Wilderness Food Storage

Are Bear-resistant Food Storage Canisters Effective?

BY STEVEN R. MARTIN and KATE McCURDY

Abstract: By way of three visitor surveys, we evaluated the effectiveness of visitor use of food storage canisters in deterring bear-human interactions in Yosemite National Park. We found that although 87% of respondents reported using a canister on their trip, only 62% reported full compliance by fitting all their food, trash, and toiletries into their canisters on every night of the trip. The main issues are overflow and inadvertently leaving items sitting out or in packs or tents, which led to incidents in which bears obtained food. The overflow issue is largely due to backpackers not realizing how much space their food will take up, or conversely underestimating the actual capacity of a food storage canister. Although the rate of carrying canisters is high, the actual rate of full compliance with food storage regulations is much lower. Bear-human conflicts are likely to continue as long as ineffective canister use and practices such as hanging, hiding or guarding food continue, even at low levels, especially in highly visited backcountry sites.

Introduction

Conflict between backpackers and black bears in the Sierra Nevada Mountains of central California is a serious threat to visitors and a serious problem for managers seeking to protect naturally functioning wilderness ecosystems (Graber 1981). Given the region's widespread popularity as a seasonal recreation site for wilderness enthusiasts, bear-human risks must be mitigated. Past studies in popular wilderness areas indicate that as visitor densities increase, reported bear incidents increase linearly (Merrill 1978; Singer and Bratton 1980; Keay and van Wagtendonk 1983). Approximately 100 wilderness bear incidents are reported in Yosemite annually, although the number of incidents that actually occur is thought to be much higher (Graber 1981; McCurdy 2006).

Significant negative impacts to wildlife can occur as a result of human-wildlife interactions, particularly those involving the availability of human-provided food, including alteration of wildlife behavior, nutrition, habitat use, dependency, and foraging ability (Hammitt and Cole 1998; Orams 2002; Marion et al. 2008). In evaluating methods to keep bears from obtaining human food in the Yosemite wilderness, options such as installing poles or cables to facilitate food hanging, or installing metal food lockers, were ultimately rejected because they were determined to be ineffective, an inappropriate installation in wilderness, high maintenance, a source of visitor conflict, and because they concentrated use and impacts in undesirable ways or places, sometimes leading to more habituated bears (Fincher 2009).

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While studying the interactions of bears and humans in the Yosemite wilderness, Graber (1985) and Dalle-Molle et al. (1985) offered an innovative strategy to alleviate bear-human conflict: a bear-resistant food canister that could be carried by backpackers. Although a novel idea in the 1980s, canisters have gradually supplanted the use of metal lockers,

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Figure 1—Improper food storage may habituate bears to humans and lead them to aggressively seek human food. Photo courtesy of Steven Martin and Kate McCurdy.

food hanging poles, and tree cables to become the preferred method of food storage for Sierra land managers (Koy and Anaya 2002). However, even with widespread and voluntary use of canisters, a sufficiently low level of food availability to discourage food-conditioning behavior in bears has not been realized, and incidents continue (National Park Service 2004). Van Wagtendonk (2003a) suggested that the establishment of a canister requirement in Yosemite National Park was needed to increase compliance to a level that adequately reduces the prevalence and severity of bear-human encounters.

Figure 2—Obtaining human food can negatively impact bear behavior, nutrition, habitat use, dependency, and foraging ability. Photo by Kate McCurdy.

In other regions of North America where black and grizzly bears exist, managers have enacted bear-resistant canister regulations to minimize backcountry human-bear conflict. Public lands where bear canisters are required include portions of the Inyo National Forest and Sequoia-Kings National Parks in southeastern California; Denali, Glacier Bay, and Gates of the Arctic National Parks in Alaska; Olympic National Park in Washington; the Lost Coast Wilderness in northern California; and some wilderness areas in the Adirondack State Park in New York. Other parks and forests in the western United States where bears are present encourage the use of canisters but do not require them. (See Mazur 2008 for additional discussion of the history and background of food storage canisters.)

Starting in April 2004, canister use was made mandatory in all Yosemite National Park wilderness areas within seven miles (11 km) of park roadways and anywhere above 9,500 feet (2,900 m) in elevation (based on the average tree line elevation in the Sierra Nevada Mountains). This regulatory action also removed the technique of counter-balancing food from tree limbs as a legal means of food storage where canisters are required. During the summer of 2005, we evaluated the effectiveness of this new regulation by asking backpackers how prepared they were to properly store food on their wilderness trips, and what food storage outcomes they experienced during their trip.

