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Distance-dependent effectiveness of diversionary bear bait sites

Stephen F. Stringham, WildWatch. 39200 Alma Ave. Soldotna, AK 99669, USA *wildwatch_consulting@yahoo.com*

Ann Bryant, BEAR League. P.O. Box 393, Homewood, CA 96141, USA *bearsnsquirrels@sbcglobal.net*

Abstract: Baiting black bears (*Ursus americanus*) to sites outside a community can alleviate famine-induced spikes in human–bear conflicts. But little is known about effects of distance between baits and communities. Bears were lured out of towns in California's Tahoe Basin to baits in adjacent forests. Delay between onsets of baiting and decline in bear–human conflict was directly related to each community's distance from the nearest bait. The amount and rate that conflicts declined were inversely related to distance. In 7 communities about 1 km from a bait, conflicts declined 41% after 1 month and 93% after 3 months; mean rate of decline was 1.2% per day. In 3 communities ≥8 km from any bait, declines were delayed ≤2 months before falling at 0.6% per day (18% decline). Total conflicts in the year after baiting (n = 346) were 35% lower (n = 533) than in the year before baiting.

Key words: baiting, black bear, brown bear, damage control, diversionary feeding, grizzly bear, human–bear conflict, polar bear, Tahoe Basin, *Ursus* spp.

Severe scarcity of wild foods rich in calories and protein can vastly elevate incursion by bears into communities as the bears forage for anthropogenic foods (Rogers 1976, 1983, 1987, 1989, 2011; Garshelis and Noyce 2007). Conventional methods of conflict minimization, such as securing anthropogenic foods, reducing detectability of those foods, aversive conditioning, and relocating bears, do not necessarily suffice, because such methods cannot solve the fundamental problem of malnutrition. In some such cases, depredations can be minimized by providing an alternative source of rich foods outside a community, a practice known as diversionary feeding or baiting. This has been used successfully with brown bears (*Ursus arctos*) for more than a century in Europe (Kavčič et al. 2013) interior, Alaska (Boertje et al.1995), Pacific Northwest (Flowers 1986, Partridge et al. 2001; Ziegltrum 2004, 2008), and Minnesota (Rogers 1987, 1989, 2011). Likewise, whale (*Balaena mysticetus*) carcasses outside Arctic coastal villages have diverted brown and polar bears (*Ursus maritimus*) away from the villages, leading to suggestions that food purposefully placed outside villages could serve the same function on a more permanent basis (Derocher et al. 2013).

One aspect of diversionary baiting that is still poorly understood is how its effectiveness is influenced by the distance between a bait station and the community or resource that the bait is intended to protect. We tested this when drought-induced famine led to a vast increase in bear–human conflicts in the Sierra-Nevada Mountains during the summer of 2007. Similar influxes by bears into local communities elsewhere in that mountain range previously were reported by Beckmann and Berger (2003 *a, b*).

During May to August 2007, conflicts in the Tahoe Basin rose steadily ≥8-fold above prior levels, despite intensifying conventional preventative measures (detailed under Methods). That increase was reversed over the next 3 months after baits were provided in the forest outside 10 communities. Although conflict rate tended to decline more in treated communities with baits compared to other similar communities without baits, there was a great deal of overlap in rates.

To understand how to achieve more universal success, we reexamined our data. One factor differing among communities was distance from the nearest bait. We hypothesized that the greater the distance of a community from the nearest bait site, the less that baiting would be likely to reduce conflicts in that community over a given span of time, and the more time that would pass before a given amount of reduction occurred. Our findings are reported here.

Study area

Our baiting experiment was conducted in the Lake Tahoe Basin along the border of California and Nevada (39° 02′ 30″ N, 120° 01′ 00″ W). Lake Tahoe is ringed by communities (Figure 1). We monitored conflicts in 20 of them: South Lake Tahoe, Eastshore, Carnelian Bay, Tahoe City, Sunnyside, Timberland, Homewood, Tahoe Pines, Alpine Meadows, Rubicon, Talmont, Cascade, Tahoma, Squaw Valley, Incline Village, Dollar Point, Christmas Valley, Northstar, King's Beach, and Truckee. Those communities are surrounded by national forest lands having few year-round human inhabitants.

