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Title

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Permalink

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Journal

Proceedings of the Vertebrate Pest Conference, 24(24)

ISSN

0507-6773

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Publication Date

2010

DOI

10.5070/V424110592

Retrofitting Dumpsters with Bear Resistant Lids to Reduce Human-Bear Conflict in New Jersey

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ABSTRACT: Black bear populations are increasing throughout North America. When areas of black bear population expansion overlap regions of substantial human use, conflict can ensue. Human-bear conflicts can have negative economic, health/safety, and social impacts. Attraction to human foods brings bears into more frequent contact with people, resulting in a higher probability of negative human-bear encounters. In order to achieve successful management of human-bear conflicts, the use of bear-resistant lids outfitted on dumpsters is one management tool. We evaluated the efficacy of Interagency Grizzly Bear Committee-approved, modified, bear-resistant lids that were installed on dumpsters in a community in northwestern New Jersey. Black bear sows exhibiting nuisance behavior were trapped in the community at dumpster sites, outfitted with either VHF or GPS satellite collars, and their movements were tracked for the year prior to the installation of the retrofitted bear-resistant dumpster lids. After the lids were installed, movement patterns of the sows were monitored to determine if bears altered their behavior and left the area when dumpster access was no longer available. Residents of the community were also surveyed and offered educational programs regarding the black bear population in their community.

KEY WORDS: bear-resistant, black bear, conflict, dumpster, garbage, New Jersey, non-lethal, refuse, *Ursus americanus*

Proc. 24th Vertebr. Pest Conf. (R. M. Timm and K. A. Fagerstone, Eds.)
Published at Univ. of Calif., Davis. 2010. Pp. 278-284.

INTRODUCTION

Black Bears in New Jersey

The American black bear (*Ursus americanus*) is a native species of New Jersey. Prior to European colonization, black bears were endemic to forested regions of the state. Due to negative attitudes towards the black bear, population numbers decreased to a point of less than 100 bears by the 1950s.

By the 1980s, an increase in black bear sightings and complaints prompted the New Jersey Division of Fish and Wildlife (NJDFW) to study the growing population. To assess and quantify the bear's population expansion, the NJDFW developed Project W-59-R, a trapping and tagging study (McConnell et al. 1997, MacKenzie 2003).

At the conclusion of the Division's studies in the early 1990s, the number of black bears in the state was estimated at 550 individuals. By 2003, the estimate had increased to 3,278 bears (Carr and Burguess 2004). In 1999, the NJDFW received over 2,000 complaints in one year related to black bears. As a result, the NJDFW developed the Black Bear Management Team, and education efforts were increased in 2001.

As the black bear population has increased, fecundity rates have also remained high, at 2.7 cubs/litter (K. I. Burguess, NJ Bur. of Wildlife Management, pers.

commun.). The NJDFW has seen an increase of over 300% in reported complaint black bear calls in the last decade. As human encroachment increases on traditional black bear habitat, the previous cultural carrying capacity of these habitats is being tested. The cultural carrying capacity of an area can be defined as the number of bears that humans will tolerate in their community. It is not possible to calculate a tolerable population number because tolerance levels will differ among individuals, and every person's attitude towards black bears may change over time.

Food Habits of New Jersey Black Bears

Black bears are classified as plastic generalists, when referring to dietary constraints (Powell et al. 1997). They will consume a wide variety of prey items, but the composition of prey varies seasonally. They eat a varied diet, and the diet changes based on environmental condition (Morse 1971). Black bears' ability to change food selection, based on abundance and nutritional quality throughout the year, makes them the ideal candidate to find and utilize a new and novel food source (Powell et al. 1997).

Black bears have adapted to the presence of humans in

New Jersey. Refuse and human food have become a part of the black bear diet. In years when natural food production is low, unintentional feeding of bears increases. Bear damage increases in a year when natural food production is low (Anonymous 2001). This is corroborated by the increase of bears at dumps, campsites, picnic areas, and urban areas in general. Bear activity in close proximity to humans has become an increasing problem (Davidson 1999).

Black Bears and Refuse in New Jersey

Managers of bear populations deal with bears habituating themselves to urban areas in search of refuse. This habituation has had a negative effect on people's attitudes towards the bears. This impacts the cultural carrying capacity for bears in an area. An average of 32% of all black bear complaints received by the NJDFW over the last 14 years were related to garbage (NJDFW, personal commun. 2009). In spring 2007, Lisa P. Jackson, former Commissioner of the New Jersey Department of Environmental Protection, outlined the need for continued research in non-lethal control methods for New Jersey black bears (A. Cradic, NJ Dept. of Environ. Protection, pers. commun.).

