

BELIEFS, ATTITUDES AND BEHAVIORS ABOUT BEAR RESISTANT FOOD  
CANISTER USE AMONG WILDERNESS USERS IN YOSEMITE NATIONAL  
PARK

by

Kathryn E. McCurdy

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Kathryn E. McCurdy

Approved by Master's Thesis Committee:

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Steven Martin, Major Professor Date

---

Chris L. Aberson, Committee Member Date

---

Richard N. Brown, Committee Member Date

---

Gary Hendrickson, Graduate Coordinator Date

---

Chris A. Hopper, Interim Dean Date  
Research, Graduate Studies & International Programs

## ABSTRACT

### Beliefs, Attitudes and Behaviors About Bear Resistant Food Canister Use Among Wilderness Users in Yosemite National Park

Kathryn E. McCurdy

Since 2004, backpackers have been required to store their food in approved bear-resistant food storage canisters within seven air miles of a road and anywhere above 2900 m in Yosemite National Park. In 2005 I evaluated the effectiveness of this requirement. Trailhead and internet-based surveys utilized the Theory of Planned Behavior to measure three behavioral constructs that influence wilderness food storage behavior. Linear regression was used to determine that all three variables (behavioral belief, subjective norm and perceptions of behavioral control) influence compliance with food storage regulations in wilderness areas of the park where canisters are required. The model offers less power in predicting and explaining food storage in wilderness areas where canister use remains voluntary. The study also assesses backpackers' canister use efficiency, and examines bear –human conflict that occurred in the Yosemite Wilderness in 2005. While 87% of respondents used canisters, only 62% of those who carried canisters reported that they were able to achieve full compliance by fitting all food, trash and toiletries into canisters on every night of their trip. Forty-five (26%) of the 108 human-bear encounters documented involved backpackers using bear-resistant food canisters.

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## INTRODUCTION

Coexisting with California's black bear (*Ursus americanus*) is not only a challenge, it is a growing necessity. The state's bear population continues to expand, not only in numbers but with the extension of its range to regions of the state where bears have been documented only in the past fifty years. Between 17,000 and 23,000 black bears are now estimated to occupy the 52,000 square mile state (California Department of Fish and Game 1998).

As one of the state's largest and most adaptable omnivores, black bears are widely recognized as an important component of California's natural ecosystem. Bears are also revered by California residents and visitors to the western United States. But as any wildlife manager will attest, facilitating the coexistence of bears and humans has proven to be difficult, expensive, controversial and often ineffective. Herrero (1985), Brown (2001) and Masterson (2005) cite a common root of bear conflict: where bears and humans occupy the same habitat, black bears are commonly fed, either intentionally or inadvertently. The feeding of black bears has led to numerous undesirable ecological and behavioral consequences to California's endemic black bear population (Harms 1977, Graber 1981, Graber and White 1983, Hastings and Gilbert 1987, Keay 1995, Matthews et al. 2003). Graber and White (1983) postulate that the California grizzly bears once served as black bears' main predator and restricted their distribution in California. The extirpation of grizzly bears from the Sierra Nevada ecosystem in the early 1900's coupled with increased availability of

human food sources is thought to have allowed for a widespread expansion of the black bear population in the state. Many generations of black bears have since been exposed to humans and their food, resulting in a host of unnatural ecological consequences. These include physiological changes such as increased body weights (Graber 1981), elevated reproductive rates (Keay 1995), alterations in normal activity patterns (Matthews et al. 2003) and loss of natural hibernation behavior (Wright 1929, Harwell 1932, Graber 1991).

Black bears are particularly susceptible to behavioral changes when exposed to humans and their food (Hastings et al. 1981). As a direct result of habituation, wildlife managers have had to destroy bears that exhibit behavioral changes such as conditioning to human food. This is generally because of the potential for serious personal injury from bears that have lost their fear of humans (Herrero 1985). In other situations, persistent property damage has forced wildlife managers to destroy bears (California Department of Fish and Game 1998, National Park Service 1991). Indirect consequences of habituation to humans include increased susceptibility to poachers, hunters and roadway mortality. The California Department of Fish and Game estimates that poaching may be the cause of as many as 1,500 black bears being illegally killed each year in California. This represents a population reduction equal to the number legally harvested in the state (Sitton 1982).

In the Sierra Nevada Mountains of central California, conflicts between backpackers and black bears are cited as a serious threat to visitors and a serious problem for managers seeking to protect naturally-functioning wilderness

ecosystems (Graber 1981). Forty percent of the state's black bear population inhabits the Sierra Nevada Mountains, with an estimated population density of between 0.5 and 1.0 bears per square mile (Grenfell and Brody 1986, Koch 1983, Sitton 1982). Over two-thirds of the land that comprises the Sierra Nevada Mountains is administered by the National Park Service and U.S. Forest Service. The National Park Service has exclusive jurisdiction to manage wildlife living within park boundaries. Wildlife residing on U.S. Forest Service land is managed by the California Fish and Game Department, but land use and wilderness policies that govern national forests are the responsibility of the U.S. Forest Service. To coordinate regional bear protection efforts, a coalition of park and forest managers established the Sierra Interagency Black Bear Group in 2001 to provide professional stewardship of bears and to promote a wild, healthy bear population in the Sierra Nevada Mountains (National Park Service 2002a). Additionally, both Yosemite National Park and Sequoia-Kings Canyons National Park are guided by comprehensive Human-Black Bear Management Plans. These plans offer both preventative and reactive measures to balance the management and protection of bears in the national parks (National Park Service 2002a). One component of the Human-Black Bear Management Plan addresses bear and human management options appropriate for the park's designated wilderness areas. Remote access to wilderness sites and the restriction of intrusive management actions in designated wilderness add complexity to the task of protecting both bears and humans in the Sierra Nevada Mountain's heavily used wilderness areas (Thompson and McCurdy 1995).

Yosemite National Park maintains over 1200 km of hiking trails, although wilderness use is predominately concentrated in just 10 of 53 wilderness travel zones, each of which are within one day's travel of the trailheads (Keay and van Wagtendonk 1983). This non-random distribution of recreational wilderness use has concentrated use in favored park locations (van Wagtendock and Coho 1986). Keay and van Wagtendonk (1983), Graber (1985), and Hastings and Gilbert (1987) found bear incidents to be significantly more prevalent in high use areas of the Yosemite Wilderness.

Recreational use of the park's higher elevations has also led to a change in black bear distribution within the park (Graber 1981). Grinnel and Storer (1924) reported that bears were rarely encountered above 2500 m in the early 1900's, which encompasses a majority of the Yosemite Wilderness. Bears are now commonly seen at elevations up to 3500 m in the park. Because natural food sources are considered suboptimal at elevations above 2400 m, Graber (1981) suggests that "the input of human food at high elevations in Yosemite...appears to provide an adequate diet for black bears during the summer." This has led to bears being conditioned to backpackers' food, and prompted park officials to implement management strategies to offset human use and its impact on black bears.

One strategy in preventing bears from obtaining food from humans is a trailhead quota system for rationing use during the park's summer months. Wilderness permits are required for overnight use in all travel zones regardless of season. The Yosemite Wilderness has averaged 117,000 visitor-use-nights per

year between 1990 and 1999 (Boyers et al. 2000). This use constitutes a small fraction of Yosemite's overall annual visitation, which averaged over 3.6 million visitors annually between 1996 and 2000 (National Park Service 2006a).

Although the wilderness receives fewer visitors than the rest of Yosemite National Park, it ranks among the most heavily used recreational areas in the National Wilderness Preservation System (Boyers et al. 2000). In 2003, overnight use of Yosemite's Wilderness was approximately 80,000 people for a total of 145,000 user nights (National Park Service 2004a).

A second strategy in preventing bears from obtaining food from humans involves mandating canister use in all wilderness areas within seven air miles of park roadways and anywhere above 2900 m and is the focus of this research.