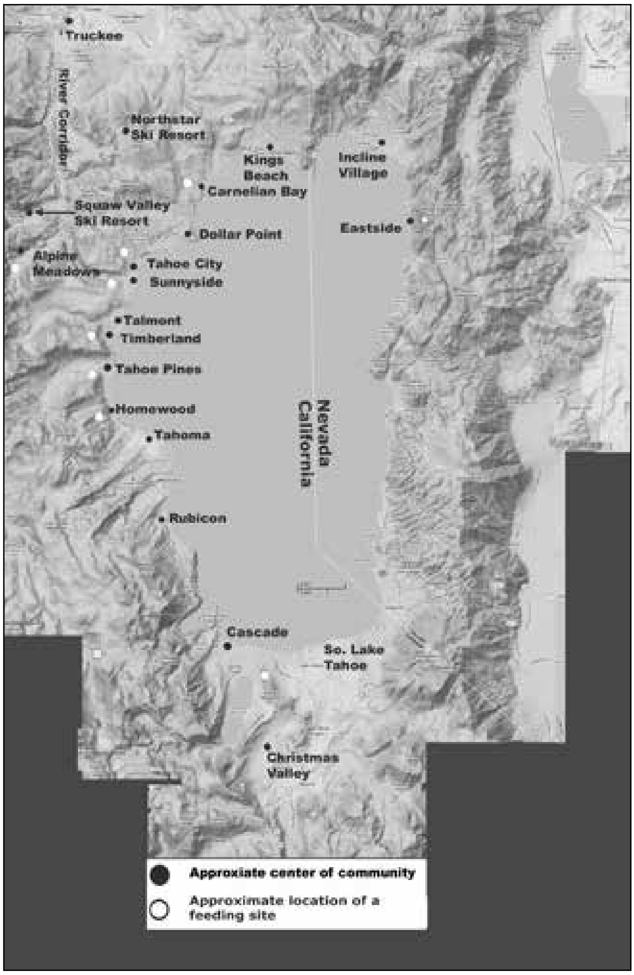

Figure 1. Lake Tahoe and selected communities surrounding it in the Tahoe Basin, on the California-Nevada border. During 2007, the BEAR League established feeding sites outside 9 communities. An independent group established a site on Mt. Rubicon. The approximate location of each site is marked with a white circle.

Methods

Rates of conflict reports and of conflicts

Since 1999, the Tahoe BEAR (Bear Education Aversion Response) League, a nongovernmental organization, has maintained a 24–7 hotline for reporting bear conflicts. Since 2003, records were kept on each report call. Through 2006, we recorded only the date and type of call (e.g., bear in yard, bear in home, bear sighting). Beginning in 2007, we also reported time, location, caller's name, nature of the report (e.g., conflict), and whether a BEAR League (hereafter, League) response team was dispatched to the site. In the event of dispatch, we recorded the location, physical surroundings (e.g., residence), attractants, and other factors contributing to the conflict. We recorded details of any human–bear encounter or damage, and actions taken by the League to resolve the situation. Data on selected topics were tabulated for analysis on a month-by-month basis. We used these League conflict reports as an index of the actual number of human–bear conflicts in our study. All duplicate reports of the same incident were excluded.

Conventional conflict countermeasures

Each year since 1999, the League reduced bear–human conflicts in the Tahoe Basin by minimizing attractiveness and accessibility of anthropogenic foods and by aversive conditioning. The League taught the public how to secure garbage and other attractants while making homes inaccessible to bears. The League promoted the installation of electric fences, electric grids to cover windows and doors of unoccupied homes, and bear-proof containers for outdoor storage of garbage and other attractants. League members responded to complaints by visiting conflict sites, where subsequently they aversive-conditioned bears during or after ushering them out of homes and yards. Seldom did a bear become so troublesome that it had to be relocated or killed by the California Department of Fish and Game.

In 2007, the League continued using those conventional countermeasures within all 20 communities before, during, and after baiting. The only way protection differed among communities was distance to the nearest bait site.

