

FIELD USE OF CAPSICUM SPRAY AS A BEAR DETERRENT

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Abstract: We analyzed 66 cases of field use of capsicum sprays between 1984–94. In 94% (15 of 16) of the close-range encounters with aggressive brown (grizzly) bears (*Ursus arctos*), the spray appeared to stop the behavior that the bear was displaying immediately prior to being sprayed. In 6 cases, the bear continued to act aggressively; in 3 of these cases the bear attacked the person spraying. In 1 of these 3 cases, the bear left after further spraying. In all 3 injurious encounters, the bear received a substantial dose of spray to the face. In 88% (14/16) of the cases, the bear eventually left the area after being sprayed. While we do not know how these encounters would have ended in the absence of spray, the use of spray appears to have prevented injury in most of these encounters. In 100% (20 of 20) of the encounters with curious brown bears or bears searching for people's food or garbage, the spray appeared to stop the behavior. The bear left the area in 90% (18 of 20) of the cases. In only 2 of these 18 cases was it known to have returned. In 100% (4 of 4) of the encounters with aggressive and surprised, or possibly predacious black bears (*Ursus americanus*), the spray appeared to stop the behavior that the bear was displaying immediately prior to being sprayed. However, no bears left in response to being sprayed. In 73% (19 of 26) of the cases associated with curiosity, the spray appeared to stop the behavior. The bear left the area in 54% (14 of 26) of the cases, but in 6 of these 14 cases it returned. In 62% (8 of 13) of the incidents where the black bear received a substantial dose to the face, it either did not leave the area or left the area and returned. Sprays containing capsicum appear to be potentially useful in a variety of field situations; however, variable responses by bears occur. Because the database is composed of diverse field records, the results should be viewed with caution.

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The number and rate of injuries inflicted by brown bears and American black bears to people appear to be generally accepted as part of having bears and the natural environments that support them and other wildlife. However, because of the tragedy of some bear-inflicted injuries, we will continue to try to reduce the chances of bear-inflicted injury (Herrero 1985). One possible means of decreasing bear-inflicted injuries would be to use a deterrent. Ideally a deterrent would be highly effective against bears but would not permanently injure bears or people. We present results of field use of sprays containing capsicum pepper derivatives as their active ingredient and deployed when bears were acting aggressively toward people, or were demonstrating other undesirable behavior.

The physiological effects of capsicum (*Capsicum* spp., family Solanaceae) derivatives on various animals have been studied (Miller 1980, Hunt 1984, Rogers 1984). Osol et al. (1967) described capsaicin (a common derivative of capsicum) as a powerful local irritant of sensory nerve endings, but causing no blisters. Capsicum causes significant inflammation of certain soft tissues, especially the eyes and respiratory tract of human beings (M. Stalder, Anza Borrego Desert State Park, Borrego Springs, Calif., pers. commun., 1995). In people, capsicum spray can cause involuntary closing of the eyes and temporary loss of muscular strength and coordination. Products containing capsicum are now used in police work against aggressive people. Most researchers conclude that the powerful local effects are temporary on all animals that

have been tested, including bears and people (see Rogers [1984] for a review). One human death was, however, caused (11 July 1993 in Concord, N.C.) by police use of oleoresin capsicum on a "combatant" (M. Stalder, Anza Borrego Desert State Park, Borrego Springs, Calif., pers. commun., 1995). The autopsy revealed that the deceased probably had several predisposing conditions, including a "significant underlying pulmonary condition." The spray can also get into the pores of soft contact lenses and can be impossible to completely remove.

When used as a bear deterrent in controlled laboratory tests and in limited field tests, sprays containing 10% capsicum derivative as their active ingredient have generally stopped the behavior evidenced immediately prior to spraying. This was true for laboratory-induced aggression in both brown bears and black bears (Miller 1980, Hunt 1984). Field testing of capsicum spray on aggressive bears has not been previously reported. Rogers (1984) successfully deterred non-aggressive black bears from baits in field tests, but he had a very small sample, $n = 5$. Hunt (1984) reported that black bears were repelled from food baits in 18 of 21 field tests; however 86% of the animals returned and resumed foraging an average of 17 minutes later. Because bears are behaviorally complex, individual differences in response to being sprayed are expected (Rogers 1984, Herrero 1985). Importantly, no one has reported that use of capsicum spray on either black or brown bears resulted in increased aggression.

Our research used data from throughout North America regarding field use of capsicum sprays on either aggressive, curious, or human-food conditioned brown bears or black bears. Despite a lack of experimental controls, we assumed that the response of bears to being sprayed is detectable. We also propose that the case history approach is the most effective means of studying the response of free-ranging, aggressive brown bears to being sprayed.

