EVALUATION OF BEAR-RESISTANT FOOD CONTAINERS FOR BACKPACKERS

John Dalle-Molle, Michael A. Coffey and Harold W. Werner

ABSTRACT: Portable food containers carried by backpackers were evaluated during 1982-1985 for their resistance to opening by black and grizzly bears and for their acceptance by backpackers. Containers were used by 1618 parties for 5535 user-nights. Bears failed to open containers in 89 attempts, sniffed or licked them 24 other times, and opened containers 20 times. Ninety one percent of parties who were asked to use containers did so. Use of container's in Denali National Park, Alaska helped reduce the incidence of bears obtaining backpackers' food by 74%.

INTRODUCTION

In the past 20 years, human use of wilderness areas has increased two and a half times (Lucas, 1983). At the same time, conflicts between people and black bears (Ursus americanus) and grizzly bears (U. arctos) in remote areas has steadily increased, often related to bears attracted to human food (Singer and Bratton 1980; Harms 1980; Hastings and Gilbert 1980; Singer 1982; Hoak and others 1983; Keay and Van Wagtendonk 1983). Bears quickly learn to associate human food with campers and become "habituated, food-conditioned" bears, and subsequent encounters with people often lead to property damage and occasional injuries (Herrero 1985). Wild populations of bears are an essential part of many wilderness areas. Altering natural bear behavior and numbers by providing artificial foods seriously lessens wilderness values.

Increased efforts have been made to educate backcountry campers to use proper techniques to prevent bears from obtaining human foods. However, food sometimes is not properly secured even when people are knowledgeble (Chester 1976; Cella and Keay 1980; Sundstrom 1983). In other cases, proper food storage methods do not always work or cannot be used. In some areas, bears have learned to remove food properly hung between trees (Harms 1980). Trees are too short or absent in other areas. Both permanent and portable bearproof containers have been recommended for backcountry use (Harms 1980; Hastings and others 1981; Hoak and others 1983).

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John Dalle-Molle is Resource Manager, Denali National Park and Preserve, Alaska; Michael A. Coffey and Harold W. Werner are Resource Managers, Sequoia and Kings Canyon National Parks, CA.

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Facilities installed in some backcountry areas to reduce bear problems include cables strung between trees from which food sacks can be hung, bear poles (single metal poles with hooks on top from which food sacks are hung), metal food lockers, and fenced campsites. These methods have not always been successful in preventing bears from obtaining human foods. Also, as facilities, they are not acceptable in some wilderness areas. Finally, they can only be used in established camps where people will be sure to camp, and campers must comply with their use. But many backcountry areas have significant dispersed use where established campsites do not exist. An easily portable method of securing food is required to meet all these needs.

Hastings and others (1981) experimented with portable containers in Yosemite National Park and concluded they would have excellent potential if they were further tested and developed. The staff of Yosemite National Park continued to develop containers prior to our involvement. B. Gilbert and B. Hastings pioneered container development and B. Cella and J. Keay continued design advances. We report here on our 1982-1985 development and testing of lightweight bear-resistant food containers that backpackers can carry. We thank R. Garcia, J. Penn, M. Benke, F. Singer, K. Jope, J. Van Horn, B. Shults, D. Waring, the San Francisco Zoo and the Roeding Park Zoo, Fresno, for help.

OBJECTIVES

1. Determine opinions of backpackers toward the design of the containers and their willingness to use them.
2. Test the degree of resistance to opening of containers by free-ranging black and grizzly bears.
3. Document bear behavior toward containers and observe how bears open containers in order to improve design and construction.

STUDY AREAS

Denali National Park and Preserve is located in southcentral Alaska and covers 9416 mi^2. Elevations range from 400' to 20,320'. Over half of Denali is mountainous terrain, much of which is shrub and tundra vegetation without trees. The majority of backcountry use occurs in such terrain, is dispersed, and is within designated wilderness. Both black and grizzly bears inhabit Denali, although most backcountry use is in grizzly habitat. Grizzly density for the area most used by backpackers is 1 bear/13 mi^2. (Dean 1976, 1984).