A variety of management strategies to mitigate bear-human conflicts in wilderness areas of the park are outlined in the Yosemite National Park Human-Black Bear Management Plan. Some are more sensitive to wilderness minimum impact guidelines than others. For example, infrastructure improvements have included the installation of poles, cables and food lockers that enable backpackers to store their food away from bears. Such facilities provide a high level of food storage security, but concentrate visitor use where there are boxes, leading to high levels of soil compaction, vegetation loss, and other use-related resource impacts, as well as compromising visitor solitude (van Wagtenonk 2003a). There are currently a total of fifty metal food storage boxes located at six backcountry campgrounds in Yosemite National Park. These campgrounds (Little

Yosemite Valley and five High Sierra Camps) are excluded from the official Wilderness designation within the park.

Other, less intrusive efforts have concentrated on educating wilderness users about black bear risks. The National Park Service routinely issues extensive printed and verbal instructions on how to avoid conflicts with bears. For many years, the information included detailed instructions on how to hang food away from bears. Over time, food hanging proved increasingly ineffective, resulting in frequent instances of bears obtaining food. Graber (1985) determined that while 95% of Yosemite National Park backpackers surveyed said they had received a brochure about food storage, and 92% believed they were following recommended food storage techniques, confirmation of actual behavior revealed that only 3% were storing their food properly. Concurrently, some bears learned to obtain food that was hung in accordance with National Park Service instructions. This combined situation led to a large number of bears becoming conditioned to human foods, altering their behavior and ecological role, and, in severe cases, necessitating their destruction in the interest of public safety.

The continuation of bear-human conflicts and inadequate success in mitigating them prompted the National Park Service to explore other methods of keeping human food from bears in wilderness areas. The most promising innovation was the development of a bear-proof food canister (Graber 1985). The one kilogram cylindrical container, developed by the National Park Service and manufactured by Garcia Machine in Visalia, California, can hold approximately four person-days worth of food. In extensive tests with zoo and wild bears, the

canister has been nearly impossible for bears to open or break (Dalle-Molle et al. 1985). It is a testament to the growing success of canisters that alternate container designs are now being developed and introduced in the outdoor recreation equipment market, reflecting efforts to reduce weight and cost of the equipment. In the Southern Sierra Nevada mountains, there are four food storage containers that are commercially-available to backpackers and stock outfitters (National Park Service 2002a). The proven reliability of the Garcia canister has allowed it to be the industry standard (Koy and Anaya 2002).

The Garcia canister is currently being widely used in National Park and Forest Service units throughout regions of North America where black and grizzly bears exist (Brown 2001). All or part of many popular backpacking areas in North America now require canister use, including portions of the Inyo National Forest, Yosemite 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 the Eastern High Peaks Wilderness in upstate 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.

Although canisters were a novel idea in the 1980's, canisters have gradually supplanted the use of metal lockers, food hanging poles and tree cables to become the preferred method of food storage for Sierra backpackers (Koy and Anaya 2002). However, even with widespread and voluntary use of canisters, a low enough level of food availability to discourage food seeking

behavior in bears has not been realized and incidents continue in the region (National Park Service 2004b). van Wagendonk (2003a) suggested that the establishment of a canister requirement in Yosemite National Park may be needed to increase compliance to a level that adequately reduces prevalence and severity of bear-human encounters. In 2004, Yosemite National Park officials enacted such regulation (National Park Service, 2004c). Starting in April 2004, canister use was made mandatory in all wilderness areas within 11 km (seven air miles) of park roadways and anywhere above 2900 m (based on average tree line elevation in the Sierra Nevada Mountains). This regulatory action also removed the technique of suspending food from tree limbs as a legal means of food storage where canisters are required. Metal food storage lockers are located at six of the park's most heavily visited backcountry destinations; these locations are exempt from the canister requirement. This study evaluates the effectiveness of the canister use regulation and provides insight into the attitudes, beliefs, and behaviors of visitors of Yosemite National Park relative to canister use.

Prior to the enactment of this requirement, the National Park Service estimated that as many as 80% of those camping overnight in the Yosemite Wilderness were voluntarily using canisters (National Park Service 2002b). In support of a new mandatory use regulation, the Yosemite Association, National Park Service and the park's concessionaire, Yosemite Concession Services (now Delaware North Companies Parks & Resorts) created a low cost canister rental program to facilitate increase use of canisters in the region. The canister

program, now operated solely by the Yosemite Association, maintains over 1000 canisters, with each canister circulating an average of 8 times a year. During the 2002 backpacking season, canisters were rented 8081 times for a total wilderness use of 38,874 days (Koy and Anaya 2002). According to an independent study conducted the same year, over 80% of wilderness users surveyed supported mandatory canister use in Yosemite National Park (Newman et al. 2005). How this correlates to actual canister use is unknown. In 2002, the National Park Service calculated that, parkwide, one canister was rented for every 1.5 wilderness permits issued (Koy and Anaya 2002). This suggests that 67% of backpackers who visited Yosemite National Park used canisters in 2002. However, several factors confuse this use statistic. The 2002 use rate calculated by the National Park Service does not account for privately owned canisters and canisters rented from facilities outside Yosemite National Park, nor does canister rental always equate with canister use. For these reasons, the rate of voluntary canister use prior to canister use being legally required is largely speculative.

Manfredo (1992) contended that social and psychological evaluations are critical components of a successful natural resource management strategy. For example, Daigle et al. (2002) found that attitudes, subjective norms and perceptions of control played a pivotal role in the formation of outdoor recreationists' views about wildlife conservation. A wide range of motivational approaches can be used to explain human behavior (Decker et al. 2001). Of these, cognitive approaches focus on values, attitudes and norms and how these enable humans to employ a thought process that leads to action. The

relationship between these theoretical approaches can be used to predict human behavior. The cognitive approach typically suggests that people's values determine their attitudes and their attitudes, in turn, affect their behaviors.

The Theory of Planned Behavior (TPB) (Ajzen 2002a) offers one explanation for how values, attitudes and norms guide behavior. A person's intention is the cornerstone of both the Theory of Planned Behavior and its predecessor, the Theory of Reasoned Action (Ajzen and Fishbein 1980). Both theories operate on the assumption that "humans are reasoning animals who systematically utilize or process the information available to them (Fishbein and Manfredo 1992). The models explain the interrelationship between an individual's beliefs, attitudes and behaviors. Understanding an individual's attitude toward a behavior and the associated subjective norm (social pressure) regarding the behavior makes it possible to predict a person's intention to perform the behavior in question. Preludes to attitude formation include the influences of behavioral beliefs and outcome evaluations (outcomes being positive or negative). The inclusion of perceived behavioral control updated Ajzen's Theory of Reasoned Action into what is now known as the Theory of Planned Behavior (Ajzen 2002a). The perceived behavioral control component acknowledges the importance of voluntary action on the process of translating intentions into behavior. A conceptual model (Figure 1) illustrates the theory.

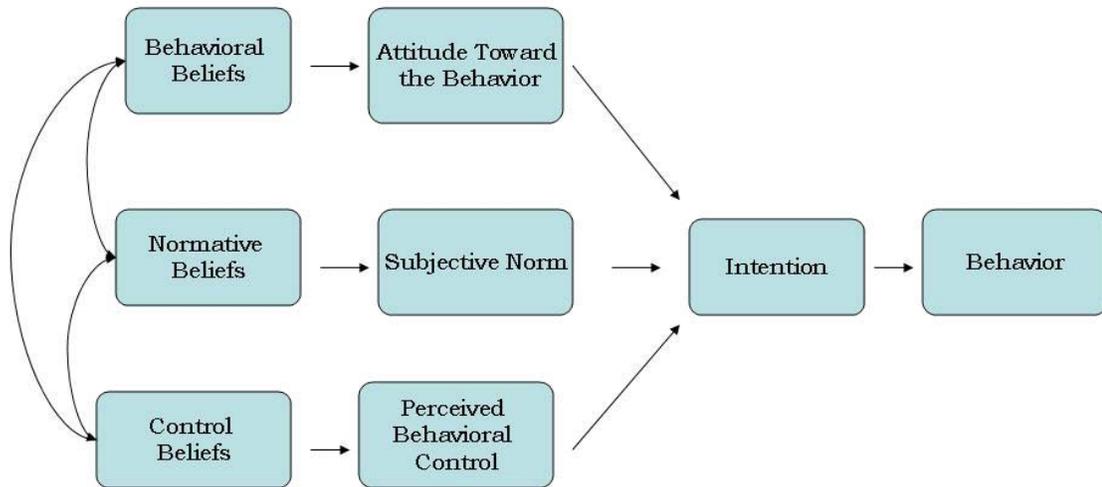


Figure 1. Theory of Planned Behavior conceptual model (Ajzen 2002a).

