

Nature based non-consumptive recreation and the American black bear:

A review

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Introduction

Prior to European colonization of North America, the range of the American black bear (*Ursus americanus*) included every state in the continental United States as well as Alaska (Lackey et al. 2013, Scheick and McCown 2014). By the late 1800s, overexploitation and habitat loss led to the extirpation of black bears from a large portion of this range (Scheick and McCown 2014). Changes in conservation laws and reforestation allowed for the black bear population to rebound and disperse widely, currently occupying between 45-60% of its historic range within the United States (Southwick 2007, Scheick and McCown 2014).

At the same time black bear populations have increased, the number of people participating in non-consumptive nature-based recreation has increased (Balmford et al. 2009). Nature-based recreation has grown every decade since the 1950s (Fortin et al. 2016). The National Park Service reported an increase in recreation visitors from 281 million in 2010 to 330 million in 2017 (National Park Service 2018). The field of recreation ecology, the study of environmental consequences of nature-based tourism and outdoor recreation as well as its management, is of emerging importance as the number of recreational users continues to rise (Monz et al. 2013). Recent research explores a variety of effects from these forms of recreation, including effects on vegetation (Pickering et al. 2007; Pickering et al. 2010), soil (Pickering et al. 2010), and wildlife.

Wildlife managers and park managers need an understanding of the interactions between bears and recreational users of natural areas, especially as bear populations and recreational use continue to rise. Managing human-black bear interactions is for the safety of the people as much as the bears. Though the number of black bear attacks is low, a correlation exists between the increase in human activity outdoors and large carnivore attacks, including attacks by black bears (Penteriana et al. 2016). Though a variety of existing literature reviews have examined the effects of non-consumptive recreation on wildlife (Ardiantiono et al. 2018, Boyle and Samson 1985, Ciuti et al. 2012, Fortin et al. 2016, Graeme et al. 2017, Steven et al. 2011), no such review exists for black bears. This review seeks to fill that gap and offer recommendations for managing interactions between black bears and recreating humans.

Methods

Using the Google Scholar and the North Carolina State University Library system databases, I reviewed and summarized articles relating to black bears and nature-based recreation. I included articles identified incidentally, typically through citations in previously acquired literature. Sources included peer-reviewed articles, reports, conference presentations, and one unpublished thesis. Search terms were black bears, bears, hiking, backpacking, food, skiing, snowmobiling, winter recreation, camping, campground, watching, kayaking, canoeing, unmanned aerial vehicles, horseback riding, bicycling, outdoor recreation, and non-consumptive recreation. I did not include hunting and fishing articles to maintain a non-consumptive recreation focus.

Research was read when initially found during searches. Each literature piece was tagged with keywords related to the subject, location, and results of the studies. This generated a large list of keywords which were used to create the 6 main groups of literature: Food, Campgrounds, Hiking/Backpacking, Winter Recreation, Drones, and Management Actions. Management Actions is further broken down into Black Bear Management and Human Management. Summaries of the literature are given in the results.

The initial focus of this review was to on effects to black bears such as biological effects, space use, and denning effects. This research is currently limited. As such, this review shifted to a general review of human and black bear interactions as they relate to nature based recreation, with a focus on nuisance bear creation and management.

Results

Thirty-six research articles were identified for use in this review. These articles all related to black bears and a form of non-consumptive recreation. Article publication dates ranged from 1970-2019. 13 articles involved human food use and black bears. Literature came from 16 different peer-reviewed publication, one conference presentation, and a thesis (Table 1). Ursus was the most common publication.

Table 1: Publication and number of articles within this review

Publication	# of Articles
Ursus	10
Bears: Their Biology and Management	5
Journal of Mammalogy	3
Journal of Wildlife Management	2
Conservation Physiology	1
Journal of Applied Ecology	1
Current Biology	1
International Bear News	1
Landscape and Urban Planning	1
Biological Conservation	1
Frontiers in Ecology and the Environment	1
Scientific Reports	1
Wildlife Society Bulletin	1
Human-Wildlife Interactions	1
Journal of Ecotourism	1

Sixteen of the articles used National Parks as their study area. Yosemite was the most commonly used (Table 2).

Table 2: National Park study areas.

National Park	# of Studies
Yosemite National Park	5
Great Smokey Mountain National Park	3
Yellowstone National Park	1
Glacier National Park	1
Big Bend National Park	1
Grand Teton National Park	1
Kenai Fjords National Park	1
Denali National Park	1
Shenandoah National Park	1
Multiple National Parks	1

Food

Black bear conditioning to human food sources has long been a management issue for wildlife managers and park managers alike (Rogers 2011, Hopkins et al. 2014). While only 63 fatal black bear attacks on humans were reported in North America between 1900 and 2009, food/garbage played a role in 38% of those attacks (Herrero et al. 2011). Black bears that become habituated to human food and lose their fear of humans are often deemed “nuisance” animals. Nuisance bears are managed with a variety of techniques, but occasionally bears pose a big enough safety risk to warrant lethal removal from the population (Singer and Bratton 1977).

