCl) was rejected after pretrial tests due to difficulty in packaging the required dosages. Two other agents with known emetic properties (Wooldridge 1980), emetine hydrochloride, the active ingredient in ipecac, and alpha-napthyl-thiourea, were considered for use but rejected due to prohibitive costs or toxicity potential. Toxicity

becomes a concern for humans and nontarget animals, including pets, when treated baits are to be used in urban areas. Human pharmacological use, high tolerance levels, and rapid metabolization of TBZ were factors contributing to its selection in this study.

Thiabendazole in powdered form was mixed with a paste of peanut butter and honey. Individual boluses, each delivering 16.5 g of TBZ, were wrapped in cheesecloth and fitted with a string for suspension in garbage containers. This delivery rate was based on dosages of 165 mg/kg of body weight and estimated mean body weights of 100 kg. Due to emetic properties of this drug, toxicity was not considered a problem although consumption of multiple baits was possible.

Garbage containers at 84 residences experiencing a high level of bear problems were selected for use. Forty-two randomly selected cans received treatment boluses. A strip of cloth bathed in Pine-Sol brand household cleaner and suspended in the treatment cans provided the olfactory CS. The remaining 42 cans received control boluses containing only peanut butter and honey. Each day we recorded bolus removal, or use of garbage without removal of bolus. We assumed that boluses missing from the can and not found in the area had been consumed by the bear. Chi-square goodness-of-fit tests were used to detect differences in use of garbage and boluses by time and treatment.

Human Behavior Modification

Education.—An educational campaign to raise public awareness and encourage compliance with a newly enacted refuse containment ordinance was initiated in spring 1988 and continued through 1991. An important component of the program was the use of television, radio, and newspaper public service announcements (PSAs). Each year a new series of PSAs were produced. Informative spots stressed the link between human-waste handling and bear problems, and suggested better containment practices. Graphic scenes of bears being shot were included in PSAs that dealt with the cause-effect relationships. Some PSAs carried warning messages, reminding the audience of their responsibilities, and of potential fines for noncompliance. To maintain public attention, especially that of younger audiences, the message was frequently delivered in an entertaining format that included animated videos, radio jingles, and coloring books. The campaign's centerpiece was a logo with the international "NO" symbol superimposed over a depiction of a bear standing at a garbage can and the slogan GARBAGE KILLS BEARS (Fig. 2). The logo appeared on all educational materials and was reproduced for display on buses, garbage trucks, and city buildings. Saturation advertisement was assured through distribution of brochures, pins, and bumper stickers at a variety of public gatherings. Cub scouts provided door to door delivery of educational materials in areas deemed to be bear high-risk zones. The joint (ADF&G and CBJ) budget for the educational efforts conducted between 1988 and 1991 was approximately $10,000 per annum.

Public contact resulting from investigation of bear complaints offered additional educational opportunities. In each case we determined if attractants were present and emphasized the importance of stringent containment methods.

Enforcement.—A city ordinance enacted after the problematic summer of 1987 carried a $100.00 fine for first offenses. Warning notices indicating noncompliance, and informing violators of potential fines, were placed at offending residences by JPD officers and sanitation workers. Through the educational program, residents were urged to report local violations. From 1988 through 1990 a uniformed JPD officer was assigned full time to enforcement of the containment ordinance. The budget for the enforcement position was eliminated prior to the 1991 season, but was reinstated by mid-summer when problems again escalated. Thirty-four citations were issued in 1988, 44 in 1989, 50 in 1990, and 34 in 1991.

RESULTS

Bear Behavior Modification

Physical Aversive Conditioning.—In 1987 and 1988 a total of 14 individual bears received physical aversive treatments (Table 1). Time between treatments varied, with the shortest interval being 1 day and the longest 11 months.

In 17 of 35 cases bears obtained human foods within

Fig. 2. Centerpiece logo for educational campaign aimed at improving public awareness of garbage-related bear problems in Juneau, Alaska.

Table 1. Summary of physical aversive conditioning trials employing 12-gauge rubber slugs and buckshot on food-conditioned and habituated black bears in Juneau, Alaska, during 1987-88.