In this study, I used the Theory of Planned Behavior to evaluate the interrelationship between backpackers' beliefs, attitudes, and behaviors relative to canister use in Yosemite National Park by measuring attitudes toward canister use, subjective norms (the collective influence exerted by four normative peer groups) and perceived behavioral control (seven control factors that dictate the ease in which canisters may be rented and used). I was able to predict the level of canister use in areas where canister use is mandatory as well as in areas where canisters are not required. I postulated that a favorable attitude toward food storage (behavioral beliefs), coupled with social pressure from other wilderness users (normative beliefs), and a canister rental system that makes them accessible for use (control beliefs), should help to explain backpackers' intentions to carry and use a canister during wilderness trips in Yosemite National Park.

## STUDY AREA

Yosemite National Park encompasses 302,000 ha on the western slope of the Sierra Nevada Mountains in central California. Elevations vary from 600 m on the western boundary to 4000 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).

Ninety-four percent of Yosemite National Park was officially designated as wilderness in 1984 and encompasses 281,855 ha of the park. There are 55 trailheads, with 1118 km of trail that provide access to 375 camping destinations in the Yosemite Wilderness (van Wagendonk 2003b). An additional 46 trailheads feed 668 km of trail on Forest Service wilderness areas adjacent to the park. 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 traverse the Yosemite Wilderness: the John Muir Trail, which originates in Yosemite and goes 340 km south to Mount Whitney, and 80 km of the Pacific Crest Trail, a 4265 km route that connects the Mexican and Canadian borders.

Wilderness users are required to use bear-resistant canisters in roughly

90% of the park's wilderness (Figure 2). Metal food storage lockers are located at six of the park's most heavily visited backcountry destinations; these locations are exempt from the canister requirement. Use in the Yosemite Wilderness in 2005 was 90,011 visitor-nights. (National Park Service 2006b).

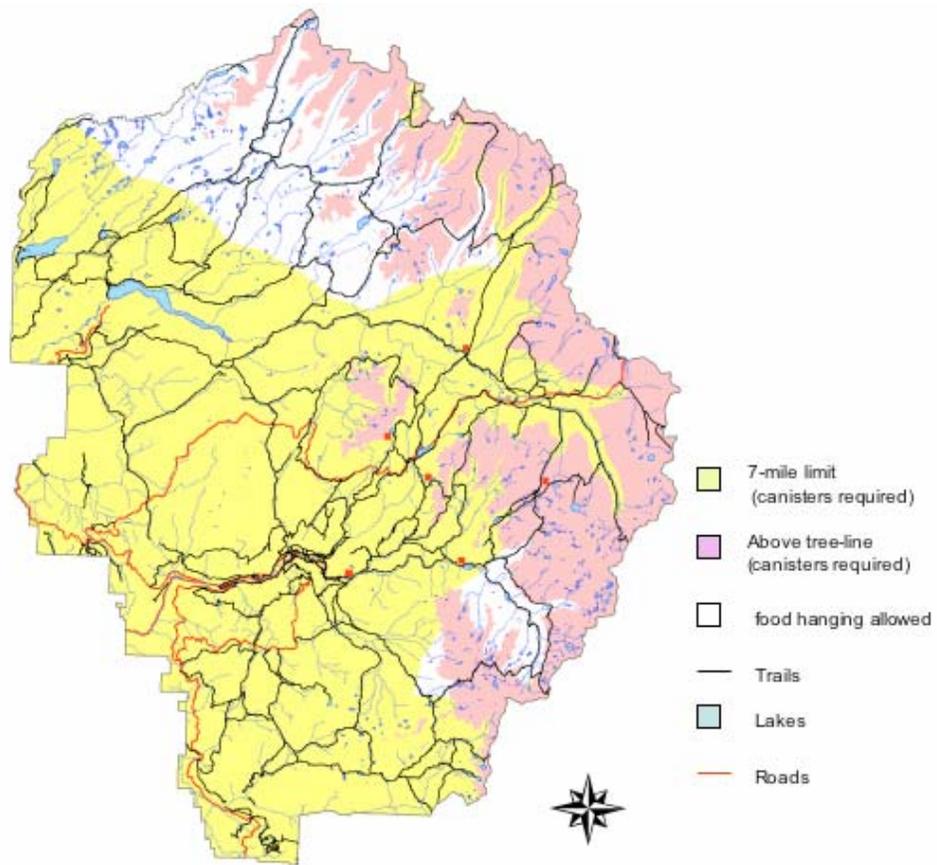


Figure 2. Yosemite National Park wilderness zones. Canisters are required within 11 km (7 air miles) from park roads and elevations above 2900 m.

## METHODS AND MATERIALS

### Sampling Procedure

A sample of 1079 individuals was drawn from the population of adults who used Yosemite trailheads in 2005 for overnight wilderness trips. Surveys were administered at randomly selected wilderness trailheads and two backpacker campgrounds ranging from 1100 m to 3000 m in elevation in Yosemite National Park between May and October, 2005. Surveys were administered under permit conditions outlined in HSU Human Subjects in Research approval # 04-96 (expiration 5/2006); OMB Expedited Approval for NPS-sponsored public surveys permit # 1024-0224-NPS#05-06 (Expiration 12/2006) and NPS scientific research and collecting permit # YOSE-2005-SCI-0049 (expiration 12/2006). Half of the trailheads were major wilderness portals; the remaining trailheads were seasonally or less frequently used as wilderness egress points. Participants were given the option of completing the survey at the trailhead or over the internet in the weeks following their trip. Three hundred sixty questionnaires were completed by backpackers at trailheads and backpacker campgrounds immediately following a wilderness trip. An additional 208 surveys were completed over the internet by those who volunteered their email address at park trailheads. The overall response rate for the survey was 61%, with the response rate being similar when taken in person (62%) or over the internet (60%).

## Questionnaire

The questionnaire utilized Theory of Planned Behavior modeling (Ajzen 2002b) to measure three categories of influence over wilderness food storage behavior – behavioral beliefs (attitudes), subjective norms (normative beliefs) and perceived behavioral control. The model was also used to assess behavioral intention to use canisters and actual food storage behaviors used during participant's backpacking trips. Finally, behavioral outcomes were documented. In particular, questions were asked to characterize the prevalence, severity and nature of bear incidents that resulted from apparent attraction of bears to backpackers' food.

Behavioral beliefs were measured with the following four questions: (a) "how important is it to me that bears don't get human food"? (b) "how important is it to me that bears are wild"? (c) "how important is it to me that I am safe when camping around bears"? and (d) how important is it that other people who camp near me are safe from bears"? Response format was a 7-point Likert scale with endpoints labeled extremely important and not at all important (Frances et al. 2004).

Normative influences are the social pressures that backpackers weigh when deciding whether to use bear-resistant food storage canisters. I identified four groups that may influence a backpacker's decision to carry and use a canister: family and friends, camping partners, the National Park Service, and other people camping nearby. I then measured the normative influences these referent

groups exert on backpackers in Yosemite National Park. Four subjective norm items were formulated: (a) “most people who are important to me think that I should carry a food storage canister” (b) other people camped near me think I should carry a food storage canister” (c) “other members of my backpacking group think I should carry a food storage canister” and (d) “the National Park Service thinks that I should carry a food storage canister”. The response format was a 7-point Likert scale with endpoints labeled strongly agree and strongly disagree.