Bear-resistant dumpsters and garbage totes have proven to be an effective non-lethal management technique. However, to date no study has been conducted to evaluate these techniques on the growing black bear population in New Jersey.

Purpose of Study

The goal of this study was to evaluate the effectiveness of modifying dumpsters in changing bear behavior to decrease human-bear interactions. The objectives of this study were 1) to determine bear home range before and after lid installation, 2) to survey the residents of the study area regarding their attitude towards black bears, 3) to document, using trail cameras, bear activity at the dumpster sites, and 4) to evaluate hard and soft mast in the bear's home ranges.

METHODS

Study Area

The study site, Great Gorge Village (GGV), Vernon Township, Sussex Co., New Jersey, is a developed area consisting of over 1,400 condominiums, townhomes, and personal residences (Figure 1). The study area is home to a minimum density of 3 bears per mi² (K. I. Burgess, NJ Fish and Wildlife, pers. commun.). GGV was selected because of the high bear activity at dumpsters throughout the community.

In GGV, the majority of the terrain is landscaped, and the surrounding area directly bordering GGV is typical of northwestern New Jersey. The area consists of wetlands, streams, and lakes. The vegetation in this part of the state is characteristic of upland forest and lowland swamps and drainages (Robichaud and Buell 1973). The forests are composed of chestnut oak (*Quercus prinus*), pitch pine (*Pinus rigida*) and white oak (*Quercus alba*).

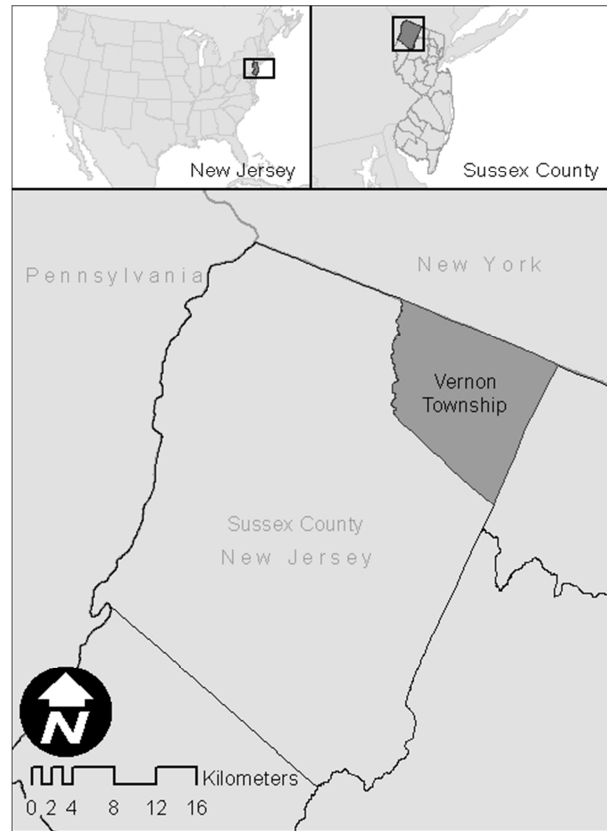


Figure 1. Map of Vernon Township, New Jersey.

Dumpster Lids

There are 76 steel garbage dumpsters ranging from 2 - 8 cubic yards in GGV. The dumpster lids are a heavy-duty polymer plastic. In addition, each dumpster is retrofitted with a gravity-locking steel bar, in an effort to reduce bear activity.

A retrofitted dumpster lid prototype, modeled after Interagency Grizzly Bear Committee-approved dumpsters, was manufactured (Bear Proofing R-Us, Gatlinburg, TN). The prototype was installed on a 6-cubic-yard dumpster and observed for effectiveness of preventing bear access, from October 3, 2008 to November 9, 2008. Subsequently, modifications were made to the locking mechanism by sealing the back portion of the mechanism to ensure rainwater would not be able to collect in the lock and freeze. The door size was decreased to provide reinforcement. The color of the lids was lightened from black to tan to minimize heat absorption. A rust-proofing agent was added to the new paint in order to increase longevity of the product.

An additional 24 modified lids were installed in March 2009. These lids were installed clustered together in the Northeastern region of the study site, to evaluate the effectiveness of installing bear-resistant lids throughout an entire community.

