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COEXISTING WITH BLACK BEARS:
PERSPECTIVES FROM FOUR CASE STUDIES ACROSS NORTH AMERICA

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INTRODUCTION

Across the North American landscape, rapid land use change is creating new challenges for people who are interested in conserving wildlife populations, as well as for those who strive to minimize people's negative interactions with wildlife. Growing human populations, dispersed, rural residential development spreading across the landscape, and increasing use of wildland areas for recreation are all major drivers in this dynamic. The net result is that fewer regions of the continent are untouched by the hand of human influence, and, increasingly, questions of conservation and attempts to minimize conflict have to do with understanding how species relate to the interfaces created by human land use patterns.

Naturally, not all species are equally impacted by these land use changes. This working paper pays particular attention to impacts on wide-ranging species by looking closely at black bears (*Ursus americanus*). Black bears are a species that captures both the public's imagination and, at times, its fear and concern. For this reason, they offer a critical insight into the relationship between people's behavior and their demands about wildlife management and conservation.

Several factors of black bears' biology and behavior make them particularly strong candidates for this conversation about human-wildlife conflict, and a particularly challenging species to manage. With large home ranges, they are impacted by land use changes throughout a wide area. And when they are confronted by the presence of human behavior, they are particularly adaptable and curious, forming commensal relations with humans that often create problems.

Black bears' foraging strategy is inherently opportunistic. Although the species is taxonomically classified as a carnivore, they are in fact omnivores that vary their diet seasonally and annually in response to changing availability of foods. Likewise, black bears are strongly driven by food consumption; particularly in the fall, black bears must consume an excess of calories for sustenance during winter hibernation. Females face the additional caloric demand of birthing and lactating in the den. Given these caloric demands, black bears have developed extremely opportunistic and curious behavior. The foraging strategies that permit successful location of food sources in the wild, however, become more problematic when bears come into contact with humans. The species takes full advantage of novel food resources, such as garbage and other food sources provided by humans.

On a species level, these strategies and their inherent adaptability has served black bears well; whereas grizzly bears (*Ursus arctos horribilis*) have faced a shrinking range across the continent, black bears have generally persisted and their distribution and many localized populations are expanding. Wide distribution and growing populations, however, often put black bears at the forefront of human-wildlife conflict. And, as described above, humans continue to expand their sphere of influence on the North American landscape, resulting in an increased need for understanding of the management and conservation issues associated with wildlife conflict. These issues are only likely to increase over the coming decades.

To effectively conserve black bears and minimize bear-human conflict, it is necessary for conservationists and managers to understand a suite of issues, including: bears' behavior, biology, and population dynamics; human attitudes and reactions; and the efficacy of management strategies. This working paper presents case studies spanning these topics drawn from the Wildlife Conservation Society's experiences researching bears and bear management across the United States. These four case studies represent different ecosystems and different approaches to studying these complex issues. Collectively, they provide a unique and varied perspective, as well as the opportunity for interesting comparisons.

The authors have significant and diverse experience; Wildlife Conservation Society programs have been focusing on black bears and the species' conservation and management issues in four sites for a combined total of 34 years. Our collective efforts have examined many aspects of the issue, including changes in bear behavior and population demographics, non-lethal deterrents and other potential solutions, policy and management issues, and education efforts to alleviate the problem. Beyond simply having a research and outreach focus, Wildlife Conservation Society staff have actively engaged with managers to forge policy solutions. This array of experiences enriches this paper.

There are abundant resources on bear biology and management available elsewhere, and this working paper does not attempt to duplicate those valuable efforts. Rather, through the presentation of four unique case studies drawn from different regions, it synthesizes a particular cross-section of issues, with particular focus on providing insight into the underlying causes of conflict, extracting lessons learned, and identifying management recommendations for reducing bear conflict.

We hope that this working paper will be a valuable resource for managers, municipalities, or others grappling with questions of how to more effectively manage human-bear conflict. In the process, we also hope that it will be a useful conservation tool to aid in this complex issue.

HUMAN-BLACK BEAR CONFLICT: AN OVERVIEW

There is abundant evidence from varied regions and ecosystems that human-bear conflict is an increasing problem. In New Jersey, for example, increasing bear and human populations have resulted in striking conflict levels, which in turn have resulted in significant management challenges. Between 1995 and 2003, the state Department of Fish and Wildlife observed dramatic increases in the numbers of bear-vehicle collisions and municipalities reporting sightings or damage. During this period, bear damage complaints skyrocketed from 285 to over 1200 (Carr and Burguess, 2004).

New Jersey's experiences are symptomatic of the factors at play in a suburban environment, and similar trends are evident in comparable settings elsewhere.

These trends also extend to different systems. The Lake Tahoe case study in this volume describes a 10-fold increase in citizen complaints about black bears in Nevada since 1990. In just one town in Colorado, where the number of luxury homes is increasing, wildlife officers field up to 40 calls a week about bears on front lawns, in gardens, and in dumpsters. In response to nuisance calls, wildlife officials had to destroy at least 30 bears throughout Colorado in summer 2007, and reports of human-bear encounters were up at least 70% from 2006 (Kohler 2007).

State and national parks also experience dramatic levels of bear conflict. In Yosemite National Park, 9,333 incidents were documented between 1989 and 2002. Sequoia, Kings Canyon, Great Smoky Mountains, and Redwood National Parks have all documented smaller, but still significant, numbers of conflicts.

These high levels of human-black bear conflict have negative implications for bear and human populations alike.

Bear populations suffer a range of consequences, but some of the most pointed examples of these impacts are increased mortality levels. Our work in Nevada illustrates this effect; since 1997, all documented bear mortalities in Nevada have been the result of human activities, such as car accidents, lethal removal of "nuisance" bears, and accidents in homes. Beyond direct mortality, black bears experience a range of impacts from increasing contact with humans. These include the obvious -- reliance on human food sources, decreased natural foraging behavior, increased conflict with humans – but also a host of physi-

ological and behavioral impacts such as a decreased home range, increased birth rates, and potential shifts in daily activity patterns (Beckmann and Berger 2003a,b). Cumulatively, direct mortality and the other consequences of human-bear conflict have the potential to reduce population growth in local bear populations. This phenomenon is discussed in greater detail in the New Mexico and Lake Tahoe case studies. These studies illustrate the significant conservation challenges presented by a trend of increasing human-bear conflict.

Although conservation concerns are of great interest to us, it's clear that many management decisions are driven by impacts to humans, and these too are compelling and sometimes serious. Although in reality black bears pose little threat to human safety, they are sometimes feared. The species' power in the public eye can lead to intense public safety concerns and, thus, extreme management reactions. This fear, though largely unwarranted, does have a few significant bases for fact. On average over the last decade, there has been approximately one human fatality from a black bear per year in North America, in addition to occasional injuries caused by black bears. Although these certainly represent the extreme of what is possible when black bear-human conflict escalates, these events clearly illustrate the need to take these powerful creatures seriously, and to work to avoid conflict situations. Studies have demonstrated that a high proportion of negative bear interactions are a result of bears becoming habituated to humans and food-conditioned. (Herrero 1989) Habituated bears, while appearing tame and approachable to the public, often can be the most dangerous. Naturally, this reinforces the importance of preventing bears from becoming conditioned to humans and human foods.

Direct mortality and the other consequences of human-bear conflict have the potential to reduce population growth in local bear populations.

In addition to public safety concerns, human-bear conflict has basic economic implications, both in terms of the damage that it causes and the management that aims to prevent damage. In terms of direct damage, there are a broad range of impacts, from nuisance-level to truly costly – from food stolen from campsites to backpacks, tents, cabins, homes and cars damaged. Between 1989 and 2002, for example, annual property damage cost estimates in Yosemite National Park ranged from $32,303 and $659,569. On several occasions in Nevada, bears breaking into homes have caused over $10,000 in damage in a single night.

C. Lackey/NDOW

Habituated bears are capable of doing significant damage in the pursuit of food.

The public safety and economic impacts of human-bear conflict illustrate the need for improved management options and practices. In this discus-

sion, however, it is important to recognize that humans are a root cause of many of these issues, and that focusing on bears as a public safety threat or as an economic nuisance is largely counterproductive. To solve these problems, the central focus needs to be human behavior.

The root of most bear-human conflict is the availability of anthropogenic food sources – everything from unsecured garbage to birdseed, dog food, or unattended coolers and backpacks full of chocolate. As was discussed above, bears are opportunistic foragers and are easily adaptable to new food sources. Learning to make the most of the presence of anthropogenic foods comes very naturally for these intelligent creatures, and it is a good strategy in terms of reducing the amount of effort that they need to expend to find food. This biological proclivity for taking advantage of opportunities often leads to trouble, however. The results from many of the case studies in this volume suggest that anthropogenic foods is a leading cause of human-bear conflict. In the New Mexico case study, we found that bears whose home range overlapped towns with unsecured garbage were most likely to get into conflict with humans. Our research and others' in the Lake Tahoe Basin suggests that bears there are becoming increasingly reliant on anthropogenic foods and as a result, a segment of the population now forages almost exclusively on garbage. In our case study in Yosemite National Park, 35% of the bear-human conflict incidents documented between 1989 and 2002 were the result of conditioned bear behavior; most of the rest were attributed to human error. And in the Adirondack study area, bears have become more reliant on inadequately stored food and have increasingly exhibited aggressive behavior towards campers. Our work is in line with what we hear from researchers and managers in other regions; when bears become accustomed to accessing anthropogenic foods, human – bear conflict results.

L. Karasin

Unsecured trash cans and dumpsters provide easy pickings for a black bear. It doesn't take many experiences such as what took place here to fuel conflict situations between bears and people.

Natural patterns and factors such as drought and mast failure can contribute to – or exacerbate – a bear problem that hasn't really surfaced or has remained under control. For example, widespread acorn failures documented throughout New Mexico during 1999-2001 were associated with record high nuisance complaints and roadkills, indicating that bears were spurred to travel long distance and risk conflict situations (NMDGF, unpublished data). As a result, managers may need to be particularly attentive and proactive in preventing conflict situations in years when these natural factors increase the risk of conflict.

As we have noted, North Americans are spreading out on the landscape and are, increasingly, developing houses, communities, and cities that are in close proximity to natural bear habitat, and also recreating in the midst of prime bear habitat. Our land use patterns, therefore, suggest that human – black

bear conflict is an issue that is not going to go away easily. The proximity of humans and black bear populations is the first step in the emergence of conflict problems. Our New Mexico and Nevada case studies both demonstrate that conflict incidents are most common where bear populations are contiguous with human population centers. Likewise, in Yosemite National Park and the Adirondack Park, we have observed that conflict incidents are concentrated in sites that receive high levels of human use. At times, these trends are exacerbated by poor management and land use planning decisions. For example, one of the parking lots in Yosemite is located in an apple orchard. It is little wonder that concentrating human activity in a location of natural (or semi-natural) bear foods is a recipe for conflict. While the proximity of human habitation and activity to bear habitat opens the door to human – bear conflict, it is a pattern of people making anthropogenic foods available to bears that really beckons bears to engage in the human realm.

North Americans are spreading out on the landscape and are, increasingly, developing houses, communities, and cities that are in close proximity to natural bear habitat, and also recreating in the midst of prime bear habitat.

We feel strongly that black bear-human conflict is a problem that deserves attention and, wherever possible, should be prevented through proactive measures before a conflict situation truly develops. We have found evidence in our work that makes us hopeful that conflict problems can be prevented. In our New Mexico case study, for example, our research demonstrates that most bears apparently try to avoid humans. On both areas that we studied carefully, the proportion of bears engaged in conflict was significantly lower than the proportion of bears overlapping potential sources of anthropogenic food. Even among bears whose home range overlapped with towns, where foods and garbage were often readily available, 27% of bears apparently stayed away from dwellings, dumpsters, and other sources of food. We conclude that the proximity of bears and humans does not necessarily lead to conflict.

Our results from this case study also demonstrate that efforts to reduce the availability of human-related food to bears can be quite effective at reducing these potential conflicts. The comprehensive bear-human management system employed by Philmont Scout Ranch, as well as the installation of bear-resistant garbage containers in two local communities, discouraged bears from obtaining food. As a consequence, the proportion of bears engaged in nuisance or depredation behavior was much smaller than might be expected. We are heartened by the success of these management activities, and offer ideas in the Management Recommendations section, below, about how similar efforts to reduce bear-human conflict can be initiated in other areas where bears and humans co-exist.

Although in much of this paper we focus on a particular species, the black bear, we also feel that there is a lot we can learn from this issue that reflects on the conservation of other carnivores as well. Across North America, but particularly in the west [e.g. Prudhoe Bay, Alaska (Burgess 2000); southern California (Beier 1993); Rocky Mountains (Weaver et al. 1996)], urban and exurban, low-density residential sprawl is compromising the local persistence of carnivore species. Our current understanding of mechanisms by which both types of sprawl affect populations that require large expanses of area is, however, limited.

Efforts to reduce the availability of human-related food to bears can be quite effective at reducing potential conflicts.

For some species, urbanization creates marvelous habitat and facilitates expansion. For instance, in addition to the typical invasive species that achieve high densities, such as cockroaches (*Order Blattaria*) or Norway rats (*Rattus norvegicus*), coyotes (*Canis latrans*) and raccoons (*Procyon lotor*) are among several of the carnivores that may achieve higher local densities in landscapes changed by humans (Sanderson 1987). Raccoons have increased by about 15-20 times during the last 60 years, undoubtedly through the development of commensal relationships with humans (Sanderson 1987). Further, for ravens (*Corvus corax*; Day 1998), arctic foxes (*Alopex lagopus*; Eberhardt et al. 1983; Burgess 2000), and brown bears (*Ursus arctos*; Shideler and Hetchtel 2000) development activities in the Prudhoe Bay oil fields have led to increases in densities, likely due to garbage availability. At the same time, Wildlife Conservation Society researchers have worked to conserve declining populations of more secretive forest carnivores such as wolverines (*Gulo gulo*) and fisher (*Martes pennanti*). Our research on the impacts of low-density development also illustrate that development patterns have inequitable impacts on species according to their habitat needs and tolerance of humans (Glennon and Kretser, 2005).

As a species that is reasonably adaptable and tolerant of human activity, black bears can help us both understand the conservation dynamics of a particular type of carnivore, and can also help managers to engage the public in conservation efforts, because of widespread interest in bears. It is our hope that this interest will be catalyzed not just to mitigate human – black bear conflict but for the conservation of other wildlife species as well.

CASE STUDIES

INTRODUCTION TO THE CASE STUDIES

The case studies presented below span diverse regions and topics. Each offers insight into a particular management context, human landscape, and set of research questions. A reader of this paper may benefit most from understanding the research performed in one of the studies and the management context of a different study. The table below is intended as a quick reference and as a guide to help readers find case studies of particular relevance to their interests.

Case Study	One	Two	Three	Four
	Beckmann et al.	Costello et al.	Smith et al.	Matthews et al.
Case study components				
Geographic setting	Nevada	New Mexico	Adirondacks	Yosemite
Urban/frontcountry	X			
Wildland interface	X	X		X
Backcountry	X	X	X	
Ecosystem type	Xeric slopes and canyons	Mixed conifer forests and conifer-oak woodlands	Eastern deciduous and spruce-fir forests	Mixed conifer forests and conifer-oak woodlands
Research focus				
Bear population dynamics	X	X		
Assessing management tools	X	X	X	X
Understanding human attitudes towards bears			X	X
Management tools assessed				
Public education		X	X	X
Tools to secure human foods and garbage	X	X	X	X
Regulations and enforcement	X	X	X	X
Managing backcountry use		X	X	X
Land use decisions	X			
Non-lethal deterrents	X		X	
Translocation	X	X		
Lethal removal of bears			X	X
Comprehensive management plans	X	X	X	X

CASE STUDY ONE:

DEPOPULATION OF WILD AREAS: ECOLOGICAL AND BEHAVIORAL CHANGES IN BLACK BEARS

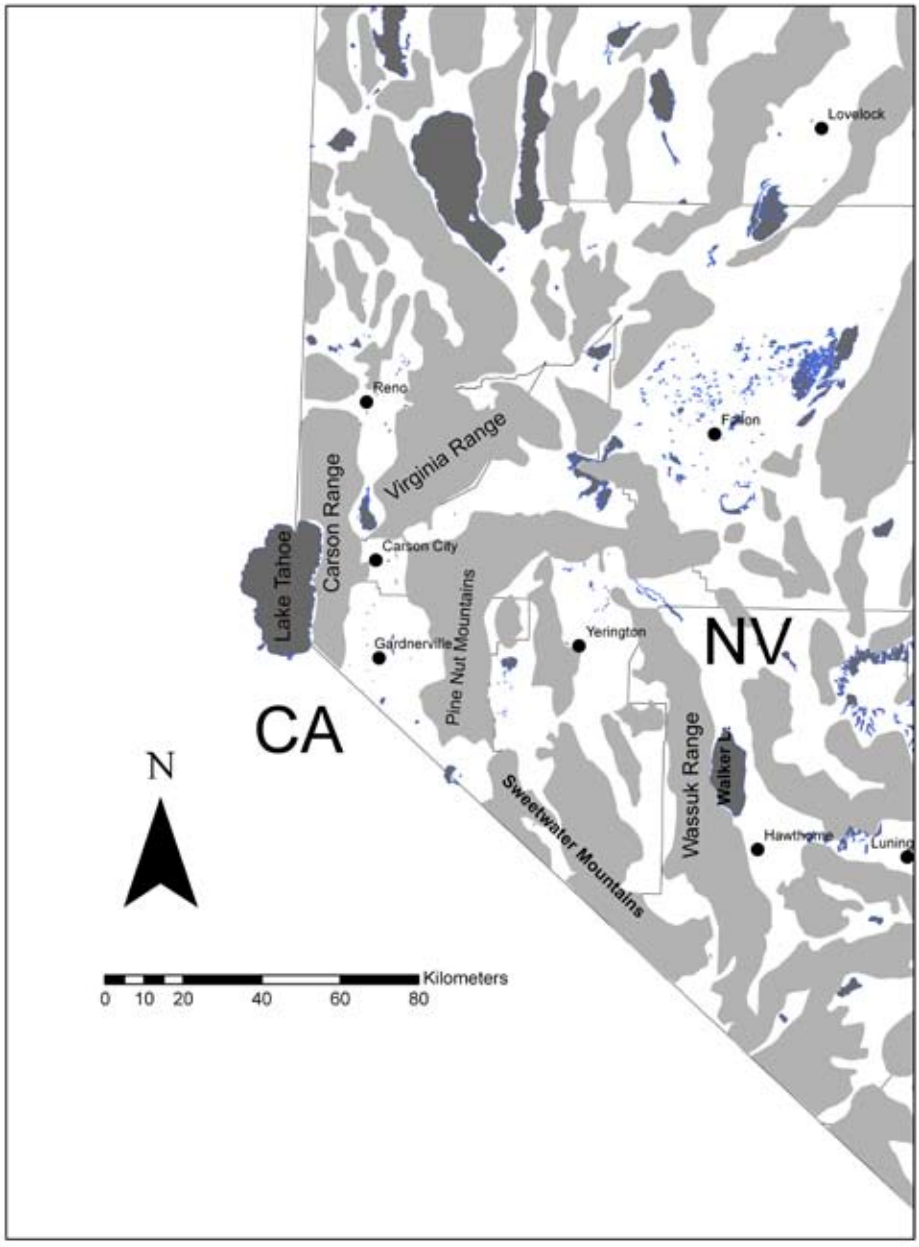
Contributors: Jon P. Beckmann and Carl W. Lackey

Background

At the interface of the Great Basin Desert and Sierra Nevada Mountains, including the Lake Tahoe Basin, black bears (*Ursus americanus*) have recently experienced rapid ecological changes and a distributional shift in response to increasing humans. Since 1990 increases in the frequency of: urban bears, collisions with vehicles, and citizen complaints were about 70-fold, 15-fold, and 10-fold respectively. Remarkably, all documented mortalities of bears (n = 151) since 1997 were due to human activities despite the protected status of bears in Nevada. The current distribution of black bears in Nevada is restricted to the Carson Range of the Sierra Nevada, Sweetwater Range, Pine Nut Range, and the Wassuk Range (Goodrich, 1990; Grayson, 1993; Fig. 1) and these 4 mountain ranges in extreme western Nevada were the focus of our work. These 4 ranges are characterized by steep topography and deep canyons and are one of the most xeric climates (< 21 cm of annual moisture) in which black bears occur in North America (Grayson, 1993). Bears in this region are at the edge of their range in the Great Basin; the nearest bear population to the east is in the Wasatch Range in Utah about 750 km away. Although black bears are listed as a game species in Nevada, there has never been a legal harvest. Details on: 1) capture and handling methods; 2) population estimate procedures; 3) definitions of urban and wildland bears; 4) home range calculations; and 5) density estimates can be found in Beckmann and Berger (2003a). A total of 165 bears have now been captured in western Nevada from 1997-2006. This case study focuses on the ecological and behavioral changes in bears near urban areas, and describes a distributional shift in the bear population from wildland areas to urban areas.