Methods

Yosemite National Park encompasses 747,956 acres (302,687 ha) on the western slope of the Sierra Nevada Mountains in central California. Elevations vary from 2,000 feet (600 m) on the western boundary to 13,000 feet (4,000 m) along the Sierra crest. The climate is Mediterranean with hot, dry summers and cool, moist winters. Plant distribution in Yosemite is strongly influenced by elevation and topography, with five major vegetation types largely dictating the seasonal distribution of black bears in the park (Graber 1985).

More than 94% of Yosemite National Park was officially designated as wilderness in 1984. There are 55 trailheads, with 695 miles (1,118 km) of trail providing access to 375 camping destinations in the Yosemite Wilderness (van Wagtendonk 2003b). The Yosemite Wilderness is bordered by the Emigrant Wilderness to the north, the Hoover Wilderness to the east, and the Ansel Adams Wilderness to the south. Two of the west's most popular hiking trails, the John Muir Trail and the Pacific Crest Trail, traverse the Yosemite Wilderness. Nearly 38,000 people spent more than 114,000 visitor-nights in the Yosemite Wilderness in 2008 (Watson 2009).

Three visitor surveys were administered within Yosemite National Park from May to October 2005. A first survey (19 questions) was given to visitors at randomly selected trailheads as they prepared to enter the wilderness. This survey focused on planned food storage methods and visitor preparedness relative to food storage. Of 501 groups contacted, 485 surveys were completed for a 97% response rate. A second longer survey was administered at randomly selected wilderness trailheads as groups exited the wilderness. This survey focused on actual food storage behaviors and outcomes, beliefs and attitudes toward bears and food storage, and group/trip characteristics. See Martin and McCurdy (2009) for survey questions and more comprehensive results. Of 924 contacted individuals, 360 questionnaires were completed by backpackers at trailheads, and 208 surveys were completed over the Internet at a later date. The overall response rate for the survey was 61%, with the response rate being similar when taken in person (62%) or with the Internet option (60%).

The third survey was administered at trailheads only to groups who reported having had a bear incident (defined as an attempt to open a food storage container, or an interaction that resulted in property damage, loss of food, trash or scented item, or personal injury). Of the 26 groups we contacted who reported such an incident, 23 (88%) completed a bear incident survey.

Results

The median age of the sample population was 36 years, with a range of 18 to 79 (minors were excluded from the survey). Respondents were primarily (63%) California residents, 28% were from other states, and 9% were foreign visitors. Fifty-nine percent had been on at least one previous wilderness trip in Yosemite National Park, and 49% planned their trip at least six months in advance. Of those with previous Yosemite wilderness experience, 57% reported having used canisters "always" or "most of the time," and 18% said bears had damaged property and/or obtained food from them. (Statistics drawn from the largest of our three surveys, the post-trip survey, n = 568.)

Pre-trip Survey

Of the 485 pre-trip survey respondents, 60% reported that they had been aware of the canister regulation changes for a year or more; 25% found out about the canister regulation when making their reservation more than one week, but less than one year in advance of their trip; 11% found out about the canister regulation when picking up their permit in the park (typically the day of or the day before the trip); and 4% reported being unaware of a canister requirement when contacted at the trailhead. Previous Yosemite trips (30%) and the Internet (30%) were the two most common sources of learning about the canister requirement, and 19% obtained their information from rangers or other park employees after arriving at Yosemite National Park. Only 5% of respondents reported that the canister requirement caused them to alter the schedule or route on their

Figure 3—When properly used, food storage canisters are an effective method of securing food from bears. Photo by Steven Martin.

Figure 4—Yosemite National Park maintains a large inventory of rental food storage canisters to facilitate proper food storage. Photo by Kate McCurdy.

trip (e.g., to choose a destination with a food storage locker to avoid carrying a canister).

Eighty-eight percent of respondents reported that their group was carrying one or more canisters on their trip (not all wilderness locations required a canister in 2005). Of the canister users, 72% reported that they would be able to achieve full compliance by fitting all their food, trash, and toiletries into their canisters on the first night of their trip; another 19% were unsure, and the remaining 8% knew that they would have excess (1% hadn't thought about it yet and couldn't answer). Of the 12% of groups not carrying a canister, nearly all planned to either use a food storage locker (63%) at one of the six wilderness locations where lockers are installed, or hang their food (30%), which, in 2005, was legal in remote portions of the wilderness. The remaining 7% admitted they would improperly store their food.

Canisters are extremely effective when used properly and conscientiously, but there is still room for human error.