Years	No. bears treated	Mean hits/treatment	Mean treatments/individual	Mean hits/individual	Speed of retreat		Retreated to			Returned to	
					Rapid	Slow	Timber	Resid	Unk	Site	Area
1987	7	1.5 (range=1-3)	1.4 (range=1-2)	2.0 (range=1-4)	75%	25%	29%	36%	35%	57%	86%
1988	10	1.4 (range=1-3)	1.5 (range=1-4)	2.1 (range=1-4)	91%	9%	38%	42%	19%	56%	100%
Total	14	1.4 (range=1-3)	1.8 (range=1-4)	2.5 (range=1-6)	86%	14%	34%	40%	26%	57%	93%

15 minutes prior to being encountered. Bears were frequently engaged in consuming or obtaining garbage upon arrival of investigator. In 15 cases bears were near a residence but there was no indication that human foods had been obtained. In one instance the bear was asleep 5 m up a tree located less than 8 m from the front door of a residence.

Bears ran after most treatments (86%). When observation was possible, bears rarely ran for more than 50 m. Bears moving to other residences never travelled more than 300 m before returning to interrupted activities. In 11 of 12 such cases bears were actively attempting to gain garbage within 5 min of the first hit. Bears frequently moved to other residential locations (40%) rather than into timbered habitat (34%). Retreat destination was unknown in 26% of the treatments. Radio-collared bears that retreated to wooded areas usually remained close to the forest edge and traveled along the perimeter of residential areas. Those animals usually resumed garbage raiding within 2 hours of treatment.

Bear responses indicated that visual, auditory, and site CS-US associations were being developed. Auditory CS seemed to produce the strongest reactions. An example of sound cue priority was noted when 1 bear eating from a garbage can was hit with 2 rubber slugs in a 5 min period. After both hits it ran several yards and then returned to the can despite obvious awareness of our presence. When the gun was cocked for the third round the bear ran toward and past us. There appeared to be no association of the pain with the investigators or the human food source, only with the sound of the gun being cocked. Several bears responded to either auditory or visual cues and would run when a police vehicle arrived, but did not respond to other cars.

Forty-three percent of the treated bears abandoned the treatment site. In those cases no return to the actual residence of treatment was reported. Most treated bears (93%) continued nuisance activity in the same general area. Only 1 bear treated with physical aversives was thought to have permanently left the area. That animal had no known history of use of residential areas or human foods prior to treatment.

Aversive treatments produced injuries in 3 cases when rubber slugs broke the skin of target animals. All injured animals were known to have returned, and no lasting effects of the wounds were noted. We did not observe aggressive behavior in any treated bears.

Most data collected by JPD on use of cracker shells and seal bombs were qualitative and reports indicated that bear flight response rapidly diminished with continued exposure. After as few as 3 exposures to explosive rounds, bears often could not be moved off a food source with cracker shells or seal bombs alone.

Chemical Ingestional Aversion

Bears routinely fed from garbage cans at all treatment sites during this study (Fig. 3). During the first half of the trial bears gained food from 42 cans. Twenty-two treated cans and 20 control cans were visited. During that same period bears consumed control (9) and treatment (10) boluses at a nearly equal rate. Removal of garbage by bears during the study period was not reduced. More cans were actually disturbed during the first half of the study period, although the difference between early (42) and late period (37) was not significant ($\bar{x} = 0.31$, df = 1, $P > 0.4$). We found no CS-US association between the pine scent and illness. Number of treatment cans (21) and control cans (16) visited during the latter part of the study did not differ ($\bar{x} = 0.67$, df = 1, $P > 0.4$). A learned avoidance of boluses was indicated. Consumption of boluses of both types was significantly different ($\bar{x} = 22$, df = 1, $P = 0.0001$) between early (19) and late (0) study periods.

Human Behavior Modification

Measured in compliance with the more stringent garbage containment ordinance, the public education campaign and enforcement efforts were very successful. Uncovered or open stockpiling of garbage was common