Remarkably, all documented mortalities of bears since 1997 were due to human activities despite the protected status of bears in Nevada.

Figure 1. The region of western Nevada with mountain ranges containing black bears (Ursus americanus). Black bears are currently found in the Carson Range of the Sierra-Nevada along the eastern shore of Lake Tahoe; the Pine Nut Range east of Carson City, Nevada; the Sweetwater Range that extends from California into Nevada; and the Wassuk Range located on the western shore of Walker Lake.



WCS Involvement

During the past 10 years (1997-2007) Jon Beckmann, an Associate Conservation Scientist with the Wildlife Conservation Society, along with Carl Lackey and others of the Nevada Department of Wildlife and the University of Nevada-Reno have been assessing how changes in the availability of anthropogenic foods and human practices have affected black bear population demographics, and distribution of bears in reasonably intact natural ecological communities. We examined two related themes: how life history patterns may contribute to population growth, and how resources affect population distribution and persistence at a landscape level. We capitalized on the distribution of a novel food resource (garbage), situated at the juxtaposition of urban and wildland areas, to examine the impact of human-altered landscapes on a mammalian carnivore. Combining spatial and temporal data sets with empirically obtained information; we have contrasted demographic, life history, reproductive, and behavioral parameters between individuals at urban-wildland interface and wildland areas. Several products have been produced from this study (e.g. Beckmann and Berger 2003a,b; Beckmann and Lackey 2004; and Beckmann et al. 2004). This case study represents a small element of the complete effort.

It is likely that interactions detrimental to carnivore conservation will increase in western North America, because many areas of human population growth are adjacent to public lands that maintain large carnivores.

History of conflict: urban sprawl and carnivores

It is likely that interactions detrimental to carnivore conservation will increase in western North America, because many areas of human population growth are adjacent to public lands that maintain large carnivores. For instance, in cities such as Albuquerque, New Mexico; Los Angeles, California; and Reno, Nevada both cougars and black bears are removed regularly or killed due to safety concerns (Logan and Sweanor, 2001; Beckmann and Lackey, 2004). Nevertheless, beyond removal of individuals, often little is known about the extent to which human landscapes bordering public lands affect distribution, life-histories, or demography of carnivore populations. From a conservation perspective, this omission in knowledge may carry serious liabilities because carnivores can neither be conserved nor prudently managed if causes that affect distributions remain unknown. Further contributing to conflicts between carnivores and humans in the Lake Tahoe region is that many areas have no regulations prohibiting deliberate or non-intentional feeding of wildlife. As a result, black bears in the Lake Tahoe Basin of Nevada and California and other parts of North America are becoming increasingly reliant upon anthropogenic food sources, primarily garbage (Keay and Van Wagtendonk, 1983; McCarthy and Seavoy, 1994; Herrero and Higgins, 1999; Beckmann and Berger, 2003a). Provisioning of food, whether deliberate or unintended, may be operating at scales substantially larger than previously thought. For example, Smith (2001) reviewed the negative effects of winter-feeding on elk (*Cervus elaphus*) along with attendant shifts in their behavior and ecology. Further, such feeding may change public perception of habitat, which ultimately might lead to the ostensible devaluation of natural habitat. Although the issue of foraging by wild animals in areas of contact with humans has received some attention, infrequently has it been from a population, ecological, or planning level.

Urban sprawl and carnivore populations

Our results from a 10-year study show significant differences between wildland and urban bears. Adult urban bears were 30% larger in mass and had home ranges 70-90% smaller than wildland conspecifics (see Beckmann and Berger 2003a). Additionally, our results point to a depopulation of wildland areas by black bears (see below). These findings are relevant not only for understanding bear biology, but for understanding how anthropogenic food sources may influence carnivore populations. Unlike other studies that demonstrate higher densities in relation to food availability in altered landscapes, our results point to a depopulation of wildland carnivores, at least if based on rapid changes in home range (sizes and location) and life history parameters as well as density. Given the plasticity of black bear foraging behavior, it is no surprise that they have in the past, and continue to increase their exploitation of available garbage in urban areas.

J. Beckmann

Dumpsters, when not bear-proofed, provide a reliable, high-calorie food source for black bears. These cubs are learning that life in an urban area offers advantages not available in nearby wildlands.

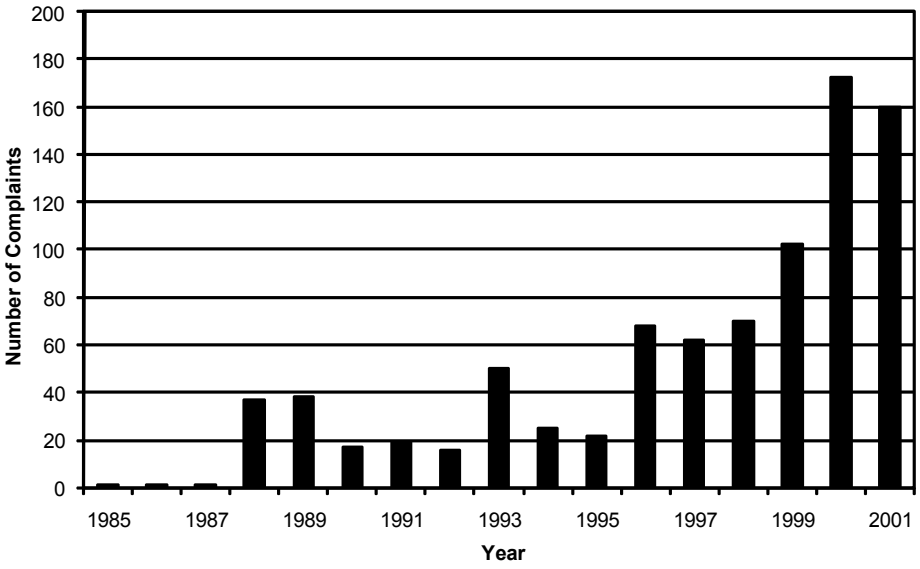
Results and Implications

Evidence of a depopulation of wildland areas

In the Lake Tahoe Basin and adjacent mountain ranges of the western Great Basin, we observed changes in both ecological traits and behavior of black bears since the late 1980's (for behavior changes see Beckmann and Berger, 2003b). When Goodrich (1990) and Goodrich and Berger (1994) studied bears in the identical region, they captured approximately 30 adult bears. Notably, when Goodrich (1990) did his studies urban bears did not exist, at least not at the current exaggerated level. Goodrich (1990) only captured a single bear in an urban area and trapping was obviously focused on where bears occurred. The number of complaints about bears to the Nevada Division of Wildlife during his study (1987-1989) was relatively very low (Fig. 2). In contrast, we have

now documented >100 urban bears, a 10-fold increase in the annual number of complaints and an over 17-fold increase in the annual bear mortality rate due to vehicles since then (see below). In addition, densities have increased by 3+ fold over baseline, historical levels (Goodrich, 1990). Changes have been so great that the estimated density of urban bears at our study site is the second highest density of black bears in North America (Carney, 1985; Schwartz and Franzmann, 1991; Clark and Smith, 1994; Garshelis, 1994). In contrast, the historical densities for our study population were low to intermediate relative to those elsewhere in North America (Garshelis, 1994), due to the xeric climate of our study site.

Figure 2. The number of complaints concerning black bears filed by citizens in the state of Nevada with the Nevada Department of Wildlife since 1985.



... bears are being 'pulled' out of wildland areas, enticed by food (as evidenced by the positive change in body mass), and concentrated into urban areas ...

The non-linear (*i.e.* 1:1) relationship of these increases relative to a 26% growth in the human population during the same time frame suggests that bears are being 'pulled' out of wildland areas, enticed by food (as evidenced by the positive change in body mass), and concentrated into urban areas by a clumped food resource. Garbage may be the ultimate resource for bears: it is always available regardless of environmental conditions, including season; it is predictable in both space and time (*i.e.* garbage cans are always set out the same day of the week); it is highly clumped (for instance, in residential areas) so that little energy expenditure is required to move from one patch (garbage can or dumpster) to the next; and it is always replenished after use. This rapid distributional shift of the bear population into urban areas caused individuals to experience other associated ecological changes. For example, higher densities of bears in urban areas were accompanied by a 90% reduction in mean home range size for males and a 70% reduction for females.

Because stomachs of necropsied bears were filled with garbage, and garbage was concentrated in urban areas and was present in sites where we most successfully captured bears, we believe that garbage concentrated in urban areas is the proximate cause of a recent and more clumped distribution of bears across the landscape. For example, in the Lake Tahoe Basin bears were historically found

throughout the entire Carson Range (Hall, 1946; Goodrich, 1990). However, due to the redistribution of bears on the landscape over the last decade we were unable to capture any bears in the Carson Range outside of urban areas except at one small site (Little Valley, a 7 km^2 area). These findings re-affirm our supposition of dramatic and rapid decadal ecological shifts.

Why has an increasing food supply not led to more bears on the landscape and a subsequent repopulation of wildland areas? We suggest the answer lies in the fact that bears in urban areas have experienced elevated levels of mortality that exceed reproductive rates and that, as our data show, bears foraging in urban areas are larger and more fecund (Beckmann and Berger, 2003a). In other words, from a bear perspective, the use of urban areas should lead to higher reproductive fitness.

Why has an increasing food supply not led to more bears on the landscape and a subsequent repopulation of wildland areas?

Nevertheless, black bears that were apparently enticed into urban areas from wildland regions, at least in portions of the northern Sierra Nevada, never realized this putative fitness; as such bears were more susceptible to anthropogenic causes of mortality. During this study, 100% of 151 marked black bear deaths with a known cause were due to human activities despite the continued protected status of bears in Nevada. Of the 151 deaths, causes were as follows: 89 vehicles, 27 agency management actions for public safety, 17 for preying on livestock; 2 illegal, and 16 due to other causes (*e.g.* non-target species in Wildlife Services snares, euthanized for poor body condition, accidents in homes, etc). In a review of >15 studies on 8 different species of large carnivores worldwide, including black bears, Woodroffe and Ginsberg (2000) showed that the proportion of mortality due to anthropogenic causes ranged from 7-95%. The mortality rate of bears in Nevada is at the high end of this range.

The number of bears killed by vehicles annually has increased 17-fold over the past decade. During the late 1980's, on average less than 0.5 bears/year were killed by vehicles (Goodrich, 1993); in contrast, from July 1997 to December 2006, vehicles killed 8.9 bears/year. In addition to vehicle-caused mortality, Nevada Department of Wildlife personnel destroyed 27 bears for public safety concerns when the bears began breaking into homes in search of food. During the three-year period of Goodrich's (1990) study prior to bears becoming food conditioned, no bears were destroyed because of safety concerns. High levels of mortality in urban areas are currently exceeding recruitment rates into the population (Beckmann and Berger, 2003a), thus urban densities, although high, have not reached an upper limit, at which point bears should repopulate wildland areas. Highly exaggerated levels of mortality in urban areas have led to the creation of sinks and bears are unable to repopulate vacated wildland areas following the shift to urban centers and food sources (Beckmann and Lackey, submitted).

Discussion

Drought and accelerated human-induced changes

What precipitated this dramatic population shift? Although we cannot identify factors with certainty due to lack of an appropriate experimental design, it seems reasonable to suggest a combination of abiotic and biological causes. Between 1986-1992, a drought occurred that was one of the worst on record

in the Sierra Nevada and in the state of Nevada (Goodrich, 1990; U.S.D.A., 2002). The sudden increase in bear complaints following the drought suggests that a lack of wildland foods may have been a catalyst for the shift to bears' reliance on garbage (Fig. 2). This notion is consistent with data on black bears from the eastern and northern U.S. where during drought years and mast failures the number of complaints by citizens spike along with the use of dumps by bears (McLellan, 1994). Similarly, in Nevada annual complaints about bears increased by >10-fold between 1990 and 2000. The rapid, punctuated shift was likely due to the drought, as in its absence a shift of bears to garbage is likely to have been more gradual. Although bears have been documented in the region since the 1860s, there were very few, if any, bears in garbage until after the prolonged drought of the late 1980s and early 1990s. This demonstrates how even a natural perturbation in a system, in this case drought, can be the catalyst for bear and human conflicts when an area is not proactive about prevention of these conflicts.

The number of bears killed by vehicles annually has increased 17-fold over the past decade.... Highly exaggerated levels of mortality in urban areas have led to the creation of sinks and bears are unable to repopulate vacated wildland areas following the shift to urban centers and food sources.

Whether bear populations have increased in our study region has not been especially clear, but the evidence suggests that this is not the case. Our suggestion that depopulation of wild areas has occurred over time hinges on the assumption that our estimate of population size accurately reflects reality. Although the number of interactions involving bears and humans increased >1000% from 1990 to 2000, our estimated population size of 180 ± 117 (95% CI) bears differs little from the estimate of 150-300 individuals in the same population a decade ago by the Nevada Department of Wildlife (C. Lackey, Nevada Department of Wildife, pers. comm.). The relative congruence in these values of population size, lend further support to the notion that the increase in complaints and anthropogenic causes of bear mortality over the last decade are due to bear redistribution across the landscape and not an increase in the number of bears. In addition, from 1997-2002 we captured fewer wildland bears (n = 28) in five years than Goodrich (n = 29) did in three despite the fact that we had a greater trapping effort (600 total trap nights versus 301), worked in two more mountain ranges than Goodrich, and we captured three times the total number of bears. These concordant pieces of evidence (*i.e.* catch per unit effort) support the premise that bears have become redistributed across the landscape irrespective of the large variance associated with both current and historical population estimates (Table 1).

Management options given availability of anthropogenic food resources

In many areas, lethal removal of "problem" bears remains a management tool. However, many state and federal agencies seek non-lethal solutions (i.e., deterrents) for dealing with "nuisance" black bears in areas such as the Lake Tahoe Basin where the checkerboard of private and public lands creates difficulties in mandating bear-resistant garbage containers. On the Nevada side of Lake Tahoe alone, ordinances requiring the use of bear-resistant garbage dumpsters would need to be passed in three different counties containing both rural areas and towns that range in population from 1,000 to 300,000 (Reno, NV); a national forest; BLM lands; state lands; various state parks; and pri-

Table 1. Summary of primary hypotheses and associated evidence for apparent depopulation of black bears from wild areas of the Sierra Nevada Range. Current data are compared to Goodrich's (1990) data from the same region that were collected in the late 1980s. Evidence and data in support of (+) or refuting (-) each hypothesis are presented (see text for details).

Hypothesis	Evidence/Data in support of (+) or refutation (-)
Redistribution of the population (*i.e.* depopulation of wildlands)	+ Trap effort 2X's greater in this study vs. Goodrich's 1990 study (catch per unit effort) + 3X's the total number of captured bears during this study vs. Goodrich's 1990 study + Number of complaints increased faster than the human population + Highly congruent overall population size estimates during this study and Goodrich's 1990 study + Current density estimates in urban areas 3X's Goodrich's density estimates despite similar overall population estimate + Current density estimates are 10X's lower in wildland areas vs. Goodrich's 1990 study + Number of complaints increased significantly following drought of 1986-1992 suggesting a lack of food resources facilitated bears' use of urban areas
Increasing population in response to novel food (garbage)	- Highly congruent population size estimates from this study and Goodrich's 1990 study prior to bears being in urban areas does not support this idea - 93% of all bears in urban areas utilizing garbage are males, thus the male segment of the population, not females, took advantage of a novel resource to impact population growth - Mortality rate in urban areas far exceeds the fecundity rate in urban areas so no possible contribution from bears utilizing garbage to a potential population increase + Could be due to immigration from California, but if true this does not explain why a concurrent decline of bears in Nevada wildland areas would occur
Neither a population increase nor a redistribution has occurred from 1990-2000	- Trap success relatively high for black bears for both current study and Goodrich's 1990 study, yet no bears were caught in urban areas during Goodrich's study in the late 1980s - Massive increase in the number of complaints/year concerning black bears - Population estimates highly congruent from this study vs. Goodrich's study suggests no population increase has occurred + Goodrich "missed" bears in urban areas, but if this was the case then it is not possible to account for the lack of complaints concerning bears during his study in the late 1980's

vate lands. The realities of passing ordinances in each of these jurisdictions, although in the process of occurring, have been tediously slow. Thus, the use of non-lethal deterrents in the region was considered by the Nevada Department of Wildlife. The most common of these non-lethal management tools used in North America have been various aversive conditioning agents and translocation of "nuisance" individuals.