Study Animals

The bears in this study were caught and collared by

NJDFW under their standard operating procedure. All bears in this study wore a collar, VHF or GPS, for a minimum of 6 months. The collars on these bears were removed from the animals by personnel of the NJDFW.

Trapping

NJDFW personnel trapped 6 bears from May 6, 2008 to March 3, 2009 using Aldrich foot snares, culvert traps, and free-range darting. The target animals for the study were females, at least 3 years of age, and over 150 lbs. Two bears were caught previously in other trapping sessions. For the purpose of this study, the date that the bear was caught and collared was the trap date reported. The capture locations were selected based on the location of complaints and predictability of the animal's behavior. A Pneu-Dart hand projector, Model 190B air-projected pistol, (Pneu-Dart, Inc., Williamsport, PA) or DAN-INJECT dart rifle (Wildlife Pharmaceuticals Inc., Fort Collins, CO) was used for injecting the anesthetic. The researchers collected biological samples from each bear in the study including blood, tissue, a tooth for aging (if not able to determine the age), and ectoparasites. The bears were weighed and measured.

Tracking

To determine the effectiveness of the dumpster modification on changing the bears' behavior, an accurate assessment of the bears' activities was made prior to the introduction of the lids. While the study animals were immobilized, wildlife biologists placed either a combination of VHF/GPS or a VHF collar on the bears. All collars were equipped with a VHF frequency to monitor movement and to retrieve the collar in the den, once the satellite collar was no longer transmitting.

The locations of the bears that were tracked with VHF collars were recorded from the ground using an Advanced Telemetry Systems (Advanced Telemetry Systems, Isanti, MI) vehicle-mounted dipole and a Telonics hand-held directional antenna (Telonics, Mesa, AZ). Bear locations were taken every 48 - 72 hours. Bears were located by triangulation with at least 3 azimuths or, when possible, visually located. Most of the locations were made by triangulating the bear's position using telemetry equipment, a compass (Silva Sweden AB, Sollentuna, Sweden), and a GPS device (Garmin International Inc., Olathe, KS). Each reading was taken at a maximum of 5-minute increments or less, so as not to be skewed by the bear's movement. The computer software Maptech Terrain Professional (Maptech, Inc., Amesbury, MA) was used to determine the triangulated coordinates of the bears. The GPS locations for the listening locations were added as markers, and an azimuth was drawn on the map in the compass direction of the loudest signal (true north, NAD 83). Where these three azimuths crossed was determined to be the location of the bear. This technique had been tested by MacKenzie (2003), indicating that radiolocations had an average difference of 0.05 mi from the actual (error = 264 ft).

Satellite/Radio collars (Northstar Science and Technology, King George, VA) were placed on four bears within the research area. Collars were programmed

to collect 24 GPS locations per day at a rate of 1 per hour. Locations of animals were available in real time via the Internet at a password-protected website. Data were provided on Google maps, and GPS coordinates were downloaded from the website. The collars displayed a reading on the website that indicated if the bear was moving at the time each transmission occurred. After all collars were retrieved, they were sent back to the manufacturer, who downloaded the stored on-board locations. The downloaded, on-board locations were used to determine bear movement.

Trail Cameras

Five Reconyx PC85T Professional Rapid Fire Color IR cameras (color by day, monochrome by night) with a 2.5× telephoto lens (Reconyx, Inc. Hoken, WI) were placed at dumpster sites throughout GGV, from July 2008 to November 2008, to observe bear behavior. In 2009, five additional Reconyx PC90 cameras with a 1.7× telephoto lens were added. From April 2009 to November 2009, five of the cameras photographed the experimental area, and five cameras photographed the control area of GGV.

Home Range Estimation

Home range was calculated using in Arc View 9.3 (ESRI, Redlands, CA). Using the Animal Movement Extension procedure (Hooge and Echenlaub 1997), the data were converted to a shape file using the KERNEL Home Range Estimation, which provided the least biased estimates of the 95% home range area (Powell et al. 1997).

Mast Analysis

During July 2008 and 2009, a soft mast study was conducted within the home range of each of the study animals. Using the Animal Movement Extension fixed kernel density estimator in ArcView 9.3 at a 50% utilization distribution, a random point was generated within each core kernel generated for each animal (Hooge and Echenlaub 1997). At the coordinates chosen within each of the core kernels, five 3-m radius circular plots were evaluated. One plot was at the exact coordinates generated by the computer; the others were 100 m away in each cardinal direction. In each of the five plots within a core kernel, every species capable of bearing ripe soft mast in July was recorded. The percent of the plot covered by each of these fruit-bearing species and the percentage of each of these species bearing ripe fruit was recorded. A soft mast index value was generated for each of the kernels by summing the products of percent cover and percent of plants bearing ripe fruit. Anecdotal hard mast observations were recorded in September and October of 2008 and 2009. The observations were recorded on a scale of very poor, poor, fair, good, very good, or excellent.