Sequoia and Kings Canyon National Parks are adjacent to each other in southern California and are administered as one unit. They total 1350 mi^2., most of which is designated wilderness. Elevations are 1280' to 14,494'. Most of these parks is conifer forested with the remainder being chaparral, woodland, meadows and rock. Black bears are found mainly below 9,000'.

METHODS

Several models were developed and tested (fig. 1), but we report only on the most recent, improved ones (table 1). All were made primarily of

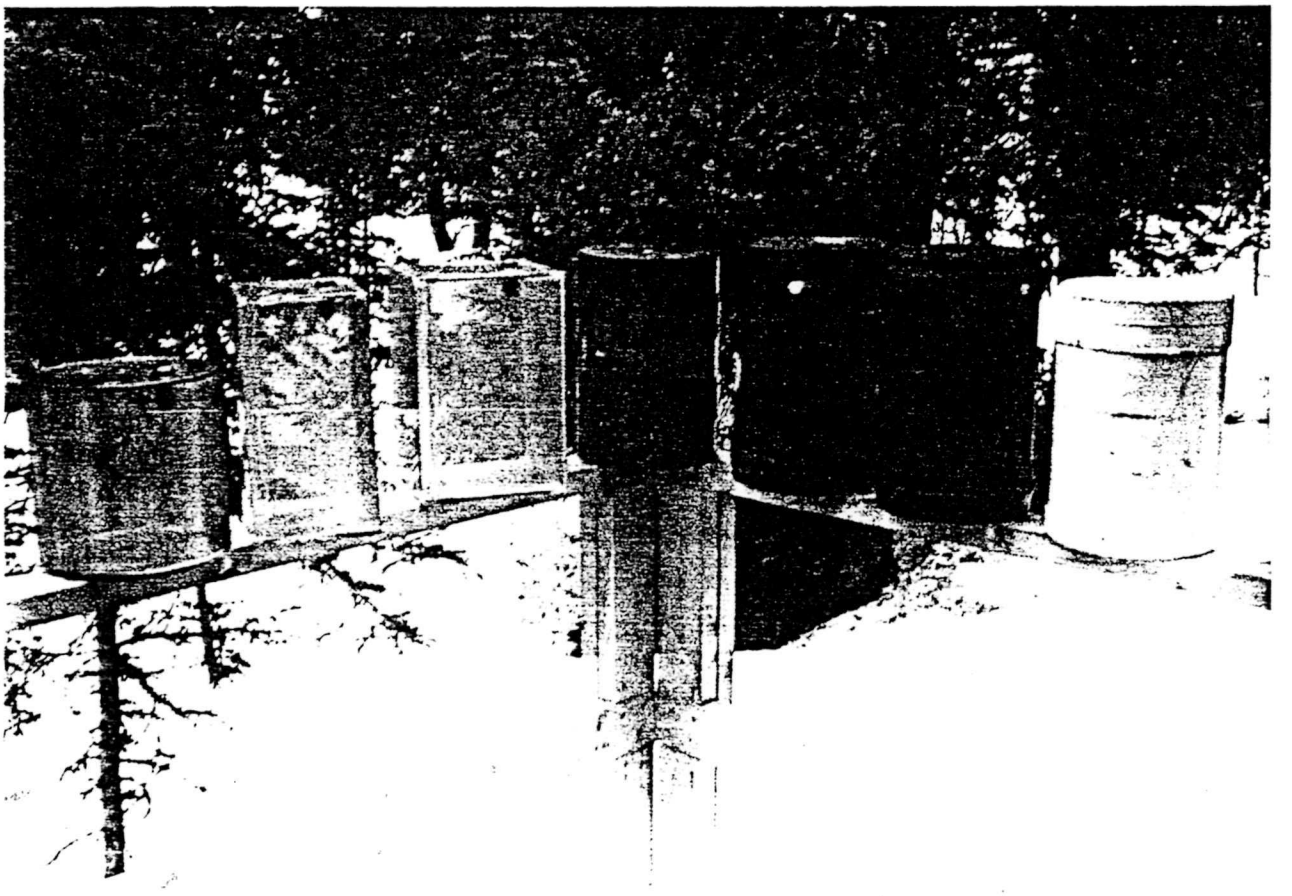

Figure 1.--Some containers tested so far. From left, models L89, L8612, L8812, 806, 802, 801, and PVC 29.