A survey conducted by the Virginia Department of Game and Inland Fisheries in 2001 revealed 33 states currently manage black bears and respond to citizen complaints about "nuisance" bears (D. Kocka, Virginia Department of Game and Inland Fisheries, personal communication). Of those, 26 (79%) administer deterrent techniques with the aim of behavioral alteration of "nuisance" individuals. The use of deterrent techniques, although not a new management tool, has been increasing rapidly in both Canada and the United States primarily in response to the public's request for non-lethal bear management near urban-wildland interface areas.

... non-lethal deterrents, including dogs, are likely not an effective long-term strategy for dealing with 'nuisance' black bears in urban settings ...

Yet, there is a paucity of rigorous study on the effectiveness of common deterrent techniques management agencies currently use to alter behavior of "nuisance" bears, although exceptions to this shortage clearly exist (Gilllin et al., 1994; Ternent and Garshelis, 1999; Clark et al., 2002; Beckmann et al., 2004).

Between 1997 and 2002, WCS scientists, working along side agencies, examined the efficacy of both relocation (Beckmann and Lackey, 2004) and the six most common non-lethal deterrents (Beckmann et al., 2004) state and federal agencies currently use to alter the behavior of 'nuisance' black bears. We evaluated the efficacy of bear deterrent techniques in the Lake Tahoe Basin of the Sierra-Nevada range by contrasting animals randomly assigned to an experimental (treatment) or to a control (no treatment) group. Experimental bears were pepper sprayed, shot with 12-gauge rubber buckshot and a rubber slug, and exposed to cracker shells. Additionally, half the bears that received the treatment were chased by dogs (see Beckmann et al., 2004 for details on deterrents). Our findings were that non-lethal deterrents, including dogs, are likely not an effective long-term strategy for dealing with 'nuisance' black bears in urban settings as 92% of the bears given deterrents returned to the exact urban patch where they were originally captured and continued to forage on garbage and food in dumpsters, vehicles, and in several cases inside homes (Beckmann et al., 2004). The vast majority of bears exposed to deterrents returned within 40 days (Beckmann et al., 2004) and all relocated bears, even those moved up to 100 km away returned (Beckmann and Lackey, 2004). We recorded little evidence that non-lethal deterrents or relocation would eliminate or even reduce conflicts between bears and humans when anthropogenic food sources are not adequately contained.

CASE STUDY TWO:

A SPATIAL ANALYSIS OF POTENTIAL AND REALIZED BLACK BEAR-HUMAN CONFLICT IN NEW MEXICO

Contributors: Cecily M. Costello, Donald E. Jones, Kristine H. Inman, Robert M. Inman, Bruce C. Thompson, Howard B. Quigley

Background

The black bear is native to all of the forested mountain ranges of New Mexico. Following drastic population declines during the early 1900's (precipitated by conflict with humans and livestock), bear populations have increased in recent decades. Approximately 6,000 black bears exist throughout their previous range, estimated at nearly 15 million acres (Costello et al. 2001). Nearly one third of that range is situated on private lands and nearly 20% falls within about 2.5 miles of human-populated areas. This juxtaposition of bears and humans provides a considerable potential for bear-human conflict. This case study, part of the larger New Mexico Black Bear Study, was designed to examine potential and realized bear-conflict within two study areas of New Mexico.

C. Costello

The community of Red River, New Mexico, is near the Northern Study Area. As the photograph shows, bear habitat and human communities exist in close proximity in this region.

It has been documented that increases in bear-human conflict often coincide with failures in the production of natural foods, such as nuts and berries (Rogers 1976). An often overlooked corollary to this observation is that during periods when natural foods are not scarce, most bears seemingly avoid anthropogenic foods, even when they might be readily available. So how prevalent is the black bear's propensity for seeking anthropogenic foods? Using data from our 8-year field study, we attempted to answer that question. Our first objective was to quantify and compare the proportion of bears whose space use patterns provide potential opportunities for acquisition of anthropogenic foods to the proportion of bears known or suspected of conflict with humans. Our second objective was to examine these patterns relative to sanitation efforts to evaluate the effectiveness of measures to reduce bear access of anthropogenic foods. Because translocation was a common response to nuisance problems, our third objective was to evaluate the effectiveness of translocation as a means of managing bear human conflict.

Throughout New Mexico, incidents of bear-human conflict were relatively few until the late 1980s, when a combination of factors, including drought (causing failures in natural foods) and human residential development increased encounters between humans and bears.

WCS involvement

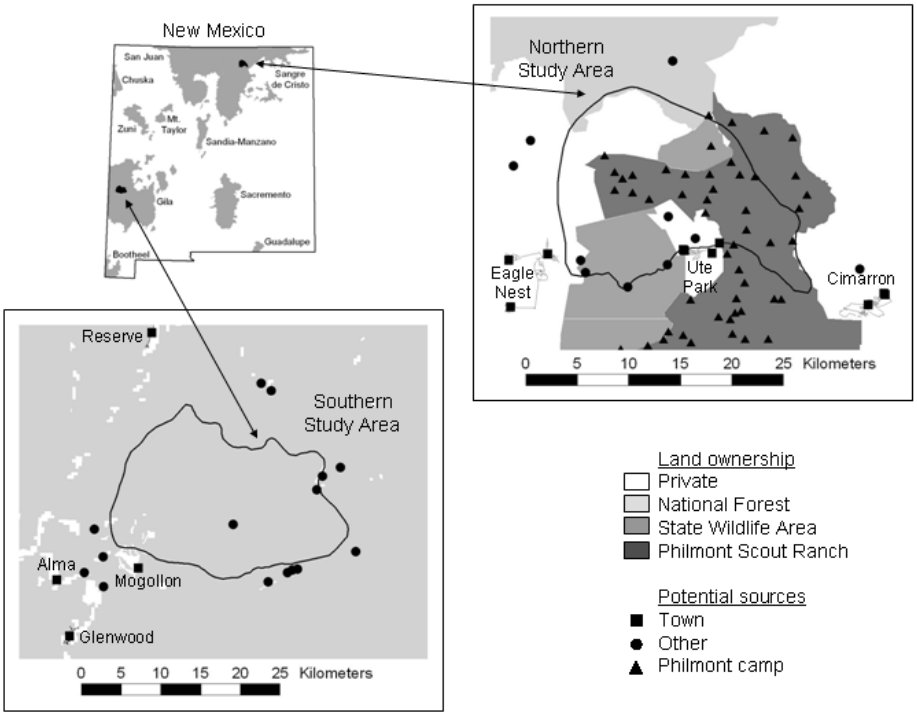
The New Mexico Black Bear Study was conceived and initiated in 1992 by members of the New Mexico Department of Game and Fish (NMDGF) and Hornocker Wildlife Institute (a small non-profit wildlife research organization which merged with WCS in 2001). At that time, information obtained from bear harvests provided little information about the status or trend of bear populations in New Mexico. Our research was designed to alleviate this uncertainty, with the goals of understanding ecology and population dynamics of black bears in New Mexico and developing a population model to estimate trends in population size and structure. In conjunction with these goals, we were also able to investigate other aspects of bear ecology, including interactions and conflicts with humans. The field study was completed in 2000 and a final report was submitted in 2001 (Costello et al. 2001). Since 2001, WCS researchers have published several scientific articles from this study (Costello et al. 2003, Costello et al. 2004, Costello et al. 2006, Inman et al. 2007), aided in the implementation of management strategies based on the work, and embarked on further analyses of kin relationships and spatial organization of black bears, using DNA samples from the New Mexico bears.

History of conflict

Throughout New Mexico, incidents of bear-human conflict were relatively few until the late 1980s, when a combination of factors, including drought (causing failures in natural foods) and human residential development increased encounters between humans and bears. During 1989, bear encounters escalated in Albuquerque and were brought to nationwide attention when a young female bear (later nicknamed "Sparky") was injured climbing a power pole. Since that time, there has been a general increase in bear complaints, public demands for control of the bear population, and increased effort to educate the public about bears and reduce availability of anthropogenic foods.

Our study involved two populations of black bears, residing in study areas with very different levels of human presence (Fig. 1). The Northern Study Area (NSA), in the Sangre de Cristo Mountains, was adjacent to 3 towns and included part of Philmont Scout Ranch (a recreation property hosting ~20,000 visitors/year). The more remote Southern Study Area (SSA), located in the Mogollon Mountains, was entirely within the Gila National Forest. The NSA had a history of recurring nuisance complaints, while the SSA had little history of conflict.

Figure 1. Black bear research was conducted in two regions of the New Mexico. The Northern Study Area, located in the Sangre de Cristo complex of suitable bear habitat, encompassed mostly private and state lands. Its position, adjacent to 3 towns and including portions of Philmont Scout Ranch, meant potential sources of anthropogenic food were numerous. The Southern Study Area, located in the Gila habitat complex, was entirely within the Gila National Forest. This remote locality encompassed far fewer potential sites of conflict.



Description of work

During our study, we marked or uniquely identified over 500 individual bears, by means of trapping and den investigations, detailed in Costello et al. (2001), Costello et al. (2003), and Inman et al. (2007). In all handling situations, we chemically immobilized bears (except for neonate cubs) and recorded body measurements and other data. Bears were marked bears with eartags and lip tattoos, and a premolar tooth was extracted for age determination using cementum annuli counts (Willey 1974). Age-class was assigned as follows: cub (<1 year), yearling (1 year), subadult (2–4 years), and adult (≥5 years). We placed radio-transmitters (i.e. collar or ear-tag transmitters) on nearly all females handled, nearly all male yearlings handled in dens, and on adult males as needed to maintain a sample of about 10 individuals per year. Using aerial telemetry,

we located radio-marked bears about once every two weeks during the active season. In all, we placed radio-transmitters on 239 bears (127 females, 112 males) and obtained over 5000 radio-telemetry locations.

For analysis of bear movements relative to areas of potential conflict, we used location data to identify and map areas of concentrated multi-annual use (i.e., home ranges). We also mapped potential sites of anthropogenic foods, including point sources (i.e., campgrounds, dispersed residences, Philmont Scout Ranch camps) and towns. We did not attempt to map or assess sources of unpredictable food, such as backcountry campsites. We buffered bear home ranges by 500m and determined overlap with towns, other sources, or Philmont Scout Ranch camps.

We attempted to determine which bears, among our marked sample, had engaged in nuisance or depredation activity. Ear-tags and radio-collars enabled agency, Philmont, or study personnel to identify individuals hazed, captured, translocated, or killed at nuisance sites. We obtained records of nuisance and depredation complaints involving marked bears from the NMDGF, Colorado Division of Wildlife (CDOW), and Philmont Scout Ranch. During the study period, several radio-collared study bears were translocated by NMDGF personnel due to nuisance or depredation activities. We also documented post-translocation movements of radio-collared bears to determine their rate of return.

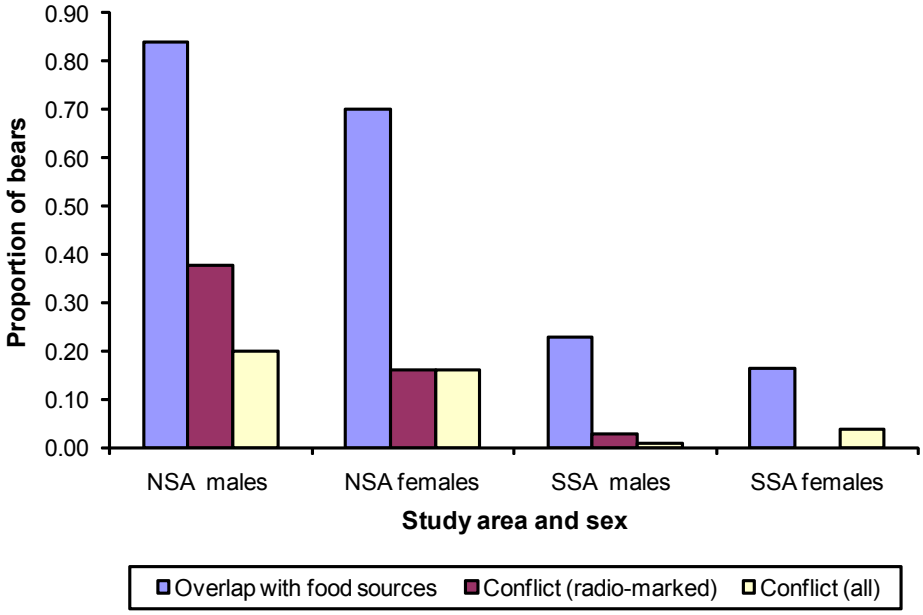
Despite the considerable potential for conflict, most bears did not engage in nuisance or depredation activities.

Results and Discussion

Overlap of bear home ranges with sites of potential human conflict was different between the two study areas (Fig. 2). On the SSA, 8 of 35 male home ranges (23%) and 7 of 43 female home ranges (16%) overlapped potential sources of anthropogenic foods. Number of sources within ranges ranged from 0–3, with an average of 0.2, for males and ranged from 0-2, with an average of 0.3, for females. Sources included campgrounds, U.S. Forest Service facilities, a private ranch, and the town of Aragon (overlapped by only 1 female bear). On the NSA, far more bears overlapped potential sources of anthropogenic food: 31 of 37 male home ranges (84%) and 35 of 50 female home ranges (70%). Number of sources within ranges ranged from 0–18, with an average of 5.3, for males and ranged from 0-7, with an average of 2.1, for females. Two thirds of males and 58% of females overlapped Philmont Scout Ranch camps. The towns of Eagle Nest or Ute Park were found within home ranges of 6% of females and 32% of males. Other sources were within 6% of female and 11% of male home ranges, and included campgrounds, state facilities, and private ranch headquarters.

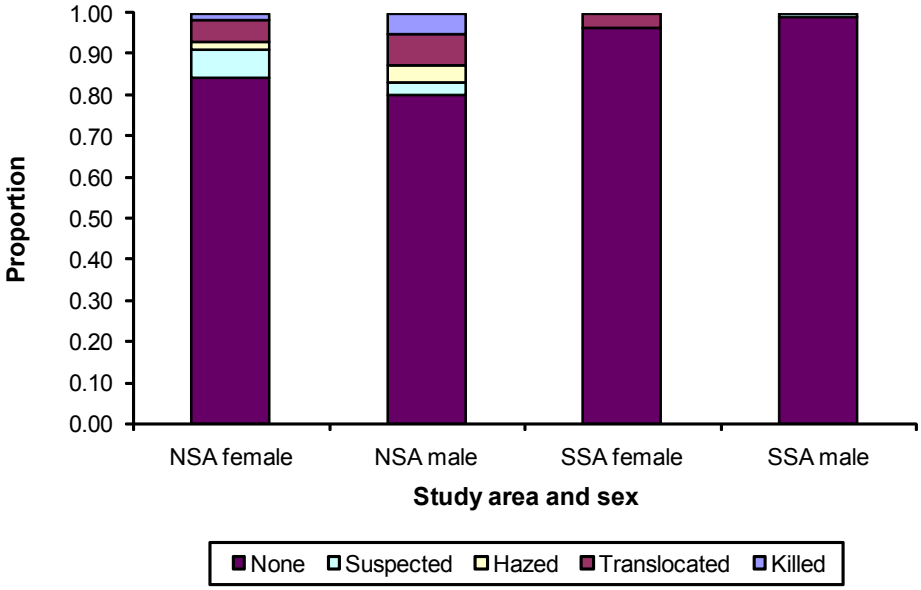
Despite the considerable potential for conflict (especially on the NSA), most bears did not engage in nuisance or depredation activities (Fig. 2 and 3). On the SSA, only 1 radio-marked bear was suspected of depredation activity; fewer than expected given overlap with potential sources of anthropogenic food. This male bear was found shot dead near a cattle carcass, however it was unknown if the bear was responsible for the death of the cattle. Among all marked bears, only 2% of females and 1% of males on the SSA were known

Figure 2. The proportion of bears whose estimated home range overlapped potential sources of anthropogenic foods was far higher than the proportion of bears known or suspected of conflict with humans, based on radio-marked bears or all ear-tagged bears. In the Northern Study Area (NSA), most bears had at least one potential food source within their range, but fewer than 40% engaged in conflict behavior. In the Southern Study Area (SSA), fewer than 30% of bears overlapped any human sites and levels of conflict were very low.



or suspected of nuisance or depredation activities (Fig. 3). Both female bears were translocated into the study area, because of nuisance activity outside its boundary. One incident arose at a public campground and the other was associated with a backcountry camp. On the NSA, 8 radio-marked females (16%) and 14 radio-marked males (38%) were known or suspected of nuisance or depredation activity; also fewer than expected given overlap with potential sources of anthropogenic food. Among all marked bears on the NSA, 16% of females and 20% of males >1 year old were known or suspected of potential nuisance or depredation activity. Of 29 NSA bears involved in conflict, half were attracted to towns with unsecured garbage or other available foods. Garbage was made available to bears most often by the use of open dumpsters lacking bear-resistant lids. Foods associated with homes included hummingbird feeders, pet foods, deer feed, and garbage. Nuisance activities of 7 bears were associated with Philmont camps and activities of 5 bears were associated with public campgrounds. Three depredation complaints arose from depredation of apiaries or domestic pigs. Four bears had traveled far from the study area (as dispersing subadults) and were involved in nuisance or depredation activities in New Mexico or Colorado.

Figure 3. In both study areas, the majority of ear-tagged black bears ≥1 year old were never known to engage in nuisance or depredation behavior. A small percentage were suspected of obtaining anthropogenic foods, hazed from nuisance sites, or translocated following a nuisance capture. Only 2% of all bears were killed as a result of nuisance or depredation, primarily because they were considered a threat to human safety.