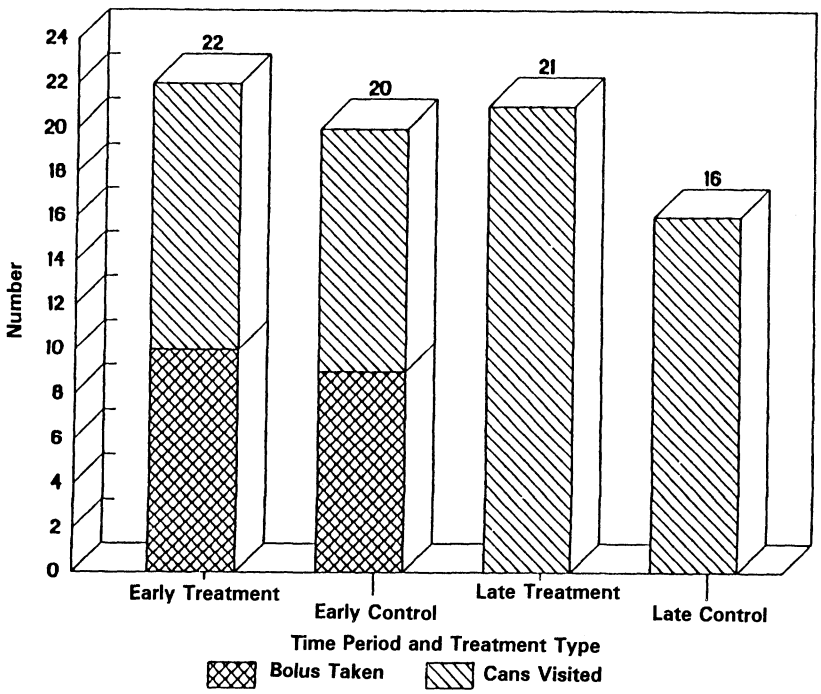

Fig. 3. Use of garbage cans and chemical boluses by black bears during ingestional aversive conditioning trials in Juneau, Alaska in 1989.

in 1987 but by mid-summer of the following year it was difficult to find such violations.

Despite improved compliance, the new ordinance failed to reduce garbage availability. The ordinance only stipulated that garbage must be contained in cans up to 30 gallons, have a tight-fitting lid, and be kept clean and relatively odor free. In response to this deficiency, educational efforts in 1989 began to emphasize the importance of keeping garbage cans inside structures and out of reach of bears. Voluntary compliance was not widespread and often not possible, particularly in areas such as mobile home parks that lack garages, sheds, or other bear-resistant structures.

PROGRAM ASSESSMENT

Program success can be evaluated by progress toward meeting stated goals: a diminished level of bear activity in town, and a reduction of nonsport kills.

Bear Activity Trends

One measure of bear activity is the number of public bear complaints recorded annually by JPD and ADF&G (Fig. 4). Complete records were available from both agencies for 1986-91. A single movement by a bear into a neighborhood may have generated multiple reports. The number of reports is then not a measure of actual incidents, but does reflect trends in nuisance activity levels. Two artifacts of the public education campaign may have biased the rate of reporting between 1988 and 1990. Our much-publicized efforts to reduce bear problems through nonlethal methods caused some of the public to become either tolerant or sensitized to bear activity and, hence, less or more prone to report bear problems. Because these biases were at least partially compensatory, we believe that public reports are an accurate indicator of trends in bear activity levels.

Bear reports declined each year from 1987 to 1989 (296, 175, and 124, respectively), but our data did not suggest that aversive attempts contributed to this improvement. While improved containment may have reduced the rate at which new bears became food conditioned, it failed to functionally prevent previously food-conditioned bears from gaining garbage. Monitoring of radio-collared bears confirmed that nuisance activity by those animals was unabated. Reduced bear activity in 1988 and 1989 was probably related to the rate at which nuisance animals were destroyed during the previous year. Regression analysis confirmed a negative relationship between bear losses and subsequent levels of bear activity ($r^2 = 0.75$, $n = 5$, $P = 0.03$); bear losses are expressed as the ratio of deaths to bear-incident reports for a given year.

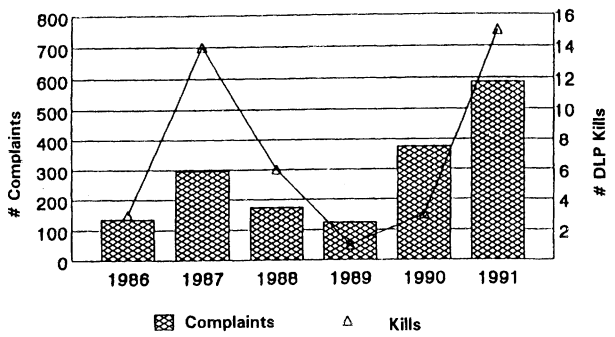

Fig. 4. Number of public bear complaints and defense of life or property bear kills (DLP) in Juneau, Alaska, between 1986 and 1991.