Baiting

From September to November 2007, orchards from elsewhere in California donated >2,000 kg of organic fruit and nuts. This food was kept in a protected, indoor location where teams of volunteers came daily to fill backpacks. Under our supervision, each team was responsible for a specific bait site. None of these foods was obtainable, except in small amounts, by bears raiding a garbage container or home within any Tahoe community.

Each initial bait site was outside a town but close enough to it or to a bear trail leading into town for town bears to find it. Once bears began eating at this site, it was moved progressively farther into the forest over the next several days to lure bears away from the town. Food was never placed twice in exactly the same location, so that persons carrying food were unlikely to encounter a bear remaining at the previous day's drop site. During each drop, food was scattered over an area of approximately 100 m^2 so that numerous bears could feed simultaneously without directly confronting one another and to reduce risk of disease or parasite transfer.

Provisioning was accomplished in the early evening to minimize chance of hikers passing by while bears were eating. Although the food was tainted with human scent, we did not provide it directly to bears, and there was negligible interaction between bears and people at bait sites. Baiting continued until the first heavy snowfall in the last days of November, after which bear tracks were no longer found, presumably due to denning. Independently of our efforts, food was deposited on Rubicon Peak by residents of the adjacent community. We have no information on their procedures.

Figure 2. A black bear searches for food and water along the shores of Lake Tahoe and the Truckee River.

Distance between communities and baiting sites

Bait sites were selected on the basis of 4 criteria. Each site had to be: (a) at a spot not visible from any trail to minimize risk that other people would chance upon it; (b) <2 km from Lake Tahoe or the Truckee River, the only water sources we had found during August; (c) at a convenient distance for League members to reach each day with bait; and (d) ≥1 km map distance from the nearest town (a distance that we guessed to be the minimum at which a site would be far enough from any town to draw bears away from that town rather than into it). Having a site near each of 10 communities inadvertently resulted in the other 10 communities being farther (≤20 km) from the nearest bait site.

The distance between each community and the nearest bait site was considered as the distance from the approximate center of each community—in most cases along the shore of Lake Tahoe—to the center of several spots where bait was placed. Baits were distributed within a radius of roughly 15 m around that center. In other words, a nominal distance of X km from the nearest own was actually X ± 0.015 km.

The 7 communities roughly 1 km from the nearest bait site were South Lake Tahoe Eastshore, Carnelian Bay, Tahoe City, Sunnyside, Timberland, and Homewood. The 13 communities farther from any bait sites were, in approximate order of increasing distance: Tahoe Pines, Alpine Meadows, Rubicon, Talmont, Cascade, Tahoma, Squaw Valley, Incline Village, Dollar Point, Christmas Valley, Northstar, King's Beach, and the city of Truckee. We monitored bear conflicts in all 20 communities, as well as along the 15-km Truckee River corridor between Lake Tahoe and the town of Truckee.

The rate of decline in conflicts per month was calculated on the basis of delay before decline began and maximum duration over which the decline occurred. If the conflict rate was lower in September than in August, we assumed a median delay of 15 days from onset of baiting on September 1 until onset of decline. For communities where declines did not begin until October or November, we assumed median delays of 45 and 76 days, respectively, after September 1. If consistent decline began in September, October, or November, maximum durations of decline were assumed to be 91, 61, and 30 days, respectively, until November 30. These figures were used in calculating (a) percent decline per day of delay prior to decline and (b) percent decline per day of decline.

Statistical analysis

Curves relating delay and duration versus distance were fit by least-squares regression after conversion to log-log scales, which normalized and linearized relationships. Regressions and ANOVAs were done with a QuatroPro spreadsheet. All analyses contrasted conflict rates among consecutive months, not weeks or days.

Results

The greater a community's distance from the nearest bait site, the longer it took for conflicts to begin declining in that community (r^2 = 0.68, $F_{1,18}$ = 37.82, df = 19, $P < 0.001$; Figure 3). Distance between community and the nearest bait station was negatively correlated with the decline of numbers of human–bear conflicts in each community (r^2 = 0.68, $F_{1,18}$ = 38.51, df = 19, $P < 0.001$; Figure 4). For example, conflict calls to the League from South Lake Tahoe peaked at 157 during August and dropped to 108 in September, a 31% decline.