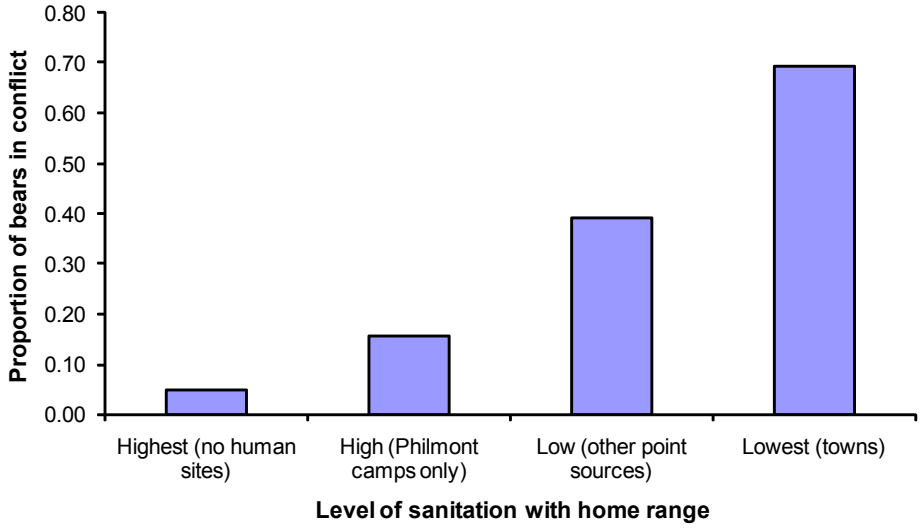


Using data from NSA radio-collared bears, we compared conflict with overlap of sites with varying level of sanitation. Food and garbage were typically made unavailable to bears in Philmont camps, therefore they were considered the most sanitized sites. In contrast, foods and garbage were often unsecured in towns and other sites, increasing chances for bears to obtain food. Towns were classified with the lowest level of sanitation, because they represented multiple point sources of unsecured food. The likelihood of a bear engaging in conflict increased as levels of sanitation decreased within its home range (Fig. 4).

The likelihood of a bear engaging in conflict increased as levels of sanitation decreased within its home range.

At least 29 females had home ranges partly or entirely within the boundaries of Philmont Scout Ranch, however only 2 created nuisance problems requiring management action, and only 2 others were suspected of nuisance activity. Likewise, at least 25 male study bears used areas of Philmont, but only 2 were involved in nuisance complaints. Throughout the study period, Philmont maintained a comprehensive bear-human management system, and these precautions appeared to be effective at minimizing bear-human conflict. Ricklefs (2005) described the management system developed by Philmont Scout Ranch, consisting of procedures for education, camping, reporting, enforcement, and response. The education component includes materials mailed to visitors prior to arrival, and further instruction by a staff ranger upon arrival. Visitors and staff are given various instructions on general bear biology and the procedures they will need to follow throughout their stay. They are repeatedly reminded that bears must be denied any human-related food or garbage (e.g., "a fed bear is a dead bear"). Camping procedures are designed to limit bear investigation of backcountry camps and eliminate opportunities for bears to obtain human foods. They include designation of an area where foods and odors are to be

Figure 4. Comparing groups of Northern Study Area bears with varying levels of sanitation within their estimated home range, proportion of bears known or suspected of conflict increased as the sanitation level decreased. Only 16% of bears that overlapped only Philmont Scout Ranch camps were engaged in conflict because of the comprehensive program designed to make anthropogenic foods unavailable to bears. In contrast, 69% of bears that overlapped towns were engaged in conflict due to numerous readily-available sources of garbage, pet food, and food put out for birds, deer, and other wildlife.



confined; use of suspended cables for hanging food and scented items; proper disposal, storage, and removal of waste; and specific requirements for placement of tents. A comprehensive system of recording all bear sightings allows staff to monitor compliance with procedures, and respond to nuisance bears. Visitors that fail to comply with procedures are reprimanded, denied earned recognition, or removed from the trail. Some are also required to perform a wildlife conservation project in their home area before they are permitted another trip to Philmont. Ricklefs (2005) reported that during 1992-2002, approximately 2000 groups were on trails each summer and 40% of them reported seeing a bear. He further stated although most bears appear human-habituated, few are considered food-conditioned, because of efforts to prevent bears from obtaining human-related foods.

On the NSA, far fewer bears had home ranges encompassing towns or other sources of food – only 9 females and 17 males. However, 76% of documented conflict by individuals was associated with these areas. Bears whose home range overlapped towns with unsecured garbage were most likely to get into conflict with humans. In our sample, they were approximately 13 times more likely than bears overlapping Philmont camps, and 55 times more likely than bears that did not overlap any sources of potential conflict. In each of the 3 towns close to the NSA, garbage disposal was accomplished using non bear-resistant dumpsters, often distributed throughout residential areas. These dumpsters were probably the initial attractant drawing bears into human-populated areas. The reward of high-calorie food obtained from dumpsters was probably enough to overcome the natural wariness of bears to humans (Herrero 1989). Human habituation, or loss of innate fear of humans, has been

Bears whose home range overlapped towns with unsecured garbage were most likely to get into conflict with humans. In our sample, they were approximately 13 times more likely than bears overlapping Philmont camps, and 55 times more likely than bears that did not overlap any sources of potential conflict.

often been directly associated with use of human-related foods by black and grizzly bears (Hastings et al. 1989, Herrero 1989). In our area, the transition from wariness to human habituation probably fit the circumstances described by Herrero (1989), whereby over time, when consumption of garbage did not result in harm or harassment to the bear, habituation developed. Increased use of other anthopogenic foods, such as hummingbird feeders or pet food, was a predictable outcome of this progression. During the mid-1990s, citizens of Ute Park funded and implemented the installation of bear-resistant lids to the dumpsters in their community. Similarly, dumpsters in Eagle Nest were fitted with bear-resistant latches through a program of the McCune Charitable Foundation and Hornocker Wildlife Institute. These actions greatly reduced nuisance activities in these towns, but did not eliminate them completely, because of the availability of other foods, including those intentionally put out for birds, deer (*Odocoileus* spp.), and even fox (*Vulpes vulpes*).

The use of translocation as a means of solving nuisance or depredation complaints had variable success.... In all cases the time elapsed between translocation and the return of the bears did allow for immediate resolution of the problem, however some bears resumed nuisance behavior at a later date.

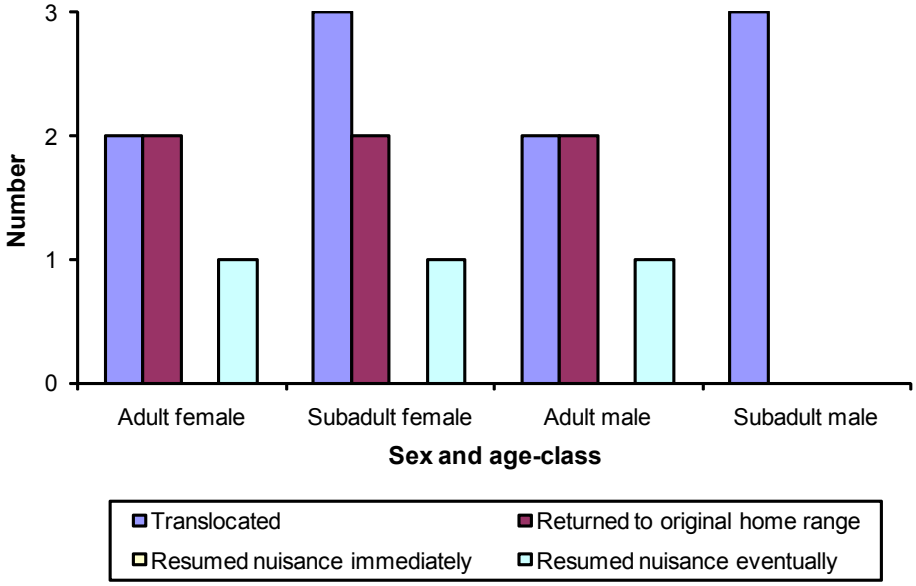
Increases in black bear nuisance problems have been correlated with shortages in natural foods (Rogers 1976, Rogers 1987). We observed longer movements by bears in New Mexico during years of acorn failure (Costello et al. 2001) indicating bears may have had to travel farther in search of food when oak production failed. Increased fall travel distances during years of food shortage have been reported in other bear studies (Garshelis and Pelton 1981, Beck 1991). We did not detect a mast-related increase in nuisance activity among our marked sample, probably due to the occurrence of only one oak failure on the NSA. However, widespread mast failures documented throughout New Mexico during 1999-2001 were associated with record high nuisance-depredation complaints, depredation kill, and roadkills (NMDGF, unpublished data).

Post-translocation movements were documented following 11 translocations of 8 bears (Fig. 5). Translocation distances ranged from 26–84 km and overall rate of return was 73%. Return movements took approximately 1–328 days. Return rate of adult bears was 100%, and each individual appeared to begin return movements immediately following translocation. Return rate of subadult bears was 57%, and 3 of 4 bears that did not attempt return movements were males. The use of translocation as a means of solving nuisance or depredation complaints had variable success. Most translocated bears, including all of the adults, returned to their original home range within days or months of their translocation. In all cases the time elapsed between translocation and the return of the bears did allow for immediate resolution of the problem, however some bears resumed nuisance behavior at a later date. Some translocations of subadult bears, especially males, were successful in that bears remained in the new, more remote area, where they did not engage in nuisance behavior. The variation in homing behavior was probably due to behavioral differences among demographic groups. Subadult male bears may not have attempted return to their previous home range, because of the dispersing behavior characteristic of this age-class. On the contrary, adult bears, and even subadult females displayed a high degree of home range fidelity during our study, indicating they would most likely show homing behavior following translocation. Homing behavior of translocated bears has been widely reported and an inverse relationship between distance moved and probability of return was evident in

all studies (Sauer et al. 1969, Beeman and Pelton 1976, McArthur 1981, Rogers 1986). In general, bears translocated more than 65 km from the capture site were less likely to exhibit homing behavior. Despite some success, translocation is not without cost to bears. Survival rates of translocated bears were found to be only 23% in Virginia and the primary cause of death was automobile collisions (Comly-Gericke and Vaughan 1997). The apparent difference in homing of subadult and adult bears suggest we need to consider age and sex of the animal, in addition to other factors surrounding the complaint, in making decisions about translocating nuisance or depredating bears. To be truly effective, any translocation must be combined with actions to eliminate the bear's access to food from the source of conflict (i.e. garbage, bird food, beehives). If the anthropogenic food remains accessible, translocation cannot realistically be viewed as a solution to the problem due to the high tendency for bears to return to their previous home range.

To be truly effective, any translocation must be combined with actions to eliminate the bear's access to food from the source of conflict (i.e. garbage, bird food, beehives).

Figure 5. Effectiveness of translocation resulting from nuisance behavior varied by sex and age-class. All adult males and most females returned to their original home range following translocation, but all subadult males remained near the translocation site. None of the translocated bears resumed nuisance behavior immediately, but several were eventually recaptured or killed due to further nuisance.



CASE STUDY THREE:

UNDERSTANDING HUMAN-BLACK BEAR CONFLICTS IN THE ADIRONDACK BACKCOUNTRY

Contributors: Zoë Smith, Michale Glennon, Leslie Karasin, Heidi Kretser, Ben Tabor

Background

The Adirondack Park is a six million acre park in northern New York. Established in 1892, it is one of the oldest and largest managed wilderness areas in the lower 48 states. The Park is a mosaic of private and public lands. Approximately one half of land within the borders of the park is public land, known as Forest Preserve, and is constitutionally protected as "forever wild." The other half is occupied by year-round and seasonal residents and includes rural communities, businesses, schools, prisons, and managed private forests. The black bear is one of the most charismatic and intriguing species in the Adirondack Park. Bears appear to have an expanding population in the Park: approximately 6,000 (NYS DEC 2003), which brings them increasingly into conflict with both backcounty recreationists and rural residents. These interactions have potential negative consequences for wildlife and humans. This case study focuses on examining and documenting the human-bear conflict in the backcountry areas of the Adirondack Park, with a specific focus on examining current management techniques and identifying solutions to reduce these conflicts.

WCS Involvement

The Wildlife Conservation Society's Adirondack Program developed the Black Bear Education, Awareness, and Research Project (BBEAR) to actively explore ways to resolve the human-bear conflict in the backcountry areas of Adirondack Park including educating backcountry users and promoting safe food storage methods in the backcountry. Through this initiative, WCS has established long-term research in the backcountry and has established multiple partnerships, including working with regional outdoor retail stores to promote the use of bear resistant food canisters and placing a Backcountry Bear Steward in highly used areas.

In 2003, WCS coordinated a research project in the Adirondack Park backcountry to explore the human component of the black bear – human conflict, focused primarily on learning about human behavior in the backcountry as a result of current outreach efforts and food storage systems available.

To this end, our goal was to document and understand the bear-human conflict issue in the study area, the eastern High Peaks Wilderness Area, and use the results to guide future outreach efforts. According to Ream (1979), measuring the level of backpackers' understanding of wildlife in conjunction with an education campaign aimed at promoting positive interaction between humans and wildlife is important in resolving the conflict between humans and wildlife. Additionally, to be effective, land managers must know the goals and perceptions of the backcountry user. Gore and Knuth (2006) point out that as new outreach and education mechanisms are developed to reduce human-wildlife conflict and financial and human resources become less available, it is critical to review and understand the effectiveness of outreach tools in order to change people's behavior towards wildlife.

History of Conflict

Since the 1970's negative interactions between black bears and humans in the Adirondack backcountry have been a common occurrence, particularly in the High Peaks Wilderness Area located near Lake Placid, NY. The number of encounters recorded in one summer has been as high as 420 in 2004. The number of actual encounters could be much higher, as some incidents are not reported. Additionally, managers have found that the number of encounters is only as high as the number of visitors in any given time. As the number of visitors increases – and data from 1980's and 1990's suggests the number of backcountry users has increased (Jenkins and Keal, 2004) – so will the number of encounters.

Most of the incidents in this area are a result of bears searching for easily-accessible human food. These incidents include bears stealing human food, destroying camping gear, and exhibiting aggressive behavior such as entering tents, leantos, or occupied campsites. While bluff charges have also been reported in this area, managers agree that this is a natural behavior and often leads to a speedy exit by the bear.

Many bears have learned to associate "bear bags" (stuff sacks hung in a tree with cord) as a reliable food source. Currently state land managers are not recommending this traditional food storage method to campers in this area for this reason (K. Kogut, pers. comm. 2004). The number and severity of bear encounters in the High Peaks has increased to an unacceptable level (NYS DEC 2004) and as more people visit the Adirondacks and store food improperly, bears are inevitably drawn to the interface of human activities and backcountry areas.

A number of possible factors have contributed to the nuisance bear problem in the High Peaks, including: an increased number of users in the High Peaks; a low level of bear awareness and food protection among users; a high level of intolerance for bears by backcountry users (NYS DEC 2004); and an increased opportunity for existing animals to steal food and learn to tolerate human presence.

Many bears have learned to associate "bear bags" (stuff sacks hung in a tree with cord) as a reliable food source. Currently state land managers are not recommending this traditional food storage method to campers in this area for this reason.

In other similar backcountry areas, such as the Smoky Mountains, removing attractants (food, garbage, etc.) has been shown to alleviate or resolve problems with bears becoming conditioned to human food. This outcome must be preceded by the willingness of backcountry users to change behavior and comply with removing attractants. As in many areas of North America, more persistent bear problems in the Adirondacks are often addressed with aversive conditioning (NYS DEC 2003). However, research in the area shows that aversive conditioning may not be effective in negatively reinforcing the undesirable behavior, but instead conditions the bear to associate the negative consequence with a particular area (NYS DEC 2003). Bears tend to avoid locations of aversive conditioning, but continue nuisance behavior elsewhere (K. Kogut, NYS DEC, pers. comm. 2004). Additionally, providing safe food storage also removes "nuisance bear" behavior. For example, in two of the most problematic campgrounds in the Adirondack Park, Limekiln Lake and Forked Lake, bear proof food storage boxes were installed. As a result, these two locations have become the least problematic.

Responding to the Conflict

In 2001 various measures were used to address the nuisance bear problem in the High Peaks. State land managers installed "food hoist cable systems" in the High Peaks which were adapted from those used in Great Smoky Mountain National Park. Proven dependable in the Smokies and many other areas of the country, the cables have had variable success in the Adirondacks. Until 2005 there were 9 cable systems installed in the High Peaks, hardly enough to store food for the dozens of visitors per weekend. Properly installed and maintained, the cables are an effective means to store food in the backcountry (NYS DEC 2003). However a number of these systems failed over the years and bears routinely obtained food from bags hung on the cable systems. These malfunctions were likely a result of lack of proper hardware for the systems and users loading the cables beyond their capacity, as well as the absence of prime locations for placing cable systems. In fact, the cables may have contributed to the habituating factor. Bears quickly learned where and when to visit the cable systems and seemed to learn through trial and error how to defeat the cables. The cables have now been removed from the eastern High Peaks.

In response to the increased bear encounters in the High Peaks and the failed cable systems, WCS became involved in the High Peaks bear situation and launched an education and outreach campaign to inform backcountry users about the ecology of the black bear in the Adirondacks, the problems that can arise from humans and bears sharing a common environment, and the means by which most of these problems can be effectively reduced or eliminated. This education program included trailhead and other signage, promoting bear resistant food canisters, and regional training sessions of information providers.

WCS determined that one of the major obstacles to the use of bear resistant food canisters was that they were not widely available to local backpackers, and so WCS partnered with the New York Department of Environmental Conservation (NYS DEC), who serve as the state land and wildlife managers, and outdoor retail shops to initiate a bear canister rental program. From 2001

through 2006, WCS purchased and distributed over 250 bear canisters to retail stores in the Adirondacks, New England, Quebec, and throughout New York State. The stores rented the canisters and informed users about their benefits. During this time, an increased number of users in the High Peaks were utilizing the canisters and the number of bear encounters started to decrease; 420 encounters were reported in 2004, compared with 177 in 2005. NYS DEC began to look more carefully at possible solutions and eventually adopted a state regulation requiring the use of commercially manufactured bear canisters in the eastern High Peaks from April 1 – November 30 starting on August 23, 2005. In 2006 the number of bear sightings dropped even lower to 93 and early analysis of 2007 data shows that the number of people who lost food to bears may also be decreasing.

Meanwhile the number of campers using canisters has increased tremendously due to both the regulation and the availability made possible by the rental program. (See Fig. 6 for how food storage changed over the period of this study.)

During this time period, the DEC initiated a High Peaks Black Bear Study (D. Winchell, NYS DEC, pers. comm. 2004). A series of steps have been undertaken to help gain insight into the bear problem, significantly reduce the number of negative bear-human encounters, help develop a comprehensive management plan with recommended actions that will be used to sustain an acceptable level of human - bear interactions, and produce scientific data for future nuisance black bear work. This study included collecting bear sighting forms to determine the number and severity of bear encounters in the High Peaks. Additionally, DEC increased its efforts to aversively condition black bears that frequently visit backcountry camping areas in an attempt to deter them from obtaining food.