Nuisance bear numbers increased in 1990 and complaints (375) increased accordingly. Of particular concern was the number of family groups using human foods that year: at least 5 with a total of 13 cubs. Three of those adult females were thought to be newly food conditioned. The elevated number of nuisance yearlings active the following year is indicative of the potential for young of the year to learn and perpetuate garbage-use habits.

By 1991 bear complaints reached a new high (587). Besides increased bear activity, the record number of complaints may have been influenced by 2 factors: (1) an announcement by ADF&G that alleviation of bear problems would not be realized without passage of a yet more restrictive containment ordinance yielding substantial reductions in garbage availability, and that efforts to modify bear behavior through aversive techniques were to cease, and (2) the injury of 2 humans in separate bear encounters. While neither injury was serious, both received lacerations requiring sutures and both occurred while the individuals were walking down public streets.

DLP Kills and Other Nonsport Losses

Incidence of DLP kills between 1986 and 1991 followed a pattern similar to that of complaints (Fig. 4) and was probably influenced by the same factors (e.g., bear activity and public tolerance). After 2 years of decline in 1988 and 1989, DLP kills increased through 1990 and reached a new high of 15 by 1991.

DLP losses are but one of several nonsport mortality factors faced by bears that frequent urban areas. The sum effect of close association with humans and use of human foods on bear demographics is complex and poorly documented (Stringham 1989). Exposure to human wastes that include a variety of chemicals, household cleaners, paints, and petroleum products has an unknown effect on bear health. We do not know how well human foods meet the nutritional demands of bears. Losses attributable to vehicle kills and cub orphaning or abandonment are more easily quantified. Nineteen bears were lost under those circumstances from the Juneau population from 1987 to 1991, representing an added 48% over DLP kills.

We met only one program objective, that of altering human refuse containment practices. The primary factor in improving containment practices was education, while enforcement action played a secondary yet valuable role. However, because the ordinance in place during this study did not effectively reduce garbage availability, and because voluntary employment of more aggressive containment practices was slow to develop, no reduction in bear activity or nonsport kills was realized.

DISCUSSION AND MANAGEMENT IMPLICATIONS

Restricting the availability of human food, primarily garbage, is recognized as a key element in efforts to resolve bear-human conflicts (Garner and Vaughn 1989, Graber 1989, Smith et al. 1989, Herrero and Fleck 1990). Achievement of that goal can be difficult (McCullough 1982) and expensive (Smith and Lindsey 1989). In many settings, such as parks, remote industrial camps, and villages, point source availability of human foods can be addressed through advance planning (Follman 1989) or reactive measures such as securing or closing problematic dump sites. In Juneau and other communities where bear problems are associated with residential garbage, restricting availability is a complex issue. Containment policy decisions in urban areas are political ones. Few if any state or local laws currently require the securing of attractive food sources from bears (Servheen 1989). Public misconceptions regarding bear problems and their resolution contribute to this shortcoming. Developing the public attitudes and awareness requisite for responsible fact-based decision making is critical.

The role of education in problem-bear management is well recognized (Tate and Pelton 1983, Clarkson and Grey 1989, Hyngstrom and Hauge 1989) and can alter human behavior and improve public understanding (Garshelis 1989). Education is vital in gaining voluntary improvement given the lack of regulations restricting human food availability. When food-conditioned bears are numerous and problems long-standing, even dramatic reductions in food availability will not result in rapid alleviation of

bear-human conflicts. Here, education can serve to reduce public apprehension and increase tolerance of bears and nuisance activities (Decker and O'Pezio 1989). Time is then available for measures aimed at reducing food availability to produce results. We credit our educational efforts with minimizing the negative impact on public attitudes that could have been expected (Herrero and Fleck 1990) following the bear-inflicted human injuries experienced in 1991.

The cost of improving garbage containment to the point of bear-proofing can be substantial and may be prohibitive when applied at individual residences. Even community systems that reduce the cost to individuals must be publicly financed. Proposals to establish such systems generate a level of public debate commensurate with their costs. Here again, education can be used to alter public perception of cost-benefit relationships. Those perceptions determine public willingness to make the financial and convenience-related sacrifices necessary to minimize bear-human conflicts (Servheen 1989). Support for programs that required minimal sacrifices was easily gained in Juneau. Because our educational efforts had not adequately addressed the public benefits of more costly programs, heated debate ensued over their suggested use in 1991.