Evidence of human food use by black bears spans the literature from the 1970’s to today. In areas without proper management, Beeman (1971) found garbage in scat of black bears primarily in camping and picnicking areas. Similarly, Singer and Bratton (1977) found that black bear-human conflict occurred at the most heavily used backpacking sites in their study, with improper food storage at the sites being a major factor. While some black bears learn to use anthropogenic food sources independently, many learn the skill from their mothers, passing down the effects generationally (Hopkins 2013). In Yosemite, where black bear feeding for wildlife viewing was once part of the park programming, researchers analyzed human food consumption by bears over the last century. Findings indicated that even after closing feeding areas, bears still maintained a high level of foraging on human foods. No substantial decrease in this behavior occurred until the park began an intensive program for black bear management, including adding food storage containers, educational programming, and extensive hazing of bears (Hopkins et al. 2014).

A 2008 survey of Yosemite backpackers found that while 87% reported carrying a bear proof food canister, only 62% were fully compliant with their food storage. Only 18% of users used legal alternatives to the canisters when they did not have enough space, and some even resorted to leaving food in their tents (Martin and McCurdy 2009). Other research indicates the correct usage of bear resistant food containers in the backcountry and bear resistant garbage cans in the front country correlates with a decrease in human-black bear incidents (Schirokauer and Boyd 2005). When human food sources are controlled, bears will still use areas with human features if natural forage is available in proximity (Onorato et al. 2003).

Campgrounds

Campgrounds offer a specific source of human food and waste to black bears. In Yosemite National Park, bears broke into minivans at a higher rate than other vehicles. As minivans are typically used by families with small children, it may be harder to remove attractants from within the vehicle. Researchers noted that anecdotal evidence indicated the apparent selection for minivans may have been from a small subset of individual bears that had learned to associate minivans specifically with food sources (Breck, Lance, and Seher 2009). Backcountry campground avoidance or use varied depending on location. In Kenai Fjords National Park, black bears avoided campsites with higher human usage but were drawn to campsites with lower use. Researchers believed the behavior could be due to wariness from negative human interactions (Smith et al. 2012). Conversely, in Glacier National Park more black bear incidences were reported in backcountry campgrounds where larger parties were allowed. Due to the higher use, these areas had a greater buildup of attractants. Additionally, areas that allow fires saw more incidences than areas permitting only stoves. Areas with fire frequently had half-burnt attractants left behind (Merrill 1978).

Hiking/Backpacking

In addition to the changes in black bear behavior from food sources provided by hikers, bear behavior and land use changes in relation to hikers and hiking infrastructure. Bears avoid high use hiking trails and the areas around them (Kays et al. 2017). The distance of avoidance varies between 0-122 meters in spring and 0-305 meters in the fall (Kasworm and Manley 1990). When denning, bears selected areas farther away from gravel roads than paved roads. Researchers hypothesized this was due to the unpredictable human use from the gravel roads as they offered hiking trail access (Reynolds-Hogland et al. 2007). In 2008, Grand Teton National Park constructed a paved non-motorized pathway. Bear use shifted in response to the path. Home range size and overall usage of the corridor did not change; however, the way bears used the corridor did. Bears chose areas with greater slope which led to more energetic output. Bear activity decreased during midday when the path was more frequently used by humans and bear usage increased during the morning, evening, and at dark. This alteration decreased the potential for human interaction but increased the potential for encounters during low-light periods, increasing the likelihood of the interaction being negative (Costello et al. 2013).

An often-overlooked effect from hiking is from outdoor recreationists with companion dogs, which contribute to black bear and other large carnivore attacks (Penteriana et al. 2016). Of the 92 black bear attacks on humans reported between 2010-2014, 53% involved dogs. In most of these cases, it appeared that dogs were off leash and drew the bear to the owner. Researchers believe black bears respond to dogs as a competitive threat, and attacks on dogs can result in attacks on humans in their proximity (Hristienko and Herrero 2014).

Winter Recreation

Winter recreation has the potential to effect denning and successful cub rearing. Manville (1980) reported that bears selected denning sites within 100 meters of active snowmobile trails. Human disturbance from the proximity of black bear dens to snowmobile trails has been found to lead to den abandonment and cub mortality (Manville 1987, Elowe and Dodge 1989). Skiing

may also lead to den abandonment. Bears in the Sierra selected areas with snow cover and slopes that were also preferred ski run areas. Anecdotal evidence reported that bears in those areas were abandoning dens as they were reported on ski runs before collared bears from the study began leaving dens (Goodrich and Berger 1994).