Under DEC leadership, the High Peaks Nuisance Black Bear Education and Outreach Team was developed to disseminate information on proper food storage and management practices in the back country. Work through this team included developing and distributing informational signs to raise awareness of human-bear conflict and to offer solutions (i.e. bear resistant food canisters.) The signs consisted of two large, 3 feet x 4 feet signs at trailheads, as well as smaller, 11" x 17" signs, in both French and English, at retail shops and information centers.

The partnership between WCS and NYS DEC also resulted in WCS participation on the NYS Black Bear Team, whose activities include updating statewide management strategies, developing outreach materials including a "Living with Bears" DVD, organizing community events and presentations, and various other activities.

The example of WCS and NYS DEC working together to resolve the bear-human conflict in the Adirondack Park illustrates the importance of partnerships in conservation. In particular, the collaboration between a state agency (NYS DEC) and an NGO (WCS) successfully demonstrates the amount of work that can be accomplished when the two entities work together to help strengthen the capacity of each other. Throughout this project period, there have been many instances in which the NGO could speak out on an issue or

From 2001 through 2006, WCS purchased and distributed over 250 bear canisters to retail stores in the Adirondacks, New England, Quebec, and throughout New York State. The stores rented the canisters and informed users about their benefits.

WCS

A large sign designed to be displayed at trailheads and in information centers appeals to campers' interests and includes information about why bear-human conflict is problematic, and how people can safely store their food while camping.

accomplish an activity that could be impossible for a state agency to attend to. For example, working with retail shops and providing free canisters was an excellent opportunity for the NGO, while the state agency would be restricted in working with a private business in such a manner. Conversely, a state agency was necessary to pass and enforce the canister regulations that the NGO would not be able to enact alone. This successful partnership has also helped to shape the research described below. For example, many of the survey questions were determined by both partners and address questions deemed important by both parties to successfully understand the bear-human conflict. Also, data has been used by both parties to support their work with this ongoing issue.

Description of Work

WCS' research has focused on: describing the characteristics of backcountry users in the Adirondack High Peaks and determining their basic understanding, knowledge and experience with black bears; examining the existing information available to backcountry users about bears and food storage; and identifying the food storage systems currently being used and evaluate their effectiveness. Understanding the need for human education and the tools necessary for proper food storage helped focus this in-depth study. The intention of this research was to guide future efforts in educating hikers and information providers, providing food storage alternatives, and assisting local land managers to make informed decisions about bear-human interactions.

In 2003, we used 5 survey methods to meet the research objectives: (1) a visitor survey was administered at major Adirondack trailheads (sample size = 485); (2) bear encounter postcard (self addressed and stamped) surveys were placed at trail register boxes (sample size = 97); (3) canister evaluation postcard surveys were distributed among participating outdoor retail stores (sample size = 22); (4) backcountry observations were performed at certain major

backcountry locations. All data collection was conducted during the high-use season (June 27 – September 30, 2003). The study area included high-traffic backcountry areas within the Adirondack Park (High Peaks Wilderness Area, St. Regis Wilderness Canoe Area, W.C. Whitney Wilderness Area, and Saranac Lake Wild Forest.)

The following year, WCS conducted follow up research at the trailheads and in the backcountry, focusing on the High Peaks area. The goal was to gather additional information about bears and food storage. The results were meant to serve as a preliminary measure of food storage prior to the proposed regulation to make food canisters mandatory in the eastern High Peaks. Specific research goals were to: understand the method of food storage used in the High Peaks; examine the message backpackers receive regarding bears and food storage; and determine effective means to relay future messages to backpackers regarding bears and food storage.

In 2004, we asked backpackers at major trailheads in the High Peaks to reply to a simple survey containing 19 questions about their previous experience camping in the Adirondacks, previous bear encounters, information received prior to the trip, experience with using bear resistant food canisters, and ideas about disseminating future information to campers about bears. Surveys were administered at key trailheads accessing the High Peaks region. Our researchers interviewed people coming in and going out of the High Peaks at random times using a sample of convenience. Sample size was 141.

WCS continued its research in the Adirondacks to further examine food storage techniques being used after the canister regulation took effect. The specific research goals were to understand the method of food storage used in the High Peaks; determine the ease of compliance and rate of compliance to the regulation; gauge people's understanding of using the canisters correctly and opinions of canisters; understand where people learned about the canister regulation. This research was meant to get a sense of how the regulation changed the bear situation in the backcountry.

During the post-canister regulation research, we asked backpackers at major trailheads in the High Peaks to reply to a simple survey containing questions about their previous experience camping in the Adirondacks, bear encounters, and experience with using bear resistant food canisters. Surveys were administered at key trailheads and interior backcountry locations. Our researchers interviewed people coming in and going out of the High Peaks at random times using a sample of convenience. Sample size in 2006 was relatively low, $n = 117$. While the 2007 data has note been analyzed at the time of press, we anticipate a much more robust sample size ranging from 300-500.

Results and implications

Attitudes about bears: We found that generally, Adirondack backcountry users had a positive attitude about bears in the Adirondacks and wanted to protect bears. However, many visitors to the backcountry did not have an accurate understanding of the bear situation in the area they were visiting. We found that approximately one-third of users in the High Peaks were novice or first time visitors to the area. Most visitors to the Adirondack backcountry had not

encountered a bear before and had not lost food to a bear and therefore may not have been familiar or concerned with safe food storage practices. Figures 1 and 2 demonstrate some of what we learned regarding users' knowledge and expectations regarding bears.

Figure 1. We asked users about their expectations of encountering a bear. This expectation could have implications for how they store food and if they listen to rangers' and others' messages regarding proper food storage. Approximately 60% of users felt that it was "somewhat likely" that a bear would take their food.

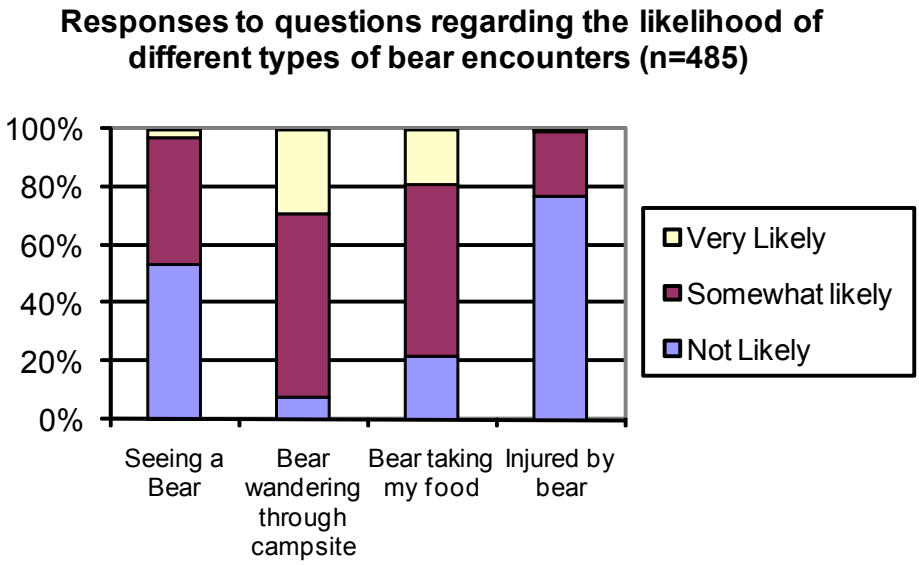
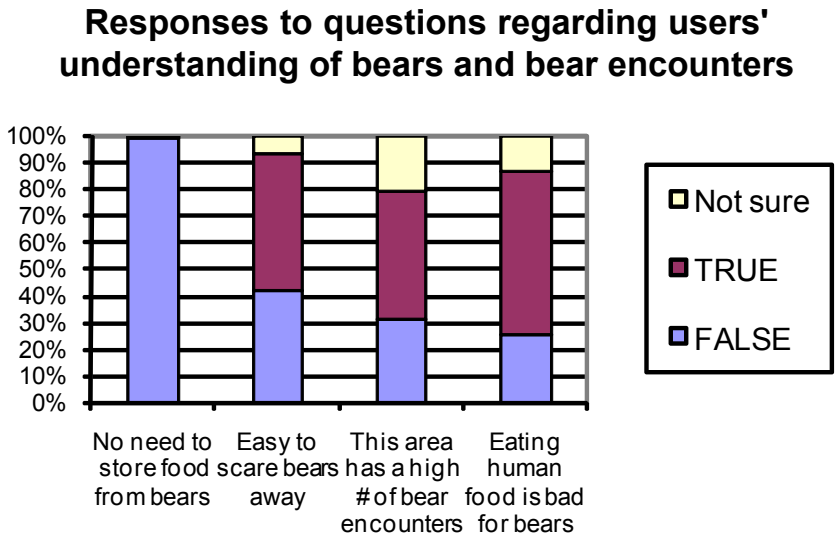


Figure 2. Most users (accurately) answered false to the question "There is no need to store food from bears." On other questions, users were not as uniformly informed about bears. In particular, only about 60% of users questioned believed that eating human food was bad for bears.



Bear Messages and Information Sources: In the 2003 survey, most users received food storage and bear information from a trailhead sign, a Forest Ranger, in books or magazines, or relied on past experiences. Study results indicate that visitors generally had confidence in the information the Forest Rangers and NYSDEC offices provide and would likely contact them prior to future trips along with consulting trailhead signs and information centers. Most visitors thought they needed to know more about food storage and said they would change their behavior if they learned how to better store their food. However, this was not tested. In general, spoken instructions from any type of expert were regarded as highly effective. Other written materials such as posters, brochures, magazine articles, and websites were also regarded as effective in communicating messages to backcountry users.

In 2004 we asked backpackers to rate the types of information that would be most interesting and effective for future messages regarding bears and food storage. Figure 3 shows how users responded concerning which types of content they were most interested in seeing in future, and Fig. 4 shows what types of media and communication were reported as most effective.

Figure 3. Most people ranked those topics with some human element as most interesting; users were less interested in state regulations and bear biology.

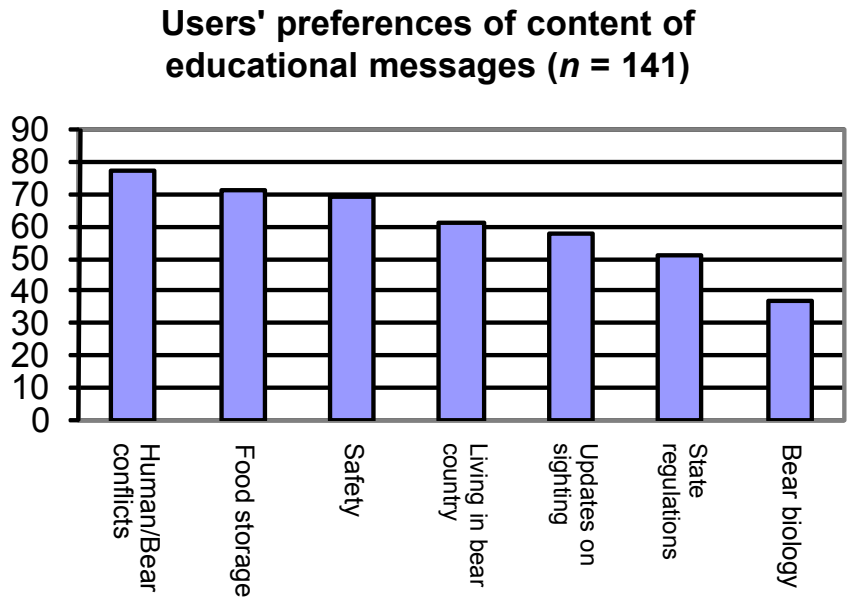
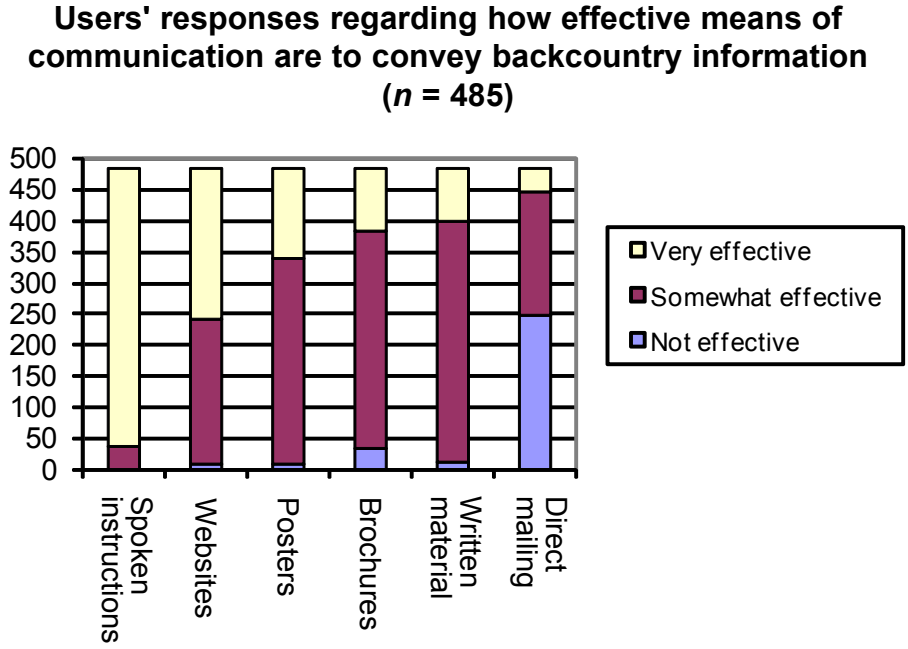
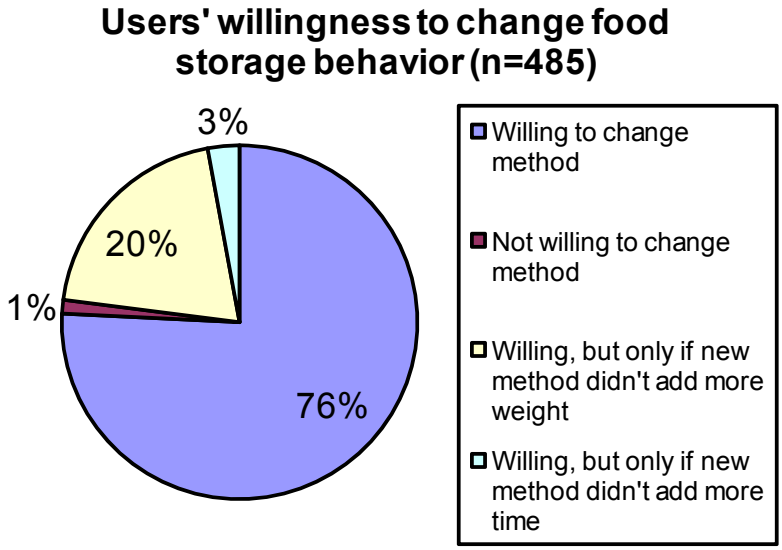


Figure 4. Spoken instructions were reported as most effective. Direct mailings were reported as fairly ineffective.



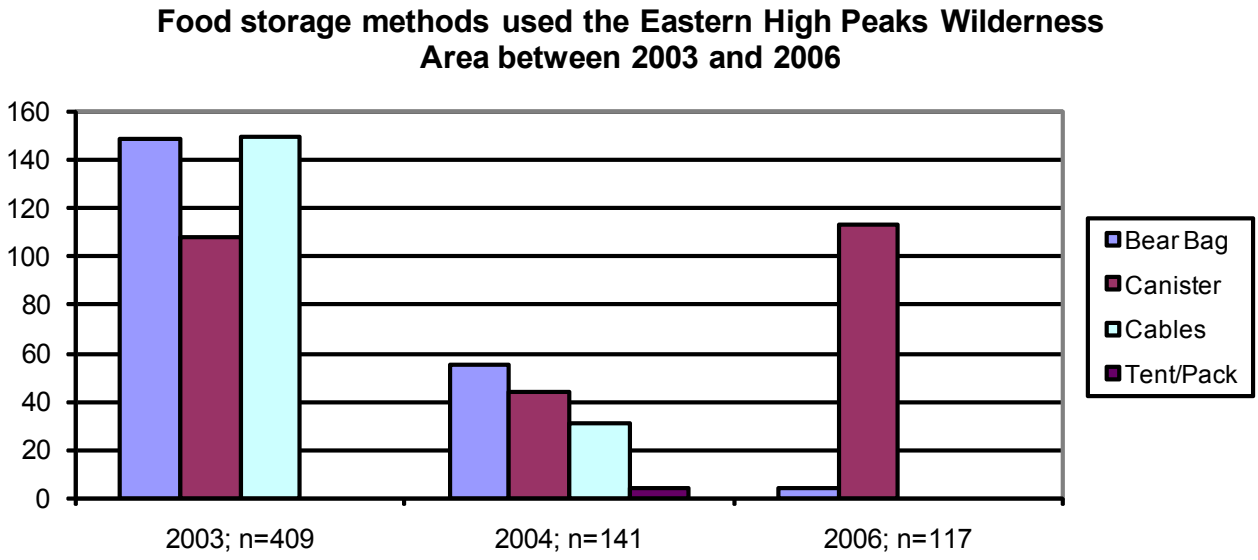
Food Storage Use and Functionality: Generally, backcountry users were very familiar with bear bags, the traditional method of storing food, and think they are convenient but ineffective for storing food. On the other hand, most users thought the cable systems (no longer installed) were effective but were somewhat inconvenient. Most people knew how to use the cables and had used them in the past but did not rely on them to store their food. In the 2003 survey, a small number of visitors were familiar with bear resistant food canisters or had used them in the past and felt comfortable using them. At the time of the study 26% of backpackers used canisters. We found that experience plays a critical role in determining food storage. Visitors who had lost food in the past were more likely to use a canister in the future. Although as of 2003 we observed an increase in the number of people aware of the need to use canisters to store food safely from bears, still almost half did not think it was necessary to do so. Those users who did use canisters generally thought that they were easy to use and convenient. However, they expressed some concern about affordability and weight. Most people we talked to were willing to purchase a canister and/or use one in the future (Fig. 5). Most people were aware that if they did not follow food storage regulations a Ranger could ticket them.

Figure 5. At the outset of our study, it was important to learn whether new information could inspire users to change their behavior regarding food storage. In 2003, most users responded that they were willing to improve their behavior.