plastic materials. Model 802 has a metal double push-button lid-latching system. Model 806 has a lid fastened by a metal cam-lock that is rotated once about 360° by placing a coin, knifeblade, key or similar object in a slotted head and turning. The Lexan models have a modified metal cam-lock that is turned the same way but must be rotated several times to tighten the cam in place.

Table 1.-- Specifications of bear-resistant food containers used in tests.

Model	Material	Style	Dimensions	Weight lb	Weight oz	Capacity in^3
802	black ABS	cylinder	8"x13"	4	7	653
806	black ABS	cylinder	8"x12"	3	4	603
L89	clear Lexan	cylinder	8"x9"	3	6	452
L8612	clear Lexan	rectangle	8"x6"x12"	2	10	576
L8812	clear Lexan	rectangle	8"x8"x12"	3	10	768

Zoo Tests

Containers were first tested with zoo grizzly bears. Containers were baited with fish oil and placed in the enclosure with the bear. The bears' behavior toward the container was recorded until it apparently lost interest or was successful in breaking in. Tests often resulted in new models being designed or in design changes on existing models.

Field Tests

Containers were baited with fish oil and/or other odorous food and placed upwind of free-ranging bears so the scent would be carried to the bears. The bear's behavior toward the containers was recorded until the bear lost interest or was successful in breaking into it. If a bear was successful, it was chased off before it could obtain a food reward.

Containers were also distributed to backpackers at trailheads and visitor information stations. Distribution was not random because we wanted to test our limited supply of containers in the areas that had the highest number of bear problems. A brief explanation of the container program was given, as well as standard safety procedures to follow in bear country. A survey form was started on the backpacking party and when they returned they were asked their opinions on several aspects of container design and use. If a bear approached their camp, further questions were asked regarding bear behavior toward the containers. Parties unwilling to use the containers were recorded as "nonusers." Halfway through the test program, backpackers in some zones in Denali were required to use containers as part of their backcountry permit stipulations. If they

chose not to, they were routed to zones not requiring containers.

RESULTS

During 1982-1984, containers were used by 1618 parties for 5535 user-nights. Denali had 1281 parties for 4593 user-nights, while Sequoia and Kings Canyon had 337 parties for 942 user-nights. Denali's much larger test was possible because of a larger stock of containers and the relative ease of contacting backpackers, most of whom enter and leave the park at one contact station.

Backpacker Survey

Reactions to the containers, after using them for backpacking, are shown in table 2.

Overall evaluation -- Users were positive toward the container idea; only less than 2% thought it was a poor idea. There was no real difference in approval between models 802 and 806 (X^2=1.8, 1 df, P=0.82) despite a 19 oz. weight difference.

Table 2.-- User opinions of bear-resistant food containers.

	Sequoia & Kings Canyon	Denali
	----------Percent-------	
Overall	(N=281)	(N=1104)
Good idea	98	98
Poor idea	1	2
Use again	(N=274)	(N=1119)
Same design	66	70
Different design	26	26
No	8	4
Weight	(N=258)	(N=1132)
Ok	64	67
Too heavy	36	33
Size	(N=254)	(N=1302)
Ok	75	78
Want smaller	15	14
Want larger	10	8
Shape	(N=274)	(N=1098)
Ok	73	80
Want rectangular	12	11
Want other	15	9
Latch system	(N=264)	(N=1090)
Ok	86	92
Other suggestions	14	8

Nine percent of those asked to carry containers (N=1523) declined. At Denali, only 4.6% declined, with 66% of those stating that the containers were too heavy. Most of these nonusers were only offered model 802, the

heaviest one. At Sequoia and Kings Canyon, 41% of those inquiring about containers declined (N=180). Several nonusers in all three parks volunteered to use containers under different trip situations or if lighter ones were available.