Drones

Unmanned aerial vehicles (i.e. drones) are increasingly available to the public as well as researchers. Ditmer et al. (2015) reported that free ranging black bears, including those in dens, had a physiological response to unmanned aerial vehicles (UAVs) in the form of increased heart rate, but did not exhibit a behavioral response. In later research, Ditmer et al. (2018) determined that captive bears initially exhibited a physiological response to UAVs but that they quickly habituated to them after several interactions. The decreased reaction to UAVs held true after stopping flights for 118 days. Researchers cautioned that this habituation to UAVs may lead to general habituation to human machines, potentially increasing human-black bear conflict.

Management Actions

Some parks have adopted new management strategies, leading to a decrease in effects of recreation on black bears, particularly regarding use of human food and direct interactions with humans. These parks have used a combination of black bear management and user management to reach their goals (Spencer et al. 2007, Hopkins et al. 2014, Garshelis et al. 2017).

Black Bear Management

Aversive conditioning of bears, typically through shooting bears with rubber buckshot and rubber slugs, pepper spray, and chasing with dogs, is a common form of black bear management (Schirokauer and Boyd 1995). As part of their hazing program, Yosemite National Park tested an alert system for previously captured nuisance bears. These bears were fitted with a radio collar upon initial capture. The alert system scanned for related frequencies as bears entered areas deemed off-limits, such as campgrounds. If a frequency was detected, the alert system would send out an automated message through established radio channels. The alert system led to an increase in park staff finding bears within off limits areas and increased subsequent hazing (Breck et al. 2007).

Rarely utilized in the United States and North America, diversionary feeding can be used to keep animals away from areas of potential conflict (Garshelis et al. 2017). Rogers (2011) placed an experimental diversionary feeding site outside of a U.S. Forest Service campground and residential site near Ely, Minnesota. Diversionary feeding took place for 8 years. The campground did not have any educational programs or other bear safety measures such as installation of bear safe garbage cans during the study period. Nuisance complaints decreased compared to pre-diversionary feeding years and other areas of the state. No bears that used the feeding site became nuisance animals. The bears on the periphery of the study area did not encounter the feeding site were the only ones removed as nuisance animals during the study period.

User Management

Black bear-human interactions are also managed through attempts at managing the outdoor recreationist and their activities. Common forms of people management cited in the literature were educational campaigns (Gunther and Hoekstra 1995, Schirokauer and Boyd 1995, Creachbaum et al. 1998, Greenleaf et al. 2009), installation of bear resistant garbage cans (Vaughan et al. 1989, Creachbaum et al. 1998, Greenleaf et al. 2009), requiring bear resistant containers for backpackers, prohibiting overnight storage of food in vehicles, and increased enforcement of regulations (Vaughan et al. 1989, Gunther and Hoekstra 1995, Greenleaf et al. 2009).

Risk perception of outdoor recreationists should be evaluated and made part of the educational programs. In a survey of Adirondack campers, Gore et al. (2007) found that 90% of campers had interactions with bears, but 78% perceived no risk. Campers returned to campgrounds specifically to see bears, and managers perceived campers as deliberately choosing to interact with bears. These results suggest more communication needs to happen between managers and campers to help understand risk and supports the need for a combination of management tools including food lockers and bear safe garbage receptacles. Surveys also indicate that encouraging visitors' ideas that black bears should be wild may impact outdoor users' willingness to follow regulations and suggest that researchers should not tag bears ears obviously (Martin and McCurdy 2009).

Recommendations and Conclusion

The original purpose of this literature review was to summarize the current research regarding the effects of non-consumptive recreation on black bears. This summary was meant to help minimize any negative effects. The research on direct effects to black bears from this recreation is limited. While there are some studies into direct effects to black bears themselves, much research emphasis has been placed on the creation and management of nuisance bears. More research should be completed in the future into direct effects on black bears, such as changes in landscape use or den abandonment. Given the research currently available, the following management recommendations have been developed to respond to the previously summarized literature.

Park managers must manage the effects of non-consumptive outdoor recreation from two fronts: managing black bears and managing the outdoor recreationists themselves. Educational efforts are a key portion of this management, but education alone rarely leads to behavioral changes (Dietsch et al. 2017). Black bear education campaigns should analyze their effectiveness using more indicators than just number of black bear complaints, as is often the case. Evaluation should focus on actual human behavioral changes rather than simply message delivery. Gore et al. (2006) suggest evaluating programs using a broad suite of variables including black bear harvest, food availability, management, habitat, human dimensions variables, weather, and ecology. Education programs should also include the appropriate way to respond to a black bear and a black bear attack if one should occur. Encouraging bear spray for hikers decreases chances of fatality as well (Herrero et al. 2011). In addition to education, proactive enforcement of rules and regulations will increase management success (Baruch-Murdo et al. 2007).