Survey

A survey was distributed to residents of GGV in October 2008, prior to the installation of the bear-resistant dumpster lids. The same survey was redistributed in November 2009, after having the bear-resistant dumpster

lids in place for 9 months. This survey was designed to determine how residents' attitudes had changed toward bears in the area over the 2-year study. The surveyors were able to distinguish if survey participants lived in the experimental or control portion of GGV; survey participants were not aware of this distinction. Surveys were returned anonymously via mail.

RESULTS

Home Range

A total of 23,061 locations were collected over the 18-month study period (6,518 in 2008 and 16,543 in 2009) from the 6 bears in the study. Only 4 of the 6 bears contributed data locations to the entire study. One bear (#2986) was euthanized for aggressive behavior, and bear #5316 was shot during New York State's archery season.

Bear #5538 was initially handled on May 2, 2008, when she was captured in a culvert trap in GGV adjacent to a dumpster. At the time, she weighed 179 lbs and did not have any cubs. In 2008, 2,179 locations were collected for this animal, resulting in a core kernel home range of 1.28 mi². An additional 4,988 locations were collected in 2009, yielding a core kernel home range of 1.01 mi². She did not move her core kernel home range away from the study site, but she reduced the area she frequented. The retrofitted lids did not have an effect on her core kernel home range.

Bear #2986 was handled on June 3, 2008, when she was free-range darted behind a dumpster in GGV. At the time, she weighed 268 lbs and three cubs were observed. Eight days after she was handled, she became increasingly aggressive and was euthanized by wildlife control. No locations were collected for this animal.

Bear #5316 was handled on June 26, 2008, when she was trapped in a culvert trap next to a dumpster in a neighboring community. At the time, she weighed 160 lbs and was lactating; one cub was visually located. A core kernel home range of 2.21 mi² was determined from 1,116 locations collected in 2008. During her pre-denning hyperphagia, she crossed the state line into New York. While in New York, the animal was shot and killed during New York State's archery season. As a result, the collar was recovered and no locations were collected in 2009.

Bear #4848 was trapped in a culvert trap on June 28, 2008 next to a dumpster in a neighboring community. At the time she weighed 146 lbs and had no cubs. In 2008, 2,256 locations for this animal were collected, yielding a core kernel home range of 1.91 mi². An additional 5,267 locations were collected in 2009, yielding a core kernel home range of 1.52 mi². She moved her core kernel home range 440 m away from the study site.

Bear #6870 was culvert trapped in a neighboring residential area on May 5, 2008. At the time, she weighed 145 lbs and had no cubs. In 2008, 857 locations were collected for her, yielding a core kernel home range of 1.34 mi². An additional 2,870 locations were collected in 2009, yielding a core kernel home range of 1.15 mi². Bear #6870 did not move her core kernel home range away from the study site. The study site remained centrally located in her core kernel home range for both years.

Bear #3494 was culvert-trapped at a dumpster in GGV on August 11, 2008. At the time she weighed 178 lbs, and two cubs were observed. In 2008, she was tracked by radio telemetry and 64 locations were collected, from which a home range of 1.78 mi² was calculated. In 2009, 3,418 locations were collected, resulting in a home range of 1.54 mi². She moved her core kernel home range 1,680 m away from the study site.

Trail Cameras

The 5 trail cameras installed in 2008 produced a total of 1,345 photographs of black bears. Cameras were functioning for 363 camera-nights between July and November 2008, recording an average of 3.7 bear photos per 24-hour period. Due to the angle of many of the photos, individuals could not be conclusively identified. Prior to lid installation, cameras in the control area recorded 576 photos, or 3.2 bears per day, while cameras in the experimental region recorded 812 bear photos, or 4.5 bears per day.

A total of 10 trail cameras were installed in 2009, resulting in 7,443 photographs of black bears. Cameras were functioning for 779 camera-nights between July and November 2009, recording an average of 9.6 bear photos per 24-hour period. Unfortunately, due to the angle of many of the photos, individuals could not be conclusively identified. In this year, after the lids were installed, cameras recorded 7,208 photos, or 15.7 bears per day, in the control area, while cameras in the experimental area recorded 235 bear photos, or 0.7 bears per day (Figure 2).