We thank the people who provided us with the field records on which our data are based. A special thanks is owed to R. Potts and B. Holmes of Katmai National Park for providing a number of well-documented records of interactions in the Brooks River area. We also thank C. Gagnon of Counter Assault Personal Defense Sprays for sharing descriptions of the spray use that had been sent to him.

METHODS

As part of a broader study of bear-human interactions, we sent inquiries to 235 agencies throughout Canada and the United States that either had responsibility for bear management or whose personnel frequent bear habitat. We requested records of field use of aerosol sprays containing extracts of capsicum as a deterrent against bears. In addition to agency reports of such use, we directly contacted individuals who because of newspaper reports or word of mouth, we believed had used capsicum spray as a bear deterrent.

We analyzed reports of capsicum spray use on bears by entering each incident into a computer database. Such reports are subject to various recording and interpretation errors and to the problem of trying to adequately represent complex, real-world situations (with many variables complexly interwoven) in a form permitting analysis. Such errors and uncontrolled variables create "noise" in the database, but with our sample size we assume that patterns of response by bears to use of capsicum spray as a deterrent emerge as an approximation of free-ranging bears' actual responses to being sprayed. Because these incidents were not part of a controlled experimental design, we did not statistically analyze the data since results should be viewed with caution given the lack of controlled methodology. One inconsistency is that various capsicum sprays were used in the field situations. Variations between brands could not be systematically investigated because of small sample sizes for all brands except Counter Assault (Bushwacker Backpack and Supply Co., Missoula, Mont.) ($n = 50$). All sprays used in situations included in our database likely contained 10% capsicum extract as their active ingredient.

We grouped data by bear species and by the behavior or inferred motivation of the bear in the incident. For both black and brown bear incidents, we recognized 2 types of incidents. In 1 type, the bear's behavior prior to being sprayed appeared to be searching for food or garbage or being curious. When aggression was involved it seemed to be directed toward obtaining food or garbage. Often such incidents took place in developed portions of parks, and the bear probably had a history of feeding on people's food (including just-caught fish) or garbage. In the second type of incident, people perceived that the bear was acting aggressively prior to being sprayed, without the element of food or garbage. These incidents included bear behaviors such as charging, making aggressive noises, or persistent following.

RESULTS

We analyzed 66 cases of field use of capsicum sprays. Brown bears were involved in 36, black bears in 30. Incidents occurred primarily in Alaska, British Columbia, Montana, and Alberta.

Delivery of Spray to the Bear.—We separated the incidents into 3 classes: cases where the bear was reported by the sprayer to have received a substantial dose to the face, cases where it reportedly did not, and cases where the dose was not determined. Although we did not apply any statistical tests, no obvious differences in response were apparent between these subsets and therefore we pooled data. In slightly more than half of the incidents, the person using the spray reported that the bear received a substantial dose of spray to the face.

Brown Bears Acting Aggressively.—In 81% (13 of 16) of these incidents the person reported not being aware of the bear until it was <50 m away; however, in 2 incidents the bear or bears involved were first sighted at >200 m. In 88% (14/16) of the cases the bear charged at the person or people. In 62% (10 of 16) of the incidents, a female bear with offspring (ages varied) was involved, and in 6 only a single bear was seen. Only 1 incident was known to have involved an adult male bear.

In 94% (15 of 16) of the cases, use of the spray was associated with the bear stopping its aggressive behavior. In 38% (6 of 16) of the cases, the bear either continued to act aggressively (1 of 16) or briefly stopped but then resumed its aggressive behavior (5 of 16). In 3 of these cases, the bear attacked and injured the person using the spray. In 2 cases the person spraying required <24 hours of hospitalization; the other required >24 hours of hospitalization. In 1 of these 3 cases further spraying appeared to have caused the bear to leave. Of the 3 inci-

dents that resulted in injury to the person using the spray, 2 involved a female with one or more cubs, and the other involved a single, adult male. In all 3 injurious encounters, the bear received a substantial dose of spray to the face at close range. In 2 incidents, the person was injured after spraying a bear that was attacking a companion. Here the approach by the sprayer, combined with the spraying, redirected the attack to the person spraying. In 88% (14 of 16) of the cases the bear left the area after being sprayed. These included incidents where the bear continued to act aggressively after the first spraying and did not leave until after the second or third spraying. In 12% (2 of 16) of the cases the bear remained and the person left the area.