I identified seven control factors pertaining to a backpacker’s self-efficacy, or perceived ability to effectively carry out an intention to use a food storage canister while backpacking in Yosemite. For example, some backpackers may believe that it is difficult to rent or return a canister, that the canister rental fee is too high, that they will be unable to fit a canister in their pack, or that canisters are too heavy to carry. To assess perceived behavioral control, respondents were asked to respond to the following comments: (a) “food storage canisters are easy to obtain” (b) “rental canisters are easy to return in Yosemite National Park” (c) “food canisters are easy to rent in Yosemite National Park” (d) “bear-resistant food canisters are too heavy to carry and (e) “food canisters are too small to hold all the food I want to take”. The response format was a 7-point Likert scale with endpoints labeled strongly agree and strongly disagree.

To measure behavioral intentions, participants were asked to respond to the following two comments: (a) “even in areas where they aren’t required, I will use a food canister on future trips in the Yosemite Wilderness” and (b) “where they

are required, I will use a food canister on future trips in the Yosemite Wilderness". The response format was a 7-point Likert scale with endpoints labeled strongly agree and strongly disagree.

Additional behavioral predictors included current and past behavior. Participants were asked to report whether or not they carried a canister on their just-completed trip, and on how many nights of the trip all their food fit into the canister. Participants were also asked to indicate how often they used food canisters on previous wilderness trips (always, often, occasionally, seldom or never).

Finally, the survey included questions regarding current and past bear encounters that respondents experienced during wilderness trips in Yosemite. Those who had a bear visit their camp were asked to characterize the nature and outcomes of the encounter (whether the bear obtained food, trash or toiletries, caused damage, exhibited aggressive behavior, or refused to leave). If a bear caused damage, respondents were asked to list items taken or damaged, and report the date, time and location of their incident.

SPSS statistical software (SPSS Inc. Chicago, Illinois) was used to run hierarchical regression models based on the Theory of Planned Behavior. Multiple regression allowed me to input composite variables that measure attitude, subjective norm and perceived behavioral control to predict canister use in areas where canister use is voluntary as well as in areas where canister use is required. Microsoft Excel (Microsoft Inc. Redmond, Washington) was used to analyze bear incident and demographic data.

Two data issues had to be resolved prior to analyses. To contend with missing data, I interpreted the data using three different analysis techniques. First, I employed a listwise deletion of missing data if one or more of 28 behavioral intention questions were unanswered. This resulted in a sample size that ranged in size from 184 to 527 cases, depending on the analysis. Second, I replaced missing data with scores that reflected a neutral response (mean imputation), allowing inclusion of more cases (a range of 539 to 568 respondents, again depending on the analysis). Finally, I ran an imputation on the missing questions using maximum likelihood imputation (ML, also known as EM). This technique employs an algorithm analysis of data to generate likely responses where data is missing, and is widely used to provide more accurate estimates of parameters than listwise deletion or mean substitution (Schafer and Graham 2002, Aberson and McVean 2003). The maximum likelihood analysis provided a sample size of 538 to 549 cases.

A comparison of the three analyses revealed that regression analysis did not differ significantly between the three samples. Results were therefore reported for each of the three different analysis techniques – mean substitution, listwise deletion, and maximum likelihood imputation. Where data is presented using only the maximum likelihood imputation data set, results are annotated.

The second issue that I addressed prior to running my analyses was that skew and kurtosis ratios indicated that the data collected in Yosemite did not meet normality assumptions necessary to run regression analysis (Harlow 2005).

Many of the variables were negatively skewed and had to be corrected with data transformations to restore normality to the data.

## RESULTS

Surveys collected on site were screened for completeness and those filled out at least half way were entered into a database managed by PsychData (PsychData, LLC, State College, PA). Male respondents represented a significantly greater proportion of the survey sample (n= 375, 71%) than women (n= 154, 29%). Sixty-two percent were California residents, while 153 (29%) were from other U.S. states and 52 (9%) were visitors from foreign countries. The median age of respondents was 36 years with a range of 18 to 79 (minors were excluded from the survey). Three hundred and twenty respondents (59%) had been on at least one previous wilderness trip in Yosemite National Park. Two hundred and seventy-six respondents (49%) planned their trip more than 6 months in advance. Two hundred and nine respondents (65%) took their first trip when food hanging was legal, 18% had previous run-ins with bears, and 1 in 4 (25%) were new to using canisters.

### Respondent Demographics

Of the 568 respondents who completed the survey, 493 reported using a canister on their trip (87%), while 75 (13%) said they did not use a canister. Of canister users, 307 (62%) reported that they were able to achieve full compliance by fitting all their food, trash and toiletries into their canisters on every night of

trip. One hundred and fifty one (31%) had to leave items out of their canister on some nights of their trip. The remaining 34 (7%) had excess items most or all nights of their trip. A follow-up question was posed to canister users who had to contend with food that exceeded canister space on one or more nights of their trip. Of the 164 people who responded, 74 (45%) said they were able to fit all their food, toiletries, and trash by the second night of their trip, with another 58 (35%) able by the third night. An additional 18 respondents (11%) were only able to fit everything by the fourth night. The remaining 11 respondents (7%) reported never being able to fit all their food-related items in the canister.

When queried about what was done with items that didn't fit in their canisters, respondents supplied a range of answers, only 33 (18%) of which represented legal alternatives to storing their food. Twenty-two respondents (12%) reported using a food storage locker and 11 (6%) counterbalanced their food from a tree limb, presuming that they were camped greater than 11.3 km (7 miles) from a road and counterbalancing was therefore legal. The remaining 147 respondents (88%) were considered non-compliant canister users because they hung food, trash or toiletries in a tree (n=49, 27%), left food, trash and/or toiletries sitting out (n=49, 27%), buried, hid, suspended over cliff, sunk underwater, or covered in rocks (n=27, 15%), kept in tent (n=13, 7%), or kept in pack (n=9, 5%).

Wilderness users who opted to not carry canisters (n=69) cited four general reasons for their decision. Thirty (43%) reported that they limited their trip to destinations where food storage lockers exist so they could avoid using

canisters. Perceived behavioral control issues of inconvenience, weight, bulk, expense and size were listed by 26 respondents (38%) as “logistical” reasons for not using a canister. Twelve respondents (17%) thought they could get by without one or didn't expect to encounter bears. Only 1 (<1%) person admitted that pure negligence prevented them from taking a canister.

Nearly three quarters of the people I surveyed in 2005 reported that they did not encounter a bear during their trip (n=390, 71%), while 28% said that they had (n=156). Seven respondents (one percent) reported having more than one bear encounter during their trip. Ninety-seven of the reported encounters occurred in the Yosemite wilderness and 11 took place south of Yosemite on the Pacific Crest or John Muir Trails. An additional 34 bear encounters reportedly took place in the Yosemite front country but were excluded from analysis because of they did not occur in wilderness.

In my analysis, a distinction was made between bear encounters and incidents by evaluating the outcome. A bear seen or heard in a campsite was considered an encounter as long as the bear didn't attempt to cause physical harm to the backpackers or their property. If the bear threatened to or did cause property damage or physical harm to a human, I considered it to be an incident. Bear encounters were further categorized by the location and extent of food loss or property damage.

The 108 human-bear encounters reported in or near the Yosemite wilderness were analyzed by the timing and the outcome of each bear's visit to produce a total of 176 encounter characteristics. Bears were seen in or near

backpacker's campsites 115 times (65%). In an additional 28 instances (16% of all encounters) bears were not only seen, they remained in camp for an hour or more. In 24 of the encounters (14%) bears spent time in camps without being seen; in nine of the encounters (five percent) they were heard but not seen.