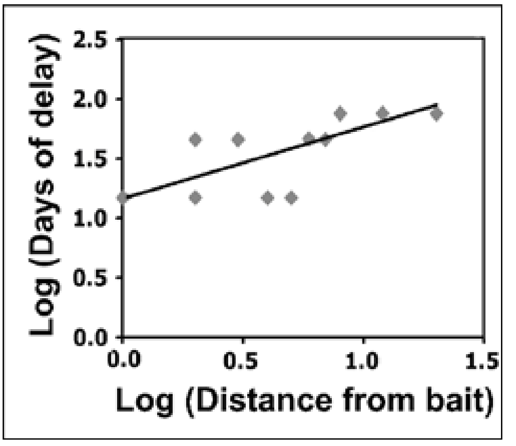

Figure 3. Delay (days) before conflicts began declining as a function of each community's distance (km) from the nearest bait site during September to November 2007 in the Tahoe Basin on the California-Nevada border. Twenty communities are represented, although several data overlap so much that they appear as single points.

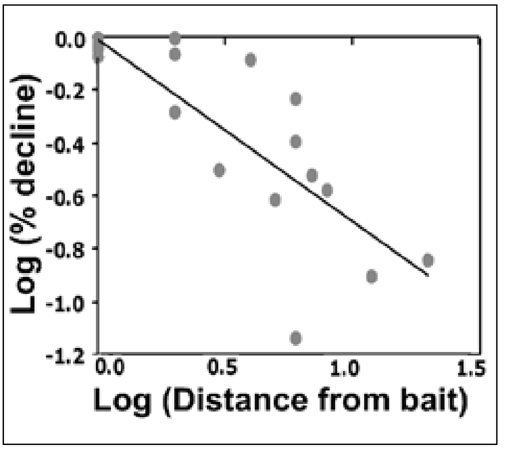

Figure 4. Decline in conflicts from September 1 to November 30, 2007 as a percentage of the peak conflict rate for each community relative to each community's distance (km) from the nearest bait site. All 20 communities are represented, although several data overlap so much that they appear as single points. Data from the Tahoe Basin, on the California-Nevada border.

In 7 communities located about 1 km from a bait site, conflicts declined by an average of 41% during September and 93% by the end of November, at a mean rate of 1.2% per day. By contrast, 3 communities ≥8 km from any bait showed no decline until November, during which time conflicts fell only 18%, a mean rate of 0.6% per day.

Discussion

We used month-to-month and year-to-year variation in number of unduplicated conflict reports as an index of human–bear conflict. The correlation between reporting rates and actual conflicts is not likely to be 1.0 (Howe et al. 2010). However, Bryant and Stringham (unpublished data) found no indication of bias, due to the 2 intervening variables that are most likely to substantially lower that correlation, seasonal variations in either: (a) the numbers of people present in the Basin to experience and report conflicts; or (b) in the amount of garbage and other anthropogenic foods that might attract bears into communities. We found no basis for supposing that the percent of conflicts reported changed during our study. We therefore concluded that trends in conflict report rates provide an unbiased, if somewhat noisy, index of trends in actual conflict rates.

Distance to water

We have not been able to identify any factors other than baiting that might account for the relationships we found between conflict reduction versus distance to the nearest bait sites. Nevertheless, given that this study occurred during a historic drought, 2 obvious considerations are the distances separating (a) each bait site and (b) each community from the nearest source of drinking water for bears. However, we did not include either of those distances in our statistical analysis. Given that virtually all of the communities were on the shore of Lake Tahoe or of the Truckee River, with negligible differences in their distances to water, those distances could not account for the large differences in conflict rates observed among communities once baiting began. Likewise, the difference in distance from each community to the nearest bait site approximated the difference in distance between those same bait sites and the lake or river. A second reason for not including each bait site's distance from the nearest known water source in our statistical models is that we could not preclude the possibility that each bait site was closer to 1 or more smaller water sources that we did not find.