The most common type of canister (69%) being used in Yosemite in 2005 was the Backpacker's Cache, commonly known as the Garcia (after the name of the manufacturer). Forty-seven percent of the canisters used in Yosemite in 2005 were rented from the park, which rents only Garcia Backpacker Cache canisters; 42% were personally owned; and the remaining 11% were borrowed or rented outside of Yosemite National Park.

The final five questions of the survey pertained to the food backpackers packed into their canisters. Sixteen percent of respondents bought their food within a day of their trip; an additional 55% bought their food within a week of their trip; and 28% bought their food more than a week prior to their trip. Fifteen percent did not pack their food into their canister(s) until the day of the trip, and 55% packed their canister(s) the day before the trip; the remainder packed their canister(s) two or more days prior to their trip. One group in three reported purchasing all of their food with canister capacity in mind, and an additional 21% purchased most of their food (80% to 90%) with canister capacity in mind. Forty percent reported repackaging most or all (between 70% and 100%) of their food to reduce bulk, and 79% said that all of their dinners consisted of dried or dehydrated food. Logistic regression was used to determine that backpackers who took measures to maximize the space in their canisters were more likely to fit all their food, trash, and toiletries in their canisters on every night of their trip (R^2 = 0.133, $F_{(2,424)}$ = 3.8, p < .05). Significant correlations were found between the number of canisters carried and both group size (r = .78) and trip length (r = .11), but not between the number of canisters carried and any of our three measures of canister packing effort (percentage of dried or dehydrated dinners, percentage of food purchased with canister capacity in mind, and percentage of items that were repackaged to reduce bulk). The number of person-nights per canister was calculated by multiplying group size by length of trip (number of nights) and dividing by the number of canisters being carried by the group. The median number of person-nights per canister was 4.0.

Post-trip Survey

Of the 568 respondents who completed the post-trip survey, 87% reported using a canister on their trip. Of canister users, 85% reported packing their canister(s) before leaving the trailhead to see if everything would fit, yet only 62% reported being able to achieve full compliance by fitting all their food, trash, and toiletries into their canisters on every night of the trip. Of those who could not fit everything into a canister on every night of the trip, 45% said they were able to fit all their food, toiletries, and trash by the second night of their trip, 35% by the third night, and 11% by the fourth night; 7% reported never being able to fit all their food-related items into a canister. We found a significant positive correlation (Spearman's rho = .153, sig.< 0.01) between number of person-nights per canister and the extent to which all food, trash, and scented items fit into the canister.

When queried about what was done with items that didn't fit in their canisters, respondents supplied a range of answers, only 19% of which (at most) represented legal alternatives to storing their food—12% reported using a food storage locker, 6% counterbalanced their food from a tree limb (a legal practice in 2005, but only if camped more than 7 miles [11.3 km] from a road), and 1% borrowed canister space from a neighbor. The remaining 81% of noncompliant canister users hung (but did not counterbalance) food, trash, or toiletries in a tree (27%), left food, trash, and/or toiletries sitting out (27%), buried, hid, suspended over a cliff, sunk underwater, or covered in rocks (15%), kept in tent (7%), or kept in pack (5%).

The 77 respondents who opted to not carry a canister cited four general reasons: 43% said they limited their

trip to destinations where food storage lockers exist so they could avoid using canisters; 38% gave reasons of inconvenience, weight, bulk, expense, and size; 17% thought they could get by without one or didn't expect to encounter bears; and one respondent admitted pure negligence prevented him/her from taking a canister.

Despite backpackers' relatively high rate of compliance with the park's new wilderness food storage regulations, 28% of those surveyed reported that a bear visited their camp during their trip. Of those 156 encounters, 26% reported the bear attempted to open or break a food storage container (none successfully), 8% reported that the bear damaged property such as a tent, backpack, or stuff sack, and 3% reported that the bear bluff charged or exhibited other threatening behavior. Most germane, 9% (14 separate incidents) reported that the bear successfully obtained food, trash, or other scented items that were not properly stored. In 12 of those 14 incidents the group had a food storage canister with them on the trip, but in 9 of those 12 incidents the respondent admitted that they had overflow items that did not fit into the canister. In two incidents, food or trash was inadvertently left out, and in the final incident, food was left out unattended during meal preparation as the campers were a short distance away. In the two incidents where a canister was not being used, food and/or trash was being stored in the tent in one case, and was inadvertently left out of a food storage locker in the other.