We found that in 2004, slightly more backpackers used bear bags to store food on their trip (39%), and 31% used a bear canister. When asked why they were not using a canister on this trip, 26% didn't think it was necessary, 22% didn't know about the canisters, 12% thought they are too bulky and heavy, 0.02% thought they are too expensive, and only 0.02% didn't know where to buy or rent a canister. In 2006, just after the canister regulation was mandated, there was a significant increase in the number or people using canisters (96%) and only 0.3% used bear bags. Figure 6 shows the change in food storage methods over time. While there was a major effort to inform the public about the proposed regulation coming in 2005, only 45% of users were aware of this upcoming mandate, compared to 2006 when 88% of people surveyed were aware of the regulation. According to the NYS DEC bear sighting forms, there were 420 bear sightings in 2004, and 50% of those who sighted a bear lost their food. This stands in comparison to NYS DEC data in 2006 showing that the number of bear sightings decreased to 93 and that only 26% of those who sighted a bear lost food (B. Tabor, NYS DEC, pers. comm. 2007).

Figure 6. The proportion of survey respondents using bear canisters increased dramatically over the time period of the survey.



From 2001-2007, the work of WCS and NYS DEC to alleviate the human-bear conflict in the High Peaks Wilderness area of the Adirondack Park has resulted in a number of successes. Canisters have become more accessible, information has been disseminated on the need to use the canisters, and a regulation requiring the use of canisters has been implemented. The data from this period shows that the use of canisters has increased to almost 100% and the number of food losses has decreased significantly. The end result is that there are fewer human-bear conflicts in the backcountry. This is quite a remarkable level of compliance and result in a relatively short period of time.

However, in summer 2007 there were a number of incidents in the High Peaks in which campers used the canisters improperly (i.e. no lid or loose lid) resulting in bears obtaining food directly from canisters. Additionally, one particular brand of canister failed multiple times and bears were able to pry open their lids. In one incident, a factory-manufactured canister was broken in half. The failure in this type of canister resulted in bears trying harder to get into other brands of canisters and being motivated to continue to show up night after night. This particular situation in the High Peaks "nuisance bear" chain of events is yet another factor contributing to habituating and food conditioning bears in the Adirondack backcountry. Wildlife managers and WCS are rethinking ways to address the human-bear conflict in this region that will eventually break the slow transitional cycle of bears obtaining human food. While the number of incidents has decreased since the canister regulation was instituted, the series of imperfect solutions (bear bags, cables, one brand of canisters) has slowly led to an increase in bears' learning potential and thus, the perpetuation of the conflict.

While we continue to debate the next step for human-bear conflict management in the backcountry, we continue to operate under the principle that there is a list of critical ingredients needed to contribute to a successful human-wildlife conflict program. First the public needs to be aware that there is a problem that requires a change in their behavior. This can often be influenced by education and outreach. However, education often isn't enough. When this is the case, it may be necessary to control human behavior through rules, such as the canister regulation or local ordinances. Second, there needs to be the opportunity for the public to change the behavior that is leading to the conflict – in this case keeping food safely from bears. In our example we address this by providing canisters to the public through retail shops. Third, there must be enforcement of the regulations to ensure compliance. All of these actions require partnerships and agreements between state agencies, NGOs, and other entities. With these components in place, we found that human-bear conflict can begin to be resolved.

There is a list of critical ingredients needed to contribute to a successful human-wildlife conflict program.

CASE STUDY FOUR:

HUMAN-BLACK BEAR INCIDENTS IN YOSEMITE VALLEY, YOSEMITE NATIONAL PARK, CALIFORNIA 1989-2002

Contributors: Sean M. Matthews, Schuyler S. Greenleaf, H. Malia Leithead, Brenda K. Lackey, John J. Beecham, Howard B. Quigley, and Sam H. Ham

Background

The annual number of human-bear incidents documented in YNP between 1989 and 2002 ranged between 230 and 1,584. Corresponding annual property damage estimates ranged between $32,303 and $659,569.

Since the 1920's anthropogenic influences have led to alterations in natural black bear behavior, food habits, reproductive rates, physical size, distribution, and population levels in Yosemite National Park (YNP), California. The availability of human food and trash have resulted in changes in bear behavior to maximize opportunities to consume these food items and have led to increases in human-bear interactions resulting in property damage and personal injury. In an effort to reduce the number of conflicts, the National Park Service initiated the Human-Bear Management Program in YNP in 1975. Goals of the program included restoring and maintaining the natural distribution, abundance, and behavior of the black bear population; providing for the safety of visitors and their property; and providing opportunities for visitors to understand, observe, and appreciate black bears in their natural habitat. Intensive bear management efforts have been concentrated within the 18 km^2 of Yosemite Valley (YV), which receives 90% of the nearly 3.5 million people who visit YNP annually and accounted for 62% of the human-black bear conflicts documented in YNP between 1989 and 2002. In this case study, our objectives were to assess the success of bear management in YV and develop recommendations for improvement.

WCS involvement

Recent increases in human visitation and bear incidents in Yosemite National Park led park managers to invite the Hornocker Wildlife Institute (a program of the Wildlife Conservation Society) and the Department of Resource, Recreation, and Tourism at the University of Idaho to conduct an examination and evaluation of factors influencing human-bear interactions. The annual number of human-bear incidents documented in YNP between 1989 and 2002 ranged

between 230 and 1,584. Corresponding annual property damage estimates ranged between $32,303 and $659,569. However, a decreasing trend in the number of incidents in YNP between 1998 and 2002 corresponded to efforts outlined by the Human-Bear Management Program. The goals of this project were to provide recommendations for the Yosemite Human-Bear Management Program by accurately identifying methods to improve bear management to reduce the number of problem bear incidents and provide for the continued, long-term existence of bears in this intensively used National Park. WCS has also assisted in implementing management recommendations in YNP and disseminated findings and recommendations to other managers faced with human-bear conflicts.

The project was funded by Yosemite National Park and the Yosemite Fund. Field work began in 2000 and a final report was completed in 2003 (Matthews et al. 2003). Several products have been produced from this study (Lackey 2002, Lackey and Ham 2003a, Lackey and Ham 2003b, Greenleaf 2005, Matthews et al. 2006). This case study represents a small element of the complete effort.

The documented history of human-bear conflicts in Yosemite dates back to the first arrival of non-Indians in 1851

History of conflict

The documented history of human-bear conflicts in Yosemite dates back to the first arrival of non-Indians in 1851 (National Park Service 2003). Yosemite was originally inhabited by both California grizzly (*Ursus horribilis californiana*) and black bears. The possible exclusion of black bears by grizzlies from many areas of the park ended in 1895, when the last grizzly observed in YNP was shot. Also during the late 1800's, tourism quickly began impacting the ecosystems and wildlife of YV. Limitations in transportation restricted the removal of garbage, forcing park managers and hotel operators to use open pit dumps in YV.

By the 1930's, as many as 60 bears were observed during the summer season in the 18 km^2 of YV (National Park Service 2003). Artificial feeding areas were established in 1937 in the west end of YV in order to draw bears away from developed areas in the east end of YV. These feeding areas also provided the visiting public with a unique opportunity to see bears.

By the 1940's, it was recognized that continued feeding of bears and lethal control of bears demonstrating threatening behavior toward people had altered the natural ecology of the bear population in YNP (Beatty 1943, National Park Service 2003). This led to closures of artificial feeding areas in the 1940's. Additionally, the introduction of dumpster-style trash containers and the ability to transport their contents to landfills outside of the park allowed for the closure of the dumps in YNP in 1971. However, removal of these artificial food sources was followed by increases in human-bear conflicts as bears turned to raiding campsites and breaking into vehicles to obtain food.

The National Park Service initiated the Human-Bear Management Program in YNP in 1975 to address continuing negative human and black bear interaction issues (National Park Service 1975). The objectives of the program included providing public information and education; eliminating the availability of artificial food sources to bears by providing bear-resistant food storage devices and garbage receptacles; enforcement of regulations regarding proper food stor-

age and feeding of YNP wildlife; relocation or destruction of problem bears; and research and monitoring.

Keay and Webb (1989) reviewed the history and assessed the effectiveness of the program from its inception until 1986. They concluded more aggressive public education, continued efforts to reduce the amount of human food available to bears, and strict law enforcement might increase the effectiveness of the program. Since the assessment by Keay and Webb (1989), YNP personnel began installing and requiring the use of bear-resistant food storage lockers in 1991, with each YV campsite having a locker installed by 1994. In a similar effort to reduce the number of conflicts in YV parking lots, overnight storage of food in vehicles was prohibited in 1999.

National Park Service

The Human-Bear Management Program was formed to address continuing negative interactions.

Significant advances in the Yosemite Human-Bear Management Program were made following an annual $500,000 congressional appropriation in 1999. Funds were used to staff additional bear-related positions, purchase additional food storage lockers, improve public information, and conduct research. The Yosemite Bear Council, a collaborative organization with representatives from each park division and park cooperators, was also formed to coordinate the Human-Bear Management Program.

Description of work

We analyzed data from YNP's human-black bear incident database for incidents that occurred in YV between 1989 and 2002. YNP managers defined a bear incident as a bluff charge or other aggressive behavior, personal injury, property damage, bear trapped in or released from a dumpster, and cases of bears obtaining human food (National Park Service 2002). We did the following:

- Determined the percentage of park-wide incidents that occurred in developed areas within YV
- Tested for trends in the number of incidents that occurred in developed areas within YV
- Evaluated if the installation of food storage lockers in campgrounds and food storage regulations in parking lots resulted in changes in the number of human-bear conflicts in these areas of YV
- Quantified causes which resulted in the largest proportions of human-bear incidents documented in YV

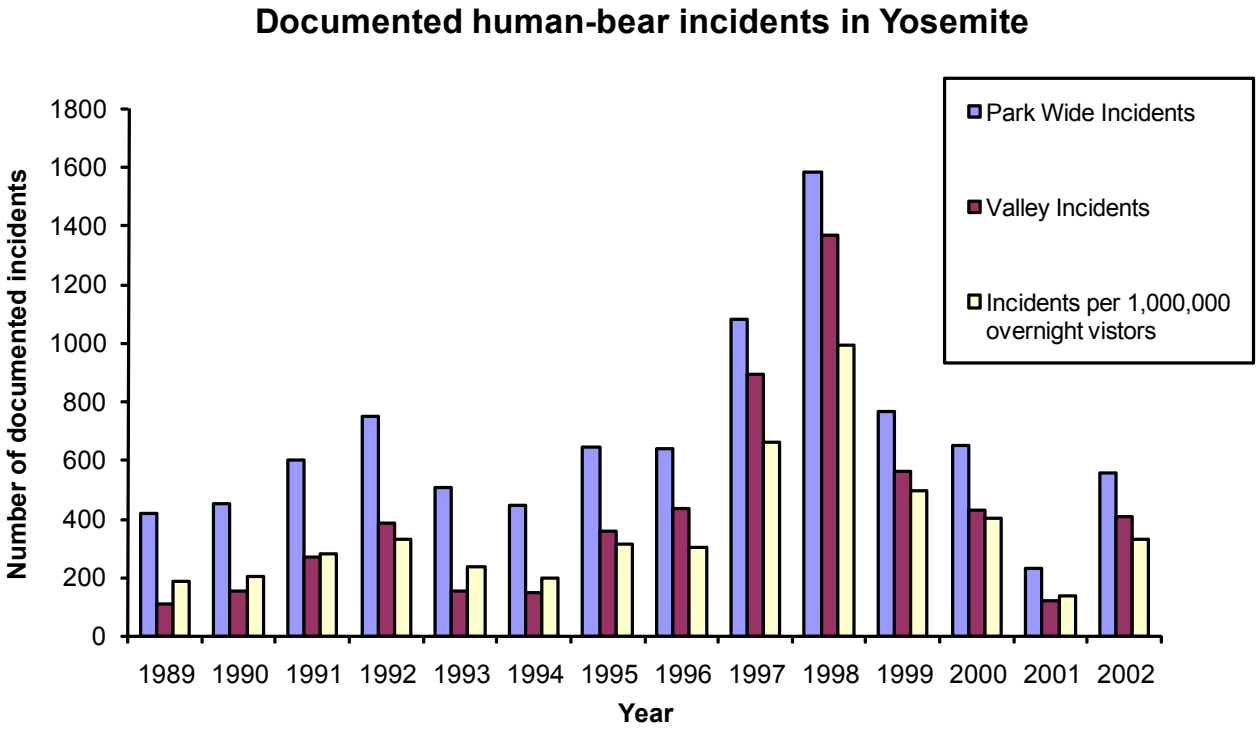
- Tested the distribution and efficacy of the education materials being used by YNP to educate park visitors and employees about human-bear conflicts and food-storage regulations
- Quantified the frequency of use of different corrective actions taken following human-bear incidents.
- Identified the age and sex classes of bears involved in human-bear incidents.

For a more detailed treatment of the methods and results presented here, see Matthews et al. (2003).

Results

A total of 9,333 human-bear incidents were recorded in Yosemite National Park between 1989 and 2002. An average of 667 incidents occurred during each of the 14 years, with a maximum of 1,584 in 1998 and a minimum of 230 in 2001. We detected no increasing or decreasing trend in the number of human-bear incidents recorded park-wide between 1989 and 2002 (Fig. 1). However, since the recorded high of 1,584 incidents in 1998, the number of annual incidents has been on a decline. Park-wide, 62% of incidents occurred in YV. We detected no trend in the number of recorded human-bear incidents recorded in YV between 1989 and 2002 or since the recorded high of 1,369 incidents in 1998 (Fig. 1).

Figure 1. The number of annual human-bear incidents documented in Yosemite Valley and Yosemite National Park, Calif. between 1989 and 2002.



Most incidents in YV occurred in campgrounds (53%) and parking lots (44%). Only 3% of incidents occurred in businesses or residences and less than 1% occurred on or near trails and in picnic areas. We detected a decreasing trend in the proportion of incidents that occurred in campgrounds and an increasing trend in parking lots. Mean annual incidents occurring in YV campgrounds did not differ prior to ($\bar{x}$ = 135) and following ($\bar{x}$ = 189) a food storage locker being installed in each YV campsite in 1994. Mean annual incidents occurring in YV parking lots did not differ prior to ($\bar{x}$ = 243) and following ($\bar{x}$ = 183) regulations prohibiting the overnight storage of food in vehicles.

Conditioned bear behavior, human error, and accidental encounters were documented as the cause of 35, 65, and < 1% of the human-bear incidents, respectively. Because accidental encounters were relatively infrequent, they were not considered further in the analyses. We detected a decrease in the proportion of incidents due to conditioned bear behavior and an increase in the proportion of incidents due to human error.

We found that 7% of victims involved in a human-bear incident reported they had not received bear-related information. We did not detect an increasing or decreasing trend in the proportion of victims who reported not receiving bear information prior to an incident. Of those incidents resulting from human error, we also found that 7% of victims reported that they did not receive some form of bear-related information prior to the incident.

Most incidents in YV occurred in campgrounds (53%) and parking lots (44%).... Conditioned bear behavior, human error, and accidental encounters were documented as the cause of 35, 65, and < 1% of the human-bear incidents, respectively.

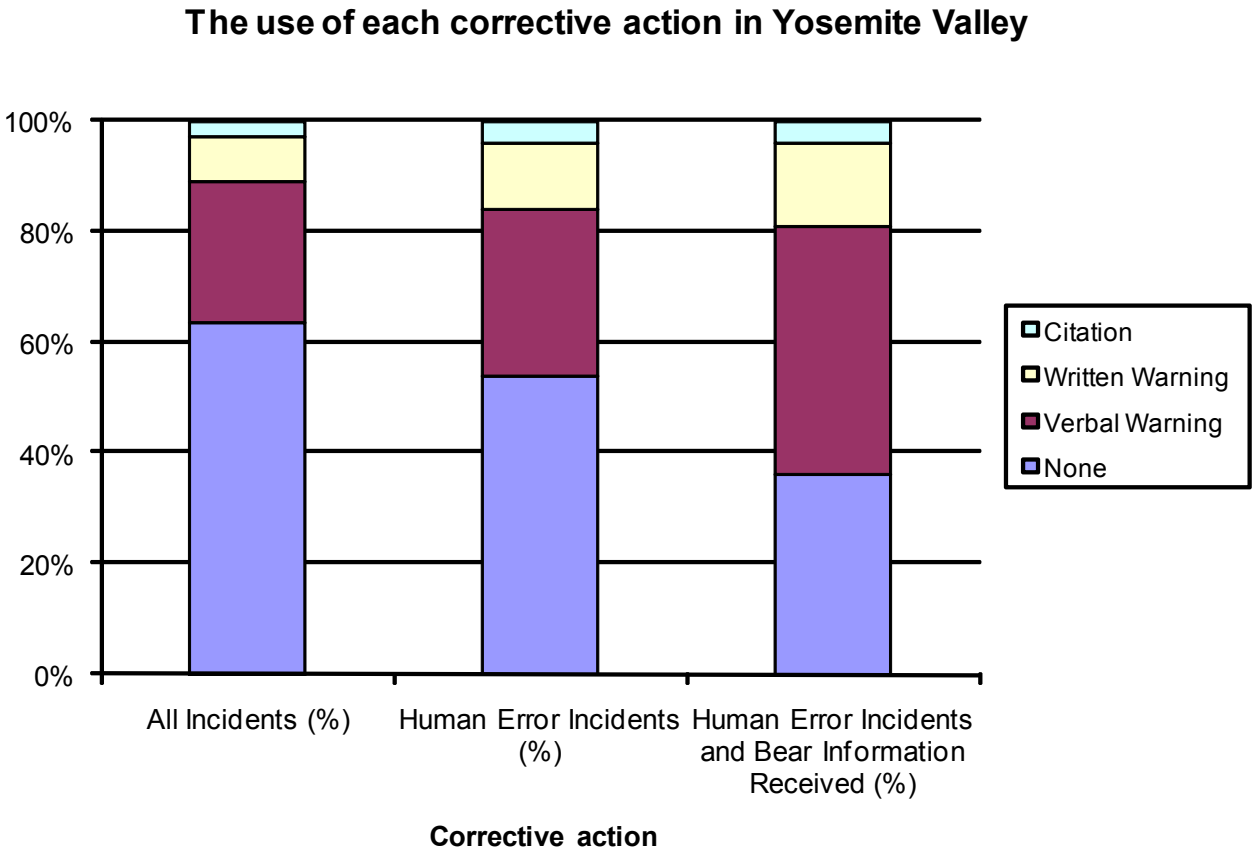
YNP personnel implemented no corrective action in 64% of the 5,110 incidents that occurred in YV between 1989 and 2002 in which an outcome was reported. In other cases, YNP personnel gave verbal warnings (26%), written warnings (8%), and citations (3%). We detected a decreasing trend in the proportion of incidents where no corrective action was taken. Larger percentages of verbal and written warnings were given following incidents where human error was identified as the cause and following incidents where human error was identified as the cause and the visitors involved reported they had received bear-related information prior to the incident (Fig. 2). However, the percentage of citations given remained nearly equal in each incident situation (Fig. 2).