Forty-four percent of the bear encounters reported were limited to a bear or bears investigating backpackers' campsite without further incident (n=77). An additional 45 reports documented bears unsuccessfully attempting to open or break a food storage container, accounting for 26% of all encounters. Fifty (29%) of the encounters resulted in bears obtaining food or causing property damage. Bears bluff-charged or exhibited other threatening behavior on four occasions, accounting for less than two percent of all encounters. No cases of bears causing human injury were reported during my 2005 survey effort.

Of the 50 reported instances of bears obtaining food or causing property damage, only 20 (40%) of the respondents provided details of the incident in a follow-up question requesting a list of the items obtained or damaged by a bear. Of these, 11 respondents (55%) reported that no food was obtained by the bear, it only caused property damage. In the remaining nine incidents where bears obtained food, only three reported that the bear obtained a large amount of food or trash, accounting for 15% of all incident reports. Twenty percent got a small amount of food or trash and the final 10% resulted in a bear only obtaining scraps of food or trash (n=2).

## Main Analyses

In the following sections I examine the findings relevant to our primary hypothesis that an attitude-behavior link exists in Yosemite National Park regarding wilderness food storage. In a series of hierarchical regression analyses, we tested the predictive validity of the theory of planned behavior. These analyses are followed by an examination of the relations between direct measures of attitudes, subjective norms and perceptions of control and their respective belief-based counterparts.

### Behavioral Beliefs

Behavioral beliefs are the most direct measure of attitude based on salient feelings about food storage. To measure behavioral beliefs, a composite variable was created by weighting four behavioral belief responses by their corresponding outcome evaluation scores.

Four behavioral beliefs were identified during pre-testing in Yosemite National Park in July of 2005: (a) that bears and other wildlife should not get human food; (b) that bears should be wild; (c) that park visitors should be safe from bears; and (d) that personal safety around bears is important. These values were weighted with outcome evaluations relating to each behavioral belief – that using a food storage canister will (a) keep bears and other wildlife from getting human food; (b) bears will remain wild; (c) other park visitors will be safer from

bears; and (d) an individual's personal safety around bears will increase.

The validity of the indirect measures was confirmed using a series of bivariate correlations between each of the four indirect measures of behavioral beliefs and their outcome evaluation (Table 1). Significant positive correlations exist for each of the paired constructs, indicating that the indirect measures of attitude accurately measured backpackers' behavioral beliefs. Low correlations would likely be the result of indirect measures that were poorly constructed or that inadequately encapsulated the possible range of behavioral beliefs that people hold about food storage (Frances et al. 2004). Alternatively, correlations approaching 1.0 would indicate that respondents could not discern differences between the behavioral belief and outcome evaluation constructs presented in the questionnaire.

A behavioral belief composite score was calculated for each respondent, based on eight attitude-related questions dispersed throughout the questionnaire. A high score of 196 means that, overall, the respondent is in favor of using bear-resistant food canisters for food storage. A low score of 4 means that, overall, the respondent is against using bear-resistant food canisters for food storage. A score of 64 means that overall the respondent has neutral beliefs about food storage canisters. Mean scores for behavioral beliefs ranged from 155.9 to 161.2 depending on the data set analyzed (Table 2). These scores indicate that, on average, respondents were generally in favor of using food canisters for food storage.

Table 1. Correlations between indirect measures of behavioral beliefs and their outcome evaluations demonstrate internal consistency in measures used to assess backpacker's attitudes about food storage in Yosemite National Park, 2005.

Behavioral belief strength	Outcome evaluation	Correlation
How important is it that bears and other wildlife don't get human food?	Use of a food storage canister will keep bears and other wildlife from getting human food	0.20*
How important is it that other people who camp nearby are safe from bears?	Use of a food storage canister will keep other park visitors safer from bears	0.29*
How important is it that bears are wild?	Use of a bear resistant food storage canister will help keep bears and other animals wild	0.20*
How important is it that you are safe when camping around bears?	Use of a canister will keep me and other members of my group safe from bears	0.32*

\* significant at  $p < 0.05$ , \*\* significant at  $p < 0.01$ , \*\*\* significant at  $p < 0.0001$

Degrees of freedom for all tests is 1,547

Imputed data presented

Table 2. Mean behavioral belief composite scores based on eight indirect measures of attitude about bears and food storage in self-report surveys completed by backpackers at Yosemite National Park trailheads from June-October 2005.

Data set analyzed	Sample size	Minimum score possible	Maximum score possible	$\bar{x}$	Standard deviation
Mean substitution	568	18	196	155.9	36.8
Listwise deletion	514	18	196	161.2	32.1
Maximum likelihood imputation	549	18	196	160.7	31.8

Additionally, four direct measures of attitude toward the behavior were gauged: that canister use is (a) agreeable; (b) difficult; (c) a good practice; and (d) valuable. Multiple regression was employed to evaluate the four directly-measured attitude scores using the sum of the weighted behavioral beliefs as the predictor variable. Results are presented using maximum likelihood imputation (Table 3).

### Subjective Norm

Subjective norm is the indirect influence that peer pressure has on shaping attitudes regarding food storage. Four groups that provide social pressure to use food canisters were identified during pre-testing in Yosemite National Park in July of 2005: (a) other visitors camped nearby; (b) other members of one's backpacking group; (c) people whose opinions are important to the respondent; and (d) the National Park Service. Measures of normative beliefs and motivation to comply were combined to gauge the importance of these different peer groups in the pressure they exert for others to use canisters.

The validity of these measures was confirmed using a series of bivariate correlations between each of the four indirect measures of subjective norms and their weighted influence (Table 4). Significant positive correlations exist for each of the paired constructs, indicating that the indirect measures of subjective norm accurately measured the influence that peer pressure has on backpackers' use of canisters.

Table 3. Behavioral belief predicted from the directly measured attitudes that food storage canister use is “agreeable”, “easy”, “a good practice” and “valuable” in Yosemite National Park, 2005.

Direct attitude measure	n	$\bar{x}$	Standard deviation	F	R <sup>2</sup>
Agreeability of using a canister while backpacking in the Yosemite Wilderness	549	6.01	1.5	204.5*	0.27*
Ease of canister use a while backpacking in the Yosemite Wilderness	549	5.0	1.7	69.2*	0.11*
Goodness of using a canister while backpacking in the Yosemite Wilderness	549	6.4	1.1	216.4*	0.28*
Value of using a canister while backpacking in the Yosemite Wilderness	549	6.32	1.1	361.8*	0.40*

\* significant at  $p < 0.05$ , \*\* significant at  $p < 0.01$ , \*\*\* significant at  $p < 0.0001$

Degrees of freedom for all tests is 1,547

Imputed data presented

Table 4. Correlations between direct measures of subjective norm and indirect measures of motivation to comply demonstrate internal consistency in the questionnaire items used to assess the influence of social pressure on bear-resistant food canister use in Yosemite National Park, 2005.

Direct measures of subjective norm	Motivation to comply	Correlation
Other visitors camped near me think I should carry a food storage canister	How important is it that you do what people who are camping near you think you should do?	0.26 *
Other members of my backpacking group think I should use a food storage canister	How important is it to you that you do what members in your backpacking group think you should do?	0.25*
People who are important to me think that I should use a food storage canister	How important is it to you that you do what people whose opinions you value think you should do?	0.28*
The Park Service thinks that I should use a food storage canister	How important is it to you that you do what the National Park Service thinks you should do?	0.12*

\* significant at  $p < 0.05$ , \*\* significant at  $p < 0.01$ , \*\*\* significant at  $p < 0.0001$

Degrees of freedom for all tests is 1,547

Imputed data presented

A subjective norm composite score was calculated for each respondent, based on eight peer group-related questions dispersed in the questionnaire. A high score of 196 means that, overall, the respondent experiences social pressure to use a bear-resistant food canister for food storage. A low score of 4 means that, overall, the respondent experiences social pressure not to use a bear-resistant food canister for food storage. A score of 64 means that overall the respondent experiences no social pressure to use food canisters. Mean scores for subjective norm ranged from 101.5 to 105.0 depending on the data set analyzed (Table 5). Scores calculated from the survey samples indicate that respondents experience a moderate degree of social pressure to use food canisters for food storage in Yosemite National Park.