Willingness to use again.--Of the users, 68% were willing to use the same models again, while 26% would use a different model, and 6% would not use any. There was no difference in willingness to use models 802 or 806 (X^2 =0.90, 1 df, P=0.65).

Weight.--Weights were satisfactory to 66% but too heavy to 35% of the users. Significantly more users of model 806 approved it's weight than did users of the heavier 802 model (X^2=6.2, 1 df, P=0.98)

Size.--Container sizes were approved by 77% of the users. Fifteen percent wanted smaller containers, while nine percent wanted larger ones.

Shape.--Seventy-seven percent of the users were satisfied with the shapes of the containers. Almost 12% of the users of cylindrical models would have liked a rectangular shape, while only a few who used the rectangular models wanted cylindrical ones.

Latch systems.--Users were highly satisfied with the latches; 89% approved them. There was no difference between approval of the cam-lock and push-button systems (X^2=0.74, 1 df, P=0.61).

Carrying system.--None of the containers initially had strap holders for securing containers on the outside of packs. Many users preferred to use straps than place the container inside their pack. We did not survey users about carrying systems, but many commented on the need for strap holders. Model 802 has protruding rims which prevents a container from sliding out of straps, but the other models are smooth-sided. We installed strap holders on some containers as a result of the early comments and did not experience problems or negative comments.

Care of containers.--User care of containers is considered an indication of program acceptance, as well as a useful measure of maintenance costs. Although 16% of the containers (N=876) were considered dirty upon return, most were only slightly so. Two containers were broken by misuse and nine were reported lost, stolen or were never returned.

Willingness to buy or rent.--Half who responded to this question (N=766) were willing to pay at least $10.00 for a container and 32% would pay at least $15.00. In Denali 19% were unwilling to purchase containers (question not asked in Sequoia). Also in Denali 20% (N=728) were not willing to rent containers, 27% would rent for up

Compliance with use.--In a sample of 60 parties throughout Denali who had containers checked out, we found only one party that did not actually take the container. This party had canned food only and felt they did not need the container.

Bears' Behavior Toward Containers

Zoo tests.--The most recent container models withstood considerable efforts by zoo grizzly bears to break in (table 3). Only a 1400 lb. grizzly was able to break a container. Bears bit, stood on, pawed, embraced, rolled and even dropped containers from a six-foot height. Several times they threw one 15' against the concrete walls. Only after containers passed most of the zoo tests were they used in our field tests.

Table 3.-- Final tests of bear-resistant food containers with zoo grizzly bears, before containers were accepted for field and user tests.

Model	Bears' Weight (pounds)	Test Duration (minutes)	Results
802	300	20	tooth marks
802	450	20	tooth marks
806	600	20	tooth marks
806	700	40	tooth marks
	720		
806	1400	10	cracked container
L8612	650	70	tooth marks
L8612	700	80	tooth marks
	800		largest bear carried container in mouth.
	900		

Field tests.--Bears attempted to break open containers 89 times (table 4), only sniffed or licked containers 24 times and ignored containers 12 times. In addition, we sent two model 806 containers to Katmai National Park, Alaska. Grizzly bears there attempted unsuccessfully to open containers twice and once only sniffed (K. Jope, pers. comm.). Of the 20 successful openings of containers, grizzlies chewed into two model L8612 containers. Seven containers were opened due to a manufacturing defect in one batch of model 806 when lid tab glue joints failed. We made considerable effort to break this joint on other batches without success. In two cases, users overpacked model 806 containers so the lids bulged out enough to allow bears to pull the lid up with a claw. Newer versions of model 806 have three cam-locks instead of one so this can no longer happen. In the remaining nine of the 20 openings bears got into containers in unknown ways but evidence indicates the lids were not latched. Bears also got food from containers four times when the lids were known to be unlatched. This usually happened when people were cooking and a bear suddenly appeared. In a few similar cases, the campers had the presence of mind to place their food in the containers, secure the lids and then leave. In these instances, the bears were not able to break in. Although bears sometimes moved containers and in a few cases users accidently caused the containers to roll downslope, no containers

were lost this way.