Adult male (55%) and adult female (41%) bears were involved in the majority of incidents where the bear involved was identified (n = 346). Subadult male and subadult female bears were involved in 3 and 1% of the incidents, respectively.

Discussion

Human-black bear incidents remain a significant concern in YNP. Considerably larger numbers of incidents have been documented in YNP in the recent past (9,333 between 1989 and 2002) compared to other national parks with black bear populations. By means of comparison, Sequoia and Kings Canyon National Parks personnel jointly documented 4,843 human-bear incidents between 1989 and 2002 (National Park Service, Sequoia and Kings Canyon National Parks unpublished data). Great Smoky Mountains National Park personnel documented 2,170 between 1990 and 2002 (National Park Service,

Figure 2. The use of each corrective action in Yosemite Valley, Yosemite National Park, California between 1989 and 2002 following all incidents (*n* = 5,110), incidents where human error was determined to be the cause (*n* = 2,637), and incidents where human error was determined to be the cause and bear-related information was received prior to the incident (*n* = 1,316).



Great Smoky Mountains National Park unpublished data). Redwood National and State Parks personnel documented 205 between 1989 and 2002 (National Park Service, Redwood National and State Parks unpublished data).

Despite comparatively larger numbers of human-bear incidents and the lack of significant declines between 1989 and 2002, the efforts directed by Human-Bear Management Program in YNP appear to have achieved some level of success. Although Keay and Webb (1989) did not address trends in incidents in YV specifically, they did detect a significant decline in the number of incidents that occurred in front-country areas of YNP between the initiation of the Human/Bear Management Program in 1975 and 1986. And despite the lack of a decreasing trend in the number of human-bear incidents between 1989 and 2002, an encouraging downward trend was detected from the recorded high number of incidents in 1998 until 2002 Park-wide. These recent decreases have been attributed to additional efforts made possible by a 1999 congressional appropriation of funds. The appropriation allowed for increased staffing levels, improved communication efforts directed at informing visitors about human-bear incidents, the installation of additional food storage lockers, and the implementation of additional food storage regulations and enforcement.

YV remained an area of particular concern for YNP personnel, given that 62% of the annual incidents occurred in this small area, though it is equal to only 0.6% of the area of YNP. This high concentration of incidents is most likely related to high levels of human use. Graber (1981) identified the presence of high levels of human use in optimal, natural bear habitat as a contributing factor to human-bear conflicts in YV.

Within YV, campgrounds and parking lots continued to have high concentrations of human-bear incidents. Keay and Webb (1989) found incidents in front-country areas occurred primarily in campgrounds (67%) and parking lots (25%) between 1975 and 1986. Similarly, we found the largest percentages of incidents were documented in campgrounds (53%) and parking lots (44%). However, we found a decreasing trend in the proportion of incidents that occurred in campgrounds and in increasing trend in the proportion of incidents that occurred in parking lots. These trends could be attributed to the timing of management actions. Efforts to reduce human food availability in YV campgrounds began with the installation of food storage lockers, beginning in 1991, with each YV site having a locker by 1994. However, efforts to reduce human food availability in YV parking lots did not begin until 1994, with the current regulations prohibiting the storage of food in vehicles overnight not being implemented until 1999.

Graber (1981) identified the presence of high levels of human use in optimal, natural bear habitat as a contributing factor to human-bear conflicts in YV.

Several factors may have contributed to the apparent lack of success of food storage containers in campgrounds. Park personnel identified design flaws in some models of food storage containers which allowed bears to gain access to food stored in properly secured containers. Additionally, visitors found some of the earlier models difficult to close and secure properly. Finally, visitors have also reported that containers were not large enough to store all of their food.

Factors that may have contributed to the apparent lack of success of the 1999 regulation prohibiting the overnight storage of food in vehicles were visitors failing to follow the regulation and conditioned bear behavior. Given its relative novelty, YNP personnel need to make continued efforts to educate visitors of this regulation. Additionally, conditioned bears have been documented breaking into vehicles without any detectable food or other attractant inside. Greater consideration should be taken in destroying bears exhibiting this level of habituation, as called for in the Human-Bear Management Plan (National Park Service 2002).

Visitor failure to follow food storage regulations continued to be a significant concern in YV. Trends in both the number and proportion of incidents attributed to human error significantly increased between 1989 and 2002. Similarly, Keay and Webb (1989) found 38 and 59% of the human-bear incidents which occurred in front-country areas were the result of conditioned bear behavior and human error, respectively. They also identified a decrease in the proportion of incidents due to conditioned bear behavior and an increase due to human error between 1975 and 1986. Park personnel relied on communication and enforcement methods to promote proper food storage. Improvements in each of these approaches should be made in order to increase their effectiveness (see Lackey and Ham 2003a, Lackey and Ham 2003b).

Yosemite managers have been successful in distributing bear-related information, with only a small proportion of victims (7%) reported not to have received bear-related information. Similarly, Keay and Webb (1989) determined 11% of front-country victims did not receive bear-related information. Keay and Webb (1989) concluded that visitors must be motivated through communication efforts and provided simple techniques to make food inaccessible to bears. While messaging regarding human-bear issues was received by a majority of YV visitors, continued efforts should be made to make messaging and its delivery more motivating (see Lackey and Ham 2003b). These approaches include using a variety of media types to convey messages, including permanent and temporary signage, videos, and face-to-face interactions with YNP staff. These approaches also need to be vivid (i.e. bright colors, catchy language) and in some cases incorporate a temporary look, for example a dry-erase board in a campground kiosk displaying the number of visitors who have lost their food and/or had property damaged by a bear during the season. Additionally, messaging needs to relay not only the regulatory aspects of food-storage policies, but also how bear biology and habituation relate to human-bear conflict.

A more aggressive law enforcement campaign including larger financial penalties would be an additional motivating factor for non-compliers.

Regulations requiring the use of food storage lockers and prohibiting the overnight storage of food in vehicles have not been supported by strong law enforcement actions (e.g. citations) in either the campgrounds or parking lots of YV. A more aggressive law enforcement campaign including larger financial penalties would be an additional motivating factor for non-compliers. More aggressive law enforcement was also recommended as an alternative by Keay and Webb (1989) and was proven successful in reducing the availability of human foods in Yellowstone National Park (Meagher and Phillips 1983). Yosemite managers should establish stronger Title 36 language for improper food storage violations (36 CFR section 2). This would enable law enforcement rangers greater ability to issue citations for food storage violations and provide financial incentive for visitors to follow food storage regulations.

Considering the management goal of reducing the number of human-bear conflicts and the involvement of adult female bears in human-bear conflicts, Yosemite managers should consider more prompt destruction of conditioned bears. Meagher and Fowler (1989) found that efforts to protect and preserve grizzly bears, particularly adult females, led to the destruction of more bears than would have occurred if individuals were removed once they were identified as a conditioned bear. Bear management in Yellowstone initially involved the translocation and destruction of conditioned bears. These removals were followed by efforts to educate people, increased law enforcement, intensified sanitation, refinement of management techniques, and development of a monitoring system to provide management information. These efforts were followed by the development of an awareness that preventative bear management must be a consistent part of park operations. These management steps led Meagher and Phillips (1983) to report Yellowstone National Park bear managers appeared to have achieved their objective of restoring bear populations to subsistence on natural forage within the park.

We recommend YNP managers implement more motivating educational efforts, a stronger law enforcement program, and the prompt destruction of habitual nuisance bears to further reduce the number of human-bear incidents in YV.

Bear management in Yosemite has followed a similar path. However, YNP managers have not made extensive efforts, as in Yellowstone, to remove conditioned bears from the population or impose financial penalties on non-compliers. As Meagher and Fowler (1989) recommended to Yellowstone managers, although we acknowledge public and political pressures to retain individual bears, we suggest the prompt destruction of habitual nuisance bears may enhance population welfare through the recruitment of naïve individuals.

Successful management of human-bear interactions involves the combination of a variety of elements; including visitor education, law enforcement, sanitation, "bear-resistant" food storage and waste containers, monitoring, and research. Although single elements did not appear successful in reducing the number of human-bear incidents, their combined use has probably contributed to the decline in park-wide incidents. In order to achieve further declines, we recommend YNP managers implement more motivating educational efforts, a stronger law enforcement program, and the prompt destruction of habitual nuisance bears to further reduce the number of human-bear incidents in YV.

MANAGEMENT RECOMMENDATIONS

The variety of management tools we have at our disposal to deal with bear-human conflict is complex. However, the heart of the solution is quite simple – to keep bears from obtaining anthropogenic foods under any circumstances. Many of the methods we have discussed, such as translocation or deterrents, are merely responses to existing problems. They can never be expected to succeed in eliminating bear-human conflict if the sources of anthropogenic foods remain available to bears. Even a single reward of rich foods obtained from humans may be enough to nullify any negative reinforcement generated from deterrents.

The good news is that efforts to reduce the availability of anthropogenic food to bears can be quite successful at reducing bear-human conflict, as evidenced by some of our case studies and others. An important message from the New Mexico case study is that when food was made unavailable, bears were capable of living in close proximity to humans without conflict. During that study, we monitored bears as old as 23 years residing within Philmont Scout Ranch that had never been suspected of conflict, despite close proximity to camps and trails.

With these lessons in mind, we present a summary of management strategies below, with the understanding that only those strategies that prevent bears from accessing human foods will actually prevent conflict, while other strategies will at best be mechanisms to manage existing conflict. Lastly, we share some thoughts about comprehensive planning approaches for management.

The heart of the solution is quite simple – to keep bears from obtaining anthropogenic foods under any circumstances.

Strategies to prevent bear-human conflict

All of the management strategies presented in this section contribute directly or indirectly to keeping anthropogenic food away from bears – and bears away from food – since this is the key to successfully preventing bear-human conflict. The components of a successful prevention strategy may include:

- Educating the public about keeping human food from bears
- Requiring the public to, and providing the means to, secure food and garbage
- Enforcing requirements and laws
- Land use decisions and other strategies to keep people and bears apart

With the exception of the last strategy, the goal of these policies is to allow humans and bears to live near one another while avoiding the creation of conflict situations. Given that people are building homes inside prime bear habitat across North America, it is an unrealistic management goal to expect these areas to be free of bears. Instead, the goal should be to have bears in these habitats, but foraging on natural, not anthropogenic, foods.

Education

Education must be the root of any successful management strategy. It provides a proactive measure to prevent conflicts. Luckily, in our experience the general public has demonstrated an interest in conserving black bears. It is the responsibility of the manager to develop an engaging educational campaign to take advantage of this widely held interest among the public. Educational materials should address the links between the feeding ecology of black bears, the process of habituation and aggressive behaviors, and non-lethal and lethal control measures used to manage aggressive bears for the sake of public safety. These materials should also outline methods of proper food storage and waste disposal as effective means to avoid human-bear conflicts, provide information on opportunities to comply with ordinances and regulations, the repercussions for violating regulations (citations/fines), and methods to report bear sightings and conflicts when they occur. To effectively capitalize on the public's interest in conserving black bears, these messages should empower the public to understand and act upon their ability to play an important role in protecting the species by keeping anthropogenic foods secure. In addition, there should be adequate opportunity to access bear-resistant equipment and/or this infrastructure should be readily available so the public can comply with recommendations for keeping food and garbage from bears.

The goal of these policies is to allow humans and bears to live near one another while avoiding the creation of conflict situations.

Our case studies indicate that educational efforts that provided detailed guidelines or instructions about securing foods from bears were most effective. This was especially true when bear-resistant infrastructure or equipment was readily available. In the Adirondack case study, compliance with food storage regulations increased as canisters were made more available to backpackers. In our New Mexico study, we found that the camping and food storage procedures were typically followed by scouts on Philmont Scout Ranch because they were specific, realistic and the infrastructure was in place.

There are several other nuanced messages that managers should consider delivering to their audience. For example, it is important to educate people living in regions of bear habitat to understand that simply having bears in the area is not a problem as long as they feed on natural foods and are not human food-conditioned. It is also important for the public to understand that by having bears in the area, there will be times when bears will forage on items such as fruit trees or native plants, and use areas such as urban fish ponds for swimming. The public should recognize that this is just part of living in bear habitat, and that these activities do not constitute a bear being "aggressive." The concept of living with bears and tolerating their natural behaviors needs to be part of an effective public education campaign.

As important as having the right elements in an educational campaign is coming up with effective means to deliver these messages. Communication messaging on black bears targeted for the public needs to capture people's attention, influence their beliefs, and alter their behavior. This is a difficult combination of requirements and demands strong, effective messages.

Reaching the audience

There are many opportunities to capture the public's attention, and lots of communication mechanisms to explore. Most of these will be most effective if they take advantage of an immediate interest among the audience – for example, because the backpacker is about to enter the backcountry, or because the homeowner realizes that there has been a lot of bear activity in her neighborhood. Towards this end, messages that seem timely and based on current information will be most effective. While we suggest using a wide array of media, including signs, videos, press releases, electronic materials and brochures, our work in the Adirondacks clearly shows using direct mailings that include no human element are least effective in communicating information to the public about bears and food storage. Other networks and avenues of dissemination should be explored, including homeowner's associations, trash haulers, hiking and backpacking clubs, information centers, local and regional businesses such as outdoor retail shops, hardware stores, or supermarkets, state land management agencies, and conservation and community groups.

Communication messaging on black bears targeted for the public needs to capture people's attention, influence their beliefs, and alter their behavior. This is a difficult combination of requirements and demands strong, effective messages.

We found that for backcountry users, attention-getting messages are best when they are brief and vivid, and can easily be updated (e.g. a dry-erase board with a tally for the number of human-bear incidents in the campground for the season.) Our research in the Adirondacks has revealed that spoken messages are also highly effective and should be employed whenever possible and timed such that the message comes close to the time of the outdoor experience. Personnel, such as Forest Rangers, campground patrols, conservation officers, park volunteers, naturalists, etc. can act as interpreters of this message. It can also be an effective technique to provide opportunities for the public to witness damage first-hand. For example, a ripped tent at a trailhead speaks volumes. These images and video can also be disseminated through the internet and video. Where possible, direct education such as requiring a backpacker to watch a video or presentation, or sign a contract before entering the woods, can also be a great option.

In Yosemite, two field experiments were conducted to test bear related messages and to increase our understanding of the public's perception of risk associated with human-bear interactions. Five different signs were developed with varying communication approaches, including humor, emotion, a personal story, brevity, and existing Park Service language. The largest percentage (44%) of the public ignored the sign treatments. About 32% glanced at the signs for less than two seconds. Among the people who viewed the signs for an extended period (24%), the inclusion of emotion, vividness, and humor in the test signs appeared to increase the proportion who viewed for more than 20 seconds. Most (84%) of the visitors who were interviewed described the sign information as familiar. Overall, the experimental treatments using vivid statistics and

vivid story had no effect on the public's perception of risk regarding bear-related incidents. (see Lackey 2002 and Matthews et al. 2003). These results suggest, among other things, that old messages should be updated periodically to look new, should contain brief messages displayed vividly (i.e. colors, fonts, headlines), and include an element of human interest. Managers should consider the placement and frequency of signs to maximize the opportunity to repeat messaging and further increase chances of effectiveness. Signs are just one tool to communicate to the public, however, and there should be consideration of other forms of media as well.

Changing minds

Changing people's beliefs and behavior is much more challenging than getting their attention. Managers need to convey the message that human-bear conflicts are serious and likely if preventative measures are not taken. Methods for influencing people's beliefs and behavior involve addressing the public's prominent beliefs about bears, with less focus on targeting the problem only. Thus, managers need to connect what people know and hold dear about bears and human-bear conflict. Messaging proves more influential if it is aligned with something the reader already believes about bears. For example, a message that targets campers' concern about having food to eat might be: 'ACTIVE BEAR AREA – If you want enough food for breakfast, then store your food and all smelly things in your food-storage locker!'

Messages will be better received if they are conveyed by credible sources such as state wildlife managers, wildlife biologists, forest rangers, hiking clubs, and local experts. Consider choosing a spokesperson for the educational campaign, such as a famous outdoorsperson or a trusted member of the community.

H. Fener, HWI/WCS

The Human-Bear Management Program was formed to address continuing negative interactions.

Similarly, messages stand a better chance of altering the public's behavior if they are in tune with their audience. Understanding the audience, their knowledge, questions, and priorities, will increase the likelihood of a successful education campaign. For example, individuals who have experienced past negative bear encounters seem to draw on this to shape behavior. Consider incorporating these experiences in to the message for more experienced audiences and users. On the other hand, novice backpackers, first time visitors, or naïve members of the community may not have experience with bears or understand the risk of bear encounters. Messages to this group may need to contain more basic messages and more explicitly state the desired behavior.

In both the Yosemite and Adirondack studies we found the manner in which a person processes information is based in part on a person's prior knowledge and first hand experience, and it may be the case that highly experienced backcountry visitor rely on their experience rather than signs to guide their behavior. Thus, another challenge for managers is to change the public's perception of their vulnerability. In Yosemite, people think bear incidents are serious, but unlikely. Unless both are high (i.e., bear incidents are considered serious and likely), then behavior change is unlikely. Our findings indicated that visitors' behavior is usually appropriate and that the park generally experiences a high level of compliance. We know why some violators do not comply. Reasons include laziness, the belief that "I didn't think it would happen to me," and a lack of convenience and ease of compliance. To better ensure compliance, there should be a focus on efforts to increase the ease of compliance, recall of proper behavior through messaging, and law enforcement. In Yosemite we found that it is inaccurate to assume that non-compliant behavior is a result of lack of knowledge (see Lackey 2002 and Matthews et al. 2003).

Understanding the audience, their knowledge, questions, and priorities, will increase the likelihood of a successful education campaign.

Our successes and failures clearly indicated that people were less likely to follow food or garbage storage procedures when they perceived no negative consequences for non-compliance. In the Yosemite study, where conflict levels were high, we observed that fewer than 5% of conflict incidents resulted in citations, even when human error was determined to be the cause and bear-related material was received prior to the incident. In contrast, compliance with food storage procedures was apparently much higher among campers on Philmont Scout Ranch in New Mexico due to the high likelihood of a reprimand, expulsion from Philmont, or assignment of a conservation project to be completed at home.

Education partnerships and models

There are many effective bear education campaigns operating on local, state and national levels. These can provide resources, materials, or ideas. Additionally, partnerships with state or local conservation groups or universities can provide resources to institute education and outreach programs.