Brown Bear Acting Curiously or Searching for People's Food or Garbage.—In each of these cases the bear involved was either not acting aggressively prior to being sprayed (80%, 16 of 20) or the aggression involved a direct approach apparently aimed at getting a person's food, such as a fish (20%, 4 of 20). The bear was, however, behaving in a way that the person using the spray found undesirable. In 80% (16 of 20) of these cases, only a single bear was involved. In the other 20% (4 of 20) cases, a sibling pair or larger sibling group was involved. In total, 85% (17 of 20) of the incidents involved subadult bears. In 100% (20 of 20) of the cases, use of the spray was associated with the bear stopping the undesirable behavior immediately after being sprayed. The bear left the area immediately after being sprayed in 90% (18 of 20) of the incidents. In only 2 of these cases was the bear known to have returned. In 38% (3 of 8) of the incidents where the bear did not receive a substantial dose of spray to the face, the people involved reported that the bear was apparently deterred by the sound of the spray discharging and the spray cloud.

Black Bears Acting Aggressively.—In 3 of 4 cases a black bear either charged (2 cases) or vocalized aggressively and then approached (1 case). All three of these cases appeared to involve responses to 1 or 2 people suddenly being within 50 m of 1 or 2 black bears. In 1 case the aggressive bear may have been 1 member of a pair of black bears engaged in courtship. In the fourth case, the bear exhibited predatory behavior as defined by Herrero (1985) and Herrero and Higgins (1995). The bear saw the people involved, followed them for several minutes, and then approached quietly.

In all of the 4 incidents the spray apparently changed the behavior of the bear; however, in no cases did the bear leave the area after being sprayed. In 1 case the bear was shot and killed after being sprayed. In another case the bear left after a shotgun was fired. In the other 2

cases the person left. In 1 the bear didn't follow, but in the other the bear followed and the person was finally able to make it to camp, but only after firing a bear banger. No people were injured.

Black Bears Acting Curiously or Searching for People's Food or Garbage.—As with brown bears, in this type of incident prior to being sprayed the black bear was either not acting aggressively (85%, 22 of 26) or the aggression seemed to be directed at obtaining food or garbage (15%, 4 of 26). In 92% (24 of 26) of these cases only 1 bear was seen. In the other 8% (2 of 26) of incidents, a female bear with 1 or more cubs was involved. In 73% (19 of 26) of this type of incident the spray had the apparent effect of changing the behavior. In the other 27% (7 of 26) of cases, the spray elicited varied and sometimes unclear responses. In 2 of these cases, the bear showed no apparent response to being sprayed. The bear left the area after being sprayed in 54% (14 of 26) of the cases; however, in 6 of these 14 cases the bear returned. In 62% (8 of 13) of the incidents where the bear received a substantial dose to the face, it either did not leave the area or it left and returned.

Environmental Conditions and Spray Application.—In 9% (6 of 66) of incidents, the sprayer reported that environmental conditions interfered with the application of the spray. In 4 of these incidents, there was a headwind or crosswind. In the fifth incident, heavy rain quickly dispersed the spray. In the sixth incident, thick bushes limited the size of the spray cloud. None of the incidents involved injury. However, in 2 incidents involving a headwind, the person using the spray had it blown back on him and was affected by it. To deliver a substantial dose of spray to the bear under typical conditions, most sprayers reported having to be within 6 m of the bear, with greater success from within 3 m.

Mechanical Problems with Spray Canisters.—In 3% (2 of 66) of incidents, the sprayer reported some mechanical deficiency with the spray. In 1 incident, the spray released from the canister in a stream-like shot rather than as a mist or fog. In another incident, the canister lost pressure and some of the contents dribbled down its side. The sprayer thought the canister was clogged, but it may have been empty. Neither of these incidents involved injury. In a third incident, the sprayer was injured by a brown bear when the can emptied during the bear's charge.

DISCUSSION AND CONCLUSIONS

Our results are consistent with tests conducted on a small number of captive grizzly bears (Miller 1980, Hunt 1984) and on captive (Hunt 1984) and free-ranging black

bears (Hunt 1984, Rogers 1984). Capsicum spray appeared to be reasonably, but not 100%, effective as a deterrent against free-ranging, aggressive brown bears. Many of the cases we studied involved female brown bears apparently defending their young and responding to a person suddenly sensed nearby, although in 2 cases the bear family was first seen at >200 m. In most cases the bear or bears involved responded by charging. In 6 of 16 cases the bear continued to act aggressively after being sprayed. In a minority of instances, despite receiving a full dose of spray to the face, the bear inflicted injury to the person using the spray. Despite a small number of people being injured after spraying an aggressive brown bear, in no cases did use of the spray appear to be responsible for increasing the extent of injury.

We do not know how a given incident might have ended without use of the spray. Herrero (1985) reported that most brown bear charges did not result in contact or injury when spray was not used and that black bears often charged people but very rarely contacted and injured them.