Behavioral learning theory suggests that, if prevented by such means as containers, bears that are conditioned to obtaining food from people may redirect their efforts to stimuli associated with past human food rewards, and so they may aggressively approach people or their equipment (McCullough 1982). None of our bears exhibited such aggression while still in or near the sites after they had been unsuccessful with containers. However, since they were unmarked bears, we were not able to determine their later behavior. However, a reduction of 31% in bear/people conflicts in Denali during 1982-1984 (Van Horn and Dalle-Molle 1984), and a 74% reduction in bears obtaining human food in the backcountry of Denali during 1982-1985, suggests that bears have lessened their activity and aggression toward people and equipment.

Table 4.-- Reactions of bears to containers when bears were aware of container.

	Black bears		Grizzly bears
	Sequoia[1]	Denali	Denali
	--------Number (%)--------		
Unsuccessful Openings	61(76)	2(100)	26(41)
Successful openings	13(16)		7(11)
Sniffed or licked only	3(4)		21(33)
Ignored container	3(4)		9(14)

[1] Does not include 1985 data.

DISCUSSION

Container model 806 has been the most successful model, once we added strap holders and two additional cam-locks. For most areas with bear problems, model 806 should be adequate to reduce bears' obtaining human food. However, no container is likely to be absolutely bear-proof, even when properly used. Most of the free-ranging bears that tested our containers were relatively small (100-250 lbs.). Those in Sequoia/Kings Canyon are very experienced in obtaining hikers' food, but the containers generally foiled them. The zoo tests helped detect many problems but not all. The only uncorrectable container model failures we had during field tests were the model L8612 containers that were chewed into, after having passed zoo tests with much larger bears.

Users' opinions on all aspects of the containers were very similar between Sequoia/Kings Canyon and Denali. Containers were very strongly supported by those who actually used them. The high proportion of backpackers at Sequoia/Kings Canyon who declined to use them indicates a need for a better distribution system and/or for a better way to convince backpackers of the value of the containers in preventing bear problems. When

containers were required in certain areas of Denali, nonuse dropped to less than one percent with few complaints.

Weight was the main dislike. Unfortunately, we had only a small number of the lightest model, L8612, and were unable to obtain a large enough sample of opinions about it to determine if it was significantly more acceptable than the heavier models. However, the fact that so many people were willing to use the heaviest containers despite their dislike of the weight is an indication that we should be able to lower the nonuser rate by offering lighter models.

Some backpackers initially were unwilling to use containers because of their bulk; the volume capacity was more than they needed. When we suggestd they fill unused container space with nonfood items to reduce the bulk in their packs, they almost always agreed to use the containers. There was a slightly greater preference for rectangular shapes, but the available shapes did not influence whether a person would or would not use a container. Strap holders are definitely needed to attach containers to packs. Many more people than we initially expected preferred to carry the container outside their packs than inside.

For most backcountry areas that might find these containers useful, logistics likely would be the biggest problem. Area staffs may not be sufficient to distribute and receive containers. Ideally, users should be able to buy containers from outdoor suppliers. However, the current experimental models are individually made and cost $50.00 or more. In order to encourage widespread purchases, the cost will likely have to be at least half of that, with strong information programs to convince backpackers of the need for their use. Some people who visit bear areas infrequently may not be willing to invest in a container. Rentals from outdoor stores may be possible, but the size of the containers may likely restrict the number of retailers who are willing to stock them. Further research is needed to develop stronger, yet lighter mass-produced containers (such as from a molding process) that would be inexpensive for backpackers, yet have enough profit margin to attract retailers to stock them.

In certain situations, model 806 now can be used operationally. For example, in Denali, low human use levels, strong visitor support, simple logistics, and lack of alternatives, have resulted in the containers now becoming an operational part of bear/human conflict management. Use of the containers by most backpackers in many areas of Denali has been the key to the 74% decrease in bears obtaining human food during the first four years of the container program.

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