An additional measure of subjective norm regarding canister use was directly measured by asking respondents how often friends whose opinions they value use canisters when they travel in the Yosemite Wilderness (Table 6). Multiple regression was used to evaluate the direct measure of peer pressure using the subjective norm composite score as the predictor variable. A miniscule positive correlation indicates that backpackers whose friends have used food storage canisters in the past are themselves just barely more likely to be more influenced by subjective norms.

Table 5. Mean subjective norm composite scores based on eight measures of peer group influence in self-report surveys completed by backpackers at Yosemite National Park trailheads from June-October, 2005.

Data set analyzed	Sample size	Minimum score possible	Maximum score possible	$\bar{x}$	Standard deviation
Mean substitution	568	13	196	101.5	40.2
Listwise deletion	423	13	196	105.0	42.0
Maximum likelihood imputation	549	13	196	104.9	40.2

Table 6. Subjective norm regarding food storage in Yosemite National Park predicted from past food storage canister use by respondents' peers.

Data set analyzed	n	$\bar{x}$	Standard Deviation	df	F	R <sup>2</sup>
Mean substitution	539	3.0	2.2	1,537	15.9***	0.03*
Listwise deletion	419	3.0	2.2	1,417	12.8***	0.03*
Maximum likelihood imputation	538	3.0	2.2	1, 536	15.2***	0.03*

\* significant at p <0.05, \*\* significant at p <0.01, \*\*\* significant at p <0.0001

### Perceived Behavioral Control

Behavioral controls are the real or perceived logistical hindrances that shape backpacker's attitudes regarding use of food storage canisters. This construct combines indirect measures of perceived behavioral control beliefs with scores representing the influence of each control belief. The sum of the weighted beliefs is a composite score for perceived behavioral control.

Four indirect measures of perceived behavioral control were identified during pre-testing in Yosemite National Park in July of 2005: (a) expense of canister use; (b) ease of canister use; (c) size of canisters; (d) ease of canister rental; (e) ease of canister return; and (f) ease of packing canisters. Each measure of perceived behavioral control belief strength was then weighted by combining it with a score representing the control belief power, i.e., the importance that canisters are: (a) inexpensive to use; (b) easy to use; (c) large enough; (d) easy to rent; (e) easy to return; and (f) easy to pack.

The validity of these measures was confirmed using a series of bivariate correlations between each of the six measures of perceived behavioral control strength and their weighted belief powers (Table 7). Significant positive correlations exist for four of the six paired constructs, indicating that the control belief measures (except for expense and ease of canister return) correlated with the influence that logistical issues have on backpackers' use of canisters.

A perceived behavioral control composite score was calculated for each respondent, based on 12 self-efficacy-based questions dispersed in the

questionnaire. A high score of 294 indicates that, overall, the respondent feels in control of their use of a bear-resistant food canister for food storage. A low score of 6 means that, overall, the respondent does not feel in control of their use of a bear-resistant food canister for food storage. A score of 96 means that overall the respondent has neutral beliefs about their ability to use a bear-resistant food canister for food storage. Mean scores for perceived behavioral control ranged from 156.3 to 175.1, with the mean substitution data producing the lowest mean score and the imputed data set producing the highest mean score (Table 8). These scores indicate that respondents feel a fairly high degree of control over their use of bear-resistant food canisters.

An additional measure of perceived behavioral control regarding canister use was measured directly by asking respondents how much they believe they can choose whether or not to use a food canister when camping in the Yosemite Wilderness (Table 9). Multiple regression was used to evaluate self-efficacy using the sum of the weighted perceived behavioral control as the predictor variable. The influence of perceived behavioral control is significantly predicted from backpacker's feelings of self-efficacy over their use of food canisters in Yosemite ( $R^2 = 0.029$   $F_{(1,547)} = 16.5$ ,  $p < 0.001$ ,  $M=2.7$ ,  $S.D. = 1.8$ ). Backpackers who feel in control over their choice of food storage methods are more likely to have higher behavioral control scores, indicating that their food storage behavior is positively influenced by their perceived ability to obtain, carry and use food storage canisters. A positive correlation indicates that greater control over canister use increases backpacker's likelihood of carrying a canister.

Table 7. Correlations between measures of control belief strength and control belief power reflect high internal consistency in five of six questionnaire items used to assess backpacker's ability to obtain and use bear-resistant food storage canisters in Yosemite National Park, 2005.

Control belief strength	Control belief power	Correlation
Food storage canisters are inexpensive to obtain	How important is it that it is inexpensive to obtain a food storage canister?	-0.05
Food storage canisters are large enough to hold all my food	How important is it that your food storage canister is big enough to hold all your food?	0.26*
Food storage canisters are easy to rent in Yosemite National Park	How important is it that canisters can be conveniently rented?	0.26*
Food canisters are difficult to return in Yosemite National Park	How important is it that canisters can be conveniently returned?	0.01*
Bear resistant food storage canisters are light enough to carry	How important is it that food storage canisters are lightweight?	-0.24*
Food storage canisters are easy to fit in or on a backpack	How important is it that food storage canisters take up little space in your backpack?	-0.32*

\* significant at  $p < 0.05$ , \*\* significant at  $p < 0.01$ , \*\*\* significant at  $p < 0.0001$

Degrees of freedom for all tests is 1,547

Imputed data presented

Table 8. Mean perceived behavioral control composite scores based on twelve measures of self-efficacy and control over canister use in self-report surveys completed by backpackers at Yosemite National Park trailheads from June-October, 2005.

Data set analyzed	Sample size	Minimum score possible	Maximum score possible	$\bar{x}$	Standard deviation
Mean substitution	568	36	294	156.3	49.2
Listwise deletion	228	36	294	175.1	51.5
Maximum likelihood imputation	549	36	294	163.0	47.4

Table 9. Behavioral control predicted from backpackers' perceived ability to obtain, carry and use food storage canisters in Yosemite National Park.

Data set analyzed	n	$\bar{x}$	Standard deviation	df	F	R <sup>2</sup>
Mean substitution	568	2.8	1.8	1,566	27.7***	0.05
Listwise deletion	527	2.7	1.8	1,501	49.1***	0.09
Maximum likelihood imputation	549	2.7	1.8	1, 547	16.5***	0.03

\* significant at p <0.05, \*\* significant at p <0.01, \*\*\* significant at p <0.0001

## Behavioral Intention

Addressing the final step of the Theory of Planned Behavior model, I predicted the likelihood of future canister use, first in areas where they are not required and second in areas where they have been required since 2004. This was done using a multiple regression where direct measures of intention were entered as the dependent variables, the weighted measures of attitude, subjective norm and perceived behavioral control as the predictor variables. The first regression analysis (Table 10) indicates that the combination of behavioral belief, subjective norm and perceived behavioral controls together can be used to predict backpackers' intentions to use bear-proof food canisters in areas of the Yosemite wilderness where they are not required ( $M=4.9$ ,  $S.D. = 1.9$ ,  $R^2 = 0.229$ ,  $F_{(3,545)} = 11.7$ ,  $p<0.001$ ). Individually, behavioral beliefs contribute 20% to the prediction ( $R^2 = 0.203$ ,  $F_{(1,547)} = 139.4$ ,  $p<0.001$ ). Individually, subjective norms add 2.5% to the prediction ( $R^2 = 0.228$ ,  $F_{(2,546)} = 80.7$ ,  $p<0.001$ ,  $F$  change = 17.8,  $p < 0.001$ ). Perceived behavioral control does not add significantly to the model ( $F$  change = 0.676,  $p=0.411$ ). Together the influences of personal beliefs and peer pressure can predict approximately 23% of the variance in backpacker intentions to use bear-proof food canisters in areas of the Yosemite wilderness where they are not required.