Follow-up questions from the third survey reveal more detail about incidents in which bears obtained food or trash. In more than half of the incidents, the food/trash was fewer than 50 feet (15 m) from the campers, and in half of the incidents the bear came within 5 feet (1.5 m) of a person at some point during the encounter. Overflow items were "stored" by sitting out in camp within 50 feet (15 m) of tents (n = 4); counterbalanced from a tree branch (2), hung, but not counterbalanced, in a tree (n = 2); and left in a backpack (n = 1). Reasons included food and/or trash being accidentally (unknowingly) left in a pack or tent, purposely left out because there was no room in the canister, accidentally (unknowingly) left outside the canister, left outside the canister because it wasn't known that the item should have been in the canister, and being surprised at mealtime when food was out but campers were not close enough to deter bear. When asked if there were actions they could have taken to prevent the bear(s) from obtaining food or trash, respondents said they could have better guarded their food or unsecured canister, used a more effective food storage method, repackaged their food or chosen foods that packed smaller so that everything would fit into the canister, taken more canisters, and made sure the canister lid was properly secured.

Significant negative impacts to wildlife can occur as a result of human-wildlife interactions, particularly those involving the availability of human-provided food.

Discussion

Despite a relatively high rate of canister use, backpackers' actual use of canisters was somewhat ineffective. We found that only 62% of canister users were able to store all their food, trash, and other scented items (toiletries, bait) in canisters on every night of their trip (despite 85% of the pre-trip sample saying they packed their canister(s) ahead of time, and 72% of the pre-trip sample saying everything would fit). This forced canister users to continue ineffective practices of hanging, hiding, or guarding their food on one or more nights of their trips, leading to bears continuing to get food rewards even when canisters are used. Martin and Harris (2004) reported similar results for the Lost Coast Wilderness—of the 14 groups who reported that a bear visited their campsite, 13 had food storage canisters, yet three still lost food to a bear due to overflow or food being inadvertently left out.

Additionally, in half of our reported incidents in which bears obtained food or trash, the bear came within *5 feet* (1.5 meters) of respondents in their campsites. This suggests bears may be adapting their behavior in response to the prevalence of canisters in the wilderness. Canister use clearly does not guarantee that bears will avoid campsites where campers are using canisters to store all or some of their food.

Our survey revealed a wide range of variability in backpacker preparedness levels in Yosemite National Park. Clearly Yosemite backpackers are making an effort to comply with the new canister use regulation. Most (88%) wilderness users are carrying canisters, even to places where their use was, in 2005, optional (e.g., backcountry camps where lockers exist and remote wilderness areas where food hanging was still permitted at the time); this is consistent with both Mazur (2008) and Martin and Harris (2004). A large percentage of back-

Table 1—Summary results of visitor surveys of food storage canister use in Yosemite National Park Wilderness

Survey question or item	Frequency (%)	Survey source[1]
Groups carrying one or more canisters	88	Pre-trip
Groups that said they packed canister before leaving trailhead	85	Post-trip
Groups predicting that they would be able to achieve full compliance on first night of trip	72	Pre-trip
Groups self-reporting that they did in fact achieve full compliance on first night of trip	62	Post-trip
Groups that knew in advance they would not be able to achieve full compliance	8	Pre-trip
Groups self-reporting that they never achieved compliance on any night of their trip	7	Post-trip
Groups renting canisters from Yosemite National Park	47	Pre-trip
Groups using personally owned canisters	42	Pre-trip
Groups that did not purchase food for trip until day before departure	16	Pre-trip
Groups that did not pack food into canisters until day of departure	15	Pre-trip
Groups that found out canisters were required when picking up permit in park	11	Pre-trip
Groups that were unaware of canister requirement when departing trailhead	4	Pre-trip
Groups reporting that a bear visited their campsite	28	Post-trip
Percentage of groups visited by a bear who reported the bear tried to open or break a food storage canister	26	Post-trip
Percentage of groups visited by a bear who reported having lost food and/or trash to a bear (n=14 groups)	9	Post-trip
Number of groups out of the above 14 groups who had a food storage canister with them and still lost food to a bear	n=12	Post-trip
Number of groups out of the above 12 groups who admitted to having overflow items	n=9	Post-trip
Median number of person-nights per canister	4.0	Pre-trip

[1]Pre-trip survey sample size = 485; survey administered at trailhead prior to departure; and Post-trip survey sample size = 568; survey administered at trailhead or via Internet.

packers are buying dried or dehydrated food to reduce bulk, and are repackaging their food to reduce the space it takes in a canister. However, we found that many groups still brought more food than could fit in their canisters and consequently intended to use ineffective (and often illegal) methods to store their excess. Bear conflict is likely to continue as long as ineffective food storage practices of hanging, hiding, or guarding food continue, even at low levels, especially in highly visited backcountry sites.