Strict containment measures can reduce the number of newly food-conditioned animals, but the disposition of longtime nuisance animals remains a problem. We unsuccessfully attempted to employ various aversive measures to alter behavior of nuisance bears while working to reduce garbage availability. Although it is difficult to reverse the learning process through aversion (Herrero 1985) some success has been documented (Wooldridge 1980, Stenhouse and Cattet 1984, Hunt et al. 1987). As few as 1 or 2 hits with rubber slugs have produced avoidance of a conditioning site (Dalle-Molle and Van Horn 1989). However, bears subjected to physical or ingestional aversives in urban settings are overwhelmed by positive reinforcement for their nuisance activities. Bears are learning at each contact with humans or human foods. Pain or illness inflicted under a narrow set of conditions is not likely to produce the desired aversive response over the broad range of conditions found in urban environments.

The association of a conditioning cue (e.g., unique olfactory, visual, or auditory stimulus) with pain or illness may yield aversion over a wider range of conditions. There is increasing interest in aversive techniques using sound as the conditioning stimulus associated with pain. Our observations of flight response by bears at the cocking of a gun suggested a learned auditory-pain association. Though a CS-US association can produce the aversive response we sought, the applicability of this technique in urban settings remains questionable. Initial aversive conditioning would necessarily be followed by placement of a cue-emitting device in problem areas. Repeated exposure to the cue in absence of continued negative reinforcement would rapidly lead to extinction of the conditioned response (McCullough 1982). Auditory CS cues may prove useful in areas where a discrete set of human food sources exist making negative reinforcement opportunities predictable. At best, even sound-mediated aversive conditioning should be viewed as an unproven rehabilitative tool, not a substitute for preventive measures that reduce the potential for problem bears (Hunt et al. 1987).

Successfully reducing bear problems related to food conditioning requires both a reduction in human food availability and the subsequent removal of most nuisance animals. During our study, food-conditioned animals were purposely not removed. Because several of those bears were females raising young, recruitment of newly food-conditioned bears may have been enhanced. Failure to remove nuisance animals in cases where the attractant has been eliminated can lead to an unnecessary perpetuation of the problem. Meagher and Fowler (1989) believed efforts to protect problem bears in Yellowstone yielded more bear losses than prompt elimination of nuisance animals would have. Lethal alternatives need not have a detrimental effect on public attitudes. If public ownership of the problem can be stressed, (i.e., bears are killed because of poor garbage containment) the action can reduce support for programs that ultimately reduce DLP kills.

Hunting may be a more acceptable method of removing problem animals and provides reinforcement of negative conditioning. It has proven successful in reducing bear damage or conflicts with humans elsewhere (Poelker and Parsons 1980, Garshelis 1989, Hyngstrom and Hauge 1989) particularly when problems are correlated with increasing bear numbers. While nuisance activity levels can be indicative of population trends, methods of quantifying such activity are subject to variability. Examples of typical sources of error (e.g., public attitudes and agency recording methods) were noted previously in this paper. Even if these errors are minimized, nuisance activity must be tracked long enough to control for the perturbations caused by yearly fluctuations in natural food abundance (Garshelis 1990). However, even a single stochastic event, such as failure of an important food source, can generate increased levels of nuisance activity long after

normal conditions return. Even short exposure to human foods can produce long-term food conditioning irrespective of accessibility to natural food. The number of nuisance animals can further increase through learning in offspring. Increased nuisance activity can then be exhibited in stable or even declining populations. Thus, nuisance activity alone should not be considered indicative of increasing bear numbers, and efforts to reduce nuisance activity through added hunting pressure must be approached with caution. Removal of nuisance animals through sport hunting can be beneficial but targeting only that portion of the population is difficult. Even then, increased harvests in areas where a large percent of the population is habituated or food conditioned may be excessive as unwary animals are quickly eliminated.

The Juneau program did raise public awareness of the causal relationship between mishandling of human food wastes and resultant bear problems. By late 1991 the Juneau City Assembly was prepared to draft an ordinance requiring all residential and commercial refuse to be stored in bear-proof containers or bear-proof structures. We credit this action to an educational program that heightened awareness and provided factual information for public debate.

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