Photos revealed a difference in bear activity in the experimental area, where an 84% decrease in bear activity was recorded. An 80% increase in bear activity at dumpsters in the control area, compared to the previous year, was observed.

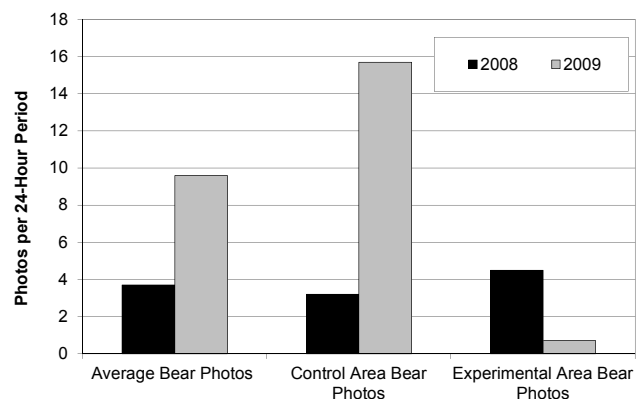


Figure 2. Frequency of bear activity at dumpsters as recorded by trail cameras.

Mast Analysis

Soft mast yield for 2008 was poor (Table 1), with an average of 1.0% ripe fruit cover in each bear's core kernel home range. A soft mast assessment could not be made for bears #2986 and #3494 in 2008: bear #2986 was euthanized too early in the study for data to be collected, and bear #3494 was not trapped until August, while soft mast assessment was conducted in July.

Soft mast yield improved in 2009 (Table 1), with an average of 12% ripe fruit cover in each bear's core kernel home range. Soft mast assessments could not be made for bears #2986 and #5316 in 2009, due to mortality the previous year.

Anecdotal hard mast observations collected for the study area in 2008 and 2009 yielded similar results to the soft mast data. The hard mast analysis for the study site in 2009 was very good.

Table 1. Percent ripe fruit cover per core kernel home range, for five black bears in Great Gorge Village, Vernon Township, New Jersey.

Bear ID #	Percent Ripe Fruit Cover	
	2008	2009
2986	Not Available	Not Available
5538	0.64	1.66
5316	3.00	Not Available
4848	0.25	16.25
6870	0.00	2.38
3494	Not Available	28.10

Retrofitted Lids

The retrofitted dumpster lids had a 100% success rate at keeping out black bears, when properly used. However, the residents of GGV found the lids difficult to open and cumbersome to maneuver, which led to human error and lid failure.

After the installation of the retrofitted lids, a 'dumpster check' was initiated and conducted at least twice per week to observe if residents were properly using the new lids, and to look for fresh bear sign near any of the 78 dumpsters. We determined that the retrofitted lids were being used properly only 52% of the time, while the traditional lids were properly closed 59% of the time. Even when the dumpster lids were not properly closed, the retrofitted lids were still more effective: when not properly closed, evidence that bears were able to access the refuse inside the dumpster was recorded 1.2% of the time, bears were recorded accessing refuse inside of traditional dumpsters 12% of the time.

DISCUSSION

Other studies have reported a wide range of home range sizes in black bears (see Table 2). In this study, as the food production increased, the core kernel home range for each of the study animals decreased by 0.27 ± 0.09 mi². This is consistent with Powell et al. (1997) who showed that animals would decrease the size of their home ranges in response to changes in food production. The more food that is produced in an area the less distance an animal needs to travel, and the less food produced the greater distance an animal should travel. This suggests that energy expenditure is a deciding factor in food selection. Powell et al. (1997) also observed this trend in Pisgah Bear Sanctuary black bears. In this study when home ranges decreased in 2009, there was an increase in natural food production, hard and soft mast, which may have been responsible for the observed

decrease in home range. This, combined with the consistent and abundant food supply that bears find in GGV dumpsters, could be one explanation for the decrease in home ranges.

Table 2. Comparison of average female black bear home ranges by state.