The main issues are overflow and inadvertently leaving items sitting out or in packs or tents. Mazur (2008) also found excess food and trash to be a significant problem for canister users in Sequoia and Kings Canyon National Parks, as did Martin and Harris (2004) in the Lost Coast Wilderness. The overflow issue is largely due to backpackers not realizing how much space their food will take up, or conversely underestimating the actual capacity of a food storage canister. Our data are consistent with this: backpackers who said they had "always" used canisters on previous Yosemite trips were more likely than expected to report that all their food and trash fit every night, whereas those who said they "rarely" or "never" used canisters on previous trips were more likely than expected to report overflow issues. Likewise, groups with a larger ratio of people and/or nights per canister were more likely to report overflow issues than groups with more canister capacity per person-night.

Most backpackers still rent canisters and, therefore, usually don't obtain their canister until the day of the trip (or at earliest the afternoon before their trip). Many also reported not completing purchases of food for their trip until the day before the trip. These two factors—not having all of the food and not having the canister until the day of or day before the trip—make it difficult for backpackers to realize, until it's too late, that they will not be able to fit everything in the canister. They often don't come to this realization until they are at the trailhead getting ready to start hiking. At that point they are simply not interested in driving back to a ranger station to rent another canister, they may not have room in their packs for an additional canister, and even if they do, the weight and space of an additional canister makes this an unappealing option.

In light of our findings, those who require their users to carry canisters may want to consider taking steps to increase backpackers' canister packing efficiency. Visitors who have never used a canister before would benefit from specific facts and details about canister packing and their holding capacity. We encourage agencies to continue, as most already do, to disseminate food storage and canister information to potential wilderness users long before they arrive, but also to strongly suggest to visitors a rule-of-thumb of a certain number of person-nights per canister; our data and personal experience suggests four person-nights per canister. The value of purchasing compact foods and repackaging cannot be overemphasized; removing bulky product packaging can

free up a large amount of space in a canister. Offering inexpensive zip-lock bags to backpackers may provide the necessary encouragement to repackage. Backpackers should similarly be strongly encouraged to choose dehydrated and/or freeze-dried food, as these items are more efficient to pack. Making rental canisters available to overnight wilderness users more than one day in advance of their departure may help some visitors. An increased emphasis on enforcement of canister requirements may be warranted. Although some might consider it an extreme measure, compliance with canister regulations might be best achieved if rangers withheld wilderness permits until backpackers can display packed canisters. This wouldn't guarantee that campers didn't also have additional food items, but it would make it clear to campers ahead of time whether or not all of their food and toiletries fit into their canister(s) before they left the ranger station, where they could obtain an additional canister if needed.

Other possible actions include agencies holding canister packing clinics at popular trailheads or ranger stations or otherwise assisting people with canister packing, making smaller rental canisters available for users who need additional space, and mailing (to backpackers who have requested a permit) a list of canister packing tips along with a bear-related DVD—*Are You Prepared for a Visit by a Bear*? (or at least a URL to the video at the park or forest website), and a canister-sized plastic bag so that backpackers who don't own a canister will know the true capacity of a canister before they arrive at the area. (An alternative might be to provide a size reference to cutting a plastic kitchen trash bag down to canister size.)

It is clear that there are, in effect, two types or levels of compliance, and the distinction is important. The first is the rate at which wilderness users carry canisters. This type of compliance is easier to assess, but it is equally if not more important to assess compliance as the percentage of users who properly store *all* of their food, trash, and other scented items in the canister(s) *every* night of their trip. This second type of compliance tends to be much lower. However, we do not believe there is sufficient reason for managers to reconsider requiring or encouraging canister use. The problems with effective canister use are not insignificant, but neither are they insurmountable. In many places canisters are still the best solution, and in wilderness may represent the minimum tool.

In all three geographic areas where surveys have been conducted (this study; Mazur 2008; Martin and Harris 2004), it was clear that there is much visitor support for using, and even requiring, canisters. The vast majority of our respondents said they care deeply about protecting bears, and want to do the right thing. But the answer to the question in the title of this article—Are bear-resistant food storage canisters effective?—is at best a qualified yes. Canisters are extremely effective when used properly and conscientiously, but there is still room for human error, and that is the root cause of most, if not all, of the problems. Other investigators (Hastings and Gilbert 1987; Seher 2007; Mazur 2008) have reached the same conclusion as this study, that compliance approaching 100% is likely necessary to avoid human-bear conflicts.

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