Black bear management can be facilitated through aversive conditioning (Schirokauer and Boyd 1995). Mazur (2010) determined that bears that were not already food conditioned were kept that way through aversive conditioning. The conditioning was less successful for bears already food conditioned, though impacts were greater when the conditioning happened immediately after obtaining food. Other research indicated aversive conditioning may only serve as a short-term strategy and alteration of bear behavior does not last over a period greater than a month (Bechman et al. 2004). Researchers noted, however, the outcomes did vary by individual.

New campground facilities offer an opportunity for proactive design. A campground was designed in the Shoshone National Forest to limit human and grizzly bear (*Ursos arctos horribilis*) interactions and the same parameters can be applied for black bears (Figure 1). Bear use areas were identified and buffer zones were created to allow bear movement without human interactions. The most vulnerable camping setup, the tent use area, was located farthest away from the bear use zones. A community area was incorporated into the layout where food use, picnicking, and most garbage collection was consolidated. Interpretive signage was geared toward bear biology, and suggestions for camper behavior was specifically related to the bear information provided (Creachbaum et al. 1998).

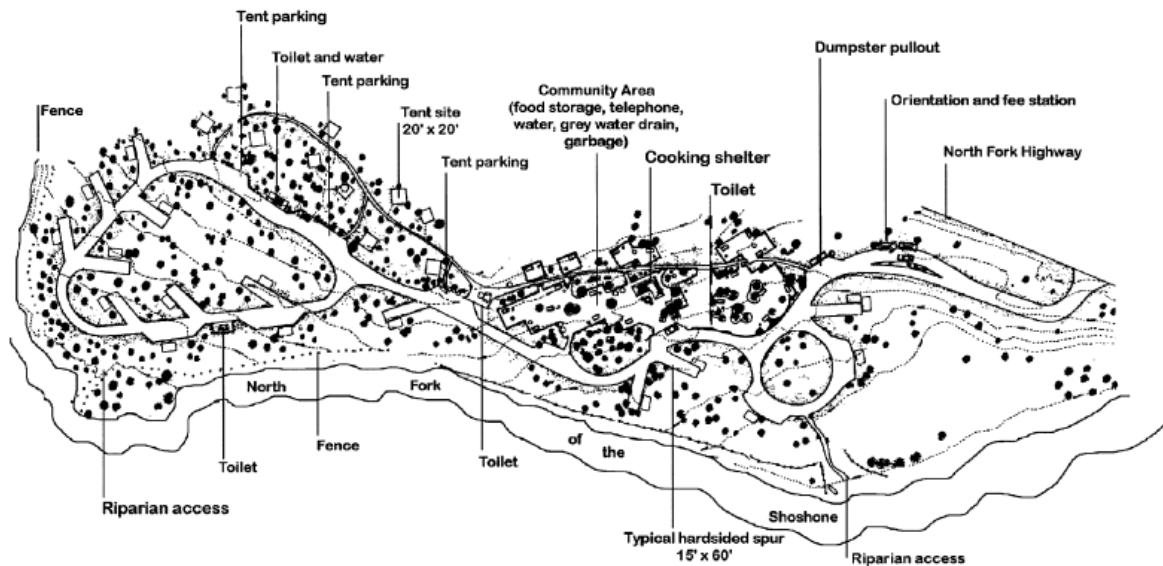


Figure 1: Three Mile Site development concept for Shoshone National Forest (Creachbaum et al. 1998)

In response to winter recreation, areas known for denning should be preserved as critical habitat (Manville 1980, Manville 1987). When establishing new paths, consideration should be given to black bear travel corridors (Costello et al. 2003). Areas of natural forage should be avoided (Onorato et al. 2003).

Diversionsary feeding, while controversial, has potential to effect black bears in a positive way while decreasing nuisance complaints. Bear baiting stations lead to larger bear size and increased bear densities, even in areas with low quality bear habitat (Masse et al. 2014). If this tactic is used, stations should be located >11.5km away from areas where human-black bear

interactions should be limited (i.e. cabins, recreation sites, etc.) (Masse et al. 2014). Variability in the methods and results of case studies indicate this is a management option that needs more research before it is accepted as standard management practice (Garshelis et al. 2017).

Further research, focusing on education and informed by human behavioral theories, needs to be completed to better understand and manage effects from outdoor recreation. This future research can help inform management techniques and develop more impactful educational initiatives. Managers, researchers, and educators should incorporate new technology such as social media into their current programs. Management must be adaptive and frequently assess results based on set goals. By using a combination of management techniques, effects from outdoor recreation on black bears can be minimized.

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