State or Providence	Average Home Range (mi ²)	Reference
Alberta (east central)	12.2	Young and Ruff 1982
Arkansas	7.5	Smith and Pelton 1990
Florida (GCE)	19.3	Maehr et al. 2003
Florida (Highlands Co)	5.2	Ulrey et al. 2005
Florida (Osceola)	17.4	Wooding and Hardisky 1994
Georgia	6.9	Cook and Conroy 2005
Idaho	10.3	Amstrup and Beecham 1976
Kentucky	23.6	Unger et al. 2005
Maryland	13.0	Beyer (pers. commun.) ^a 2005
Michigan	81.4	Bostick et al. 2005
Minnesota	7.0	Garshelis (pers. commun.) ^b 2005
Nevada	80.8	Beckmann and Berger 2003
New Jersey (1990)	5.7	McConnell et al. 1997
New Jersey (2003)	1.7	MacKenzie 2003
New Jersey (2005)	1.9	Shramko 2005
New York	37.0	Ohio DNR 2004
North Carolina	8.3	Ohio DNR 2004
Pennsylvania	37.0	Ohio DNR 2004
Southern Quebec	8.3	Samson and Huot 1998
Tennessee	9.3	Garshelis and Pelton 1981
Virginia	11.1	Hellgren and Vaughan 1987
Washington	4.4	Fersterer et al. 2001
Washington (SW Island)	0.9	Lindzey and Meslow 1977

^a B. Beyer, MD Dept. of Nat. Resources

^b D. I. Garshelis, MN Dept. of Nat. Resources

In a previous black bear home range study in New Jersey, Shramko (2005) evaluated female black bear home ranges pre and post hunting season, reporting that female black bear home ranges increased after a harvest. He also found that the bears increased their core kernel home ranges by 0.7 mi² after a hunt. A proposed explanation for this increase in home range size was the population decrease, as a result of the hunt, allowing the remaining animals to increase their home ranges due to reduced competition and territorial defense. Shramko's (2005) explanation of home range size increase was based on the population reduction from the harvest. He did not take mast production into account during his analysis. If mast production had decreased from 2004 to 2005, this could be another factor in the increase of home ranges. Also, the bears in this study were 'urban bears', meaning they reside in areas of human development. An increase in access to human foods could also have played a role in home range selection.

Currently, there is no method of population control to regulate the expanding New Jersey black bear population. In New Jersey, black bears have no natural predators, no pressure from a hunting season, and they have access to

refuse as a year-round food supply. The decrease observed in core kernel home ranges in this study may be the result of an increasing New Jersey black bear population. Based on our observations from photos taken using camera traps, it appears that using bear-resistant garbage dumpsters is an excellent way to control bear activity in an area. However, bear activity in the surrounding area increased. This suggests that in highly urbanized states such as New Jersey, management with bear-resistant garbage containers alone is not adequate. The containers only move the bears to the surrounding areas, which in New Jersey is another residential neighborhood.

The hard and soft mast assessments gave us an indication of the amount of natural food available to the bears in the study area. It can be inferred that due to the poor mast production in 2008, the study animals needed to subsidize their diets with human food. However, mast production in 2009 substantially increased, but we saw an increase in dumpster activity by the study animals. This may indicate that once black bears become habituated to human food sources, they will continue to feed on them regardless of the availability of natural foods.

The retrofitted bear-resistant dumpster lids, when properly closed, had a 100% success rate. The residents of GGV frequently did not properly close the lids, because of the weight and angle of the lids. However, neither did residents of GGV properly close the traditional, lighter dumpster lids made of plastic. Complete compliance in such tasks, when relying on human behavior, may be difficult to achieve. It is important to note that when dumpster lids were not properly closed, retrofitted lids still reduced black bear activity 10-fold (1.2% vs. 12% failure rate) when compared to traditional lids.

The home range of black bears in New Jersey may continue to decrease with current management practices. Bears that have become habituated to human food sources will continue to utilize them regardless of the natural food availability. Bear-resistant dumpster lids and proper garbage disposal are effective, even without complete compliance by residents. It is also evident from this study that 'bear-proofing' a community in an urban setting cannot effectively be used as the sole black bear management tool in nuisance abatement. Though it alleviates human-bear conflict in one area, it increases human-bear conflict in the surrounding area. In an urban setting with a dense black bear population, such as New Jersey, this only relocates the problem.

Black bear-resistant garbage containers should be used in New Jersey as part of an integrated management strategy. Management of the bear population through a variety of methods including hunting, aversive conditioning, and proper garbage disposal in bear-resistant containers, will create an environment with reduced human-bear conflict.

ACKNOWLEDGEMENTS

We express our sincere thanks to the New Jersey Division of Fish and Wildlife for their expertise in trapping and handling the study animals; to Bear Trust International, for the funding to conduct this project; and to East Stroudsburg University's

Northeast Wildlife DNA Laboratory, for countless hours of support, with everything from stuffing envelopes to conducting telemetry.

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