The second regression analysis (Table 11) revealed that the combination of behavioral belief, subjective norm and perceived behavioral controls together also provide a significant prediction of backpackers' intentions to use bear-proof

food canisters in areas of the Yosemite wilderness where they are required (M=6.5, S.D. = 1.0,  $R^2$  model = 0.263  $F_{(3,545)} = 64.8$   $p < 0.001$ ). Individually, behavioral beliefs contribute 25% to the prediction ( $R^2 = 0.247$ ,  $F_{(1,547)} = 179.4$ ,  $p < 0.001$ ). Individually, subjective norm adds 1% to the prediction ( $R^2 = 0.256$ ,  $F_{(2,546)} = 94.0$ ,  $p < 0.001$ ,  $F$  change = 6.7,  $p = 0.01$ ). Perceived behavioral control adds 1% to the prediction ( $R^2 = 0.263$ ,  $F_{(3,545)} = 64.8$ ,  $p < 0.001$ ,  $F$  change = 5.0,  $p = 0.026$ ). Together the influences of personal beliefs, peer pressure and logistical issues can predict approximately 26% of the variance in backpacker intentions to use bear-proof food canisters in areas of the Yosemite wilderness where they are required.

Table 10. Results of hierarchical regression analyses predicting backpackers' intentions to use bear-proof food canisters in areas of the Yosemite wilderness where they are not required, based on behavioral belief, subjective norm and perceived behavioral control to the model.

Data set analyzed	Hierarchical model	$\bar{x}$	Standard deviation	Zero order	Beta	R <sup>2</sup> model	F model	R <sup>2</sup> change	F change	pr <sup>2</sup>
Mean Substitution df <sub>(1,568)</sub>	1 – Behavioral Beliefs	155.9	36.8	0.43	0.33***	0.18	126.6***	0.18	126.6***	0.09
	2– Subjective Norm	101.5	40.2	-0.35	-0.18***	0.21	75.6***	0.03	20.2***	0.03
	3 –Control Beliefs	123.3	39.6	-0.24	-0.04	0.21	50.6***	<0.01	0.76	<0.01
Listwise Deletion df <sub>(1,183)</sub>	1 – Behavioral Beliefs	161.2	32.1	0.45	0.36***	0.20	45.6***	0.20	45.6***	0.10
	2 – Subjective Norm	104.9	41.9	-0.31	-0.14	0.22	25.4***	0.02	4.4*	0.02
	3 – Control Beliefs	175.1	51.5	-0.26	-0.06	0.22	17.4***	<0.01	0.70	<0.01
Maximum Likelihood Imputation df <sub>(1, 549)</sub>	1 – Behavioral Beliefs	160.7	31.8	-0.45	0.36***	0.20	139.4***	0.20	139.4***	0.11
	2 – Subjective Norm	104.9	40.2	-0.34	-0.17***	0.23	80.7***	0.03	17.8***	0.03
	3 – Control Beliefs	162.9	47.4	-0.23	-0.03***	0.23	54.0***	<0.01	0.68	<0.01

\* significant at p <0.05, \*\* significant at p <0.01, \*\*\* significant at p <0.0001

Table 11. Results of hierarchical regression analyses predicting backpackers' intentions to use bear-proof food canisters in areas of the Yosemite wilderness where they are required, based on behavioral belief, subjective norm and perceived behavioral control.

Data set analyzed	Hierarchical model	$\bar{x}$	Standard deviation	Zero order	Beta	R <sup>2</sup> model	F model	R <sup>2</sup> change	F change	p <sup>r2</sup>
Mean Substitution df <sub>(1,568)</sub>	1 – Behavioral Beliefs	155.9	36.8	0.52	0.43***	0.27	214.1***	0.27	214.1***	0.16
	2 – Subjective Norm	101.5	40.2	-0.035	-0.12**	0.29	115.5***	0.02	12.5***	0.01
	3 – Control Beliefs	156.3	49.2	-0.31	-0.09*	0.30	79.***	<0.01	5.4*	<0.01
Listwise Deletion df <sub>(1,183)</sub>	1 – Behavioral Beliefs	161.2	32.1	-0.49	-0.34***	0.25	59.5***	0.25	59.5***	0.13
	2 – Subjective Norm	104.9	41.9	0.34	0.14*	0.27	33.2***	0.02	5.4**	0.02
	3 – Control Beliefs	175.1	51.5	0.35	0.15*	0.29	23.9***	<0.01	4.2*	0.02
Maximum Likelihood Imputation df <sub>(1, 549)</sub>	1 – Behavioral Beliefs	160.7	31.9	-0.049	-0.43***	0.25	179.4***	0.25	179.4***	0.16
	2 – Subjective Norm	104.9	40.2	0.31	0.09*	0.26	94.0***	<0.01	6.7**	<0.01
	3 – Control Beliefs	162.9	47.4	0.28	0.09*	0.26	64.8***	<0.01	5.0*	<0.01

\* significant at p <0.05, \*\* significant at p <0.01, \*\*\* significant at p <0.0001

## DISCUSSION

Previous investigations using the Theory of Planned Behavior have demonstrated predictive validity in explaining attitudes toward a targeted behavior and subsequently, intentions to perform the behavior (Bright et al. 1993, Evans and Norman 1998, Cunningham and Kwon 2003, Hrubes et al. 2001, Clark-Richardson 2003). Ajzen and Driver (1992) used the Theory of Planned Behavior to examine outdoor leisure intentions and behaviors and found that 50% to 86% of the variance in the intentions of college students to engage in outdoor recreation activities could be predicted from attitudes toward the behaviors, subjective norms and perceptions of behavioral control. Hrubes et al. (2001) found that attitude, subjective norms and perceived behavioral control explained 93% of the variance in hunting intentions. Norman and Smith (1995) predicted exercise behavior and found that attitude and subjective norm, and perceived behavioral control components of the Theory of Planned Behavior were able to predict 38% of the variance in exercise frequency. Evans and Norman (1998) determined that theoretical constructs were able to explain between 39% and 52% of variance in pedestrians' intentions to perform dangerous road crossing behaviors. Kraft et al. (2005) determined that Theory of Planned Behavior components accounted for 51% of the variance in recycling intentions. In summary, each of these studies demonstrated a large amount of explained variance in their applications of the Theory of Planned Behavior model

(Cohen and Cohen 1983). explained variance in their applications of the Theory of P

In my study, the Theory of Planned Behavior afforded a statistically significant but somewhat weak prediction of canister use intentions and behavior in Yosemite National Park. In accordance with the theory, attitudes toward wilderness food storage, subjective norms and perceptions of behavior control were significant determinants of intentions. Intentions correlated strongly with self-reported behavior, with backpackers reporting that, on average, they were “somewhat likely” to carry canisters on future trips to the Yosemite Wilderness where canister use remains voluntary. The addition of a canister use requirement in the park significantly increased canister use from “somewhat likely” to “likely” in areas where canister use is now mandatory. Functionally, however, attitudes toward wilderness food storage, subjective norms and perceptions of behavior control, were able to explain only 21% to 23% of the variance in backpackers intentions to use canisters voluntarily, and 26% to 30% of the variance in backpackers intentions to use canisters where they are now required in Yosemite National Park.

By comparison, similar applications of the Theory of Planned Behavior did not always prove to be useful in understanding and predicting behavior. Best (2005) was unable to predict canister use in Glacier National Park when the Theory of Planned Behavior model was used to evaluate use of that park’s wilderness in 2004. Chandool (1997) found that the Theory of Planned Behavior did not produce a reliable prediction of wood theft behavior in Petrified Forest

National Park. A reason cited for the model's failure was that petrified wood theft proved to be an impulsive behavior, not an act deliberated before being performed. Ajzen (2002a) recommended that the Theory of Planned Behavior should only be applied to behaviors that are volitional by nature.

Of the three composite variables used to predict future canister use in Yosemite National Park, the behavioral belief variable proved to be the best predictor. This was evidenced by the large beta in relations to the other variables (0.36 for voluntary use and 0.43 for required use). Other Theory of Planned Behavior investigations also found behavioral beliefs to be the strongest predictor of behavioral intentions (Ray 1981, Galper 1995, Hrubes et al. 2001, Bright, et al. 1993).