One caution regarding generalizing our results is that in the 1 instance where capsicum spray was known to have been used on an adult female grizzly bear with cubs that charged from a nearby ungulate carcass, injury to the sprayer resulted. For certain individual brown bears, the spray may not be effective if the bear is encountered at close range and near a carcass.

Capsicum spray very effectively deterred free-ranging brown bears approaching people out of curiosity or to get at their food (including fish) or garbage. These bears which were primarily sub-adult, stopped their undesirable behavior and left the area. In 2 cases, however, the bear returned. The success of capsicum spray to deter adult, free-ranging brown bears in this context is unknown.

Because there were only 4 instances of spray use on free-ranging aggressive black bears, results should be viewed with caution. The spray appeared to be less effective than when used in aggressive incidents with brown bears. All black bears stopped what they were doing when sprayed, but none left the area immediately. Whether the spray would be effective against potentially predaceous black bear remains unanswered.

Rogers (1984) reported clear-cut aversive responses in 5 free-ranging black bears that he sprayed with capsaicin while they were approaching food he set out in a campground or garbage dump. With a significantly larger sample ($n = 21$), Hunt (1984) found that most bears were repelled from food baits after being sprayed, but most of them also returned a short while later. Our findings regarding curious black bears or bears searching for people's

food or garbage (and presumably already food-conditioned and habituated to people) were unclear. In about half of the 26 cases we studied, the bear either did not leave or it left and returned a short time later. These results show that at least for black bears, there does not appear to be an overwhelming physiological response that might cause bears to leave after being sprayed. The response to spraying might depend on the degree of food-conditioning or individual differences between bears.

Our results raise the possibility that black and brown bears have different responses to capsicum spray. The uncontrolled nature of our database does not allow further comment.

Spray dispersal into a cloud rather than a narrow stream appears to be beneficial for 2 reasons. First, the formation of the cloud (and the noise made by discharge from the canister) may in some instances be a deterrent independent of any of the spray actually reaching the bear. Second, this pattern of dispersal saves the sprayer from having to accurately direct the spray at a charging bear in what is a high-stress situation. Use of the spray does not require the training or experience needed to shoot accurately at a charging bear with a rifle or a shotgun.

The spray canisters in this data set were generally mechanically reliable. Users should be aware that mechanical failures can occur and should familiarize themselves with what to do in the event of an aggressive encounter in which the canister malfunctions or otherwise doesn't deter aggression. Users may wish to test the canister with a brief spraying to ensure that the propellant works and to become familiar with the dispersal pattern of the spray.

Users should consider environmental conditions when using the spray. The ability to deliver a sufficient amount of spray to the bear may be limited in conditions of moderate or high wind, heavy rain, or thick vegetation. If the wind blows capsicum into the user's face, this could make it difficult to either play dead or fight back, both appropriate responses in certain types of bear incidents (Herrero 1985). Conversely, if a person can maneuver upwind of the bear, the wind may assist in delivering spray to the bear. Capsicum is believed to exert its primary effect on soft tissue, causing inflammation of the eyes and inflammation and constriction of the respiratory tract (Rogers 1984, M. Stalder, Anza Borrego Desert State Park, Borrego Springs, Calif., pers. commun., 1995). For this reason, spray should be directed at the bear's face.

We believe that bears' responses to the spray are not solely a function of the dose received. A substantial dose of spray to the face was not sufficient to deter the bear in a number of incidents. Study of the 3 incidents involving injury to the person using the spray showed that the per-

son had delivered a substantial dose to the bear's face before being injured. In other incidents, the bear was successfully deterred even though it did not receive a substantial dose of spray to the face. Aggressive encounters between bears and humans are complex events influenced by a large number of variables. We believe this to be true regardless of whether capsaicin spray is used—capsaicin does not appear to become the sole variable influencing behavior after spraying.

We conclude that sprays containing capsaicin appear to be useful in a variety of field situations when used on free-ranging brown bears. Our results show an acceptable level of effectiveness and that injury will sometimes occur despite effective deployment of the spray. When used on aggressive black bears our data only cover a small sample ($n = 4$). For the remaining incidents that deal primarily with habituated and food-conditioned black bears, the sample was much larger ($n = 26$) but results were variable. We recommend further testing through documented field use and other means.

An increasing number of people are buying spray containing capsaicin for possible use against aggressive bears. This is reasonable as the spray may prevent or limit injury to people and bears. However, as Dr. Stephen French,

a grizzly bear researcher in the Yellowstone Ecosystem says, "the spray isn't brains in a can." Carrying bear spray is not a substitute for the normal precautions when traveling or camping in bear country (Rogers 1984, Herrero 1985).

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