Applicability of our results to other cases of bear incursion into communities

We provided bait for only 3 months. The distance relationships we observed might not hold where baiting is chronic. If declining effectiveness with distance between a community and the nearest bait site is due to delay in bears detecting the bait and being diverted away from communities, one would expect that even distant baits would eventually be found and utilized. In other words, if baiting is chronic, then, over the long term, more distant baits might not be less effective, just slower in reaching full effectiveness.

Rogers (2011) argued that at least small amounts of bait should always be available at bait sites so that bears know where to find supplemental food, without having to venture into a community whenever natural food supply is insufficient. If baits are less attractive than high-calorie wild foods and available in abundance only during famine, then chronic baiting will supposedly not make bears dependent on baits when preferred natural foods abound. Ideally, the combined attractiveness of baits and the habitat in which baits are found, should make those baits more attractive than anthropogenic foods available in towns or other zones where bears are subjected to harassment by humans or dogs or where they encounter unfamiliar loud noises, noxious odors, and swift-moving vehicles.

Year-round baiting of bears in Slovania with livestock carcasses and excessive amounts of dried corn increased the local bear population density to ~40 bears per 100 km^2, or 10 times higher than other bear populations in Europe (Steyaert et al. 2014). This suggests that intensive year-long baiting in Slovania increased bear densities above the habitat's natural carrying capacity. Baiting also shortened the period of hibernation. After baiting, there are so many more bears, and they are active for longer each year, that total conflict rate rose (Stayaert et al. 2014). Chronic heavy consumption of bait can generate some of the same problems found with chronic heavy consumption of garbage, for instance at dumps in Yellowstone National Park from the late 1800s until the late 1960s (Wright 1909, Stringham 1985, 1986, Craighead et al. 1995, Gunther et al. 2004). Bears that chronically sustain themselves on anthropogenic foods may be less able to subsist solely on a natural diet, once access to anthropogenic foods is terminated (Gunther et al. 2004, Robbins et al. 2004).

At Tahoe, we found that allopatric baiting during a seasonal famine best avoided spikes in bear mortality, property damage, and, possibly, human injury, where baits are placed ~1 km from the resources to be protected. It would be revealing likewise to learn how the effectiveness of baiting can be influenced by distance from baits to resources in need of protection when the baits are interspersed among those resources, e.g., among timber trees (Ziegltrum 2004, 2008), fruit and nut trees, homes or other structures.

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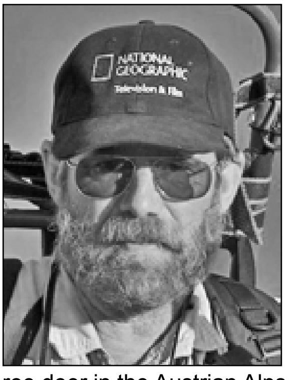
Stephen F. Stringham began researching the ecology of coastal black and brown bears in



1969, first in northern California through Humboldt State University, then at Katmai National Park through the University of Alaska. His research focuses on behavioral and population ecology, social organization, communication, tool-use, aggression, behavioral versatility, evolution, and bear–human relations. He has also studied moose, red deer, and roe deer in the Austrian Alps, as well as predator–prey relations. He has taught at several colleges and universities, including 2 Native American colleges, and most recently, as an adjunct professor at the University of Alaska. He was founding director of the Environmental Office of the Blackfeet Indian Nation. He is president of WildWatch, a consulting company, director of the Bear Viewing Association, and chair of the scientific advisory committee for the BEAR League at Tahoe, California. He received his Ph.D. in behavioral and population ecology (University of Tennessee) and his M.S. degree in wildlife management (University of Alaska).

Ann Bryant is executive director of the BEAR League, centered in the Tahoe Basin, California.

She founded the organization in 1998. It now has a membership of >3000 members, some of whom assist her in stewardship of the basin's black bears, including her 2007 diversionary baiting experiment. The organization is comprised of pioneers in citizen wildlife science and stewardship. She has also rehabilitated a wide variety of wildlife, including several porcupines, such as "Marvin" whom she is holding in the above photo. She was educated in philosophy and psychology at Mankato State University, Minnesota.