Social norms have been widely used to explain and predict recreation behavior (Ajzen and Fishbein 1980, Young and Kent 1985, Manfredo et al. 1990, Basman et al. 1996). In my study, however, subjective norm added little to the prediction of canister use in Yosemite National Park. Although statistically significant, the influence of a subjective norm contributed less than three percent to the prediction of voluntary canister use, and only one percent to the prediction of mandated canister use. That subjective norms provided a relatively minor influence on canister use is somewhat surprising given the extent that Yosemite backpackers recognize that their safety around bears depends to some degree on the food storage behavior of those camping nearby. In another Yosemite National Park study, Lackey (2002) found that normative beliefs held little explanatory ability to predict food storage behavior in Yosemite Valley drive-in

campgrounds. These findings suggest that Yosemite park visitors form behavioral intentions without a great deal of influence placed on them by other referent groups such as family, neighboring campers or park rangers.

The final component of the Theory of Planned Behavior measures the influence of perceived behavioral control in predicting behavioral intention and behavior. Ajzen (2002a) contended that perceived control over performance of a behavior can account for considerable variance in intentions and actions. Galper (1995) demonstrated this when perceived behavioral control measures were added to his model, resulting in the attitude and perceived behavioral control components together significantly predicting 67% of the variability (an increase of 22%) in athletes' steroid use intentions. Additional studies support the influence of perceived behavioral controls in predicting behavior (Gulotta 1994, Hrubes et al. 2001, Evans and Norman 1998, Ajzen and Driver 1991).

Perceived behavioral controls do not appear to influence canister use intentions or behavior in Yosemite National Park. In fact, perceived behavioral control does not add significantly to the voluntary canister use prediction in Yosemite National Park, and adds only one percent to the prediction of canister use where they are required. If a backpacker is not using a canister because he or she is in a part of the park where canisters are not required, it would be expected that issues such as canister weight, rental cost or difficulty in packing would have less influence. However, where canisters are required, perceived control did contribute a small degree of predictive power. This indicates that when canister use is required, logistical issues regarding their cost, weight, bulk,

capacity, and ease and expense of obtaining do influence behavior. These results may also be attributed to a well established canister rental program that has largely identified and alleviated obstacles that may impede backpackers from obtaining canisters. In Yosemite National Park, canisters are now easily rented and returned for a five dollar maintenance fee. Many canister brands are now available in different size and weight ranges to accommodate backpacker preferences and abilities.

Despite the existence of positive attitudes toward canisters in Yosemite, and high compliance with the new canister regulation, the results of this study suggest that the institution of a canister use regulation has been only somewhat effective as a management tool to change attitudes, norms, and behavior regarding wilderness food storage in Yosemite. While it appears that the Theory of Planned Behavior afforded significant predictive validity in explaining a percentage of the variance associated with Yosemite Wilderness backpackers' food storage behavior, only the behavioral belief construct contributed meaningfully to the model. This finding is further supported by the calculation that, despite a 97% compliance rate with wilderness food storage regulations, backpackers' actual use of canisters was largely ineffective, with only 62% of canister users able to store all their food, trash and scented toiletries in canisters on every night of their trip. This forced canister users to continue ineffective practices of hanging, hiding or guarding their food on one or more nights of their trip.

The results of this investigation indicate that park managers may want to direct their canister use messages toward changing specific attitudes and norms regarding wilderness food storage. To achieve this, messages should focus on increasing knowledge level and fostering positive attitudes and norms (Olson et al. 1984). Similarly, when desirable attitudes and norms exist, interpretive messages should be used to reinforce them and to discourage the undesirable ones. Yosemite National Park officials should continue to reinforce people's behavior when it comes to camping where there are bears by fostering positive attitudes toward park bears. The park's interpretive campaign that promotes the slogan "a wild bear is a beautiful sight to see" is a good example of an interpretive effort to foster positive attitudes about food storage and bears. My findings indicate that backpackers with more positive attitudes about food storage and bears are more likely to use bear-resistant food storage canisters when they backpack in the Yosemite Wilderness.

It was not a primary objective of this study to investigate possible relationships between food storage and bear incidents in Yosemite National Park. However, I was able to document 108 bear encounters that occurred in 2005 despite the widespread canister use in the Yosemite Wilderness. In roughly half of the reported incidents, bears got substantial food rewards even though canisters were used. Additionally, in 46% of reported incidents bears came within one and a half meters of respondents in their campsites. This suggests that 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 utilizing canisters to store all or some of their food. By comparison, however, campers become nearly eight times more likely to lose food to a bear in the canister-required portions of the wilderness when they are out of compliance with food storage requirements.

Despite the continuance of bear incidents, my findings provide evidence that canister use has limited the amount of human food obtainable by black bears in the Yosemite Wilderness. Anecdotal accounts and park data on previous bear activity indicate that human food is far less available now compared to when hanging food in trees was a legal means of food storage. During the course of this study the wilderness bear incident rate was lower than at any time in the past fifteen years (National Park Service 2005). However, I cannot decisively identify canister use as the main reason for the decrease in human food availability and the decrease in wilderness bear incidents. Baseline data on the availability of backpackers' food and the prevalence of bear-human incidents in the Yosemite Wilderness previous to my study is inconsistent and limited. During the time of this investigation the park received above normal precipitation, resulting in excellent natural forage conditions and an abundance of winter-killed carrion. Past studies into the diet of black bears in Yosemite indicate that bears rely less heavily on anthropogenic food sources when natural forage conditions are favorable (Hastings et al. 1981, Graber and White 1983, Mathews et al. 2003, Greanleaf 2005). At the same time, a late snow melt relegated most wilderness users to lower elevations of the Yosemite wilderness in 2005 and prevented the park's popular High Sierra Camps from opening. Past studies in national park

wilderness areas indicate that as visitor densities increase, reported bear incidents increase linearly (Merrill 1978, Singer and Bratton 1980, Keay and van Wagtendonk 1983) This suggests that fewer wilderness bear incidents may have been documented during the study simply because fewer backpackers used the park in 2005. It is also possible that backpackers who did use the Yosemite wilderness in 2005 may not accurately represent the behavioral, subjective norm and perceived control beliefs of all Yosemite backpackers, some of whom may have postponed or canceled trips planned for the atypical 2005 season. For these reasons, the Park Service is likely to see the real effects of their new wilderness food storage policy in upcoming years, in particular, when more typical Sierra weather and recreational wilderness use patterns re-emerge. The past three years were a good time to change the regulations but likely a poor time to gauge its effectiveness.

Lastly, my study suggests that Yosemite Park officials are learning of only one out of every four bear incidents that actually occur in the Yosemite wilderness. Moreover, details of incidents that are reported under-represent the magnitude and severity of the incidents that occurred in wilderness areas in 2005. The National Park Service currently relies on self-report bear incidents forms to monitor trends in bear activity and problem areas in the Yosemite Wilderness. Although wilderness rangers are greatly outnumbered by hikers in the Yosemite Wilderness, efforts to monitor the annual and long-term effects of the park's new canister regulations would be best made in the field. Although surveying backpackers at trailheads was certainly easier and less time

consuming, most of the information I was able to gather about bear activity was collected in wilderness sites, as I hiked the trails, and at dawn, when the aftermath of a bear's evening activities were revealed.

The results of this investigation may be of interest to park and forest managers beyond Yosemite. On public lands where bears and humans both exist in relatively high abundance, bear-resistant food storage canisters offer an unmatched alternative to hanging food in trees. They provide an alternative to metal food storage lockers where such equipment is incongruous with wilderness settings. Their portability allows backpackers to camp away from others, and safely store their food above tree line. Whether growing reliance on canisters throughout black bear country has been born out of necessity or out concern for the health and well being of wildlife, backpackers have widely accepted canisters as the most reliable way to avoid problems with bears. While canister use programs require considerable logistical and institutional investments, the benefit to the public and to the protection of black bears are likely to be measurable.

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