Our education efforts in Nevada were funded through the "I'm Bear Aware" campaign established by the Nevada Department of Wildlife. This campaign uses bumper stickers, flyers, radio and television announcements, and public presentations by biologists concerning living in bear country to get the message across. Of particular importance were biologists going into elementary and

middle schools to give presentations on bears while passing out bookmarkers, refrigerator magnets, pencils and other items with advice on how to properly handle garbage in areas with bears. In the Adirondacks, NYS DEC recently developed an educational DVD for the public outlining living with bears in New York State. Another model program is "Be Bear Aware" which is a North American-wide campaign using General Norman Schwarzkopf as its spokesperson. Coordinated by the Center for Wildlife Information, the program shares publications and other information to help keep bears wild. Finally, a recently-tested educational program is NeighBEARhood Watch in New York state. This program launched a community wide education campaign and measured its effectiveness; its results are illuminating with respect to the challenges of community education (Gore and Knuth 2006).

Education and communication campaigns require persistence, flexibility, and creativity. In the long run, however, they are an important foundation of any successful effort to maintain healthy, natural black bear populations in proximity to human development and activity.

In order for education campaigns to work well, managers need to be able to point to easy, effective, and reliable means for people to take action. This generally means being able to tell the public exactly how they can secure their food and garbage.

Securing anthropogenic food

In order for education campaigns to work well, managers need to be able to point to easy, effective, and reliable means for people to take action. This generally means being able to tell the public exactly how they can secure their food and garbage. The best solutions vary by location and local circumstances, as well as by available resources. However, in communities, this generally means providing bear-resistant dumpsters and garbage facilities. To achieve this often requires creativity; one example is provided by a not-for-profit in the Adirondacks. The organization is located in a community where bear encounters are consistently high. As a way to bring attention to the issue of feeding wildlife, the organization bought bear-resistant residential garbage cans and sold them to community members as a fundraiser.

In backcountry settings, making mechanisms for securing food accessible may mean making bear-resistant canisters available, or providing lockers, poles, or other forms of bear-resistant food storage and trash containers.

Whatever type of infrastructure works for your locale, it is absolutely critical for the public to be able to avoid conflicts. These facilities need to be well-placed in accessible locations and at areas of foreseeable conflict, and also need to be easy to operate. The public needs to be able to find them, which may require publishing their locations in different forms or providing maps. They also need to be serviced and repaired to remain an effective part of a human-bear management program.

In our experience, local networks can make the provision of this infrastructure possible. For example, in the Adirondacks, local retail shops are an important partner in our effort to distribute bear-resistant food canisters to backpackers. This example demonstrates how an opportunity for local participation can provide a win-win situation; it is benefiting the shops, the backpackers, and the wildlife managers. In the Lake Tahoe region, homeowner's associations have been an important partner in the effort to make bear-resistant dumpsters available and have played an important role in promoting the dumpsters.

National Park Service

Food storage lockers are an appropriate solution to encourage proper food storage behavior at Yosemite campsites.

Too often, this infrastructure is put in place only after a problem has developed locally. It would be much more effective if managers would anticipate potential problems and be proactive. For example, if the Lake Tahoe Basin would have been proactive concerning human – black bear interactions (*i.e.* already had bear-resistance garbage dumpsters in place), the drought of the late 1980s would likely not have resulted in the shift to a reliance on garbage by bears of western Nevada.

Too often, this infrastructure is put in place only after a problem has developed locally. It would be much more effective if managers would anticipate potential problems and be proactive.

Regulation and enforcement

Unfortunately, education alone is not always sufficient to ensure that everyone takes advantage of opportunities to secure their food and garbage. Law enforcement is also a critical element. Strong regulations regarding the proper storage of bear attractants and subsequent citations and fines are required for the inevitable non-compliers and hard-core deviants. Citations and fines have been demonstrated to be effective tools in providing human-bear conflict messages where other messaging techniques have failed to change the behavior of non-compliers. They also serve an effective threat for people to consider in their decision whether or not to follow bear-related regulations, particularly in areas where people see human-bear conflicts as serious but unlikely. Replacing the unlikely threat of a human-bear conflict with the likely threat of a citation or fine can motivate people to follow regulations.

A number of regulations requiring the public to secure their food and garbage exist. In the Adirondack case study, we discussed the local regulation requiring backpackers in one high-use area to use bear canisters. We also discussed various compliance measures at Philmont Scout Camp, including the idea that campers who violate wildlife feeding regulations are required to undertake a wildlife conservation project in their home town before they are allowed to participate in another trip at the camp. The most effective management strategies in the Lake Tahoe Basin were public education efforts coupled with ordinances

and laws requiring bear-resistant garbage dumpsters. In Douglas County, Nevada, for example, several homeowner associations and private businesses purchased bear-resistant dumpsters proactively after education efforts were instituted and before the new ordinance went into effect.

Of course, the key to effective regulations and ordinances is enforcement. Having one without the other will render this an ineffective management tool to reduce conflicts. At times, it is necessary for managers to engage in a targeted education campaign directed at those with the power to enforce regulations. They must understand the rationale and significance of the regulation and be willing to enforce it. This includes on-the-ground personnel such as police, conservation officers and forest rangers as well as judges who must decide on appropriate penalties.

Education, infrastructure and enforced regulations must often be used in concert, but they can yield great success when used cumulatively. From our long-term dataset with collared bears in the Lake Tahoe Basin, we documented on multiple occasions that once entire home owner associations and neighborhoods installed bear-resistant garbage containers that bears ended up leaving those areas for regions that were not 'bear-proofed'. Education was seen as the long-term strategy to have the public vested in keeping bears of the Lake Tahoe Basin wild and developing a conservation ethic, while ordinances reduced the problem in the short-term by having a negative consequence for those who needed a bit more prodding. The provision of bear-resistant garbage containers at private residences, businesses, and public lands was the single most effective management tool for reducing conflicts between bears and people in our study site. We have had similar observations in the Adirondacks, Yosemite and New Mexico.

Land use decisions

As we have noted, across North America human communities are spreading out and moving into regions that were once wild. This is resulting in a landscape where human-wildlife conflict is more predictable, and where it is less likely that black bears and other species will exist in a completely natural environment. At the same time, an increase in backcountry recreation over the past few decades has created similar phenomena even in our parks and protected areas. Much of the discussion above accepts this trend and provides managers with tools to cope with it. However, we would be remiss if we did not point out that there are opportunities for us to rethink our approach to land use and the use of our backcountry areas such that we can avoid these challenges in the first place.

Those who care about the conservation of wildlife can be an important voice in decisions about land use, and can bring the impacts of a proposal or policy on wildlife into the decision-making process. There is a growing body of literature on the relationship between land use decisions and human-wildlife interactions (Glennon and Kretser 2005, Baron 1994, Wolch et al. 1995, Kretser et al. unpublished data) and we will not try to synthesize or duplicate its messages here. Suffice it to say that land use planning and management of our backcountry areas defines the arena in which we work, and anyone who wants to

maximize his or her ability to minimize human-wildlife conflict would be well served to think first about whether there are opportunities for new or different approaches in terms of how we shape our landscape.

Wildlife managers also have an important ability to think about land use decisions on a local scale to minimize human – wildlife conflict. In our New Mexico work, we noted that at Philmont, camp sites have been located away from the forest edge to reduce the chance that bears would be walking among tents. On the other hand, managers may need to recognize that historical local land use decisions have exacerbated conflict, such as the example noted in Yosemite, where the location of a parking lot in an existing apple orchard brought bears and humans together and contributed to conflict.

Strategies to manage existing conflict problems

Where steps to prevent a bear-human conflict problem have been unsuccessful, there is often a need to manage and control an existing problem. Options for this are discussed below. As this discussion suggests, however, the efficacy of many of these options is limited, they often need to be used in combination to achieve some level of success, and none of these strategies will remove the underlying problem. It is imperative that managers recognize the limitations of these strategies. Some of them, though, can indirectly create opportunities for managers and the public to address the anthropogenic food issues that are at the root of conflict problems.

Where steps to prevent a bear-human conflict problem have been unsuccessful, there is often a need to manage and control an existing problem. However, the efficacy of many of these options is limited, they often need to be used in combination to achieve some level of success, and none of these strategies will remove the underlying problem.

Unlike the management strategies in the section above, most of the management options available for minimizing conflict involve attempting to manipulate the "nuisance" bears themselves – either through behavior conditioning, translocation, or lethal measures.

Before embarking on a program of non-lethal deterrence (behavior conditioning or translocation) it is critical for wildlife managers to define their desired outcome, and to compare this to what is realistically possible. For example, is the goal to eliminate bear conflict through a program of deterrence alone? To permanently relocate a nuisance bear? Or to buy some time in order to get the problem of anthropogenic food sources under control?

The Nevada case study demonstrates that both deterrents and translocation are ineffective in dealing with 'nuisance' black bears in urban settings; 92% of the bears given deterrents quickly returned to the same locations where they had previously been causing problems, and, similarly, all translocated bears also returned. Similarly, in our work in New Mexico all of the adult bears who were translocated (with distances ranging from 26-84 km) returned to the original location, and appeared to begin return movements immediately following translocation. Thus we believe that for adult male bears and female bears of any age (i.e. those that have established a home range), a desire to permanently move a bear through translocation is largely unrealistic. However, a desire to permanently move a subadult male bear may be realistic, if the translocation site provides suitable habitat and lacks other sources of anthropogenic food. In our New Mexico research we found that subadult males were the only demographic group in which translocation was a successful and long-term solution.

Although we feel that translocation is not in most instances a long-term solution on its own, we do feel that it can be coupled with other corrective actions (i.e. removing anthropogenic food sources) and provide the time necessary to implement these actions. In the New Mexico study, homing movements took from 1 day to nearly a year, depending on distance and timing. Among females and adult males, none of the bears resumed nuisance behavior immediately and only 43% were known to resume nuisance anytime before the end of the study. The time provided by translocation allowed managers to address the human food situation.

When an agency discusses translocation as a management tool, we recommend that several factors need to be considered: 1) translocation of subadults is more likely to have a higher success rate than for adults (generally a 100% return rate); 2) females likely should not be translocated, especially if they have cubs, because of a higher likelihood of road mortality seen in relocated bears in the Lake Tahoe Basin (Beckmann and Lackey, 2004); and 3) most importantly, translocation should only be used in conjunction with other corrective measures. As shown above, translocation was successful in the New Mexico study because it was accompanied by corrective actions. In contrast, the use of deterrents in the Lake Tahoe study was compromised by the widespread availability of anthropogenic foods and the inability of agencies to take more meaningful corrective measures.

Our evidence demonstrates that both translocation and non-lethal deterrents have limited efficacy and are not one-size-fits all solutions. At best, they may be a short-term solution to mitigating conflict behavior between black bears and people.

Our evidence demonstrates that both translocation and non-lethal deterrents have limited efficacy and are not one-size-fits all solutions. At best, they may be a short-term solution to mitigating conflict behavior between black bears and people. However, one advantage that both management options may offer is that they may provide enough time lapse before bears return and/or reestablish problem behaviors for regional managers or communities to resolve the underlying cause of the problem (*e.g.* installation of bear-resistant garbage containers, removal of BBQs or birdfeeders, etc).

In addition to the benefit of buying time for areas to correct underlying causes, non-lethal deterrents, and perhaps relocation as well, have one other major benefit that at times can be hard to quantify. This benefit is the establishment of positive public relations, and in this goal the use of deterrents may be an effective management tool. Due to the implementation of non-lethal deterrent strategies, the Nevada Department of Wildlife experienced far fewer negative responses from the local media and public in the Lake Tahoe Basin, especially in the rare instances when a bear was lethally removed by the agency, compared to the 5-year time period before these techniques were in use in their management of bears (C. Healy, Nevada Department of Wildlife, personal communication).

This public support garnered through the use of non-lethal deterrents may have the added benefit of increasing public awareness of human-bear conflicts that are created through the availability of urban food sources in the form of garbage. For example, two homeowner associations and a private campground at the south shore of Lake Tahoe spent a combined $100,000 on 350 bear-proof garbage containers in response to the use of non-lethal deterrents on bears in Nevada (M. Paulson, Tahoe Village Homeowners Association, personal communication).

Although non-lethal management is more publicly acceptable, the development of aggressive bears and the limitations of non-lethal tools often drive managers to consider lethal removal of "problem" bears in particular areas, either directly or through targeted hunting initiatives such as new hunting units, seasons, and/or quotas. Our research suggests that even lethal management techniques may not, on a population level, result in a decrease in bear-human conflict, when the lethal controls are undertaken without a full understanding of the dynamics of the bear population in question or without corrective measures to reduce availability of anthropogenic foods.

In many cases it is assumed that an increase in the number of conflicts between black bears and humans is automatically due to an increasing bear population. In some cases, it is indeed true that black bear populations are increasing with the end result being more conflicts. However, in other cases increasing conflicts between bears and people may have nothing to do with an increasing bear population. In our research in western Nevada for example, an over 1500% increase in the number of annual complaints about bears over a 10-year period was not due to an increasing bear population, but was instead due to a redistribution of bears on the landscape because of a novel food resource (garbage) in the system (see Beckmann and Berger 2003 and Nevada case study this volume). Similarly, increases in bear-human conflict statewide were more closely associated with human population growth than bear population growth in New Mexico (Costello, unpublished data).

This distinction sheds light on one of the problems with adopting new hunting opportunities as a solution to conflict; for example, because of the urban nature of some of the bears in the Lake Tahoe basin, hunting in this region is likely not an effective management option to reduce conflicts. Because of the population dynamics at work here (and the large amount of time that many bears spend in urban environments), an increase in hunting would likely only remove wildland bears and not the portion of the bear population responsible for the conflicts. In addition, in our research we observed that when bears were removed from urban areas, new bears sometimes moved in to fill vacated home ranges within short periods of time. This suggests that hunting would be even less effective at reducing conflict, since the removal of a particular bear in a conflict situation could likely just lead to a substitution of another.

Similarly, in our work in New Mexico, we found that bears were most often destroyed because they were considered a threat to human safety. Mortality from these causes accounted for 14-100% of all documented mortality among demographic categories, and evidence indicates the combined mortality from hunting, nuisance, and depredation may reduce population growth, especially in human-populated areas (Costello et al. 2001). Following our study, the New Mexico Department of Fish and Game imposed harvest limits for each region of bear habitat in New Mexico, and recognizing the potential impact of nuisance and depredation mortality on bear populations, elected to count these mortalities against the harvest limit.

These examples highlight the importance of an understanding of population dynamics in a region before deciding on a management strategy to deal with conflict behavior in bears. Because of examples such as these, we recommend that before managers adopt new hunting quotas, seasons, or units aimed at reducing bear-human conflicts, they should rigorously address questions concerning population dynamics through field studies at the site and the collection of strong, empirical data. Of course in some scenarios, hunting is likely an effective management option to reduce conflicts, but empirical data are a prerequisite to understanding if this would indeed be the case.

Managers should carefully consider the existing situation, the goals of the policy being considered, the dynamics of the resident bear population, and the strategies in place to reduce the underlying cause of the conflict before arriving at a decision about the best mechanism to mitigate existing bear-human conflict.

In comparison with generalized hunting policies, direct destruction of heavily habituated bears can be a critical component of a management strategy. Our work in Yosemite shows that a reluctance on the part of managers to destroy incorrigible bears can hinder a management program. These types of individuals are generally not good candidates for other management intervention, and their ongoing presence can stymie other progress. Removal of these individuals can help managers and the public achieve tangible progress against bear problems, and increase the public's willingness to take necessary actions.

In summary, both non-lethal and lethal control measures provide mechanisms for deterring bears from conflict and removing aggressive bears. The research and examples cited above, however, suggest that most of these reactions are likely to have limited success in genuinely making the problem go away, particularly in areas with a truly habituated bear population dependent on human foods. Managers should carefully consider the existing situation, the goals of the policy being considered, the dynamics of the resident bear population, and the strategies in place to reduce the underlying cause of the conflict before arriving at a decision about the best mechanism to mitigate existing bear-human conflict. When these strategies are implemented, they should be paired with techniques cited in the preceding section for addressing the availability of human foods.

Comprehensive Management of Bear – Human Conflict: The Elements of Success

As the preceding sections and examples illustrate, successful management of human-bear interactions involves a combination of strategies. These include, first and foremost, effectively managing the public to reduce the availability of attractants (and thus avoiding the creation of bear-human conflict to the greatest extent possible) and, when needed, managing bear populations through monitoring, the use of non-lethal deterrents, and the destruction of aggressive bears. In order to be proactive in addressing these needs and weighing the variety of management options, managers should develop a comprehensive human-bear management plan that includes data on local bear populations, surrounding habitat and travel corridors, potential bear conflict "hot-spots", public education, bear-resistant food storage and waste containers, law enforcement options, non-lethal and lethal bear-control measures, reporting opportunities, and monitoring programs. The plan then serves as a guide for on-the-ground management actions and a communications tool for the public and other managers.

Many models of comprehensive management plans exist; the system used on Philmont Scout Ranch , Mew Mexico is just one of many, including Yellowstone National Park (Leopold et al. 1969, Meagher and Phillips 1983, Gunther and Hoekstra 1998) and British Columbia's Bear Smart Community Program. The adoption of best practices from existing plans can aid in the formidable task of drafting a comprehensive plan. However, as the discussion above regarding hunting illustrates, successful planning requires a data-based understanding of the local situation. Planning for bear management cannot, therefore, be a one-size-fits-all solution.

J.L. Maher/WCS

To effectively change human behavior, managers need to consider their users and embrace a variety of techniques and strategies to reach out to them.

Implementing a human-bear management program incorporating each of these elements requires significant time and capital investments. Recognizing that managers may not have the resources to implement all elements of a comprehensive plan at once, a comprehensive plan should be drafted and can be implemented as resources become available.

Evidence clearly demonstrates that bear-proofing works. What is often missing is the willingness to formulate a strategy and make the necessary changes to current practices. In many ways, the unique life history of bears shapes our response to the problem. At the height of bear problems during the summer and early fall months, people are often engaged in the issue and cry out for a solution (particularly targeted toward the wildlife management agency). But then fall passes, winter hibernation arrives, and the problems disappear. All too often, the willingness to engage in a debate about the solution disappears as well. What is needed is a sustained dialogue between agencies, lawmakers, and the public to formulate a comprehensive plan to reduce the availability of anthropogenic food to bears and to agree on management strategies. Although initial costs may be high, it is probable that comprehensive programs will be quite cost-effective in the long-term. As Ben Franklin wisely put it, "an ounce of prevention is worth a pound of cure."

What is needed is a sustained dialogue between agencies, lawmakers, and the public to formulate a comprehensive plan to reduce the availability of anthropogenic food to bears and to agree on management strategies.

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